

EXECUTIVE SUMMARY REPORT

1. GENERAL

Narmada Valley Development Authority (NVDA) proposes to develop the Halon Irrigation Project across river Halon (a tributary of river Burner which itself is a tributary of Narmada). The project is second in the series of dams to be constructed on the tributaries of river Narmada as proposed in the Narmada Master Plan. The project is located near village Karanjia, Tehsil Bicchiya, district Mandla, Madhya Pradesh. The dam site is located 6 km from Sijhora village situated at about 60 km from Mandla on the Mandla-Bilaspur Road. The nearest rail head is at a distance of 66 km at Mandla fort (Nainpur – Mandla narrow gauge). The nearest airport is at Jabalpur situated about 180 km from project site. The project location map is shown in Figure-1.

2. PROJECT DESCRIPTION

The project envisages construction of an earthen dam with a height of 31 m and total length of 993 m with a central spillway and a canal sluice on the left bank. The project envisages a submergence area of 1680.11 ha at Full Reservoir Level (FRL). The Gross Command Area (GCA) is 18,976 ha and Culturable Command Area (CCA) is 13,040 ha. The irrigated command area is of the order of 16,782 ha. The map showing submergence and the command area is given in Figure-2.

3. ENVIRONMENTAL BASELINE STATUS

The baseline status has been categorised into the following categories:

- Physico-Chemical Aspects
- Ecological Aspects
- Socio-Economic Aspects

The baseline status for the above referred categories has been described in the following sections.

3.1 PHYSICIO-CHEMICAL ASPECTS

3.1.1 Meteorology

The climate of the project area is characterized by an oppressive hot summer, high humidity and well-distributed rainfall during the monsoon season. The year can be chiefly divided into four seasons. The summer season lasts from April to May. In the period from June to September, the area receives rainfall under the influence of the south-west monsoons. The months of October and November constitute the post-monsoon season and the winter season lasts from December to March.

The summer in the project area is quite severe in the project area and May is the hottest month of the year. The mean daily maximum and minimum temperatures recorded in the month of May are 40.9°C and 24.1°C respectively. December, is usually the coolest month of the year. The mean daily minimum temperature in the month of December is of the order of 8°C. The average annual rainfall in the area is 1480.31 mm. Majority (82%) of the rainfall in the project area is received during monsoon months (June to September). The relative humidity is generally high throughout the year. The mean annual humidity is of the order of 69%. The relative humidity is comparatively higher (75%) in the south-west monsoon and post-monsoon months. In the other months, afternoons are comparatively dry. In summer months, relative humidity is the lowest, ranging from 35 to 50% in the afternoons.

3.1.2 Geology

The rock formation in the valley reveals hard and compact fine grained ballast, dark grey in colour. The formation consists of Deccan trap of horizontal deposition of ballast entrapped with sedimentary beds. The geological sequence of the valley consists of granite gneiss unconformably overlain by Vindhyan sandstones and Deccan ballast. Exposed rock is seen in the entire width of river Halon at the project site. The project area district is mainly covered by overflowing trap, and its geology presents little variety. In the south, there is a narrow strip in which the crystalline formation is the uppermost. Whereas, on eastern side, granite, limestone and syanite appear in some plains on the edges of hills and nallhas. Trap is the uppermost rock, capped by laterite on the highest peaks.

3.1.3 Soils

Soil survey report of the command area has been prepared by the Department of Agriculture, M.P. State Detailed Soil Survey Scheme, Adhartal, Jabalpur. The land irrigability classification of the project area is given in Table-1.

TABLE-1
Classification of the project area as per land irrigability classes

S. No.	Land irrigability class & sub class	Area (ha)	Percentage
1	t	701.905	3.51
2-I	2t	1604.981	8.44
II	2ts	2845.524	14.25
III	2S	517.999	2.60
IV	Total Class 2	4968.504	24.29
3-I	3t	734.400	3.68
II	3ts	2284.482	11.44
	Total class 3	3148.282	15.77
4-I	4st	6561.293	32.84

S. No.	Land irrigability class & sub class	Area (ha)	Percentage
	Total class 4	6561.293	32.84
5-l	6st	4542.391	22.75
	Total class 6	4542.391	22.75
6.	Miscellaneous	52.900	0.27
	Total	18975.275	100.00

3.1.4 Water Resources

The Central Water Commission (CWC) has done gauging on river Burhner and assessed the water availability in the catchment of the proposed Halon project. The details of the yield are depicted in Table-2. The PMF for the project has been taken as 5884.9 m³/sec.

TABLE-2
Estimation of dependable flow

Year	Yield (Mm ³)
1978-79	406.54
1979-80	95.02
1980-81	574.60
1981-82	261.28
1982-83	269.55
1983-84	376.58
1984-85	424.20
1985-86	471.47
1986-87	383.54
1987-88	307.60
1988-89	448.44
1989-90	185.01
1990-91	650.26
1991-92	346.52
1992-93	374.62
1993-94	341.78
1994-95	748.16
1995-96	428.65
1996-97	229.11
1997-98	443.49
1998-99	373.15
1999-2000	524.04
2000-2001	274.98
2001-02	494.90
2002-03	217.52
50% dependable flow	376.58
75% dependable flow	272.27
90% dependable flow	204.52

Source : DPR

3.1.5 Water quality

Ground water quality

The pH in various groundwater samples in various season ranged from 6.9 to 7.8, indicating the marginal alkaline nature of water. The TDS in various wells ranged from 103 to 947 mg/l, 134 to 952 mg/l and 118 to 867 mg/l in winter, summer and monsoon seasons respectively. Barring one well, the TDS level in all the other wells was below the permissible limit specified for domestic use. This trend was observed in the concentration of other cations and anions as well. The BOD and COD levels were generally observed to be quite low, indicating the absence of pollution sources. The concentration of various heavy metals e.g. Copper, Cadmium, Chromium and Lead was observed to be below the detectable limits.

Surface water quality

The pH in various groundwater samples ranged from 7.1 to 7.2, indicating that water is marginally alkaline. The TDS in surface water samples in various ranged from 94 to 117 mg/l. The TDS level, was well within the permissible limit of 500 mg/l specified for drinking water. The BOD and COD levels were generally observed to be quite low, indicating the absence of pollution sources. The concentration of various heavy metals e.g. Copper, Cadmium, Chromium and Lead was observed to be below the detectable limits. Likewise, the concentration of phenolic compounds and cyanides too was observed to be very low. The concentration level of various heavy metals and toxic compounds, e.g. cyanides indicates the absence of chemical pollution sources in the area.

3.1.6 Ambient air quality

As a part of the field studies, three Ambient Air Quality Monitoring (AAQM) locations were monitored. The frequency of monitoring at each station was for two days in a week four consecutive weeks. The parameters monitored were Suspended Particulate Matter (SPM), Respirable Particulate Matter (RPM), Sulphur dioxide (SO₂) and Oxides of Nitrogen (NO_x). The concentration of various parameters was much lower than the permissible limits specified for residential, rural and other areas.

