

Chapter – 1

Introduction

1.0 General

In the year 1980, the erstwhile Union Ministry of Irrigation and Central Water Commission (CWC), formulated a National Perspective Plan (NPP) for Water Resources Development in the country which comprises of two Components: (i) Himalayan Rivers Development Component; and (ii) Peninsular Rivers Development Component. The National Water Development Agency (NWDA) was set up by the Government of India as an Autonomous Society under the Ministry of Water Resources in July, 1982 to study the feasibility of the proposals of the National Perspective Plan and give concrete shape to these proposals. The NWDA after carrying out the detailed technical study identified 30 link proposals for preparation of Feasibility Reports; 14 links under Himalayan Rivers Development Component and 16 links under Peninsular Rivers Development Component. Damanganga – Pinjal link project is one of the 16 link proposals of Peninsular Rivers Development Component.

The Feasibility Report of Damanganga-Pinjal Link project was prepared by NWDA during November, 2004 and circulated to all concerned State Governments and members of Technical Advisory Committee (TAC) of NWDA. Since then continuous efforts were made by National Water Development Agency, Central Water Commission (CWC) and Ministry of Water Resources to arrive at a consensus between the two beneficiary States of Gujarat and Maharashtra. As a result of these efforts, consensus was arrived amongst the Central Government and concerned States of Gujarat and Maharashtra for preparation of Detailed Project Report (DPR) of Damanganga-Pinjal link project. A tripartite Memorandum of Understanding (MoU) was signed by the states of Gujarat and Maharashtra and the Union Government on 3rd May, 2010 in the presence of the Hon'ble Prime Minister of India at New Delhi for preparation of Detailed Project Report of Damanganga-Pinjal Link Project.

Accordingly, NWDA has prepared the DPR of Damanganga-Pinjal link project with active support and co-operation of Central Water Commission (CWC) and other domain expert organisations like Central Soil & Material Research Station (CSMRS), Geological Survey of India (GSI), Central Water and Power Research Station (CWPRS), Tehri Hydro Development Corporation India Ltd (THDC), India Meteorological Department (IMD), National Remote Sensing Center (NRSC), Water & Power Consultancy Services (WAPCOS), Regional Remote Sensing Centre (RRSC), Nagpur etc.

1.1 Outline of the Project

Damanganga-Pinjal Link Project envisages transfer of surplus water of Damanganga basin available at proposed Bhugad and Khargihill dam sites to the Pinjal dam (proposed by Government of Maharashtra across river Pinjal, a tributary of Vaitarna River) from where the combined waters of Damanganga and Pinjal rivers will be taken to Mumbai city to augment its domestic water supply. Before affecting the transfer of water from Damanganga basin it has been ensured that the water requirements of the people in the vicinity of the project for various purposes have been met on priority.

The Project envisages construction of a dam across river Damanganga near Bhugad village in Trimbak taluka of Nasik district of Maharashtra; a dam at Khargihill across river Vagh (a tributary of Damanganga) near village Behadpada in Jawhar taluka of Thane district of Maharashtra state; a dam across river Pinjal near village Khidse in Wada taluka of Thane district (proposed by Government of Maharashtra); and 2 tunnels connecting Bhugad reservoir with Khargihill reservoir and Khargihill reservoir with Pinjal reservoir.

The objective of link project is to augment the domestic water supply to the Mumbai city, as such the project has been planned at 100% dependable water availability. NWDA and CWC jointly carried out hydrological studies of Damanganga basin as a whole and also upto the proposed Bhugad and Khargihill dam sites during January, 2013 to assess the water balance position

at the ultimate stage of development (by the year 2050 AD). The gross annual yield series for the entire Damanganga basin up to Vapi Railway Bridge has been developed for the period from 1975 to 2004 using the virgin discharge data of Vapi G&D site for the period from 1975 to 2004. As per the study, the average, 50%, 75% and 100% dependable annual gross yields of the whole Damanganga basin at Vapi railway bridge site are assessed to be 3335 Mm³, 3223 Mm³, 2547 Mm³ and 1839 Mm³ respectively.

