CHAPTER 12 ENVIRONMENTAL IMPACT SURVEY

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CHAPTER 12 ENVIRONMENTAL IMPACT SURVEY

12.1 General Description

The proposed project calls for the construction of pumped storage hydro power plants in Hevale, Jalond, and Marleshwar. Construction works will include clearing forest, setting up camps for workers, improving access roads, and opening quarries, excavating and blasting for the construction of tunnels and structures, building civil structures, and installing equipment. A typical pumped storage hydro power plant has civil structures including (1) an upper dam with an upper reservoir, (2) a lower dam with a lower reservoir, (3) waterways consisting of an intake facility, a headrace tunnel, a penstock, surge tanks, and a tailrace tunnel, and (4) a power house. The pumped storage hydro power scheme is designed to pump up water from the lower reservoir to the upper one by using surplus electric energy generated during the off-peak hours, and discharge water in the reverse direction for peak-hour power generation. The scheme does not require such large reservoirs as usually found at conventional hydro power plants.

The installed generation capacity at the proposed three plants will be around 800 MW to 1,200 MW each. The power generated by the project will be sent to the existing grid through a transmission system which will also be built under the project.

12.2 Objectives

This pre-EIA study (the "Study") is an integral part of the master plan study for the implementation of pumped-storage hydro power scheme in Maharashtra. As the fact that the Study is carried out at an early stage of the project planning process--at the master plan study (or pre-Feasibility Study) stage--suggests, the fundamental purpose of the Study is to address environmental concerns fully, so that those concerns are reflected in the basic project design covering the project's location, scale, physical layout, and so on. A traditional practice of conducting an environmental study separately after the framework of a project is fixed has been proved to be not useful or effective, as substantial modifications in the project design can not be easily made at that stage.

To be more specific, the Study has the following objectives:

i) to assess adverse (or otherwise) impacts anticipated,
ii) to explore technically and economically feasible mitigating measures for those impacts,
iii) to prepare cost estimates for the implementation of those measures, and

iv) to estimate the residual impacts expected, and also to make an overall evaluation of the proposed action from the environmental viewpoint.

The Study had another objective, namely, the technology transfer from the Japanese experts involved in the Study to GOMID. Technology transfer is an important goal of technical assistance projects financed by the Japanese Government.

BNHS, which is an NGO, was chosen as a consultant for the (original) pre-EIA for the Hevale site. It is worth mentioning that this fact reflected a recognition that the consultation with local NGOs as well as those who would be affected by an action in question is vital for any environmental study.

12.3 Institutional Arrangement

The authorities which directly deal with the environmental issues connected with any project are the Ministry of Environment and Forests at the Central Government level. At the Maharashtra state level, the authorities concerned are the Department of Forests and Environment. Major environmental laws include the Water Act, 1974, the Water Cess Act, 1977, the Air Act, 1981, the Environment Act, 1986, the Wild Life Act, 1972, and the Forest Act, 1980. The proposed project, in accordance with these laws, will be required to secure several permits.

12.3.1 Agencies Involved and Legal Framework

The Ministry of Environment and Forests (MOEF) of the Central Government is a key agency responsible for the protection of the country's environment. For major projects, an application for an environmental clearance has to be submitted to the Secretary of this ministry. At the national level, there is another key agency called Central Pollution Control Board (CPCB), which is responsible for the prevention and control of water and air pollution. Equivalent agencies at the state level are the Department of Forests and Environment and Maharashtra State Pollution Control Board (MSPCB), respectively.

(1) Institutional Setup at the National Level

MOEF of the Central Government is the apex body responsible for the protection and improvement of the country's environment. When the Environment (Protection) Act of 1986, the first comprehensive environmental law, was passed, the statutory powers for environmental protection and management were mostly conferred on this ministry of the Central Government. Environmental clearance has to be obtained from MOEF for any major project.

As per the provisions of the Environment (Protection) Act, 1986, the Central Government has the powers to take all such measures as it deems necessary or expedient for the purpose of protecting and improving the quality of the environment and preventing, controlling and, abating environmental pollution. Such measures may include:

(a) coordination of actions by the state governments, officers and authorities.
(b) planning and execution of a nation-wide program for the prevention, control and, abatement of environmental pollution.
(c) laying down standards for the quality of environment in its various aspects.
(d) laying down standards for the emission or discharge of pollutants.
(e) constituting authorities for the purpose of exercising and performing powers related to environmental issues.

Under the provisions of the Forest (Conservation) Act, 1980, as amended in October, 1992, the Central Government has to be approached for clearance of all river valley (or hydro) projects having a command area of over 100,000 ha or involving diversion of forest land of more than 20 ha. MOEF gives a single window clearance to proposals after considering the aspects of environment, forests and the wildlife preservation. For wildlife protection and preservation, both central and state governments regulate certain actions under the provisions of the Wild Life (Protection) Act, 1972, with its 1991 amendment.

As per the provisions of the Water (Prevention and Control of Pollution) Act, 1974, the Central Government constituted the Central Pollution Control Board (CPCB). The functions of CPCB, as per the provisions of the Water (Prevention and Control of Pollution) Act, 1974, are to:

(a) promote the cleanliness of streams and wells in various states.
(b) advise the Central Government on any matter concerning the prevention and control of pollution.
(c) coordinate the activities of the State Boards and resolve disputes among them.
(d) provide technical assistance and guidance to the State Pollution Control Boards (SPCBs), which were also established at the time of the enactment of the act.
(e) plan and organize the training of persons for the prevention and control of pollution.
(f) collect, compile and, publish technical and statistical data relating to pollution.
(g) lay down, modify or annul, in consultation with the State Government concerned, the standards for a stream.

(2) Institutional Setup at the State Level

The Maharashtra State Government consists of 25 departments, among which the Department of Forests and Environment is the key agency responsible for the environmental affairs. Revenue Department and Rehabilitation Department come in the picture for such state projects that involve loss of forest or displacement of population.

At the State level, the Department of Forests and Environment is responsible for the environmental protection and preservation, and is authorized to issue environmental clearance to a (non-major) project. The department has Offices of Conservator of Forest at several locations in the state, which administer forest conservation and wildlife preservation programs.

The Revenue Department has to identify (1) non-forest land to be exchanged for forest land to be occupied for a state government project (for compensatory afforestation) and (2) alternative land to be given to those who are affected by a state government project (for rehabilitation). The department coordinates, in financial aspects, between the project proponent, the Department of Forests and Environment, and the Rehabilitation Department, which administers the rehabilitation programs for residents affected by state government projects. The rehabilitation of project-affected persons including resettlement is looked after by the rehabilitation officers at the district level as per the provisions of the Maharashtra State Act for Rehabilitation of the Project Affected Persons (1986).

As per the provisions of the Water (Prevention and Control of Pollution) Act, 1974, State Pollution Control Boards (SPCBs) have been constituted to look after the aspects of prevention and control of pollution. The functions of SPCB are to:

(a) plan a comprehensive program for the prevention, control or, abatement of the pollution of streams and wells in the state.
(b) advise the State Government on any matter concerning the prevention, control or, abatement of the water pollution.
(c) collect and disseminate information relating to water pollution and the prevention, control or, abatement thereof.
(d) encourage, conduct and, participate in investigations and research activities relating to the prevention, control or, abatement of the pollution.
(e) collaborate with the Central Board in organizing the training of persons engaged in programs relating to the prevention, control or, abatement of the pollution.
(f) inspect sewage or trade effluent works and plants in connection with the grant of consent as required by the Act.

(g) lay down, modify or annul effluent standards for the sewage and trade effluents and for the quality of receiving waters.

(3) Environmental Laws and General Policies

Under the Indian Constitution, it is a fundamental duty of every citizen to protect and improve the natural environment including forests, lakes, rivers and wild life and to have compassion for living creatures. Major legislative measures introduced on the basis of this constitutional principle are the following:

(a) The Water (Prevention and Control of Pollution) Act, 1974.
(b) The Water (Prevention and Control of Pollution) Cess Act, 1977.
(c) The Air (Prevention and Control of Pollution) Act, 1981.
(d) The Environment (Protection) Act, 1986.
(e) The Wild Life (Protection) Act. 1972.
(f) The Forest (Conservation) Act, 1980.

For the protection and conservation of wildlife, measures are being taken to establish and strengthen a so-called wildlife protected area network. The number of protected areas was increased substantially from 10 national parks and 127 sanctuaries in 1970, to 75 and 421 respectively in 1993; and those areas cover today some 4.3 percent of the country.

In the recently announced Environmental Action Program, the government identifies the following seven priorities:

(a) conservation of and sustainable utilization of biodiversity in selected eco-system,
(b) afforestation, wasteland development, conservation of soil and moisture and ensuring that water sources are not polluted,
(c) control of industrial and related pollution with an accent on the reduction and/or management of wastes, particularly hazardous wastes,
(d) improving access to clean technologies,
(e) tackling urban environmental issues,
(f) strengthening scientific understanding of environmental issues, as well as structures for training at different levels, orientation and creating environmental awareness, resources assessment, water management problems, etc.,
(g) alternative energy plan.

Those priorities suggest by and large that MOEF will continue to focus its efforts on the issues of pollution control and ecological conservation.

India is a signatory to the following multinational treaties relevant to environment:

(a) Montreal Protocol,
(b) Convention on Transboundary Movement of Hazardous Wastes,
(c) Convention on Conservation of Biodiversity, and
(d) International Convention on Trade in Endangered Species of Wild Fauna and Flora

12.3.2 Procedures for Environmental Permits

The proposed project has to give due consideration to the environmental acts and general policies discussed above. In specific, the project will have to obtain an environmental clearance in accordance with the Environmental Act of 1986. Also, a forest clearance will be required in accordance with the Forest Act of 1980, as the project is likely to involve diversion of forest land exceeding 20 hectares in area. Since the project will not discharge effluents into streams or emissions into the air, basically no restrictions will be imposed on the basis of the Water Act of 1974, the Water Cess Act of 1977, or the Air Act of 1981. (These acts do not concern air or water pollution during construction.) However, the project has to consult MPCB and obtain a certificate from it stating that the project will not pollute water or air, known as no objection certificate (NOC).

Basically, no development activities are allowed in national parks or sanctuaries established under the Wild Life Act of 1972 (amended in 1991). Two of the three proposed sites for the project are located in sanctuaries: the Jalond site (Kulsubai Harishchandragad Sanctuary) and the Marleshwar site (Chandori Sanctuary). Areas required for the implementation of the project have to be denotified before any approval work is initiated. For the denotification, a resolution of the state legislature is required.

A state legislation called the Maharashtra Project Affected Persons Rehabilitation Act, 1986 stipulates rules regarding the treatment of population displaced or affected by state projects. Because the project at any of the proposed three sites will not involve displacement of a large number of people, a "comprehensive rehabilitation plan" for those people may not have to be prepared in accordance with the act. (At the Ilevale site, no persons will be displaced by the project, whereas at the other two sites, a few households might lose their houses.) However, if anyone is displaced, the project proponent will still have to provide all the civil amenities prescribed in the act, in the new gaothan (i.e., village) or in the extended part of any existing gaothan to be established for the purpose of rehabilitation of displaced or affected residents. The act also stipulates the size of a plot to be

granted for each category of affected people. It must be noted that even if few people are displaced, agricultural land owned by individuals and/or properties owned by the village will be partially inundated by the project.

In addition to the permits discussed above, a site clearance is required from MOEF (as stipulated in the EIA Notification of 1994). Procedures for all the permits required and the denotification of a part (or the whole) of a sanctuary are shown on **Fig. 12.3-1**.

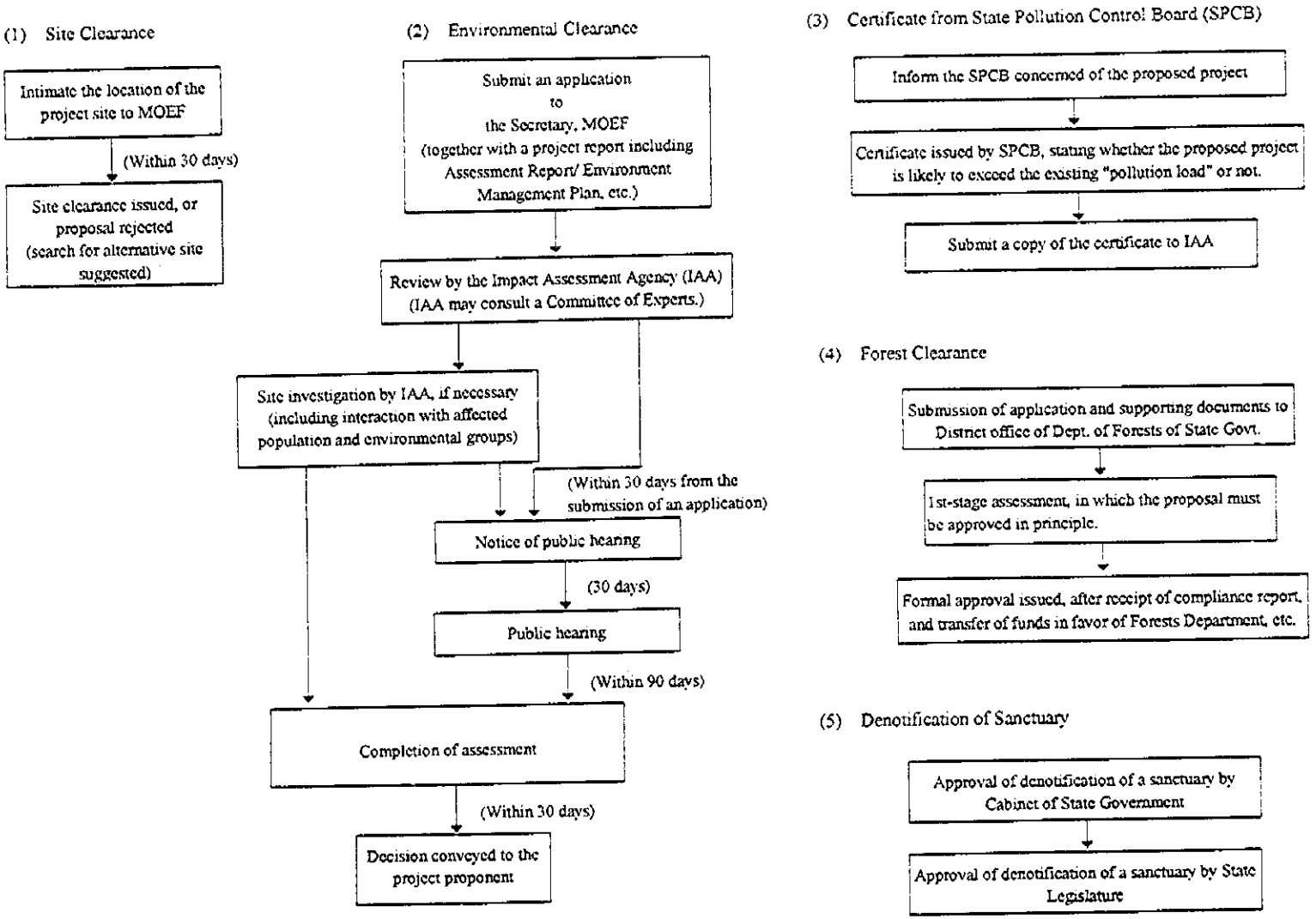

Fig. 12.3-1 Procedures for Environmental Permits

12.4 Methodology

12.4.1 Guidelines for Pre-EIA

The types of environmental permits required as well as the procedures for those permits have been discussed earlier in this report. An MOEF publication entitled "Handbook of Environmental Procedures and Guidelines (1994)" provides up-to-data information on permits. Although MOEF has no publications containing comprehensive guidelines for (pre-)EIA (those for industrial projects are mentioned in the handbook), what items are expected to be addressed in the (pre-)EIA for the proposed project can be inferred mostly from the "Environmental Appraisal Questionnaires for River Valley Projects", which is available at MOEF. Also, EIA guidelines for industrial projects provide some information applicable for the proposed project. Based on those documents, the following are regarded as guidelines for EIA which are relevant to the proposed project.

First, MOEF defines the purpose of EIA as identifying and evaluating the potential impacts (both beneficial and adverse) of development projects on the environmental system.

Secondly, although no specific suggestions are made regarding the study items, the above-mentioned questionnaires ask for the information on various issues, among others: (Thus, discussions on these parameters are normally expected in EIA.)

i) land use pattern
ii) submerged area
iii) forest type
iv) construction (duration, peak labor strength)
v) resettlement
vi) ground water
vii) flora and fauna (endangered or rare species, habitat of avifauna)
viii) cultural, historical, religious, archeological, and recreational importance
ix) endemic health problems
x) water (logging, salinity, water borne diseases)
xi) fishery
xii) protection of reservoir slopes
xiii) provision for environmental studies, management and monitoring

Thirdly, it is stipulated that project proponent may furnish pre-EIA report based on one season data (other than monsoon). Because the Study is pre-EIA, this provision is applicable. In fact, the baseline survey for the Study was conducted only for one season--post-monsoon season.

Giving a full consideration to the above requirements and provisions, the JICA Study Team determined the study items which were deemed to be appropriate and necessary, and prepared the terms of reference (TOR) for the actual survey and study. In line with the TOR, the survey and study was carried out by GOMID and BNHS.

Primary and secondary data were collected at the sites and at government agencies concerned. Field observation and measurement was employed to obtain primary data on biological and physical parameters, whereas interviews were conducted to collect data on socio-economic and cultural parameters. Information was collected also from other experts of the study team including geologists and civil engineers.