3.1.7 Noise Environment

The day time equivalent noise level at various sampling stations ranged from 39.2 to 40.5 dB(A) and 39.1 to 40.6 dB(A) in winter and summer seasons respectively. In post-monsoon season, the day time equivalent noise level at

various sampling stations ranged from 38.8 to 39.4 dB(A) The noise levels were observed to be well within permissible limits specified for residential area.

3.1.8 Land use pattern

The land use pattern of the command area is given in Table-3.

TABLE-3
Landuse pattern of the command area

Land use category	Area (ha)
Water bodies	49.34 (0.26)
Agricultural land	9852.34 (51.92)
Open vegetation	1178.41 (6.21)
Dense vegetation	4269.6 (22.50)
Scrubs	3129.14 (16.49)
Settlement	497.17 (2.62)
Total	18976 (100)

Note : Figure in brackets indicate percentage

The GCA has maximum area under agriculture (51.92%) followed by area under vegetation (28.71%). Scrubs account of 16.49% of the total command area. The area under water bodies within the command area is quite low, i.e. (0.26%).

3.2 ECOLOGICAL ASPECTS

3.2.1 Vegetation

The Halon Dam project area lies in two districts namely Balaghat and Mandla. The major forest categories reported in the project area are Mixed Forests and Sal forests. In order to assess the density, diversity of the forest in the command area, an ecological survey was conducted for three seasons in the month of December 2004, May 2005 and October 2007. The following sampling sites were covered as a part of the survey:

- Near Mangabeli & Rajo village
- Near Pandulata and Sanjhari village
- Near Kukkara village

Dominance characteristics**Near Mangabeli and Rajo village**

The dominant tree species observed at this sampling site was Dhaura (*Anogeissus latifolia*) with co-dominance of Amta (*Bauhinia malaberic*) and Landia (*Lagerstromia parviflora*).

Near Pandulata and Sanghari village

At this site Landia (*Lagerstromia parviflora*) was observed as dominant tree with co-dominance of Saj (*Terminalia tomentosa*), Mahua (*Madhura latifolia*), Dhaman (*Grewia tilacfolia*) etc. About 16 tree species were observed at this site and barring few species, density of other tree species ranged from 10 to 15 trees/ha.

Near Kukkara village

The dominant tree species observed at this sampling site was Sal (*Shorea robusta*). The other tree species observed in the area are Dhaman (*Grewia tilacfolia*), Jamun (*Syzygium cuminii*), Saj (*Terminalia tomentosa*), etc.

Diversity Indices

The Shanon Diversity and Evenness Indices estimated various sites are given in Table-4.

TABLE-4
Shanon diversity index (H) & Evenness index (e) at different sampling sites for species

Winter Season						
Sampling sites	Shanon Index (H)			Evenness Index (e)		
	Tree	Shrubs	Herbs	Tree	Shrubs	Herbs
Near Mangabeli	3.1	2.56	2.56	3.25	3.03	3.29
Near Pandulata/ Sanghari	3.9	2.39	2.77	3.24	3.07	3.277
Near Kukkara	2.55	2.30	2.77	2.55	2.96	3.96
Summer Season						
Near Mangabeli	3.10	2.56	1.92	3.25	3.03	2.47
Near Pandulata/ Sanghari	3.9	2.39	2.24	3.24	3.07	2.65
Near Kukkara	2.55	2.3	1.92	2.55	2.96	2.75
Post Monsoon Season						
Near Mangabeli	3.10	2.56	2.91	3.25	3.03	3.74
Near Pandulata/ Sanghari	3.90	2.39	2.77	3.24	3.07	3.27
Near Kukkara	2.55	2.30	2.72	2.55	2.96	3.89

3.2.2 Fauna

The project area does not support good habitat for large mammals. There is no major fauna observed in the command area of the proposed project. No rare and endangered species too have been recorded in the project affected area. Kanha Tiger Reserve is in the vicinity of the submergence area which is situated at a distance about 5-7 km from the periphery of the proposed submergence area boundary.

3.3.3 Fisheries

River Halon is the tributary of Narmada which is the largest river of district. The river is seasonal in nature and most of its stretch remains dry during the summer months. This can be attributed to the phenomena, that no major fisheries have developed in river Halon. The main commercially important fish species in the river are *Labeo rohita*, *Cirrhina mrigala*, *Catla catla*, and *common carp*.

The fisheries survey was conducted during summer, post-monsoon and winter season with the help of local fishermen using cast net and gill net. *Labeo* was the dominant species in all the three seasons and comprised about 37 to 44% of the total fish catch. The next dominant species was *Cirrhina mrigala* which accounting for about ranges between 12 and 18%. The other fish species observed were *Catla catla*, *Cyprinus carpio* and *Clarias batracus*.

Tank and pond fisheries are common in the project area. Locals culture fisheries in small tanks and ponds. The major fish species cultured in tanks and ponds in the project area is given in Table-5.

TABLE-5

Fish species cultured in the project area

Scientific name	Common name
<i>Labeo rohita</i>	Rohu
<i>Catla catla</i>	Katla
<i>Cirrhina marigala</i>	Marigal
<i>Cyprinus carpio</i>	Common carp
<i>Ctenopharingodon idela</i>	Grass carp
<i>Hypophthalmichthys mglitric</i>	Silver carp

3.3 SOCIO-ECONOMIC ASPECTS

3.3.1 Demographic profile

The dominant caste group in the area are the Scheduled Tribes, followed by the General Castes. The number of females is marginally higher in the two blocks of Mohgaon and Ghungri. However, considering the command area in totality, the male female population almost works out to be in equal proportion. The literacy

rate in various command area blocks is quite low (19.6% to 32.9%), indicating socio-economic backwardness of the area.

3.3.2 Occupational profile

The occupational profile of the command area is given in Table-3.43. It is observed that agriculture is the main occupation in the command area. About 95% of the main workers are involved in this location, either as farmers (70.3%) or as agriculture labour (24.8%). The workers under household industrial category is quite low (about 5%). The skewed occupational profile indicates the absence of avenues for occupation, apart from agriculture. This is an indication of backwardness as far as industrialization is concerned.

3.3.3 Agriculture

The major crops grown in the area is paddy followed by wheat. Among the oil seeds, mustard is quite common. The irrigation intensity is low and use of agro-chemical dosing too is low. These factors are responsible for low agricultural productivity in the area.

3.3.4 Public health

The major water-borne diseases include Gastro-enteritis, Dysentery diarrhea, Jaundice and Malaria. It is noticed that the Gastroenteritis is the commonly observed water borne disease in the command and leads to fatalities as well. The climate in the project area is suitable for the growth of mosquitoes. In many parts of the command area, stagnant pools of water are observed which serve as ideal habitat for proliferation of mosquitoes. The area thus is prone to malaria. The pathogen responsible for incidence of malaria in the project area are *Plasmodium falciperum* and *Plasmodium vivax*. Few deaths too as a result of malaria too have been reported. A maximum of 12 deaths due malaria were reported in the command area blocks in 2001. It is observed that there is a sharp decrease in the incidence of malaria since year 2003.