Similarly, the gross annual yield series at Bhugad and Khargihill dam sites have also been developed for the period from 1975 to 2008 based on observed discharge data at Nanipalsan and Ozarkhed G&D sites respectively which are located just d/s of the proposed dam sites. The average, 50%, 75% and 100% dependable annual gross yields at Bhugad dam site are assessed to be 785 Mm³, 733 Mm³, 517 Mm³ and 372 Mm³ respectively. The same at Khargihill dam site are assessed to be 986 Mm³, 939 Mm³, 748 Mm³ and 477 Mm³ respectively.

After considering the upstream utilizations planned by the states for irrigation (43.66 Mm³) through existing, ongoing and proposed projects, reservoir evaporation losses for hydropower projects (77.7 Mm³), domestic requirement (2.03 Mm³), Industrial requirement (6.65 Mm³), and return flow as regeneration from domestic and industrial uses (6.94 Mm³), the net annual yield at Bhugad dam site are assessed to be 668 Mm³, 610 Mm³, 395 Mm³ and 284 Mm³ at average, 50%, 75% and 100% dependabilities respectively. In addition, the down-stream requirements for Environmental and ecological needs will be 5.79 Mm³, and down-stream committed releases for Madhuban reservoir will be 91 Mm³.

Similarly, the net annual yields available at Khargihill dam site at average, 50%, 75% and 100% dependabilities are assessed to be 871 Mm³, 820 Mm³, 629 Mm³ and 401 Mm³ respectively keeping a provision for upstream utilizations planned by the states for irrigation (60.81 Mm³), reservoir evaporation losses for hydropower projects (57.51 Mm³), domestic requirement (0.72 Mm³), Industrial requirement (3.94 Mm³), and regeneration from

domestic and industrial uses (4 Mm³). In addition, the environmental and ecological needs in the down-stream will be 5.11 Mm³.

About 284 Mm³ and 401 Mm³ of surplus water at 100% dependability is available at proposed Bhugad and Khargihill dam sites respectively for transfer to proposed Pinjal reservoir for augmentation of domestic water supply to Mumbai City. The total quantity of surplus water available in Damanganga basin at the proposed Bhugad and Khargihill reservoirs for transfer to Pinjal reservoir works out to 685 Mm³. To work out the quantity that can be diverted from Bhugad and Khargihill reservoirs to Pinjal dam for augmentation of drinking water supply to Mumbai city, simulation analysis considering the inflows, local demands, committed down-stream release, environmental flow requirement and capacity of the reservoirs has been carried out for the period from 1975 to 2004. Simulation analysis indicates that about 210 Mm³ of water from Bhugad reservoir and about 369 Mm³ of Water from Khargihill reservoir at 100% success rate (total 579 Mm³ from Damanganga basin) can be transferred to Pinjal reservoir. The waters available at Pinjal dam for transfer to Mumbai for augmentation of domestic water supply is 316 Mm³. The combined surplus waters of Bhugad and Khargihill reservoirs of Damanganga basin and Pinjal reservoir of Vaitarna basin for transfer to Mumbai city is assessed to be 895 Mm³. The index map of Damanganga-Pinjal link project is at Plate 1.1 of Volume –VI.

1.2 Justification and Objective of the Project

The trend of development in the metropolitan city of Greater Mumbai is so fast that it is anticipated that there would be acute shortage of domestic water by the year – 2050. As per the assessment of Municipal Corporation of Greater Mumbai (MCGM) the present domestic water demand for Mumbai City (year 2012) is 4529 MLD (1653 Mm³) and the cumulative water supply from all the sources is 3675 MLD (1341 Mm³). The projected domestic water demand for Greater Mumbai by the year – 2041 will be 6680 MLD (2438 Mm³) and the supply will be 4980 MLD (1818 Mm³) (on completion of Gargai and Pinjal projects) leaving a shortage in supply of 1700 MLD (620 Mm³). The shortage in water supply will further increase as the demand will reach to 7000

MLD (2555 Mm³) by the year - 2060 and the cumulative water supply from various sources including from middle Vaitarna, Bhatsa and Gargai projects will remain 4980 MLD (1818 Mm³) only. The proposed Damanganga-Pinjal link project has been planned to augment the domestic water supply of Mumbai city which will provide additional 1586 MLD (579 Mm³) of water from Bhugad and Khargihill reservoirs of Damanganga basin and about 865 MLD (316 Mm³) of water from Pinjal reservoir of Vaitarna basin.