Several meetings were held attended by JICA Study Team, GOMID, and BNHS to discuss the study methodology as well as the study items. Because in the Study, it was intended to compare the proposed three sites in environmental terms, it was necessary for all the parties to have the same objectives and the same scope of study. After a baseline survey was conducted at the sites, another meeting was held attended by the same parties to discuss in detail the method for the evaluation of probable impacts and mitigation measures. For this part of the Study, the "environmental impact matrix" attached to the TOR was used.

12.4.2 Definition of Study Area

It is essential that the Study covers all the areas where major physical, biological, and socio-economic impacts of the proposed project are expected. The pumped storage hydro scheme requires basically two reservoirs (and thus two dams) at different elevations, i.e., upper and lower reservoirs, and, for this reason, there will be two construction sites for each project. An important difference between this scheme and the conventional hydro scheme is that the former uses the same water again and again. In other words, the same water travels between the upper and lower reservoirs, while evaporation loss has to be compensated with new water. Despite this difference, the scheme basically will induce impacts in the same areas as the conventional hydro scheme would do.

Construction works of the project will include clearing forest, setting up camps for workers, improving access roads, opening quarries, excavating and blasting for the construction of tunnels and structures, building civil structures, installing mechanical and electrical equipment, and building a transmission system. These construction works and the operation of the power plant and the reservoirs will induce various impacts, among others:

i) impacts on wildlife and ecological system
ii) loss of forest and agricultural land due to submergence
iii) displacement of local people (this possibility is very small)
iv) impacts on local communities due to influx of workers
v) possible increase in water-related diseases and parasites and changes in water quality
vi) alteration of ground water level

These impacts are expected to occur mostly on and around the construction sites, reservoir areas, and downstream areas. Those areas will be focal of the Study. Although upstream areas may not be affected directly, they have to be studied in relation with reservoir sedimentation.

Traffic generated by the project is limited largely to the construction sites. However, if dam materials, such as aggregates and stones, have to be imported from outside the sites, the traffic will cause impact on a larger area along the access road.

Based on the discussion above, the survey area was determined for each proposed site. In the downstream direction, villages located within 5-10 kilometers from dam sites were covered.

12.5 Baseline Survey Data

A baseline survey was conducted from November 1995 till February 1996, during the post monsoon, winter season at the proposed three sites, namely, Hevale, Jalond and Marleshwar. The survey at the Hevale site was carried out by BNHS, and that at the other two sites by GOMID. The main objective of the survey was to collect data, both primary and secondary, indicating present physical, biological, socio-economic and cultural conditions of the general project areas.

12.5.1 Physical Aspects

(1) Climate

There are three distinctive seasons in Maharashtra, namely, Summer (March to May), Monsoon (June to mid-October) and Winter (mid-October to February). The average temperature in summer, monsoon and winter seasons in 1990 were 30°C, 27.5°C and 24°C, respectively. The maximum temperature of the year was 47°C, and the minimum temperature 4°C.

All of the proposed three project sites including Hevale, Jalond, and Marleshwar, are located in Konkan region. The region lies in a high precipitation zone with the annual rainfall

exceeding 2,000 mm. The main precipitation is brought by Southwest monsoon and about 90% of annual rainfall is received in the rainy season.

The following are climatic features of the respective sites.

Hevale Site

The Hevale site has a relatively moderate climate with annual temperature variation of about 10°C. Precipitation in the project area is relatively high with annual total exceeding 4,000 mm. Rainfall is mainly from June to early October with a few post monsoon showers.

Jalond Site

The yearly temperature variation is comparatively wide with maximum temperature above 45°C and minimum temperature below 10°C. During summer, the nights are rather cool. The annual rainfall is less than 3,000 mm in this area.

Marleshwar Site

In this area, the maximum temperature is around 35°C, and the minimum temperature about 15°C. The area receives intensive rainfall exceeding 2,500 mm in the monsoon season.

(2) Water Quality

(a) Subsurface water

Marleshwar

In Gothane, which is the nearest village to the upper dam site, there are 3 wells, all of which are perennial. There are 3 seasonal and 9 perennial wells in Bamnoli, village nearest to the lower dam site. The level of the well water table at Gothane varies between 0.8 m to 3 m below ground, while that at Bamnoli between 2.5 m to 7.75 m. The water is used for drinking and other domestic purposes.

(b) Surface water

Table 12.5-1 shows results of the quality test of water samples collected at the projects sites.

Hevale Site

A major source of drinking water is wells in the area. The test results of the quality of the Karal river water at the Hevale site indicated that physico-chemical characteristics of

the water were well below the Indian Standards for Drinking Water. In comparison, the microbiological analysis of the water for all the five samples of the river showed both MPN value and Plate count beyond acceptable limits, thus indicating the presence of faecal coliforms and consequently unacceptable drinking water quality. It may be noted that the water analysed was totally free of chemical pollutants and excess heavy metals because of the absence of industries in the proximity area.

Jalond and Marleshwar Sites

The test results show a grading of water similar to that observed at the Hevale site.

(3) Geology

Refer to Chapter 10 in this report.

Table 12.5-1 Quality of Surface Water at the Project Sites

	Substance or parameter	Indian Standard (Requirement/Desirable Level)	Hevale Site					Jalond Site		Marleshwar Site		
			L/R	L/R	L/R	L/R	L/R	U/R	L/R	L/R	L/R	U/R
			No. 1	No. 2	No. 3	No. 4	No. 5	No.6	No.7	No.8	No.9	N.10
	Essential Characteristics											
1	Colour, Hazen Units	5	-	-	-	-	-	<10	<10	<10	<10	<10
2	Odour	Unobjectionable	Nil (Nil)	Nil (Nil)	Nil (Nil)	Nil (Nil)	Nil (Nil)	-	-	-	-	-
3	Taste	Agreeable	-	-	-	-	-	-	-	-	-	-
4	Turbidity NTU	5	-	-	-	-	-	1.8	1.8	2.0	1.5	1.5
5	pH	6.5 - 8.5	6.6 (6.8)	7.2 (6.8)	7.9 (6.8)	7.9 (7.0)	9.7 (6.8)	7.4	7.2	7.3	7.2	7.3
6	Total hardness (as CaCO3) mg/l	300	-	-	-	-	-	36	36	32	40	33
7	Iron (as Fe) mg/l	0.3	-	-	-	-	-	0.1	0.1	0.1	0.1	0.1
8	Chlorides (as Cl) mg/l	250	10.0 (12)	10.0 (12)	10.0 (12)	10.0 (11)	9.0 (12)	16	16	16	17	18
9	Residual Free Chlorine mg/l	0.2	-	-	-	-	-	-	-	-	-	-
	Desirable Characteristics											
10	Dissolved solids mg/l	500	-	-	-	-	-	89	96	85	80	90
11	Calcium (as Ca) mg/l	75	3.4 (8.2)	2.4 (4.6)	1.0 (9.8)	1.0 (8.0)	1.0 (8.0)	12.4	11.2	8.4	6.4	5.6
12	Copper (as Cu) mg/l	0.05	-	-	-	-	-	-	-	-	-	-
13	Manganese (as Mn) mg/l	0.1	-	-	-	-	-	0.03	0.03	0.03	0.03	0.03
14	Sulphate (as SO4) mg/l	200	2.6 (0.8	1.1 (1.6)	1.2 (14.)	1.5 (1.3)	1.0 (1.3)	10	9	9	7	8
15	Bacteriological characteristics MPN/100 ml	10	- 1100*	- 460*	- 1100*	- 150*	- 240*	- < 2	- 99*	- 70*	- 130*	- 5

Source: Indian Standard: IS 10500 (1991). GOMID and BNHS Survey Reports.

Note: U/R: Upper Reservoir, L/R: Lower Reservoir

* Undesirable

Analysis was made by Aic Watson Laboratories, Mumbai (for Hevale Site) and Victoria Jubilee Technical Institute, Mumbai (for Jalond and Marleshwar Sites).

Figures in parentheses are data produced by BNHS.

(4) Land Use and Agronomy

(a) Hevale Site

The entire project area including both upper and lower reservoir sites comes under the reserved forest area of Changad taluka (sub-district) of Kolhapur District. No villages or agricultural land will be directly affected by the project.

The upper reservoir site is surrounded by bush and grassland. There are no villages in the vicinity of the site. Downstream of the lower dam site, there are some villages, including Bambarde and Terwanmedhe, which are located 6.5 km and 8 km from the site respectively. The land use pattern of these two villages is presented in Table 12.5-2.

Table 12.5-2 Land Use of Villages near Hevale Site

(ha)

Village	Total	Forest	Agricultural, irrigated	Agricultural, non-irrigated	Cultivable waste	Uncultivable waste
1. Bambarde	1,370	432 (32%)	0	24 (2%)	606 (44%)	308 (22%)
2. Terwanmedhe	677	111 (17%)	0	69 (10%)	383 (56%)	115 (17%)

Source: BNHS Report.

(b) Jalond Site

Upper reservoir area

The upper reservoir site is located within the boundaries of the Harichandragadh Kalsubai sanctuary. The reservoir area consists mainly of public forest land (including reserved forest), agricultural land, private forest land, and wasteland. The land use is more or less as follows:

a) Public forest land 50%
b) Agricultural land 20%
c) Private forest land 20%
d) Wasteland 10%

Over one-third of the agriculture land is used for cultivation of "Kharif Paddy".

The principal crops grown in the area are Rice and Bajari. The villagers produce Rice and Bajariin 40% and 15% of the total cultivated area, respectively. Other crops produced are Nagli, Macca (Corn), wheat, etc. Vegetables are also produced. Natural farming without much chemical manure, pesticide management, and antiweeds treatment is common. Some crops like Nagle and Maca are produced mainly in slopes, although no prominent terracing is noticed. Usually, one Kharif crop is produced in Rainy Season. The productivity is low even by the local standards.

The live stocks held by the villagers are of country type. No high breed cultures are available. Therefore, the milk and milk products produced are less in quantity than otherwise. Cowdung cakes are used as fuel. Main income from the live stock is derived from meat rather than from milk products.

Cultivators spread dried leaves and set fire to them. The ash produced by this method acts like a fertilizer. Sometimes, urea is used as fertilizer. High-quality seeds and fertilizers are supplied also by the Government of Maharashtra at subsidized rates.

Lower reservoir area

The land use of the lower reservoir area is as follows:

a)	Public forest land	10%
b)	Agricultural land	25%
c)	Private forest land	60%
d)	Wasteland	5%

Out of the total agricultural land, about 40% is under Kharif Paddy. Wasteland includes rocky outcrops, water bodies, and cultivable wasteland after reclamation and levelling work. The crop pattern of the area is as follows:

a)	Rice	40%
b)	Bajri	30%
c)	Others	30%

(c) Marleshwar Site

Land is cultivated during "Kharif Season" (June to November). The crops mainly grown are Rice (Oriza Sativa) and Nagli (Elusine Coracana). Rice is produced in the submergence areas, whereas Nagli is the main crop in the catchment area. About 3 to

4 ha of paddy land and 30 to 40 ha of Nagali land may be lost, if the project is implemented. Approximately 9 to 10 tons of rice and 360 to 480 tons of Nagli is produced per hectare of land.

Table 12.5-3 compares the land use pattern for the three project sites. The table also identifies conditions of catchment areas.

Table 12.5-3 Comparison Land Use Pattern for Project Sites

Project site	Hevale		Jalond		Marleshwar	
	Upper reservoir	Lower reservoir	Upper reservoir	Lower reservoir	Upper reservoir	Lower reservoir
1. Site Area	Entirely under reserved forest. No villages or agricultural land occur.		Under Harichandra Kalsubai Patel Sanctuary. There are no villages in the area , but a few villages in the vicinity area. Agricultural land exists near the villages.	There are no villages in the area. The area consists of reserved forest (50%), private forest (20%), agricultural land (10%).	Currently under Chandoli Sanctuary. There are no villages in the area, but one located near the boundary of the reservoir site.	There are no villages in the area, but a few villages in downstream area.
2. Submerged Area	32ha of reserved forest. Covered with grassland, scrub vegetation, and stony waste.	50ha of reserved forest. Covered with dense forest and bush. Exposure of bedrock frequently occurs at the both banks of the river.	180ha including 90ha of reserved forest. Part of the remaining land is of agricultural use. At places, there is outcrop of sheet rock.	55ha including 50ha of non-reserved forest. Part of the rest (about 1ha) is agricultural land.	About 210ha of private land comes under submergence, out of which 20ha is agricultural land.	About 60ha of private land comes under submergence, including 6ha of agricultural land. The remaining 54ha of land is covered mostly with trees and bushes.
3. Catchment Area	Geologically stable. Being embanked, the reservoir will not be affected by activities in the catchment area.	Geologically stable. Covered with forest.	Areas of stony waste are geologically stable. In other areas, agricultural activity frequently occurs.	No people live in the area. Soil erosion during the monsoon season.	Several villages occur in the upstream area. In general, the area is hilly, and in places covered with thick forest.	There are no villages in the upstream area. In general, the area is hilly, and in places covered with thick forest.

12.5.2 Biological Aspects

(1) Biological Findings at Hevale Site

(a) Methodology

For the assessment of the bio-diversity of the study area, the area was demarcated broadly into Core Areas and Buffer Areas.

(i) Core Areas:

Core Areas are representative areas directly affected by the project. Five specific habitats were chosen to assess the floral and avifaunal richness. They are I) to V) as below:

I) Riverine habitat in the proposed lower dam area
II) Habitat on the steep slopes of the left bank of the Karal River, in the proposed lower dam area
III) Habitat on the gradual slopes of the right bank of the Karal River, in the proposed lower dam area
IV) Scrub/fragmented-forest habitat in the proposed upper reservoir area
V) Grassland habitat in the proposed upper reservoir area

During the study, it was recognized that the grassland area of V) was not a critical habitat in terms of the above-mentioned parameters, since the area did not have any major trace of species, nor was observed to harbour large avifaunal population. For this reason, the area was excluded from the study. It was also found the areas I) and III) were similar in terms of type of habitat. Thus, the two areas were observed as a single habitat area.

For the botanical study, eleven quadrates of 10m x 10m were analysed for each of the above-mentioned habitats to ascertain the species diversity. For the study on avifauna, birds were observed and counted on either side of a pre-determined trail for 100 meter distance, while walking in each habitat for 1 kilometer distance. The bird count was carried out early in the morning between 7 a.m. and 9 a.m. Two binoculars (8x30 and 10x50) were used to identify the birds. In both studies, the diversity was determined by using the Shannon-Wiener Index viz.,

$$H' = -\sum_{i=1}^{n} Pi^{m} InPi$$

where Pi is the proportion of individuals in the 'ith' species.

The reptiles and amphibians were searched in the forest and by the streams at their typical habitats by looking under stones and logs. Fishes were collected with the help of dip net.

(ii) Buffer Areas:

Buffer Areas are outside Core Areas, located within a 10 km radius from the lower dam site area. The areas were covered by jeep to identify the plants in the study area and the existence of wildlife.

(b) Habitat

Based on the botanical study, both the upper and lower reservoir areas were found to be fairly rich in vegetation. The species diversity index (S.D.I.) of trees in the habitats were estimated as follows:

(i)	Core Areas I) and III)	:	(riverine habitat and eastern gradual slopes in lower dam site area) S.D.I. = 24.44
(ii)	Core Area II)	:	(western steep slopes in lower dam site area) S.D.I. = 26.11
(iii)	Core Area IV)	:	(scrub/fragmented-forest in upper reservoir area) S.D.I. = 15.86

Endemic Plants to peninsular India, found in the study area were 120 in number, indicating a high diversity of important tree species. Medicinal Plants available in the study area are more than 66 in number.

The vegetation of the study area is evergreen to semi-evergreen in nature, and it changes from foot hills towards flat topped mountains. The foot hills posses typical floristic elements of Konkan region. Similarly, the ghat (mountain) area is characterized by typical plant species of Western Ghats. The valleys on western side of Tillari have evergreen vegetation of considerable interest. Mountain tops (plateau) hold evergreen

forest composed of Memecylon umbellatum, Garcinia spicata, Terminalis chebula, Syzygium cumini, Diospyros candolleana, Cannamonum vernum, etc.

Insectivorous plants of the region include Drosera indica, D. burmanni, Utricularia gramminifolia, U. reticulate and U. striatula. Parasites of the area include Strigo geanerioides, Dendrothoe fulcata, D. trigona, Hexixanthera wallichiana, Merosolin capitellatus, Scurrula philippensis and viscum angulatum. Common epiphytes are Hoya wightii, Acampe praemorsa, Aerides crispum, A.maculosum, Bulbophyllum fimbriatum, Dendrobium spp., Eria dalzellii E.reticosa and Oberonia recura.

Being part of the Western Ghats in Maharashtra, the natural, thick vegetation of the area is expected to harbour a wide variety of wildlife. The presence of water in the form of the Koral river, along with the densely forested slopes on either side of the river, is expected to provide good nesting and breeding sites for wildlife in the area. **Tables 12.5-4 and 12.5-5** respectively indicate the analysis of plant species in the study area, and the dominant families of angiosperms in ascending order.

Table 12.5-4 Analysis of Plant Species at Hevale Site

	Dicot	Monocot	Total
Families	97	21	118
Geners	351	115	436
Species	549	147	696

Source: BNHS Report, 1996.