3.3.5 Water supply

The main source of water supply in the command area is groundwater, i.e. handpump. However, there are some villages which comes under piped water supply scheme. Apart from the above, water supply is also made through tubewells/dugwells. There are about 144 villages in the Mandla district under piped water supply scheme with no treatment facilities. Treated water is supplied only in the Bichhiya and Mohgaon towns.

3.3.6 Industries

As per the information furnished by the Department of Industries, Mandla, there are no major industries (either agro or others) existing in the command area and its surroundings.

4. PREDICTION OF IMPACTS

The impacts on various aspects of environment are briefly described in the following sections.

4.1 IMPACTS ON LAND ENVIRONMENT

a) Construction Phase

Environmental degradation due to immigration of labour population

The peak labour and technical staff congregation would be of the order of 6,000 and 1,000 respectively. The total increase in population shall be of the order of 19,300. Separate accommodation and related facilities for workers, service providers and technical staff are to be provided as a part of the project. The congregation of labour force is likely to create problems of sewage disposal, solid waste management and felling of trees for meeting fuel requirements, etc.

Operation of construction equipment

During construction phase, various types of equipment will be brought to the site. These include crushers, batching plant, drillers, earth movers, etc. The siting of these construction equipment would require significant amount of space. In addition, land will be required for storage of various construction material as well. However, land for this purpose will be temporarily acquired, i.e. for the duration of project construction phase (6 years).

The site for storage of construction material and equipment should be selected that it causes minimum adverse impacts on various aspects of environment. Such land requirements are temporary in nature ranging from 3 to 6 years. Efforts shall be made that such facilities are located on government or panchayat land only and to the extent possible away from human population, so that hardships caused as a result of land acquisition, though temporarily on this account are minimized to the extent possible.

Soil erosion

The runoff from various construction sites, will have a natural tendency to flow towards along with the natural drainage. Thus, the disposal of drainage effluent

with such high turbidity levels is bound to affect the water quality, especially in the lean season. The drains/nallahs close to various construction sites along the canal alignment are seasonal in nature. Normally in such rivers biological productivity is not high. Hence, the increase in turbidity levels are not expected to be significant in nature.

b) Operation Phase

Acquisition of land

The land required for submergence and canal alignment is 2,220.11 ha. The details are given in Table-6. In addition, land will also be required for minors and sub-minors, distributaries, approach road, contractor's working space, etc.

TABLE-6
Details of land requirement

Use	Area (ha)
Reservoir area	1680.11
Canal network	540.00
Total	2,220.11

The details of land coming under reservoir submergence are given in Table-7.

TABLE-7

Details of land coming under reservoir submergence (ha)

Village	Tehsil	District	Private land	Government land	Forest land	Total
Karanjia	Bichhiya	Mandla	28.56	1.10	-	52.66
Birsa	Bichhiya	Mandla	220.41	10.17	-	230.58
Mangabeli	Bichhiya	Mandla	195.67	10.30	10.95	216.92
Rajo	Bichhiya	Mandla	140.59	25.10	1.90	167.59
Dharamपुरi	Bichhiya	Mandla	-	4.05	-	4.05
Boda	Baihar	Balaghat	30.67	18.47	4.48	53.62
Kukarra	Baihar	Balaghat	10.45	3.00	0.36	13.81
Kohlikhapa	Baihar	Balaghat	46.25	3.622	2.148	52.02
Alna	Baihar	Balaghat	219.29	30.00	1.52	250.81
Murenda	Baihar	Balaghat	10.64	11.10	8.21	32.95
Parasmou	Baihar	Balaghat	133.58	2.10	9.02	144.50
Sanjhari	Baihar	Balaghat	210.78	14.497	23.033	248.31
Dhudwa	Baihar	Balaghat	4.89	-	4.12	9.05
Pandutala	Baihar	Balaghat	131.44	20.80	37.72	189.96
Semarkheda	Baihar	Balaghat	-	-	6.30	6.30
Total			1413.02	157.29	109.80	1680.11

Change in land use pattern

The proposed project envisages irrigation intensity of 128.7%, i.e. 72.9% in Kharif and 55.8% in Rabi cropping seasons respectively. The pre-project cropping intensity is 79.6% which includes 58.3% in Kharif and 21.3% in Rabi season respectively. As per the satellite data, at present the area under agriculture and scrubs is 9,852.34 ha and 3,129.14 ha respectively. The total area under agricultural and barren lands is 12,981.48 ha. The CCA of the project area is 13,040 ha. Thus, a part of the area shown as scrub land as per satellite data is coming within the command area. Thus, the land which is under scrubs at present, would be brought under agriculture, which is a positive impact. The proposed project thus will not only increase the irrigation intensity but shall also increase the cropping intensity from 79.6% to 128.7%.

4.2 IMPACTS ON WATER RESOURCES AND QUALITY

a) Construction Phase

Impacts due to sewage generation from labour camps

The major sources of water pollution during project construction phase are the sewage generated from the labour camps/colonies. The increase in the population is expected to be of the order of 19,300. It is proposed to construct residential, non-residential facilities and buildings near Sijhora dam site Bichhiya and Mandla.

The total domestic water requirements of the labour population (including families) is expected to be of the order of 1.31 mld @ 70 lpcd. It is assumed that about 80% of the water supplied will be generated as sewage. Thus, the total quantum of sewage generated is expected to be of the order of 1.04 mld. The total BOD load contributed by various labour camps/colonies will be about 169 kg/day. It is recommended that an Oxidation ditch be commissioned at various labour colonies.

Impacts due to runoff from construction sites

Substantial quantities of water would be used in the construction activities. With regards to water quality, waste water from construction activities would mostly contain suspended impurities. Adequate care should be taken so that excess suspended solids in the wastewater are removed before discharge into water body.

b) Operation Phase

Impacts on downstream users

The water requirement for Halon Irrigation Project is 133.34 Mm³ including 81.56 Mm³ in Kharif season and 51.78 Mm³ in the Rabi season. The diversion of water for irrigation in the command area could lead to adverse impacts on the downstream flow regime. However, river Halon is seasonal in nature and remains dry during dry season and there are no designated down stream users of water, Hence, no significant adverse impacts on riverine ecology is anticipated.

Impacts on waterlogging and soil salinity

The proposed project envisages application of 133.34 Mm³ per annum of water for irrigation over a CCA of 16782 ha. Thus, about 795 mm of water will be applied every year in the command area. About 25% of the water released in the canal is lost in the conveyance system and further 25% is lost during field application. Most of the water lost contributes to the groundwater recharge. The seepage losses from main canal (2.5%) and distributaries (2.5%) is limited in the area around the canals, but the water lost in water courses (6%) and field channels (14%) and the field application losses are contributed over the whole area.

The natural drainage network in the project area has minimum average slope of 0.35% and some drains have average gradient as high as 5.9%. Relief conditions in the command area are very good. Thus the natural drains will take care of the lateral and main drains. Only field drains and connecting drains are required which will be made under the on-farm development works.