The preliminary water balance study of Damanganga basin and at proposed Bhugad and Khargihill dam sites (Technical Study No. 24) was carried out by NWDA which indicates that the surplus water is available in Damanganga basin. Accordingly, Preliminary Feasibility study to ascertain whether the project is feasible was carried out for diversion of surplus waters of Damanganga basin to Pinjal reservoir for augmentation of domestic water requirement of Mumbai city. The project was found techno- economically viable and accepted by the TAC of NWDA. While working out the quantity of water that can be diverted through Damanganga – Pinjal link, the in-basin requirements of water up-stream and down-stream of the dams at ultimate stage of development have been considered, as such the diversion of water through the proposed Damanganga – Pinjal link project seems to be justified.

1.3 Lessons Learned from Previous Projects

A few examples of Inter-basin water transfer Projects implemented in the past as well as recent past in India are as under:

Periyar Project: The project is the most notable endeavor of the 19th century in trans-basin diversion. The project involves transfer of water from Periyar basin to Vaigai basin. A masonry gravity dam of 47.28 m high has been constructed across a gorge on west flowing Periyar river. A 1,740 m long tunnel with a discharging capacity of 40.75 cumecs has been driven across the mountain barrier to convey the water eastwards to Vaigai basin. The project was commissioned in 1895 and provided irrigation to an area of 57,923 ha initially, which has since been extended to 81,069 ha. There is also a power station of 140 MW capacity.

Parambikulam - Aliyar: The project is a complex multi-basin multi-purpose project of seven streams; five flowing towards the west and two towards the east, which have been dammed and their reservoirs interlinked by tunnels. The project envisages transfer of water from Chalakudy basin to Bharatapuzha and Cauvery basins. The water is ultimately delivered to drought prone areas in Coimbatore district of Tamil Nadu and the Chittur area of Palakkad District of Kerala. The command area for irrigation is presently about 1,62,000 ha. There is a total of 185 MW power generation capacity at four power houses. This project was built during the second and third five year plans.

Kurnool - Cudappah Canal: A private company started this scheme in 1863. The project envisages transfer of water from Krishna basin to Pennar basin. A 8.23 m high anicut was built on the river Tungabhadra upstream of Kurnool town. A 304 km long canal with a capacity of 84.9 cumecs at its head extends from Krishna to Pennar basin and irrigates an area of 52,746 ha. The scheme was taken over by Govt. of India in 1882.

Telugu Ganga Project: This project has been implemented primarily to meet the pressing need of water supply to Chennai metropolitan area. It brings Krishna water from Srisailem reservoir through an open canal, first to Somasila reservoir in Pennar valley. This involves rock cuts upto 35 m deep. From Somasila, the water is taken through a 45 km canal to Kandaleru and then to Poondi reservoir in Tamil Nadu through another 177 km long canal. By mutual agreement, 12 TMC of water is to be delivered to Tamil Nadu at the border, from Krishna basin. This will greatly augment the water supply to Chennai city. The canal also irrigates 2.33 lakh ha. in Andhra Pradesh enroute. The project was made possible by Maharashtra, Karnataka and Andhra Pradesh voluntarily foregoing 5 TMC each from their entitlement. This project is a fine example not only of hydraulic engineering but also of Inter- State co-operation.

Ravi-Beas-Sutlej- Indira Gandhi Nahar Project: Beas-Sutlej link in combination with the Indira Gandhi Nahar Project is a standing example of how the large inter basin transfers brought about all round socio-economic growth with overall enhancement in the ecology and environment of the