Table 12.5-5 Dominant Families of Angiosperms in Ascending Order

	Name of the family	No. of Genera	No. of Species
1.	Poaceae	39	66
2.	Fabaceae	23	52
3	Acanthaceae	20	37
4.	Rubiaceae	17	31
5.	Asteraceae	22	31
6.	Orchidaceae	11	23
7.	Euphorbiaceae	14	22
8.	Lamiaceae	10	17
9.	Moraceae	2	14
10.	Asclepiadceae	10	13

Source: BNHS Report, 1996.

(c) Avifauna

With reference to avifauna, 69 species were recorded in the study area, including 55 resident and 14 migratory species. They varied from raptors to frugivorous birds.

Results of the findings on avifauna are as follows:

(i) Species richness:

In total, 11 orders, 27 families, 53 genera and 69 species of birds were recorded. Forty (40) species were recorded in Core Areas, and 44 species in Buffer Areas. Among the habitats in Core Areas, 27 species in riverine I), 20 species in the forest at western steep hills II), 11 species in the forest at gradual slopes III), 10 species in the scrub/forest IV), and no species in the grassland V) were recorded.

The status of endangered/threatened species is as follows:

- Pied Indian Hornbill, a bird in Schedule I of the Indian Wildlife Act, was recorded in both Core Areas (in the lower dam site area) and Buffer Areas.

- Peafowl, another bird in Schedule I of the Indian Wildlife Act, was recorded in Buffer Areas.

(ii) Species diversity:

Among the habitats investigated, the species diversity was highest in the riverine habitat I), with the diversity index of 2.99. The species diversity was higher in Buffer Areas than in Core Areas. Species richness and diversity at different habitats are exhibited in **Table 12.5-6**.

Table 12.5-6 Species Richness and Diversity of Avifauna in Hevale Site

Habitat	Species Richness	No. of Individuals	Species Diversity Index
Lower Dam Site Area			
Riverine I)	27	55	2.99
Forest at western slopes II)	20	41	2.81
Forest at eastern slopes III)	11	24	2.18
Upper Reservoir Area			
Scrub/forest IV)	10	25	2.12
Grassland V)	0	0	0.00
Total			
Core Areas (I) to V))	40	137	3.17
Buffer Areas	44	107	3.40

Source: BNHS Report, 1996.

(iii) Relative species abundance:

In Core Areas, small sunbirds were most frequently observed (20.44%), followed by Purple sunbird (7.30%), Paradise flycatcher (5.84%), and Jungle babbler (5.11%). In contrast, the house crow was the most abundant species (14.95%) in Buffer Areas. Common birds like Redvented bulbul (5.61%), Jungle babbler (4.67%) and Redrumped swallow (4.67%) were also abundant in Buffer Areas.

(d) Mammals

The members of the cat family and the sloth bear seem to be the most important animals in the study area. An Indian Giant Squirrel (Ratufs indica) was spotted during the survey. Whereas no endangered species of mammals was actually spotted during the study, information from local residents reveals the presence of the Indian Tiger in the lower dam site area. According to data provided by the Forest Department for Tillarinagar Irrigation Project in 1991, no endangered species were expected to be present in the Tillariwadi catchment areas.

The local information of faunal species observed in the study indicate the presence of the following mammals listed in Schedule I of the Wildlife Protection Act.

i) Tiger (Panthera tigris)
ii) Leopard (Panthera pardus)
iii) Leopard Cat (Felis bengalensis)
iv) Sloth Bear (Melursus ursinus)

(e) Lower vertebrates

Reptiles were rarely observed except the common garden lizard, Calotes versicolor, and some specimens of Mabuya sp. The occurrence of common tree geckos, and monitor lizard is predicted based on the type of existing habitat. The occurrence of different species of snakes is also possible in the dense forest. All the four major species of poisonous snakes viz. Cobra, Viper, Krait, and Indian rock python were reported by local residents.

(f) Fish

No endangered fish or important aquatic plants were observed. The fish identified include Rashora daniconius, Puntius melanampyx, Garra sp., Puntius amphibious, Palaemonid prawns. Nemacheilus sp., Rasbora daniconius and Carps sp. No fish diseases were reported during the period of the study.

(2) Biological Findings at Jalond Site

(a) Flora

The project area is covered with mixed dense forests, open scrubs and pasture land. Rock outcrop occurs frequently. The forest density is usually 0.30 to 0.40. The density and species richness of trees at different habitats was studied by looking into 25 m x 25 m quadrates. The results are as below.

Type	No. of Species	No. of Trees
Dense forest	18	50
Open Scrub	12	32
Grassland	3	10

Revenue sources from the forest are Bamboo, Grass, Tendu, Gum, Apta and Sitafal.

(b) Fauna

According to the villagers, the following animals live in the area:

i) Tiger
ii) Bear
iii) Wolf
iv) Hyena
v) Jackal
vi) Deer

It is said that one tigress with two calves were occasionally seen two years ago. Tigers survive by eating cattle, goats, and small animals in the forest. They normally stay in caves during the day time, and climb down for water and food during the night.

The surrounding forests are rich in avifauna. Water birds are seen largely in the monsoon season. The National bird peacock, which is a protected species, is abundantly seen.

(c) Fish

Fish and other aquatic biota are seen only during the monsoon season, as there is no flow after the season. Small- and medium-size fishes migrate to the area from down stream areas during the monsoon season for breeding.

(3) Biological Findings at Marleshwar Site

(a) Flora

The site area is a semi-evergreen forest area with a variety of flora and fauna. During the monsoon season, the forest becomes full with various species of flora.

(b) Fauna

According to the Conservator's Office in Kolpur, the endangered species found in the site area include Tiger, Barking deer, and Giant Squirrel. The area also has a variety of birds including the endangered bird of peacock.

(4) Endangered Wildlife and Important Flora Found at Project Sites

Primary and secondary data and information collected during the baseline survey indicate the (possible) presence of a few endangered species in the project site areas, as shown in **Table 12.5-7**. Important flora species found in the areas are also listed in **Table 12.5-8**.

Table 12.5-7 Endangered Wildlife Species Found in Project Site Areas

Project Site	Hevale	Jalond	Marleshwar
Birds	1. Common Pea fowl	Peafowl	Peacock Owl
	2. Malabar Pied Hombill		
	3. Great Pied		
	4. Hombill		
Mammals	1. Smooth Indian	Hyena	Tiger
	2. Otter	Tiger	Barking deer
	3. Tiger	Leopard	Giant Squirrel
	4. Leopard	Wolf	
	5. Leopard Cat	Jungle Cat	
	6. Sloth Bear	Sloth Bear	
	7. Jackal	Jackal	
	8. Jungle Cat		
Amphibians	-	-	-
Reptiles	-	-	-
Fishes	-	-	-
Insects	-	-	-
Invertebrates	-	-	-

Note : Endangered species were identified with the handout issued by the Forest Dept. of Maharashtra State during Wildlife Week in 1995.

Source : Hevale: BNHS Report, 1996.
Jalond and Marleshwar: GOMID Reports, 1996

Table 12.5-8 Important Flora Found in Project Site Areas

Project Site	Hevale	Jalond	Marleshwar
1	Pittosoprum florinundum	Brideliaretusa	Engenia jambolana
2	Holigarna arnoltiana	Cassia fistula	Glochydeonlanceolariumn
3	Elaeagnus latitolis	Mangifera indica	Mangitera iadica
4	Terminalia arjuna	Saccopetalum tomentosum	Semecarpus anacardium
5	Terminalia chebula	Terminalia tomentosa	
6	Phyllanthus imblica	Biuhinia gacamosa	
7	Terminalia bellirica	Vanguria spinosa	
8	Terminalia crenulata		
9	Erirocarpus nimmonii		
10	Terminalia tomentosa		
11	Diospyros montana		
12	Bridellia rotusa		
13	Steculia guttata		
14	Xylia xylocarpa		
15	Sapium insigne		

Source : Hevale: BNHS Report, 1996
Jalond and Marleshwar: GOMID Reports, 1996
Wild Institution of India Derradun

12.5.3 Socio-Economic and Cultural Aspects

About 70% of the people in Maharashtra depend on agriculture, while only 12% of the total cultivated area is irrigated. The principle food crops are wheat, rice, jowar, bajra and pulses, and the important cash crops are cotton, sugarcane, groundnut and tobacco. Villagers near the project sites earn their living by cultivating small, less fertile land and by keeping cattle. Some of the villages are inhabited by tribal population.

(1) Villages Affected by the Project

Data and information on various villages near the project sites was collected by visiting them and interviewing the village head (surpanch) along with a few other villagers. The data and information gives an idea of the village profile in terms of its population, number of households, crop pattern, presence of facilities such as school, dispensary, transport, telephone, road, electric power etc. **Table 12.5-9** presents the names of the villages visited. **Tables 12.5-10 and 12.5-11** show comparative profiles of the villages and the populations.

Table 12.5-9 Villages near the Project Sites

Project site	Village	Location
1. Hevale		
Upper reservoir	Nil	There are no villages in the vicinity area.
Lower dam	(1) Bambarde	Located 6.5 km downstream from the dam site, and close to prospective quarries.
	(2) Tervanmedhe	Located 8 km downstream from the dam site.
2. Jalond		
Upper dam	(3) Kumshet	Located 2 km from the dam site, and part of the agricultural land will be affected.
Lower dam	(4) Bandeshetwadi	Located in the immediate vicinity of the construction area, about 1 km from the dam site.
	(5) Navalwadi	Located by the construction area, about 2 km from the dam site.
3. Marleshwar		
Upper dam	(6) Gothane	Located 2.5 km from the site. Part of the agricultural land will be inundated.
Lower dam	(7) Bamnoli	Located in the immediate vicinity of the construction area, about 1 km from the site.

Table 12.5-10 (1) Village Profiles

Project site	Hevale		Jalond			Marlesbwar	
	Lower dam		Upper dam	Lower dam		Upper dam	Lower dam
Village	Bambarde	Terwanmedhe	Kumshet	Bandveshet wadi	Naval wadi	Gothane	Bomnoli
1. Population	421	417	n.a.	180	270	750	1,600
2. No. of house-holds	116	90	n.a.	n.a.	n.a.	140	339
3. No. of houses	n.a.	n.a.	n.a.	30	40	96	276
4. Type of house	Most houses are Kuccha with mud walls and tilled roofs. The remaining houses are of stone walls and tilled roof.	Most houses are Kuccha with mud walls and tilled roofs. The remaining houses are of stone walls and tilled roof.	n.a.	n.a.	A half of the houses are with brick walls and tiled roof. Those houses have a floor area of 500-600 ft^2 with 3 rooms. Others are mud walled with thatched roof usually with one room (100-300ft^2).	Mud walls with thatched roof. A few houses have mangalore tiled roof.	Mud walls with thatched roof. A few houses have mangalore tiled roof.
5. Water source	Kharal river water	Well water and tanker water	Well water during monsoon and tanker water supply during dry season	n.a.	Well water through pipe line after disinfection	Well water (3 wells)	Well water (13 wells)

Table 12.5-10 (2) Village Profiles

Project site	Hevale		Jalond			Marleshwar	
	Lower dam		Upper dam	Lower dam		Upper dam	Lower dam
Village	Bambarde	Terwanmedhe	Kumshet	Bandveshet wadi	Naval wadi	Gothane	Bomnoli
6. Electrification rate (%)	Available	Available	Available	Available	50%	75%	95%
7. Amenities							
a) School	n.a.	2 primary schools and 1 middle school	1 primary school up to 6th std.	n.a.	1 pre-primary school and 1 primary school	1 primary school up to 7th std.	1 primary school up to 4th std. and 1 middle school up to 7th std.
b) Health facility	No hospital, but a PHC is within 10 km radius.	No hospital, but a PHC is within 10 km radius.	No hospital in this village but a nurse visits once a month.	n.a.	1 primary health subcenter available at Nahade, 5 km away.	No health centre, but a nurse visits regularly from PHC.	No health centre in this village but a nurse from PHC visit once in a fortnight.
8. Transportaion	Bus and train services are available at 9 km away.	Bus and train services are available at 10 km away.	Bus service is available from this village during fair season.	n.a.	Bus service is available from this village during fair season.	One bus (one trip/day) is available to Nivati (6 km away) during fair season.	Bus service is available from this village to Devrukh (4 or 5 trips per day).

Note: n.a.: Information not available.

PHS: Primary Health Center

Table 12.5-11 (1) Population Profiles

Project site	Hevale		Jalond			Marleshwar	
	Lower dam		Upper dam	Lower dam		Upper dam	Lower dam
Village	Bambarde	Terwanmedhe	Kumshet	Bandveshet wadi	Naval wadi	Gothane	Bomnoli
1. Population	421	417	n.a.	180	270	750	1600
2. Population growth/yr	n.a.	n.a.	n.a.	n.a.	n.a.	1 to 1.5%	1 to 1.5%
3. Male -female ratio	1:1.22	1:0.91	n.a.	n.a.	1:0.94	1:1.03	1:1.46
4. Age group							
i 0-15	14%	44%	n.a.	n.a.	60	287	469
ii 16-30	43%	22%	n.a.	n.a.	100	215	373
iii 36-50	33%	30%	n.a.	n.a.	80	161	493
iv 51 and above	10%	4%	n.a.	n.a.	30	84	293
5. Source of income	Farming	Farming	Farming	Farming	Farming (milk & meat sale)	Farming	Farming (During off-season, most men work in Mumbai.)
6. Income per annum	n.a.	Rs. 10,000 - 15,000	n.a.	n.a.	Rs.3,000 - 5,000	Rs.5,000 - 10,000	Rs.5,000 - 10,000
7. Expenditure as% of income	n.a.	40 to 60% for food and other household items.	n.a.	n.a.	60% for food and 20% for other household items.	About 90% to 95% is spent.	About 90% to 95% is spent.

Table 12.5-11 (2) Population Profiles

Project site	Hevale		Jalond			Marleshwar	
	Lower dam		Upper dam	Lower dam		Upper dam	Lower dam
Village	Bambarde	Terwanmedhe	Kumshet	Bandveshet wadi	Naval wadi	Gothane	Bomnoli
8. Major causes of death	Age, respiratory ailments, etc.	Age, respiratory ailments, etc.	n.a.	n.a.	n.a.	Age	Age
9. Education	Most people studied up to the primary level.	Most people studied up to the primary level.	n.a.	n.a.	n.a.	n.a.	n.a.
10. Other	Mostly Hindu Marathas with 89 Scheduled Cast.	At least one person per HH emigrated to join arm forces for work. Mostly Hindu Marathas with 111 Scheduled Caste. Occasional occurrence of influenza and malaria.	n.a.	n.a.	Isolated village, and migration of villagers is rare. 90% children go to school. Villagers are tribal Hindu Matakur, Kadkari tribe.	10 - 20% of population migrate to towns. Most people are illiterate.	10 - 20% of population migrate to towns Most people are illiterate.

Note: n.a.: Information not available.

Source: BNHS Report, 1996. GOMID Reports, 1996.

(2) Archaeology

The Government of Maharashtra has an Archaeological Department to declare important monuments as protected monuments and to preserve them. The department has two Directors, one responsible for the monuments and the other responsible for the manuscripts and other ancient papers, etc.

Various cities have ancient monuments like temples, mosques, palaces, minars, etc. Near the upper dam site of the Marleshwar project site, there is a well-known temple called Marleshwar Temple. Except this temple, existence of no structures or sites of historical or cultural significance is reported in the general areas of the proposed project sites in Hevale, Jalond, and Marleshwar.

(3) Migration into Project Areas

Generally, permanent migration does not take place for the general areas of the Jalond, Marleshwar and Hevale sites. On the other hand, seasonal migration from other states or regions does take place; but it is limited mostly to workers who are brought by contractors for various construction activities for roads, dams, buildings, etc. In Hevale, it has been reported that workers are brought for bamboo cutting. Basically, these workers return to their native places after the completion of work.

(4) Tourism and Recreation

There presently are no places of interest for tourism and recreation within the study areas for the project. However, once upper reservoirs are created for the project in Jalond and Marleshwar, they will be potential sites for tourist attraction, as those reservoir sites are located within the boundaries of sanctuaries.

(5) Public Health and Water-Borne Diseases

(a) Institutional framework

The public health is looked after by two agencies, namely, Public Health Department (PDH)of the State and the local bodies like District Local Boards, Municipalities, and the village Panchayat. The District Health Officer represents the PHD, and he/she is the Head of the District in all public health matters. The district health officer investigates the causes, origin and spread of diseases, both epidemic and endemic, and

adopts preventive measures to control diseases such as Cholera, Plague, Guinea worm, Influenza, Malaria, etc. Education is provided to villagers regarding family planning, nutrition and other health aspects.

The State Government has plans to ensure safe water supply to rural population of the State. The progress in this context, however, is still poor, and villagers still have to depend upon the water supply from shallow wells. These wells often dry up in dry seasons; and the villagers have to transport water from long distances. The incidence of water-borne diseases such as typhoid, cholera, dysentery, and other diseases caused by water-borne parasites such as guinea worm becomes high, although those diseases occur sporadically, and do not reach epidemic proportions.

(b) Health facilities

The medical facilities provided by the Government as on 1993 are depicted in **Table 12.5-12.**

Table 12.5-12 Number of Medical Facilities in Maharashtra State (1993)

Hospitals	Dispensaries	Primary Health Centers	Primary Health Units	TB Hospitals/ Clinics	Total Beds	Beds per Million of Population
830	1,702	1,690	151	1,977	1,16,075	14

Source: Director, Economics & Statistics, Gov't of Maharashtra, Handbook of Basic Statistics of Maharashtra State, 1993

In the case of Jalond, fairly good medical facilities are available at Rajur, and in the case of Marleshwar at Deorukh and Ratnagiri. With regard to Hevale, there is a hospital at Kodali, and primary health centers at Bhedshi Pale, Sargave Patge and Halkarni.