Changes in water quality due to increased use of fertilizers

With the introduction of irrigation, use of fertilizers is likely to increase, to maintain the increased levels of production. The drainage system (natural or man-made) is likely to contain much higher level of nutrients. The climatic conditions in the project area too is suitable for the proliferation of eutrophication in the project area. Thus, in the project operation phase, there will be increased probability of eutrophication in the water bodies receiving agricultural runoff. As a part of Environmental Management Plan ,appropriate control measures have been recommended.

Impacts due to effluent from project colony

It is proposed to provide biological treatment facilities including secondary treatment units for sewage so generated from the project colony. This will ensure that there are no adverse impacts due to disposal of effluents from the labour colony.

Impacts on downstream water quality

The reduction in flow as a result of diversion of water for irrigation would lead to significant reduction in downstream discharges. The river is seasonal in nature and flows for dilution of sewage in any case are not available in dry months of the year. There are no major rivers confluencing with river Halon, just downstream of the project site. In the intervening stretch, there are few villages, along both the banks of river Halon. In these villages, generally open defecation is practiced, and there is no sewerage system which conveys sewage/domestic waste upto the river. However, during monsoon months, runoff from initial rains is bound to have high BOD and other pollution loads. But during monsoons, the river also carries significant flows which provide adequate dilution to prevent any adverse impact on downstream water quality.

4.3 IMPACTS ON TERRESTRIAL ECOLOGY

a) Construction Phase

Flora

Workers and other population groups residing in the area may use fuel wood (if no alternate fuel is provided) for whom firewood/coal depot could be provided. In absence of alternative source of fuel, the labour population would resort to cutting of trees and vegetation in areas close to various construction sites. Hence, to minimize such impacts, community kitchens or fuel depot has been recommended.

Fauna

During construction phase, a large number of machinery and construction labour will have to be mobilized. This activity may create some disturbance to the wildlife population. The forest area shall not be covered for irrigation. The area which is to be irrigated, and comprises mainly of agriculture land interspersed with settlement. As a result of absence of forest or vegetal cover in the command area and increased level of human interferences in the area, wildlife is generally absent in the area.

b) Operation Phase

Loss of forests

The proposed project envisages submergence of 1680.11 ha and the break up is given as below:

- Private land : 1413.02 ha
- Government land : 157.29 ha

- Forest land : 109.80 ha

In addition about 39.03 ha of forest/government land is being acquired due to canal alignment. As per the ecological survey conducted in the submergence area, the tree density ranges from 130 to 300 per hectare. The low tree density in the submergence area indicates the degraded status of forests in the area. No rare and endangered tree species too are reported from the project area. Thus, no major impacts are anticipated on vegetation of the area due to acquisition of land for various project appurtenances.

Impacts on wildlife

The forest land to be acquired has low tree density and no major faunal species are reported. It has been reported based on the interaction with locals, etc., no major fauna is reported. The project area does not appear to be on the migratory routes of animals and therefore, the construction of project will not affect migration of animals as well. The river even, in the pre-project phase, acts as a barrier to the movement of wildlife and there are no reports of wildlife crossing river halon. Thus, construction of the reservoir as a part of the project, is not likely to have any impact on wildlife movement in the area.

Impacts on migratory routes

The faunal species observed in the project area is not migratory in nature. The construction of the proposed Halon irrigation Project, will form a reservoir of area, and is not expected to have any impact on the migratory route. The river in the pre-project scenario, acts as a barrier to the movement of fauna, as a result of which no major migratory route has developed. Thus, no adverse impacts on migratory routes is anticipated as a result of the proposed project.

Impacts on Kanha National Park

Kanha national Park is located at a distance of 5-7 km from the reservoir periphery. Since no portion of national park is getting affected, as a result of the proposed project, hence, no impact on fauna is anticipated as a result of the construction and operation of the proposed project.

4.4 IMPACTS ON AQUATIC ECOLOGY

a) Construction Phase

Impacts due to increased human activities

The increase of human activities in the project area, results in enhancement in indiscriminate fishing including use of explosives. The use of explosive material to kill fish in a pool would result in complete loss of fish and other aquatic life making a river stretch completely barren. Indiscriminate fishing will reduce fish stock availability for commercial and sport fishermen. Thus, it is recommended that adequate surveillance measures are implemented during project construction phase to ameliorate such impacts.

Extraction of construction material

Extraction of gravel and sand causes considerable damage to fish stocks and other aquatic life by destabilizing the sub-stratum, increasing the turbidity of water, silting of the channel bottom and modifying the flow, which in turn may result in erosion of the river channel. These alterations upset the composition and balance of aquatic organisms. For the construction site at or near Narmada the effluent with high turbidity levels would outfall in river Narmada. Though riverine ecology is well developed in river Narmada, but the flow in river Narmada provides adequate dilution. Thus, no adverse impacts on this account are anticipated.

b) Operation Phase

Impacts on riverine ecology

The water for diversion for irrigation in Halon Irrigation project would lead to marginal reduction in flow. The quantum of diversion is within the stipulated use, hence, no adverse impacts on downstream users is anticipated.

Impacts on fisheries potential

Within the command area blocks there are quite a few fish ponds and tanks in districts Balaghat and Mandla in which pisciculture is being practiced. The total area under these ponds is more than 8000 ha. With the increased availability of water the tank and fisheries potential would improve. The average fish production from these tanks is about 0.5 tonnes/ha/yr. However, in the irrigation tanks and in intensively cultured ponds, the average fish yield is of the order of 1 to 2 tonnes/ha/yr. Thus, with introduction of extensive pisci-culture, fish production is expected to increase significantly.

4.5 IMPACTS ON NOISE ENVIRONMENT

a) Construction Phase

Noise due to construction equipment

In water resource projects, the impacts on ambient noise levels are expected due to operation of construction equipment. It is a known fact that there is a reduction in noise level as the sound wave passes through a barrier. Thus, no increase in noise levels is anticipated as a result of various activities, during the project construction phase. There could be marginal impacts on the population residing in proximity to the canal alignment during construction phase as a result of various activities. However, based on past experience in similar projects, the impact however, is not expected to be significant.

4.6 IMPACTS ON AIR QUALITY

a) Construction Phase

Pollution due to fuel combustion in various equipment

The operation of various construction equipment requires combustion of fuel. Normally, diesel is used in such equipment. The major pollutant which gets emitted as a result of diesel combustion is SO₂. The SPM emissions are minimal due to low ash content in diesel. The short-term increase in SO₂, even assuming that all the equipment are operating at a common point, is quite low, i.e. of the order of less than 1µg/m³. Hence, no major impact is anticipated on this account.

Fugitive Emissions from various sources

During construction phase, there will be increased vehicular movement. Lot of construction material like sand, fine aggregate is stored at various sites, during the project construction phase. Normally, due to blowing of winds, especially when the environment is dry, some of the stored material can get entrained in the atmosphere. However, such impacts are visible only in and around the storage sites. The impacts on this account are generally, insignificant in nature.