region. Under the Indus Water Treaty, the water of three eastern rivers viz. Sutlej, Beas and Ravi were allocated to India. As the land to be benefited in India lies mostly to the east and south of these rivers, the rivers had to be interlinked and the water conveyed through canal systems for serving vast tracts in India. The main storage on Sutlej is at Bhakra, while that on Beas is at Pong. Bhakra system provides irrigation to 26.3 lakh ha. of new area besides stabilization of existing irrigation of 9 lakh ha. The aggregate generation capacity of power on Bhakra Nangal Project is 1,354 MW. A diversion dam, Pondoh, 140 km upstream of Pong on Beas, enables diversion of water from Beas to Bhakra reservoir and generates 165 MW of power. The Beas-Sutlej link is 37.25 km long of which 25.45 km is tunnel through difficult rock formations. The capacity of the tunnel is 254.70 cumecs. Another dam on Ravi namely, Ranjit Sagar dam will provide additional water to Beas and also generate a large block of hydro-power. Subsequently, it was decided to link the Indira Gandhi Nahar Project with the river systems to provide 9.36 BCM of water to Rajasthan Canal for irrigating the areas of Thar Desert.

It is no exaggeration to say that the transfer of surplus waters of Ravi, Beas and Sutlej to Rajasthan right upto Jaisalmer and Barmer through Indira Gandhi Nahar Pariyojana has eliminated drought conditions, provided power benefits, transformed desert waste land into an agriculturally productive area by bringing irrigation and vegetation to about 2 million hectare area. Contribution in agricultural production due to implementation of the project is worth Rs. 1,750 crores annually. Canal water is also available for meeting domestic needs. The project has substantially changed the living standard and socio-economic conditions of the people in the area.

Sardar Sarovar Project: The Sardar Sarovar Project across river Narmada is a landmark project for harnessing the water resources of Narmada river basin in an integrated way to meet the in-basin water requirements as well to transfer surplus water to Saurashtra & Kachchh region of Gujarat and desert area of Jalore and Barmer districts in Rajasthan which have no other dependable water source, ensuring to minimize the ecology degradation, advancement of desert and salinity ingress in the regions. The main canal of Sardar Sarovar Project which is 458 km long in Gujarat and 75 Km in Rajasthan Crosses

several rivers basins in western part of the country; Dhadhar, Mahi, Sabarmati, Banas and Luni. The transfer of water from Narmada to these river basins have regenerated rivers which have become dead in recent past. Although project is still partially completed Narmada Water has also been transferred to 370 villages, Ponds in Gujarat.

These examples indicate that to even out the uneven distribution of rainfall with respect to space and time, Interlinking of Rivers Projects are need of the future.

1.4 National Perspective Plan for Water Resources Development

The erstwhile Union Ministry of Irrigation and Central Water Commission formulated, in the year 1980, a National Perspective Plan (NPP) for water resources development which comprises of following two components:

- a) The Himalayan Rivers Development, and
- b) The Peninsular Rivers Development

The distinctive feature of the National Perspective Plan is that the transfer of water from surplus basin to deficit basin would essentially be by gravity and only in small reaches, it would be by lifts not exceeding 120 metres. These two components are briefly outlined in the following paragraphs.

a) Himalayan Rivers Development

Himalayan Rivers Development envisages construction of storage reservoirs on the principal tributaries of the Ganga and the Brahmaputra in India, Nepal and Bhutan, along with inter-linking canal systems to transfer surplus flows of the eastern tributaries of the Ganga to the west, apart from linking of the main Brahmaputra and its tributaries with the Ganga and Ganga with Mahanadi and augmentation of flow at Farakka.

The Himalayan Rivers Development Component would provide additional irrigation benefits to an area of about 22 M ha and generation of hydro-power for about 30 million KW, besides providing substantial flood control in the Ganga-Brahmaputra basins. It would also provide the necessary flow required to flush the Kolkata Port and for the inland navigation facilities across the country.

b) Peninsular Rivers Development

This component is divided into four major Parts:

- i. Interlinking of Mahanadi – Godavari - Krishna- Pennar - Cauvery rivers and building storages at potential sites in these basins

This is the major interlinking of the river systems where surpluses from the Mahanadi and the Godavari are intended to be transferred to the needy areas in the south.