12.6 Environmental Impacts

12.6.1 General

Probable environmental impacts of the proposed project were assessed on major components of the environment, such as forestry, river water, villages, etc., at the three proposed sites of Hevale, Jalond and Marleshwar. The proposed project, largely because it is a site specific river-valley project, will inevitably cause environmental impacts during the pre-construction, construction and post-construction stages. It is necessary that such impacts are understood so that the adverse impacts may

be mitigated wherever possible. It may be noted that the project still being in the conceptualization stage, the prediction of impacts is based solely upon the existing baseline scenario and the likely actions of the project. This exercise is, however, expected to be beneficial to incorporate changes in the infrastructure and the envisaged project actions, wherever deemed to be necessary.

Most of the adverse impacts are expected to occur during the construction period. The construction activity would generate air (including noise) pollution as well as water pollution. The excavating machinery would elevate the ambient particulate concentration due to dust generation. The exhaust fumes from diesel/gasoline driven vehicles/cranes would elevate the concentration of SO_2, Nitrogen Oxides, CO and CO_2 in the ambient air. This negative impact, however, would last during the construction stage only, and the concentrations of pollutants should revert. Similarly, during construction, the decibel level of noise would go up due to the use of heavy equipment and vehicular traffic. It will be restored to its normal level after the construction phase.

The water courses would be fouled up during the construction period due to turbid water and waste water originated from the construction site. The river water is also likely to be used by the contractors for construction activities, such as washing coarse aggregates and preparing concrete. The water table in the area might go down, and the availability of water in the existing wells would be low since the water, both surface and subsurface water, might be used by the contractors for above-mentioned uses. The water table would take some time (one monsoon season) to recover after the construction, and it would then permanently improve due to storage in the reservoirs. (This could be termed as a positive impact.)

Without proper treatment and mitigation measures, some impacts may continue even after the construction. For example, reservoir water, if deteriorated, will be a threat to the public health. Needless to say, people if displaced by the project have to be rehabilitated.

Potential impacts at respective project sites were assesses below in line with the "Environmental Impact Matrix" of TOR.

12.6.2 Hevale Site

(1) Villages/Inhabitants to Be Displaced

There are no human communities in the project site. The upper and lower reservoirs are planned in forest land, and no village land will be utilized for the project. Thus, the impact which is normally associated with displacement of villages and inhabitants is absent.

(2) Agriculture

No agricultural land would be acquired for the project either at the upper or lower reservoir site, while minor acquisition may be needed, for instance, to expand or extend existing access roads. The impact normally associated with acquisition of agricultural land is basically absent. Irrigation by means of diverting or pumping up water from the rivers is not practiced.

(3) Forestry

Approximately 82 ha of reserved forest land would be lost for the construction of upper and lower reservoirs. The standing trees in the reservoir areas would have to be cut. This activity is expected to have a minor negative impact on the ambient temperature and rainfall. More importantly, the wildlife habitat in the areas would be killed. Some small animals may be killed, whereas avifauna and larger mammals would probably migrate to safer areas. The tree cutting operation is also likely to foul the existing water courses. The site clearance operation would generate exhaust fumes of CO_2, CO, SO_2, etc. due to the use of heavy earth excavating/moving equipment and heavy vehicles. The impacts on the air, water, and surrounding forest area are of a temporary nature, and the pollution level is expected to revert to its original magnitude after the construction period. However, loss of forest and wildlife habitat is expected to have long-term ecological impacts at both global and local levels. Timber of commercial value will be salvaged, and its proceeds will be given to the Department of Forests. The salvage costs should be covered by GOMID.

(4) Fishery

There is no established fishery business in the project area including the upper and lower reservoir areas. In monsoon season, some local inhabitants supplement their food intake by catching fish in the streams. However, this is on a negligible scale. In monsoon, the construction activities at both the reservoir sites at the surface would be minimum; and quantum of water flowing through the existing water courses would not be reduced. The minor fishing activity could continue, although the fish habitat would be significantly damaged due to turbid water originated from the construction site. The project does not involve diversion of flow, and therefore no long-term impacts are expected on native species. Presence of no rare species was reported.

(5) Land Transportation

An approximately 2 km road would be built for access to the upper reservoir site. The lower reservoir site is approachable by an existing road. A road of 2-3 km distance would also be built to gain access to the site of a tunnel which leads to the powerhouse. The activities of road construction would create air and noise pollution, but virtually no traffic congestion, as the area has little traffic. The impact induced by construction-related traffic on the environment outside the project site would be limited, as the import of aggregates would not be required for the upper reservoir, and sites for quarries and borrow pits are located near from the lower dam/reservoir. However, there would be traffic safety problems against local residents. There would be no significant positive impact in terms of improvement of traffic network in the area.

(6) River Transportation

The river is shallow, and is not used for transportation purpose. Thus, there will be no impact.

(7) Public Health

There would be considerable work force at the site. During the peak load of work, there could be about 3,000 workers, which would create a significant burden on the environment. Most of the labour and supervisory staff during pre-construction and construction stages would be imported outside the project site. In the absence of any infrastructure facilities such as housing, safe water supply, sewerage and storm drainage arrangement, health centers, etc., they would have a significant negative impact on the environment, and there is a possibility of onset of epidemics or water-borne diseases. Malaria, the dominant water-borne disease, is already endemic in the area. The project might lead to an increase of malaria cases, since more favourable breeding places for mosquitoes might be created.

(8) Aesthetics

Construction of a dam is not perceived to be a significant loss of scenic beauty by the local residents. Creation of water masses is considered to enhance the beauty of the locations at the upper and lower reservoirs sites. However, the impact would be negative, if the left-over construction material and debris etc. is not removed from the sites. The power station is planned to be built underground. The on-the-ground switch yard, which might be considered

to be aesthetically detrimental, would be provided with landscape works including tree planting.

(9) Cultural Assets

There is a temple near the upper reservoir site. However, no significant impact is expected against the property. No other cultural assets exist in the project area.

(10) River/Ground/Reservoir Water

Surface and subsurface water quality would deteriorate during the entire construction phase and early post-construction phase (for a year or so) as mentioned in paragraph 12.6.1 above, unless suitable measures are taken. The ground water table would be affected, if large amount of water is pumped up for use. One monsoon season would be required to store water after the construction, which would affect the downstream flow. However, the agricultural activity would not be seriously affected, since no river water is pumped up for use in any case. A positive impact can be assured, if after the construction, a limited quantity of stored water in the reservoirs can be supplied to nearby villages.

During the post-construction period, aquatic weeds might proliferate in the reservoirs, without proper measures, such as clearance of wood vegetation from the inundation areas prior to flooding. Because the same water would be repeatedly used (for this pumped storage hydro scheme), reservoir water might be deteriorated rapidly, without proper management of the catchment area in terms of land use, wastewater discharge, use of agricultural chemicals and fertilizers, etc. The risk of water-related diseases would also increase.

With the absence of proper watershed management and reservoir operation, the storage capacity of the reservoirs would decrease at high speed due to sedimentation. Long-term climatic changes possibly induced by the reservoirs will be imperceptible.

(11) Flora/Fauna

Except two avifauna species, no endangered flora/fauna species were found in the project area during the baseline survey, while presence of a few endangered mammal species was reported by villagers. No sanctuaries are located in or around the area. However, since forest land has to be acquired at both the upper and lower reservoir sites, there would be a loss of flora and fauna at these sites. Avifauna and the larger fauna may migrate to other safer areas. Without proper measures, the wildlife habitat around the sites would be ruined by imported

workers. Cutting trees and hunting animals and birds might not be prevented without proper measure.

(12) Air

Air quality would deteriorate during the construction stage, which would create a temporary negative impact on the environment. Odor caused by eutrophic reservoir water might prevail after the construction.

12.6.3 Jalond Site

(1) Villages/Inhabitants to Be Displaced

No village amenities and infrastructure would be taken either at the upper or lower reservoir site. The socio-economic negative impacts normally associated with the displacement of villages and inhabitants is absent.

(2) Agriculture

At the upper reservoir site, about 50 ha of agricultural land would have to be acquired. Loss of agricultural land at the reservoir site would be limited to small, rather infertile land. Any loss of land would creates a negative socio-economic impact on the farmers owning the land, because their livelihood depends on whatever the agricultural land that they posses. Their income from other sources is negligible. There is hardly any idle land left around the villages that could be converted to land for agriculture. The offsprings of most of the inhabitants are no longer attracted by their rural surroundings, and leave for the nearest green pastures such as cities to get job there. Since the agricultural produce is normally self-consumed, the farmers have to depend upon the money orders sent by their offsprings from the cities. The negative impact of acquiring agricultural land has to be viewed in the above context.

(3) Forestry

In total, 280 ha of forest land including 90 ha of reserved forest land would have to be acquired for the project at the upper and lower reservoir sites. This would have a significant negative impact on various aspects of the environment. The loss of forest at the lower reservoir site would be limited to 50 ha of non-reserved forest. The upper reservoir site is currently under a proposed sanctuary.

(4) Fishery

It is reported that villagers living in the upper reservoir area catch small crabs for sustenance in the river during the rainy season. However, the impact will be limited as the amount of the catch is very small, and there is no organized fishery business at the sites or in the downstream area.

(5) Land Transportation

The existing road to Kumshet Village would serve as the access to the upper dam and head race surge tank areas, although it would have to be repaired and widened. The exiting road to Navalwadi village would provide access to the lower dam site area, while it would also need some improvements. Those roads do not have much traffic; and thus the impact on the traffic by additional traffic generated by the project would not be significant. The activities of road improvement would have negative impacts, as mentioned in paragraph 12.6.2(5) above, and there would be possible traffic safety problems, if many vehicles were mobilized for import of construction materials.

(6) River Transportation

The river is not used for transportation purpose, and therefore there will be no impact. There exists at least one mini-hydro project well below the upper dam site.

(7) Public Health

The negative impact on public health would be similar to that mentioned in paragraph 12.6.2(7).

(8) Aesthetics

Creation of water mashes at both reservoir sites would have impacts as described in paragraph 12.6.2(8).

(9) Cultural Assets

There are no cultural assets in the project area.

(10) River/Ground/Reservoir Water

There would be negative impacts as mentioned in paragraph 12.6.2(10).

(11) Flora/Fauna

One endangered avifauna species was observed during the baseline survey, and presence of a few endangered mammal species was reported by villagers. Negative impacts on flora/fauna are expected as mentioned in paragraph 12.6.2(11).

(12) Air

The air quality would deteriorate temporarily during the construction period and there might be odor caused by eutrophic reservoir water during the post-construction period, as mentioned in paragraph 12.6.2(12).

12.6.4 Marleshwar Site

(1) Villages/Inhabitants to Be Displaced

No human communities would be inundated and no one would be displaced by the project. At the upper reservoir site, however, a large portion of the land upon which the life of the inhabitants of one village (i.e., Gothane) is dependent (regardless of whether it is farm land or not) would be inundated.

(2) Agriculture

Approximately 25 ha and 7 ha of agricultural land would have to be acquired at the upper and lower reservoir sites, respectively. The negative impacts associated with such acquisition would be similar to those described in paragraph 12.6.3(2). The impact of the loss of agricultural land at the upper reservoir site would have to be assessed in terms of its proportion to the total agricultural land to be left. Waste land is often used to graze cattle. Thus, the submergence of waste land would also affect, if a large area is involved.

(3) Forestry

Approximately 150 ha and 50 ha of non-reserved forest land would have to be acquired for upper and lower reservoirs, respectively. Most of the forest land at the upper reservoir site is

stony waste or infertile land with few trees and little vegetation, while the lower reservoir area is covered mostly with thick forest. The negative impacts associated with the acquisition of forest land would be similar to those described in paragraph 12.6.2(3).

(4) Fishery

There is no organized fishing business in the area concerned. Fish catch by villagers during monsoon season will decrease. No other negative impacts are expected.

(5) Land Transportation

The existing road to Gothane Village would serve as the access to the upper dam site area, while it would need improvements. The exiting road to Marol Village would have to be improved and extended to have access to the lower dam and power house tunnel sites. Those roads have little traffic. During the construction period, there would be negative impacts as mentioned in paragraphs 12.6.2(5) and 12.6.3(5).

(6) River Transportation

No rivers are used for transportation purpose in the general area of the project. No impacts are expected.

(7) Public Health

The negative impacts on public health would be similar to those mentioned in paragraph 12.6.2(7).

(8) Aesthetics

Creation of reservoirs would have a positive impact as described in paragraph 12.6.2(8).

(9) Cultural Assets

There is a temple called Marleshwar Temple below the upper reservoir site. Near the temple, there are a few small falls, which are considered to be a part of the temple, and sacred. The falls are located downstream from the site; and therefore, they will become dry, if the flow is completely blocked at the planned dam. The dam would not be seen at the sight of the temple or from the temple.

(10) River/Ground/Reservoir Water

Both surface and subsurface water would be affected as mentioned in paragraph 12.6.2(10).

(11) Flora/Fauna

No endangered flora/fauna were found during the baseline survey, while presence of a few endangered fauna species was reported by villagers. Negative impacts on flora/fauna would be expected as mentioned in paragraph 12.6.2(11).

(12) Air

The air quality would deteriorate temporarily during the construction period, and odor might prevail in the reservoirs, as mentioned in paragraph 12.6.2(12).

12.6.5 Environmental Impact Matrix

Based on the discussion above, environmental impacts anticipated at the three project sites can be summarized as shown in **Table 12.6-1**. A comparison of the three sites is also made in terms of the potential impacts. Socio-economic impact measured by the loss of agricultural land will be the smallest at the Hevale site. The three sites will not differ significantly in terms of ecological impact, except that only the Marleshwar site will not involve any loss of reserve forest.

Table 12.6-1 (1) Environmental Impact Matrix

Environmental component affected	Impact: Phase	Impact	Project site	Area affected	Significance	Duration
1. Village/inhabitants to be displaced	Pre-Con. & Con.	Nil. No houses or no major infrastructure facilities of villages will be inundated or lost.	Hevale	n.a.		
			Jalond			
			Marleshwar			
2. Agriculture	Con. & Post-Con.	Loss of agricultural land. The total agricultural land to be inundated or lost will be: none (or negligible) at Hevale, 50 ha at Jalond, and 32 ha at Marleshwar. Little impact is expected on agricultural activities attributable to changes in ground water.	Hevale	1	1	3
			Jalond	2	3	3
			Marleshwar	2	3	3
3. Forestry	Con. & Post-Con.	Loss of forest. The total forest land to be lost will be: 82 ha of reserved forest at Hevale, 190 ha of reserved and 90 ha of non-reserved forest at Jalond, and 200 ha of non-reserved forest at Marleshwar.	Hevale	2	3	2
			Jalond	2	3	2
			Marleshwar	2	3	2
4. Fishery	Con. & Post-Con.	Decrease in fish catch. However, fishery is practiced only on negligible scale.	Hevale	3	1	2
			Jalond	3	1	2
			Marleshwar	3	1	2
5. Land transportation	Pre-Con. & Con.	Traffic blockage and traffic safety problems. Existing roads will serve as the access to the construction sites, while they will be improved and extended. Those roads currently have little traffic, and basically, construction-related vehicles will remain on site and rarely go outside the project sites. Unless aggregates (concrete materials) are imported from outside the project sites, impact will be limited. Improvement and extension of the existing roads would have little benefit for the regional transportation network as a whole.	Hevale	3	2	2
			Jalond	3	2	2
			Marleshwar	3	2	2
6. River transportation	Con.	Nil. Rivers are not used for transportation.	Hevale	n.a.		
			Jalond			
			Marleshwar			
7. Public health	Con. & Post-Con.	Possible onset of epidemics or water-borne diseases. In the absence of infrastructure facilities for project workers, such as housing, safe water supply and sewage, there is a possibility of outbreak of epidemics. The risk of water-related diseases will be high, without proper management of the catchment area and reservoirs.	Hevale	3	3	3
			Jalond	3	3	3
			Marleshwar	3	3	3

Table 12.6-1 (2) Environmental Impact Matrix

Environmental component affected	Impact: Phase	Impact	Project site	Area affected	Significance	Duration
8. Aesthetics	Con. & Post-Con.	Enhancement of the beauty of the location due to the creation of reservoirs as water masses (positive impact). This benefit can be valued at the Jalond and Marleshwar sites, because they are located in sanctuaries as sight-seeing resources. (Negative impact is perceived to be negligible.)	Hevale	2	1	3
			Jalond	2	2	3
			Marleshwar	2	2	3
9. Cultural assets	Con. & Post-Con.	There is a small, local temple in the vicinity of the upper reservoir site of Hevale, which however will not be affected. Below the upper dam site of Marleshwar, there is a famous temple called Marleshwar Temple. Without a proper measure, the falls belonging to the temple will be affected. There are no other cultural assets in or around the project site areas.	Hevale	n.a.		
			Jalond			
			Marleshwar	1	3	3
10. River/ground/ reservoir water	Con. & Post-Con.	Water pollution caused by turbid water, alkaline water by concreting, eutrophic reservoir water, etc. Problems resulting from decrease in water flow. Possible change in ground water level.	Hevale	3	3	3
			Jalond	3	3	3
			Marleshwar	3	3	3
11. Flora/fauna	Pre-Con & Con.	Loss of flora and fauna in the forest to be acquired, and disturbance of habitat in surrounding areas, due to noise, air pollution, etc.	Hevale	3	3	2
			Jalond	3	3	2
			Marleshwar	3	3	2
12. Air	Con. & Post-Con.	Air pollution caused by operation of construction equipment and construction-related vehicles. Odor caused by eutrophic reservoir water.	Hevale	2	2	3
			Jalond	2	2	3
			Marleshwar	2	2	3

Note: 1. n.a.: Not applicable Con: Construction

2. Affected area:
   1. Small (Limited to particular sites)
   2. Medium (Project site and its close vicinity)
   3. Large (Neighboring area)
3. Significance:
   1. Insignificant
   2. Moderately significant
   3. Significant
4. Duration:
   1. Short (Very limited duration)
   2. Medium (Basically, construction period)
   3. Long (Construction and post-construction periods)

12.7 Mitigating Measures and Environmental Management Plan

12.7.1 General

In order to mitigate the adverse impacts likely to arise due to the construction and operation of the proposed project at the Hevale, Jalond, and Marleshwar sites, a comprehensive environmental management plan needs to be delineated by identifying mitigating measures for those impacts and formulating a monitoring plan. The essential objective of the monitoring plan is to observe the changes in environment so as to assure that actual impacts by the project are what have been anticipated and are within the environmentally acceptable level. It is noted that MOEF requires a project proponent to submit a half-yearly compliance report to the ministry after the project is commissioned so that the minister can monitor the implementation of the recommendations and conditions stipulated by the Appraisal Committee, subject to which the environmental clearance has been granted.