4.7 INCREASED INCIDENCE OF WATER-RELATED DISEASES

a) Construction Phase

During construction phase or for permanent settlement, if adequate precautions are not taken, the vector-borne disease epidemiology may show sudden or long lasting change. Many of the immigrant population could be reservoir of infection for various communicable diseases. Once they settle in labour camps/colonies, there could be increased incidence of various diseases. This aspect needs to be

looked into with caution, and efforts must be made to ensure that a thorough check up of the labour population congregating in the area is conducted. Those affected by any ailments need to be properly quarantined depending on the ailment with which they are suffering.

b) Operation Phase

Increased incidence of water-related diseases

The association between irrigation development and the incidence of water related diseases such as malaria, etc is well established. The available data clearly indicates that the major water related diseases prevalent in the project area are malaria and gastroenteritis. The preferred environmental setting for vectors is fresh water open to sunshine or moderate shade. The habitats for larvae growth are permanent or semi-permanent standing fresh water such as small ponds, pools, standing agricultural water, permanent or semi-permanent fresh water such as open stretches or canals. Thus, the project may create favorable conditions for breeding of new pathogens or vectors such as mosquitoes, etc. Most of the water borne diseases can largely be prevented by adequate hygiene. The experience of various project confirms the above mentioned hypothesis. In the project area, a sudden spurt in the incidence of malaria is expected, if adequate control measures are not taken up.

Improvement in availability of water for various uses, increased agricultural production, availability of diversified food, strengthening of educational and health facilities significantly improves public health in the project area. On the other hand, water resources development also has negative impacts, since, it could increase the habitat of certain vectors like mosquitoes. Thus, poorly planned and managed water resources projects could increase the prevalence of vector-borne diseases like malaria and filariasis.

4.8 IMPACTS DUE TO COMMAND AREA DEVELOPMENT

In the project operation phase, the cropped area in Kharif cropping season will increase from 7596.3 ha to 9506 ha. The increase in cropped area in Rabi cropping season shall be from 2772.10 ha to 7276 ha. The increase in cropping intensity will increase the agricultural production, with a corresponding increase in the remuneration from agriculture. The increased income levels will have a quantitative effect on the quality of demand for various facilities, which will facilitate improvement in the infrastructure sector. At present, the area under agriculture in the command area is 10378.40 ha with a cropping intensity of 79.54% (58.28% in Kharif season and 21.26% in Rabi season). With the introduction of irrigation, not only the irrigation intensity will improve, but the cropping intensity in Kharif and Rabi seasons will improve from 58.28% to 72.89%. and 21.26% to 55.78% respectively. The total agriculture production would increase from 10,676 tonnes/year at pre-project level to 81,505

tonnes/year in project operation phase. The increase in cost of value of produce would increase from Rs.64.3 million to Rs.614.40 million. The net income would increase from Rs.45.65 million to Rs.537.62 million. The area will have increased demands for services, such as sewerage system, communication, transportation, medical and educational facilities, etc. It is presumed that all these developments would result in generation of additional employment. Thus, with the increased income level, there will be a greater impact for urbanization in the command area.

Improvement in livestock

During project operation phase project food grain production will increase from 10676 tonnes per year to 81,505 tonnes per year. The increase in agriculture by product would be of the order of 70,829 tonnes per year. Assuming even 50% of agriculture by product is usable as fodder, hence, about 35,415 tonnes of additional fodder would be available. This would satisfy the fodder requirements of about 3,800 cattles per year. This will reduce the pressure on the existing forests or vegetation of the area, which is a significant positive impact. Considering cost of fodder as Rs. 1,500/tonne, the cost of increased fodder production would be of the order of Rs. 53.12 million/year. The project would also improve the water availability for livestock. The coupled with improved fodder availability is likely to improve the livestock status of the area.

Employment generation

The introduction of irrigation requires a greater amount of labour in fields. This would improve the employment scenario not only for the local farmers, but would also increase the demand for agricultural labour. With the increase in the irrigation intensity, manpower requirement in the agriculture sector would increase by 2.32 million man days per year. As per the general definition, a main worker is defined as one who is engaged in any economically productive activity for at least for 183 days or six months in a year. Thus, the increased irrigation intensity will ensure employment to about 12,600 persons per year, which is a significant positive impact.

5. RESETTLEMENT AND REHABILITATION PLAN

The total private land to be acquired for the project is about 1413.02 ha, located in 15 villages. The details of project affected families are given as below:

- No. of families whose only houses are affected 8
- No. of families whose land and houses are affected 136
- No. of families whose only land is affected 1433
- Total No. of affected families 1577
- No. of families whose land coming under submergence 1569

The cost required for implementation of Resettlement and Rehabilitation Plan is Rs. 4.32 million. The details are given in Tables-8 to 10.

TABLE-8**Abstract of cost required for land**

Sl. No.	Item	Amount (Rs. lakh)
1.	Provision for compensation of land and property coming under submergence.	3026.57
2.	Provision for rehabilitation of families affected due to construction of dam	584.576
3.	(A) Solatium charges @ 30% of cost of land.(1157.56) (B) Interest charges @12% on ½ of compensation for 2 years.	347.268 363.18
	Total	4321.594

TABLE-9**Details of cost required for acquisition of land**

S. No	Item	Qty.	Unit	Rate	Amount (Rs. lakh)
1.	Compensation for land coming under submergence.				
	(A) Culturable Area				
	(i) Mandla District				
	(a) Type I				
	(b) Type II	212	Ha.	114000/-	241.68
	(c) Type III	283	Ha.	67000/-	189.61
	(ii) Balaghat District				
	(a) Type I	120	Ha.	55000/-	66.00
	(b) Type II	296	Ha.	114000/-	337.44
	(c) Type III	394	Ha.	67000/-	263.98
		107	Ha.	55000/-	58.85

S. No	Item	Qty.	Unit	Rate	Amount (Rs. lakh)
	(B) Compensation to be paid for filed bunds.				
	(i) Mandla District	20	Ha.	55000/-	11.00
	(ii) Balaghat District	30	Ha.	55000/-	16.50
	(C) Culturable area (Fellow land)				
	(i) Mandla				-
	(ii) Balaghat				-
	(D) Compulsory acquisition Charges @ 30% of item 1 (a) + 1 (C)=1157.56				347.268
	(E) Land under forest (with revenue dept.)				
	(F) Forest land (up-to F.R.L.)				
	(i) Mandla	12.85		920000/-	118.22
	(ii) Balaghat	94.67		920000/-	870.96
	(G) Ponds	1		120000/-	1.20
2.	Compensation of Trees and Forest Land				
	(a) Compensation to be paid for fruit bearing trees.	3136	Each	1200/-	37.63
	(b) Other trees	23825	Each	800/-	190.60
3.	Compensation for Private Property				
	(A) House – Compensation to be paid for houses				
	Mandla District –	36080	Sqft.	400/-	144.32
	(a) Kachcha 50 Nos.	1496	Sqft.	900/-	13.46
	(b) Pakka 6 Nos.	32476	Sqft.	400/-	129.90
	Balaghat District –				
	(a) Kachcha 43 Nos.				
	(b) Pakka				
	(B) Other Property – Compensation to be paid for well				
	Mandla District –				