- ii. Interlinking of west flowing rivers, north of Mumbai and south of the Tapi

This scheme envisages construction of as many optimal storages as possible on these streams, and interlinking them to make available appreciable quantum of water for transfer to areas, where additional water is needed. The scheme provides for taking canal to provide waters to Saurashtra and Kutch areas of Gujarat by substitution and another water supply canal to the metropolitan areas of Mumbai, it also provides irrigation to the coastal areas in Maharashtra.

- iii. Interlinking of Ken-Chambal Rivers

The scheme provides for a water grid for Madhya Pradesh, Rajasthan and Uttar Pradesh and Interlinking canal backed by as many storages as possible.

iv. Diversion of other west flowing rivers

Heavy rainfall on the western side of the Western Ghats runs down numerous streams which empty into the Arabian Sea. Construction of an interlinking canal system, backed up by adequate storages, could be planned to meet all requirements of Kerala as also for transfer of some water towards east to meet the needs of drought affected areas.

The Peninsular Rivers Development Component would provide an additional irrigation to an area of about 13 M ha and generation of about 4 million KW of hydro power.

The proposals of National Perspective Plan would thus give an additional benefit of 25 M ha of irrigation from surface waters, 10 M ha by increased use of Ground water and generation of 34 million KW of hydro power, apart from the incidental benefits of flood control, and other multipurpose benefits.

Two link projects viz. Damanganga – Pinjal link and Par – Tapi – Narmada link were identified under second part of Peninsular Rivers Development Component of NPP.

1.5 Memorandum of Understanding between Centre and States and Inter-state Aspects

The Damanganga-Pinjal Link Project envisages diversion of surplus water available at proposed Bhugad and Khargihill reservoir sites to Pinjal reservoir for augmentation of domestic water supply of Greater Mumbai city. The Feasibility Report of this project was prepared by NWDA during the year 2004 and circulated to the concerned State Governments and members of Technical Advisory Committee (TAC) of NWDA. The Damanganga River is an Inter-state River spreading its catchment area in the states of Maharashtra and Gujarat and UTs of Dadra & Nagar Haveli and Daman & Diu. Series of meetings were held by National Water Development Agency, Central Water Commission and Ministry of Water Resources with the concerned States of

Gujarat and Maharashtra to arrive at the consensus for preparation of Detailed Project Report of this Project. The concurrence for preparation of Detailed Project Reports of Damanganga-Pinjal and Par-Tapi-Narmada Link Projects by the State Government of Maharashtra was issued by Water Resources Department, Government of Maharashtra vide their letter No. MoU-2008/(105/08)/WRI of May, 2008 and the concurrence of the State Government of Gujarat was issued by Narmada Water Resources, Water Supply & Kalpasar Department vide their letter No. 5/2005/NWDA(96)-J dated 1st May, 2008. Copy of these letters is placed at Annexure – 1.1 and 1.2 in Volume - II respectively. Subsequently, a tripartite Memorandum of Understanding (MoU) was signed by Hon'ble Chief Ministers of Maharashtra and Gujarat and Hon'ble Union Minister of Water Resources on 3rd May, 2010 in the auspicious presence of the Hon'ble Prime Minister of India. A copy of the MoU is placed at Annexure – 1.3 in Volume – II.



The Chief Minister of Gujarat, Shri Narendra Modi, the Chief Minister of Maharashtra, Shri Ashok Chavan and the Union Minister for Parliamentary Affairs and Water Resources, Shri Pawan Kumar Bansal signing a tripartite MoU for preparation of DPR of Damanganga-Pinjal Link Project and Par-Tapi-Narmada Link Project in the presence of the Prime Minister, Dr. Manmohan Singh, in New Delhi on May 03, 2010.



The Prime Minister, Dr. Manmohan Singh along with the Chief Minister of Gujarat, Shri Narendra Modi, the Chief Minister of Maharashtra, Shri Ashok Chavan and the Union Minister for Parliamentary Affairs and Water Resources, Shri Pawan Kumar Bansal at the signing ceremony of a tripartite MoU for preparation of DPR of Damanganga-Pinjal Link Project and Par-Tapi-Narmada Link Project, in New Delhi on May 03, 2010.