Compared with ordinal hydro power schemes, pumped-storage hydro power schemes normally require smaller reservoirs and hence have smaller environmental impact. However, they are also "site specific", depending on particular site conditions. For this reason, in particular, not all the adverse impacts expected can be mitigated. For unavoidable impacts, e.g., loss of forest, compensatory measures are often the only feasible "solutions".

Applicable mitigating measures are discussed below for the potential impacts on different environment components identified in the preceding chapter. Costs for implementation of the major mitigation measures identified and a monitoring plan are also estimated.

12.7.2 Hevale Site

(1) Agriculture

No agricultural land will be inundated by the project at either the upper or lower reservoir site, although small plots at particular sites may be lost due for example to the necessity of widening access roads. Mitigation measures, if necessary, would be to provide for monetary compensation or alternate land, if available.

(2) Forestry

In total, 82 ha of reserved forest land is estimated to be inundated by the project. Site clearance, which includes cutting standing trees, will have to be resorted to not only in the

submerged areas of both the lower and upper reservoirs but also at locations of a switch yard, staff quarters, office buildings, etc. As per the provisions of the Forest (Conservation) Act 1980, alternate non-forest land for compensatory afforestation will have to be identified with the help of the Revenue Department of the State Government. The Department of Forests and Environment of the State Government will carry out the compensatory afforestation on behalf of GOMID, although all the costs incurred for this purpose as well as the costs for salvage logging in the project area have to be borne by GOMID. In finding the site for compensatory afforestation, priorities should be given to the watershed area, which has to be protected for longer life span of reservoirs. There will be no effective mitigation measures except scaling-down reservoir size.

In order to prevent illegal logging in the surrounding area by the project workers, monitoring will be required. As a preventive measure, sufficient fuel should be provided for workers by contractors.

The site clearance will involve excavation, and this will increase the ambient particulate water level in the air due to dust. This would be taken care of, to some extent, by sprinkling water. Basically, the impact is temporary during construction, and no further mitigating measures would be necessary.

(3) Fishery

Although there is no established fishery business in the project area, some local inhabitants supplement their regular food by catching fish in the local streams in the monsoon season. This practice is almost on a negligible scale. However, monetary compensation for the unrealized catch due to the various impacts of the project (e.g., decrease in the flow, turbid water, etc.) will be required. Release of compensation flows, if deemed to be effective, should be studied.

(4) Land Transportation

During the pre-construction and construction phases, the activities of road construction, for both extension and improvement of the existing roads, will create noise, dust and vehicle exhaust gases pollution. Traffic will be hindered, and there will be also safety problems against local residents. Some traffic will be generated during the construction period mainly by vehicles carrying construction-related materials and equipment to the sites. Instructions should be given to contractors for safe driving, and, if necessary, persons who control the

traffic should be placed at appropriate spots. Bottleneck can be improved by widening the road.

(5) Public Health

Most of the project workers will be imported from outside the project area. At peak periods, there could be a work force of 3,000 persons. Facilities for safe water supply through tankers and sanitation (toilets, drainage, septic tanks, etc.) should be provided. A dispensary should also be provided at each site, with a qualified doctor (with sufficient knowledge of epidemics and water-related diseases), and paramedical staff as well as adequate stock of medicines. It will be necessary to have a regular programme for malaria abatement by spraying DDT to destroy mosquitoes. Medical check should be carried out regularly for workers and local residents, and education campaign should be undertaken to raise the awareness on public health issues. Medical screening can be implemented by contractors in hiring workers. During the post-construction period, the number of persons at the site will be much less as per the requirement of the operation and maintenance. However, most of the facilities will have to be maintained.

(6) Aesthetics

Tree planting and creation of gardens at the project site will improve the aesthetics of the site in the post-construction period.

(7) River/Ground/Reservoir Water

During the construction period, the water quality of existing streams will be debased because of the construction activity. As aggregate for dam and concrete material, excavation material will be used after being washed. This wash will require a large amount of water, and in turn will generate a large quantity of turbid water. This turbid water and waste water generated by other activities have to be stored in sedimentation ponds before being discharged.

The ground water table might go down, if river/ground water is used for the project during construction. Importing the entire amount of water required from outside site may not be economically feasible. Thus, compensation will have to be made by providing water by tankers. Investigation should be conducted into all the wells in the surrounding area to assess more accurately the potential impact on existing wells and to determine the compensatory water requirement. (Due to reservoir storage, the quantity of water available in those wells may improve during post-construction period.)

In order to prevent reservoir water from becoming eutrophic, complete clearance of vegetation in reservoir areas prior to flooding is essential. Further, catchment area control and management is required for the same purpose and for the maximum life for reservoirs.

(8) Flora/Fauna

Those endangered avifauna and mammal species observed or reported would escape to safer areas. Because reservoirs to be created are relatively small, rescue operations for animals will not be necessary. On the other hand, submergence of forest land will inevitably result in loss of trees/plants and wildlife habitat. For this negative impact, no effective and feasible measures would be available, while compensatory afforestations will be carried out, assuming that it would create similar wildlife habitat that would be lost.

(9) Air

Temporarily, the ambient air pollution level will increase in the pre-construction and construction periods, especially in terms of, SO_2, CO and oxides of nitrogen. There will be no special mitigating measures.

In order to prevent odor from reservoir water, complete clearance of reservoir sites will be required. Activities in the catchment area should be controlled so that substance which may make reservoir water eutrophic does not flow into reservoirs.

12.7.3 Jalond Site

(1) Agriculture

About 50 ha of agricultural land will be lost. As per the provisions of the Land Acquisition Act and Maharashtra State Act for Rehabilitation of Project Affected Persons, alternate agricultural land and/or compensation will have to be provided to persons whose agricultural land will be acquired for the project. They also will have to be given employment priority at the construction site and at the power plant to be built, so that long-term impact caused by loss of agricultural land may be mitigated.

(2) Forestry

Approximately 280 ha of forest including 190 ha of reserved forest land will be lost at both the upper and lower reservoir sites. As per the relevant legal provisions, alternate land for compensatory afforestation will have to be identified with the assistance of the Revenue Department of the State Government. Once such land is found, the Department of Forest and Environment will carry out the afforestation work, while all the costs will have to be borne by GOMID. The afforestation aims at balancing the negative impact of deforestation at the project site. The site clearance will involve excavation, which will increase the ambient particulate level in the air due to dust. This impact can be mitigated to some extent by sprinkling water.

(3) Fishery

In monsoon, local inhabitants supplement their regular food by catching fish in the local streams. The quantum of water in the existing water courses may little be affected in monsoon, even if diverted, and the limited fishing could still continue in the construction stage. However, compensation should be offered for any loss of catch.

(4) Land Transportation

The activities of road improvement will create noise, dust and vehicle gasses pollution. The local traffic volume, which is comparatively light currently, will be increased due to project-related vehicles. There will be no effective measures to reduce the level of noise or vehicle gasses pollution, while dust can be reduced by sprinkling water or by driving slowly. Safety instructions should be given to contractors, and, if deemed to be necessary, persons who control the traffic should be placed at appropriate spots.

(5) Public Health

Facilities for safe water supply through tankers and sanitation should be provided for the estimated labor force of 3,000 at the peak periods. A dispensary should also be provided at both upper and lower reservoir sites to monitor the health among the workers and local residents. A malaria control program should be carried out.

(6) Aesthetics

Landscape works including tree planting and creation of gardens will improve the aesthetics of the project sites in the post-construction period.

(7) River/Ground/Reservoir Water

To minimize the deterioration of the water quality during construction period, wastewater from construction activity will have to be treated before being discharged into the stream. Adequate sewage facilities will be required for project workers. The ground water table may get depleted, if the construction work uses considerable amount of ground water. This impact can be mitigated by supplying water by tankers to the villages affected.

In order to prevent reservoir water from becoming deteriorated during the post-construction period, watershed management will be required. The watershed management should incorporate plans for sustainable community development. Woody vegetation should be cleared from reservoir areas completely, prior to flooding.

(8) Flora/Fauna

The upper reservoir site area is currently a part of a declared sanctuary. (A change in the boundaries of the sanctuary is required for the project implementation.) Because the area would be immediately adjacent to the sanctuary, measures for wildlife protection would be necessary. Provisions should be included in the employment contract with project workers preventing them from hunting, cutting trees, etc. Such provisions can also be considered that allow no workers to stay in the area after their contracts are expired.

(9) Air

Temporarily the ambient air pollution level will increase in the pre-construction and construction periods. There would be no effective mitigation measures.

12.7.4 Marleshwar Site

(1) Agriculture

About 32 ha of agricultural land would have to be acquired. As per the provisions of relevant laws, alternate land and/or monetary compensation will have to be provided to

affected persons. Offering employment priorities to them should also be considered, as discussed in paragraph 12.7.3(1).

(2) Forestry

Approximately 200 ha of non-reserved forest land will have to be acquired for the project. As per the legal provisions, compensatory afforestation must be carried out at alternative land, which needs to be identified with the assistance of Revenue Department of the State Government.

(3) Fishery

Local inhabitants catch fish in the local streams to supplement their regular food. Although this practice is on a negligible scale, any loss of catch should be compensated.

(4) Land Transportation

The existing roads leading to Gothne village and Maral village would serve as access to upper and lower reservoir sites, respectively. Those roads will have to be improved and extended. The activities of road repairs and construction will create noise, dust and vehicle exhaust gas pollution, which will not be effectively mitigated. Traffic will be hindered to some extent, and safety problems against local residents may arise. Instructions should be given to contractors for safe driving, and if necessary, warning signs and/or persons who control the traffic should be placed at appropriate spots.

(5) Public Health

For project workers, facilities for safe water supply through tankers and sanitation (e.g., toilets, drainage, septic tanks, etc.) should be provided. Samples of water should be tested periodically for their suitability. A dispensary will be required with a qualified doctor, paramedical staff, and sufficient stock of medicines. It will be necessary to conduct periodically medical check for local residents and project workers and to have a regular program for malaria control.

(6) Aesthetics

Landscape works including tree planting and creation of gardens should be carried out to improve the aesthetics of the project sites in the post-construction periods.

(7) Cultural Assets

Sufficient flow has to be secured to sustain the small falls at Marleshwar Temple. If necessary, a new watercourse should be built for this purpose.

(8) River/Ground/Reservoir Water

Construction-related wastewater should be treated before being discharged into the streams. Possible depletion of well water in the surrounding area will have to be mitigated by supplying water by tankers to the villages affected.

In order to prevent deterioration (deoxygenation) of reservoir water, complete clearance of reservoir areas prior to flooding is necessary. Also, a watershed management plan should be formulated, as mentioned in paragraph 12.7.3(7).

(9) Flora/Fauna

Similar to the case of the Marleshwar site, the upper reservoir area would be adjacent to a declared sanctuary. Punitive provisions may need to be included in the employment contract with project workers for the protection of wildlife in the surrounding area. Education should be provided for the workers for ecological preservation.

(10) Air

The ambient air pollution level would increase temporarily in the pre-construction and construction periods. However, there will be no effective mitigating measures. Table 12.7-1 summarizes primary mitigation measures for major impacts.

12.7.5 Monitoring Plan

Monitoring is an integral part of the environmental management, and is required both during and after construction to ensure that mitigation measures taken are functioning as expected and no impacts are occurring other than previously anticipated. Major environmental elements needed to be monitored are the following:

(1) Watershed Protection

Catchment area has to be managed and protected to minimize the occurrence of land slides and soil erosion, and thus to ensure a maximum life of a reservoir. By monitoring the catchment area, it must be ensured that no disturbance is made by residents in the area resulting in land slides and soil erosion, and trees planted for the purpose of reforestation of the area are growing. If necessary, measures must be taken, including further reforestation, restriction of activities by the residents, and control of immigration into the area. Coordinated efforts with the Office of Conservator of Forest concerned will lead efficient and effective results. The monitoring should continue throughout the project life.

(2) Public Health Protection

A dispensary will be established at each construction site. By this institution, monitoring of public health will be conducted. Monitoring activities will include periodical health check for both project workers and local residents, and project area reconnaissance to investigate possible causes for outbreak of an epidemic or water-borne diseases. Staff of the dispensary may include a medical doctor, two nurses, a laboratory technician etc. The monitoring will be conducted every other month during the construction and for one year after the construction. About one week will be required each time.

Water quality needs to be monitored, as the discharge of water used for various construction-related activities may degrade the quality of both surface and subsurface water. The monitoring will be entrusted to an outside laboratory, and will be carried out once every month during the construction and also periodically during the post-construction period.

(3) Wildlife protection

Wildlife and its habitat will also be regularly monitored. The monitoring includes reconnaissance in the project area and education of project workers about the importance of wildlife protection and conservation. Financial provision will be made to entrust the monitoring work to the Office of the Conservator of Forest of the region concerned. Monitoring will continue for one year after the construction.

12.7.6 Estimated Costs for Implementation of Mitigation Measures and Monitoring Plan

Table 12.7-2 shows crude estimates of the costs for the implementation of major mitigation measures and a monitoring plan at the proposed three sites. In principle, monitoring is expected to continue

during the entire project life, for watershed protection and public health. Supply of water by tankers and provision of sanitation for project workers are regarded as part of the obligation by contractors, and therefore are not included in the cost estimates.

Table 12.7-1 Summary of Mitigation Measures for Major Impacts

Component of Environment	Impact	Mitigation Measure
1. Agriculture	- Loss of agricultural land	- Alternative land/monetary compensation.
2. Forestry	- Loss of forest	- Compensatory afforestation. - No effective measures except scaling-down the reservoir size (including adoption of pondage-type reservoir).
3. Fishery	- Decrease in fish catch	- Adequate treatment of construction-related waste water/monetary compensation.
4. Land transportation	- Traffic blockage and safety problems	- Improvement of bottleneck. - Safe driving instructions. - Placing persons who control the traffic at appropriate spots.
5. Public health	- Possible onset of epidemics or water-borne diseases	- Medical screening in hiring project workers - Provision of adequate housing, sanitation (toilets, drainage, septic tanks, etc.) safe water, and dispensaries (with qualified doctors and paramedical staff) for workers. - Provision of safe water (tanker water) for villagers. - Periodical medical check for workers and villagers. - Education campaign to raise awareness on public health issues. - Malaria abatement (by spraying DDT). - Project area reconnaissance to investigate possible causes for outbreak. - Proper management of catchment areas and reservoirs. - Reservoir water analysis.
6. River/ground/reservoir water	- Deterioration of the quality of river/ground water	- Complete clearing of reservoir areas (prior to flooding). - Adequate treatment of construction-related waste water.
	- Possible depletion of water at village wells	- Water supply by tankers (for villagers). - Alternative source of water for the project.
	- Deterioration of the quality of reservoir water	- Complete clearing of reservoir areas (prior to flooding). - Proper management of catchment areas and reservoirs
7. Flora/fauna	- Loss of flora/fauna/habitat at project sites	- No effective measures except scaling-down reservoir size (including adoption of pondage-type reservoir).
	- Loss of flora/fauna/habitat in surrounding areas	- Education of project workers for wildlife conservation. - Provision of sufficient fuel for workers.