S. No	Item	Qty.	Unit	Rate	Amount (Rs. lakh)
	(a) Kachcha (b) Pakka	11 Nos. 6 Nos.	Each Each	30000/- 60000/-	3.30 3.60
	Balaghat District – (a) Kachcha (b) Pakka	6 Nos. 2 Nos.	Each Each	30000/- 60000/-	1.80 1.20
4.	Compensation for Govt. Property (Other than forest) (a) Electric Poles (b) Bridge	16 3	Each Each	1558/- 150000/-	0.25 4.50
5.	Colony/road etc. Compensation to be paid for land acquired for colony/road etc.	8	Ha.	114000/-	9.12
6.	Stationary required for preparation of land acquisition proposals tracing blue prints duplication etc.	14 vill.	Each	5000/-	0.70
7.	Cost of boundary stones purchase of maps demarcation of property acquired @ 1% of cost of land.				12.84
8.	Hire charges of inspection vehicle for verification of work during land acquisition.	20000/ per month for five years	--	L.S.	12.00
9.	Legal expenses required during acquisition	--	--	1%	12.84
10.	Compensation for electric line coming under submergence.	--	--	L.S.	12.00
11.	Publicity required for evacuation of villages during monsoon together with safety demarcation.	For 3 years	--	L.S.	2.00
12.	Construction of new temple.	1	-	L.S.	2.61
13.	Establishment of land acquisition and other expenses 6.25% of 1157.56 Item No. 1 (a)+(c)	-	--	--	72.348
	Total				3197.739
	Deduct : Resale value of wood against item No. 2(a) and (b) @ 75% of the compensation (Rs. 228.23 lakhs)				(-) 171.17
	Net total Rs.				3026.57

TABLE-10
Cost estimate for implementation of Resettlement and Rehabilitation Plan

S. No.	Description of Item	Qty.	Unit	Rate	Amount (Rs. lakh)
1.	Resettlement grant (for all) families to be rehabilitated.	664	Each family	18700/-	124.16
2.	Grant in aid (compensation Rs. 2000/- per ha.)	339	Each family	2000/-	6.78
3.	Acquisition of land for resettlement of families affected @ 0.0502 ha. for one family	33.32	Ha	55000/-	18.326
4.	CIVIL AMENITIES –				
	(a) Primary School @ 100 family 664/100=7No.	7	No.	300000/-	21.00
	(b) One Community Hall Panchayat Bhavan @ 664/500 family	1	No.	160000/-	1.60
	(c) One dispensary for every 500 families.	1	No.	190000/-	1.90
	(d) One seed store for 664 families.	1	No.	86000/-	0.86
	(e) Drinking water well throught for every 50 families.	13	No.	60000/-	7.80
	(f) One pond for 664 families.	3	No.	180000/-	1.80
	(g) One tree platform every 664/50 families	13	No.	42000/-	5.46
	(h) One religious Place of worship for 664 family.	1 No.	Each	261000/-	2.61
	(i) Construction of approach road and link roads for new abadi.	16 Km.	Km.	80000/-	12.80
	(j) Electrical distribution lines and street light 2 km./100 families.	13	Km.	266000/-	34.58

S. No.	Description of Item	Qty.	Unit	Rate	Amount (Rs. lakh)
	(k) Children's park for 664 families.	1	No.	250000/-	2.50
	(l) Goshala (cattle yard) one per 100 family $664/100=7$	7	Nos.	75000/-	5.25
	(m) Crematorium/G rave yard $664/100=7$	7	No.	50000/-	3.50
5.	Distribution of culturable land of oustees. (40% of 1413.02 Ha.)	565	Ha.	41000/-	231.65
6.	Grant for ST/SC landless or Agricultural labours for establishing their self employment.	8	Nos.	49300/-	3.94
7.	Adding 1% preliminary survey and investigation of item 4 & 5 (Rs. 333.31 lakhs)				3.33
8.	Grant for displaced families in addition to house compensation for the construction of house as per the norms of Indira Awas at new township (25% of 664)	166	Family	20000/-	33.20
9.	Planning of one model village with consultation of experts.	One/village	L.S.		0.50
10.	Transportation aid for shifting of rehabilitated families.	664	Families	5000/-	33.20
	Total				556.746
	Add 5% for work charged and contingencies				(+) 27.83
	Grand Total				584.576 lakhs

6. ENVIRONMENTAL MANAGEMENT PLAN

6.1 ENVIRONMENTAL MEASURES DURING CONSTRUCTION PHASE

Facilities in Labour Camps

It is proposed that it should be made mandatory for the contractor involved in the construction activities to provide adequate facilities for water supply and sanitation. It is recommended that the contractor provides living units of 30-40 m² to each of the labour family involved in the construction activities. The unit should have proper ventilation.

Water supply

Appropriate water supply sources need to be identified. Proper infrastructure for storage and if required treatment e.g. disinfection or other units, should also be provided.

Sewage treatment

The labour population is proposed to be situated in existing colonies. One community toilet needs to be provided for 20 persons. The sewage from the community toilets shall be treated in oxidation ditch.

Provision of community kitchen and Free Fuel

A community kitchen could be provided where workers have their meals. The fuel used in such community kitchens could be LPG or diesel. The project authority in association with the State Government should make necessary arrangements for supply of kerosene/LPG. The fuel would be supplied at sub-sidised rates to the local/contract labour for which provision should be kept in the cost estimate.

Solid waste management

The labour colonies will generate substantial amount of municipal wastes. Adequate facilities for collection, conveyance and disposal of solid waste needs to be developed. For solid waste collection, 30 number of masonry storage vats, each of 2 m³ capacity should be constructed at appropriate locations in various labour camps. These vats should be emptied at regular intervals and the collected waste can then be transported to landfill sites. Two covered trucks to collect the solid waste from common collection point and transfer it to the disposal site should be put to service. A suitable landfill site should be identified and designed to contain municipal waste from various project township, labour colonies, etc.

Restoration of construction sites

Normally the construction sites are left unreclaimed, with construction waste being left without being properly disposed. In the proposed project, it is proposed to collect the construction waste from various construction sites, and disposed off at sites identified in consultation with the district administration. The various construction sites would be properly levelled. The levelling or reclamation of various construction sites, should be made mandatory for the contractor, hence, no additional cost has been earmarked as a part of the cost to be earmarked for implementation of EMP.

6.2 MAINTENANCE OF WATER QUALITY

In the project operation phase, a colony is likely to be set up. It is proposed to provide sewage treatment plant in the project colony, cost of which shall be included in the contract for constructing the project colony. Hence, separate provisions for the same have not been included in cost estimate for implementation of Environmental Management Plan.