The gist of the MoU entered is as follows:

1. Union Government shall identify and decide the organisational framework necessary for preparation and completion of the Detailed Project Report (hereinafter referred as DPR) of Damanganga-Pinjal link and Par-Tapi-Narmada link.
2. Specific MOUs as required will be entered into amongst the States of Gujarat, Maharashtra and Union Government based on the DPR of Damanganga-Pinjal link and Par-Tapi-Narmada link and Agreements

reached on scope of each of the links, sharing of costs and benefits and arrangements for management and control of water etc.

3. The Maharashtra State Government will get the benefits through the Damanganga-Pinjal Link Project by way of augmentation of water supply to meet the domestic water requirement of Mumbai city, while Government of Gujarat will be free to utilise remaining water spilled from Bhugad & Khargihill dams. In pursuance of the said objective, broad consensus and in principle understanding was arrived at through consensus building efforts of the Union Government and the States of Gujarat and Maharashtra to ensure optimum and integrated planning, successful implementation and effective monitoring and operation of Damanganga-Pinjal Link Project under National Perspective Plan. The issue of water sharing, quantum of diversion in link canal, exploring the possibilities of hydropower generation in Damanganga basin, extending the link to Tansa reservoir etc., raised by States will be addressed and resolved before the finalisation of the DPR.
4. It is proposed that the Gujarat State will get the benefits of Par-Tapi-Narmada link Project through en-route irrigation from the link canal and also in the drought prone Saurashtra and Kutch region by way of substitution. The sharing of hydro power produced in the power house located in this link project will also be studied during the preparation of DPR. In pursuance of the said objective, broad consensus and in principle understanding was arrived at through consensus building efforts of the Union Government and the States to ensure optimum and integrated planning, successful implementation and effective monitoring and operation of Par-Tapi-Narmada Link Project under National Perspective Plan.
5. The feasibility of utilisation of water by Maharashtra State in their territory by lifting water over the western divide will also be examined during preparation of DPR. The issue of compensating the quantity of water contributed from Maharashtra catchments raised by Maharashtra

State will be decided by States mutually after preparation of DPR when diversion quantity through this link is firmed up.

6. At DPR stage, the size of canal from Ukai Dam to Narmada canal will be decided based on simulation studies, keeping in view the request of Government of Gujarat about retaining the size of canal as designed in Feasibility Report of Par-Tapi-Narmada link considering the diversion of water from Tapi basin.
7. The preparation of DPR of both the links, i.e. Par-Tapi-Narmada and Damanganga-Pinjal link will be taken up together by National Water Development Agency, an autonomous body under the Ministry of Water Resources on behalf of Union Government.
8. Both the States shall enter into and abide by Agreements with the Union Government and amongst themselves in the larger interest of combating natural calamities of floods and droughts in different regions of the country.
9. Any review / amendment of the MOU shall be done if the same is agreeable to by all the parties.
10. This is being executed amongst the State of Gujarat, State of Maharashtra and Union Government for preparation of the DPRs of Damanganga-Pinjal Link Project and Par-Tapi-Narmada Link Project.

1.6 Selection of proposed Scheme:

a. Background of the Project

Initially NWDA prepared Prefeasibility Study Report for Damanganga – Tansa Link Project, which envisages that the surplus water from Bhugad and Khargihill reservoirs would be released downstream in the river itself and will be picked up at the existing Madhuban reservoir constructed across river Damanganga in the downstream of Bhugad and Khargihill reservoirs. The open canal was proposed to off take from Madhuban reservoir to carry the

water upto Tansa river from where the water will be taken to Mumbai city as per the plans of Municipal Corporation of Greater Mumbai and Mumbai Metropolitan Regional Development Authority for augmentation of domestic water supply of Mumbai city. The Government of Gujarat suggested that the use of Madhuban reservoir as pick-up point may be avoided as it would have certain operational problems. Also, these proposals would require pumping of water from Tansa river to Mumbai city.

b. Proposal at Feasibility Report Stage

Considering the suggestion of Government of Gujarat, the NWDA has studied on the topo-sheets the possibility of transfer of Damanganga water to Mumbai city without using Madhuban reservoir. Based on the topo-sheet studies and subsequent discussions with the authorities of Municipal Corporation of Greater Mumbai (MCGM) and Mumbai Metropolitan Region Development Authority (MMRDA), it has been found possible to connect Bhugad reservoir with Khargihill reservoir and Khargihill reservoir with Pinjal reservoir (proposed by Government of Maharashtra across river Pinjal) by tunnels, from where the combined surplus waters of Damanganga and Pinjal rivers will be taken further to Mumbai city as per the planning of Municipal Corporation of Greater Mumbai and Mumbai Metropolitan Region Development Authority. In order to establish the feasibility of the proposal, NWDA had carried out the field Survey & Investigations for Damanganga-Pinjal link project and prepared a Feasibility Report during November, 2004.