Table 12.7-2 Estimated Costs for the Implementation of Mitigation Measures and Monitoring Plan

Mitigation measure/monitoring item	Unit Cost	Hevale		Jalond		Marleshwar	
		Quantity	Cost (mil. Rs.)	Quantity	Cost (mil. Rs.)	Quantity	Cost (mil. Rs.)
1. Clearance of woody vegetation[1] (including salvage logging)	15,000 Rs./ha	90 ha	1.4	181 ha	2.7	204 ha	3.1
2. Compensatory afforestation[2]	30,000 Rs./ha	90 ha	2.7	253 ha	7.6	220 ha	6.6
3. Compensation for loss of agricultural land	25,000 Rs./ha	0	0	50 ha	1.3	32 ha	0.8
4. Watershed protection							
(1) Reforestation[3]	20,000 Rs./ha	12 ha	2.3	24 ha	4.8	62 ha	12.4
(2) Periodical monitoring[4]	3,000 Rs./ha/year	12 ha/ 8 years	2.9	24 ha 8 years	5.8	62 ha 8 years	14.5
5. Domestic water supply for villagers[5]	320 Rs./person/year	1,500 persons 8 years	3.8	1,200 persons 8 years	3.1	3,000 persons 8 years	7.7
6. Public heath protection							
(1) Dispensary[6]	1,000,000 Rs.	1	1	1	1	1	1
(2) Periodical monitoring including water analysis[7]	90,000 Rs./year	8 years	0.7	8 years	0.7	8 years	0.7
7 Wildlife protection (monitoring)	50,000 Rs./year	8 years	0.4	8 years	0.4	8 years	0.4
8. Landscaping	700,000 Rs.	Lump Sum	0.7	Lump Sum	0.7	Lump Sum	0.7
	Total Costs (mil.Rs.)		15.9		28.1		47.9

Notes: 1. Clearance area: Inundated area x 1.10% x vegetation area ratio (VAR)
VAR: Hevale 100%, Jalond 70%, Marleshwar 80%

2. Compensatory afforestation area: Inundated forest area x 110%
3. Reforestation includes tree planting, provision of drainage system and other capital investment for watershed management and control.
Reforestation area: Catchment area x 0.5 - 2%
Hevale 0.5%, Jalond 1%, Marleshwar 2%
4. Reforestation work will be implemented at an early stage of construction, say, during the first two years. Monitoring work will focus on the reforestation area. The cost estimate for the monitoring work takes account of the work during the construction period and the first three years of operation.
5. Tanker water cost is assumed at 400 Rs. per 10,000 litters. Water requirement per person is estimated at 40 litters a day. It is assumed that the tanker water supply is required for 200 days a year during the entire construction period and the first year of operation. The water supply cost is estimated at 320 Rs/person/year.
6. Costs to set up a dispensary. (During the peak construction period, two dispensaries may be required, since there are two separate construction sites (i.e., upper and lower dam sites)).
7. Costs to operate a dispensary and to carry out monitoring work including periodical medical check for local inhabitants and water analysis.

12.8 Conclusions

The proposed project is a site specific river-valley project, depending upon particular site conditions and requiring reservoirs to store water. Although its reservoirs are grossly smaller than those usually required for ordinal hydro-power projects with similar generation capacity, the project inevitably has significant adverse impacts on the environment. Some of the impacts can be mitigated effectively, and others can not. Compensation is sometimes the only solution to the latter.

Basically, the proposed project sites will not be much different in terms of the type and degree of impacts involved. Wherever implemented among the three sites, the project will not involve displacement of local population. It, however, is expected to have the following major adverse impacts:

i) loss of forest (including loss of flora, fauna, and wildlife habitat),
ii) loss of agricultural land,
iii) possible onset of epidemics or water-borne diseases, and
iv) deterioration (deoxygenation) of water quality during the construction and post-construction periods, and possible depletion of ground water during the construction period.

With respect to the loss of forest and agricultural land, the degree of impact measured by area to be inundated, is slight different at respective sites as follows:

Site	Hevale	Jalond	Marleshwar (ha)
(1) Loss of Forest Land	82	280	200
(Reserved forest)	(82)	(190)	
(Non-reserved forest)		(90)	(200)
(2) Loss of Agricultural Land	0	50	32

Because the project is site specific, loss of forest and agricultural land can not be avoided. As a mitigation measure for the loss, scaling down the reservoir size might be effective. However, this mitigation measure should be assessed also in terms of whether the change can be financially and economically justifiable or not. Even with the measure, the impact can not be entirely mitigated at any of the proposed sites. For the loss of forest, compensatory afforestation has to be implemented as par the Forest Act, and similarly for the loss of agricultural land, alternative land or monetary compensation has to be offered as par the Maharashtra State Act for Rehabilitation of the Project Affected Persons.

With reference to the other significant impacts, all the three sites are similar, and there are effective mitigation measures. To minimize possible onset of epidemics or water-borne diseases, the following measures should be taken:

i) Housing, safe water, and sanitation (toilets, drainage, septic tanks, etc.) should be provided for the project workers.
ii) A dispensary should be provided on the site with a qualified doctor and paramedical staff as well as adequate stock of medicines.
iii) A regular programme for malaria abatement should be implemented by spraying DDT to destroy mosquitoes.
iv) Medical check should be carried out regularly for both workers and villagers, and education campaign should be undertaken to raise the awareness on public health issues among them.
v) Project site reconnaissance should be carried out periodically to investigate possible causes for outbreak of an epidemic or a water-borne disease.
vi) Water quality (river/ground/reservoir water) should be analysed periodically.

Deterioration of water quality may not be completely avoided. However, to minimize the deterioration of river water during the construction period and the eutrophycation of reservoir water during the post-construction, the following measures should be taken:

i) Turbid water and other construction-related waste water should be treated sufficiently before being discharged into the stream.
ii) Reservoir areas should be completely cleared prior to flooding.
iii) Catchment area should be managed and controlled properly so that such substance and material do not flow into the reservoir that may make the reservoir water eutrophic.

There will be a possible depletion of ground water at existing wells in the general area of the project, if ground water is pumped up for the use for the project. If well water gets depleted because of diversion of flow, or if river/ground water becomes debased, tanker water should be provide to affected villagers.

Minor and moderate impacts expected are (1) decrease in fish catch, (2) traffic safety problems, and (3) air pollution. Basically, those impacts will occur during the construction period only. A solution to the first impact, for which turbid water will be mainly responsible, is monetary compensation. For the second one, such measures as placing persons who control the traffic at necessary spots and improving bottleneck by widening the road should be considered. For the third

one, there would be no effective measures, except instructing drivers to drive slowly, and sprinkling water to reduce the level of dust in the air.

Monitoring is an integral part of environmental impact management, and is required during and after the construction to ensure that actual impacts by the project are within the environmentally acceptable level, and that no impacts are occurring other than those previously anticipated. Environmental elements needed to be monitored include:

i) watershed protection to minimize the occurrence of land slides and soil erosion and thus to assure maximum life of the reservoir,
ii) public health protection to prevent outbreak of epidemics and water-related diseases, and
iii) wildlife protection to minimize the disturbance of the environment in the surrounding area by project workers.

Costs to implement major mitigation measures and a monitoring plan are estimated roughly at:

i) Rs. 15.9 million at the Hevale site,
ii) Rs. 28.1 million at the Jalond site, and
iii) Rs. 47.9 million at the Marleshwar site.

As noted earlier, unavoidable impacts are attributable basically to the fact that the project is site specific and requires reservoirs. The mitigation measures and monitoring plan discussed above should be implemented in a strict and satisfactory manner with sufficient funds provided. It is required rather than recommended that contractors have stringent employment provisions with workers that prevent disturbance of the surrounding environment by them, and provide adequate housing, safe water supply, sanitation, and fuel for them. If those requirements are fulfilled, a substantial portion of the negative impacts can be mitigated.

CHAPTER 13 STUDY IN THE FUTURE

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CHAPTER 13 STUDY IN THE FUTURE

13.1 General

This Study was started in September, 1994 to establish a pumped storage hydroelectric power development program which will be subjective to the feasibility study in the future for Maharashtra State, India. The objectives of the Study were to produce a Master Plan for pumped storage hydroelectric power development and to conduct a Pre-feasibility Study accordingly regarding the several candidate sites.

Ministry of Environment and Forests (MOEF), Maharashtra State, advised that two of the three sites subjected to the Pre-feasibility Study were situated in environmental protection areas. The Ministry also instructed the suspension of the geological site investigation at these sites (December, 1995). Although aerial photography surveys were made at the three sites in question, the Indian Government did not provide permission for the taking out the resulting topographic maps from the country. The pre-feasibility study could not be conducted in Japan as per the agreement between JICA and GOMID.

The Pre-feasibility Study shall be carried out in the next step based on the results of master plan and detailed site investigation which are compiled in this report.

General contents and approach of the Pre-feasibility Study are described in this Chapter.

13.2 Geology

13.2.1 Geological Investigation

Based on the available investigation results, rock mass conditions and problems at the 3 locations are summarized in **Table 13.2-1**.

Table 13.2-1 Order of Priority of Projects

Priority	Site	Structure	Rock Mass Condition
1	J A L O N D	Upper Reservoir	The valley indicates V shape and outcrops are exposed at the bottom and wall of the valley. The seismic velocity is 4.6 km/sec. Gravity dam is feasible. Aggregate is available near the site. Drilling was not carried out because the site is within Sanctuary
		Lower Reservoir	The engineering geological conditions at the dam site are quite good. Below the foundation level, Amygdaloidal Basalt is distributed. It is nearly massive i. e. unjointed and excellent as dam foundation.
2	H E V A L E	Upper Reservoir	Foundation rock would have adequate strength. The geological feasibility of this site depends on the water tightness of the rock, in which columnar joints are developed. Equally important is likelihood of escape of water at the escarpment face. It is difficult to prognosticate on this aspect at this stage of investigation. A man-made reservoir with concrete facing is being studied.
		Lower Reservoir	The quality of bed rock as foundation for a masonry dam is excellent in terms of strength, massiveness and permeability. Continuous outcrops of quartzite/mica schist are exposed at the toe of left bank slope and the depth of bed rock would be great judging from the seismic survey results of the adjacent areas.

Priority	Site	Structure	Rock Mass Condition
	M A R	Upper Reservoir	At the bottom of the valley (borehole UM2), the depth to acceptable foundation grade for the contemplated masonry structure is 14m. The same for left and right banks are 34m and 38m in depth respectively. No data on permeability of overburden (laterite) are available at the dam axis. Consequently, it is difficult to prognosticate if the thick laterite (34-38m depth) would permit leakage through the abutment or not. Laterite of 20 to 22m thick is distributed all over the reservoir.
3	L E S H W A R	Lower Reservoir	[Dam Axis I --- Downstream Alternative] On the right bank, a zone of Volcanic Breccia/Tachylytic Basalt was encountered from RL 193m to 183m and from RL 173m to 158m. Presuming that this soft zone is horizontally disposed, it would be necessary, in case a masonry/concrete dam is constructed here, to strip it so that this soft zone is completely replaced with concrete. Similarly on the left bank, the 10m thick Tachylytic Basalt was encountered. Slope failure due to seepage from the reservoir may occure. In the riverbed, the foundation grade for a masonry/concrete dam may be kept at the bottom of the first Tachylytic Basalt layer (14m in depth). However, deep excavation to eliminate the 10m thick soft zone of Tachylytic Basalt in the abutments and riverbed would be costly and difficult. [Dam Axis II --- Upstream Alternative] Tachylytic Basalt is distributed at RL 205m to RL 196m on the right bank and about RL 196m on the left bank. It is difficult to remove the Tachylytic Basalt. Because of a narrow and partially rocky valley, Dam Axis II is more attractive than Dam Axis I. However, considering rapid diurnal fluctuation of the water level, fairly steep and covered reservoir rim is likely to develop instability of slope. Landslide configurations were found in the reservoirs of both alternatives.

Considering the above mentioned problems, the evaluation of the dam foundation depends on the geology at each site, i.e. massive Amygdaloidal Basalt or hard and fine but cracky Compact Basalt. Furthermore, at Marleshwar, the distribution of landslide configuration and Tachylytic Basalt is a problem. The first priority of investigation is to make a 1/1,000 scale geological map of the project area.

For Jalond and Ilevale, the investigation for the preliminary design is needed. AFor Marleshwar, the investigation at places in question is needed because the rock mass condition is not good. The proposed geological investigation plan is as follows:

(1) Jalond Site

(a) Upper Dam Site

(i)	Dam Site	Drilling: 80m x 5 locations (including 3 drilling not yet started)
(ii)	Rock Test	5 samples x 5 location
(iii)	Lugeon Test	26 x 5 locations
(iv)	Underground Power Station Site	450m x 1 location (Rock test: 10 samples)
(v)	Surge-tank Site	100m x 1 location (Rock test: 10 samples)
(vi)	Water-conveyance locations) Conduit Site	100m x 3 locations (Rock test: 4 samples x 3
(vii)	Seismic Survey at Water-conveyance Conduit	1 km
(viii)	Quarry Site locations,	100m x 3 locations (Rock test: 5 samples x 3 Slaking test: 3 samples)
(ix)	Seismic Survey at Quarry	1.5 km

(b) Lower Dam Site

(i)	Dam Site	Drilling: 70m x 4 locations (100m grid)
(ii)	Rock Test	5 samples x 4 location
(iii)	Lugeon Test	23 x 4 locations

(iv)	Adit	Dam site 1.5 x 2.0 x 30m x 2 locations, Sketching
(v)	In-situ Shear Test	1 x 2 locations x 2 sites
(vi)	Plate Load Test	1 x 2 locations x 2 sites
(vii)	Outlet	Drilling: 50m x 1 location
viii)	Seismic Survey at Outlet	1 km
(ix)	Quarry Site	100m x 3 locations (Rock test: 5 samples x 3 locations, Slaking test: 3 samples)
(x)	Seismic Survey at Quarry	1.5 km
(xi)	Survey for Soil Material	Reconnaissance, Drilling: 3 locations (sampling and compaction test: 5 samples)

(2) Hevale Site

(a) Upper Dam Site

(i)	Dam Site	Drilling: 30m x 7 locations
(ii)	Rock Test	5 samples x 7 location
(iii)	Lugeon Test	9 x 7 locations
(iv)	Underground Power Station Site	550m x 1 location (Rock test: 10 samples)
(v)	Surge-tank Site	100m x 1 location (Rock test: 5 samples)
(vi)	Water-conveyance locations) Conduit Site	100m x 3 locations (Rock test: 4 samples x 3
(vii)	Seismic Survey at Water-conveyance Conduit	1 km
(viii)	Quarry Site locations,	100m x 2 locations (Rock test: 5 samples x 3 Slaking test: 3 samples)
(ix)	Survey for Soil Material	Reconnaissance, Drilling: 3 locations (sampling and compaction test: 5 samples)
(x)	In-situ Permeability Test	Vertical shaft ϕ 1.8m x 10m

(b) Lower Dam Site

(i)	Dam Site	Drilling: 70m x 4 locations
(ii)	Rock Test	5 samples x 4 location
(iii)	Lugeon Test	23 x 4 locations
(iv)	Adit	Dam site 1.5 x 2.0 x 30m x 2 locations, Sketching
(v)	In-situ Shear Test	1 x 2 locations x 2 sites
(vi)	Plate Load Test	1 x 2 locations x 2 sites
(vii)	Outlet	Drilling: 50m x 1 location
(viii)	Seismic Survey at Outlet	1 km
(ix)	Quarry Site locations,	100m x 3 locations (Rock test: 5 samples x 3 Slaking test: 3 samples)
(x)	Seismic Survey at Quarry	1.5 km
(xi)	Survey for Soil Material	Reconnaissance, Drilling: 3 locations (sampling and compaction test: 5 samples)

(3) Marleshwar Site

(a) Upper Dam Site

(i)	Pond	Drilling: 45m x 5 locations
(ii)	Laterite Sampling	Triple tube sampler ϕ 120mm x 3 x 5 locations
(iii)	Laboratory Permeability Test	Laterite: 3 samples x 5 locations
(iv)	Laboratory Soil Test	Laterite: Index test, Unconfined and Triaxial Compression Test
(v)	In-situ Permeability	Laterite: Vertical shaft ϕ 1.8m x 10m, 3 tests
(vi)	Lugeon Test	3 x 5 locations (Basalt)
(vii)	Underground Power Station Site	600m x 1 location (Rock test: 10 samples)
(viii)	Surge-tank Site	100m x 1 location (Rock test: 5 samples)
(ix)	Water-conveyance Conduit Site	100m x 3 locations (Rock test: 4 samples x 3 location)
(x)	Seismic Survey at Water-conveyance	1 km

	Conduit	
(xi)	Quarry Site locations,	100m x 3 locations (Rock test: 5 samples x 3 Slaking test: 3 samples)

(b) Lower Dam Site

(i)	Dam Site	Drilling: 70m x 4 locations
(ii)	Survey for Ponding Area	Drilling: 70m x 6 locations
(iii)	Survey for Landslide	Drilling: 35m x 2 locations x 4 sites
(iv)	Soil Test	Index test
(v)	Stability Analysis	2 sections
(vi)	Monitoring	Pipe strain gauge 35m x 4 locations
(vii)	Rock Test	5 samples x 6 locations
(viii)	Lugeon Test	23 x 4 locations
(ix)	Galley	Dam site 1.5 x 2.0 x 30m x 2 locations, Sketching
(x)	In-situ Shear Test	1 x 2 locations x 2 sites
(xi)	Plate Load Test	1 x 2 locations x 2 sites
(xii)	Outlet	Drilling: 50m x 1 location
(xiii)	Seismic Survey for Outlet	1 km
(xiv)	Quarry Site	100m x 3 locations (Rock test: 5 samples x 3 locations, Slaking test: 3 samples)
(xv)	Seismic Survey for Quarry	1.5 km
(xvi)	Survey for Soil Material	Reconnaissance, Drilling: 3 locations (sampling and compaction test: 5 samples)

13.2.2 Survey Plan for Future

Many kinds of information such a Lugen map, rock mass parameters, modeling of the ground, design parameters (including those of fill material), study for cut-off of water, survey for temporary construction, and survey for temporary road, are needed for the detailed design. Survey plan for the detailed design will be proposed after the investigation proceeds.