6.3 HEALTH DELIVERY SYSTEM

The various measures for control of Public Health are listed as below:

- The site selected for habitation of workers should not be in the path of natural drainage.
- Adequate drainage system to dispose storm water drainage from the labour colonies should be provided.
- Adequate vaccination and immunization facilities should be provided for workers at various construction sites.
- The labour camps and resettlement sites should be at least 2 to 3 km away from quarry areas.

It is proposed to develop one dispensary if the proposed project area. The staffing details are given in Table-11.

TABLE-11
Details of staff in the dispensary

Para medical staff	Numbers
Doctors	2
Auxiliary Nurse	4
Male Multipurpose Health worker	4
Attendant	4
Driver	3
Total	17

The dispensary building shall have the following facilities:

- waiting hall where 20-30 people can sit.
- rooms for doctors
- one room for staff
- two rooms for stores
- one general ward to accommodate 10 beds
- one minor operation theater/dressing room
- one garage with space for vehicle

A first aid post shall be provided at the major construction site. These posts will have the following facilities:

- First aid box with essential medicines including ORS packets
- First aid appliances-splints and dressing materials
- Stretcher, wheel chair, etc.

6.4 SUSTENANCE & ENHANCEMENT OF FISHERIES POTENTIAL

The commissioning of the proposed Halon Irrigation Project will increase the water availability in the project command area. The important management measures can be as below:

- slope and sides of dykes should be provided with grass turving to reduce erosion
- ponds should be properly prepared
- manuring of ponds should be done before stocking and at regular intervals after stocking
- to avoid oxygen depletion, the manure should be put in heaps in ponds;
- on fouling of water or development of thick algal bloom, manuring & feeding should be stopped for some time;
- supplement natural food with artificial feed;
- sampling of fish stock every month to observe their growth rate & health.

6.5 CANAL BANK AND ROAD SIDE PLANTATION

The proposed project envisages construction of main canal of length 81.50 km. It is proposed to develop plantation on both side of distributaries, which would improve the overall aesthetics of the area.

6.6 INFRASTRUCTURE FOR AGRICULTURAL DEVELOPMENT

Financial and credit facilities

The credit agencies through their various rural development schemes can play a very important role. An optimal combination of short term, intermediate term and long term credits may be formulated to provide maximum benefits to the command area population.

Marketing facilities and institutions: Improved marketing facilities and procedures contribute to the objectives of agricultural development directly through providing greater use of a given level of production and indirectly by fostering increased production. Inefficiencies in processing, storing and transporting agricultural produce can cause actual loss of product

Efforts shall also be made to develop the transportation and storage facilities. The co-operatives can play a very important role in the marketing of agricultural commodities and supply of inputs to the farmers. The cooperatives through interaction with government agencies, research institutes can popularise new farm inputs, marketing facilities etc. These structures can be built as a part of various rural development schemes of the state and central government.

6.7 CONTROL OF WATERLOGGING AND SOIL SALINIZATION

There are few pockets in the command area, where ground water levels are high. It is proposed that these pockets be excluded from the command area and ground water wells should be developed in these pockets for the irrigation purpose. The cost of commissioning of these wells shall be borne by the project proponent. The operation cost for meeting the energy requirements shall be borne by the project proponents.

The project proponent shall develop a Water User Group comprising farmers to be served by these wells. The Water User Group shall elect a Group Leader which in all probability be the farmer in whose land the well is constructed. The Group Leader shall decide the water charges to be levied from the water users in consultation with the other members of the water user group. The Group Leader will ensure the equitable distribution of water among the water users.

6.8 CONTROL OF AQUATIC WEEDS

Aquatic weeds are those unwanted and undesirable vegetation, which reproduce and grow in water and if unchecked, may choke the water body posing a serious menace to canal management. Various control measures can be implemented for control of aquatic weeds. These include introduction of fish species that feed on aquatic weeds. In addition weeds in small or medium sized sheets can be controlled by manual or mechanical methods as well.

6.9 CONTROL OF WEEDS ON AGRICULTURE LANDS

Measures against weeds comprise mechanical (cultivation and mowing), cultural or cropping, biological and chemical means. These include:

- hand weeding
- adopting farming practices that change the conditions in such a way as to enable plants to compete with weeds
- use of weedicida.

6.10 PESTS CONTROL

Integrated pest management strategy should be followed to reduce the use of pesticides. In this method, a limited number of insecticidal sprays are undertaken and simultaneously bio-control agents like pheromones, etc. are used. The pheromones are organic compounds developed specifically for each type of pest which are commercially synthesized in the laboratories and sold in the market.

6.11 TRAINING AND EXTENSION COURSES FOR FARMERS

The change from rainfed to irrigated cropping requires extension, training and demonstration programmes for farmers. Considering these aspects it is proposed that the project authorities needs to provide adequate training to farmers. The training shall include the following aspects of environmental protection:

- Prevention of spread of water related diseases;
- Safe use of agro-chemicals, and
- Environmental conservation programmes.

6.12 NOISE CONTROL MEASURES

The contractors will be required to maintain properly functioning equipment and comply with occupational safety and health standards. The construction equipment will be required to use available noise suppression devices and properly maintained mufflers.

The effect of high noise levels on the labour population involved in construction activities is to be considered as likely to be particularly harmful. To prevent these effects, it has been recommended by international specialist organisations that the exposure period of affected persons be limited as specified in Table-12. Alternatively, they should be provided with effective personal protective measures such as ear muffs or ear plugs to be worn during periods of exposure.

TABLE-12
Maximum Exposure Periods specified by OSHA

Maximum equivalent continuous noise level dB(A)	Unprotected exposure period per day for 8 hrs/day and 5 days/week
90	8
95	4
100	2
105	1
110	1/2
115	1/4
120	No exposure permitted at or above this level

The other measures to control noise could be as follows:

- Equipment and machineries should be maintained regularly to keep the noise generation
- Silencers and mufflers of the individual machineries to be regularly checked;
- Yearly audiometric survey on workers exposed to high noise levels should be undertaken.

6.13 LIVESTOCK DEVELOPMENT

The following measures are specifically recommended for improvement of livestock in the command area:

- Measures to improve availability and quality of feed
- Improvement in standard of nutrition by increasing the availability and quality of feed. The proposed project would go a long way in improving the availability of fodder.
- Improvement in marketing system to facilitate the movement of livestock and livestock products.
- Development of facilities to ensure easy availability to purchase inputs like drugs, draught oxen, tools, etc.
- Improvement in extension services by regular organization of field demonstration and improvement in visual-aid facilities.
- Establishing grass-legumes in pasture areas.
- Sourcing the soil conservation areas with improved forage species and prevention of grazing over these areas. The grass can be cut and transported to the point of consumption.

- Planting of trees such as *Leucaena* and *Sesbania* at a very close spacing along contours within arable areas.

6.14 ESTABLISHMENT OF ENVIRONMENTAL LABORATORY

An independent laboratory with facilities for chemical analysis should be set up in due course. A separate dust-proof room will have to be provided for installing analytical instruments.