The proposal consists of the following components:

- (i) A 826.60 m long composite earth - cum - concrete dam across river Damanganga near village Bhugad with FRL 163.87 m and corresponding gross storage capacity of 426.39 Mm³.
- (ii) A 572.80 m long composite earth - cum - concrete dam at Khargihill across river Vagh (a tributary of Damanganga river) near village Behadpada with FRL 154.52 m and corresponding gross storage capacity

of 460.79 Mm³. A saddle dam of 272 m length and 21.35 m height with FRL 154.52 m on the left flank of the reservoir.

- (iii) A tunnel of about 16.85 km long with 5.0 m diameter connecting Bhugad reservoir with Khargihill reservoir.
- (iv) A tunnel of about 25.70 km long with 5.25 m diameter connecting Khargihill reservoir with Pinjal reservoir.
- (v) A 681 m long rubble masonry dam across river Pinjal (a tributary of Vaitarna river) proposed by Government of Maharashtra near village Khidse with FRL of 141 m and corresponding gross storage capacity of 413.57 Mm³.

C. Present Proposal at DPR Stage

During preparation of DPR the topographical survey and other investigations have been carried out. Based on the investigations at DPR stage and also considering the scarce availability of borrow area and sand in the project area, certain changes have been made in various components of the project. The project proposal at DPR stage consists of following components:

- i A 851.50 m long composite embankment (concrete face rock fill) - cum - concrete dam across river Damanganga near village Bhugad with FRL 163.87 m and corresponding gross storage capacity of 427.070 Mm³. The length of concrete face rockfill portion of the dam is 527.50 m and the length of concrete non overflow section and spill way is 324 m. The dam axis is located at Latitude: 20⁰ 12' 30" N and Longitude: 73⁰ 17' 32" E;
- ii A power house at the toe of Bhugad dam with 2 units of 1.0 MW installed capacity each;
- iii A 618.20 m long composite embankment (concrete face rock fill) - cum - concrete dam at Khargihill across river Vagh (a tributary of

Damanganga river) near village Behadpada with FRL 154.52 m and corresponding gross storage capacity of 460.896 Mm³. The length of concrete face rockfill portion of the dam is 341 m and the length of concrete non overflow section and spill way is 277.20 m. A saddle dam of 400 m length and 25.92 m height with FRL 154.52 m is proposed on the left flank of the reservoir. The main dam is located at Latitude: 20⁰ 05' 05" N and Longitude: 73⁰ 16' 27" E. The saddle dam is located at Latitude: 20⁰ 05' 18" N and Longitude: 73⁰ 15' 22" E;

- iv A power house at the toe of Khargihill dam with 2 units each of 1.5 MW installed capacity;
- v A tunnel of about 17.488 km long with 3.20 m diameter (D shape) and bed slope of 1:1342 connecting Bhugad reservoir with Khargihill reservoir;
- vi A tunnel of about 25.224 km long with 4.00 m diameter (D shape) and bed slope of 1:1717 connecting Khargihill reservoir with Pinjal reservoir;
- vii A 545 m long roller compacted concrete gravity dam across river Pinjal (a tributary of Vaitarna river) proposed by Government of Maharashtra and MCGM near village Khidse with FRL of 145.0 m and corresponding gross storage capacity of 483.0 Mm³ and a saddle dam of about 190 m long and 11.4 m high on the right flank. The main dam is located at Latitude: 19⁰ 47' 00" N and Longitude: 73⁰ 13' 00" E.
- viii Conveyance system beyond Pinjal dam to carry water upto Mumbai city to be planned by MCGM.