13.3 Hydrology

The hydrological parameters were analyzed by using the available data as summarized in Chapter 11. However, in fact, there is limitation in the data availability and the study results are not at a satisfactory level. It is to be noted that a further study is to be conducted to obtain more accurate hydrological parameters and utilize them for the subsequent detailed planning of the project. For these purposes, it is suggested to carry out the following surveys:

(1) Rainfall, river flow and sediment load shall be measured at the proposed sites.

(2) The monthly and daily rainfall data recorded at some stations which have been operated over a long period of time (30 years or more) by other organizations shall also be collected, if available.

(3) Hourly meteorological data such as vapor pressure, dry and wet temperature and so forth shall also be measured. These will be useful for PMP estimation.

13.4 Environmental Impact Survey

The major aim of this pre-EIA study is to conduct the environmental survey, assess the environmental impacts, identify mitigating measures and formulate an environmental management plan, comparatively for the three proposed sites of Hevale, Jalond and Marleswar.

However, further studies for the following issues are required because of the insufficient data obtained in this pre-EIA study.

(1) To conduct environmental survey, assess the environmental impacts, identify mitigating measures and formulate an environmental management plan based on the detailed topographic maps and land-use maps obtained from the aerial survey.

(2) To collect and survey examples relating to monetary compensation or alternative land for affected persons in other hydro-electric projects.

(3) To conduct additional environmental surveys along the transmission lines which were not performed by this pre-EIA study in spite of being essential facilities for hydro-electric power projects.

(4) To conduct a detailed survey relating to the distribution of wells, current use and water table, etc. around the proposed sites.

(5) To study the issues on the agreement process between the project proponent and the local inhabitants during construction (A community consisting of the worker's residence, schools and other relevant infrastructure will be generated around the proposed sites).

(6) To study the possibilities of committees relating to the preservation of Marleswar temple in Marleswar site.

(7) To study the adaptation of tree species to the existing vegetation of the proposed site for the case of transplantation or afforestation.

(8) To conduct a detailed survey on the latest legislation.

13.5 Power Survey

An extensive survey must be conducted concerning the power demand/supply projection of the power systems and all other relevant factors before introducing a pumped-storage power plant. The power supply plan survey contains a variety of particularly important study items, and this survey serves as the basic information for the plant planning. The studies related to the Maharashtra Pumped-Storage Master Plan have been implemented from this point of view. However, in the case of a pumped-storage project, the power system operation plan must be developed together with the power supply plan being deliberated based on the detailed analysis of a detailed power generation program and a pumping program with considerations given to the resulting power flows in the power system.

In the study of the Maharashtra Pumped-Storage Master Plan, three promising sites have been selected, although no detailed reservoir operation program has been developed. In advancing to further studies, the reservoirs in these three sites must be designed, and the pe-feasibility designs and costs of the related plants must be estimated based on specific operation programs of these plants.

13.5.1 Power Supply Plan

Some of the data of the power systems obtained by past studies are inadequate or old. These data must, therefore, be re-examined in future surveys. The following survey items must be implemented in relation for our power supply plan.

(1) Survey of present power supply/demand conditions (re-examination)

These data must be replaced with the latest data which are obtainable at the time of resuming the survey. In particular, it is necessary to identify the trends in each demand sector to enable clarification of the growth trends required for the development of demand projection.

(2) Power source composition survey and electric power development plan survey (re-examination)

It is necessary to replace these data with those related to the latest power development plan at the time of survey resumption. In particular, it is necessary to clarify the plans of large capacity thermal power plants and base load plants such as nuclear power, as well as the trend of participation of independent power producers (IPP).

(3) Study of load curves (re-examination)

It is necessary to identify the daily load curves of each season. The gross load curve of the entire power pool constituted by the WREB must be studied together with the MSEB system.

(4) Study of pumping potential (re-examination)

The pumping resources and the effect of pumped-storage operation must be quantitatively studied based on the detailed studies of the items above.

(5) Studies of optimal capacity and commissioning sequence/time

The optimal capacity and optimal commissioning years of each project site must be studied together with the items above.

(6) Power system analysis calculation

As the specific development site is identified, the power flow calculations and system stability calculations will be performed to include the effect of this specific plant.

(7) Study of operation plan

The operation plan will be studied based on comprehensive evaluation of the project sites including the reservoir characteristics.

13.5.2 Power Transmission Plan

(1) Survey of current status of transmission facilities (re-examination)

(2) Transmission facility expansion plan (re-examination)

Together with the above survey, the transmission system expansion plan of the MSEB will be surveyed in order to study the system interconnection systems for a pumped-storage plant.

(3) Determination of transmission line route appropriate to each project

In connection with the studies above, the preliminary routes will be established on topographical maps.

(4) Pre-feasibility study design of transmission lines for each project

(5) Cost estimation

13.5.3 Power Plant Design

(1) Preliminary designs of power plant layout and equipment

The pre-feasibility study designs will be developed for the project sizes derived by the study of Paragraph 13.5.1.

(2) Preliminary design of outdoor switchyard

A pre-feasibility study design will be developed corresponding to the project site characteristics and power system requirements.

(3) Preliminary design of related substations

The substations to be interconnected to the power system of the project site will be studied if such substations are required by power system characteristics.

(4) Cost estimation

13.6 Major Civil Works

(1) General

According to the results of power survey to set up the operation mode of pumped storage power plan (maximum output, duration of maximum output), the capacity of reservoir and dimension of civil structure will be determined.

First, the concept design of project planned at the master plan stage will be reviewed. The layout of project will be studied again in the next stage taking into consideration results of detailed site investigations whether the design concept at the master plan stage should be changed or not.

An optimum development scheme will be determined to study the project layout and structure in detailed.

(2) Schematic Design for Major Structures

The civil structures such as upper and lower dams, water way, power house and layout of generator, transformer and switch gear will be studied and determined. The above study will be conducted based on 1:10,000 scale topographical map and the results of all detailed site investigations.

(a) Dam and Reservoir

(i) Upper and lower dam

The major content for the schematic design of dams are the selection of the dam axis, selection of the dam type, selection of the spillway location, and the calculation of an approximate quantity of the work.

The type of dam employed is determined by the prevailing topography such as valley configurations, geology, construction materials, location of spillway and economic performance.

The general conditions in selecting the dam type for either fill, concrete, or masonry dams are provided in the following table:

General Conditions When Selecting Dam Type

Item	Fill Dam	Concrete Dam
Topography (Valley configuration)	Not suitable for narrow gorge	A narrow gorge is suitable when an arch dam is planned. A concrete gravity dam can be constructed irrespective of the gorge width.
Geology	The foundation of the impervious core zone must be Rock Class C_L or higher according to the rock classification by the Civil Engineering Research Institute of the Ministry of Construction.	The foundation of a concrete gravity dam must be rock beds which are equal or superior to Class C_M (which is better than C_I). For arch dams, even stronger rock beds are required.
Construction Materials	The necessary amounts of soil filter and rock materials must be available near the dam site.	The necessary amount of concrete aggregate must be available near the dam site.
Location of Spillway	The topographical conditions must be such that a spillway, which is separate from dam, can be provided.	A spillway overflowing the dam may be selected.

As for the hill-top type reservoir, an optimum earth moving plan should be determined taking into consideration a balance of excavation and embankment since excavated material will be utilized for embankment. The concrete facing with steel reinforcement will be 50 cm in thickness generally.

(ii) Spillway

The capacity of spillway and structure will be determined based on the design flood studied in Chapter 11.

	Upper Dam	Lower Dam
Joland	The dam axis is located at narrow gorge. Rock and aggregate materials are available in the vicinity. Concrete gravity type or masonry type may be adopted.	According to the detailed site investigation, rock fill material was not available in the vicinity of the dam site. Concrete gravity or masonry dams will be taken into consideration.
Marleshwar	According to the site investigation work, the thick literate deposit was found along the proposed dam foundation. A hill-top reservoir type will be included in alternative study, based on the further geological investigation.	It is found that upper dam axis scheme is preferable in terms of geological condition. Masonry and rockwell types will be compared to select dam type in the next stage.
Hevale	Since the hill-top type is to be constructed, optimum earth work shall be found out.	Taking consideration transportation of fill material, concrete gravity or masonry dams is recommended.

(b) Water Way

(i) Headrace and tailrace tunnels

The final water conducting route will be finalized by considering the plane route and topography between the upper dam, lower dam and power house site, and also utilizing the geological data from the detailed site investigation.

And also a sufficient overburden above the tunnel should be checked for the stability of the tunnel.

The optimum tunnel section will be determined based on the generating energy and pumping up energy which are calculated from the loss head of water way and the construction cost.

Thickness of tunnel lining will be 10% of tunnel diameter in general. Quantity of steel reinforcement in the lining concrete will be 30 kg per one cubic meter of concrete.

(ii) Surge tank

A surge tank will be provided at the before the penstock for the headrace tunnel and after the draft gate shaft for the tailrace tunnel, if the tunnel length exceeds 500 m to 1,000 m.

Volume of surge tank can be estimated using following formula.

Up surging

$$Vu = 0.49 \times \sqrt{L} \times Q$$

Down surging

$$Vd = 0.25 \times \sqrt{L} \times Q$$

Q = Maximum discharge (m^3/s)

L = Length of waterway (m)

(iii) Steel penstock

The economical design point of view, the diameter of penstock shall be gradually reduced due to increasing the design head. 10 m/sec. In velocity will be applied at the end of penstock in generally.

The thickness of steel will be calculated using following formula.

$$T = \frac{HD}{2\sigma n} + \varepsilon$$

t = thickness of steel (cm)

H = Design head (kgf/cm^2)

D = Inner diameter of penstock (cm)

σ = Allowable stress of steel penstock ($kgf/cm^{2)}$

n = Joint efficiency of steel penstock (0.95)

ε = Allowance thickness for corrosion and wear (0.15 - 0.20 cm)

$$t' = \frac{D}{400} + 0.2$$

t^1 = Minimum thickness

D = Diameter of steel penstock (cm)

Radius of penstock tunnel will be 60 cm larger than the radius of steel penstock considering workability of steel penstock erection.

(c) Powerhouse

An underground powerhouse will be expected in this project. The location of powerhouse will be determined by an integrated study of underground stability, engineering geological surrounding rockbed.

The location will be also taken into consideration lengths of headrace, penstock and tailrace tunnels as well as layout of access tunnel to powerhouse cable tunnel and construction method. Also dimension of powerhouse and elevation of turbine center will be determined based on the design of hydromechanical equipment.

13.7 Construction Cost for Civil Works

The construction cost for civil works will be estimated based on the quantity of the major construction works determined from pre-feasibility design and market prices of similar project in the vicinity of the project site.

Table 13.7-1 shows typical construction schedule of civil works.

13.8 Project Cost and Construction Schedule

13.8.1 General

Construction cost at pre-feasibility stage includes following items.

- Preparatory work
- Civil work
- Hydromechanical equipment
- Electromechanical equipment
- Transmission line
- Compensation
- Contingency
- Administration fee including engineering services

Table 13.7-1 Construction Cost for Civil Works

Work Item			Unit	Quantity	Unit Price	Amount
Reservoir Dam	Upper Dam	Excavation	m^3			
		Concrete	m^3			
		Masonry	m^3			
		Steel Reinforcement	t			
		Embankment	m^3			
		Gate	t			
		Others	L.S			23% of above sub total
	Lower Dam	Excavation	m^3			
		Concrete	m^3			
		Masonry	m^3			
		Steel Reinforcement	t			
		Embankment	m^3			
		Gate	t			
		Others	L.S			23% of above sub total
	Miscellaneous Work					3% of dam work
Water Way	Intake	Excavation	m^3			
		Concrete	m^3			
		Reinforcement	t			
		Gate	t			
		Screen	t			
		Others	L.S			20% of above sub total
	Headrace Tunnel	Excavation	m^3			
		Concrete	m^3			
		Steel Reinforcement	t			
		Others	L.S			22% of above sub total
	Surge Tank	Excavation	m^3			
		Concrete	m^3			
		Steel Reinforcement	t			
		Others	L.S			20% of above sub total
	Tailrace Tunnel	Excavation	m^3			
		Concrete	m^3			
		Steel Reinforcement	t			
		Others	L.S			20% of above sub total
	Tailrace Surge Tank	Excavation	m^3			
		Concrete	m^3			
		Steel Reinforcement	t			
		Others	L.S			20% of above sub total

Work Item			Unit	Quantity	Unit Price	Amount
Water Way	Tailrace Outlet	Excavation	m^3			
		Concrete	m^3			
		Steel Reinforcement	t			
		Gate	t			
		Others	L.S			20% of above sub total
	Miscellaneous Work		L.S			4% of water way work
Powerhouse	Powerhouse	Excavation	m^3			
		Concrete	m^3			
		Steel Reinforcement	t			
		Others	L.S			20% of above sub total
	Draft Gate and Transmission Room	Excavation	m^3			
		Concrete	m^3			
		Steel Reinforcement	t			
		Gate	t			
		Others	L.S			20% of above sub total

13.8.2 Condition of Cost Estimate

(1) Preparatory Work

Preparatory work includes following items in general.

- Access road to be constructed newly
- Improvement of existing road
- Camp facilities (office building accommodation)
- Telecommunication facilities
- Others

(2) Civil Works

The costs for civil works are estimated based on Table 13.7-1 in Chapter 13.7.

(3) Hydromechanical Equipment

Hydromechanical equipment includes following items.

- Trashracks
- Gates
- Valves
- Steel penstock

The cost includes material, fabrication, transportation, installation, commissioning insurance and others.

(4) Electromechanical Equipment

Electromechanical equipment includes following items.

- Turbine/Pump
- Generator/Motor
- Control equipment
- Main transformer
- Switchgear
- Auxiliary equipment

The cost includes materials, fabrication, transportation, installation, commissioning insurance and others.

(5) Transmission Line

Transmission line includes following items.

- Transmission lines between switch yard and substation to be connected with steel towers and their foundation

The cost includes material, fabrication, transportation, installation, commissioning, insurance and others.

(6) Contingency

The contingency will be estimated by the following procedure.

- 10% of civil works and preparatory works
- 15% of compensation
- 5% of hydroelectric equipment and electromechanical equipment respectively
- Contingency (5%) of transmission line is included in transmission line work itself

(7) Compensation

As for compensation cost, detailed items are as shown in **Table 12-14 and 12-15** in Chapter 12.

(8) Administration Fee including Engineering Services

The above cost is calculated at 8% of the direct cost. One for transmission line work is also calculated at 8% of transmission line work and included in the transmission line work itself.

13.8.3 Construction Schedule

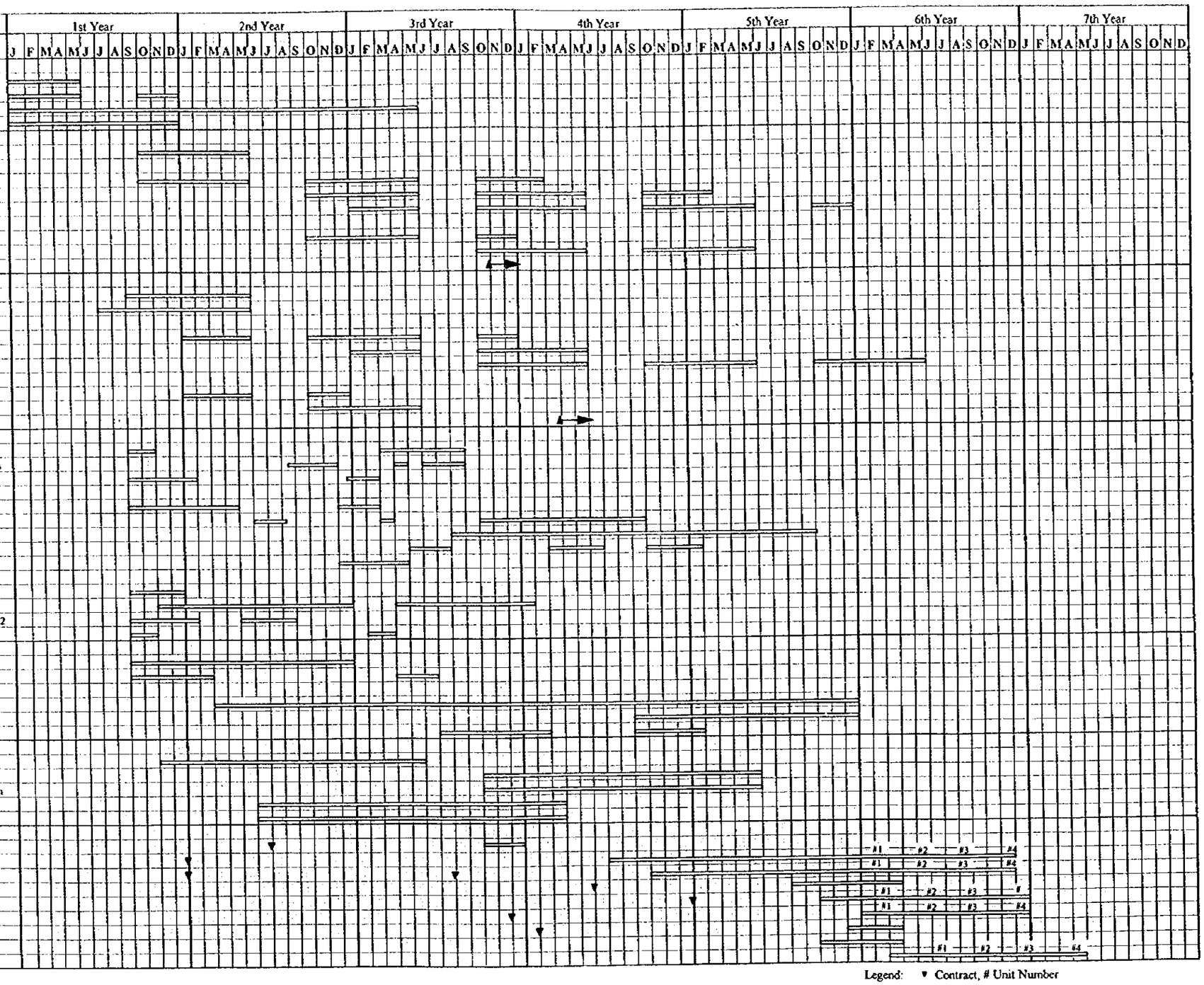
A construction schedule will be made taking into consideration the scale of project, construction method, locations of the structures and the hydrological/meteorological conditions. The conditions

that cause critical pass for the schedule will be studied and the construction method will be studied and then the appropriate construction schedule will be planned accordingly.