6.15 ENVIRONMENTAL MANAGEMENT CELL

NVDA can develop an Environment Management Cell (EMC) at the project office. The task of the Group is to coordinate specific studies to carry out environmental monitoring and to evaluate implementation of environmental mitigatory measures. One Environment Officer can also be posted at the project site who would report to the Project Incharge. The Environment Officer will report to the appropriate authority having adequate powers to implement the required measures. The other responsibilities include liaising with relevant departments at the State Government level for effective implementation of the Environmental Management Plan (EMP) and the Environmental Monitoring Programme.

7. CATCHMENT AREA TREATMENT (CAT) PLAN

Silt Yield Index (SYI) method has been used to prioritize sub-watershed in a catchment area for treatment. The area under very high and high erosion categories is to be treated at the project proponent cost.

In the catchment of the proposed project, there is no area under very high erosion category. Hence, CAT plan has been suggested for area under high erosion category, as a part of the present EIA study, the expenses of which have to be borne by project proponents. The area under high erosion category is 18,074 ha, which is about 25.3% of the catchment area considered for treatment. The cost required for Catchment Area Treatment is Rs.117.7 million.

8. DAM BREAK ANALYSIS AND DISASTER MANAGEMENT PLAN

The Dam Break Analysis study for the Halon irrigation project has been done by the Central Water Commission using HECRAS model. A separate report for the same has been prepared. The profile of the wave in the event of dam break is given in Table-13.

TABLE-13
Water depth and spread downstream of dam in the event of dam break

Distance downstream of dam (km)	Max. elevation above MSL (m)	River bed level (m)	Water depth (m)	Water spread width (m)
1	591.285	608.90	17.615	300
2	590.24	608.95	17.81	300
3	590.76	607.74	16.98	320
4	590.605	606.77	16.165	304.77
5	590.875	605.05	14.175	214.77
10	584.00	594.64	10.64	129.64
15	566.605	577.77	11.105	87.71
20	543.74	555.96	12.22	423.07
25	532	549.01	17.51	300.90
30	529.80	540.59	10.79	168.15
35	517.50	530.41	12.91	121.49
40	504.50	517.99	13.49	141.34
45	491.57	506.80	15.23	111.80
50	480.00	492.27	12.27	96.56

A Disaster Management Plan has been prepared for implementation in case of a dam break. This comprises of :

- Surveillance
- Emergency Action Plan (EAP)
- Administration and Procedural Aspects
- Preventive Action
- Communication System
- Evacuation Plans
- Public awareness for disaster management
- Management after receding of flood water

9. ENVIRONMENTAL MONITORING PROGRAMME

An Environmental Monitoring Programme should be undertaken during construction and operation phase of the project. The details of environmental monitoring programme are given in Tables - 14 and 15 respectively.

TABLE-14
Summary of Environmental Monitoring Programme during
Project Construction Phase

S. No.	Item	Parameters	Frequency	Location
1.	Effluent from STPs	pH, BOD, TSS, TDS	Once every month	Before and after treatment from each STPs
2.	Water-related diseases	Identification of water related diseases, adequacy of local vector control and curative measure, etc.	Three times a year	Labour camps and colonies
3.	Air quality	SPM, RPM, SO ₂ and NO _x	Three times a year	At major construction sites
4.	Noise	Equivalent noise level	Once every three months	At major construction sites.

TABLE-15
Summary of Environmental Monitoring Programme during
Project Operation Phase

S. No.	Items	Parameters	Frequency	Location
1.	Water quality	pH, Temperature, EC, Turbidity, Total Dissolved Solids, Calcium, Magnesium, Total Hardness, Chlorides, Sulphates, Nitrates, DO, COD, BOD, Manganese, Free Ammonia, Total Kjeldahl Nitrogen, Boron, Percent sodium, phosphates, Total coliforms, Faecal coliforms	Thrice a year	<ul style="list-style-type: none"> • Reservoir • Main canal and distributaries
2.	Soil	pH, EC, texture, organic matter	Once in a year	Command area
3.	Ecology	Status of	Once every	-

S. No.	Items	Parameters	Frequency	Location
		afforestation programmes along canal, Pasture development	year	
4.	Water-related diseases	Identification of water-related diseases, sites, adequacy of local vector control measures, etc.	Three times a year	<ul style="list-style-type: none"> Villages adjacent to project sites
5.	Weeds	Density, problem areas effectiveness of weed control measures	Once a year	<ul style="list-style-type: none"> Command area Water bodies
6.	Socio-economics	Changes in population growth, income level, infrastructure development	Once in a year	<ul style="list-style-type: none"> Command area
7.	Landuse	Landuse pattern using satellite data	Once in a year	<ul style="list-style-type: none"> Command area

10. COST ESTIMATES

10.1 COST FOR IMPLEMENTING ENVIRONMENTAL MANAGEMENT PLAN

The total amount to be spent for implementation of Environmental Management Plan (EMP) is Rs.765.10 million (Refer Table-15). This cost is exclusive of the compensation required to be given in lieu of acquisition of land and other properties. Likewise, the cost required for implementation of measures to control water logging too has not been included.

TABLE-15
Cost for implementing Environmental Management Plan

S. No.	Item	Cost (Rs. million)
1.	Sanitation facilities in labour camp	21.48
2.	Free fuel to labour population	60.15
3.	Solid waste collection and disposal system	13.05
4.	Health Delivery System	33.74
5.	Fisheries Development in command area	5.00
6.	Fisheries development in reservoir area	14.17

S. No.	Item	Cost (Rs. million)
7.	Canal bank side plantation	11.26
8.	Wildlife conservation	8.98
9.	Catchment Area Treatment Plan	117.7
10.	Compensatory afforestation	38.74
11.	Settling up of environmental laboratory	1.00
12.	Cost of Noise Meter	0.05
13.	Resettlement and Rehabilitation Plan	432.2
14.	Cost for Environmental Monitoring Programme during construction Phase (Refer Table 16)	7.57
	Total	765.09 say Rs. 765.1 million

10.2 COST FOR IMPLEMENTING ENVIRONMENTAL MONITORING PROGRAMME

The cost required for implementation of Environmental Monitoring Programme during project construction phase is Rs.7.57 million. The details are given in Table-16.

TABLE-16

Cost Required for Implementing Environmental Monitoring Programme during Construction Phase

S. No.	Item	Cost (Rs. million)
1.	Water Quality	2.24
2.	Public Health	3.86
3.	Air Quality	1.47
	Total	7.57

The cost required for implementation of the Environmental Monitoring Programme during project operation phase shall be of the order of Rs.2.38 million/year. A 10% annual price increase may be considered for every year. The details are given in Table-17.

TABLE-17
Cost for implementing Environmental Monitoring Programme during
Operation Phase

S. No.	Item	Cost (Rs. million/year)
1.	Water quality	0.18
2.	Soil quality	0.20
3.	Ecology	1.00
4.	Public health	0.50
5.	Landuse pattern	0.50
	Total	2.38