An example of construction schedule for pumped storage power project with 900 MW planned in India is shown in **Fig. 13.8-1**.

Figure 13.8-1 Example of Pumped Storage Project Construction Schedule

Activities	Quantity
1. Infrastructure	
Const. of New Road	6 km
Improvement to Existing Roads	
Colony Building Works	
Other Preparatory Works	
2. Upper Dam	
a Coffer Dam	
b Main Dam	
Excavation	738,000 m^3
Foundation Treatment	37 km
Embankment Fill	3.62 x 10 m^3
c Spillway	
Excavation	58,000 m^3
Concreting	8,800 m^3
d Impounding	
3. Lower Dam	
a Coffer Dam	
c Diversion Tunnel	D = 50 m, 280 m
d Main Dam	
Excavation	190,300 m^3
Foundation Treatment	11 km
Embankment Fill	1.85 x 10m^3
e Spillway	
Excavation	90,000 m^3
Concreting	17,400 m^3
f Impounding	
4. Waterway	
a Power Intake	B80m x L54m
b Intake Tunnels	ϕ8.9m, l = 159m,194m
c Intake Gate Shaft	ϕ12m, H = 56m x 2
d Penstocks	
HRT/Penstock Access Tunnel	ϕ9.0m, l = 480m
Upper Penstocks	ϕ8.9m, l = 195m x 2
Inclined penstocks	ϕ8.0m, l = 260m x 2
Lower Penstocks	ϕ2.5m, l = 75m x 4
Penstocks Work Adit	ϕ6.0m, l = 280m x 2
e Tailrace	
TRT Work Adit	l = 210m
Tailrace Tunnels	ϕ9.7m, l = 980m
Tailrace Gate Shaft	13m x 8m, H = 50m x 2
Tailrate Outlet	
5. Powrehouse Complex	
a Access Tunnel to Powerhouse	ϕ6.8m, l = 970m
b Cable Tunnel	l = 360 m
c Powerhouse Gavern	
Excavation	143,500 m^3
Concreting	40,000 m^3
d Transformer Room	12,170 m^3
6. Hydraulic Equipment	
a Intake Gate	2 NOS. 7.7m x 8m
b Draft Tubes Gates	4 NOS. ϕ5.6m
c Tailrace Gates	4 NOS. 8. 7m x 8.7m
d Spillway Gates	2 NOS. 5m x 6m
e Bottom Outlet	
7. Electro-Mechanical Equip.	
Crane	2 Sets
Pump Turbine	4 Units
Generator Motor	4 Units
400kV, Sw.yard & GIS Equip.	9 Bays (GIS)
Main Power Transformer	4 Sets
16.5kV I.P.B. Gen. Con. Panel	Lump Sum
C&R Panels, Protection Equip.	Lump Sum
Auxiliary Machine	Lump Sum
Testing & Commissioning	Lump Sum



Legend: ▼ Contract, # Unit Number

13.9 Economic and Financial Framework

Electric power is essential to a nation's continued industrial growth and people's welfare. While power sector investment requires massive amounts of capital and other scarce resources of the country, it is imperative that the investment be economized, to the maximum extent possible, to produce optimum financial and economic returns.

Difficulties are encountered by the mission to further specify the project parameters to proceed with financial analysis and evaluation due to the delay in processing of the JICA study. With this, this report provides an outline of the process of the economical and financial analyses as follows: (i) analytical framework, (ii) analytical processing, (iii) model configuration and parameters, (iv) financial analysis, and (v) economic analysis.

13.9.1 Analytical Framework

The guidelines for and manuals of financial and economic analysis for power projects currently in use by the Japan International Cooperation Agency (JICA) and other international lending institutions inclusive of the World Bank (WB) and the Asian Development Bank (ADB) have been referred to, wherever appropriate, in this section.

(1) Outline View

Economic analysis of the prospective investment project will be undertaken on the same basic data as the Financial Internal Rate of Return calculation with the modifications and exceptions discussed as follows:

Transfer payment which is a shift of claims on real resources from one member or sector of society to another without any change in the national income will be excluded in the Equalizing Discount Rate (EDR, alternative to Economic Internal Rate of Return) estimation. Specifically, taxes and duties, import tariff levied on locally and internationally procured project inputs. Interest accrued to local borrowings will also be excluded from EDR estimation.

Regarding tradable goods and services, economic valuation is on the basis of border prices in foreign currency terms (CIF for importables and FOB for exportables. As for non-tradable goods and services, conversion factors will be considered to convert the market value of the Project components to its value in shadow prices expressed in terms of border currency units.

Standard Conversion Factor (SCF) will be applied to the product of all non-tradable goods and services employed other than unskilled labor for the Project.

(2) Least Cost Analysis

The levelized economic cost analysis would possibly be undertaken, as necessary, to confirm that the prospective pumped-storage hydraulic power scheme would be the least-cost means of supplying peak load and also an integral part of the power system expansion program. In line with this approach, the technically feasible alternative peak generation options to the prospective project including peak adjustment coal thermal generation will be studied to determine the per unit costs.

The current unit cost of the power generation alternatives in Maharashtra in 1994 are presented herewith as indicative figures (Table below)[1].

Coal-Thermal (paisa/kWh)	96
Hydropower (paisa/kWh)	16
Gas-Turbine (paisa/kWh)	122

(3) Benefits and Costs

In principle, economic benefits attributable to the project in concern will mostly be defined in the form of (i) incremental electricity consumption, and (ii) alternative ways to produce electricity to meet the same expected demand. Assuming that the expected demand for power must be met regardless of which sector investment in the economy be prioritized, EDR analysis will be carried out in the feasibility study while explicit technical specification of the investment alternative under consideration being defined. An EDR estimate which equalizes the economic cost flows of the two alternatives, vis-à-vis, the prospective pumped storage hydropower plant and a peak adjustment coal thermal plant that deliver the same benefit will be compared with the opportunity cost of capital to confirm numerical superiority.

It is to be noted that, in the study reports previously submitted to JICA, the index of equalizing discount rate (EDR) has often been estimated in lieu of economic internal rate of return (EIRR) under the name of EIRR. Economic analysis in this report will also be adjusted in way of estimating EDR for (alternative) EIRR.

[1] Where further analysis takes place, there is a need to add costs accruable to transmission/distribution losses.

In the case of pumped-storage power projects, the variable recurrent costs and fuel costs accruable to base-load coal thermal/nuclear power supply for the project at night are to be incrementally added.

Some benefits may be realized through reducing supply costs during off-peak periods and through improving supply quality[2], and employment opportunities during construction stage. However, these benefits may be relatively small depending on further assumptions, and so will not be included in the analysis.

13.9.2 Analytical Processing

In the light of designing the investment project under the Study to promote increased efficiency in the energy sector by providing badly needed peak load capacity in the country, the following financial and economic analyses on the prospective pumped storage hydropower project would possibly be undertaken during the study period ahead:

(1) Estimation of equalizing discount rate (EDR) to determine which type of power investment (the prospective project and the alternative power generation) represents the best use of scarce resources given the decision to invest in power,

(2) Financial Internal Rate of Return (FIRR) calculation to forecast financial viability,

(3) Formation of Indicative Financial and Repayment Plans,

(4) Sensitivity analysis for variation in relevant parameters, vis-à-vis, (i) tariff, (ii) capital cost , and (iii) delay in project commissioning, and

(5) Financial and economic evaluation of the Project based on the numerical superiority as reflected in FIRR and EDR (alternative EIRR).

It is to be noted that the analysis of project accounting could not performed due to lack of the relevant data and information.

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[2]This may include improved network voltage regulation and frequency control.

13.9.3 Model Configuration and Parameters

Subject to technical and other most relevant and best available data/information at the time of final appraisal in the days to come, the numerical assumptions set for the financial analysis includes (i) project life, (ii) tariff, (iii) electricity sales, (iv) foreign exchange quotation, (v) cost estimation (base cost), (vi) physical contingency factors, (vii) price escalation factor, (viii) financial terms, (ix) O/M cost, (x) interest during construction (IDC), and (xi) discount rate. Furthermore, a sensitive analysis is to be carried out to assess the magnitude of the possible risks.

(1) Project Life

Duration of the Project will be set according to the prospective economic life of the proposed investment and anticipated construction/commissioning schedules. Currently the total project life will be set at 30-40 years inclusive of loan periods.

(2) Tariff (Revenue)

The government is currency attaching an importance to set electricity prices at long-run marginal cost (LRMC) with a view to promoting an increased efficiency in consumption, while also providing financial incentives for MSEB to further improve operational efficiency. It is reasonable to assume that the average tariff in the GOMID's power supply to the agricultural sector in 1997 is Rs. 0.5 /kWh while the average tariff in the MSEB's power supply system is Rs. 1.6 - 1.8 /kWh.

(3) Sales Volume

In carrying out the analysis, sales volume of electricity (Q) would be postulated as per the following formula, while taking MSEB and GOMID revenue projections into consideration.

Q = Average power generation x (1-Transmission loss) x (1-Auxiliary use)

(4) Foreign Exchange Quotation

The International Monetary Fund (IMF) data will be used in analysis. Conversions of the Indian Rupees to the US dollar, unless otherwise noted, in early 1997 was Rs.35.43 to one dollar. This rate is presumably assumed to represent the maximum value that the domestic currency would be worth under the market conditions for the time being.

(5) Financial Cost Estimation

In keeping with generally accepted guidelines for financial analysis, the financial costs comprise base cost (capital cost) inclusive of taxes and duties, physical contingencies, price contingency, and interest during construction as measured in constant prices. The capital costs will be reconcilable with the base costs and physical contingencies, but with the exclusion of price contingencies and interest during construction, in compliance with the generally accepted financing principles.

(6) Physical Contingencies

Reflecting expected increases in the base cost estimates of a project due to changes in quantities and methods of implementation, physical contingency allowances will be set at 5-10% of the base cost of the Project.

(7) Price Contingencies

In view of expected increases in the base cost estimates of a project due to changes in unit prices for the various project components/parts beyond the date of the base cost estimates, price contingency allowances will in most cases be set at 5-10% of initial investment. This margin may be subject to further review.

(8) Recurrent (O/M) Costs

Annual O/M costs associated with the project in operation is apt to set at 3-5% of the initial investment. With a view to avoiding intuitive assumptions in analysis, contingencies are set simply to the extent possible.

(9) Financial Terms

Multi-lateral foreign loans assume 20 years of repayment including five years of grace period, at the Banks' standard variable interest rate. As for WB and ADB, the current variable interest rates from Ordinary Capital Resources (OCR) are set at around six to seven per cent with a spread above an international benchmark such as LIBOR. The Japanese aide agency assumes 30 years of repayment inclusive of 10 years of grace at the interest rate around 2.6 percent. Annuity payments will be made twice a year, at the end of the second and fourth quarter. Interest will be payable on the diminishing balance of the outstanding principal. Consequently, interest costs will decrease proportionately as principal is amortized. Unlike

the international lending institutions, a commitment fee will not be charged against undisbursed funds.

(10) Interest During Construction (IDC)

It is to be noted that IDC does not accrue to yen-credit because of its lending policy of interest payment during construction. It neither be included in FIRR calculation.

(11) Discount Rate

In the estimation of the financial viability and economic feasibility as reflected in those indices, discount rate would be assumed to be around 10 % while taking into account the real term capital cost as of the end of 1996 in India.

(12) Sensitivity Analysis

Sensitivity analysis is to be carried out for the following three cases to assess the magnitude of the possible risks therein: (i) lower tariff by 10%, (ii) capital cost overrun by 10%, and (iii) one year delay in implementation.

13.9.4 Financial Analysis (Project sustainability)

Accounting and financial reporting system currently used by GOMID is, in principle, a cash accounting system which records income (state government budget) and expenditures only when cash is received and dispensed from the special account opened at the State Bank of India (SBI). There are four kinds of accounts in place to manage and report the large quantities/value of assets and a number of money transactions of each project transactions, vis-à-vis, Cash Account (cash transaction), Store Account (quantity account), Dead Stock Account (inventories and other non-durable current assets), and Machinery and Equipment Account (fixed assets). The implication of depreciation of fixed assets are little considered.

Nonetheless, project accounting analysis was not fully be prepared at the time of fielding in 1994 due to lack of best relevant accounting information/data of GOMID, and accounting practice not in compliance with the generally accepted accounting principles (GAAP) in the US.

(1) Tariff

By the review of the Overseas Economic Cooperation Fund (OECF), Japan, the average electricity prices per kWh was 151.38 paisa, while those for household, commerce, agriculture, industry, railroad, and sales to other states remaining at 101.02, 196.34, 27.00, 220.68, 203.07, and 95.92, in that order. In this project, tariff would be set at 27.00 paisa/kWh, while taking into account that major consumers for GOMID include farmers and agro-business entities. However, it is considered reasonable to apply 50.0 paisa/kWh in the analysis due to the firm commitment of the state government to raise electricity prices for farmers as per the long-run marginal cost of electricity supply.

(2) Financial Internal Rate of Return (FIRR)

With due recognition of the economic viability of the Project to be analyzed from a broader national perspective, the quantitative impact represented by FIRR would duly be assessed to the extent possible. In practice, a minimum financial benefit would be measured for incremental sales revenues using the average revenue per kWh sold as a proxy for benefits. With a view to self-financing future investment costs at the maximum currently in place. GOMID will be expected to generate financial internal rate of return (FIRR) reasonably equivalent or close to the current opportunity cost of capital of about 10 percent.

As previously noted, the financial costs comprise base cost (capital cost) inclusive of taxes and duties, physical contingencies, price contingency, and interest during construction as measured in constant prices, while keeping in view the generally accepted guidelines for financial analysis. The capital costs will be reconcilable with the base costs and physical contingencies, but with the exclusion of price contingencies and interest during construction. Costs are measured at constant market prices as per 1997.

Numerical expression of FIRR is given as follows.

$$r: \Sigma \{(B-C)_t * (1+r)^{-t}\} = 0 \qquad \text{where } (t=1,2,\cdots,n)$$

(3) Sensitivity Analysis

Sensitivity analysis for variation in relevant parameters, vis-à-vis, (i) lower tariff by 10 percent, (ii) capital cost over-run by 10 percent, and (iii) one year delay in project commissioning will take place to indicate resiliency against the risks as specified above.

13.9.5 Economic Analysis

The project is expected to promote increased efficiency in the energy sector by providing badly needed peaking power capacity in the State and at the same time allowing the existing thermal power plants to operate at higher efficiency. Economic analysis of the prospective investment project will be undertaken on the same basic data as the Financial Internal Rate of Return calculation with the modifications and exceptions discussed as follows:

(1) Transfer Payment

Transfer payment which is a shift of claims on real resources from one member or sector of society to another without any change in the national income will be excluded in the EDR estimation. Specifically, taxes and duties, import tariff levied on locally and internationally procured project inputs. Interest accrued to local borrowings will also be excluded from EDR estimation.

(2) Conversion Factors for Economic Costs

The use of conversion factors will be considered to convert the market value of the Project components to its value in shadow prices expressed in terms of border currency units. Standard Conversion Factor (SCF) will be applied to the product of all non-tradable goods and services employed other than unskilled labor for the Project. To date, the SCF and conversion factor for unskilled labor in use by WB and the Study team are 0.8 and 0.52, respectively.

(3) Equalizing Discount Rate (EDR, Alternative EIRR)

An EDR estimate which equalizes the economic cost flows of the two alternatives, vis-à-vis, the prospective hydropower plant and a peak adjustment coal thermal plant (or a gas-turbine power plant) that deliver the same benefit is only relevant when being assumed that the expected demand for power must be met regardless of which sector investment in the economy be prioritized.

Numerical expression of EDR is given as follows:

$$r: \Sigma \{C1_t * (1+r)^{-t}\} = \Sigma \{C2_t * (1+r)^{-t}\} \quad \text{where } (t=1,2,\cdots,n)$$

(4) Sensitivity Analysis

As is the case of financial analysis, sensitivity analysis for variation in relevant parameters, vis-à-vis, (i) lower tariff by 10 percent, (ii) capital cost over-run by 10 percent, and (iii) one year delay in project commissioning will take place to indicate resiliency against the risks as specified above.

Some benefits may be realized through reducing supply costs during off-peak periods and through improving supply quality[3]. Other non-quantifiable project benefits including employment opportunities during construction stage and for operation and maintenance after commissioning and avoided pollution from thermal standby generators. Nonetheless, these benefits may be relatively small depending on further assumptions, and so will not be included in the analysis.

[3]This may include improved network voltage regulation and frequency control.