The Water Resources Department, Government of Maharashtra vide CE, WRD Konkan region letter no. KRM/Misc/River Link/T-4(3)/7226 date 20th September 2011 indicated that the MCGM is studying the conveyance system beyond Pinjal through the consultant. During discussions with the officers of MCGM it is understood that the field investigations for Pinjal dam are also

being carried out by MCGM through consultant. As such the NWDA has not carried out Survey and Investigations in respect of Pinjal dam and the conveyance system beyond Pinjal to carry water upto Mumbai city.

1.7 Project Planning and Optimisation of Benefits

The Damanganga-Pinjal Link Project has been planned as a drinking water project for augmentation of domestic water supply of metropolitan city of Mumbai. The project being the water supply project has been planned on 100% dependability basis. It is proposed that the requirement of water for people in the vicinity of the project in the foreseeable future are to be met first before affecting any transfer of water. The requirement for various existing, on-going, and proposed projects in the upstream and committed releases in the downstream of the proposed Bhugad and Khargihill projects; water requirement for river ecology downstream of the dams have been considered. The proposed Bhugad dam intercepts about 141 km² area of the Gujarat State in the upstream of existing Madhuban reservoir. As such, about 91 Mm³ of water is to be released to Madhuban reservoir to compensate the water that could have been generated to Madhuban reservoir from the catchment area of Gujarat State intercepted by proposed Bhugad dam.

After meeting the above requirements about 579 Mm³ of water at 100% dependability (210 Mm³ from Bhugad reservoir and 369 Mm³ from Khargihill reservoir) is proposed to be transferred to Pinjal reservoir. About 316 Mm³ of water at 75% dependability is available as surplus at Pinjal reservoir proposed by Government of Maharashtra. The combined surplus waters of Bhugad and Khargihill dams of Damanganga and Pinjal dam of Vaitarna basin to the tune of 895 Mm³ is proposed to be transferred to Mumbai city for augmentation of its domestic water supply .

To meet the committed water requirements downstream of the Bhugad and Khargihill reservoirs 96.79 Mm³ and 5.11 Mm³ respectively water is to be released into the rivers. Power Potential study has been carried out to assess the hydro-power that can be generated if the water for the down- stream needs is released through Power houses. It is found that the power houses can be

installed at the toe of both Bhugad and Khargihill dams. The benefits of the projects have been optimised in the following manner:

I. Drinking Water Supply

The Damanganga-Pinjal Link Project will provide 579 Mm³ of water from Bhugad and Khargihill reservoirs in Damanganga basin to Pinjal reservoir in Vaitarna Basin. In addition 316 Mm³ of water from Pinjal reservoir in Vaitarna Basin (a separate project of MCGM) making a total of 895 Mm³ will be ultimately provided for augmentation of domestic water supply to the Mumbai city. Project will also provide water to meet the drinking water requirement of the people in the vicinity of the project.

II. Power Benefits

Two power house; one each in the down-stream of Bhugad and Khargihill reservoirs are proposed. The power potential study has been carried out by THDC Ltd. As per the study Power house at Bhugad dam will be with 2 units of 1.0 MW installed capacity each. The annual energy generation in the 90% dependable year and at 95 % plant availability will be 9.09 MU.

Power house at Khargihill dam will be with 2 units each of 1.5 MW installed capacity. The annual energy generation in the 90% dependable year and at 95% plant availability will be 16.20 MU.

III. Flood Control Benefits

Though no flood cushion has been provided in the Bhugad and Khargihill reservoirs, release of water to the link tunnels and creation of reservoirs will provide incidental benefit of flood moderation in Damanganga river.

IV. Other Benefits

Besides above benefits, many other incidental benefits such as pisciculture, recharge of ground water in downstream areas of the proposed dams, development of agro based industries and food processing units due to enhancement of water availability, improvement in water availability for irrigation & drinking in the vicinity of the reservoirs, employment generation during construction phase and afterwards, tourism development, development of infrastructure etc. will accrue from the project. This will result in upliftment of socio-economic conditions of people in the vicinity of the project area.

1.8 Methodology Adopted

The Feasibility Report of Damanganga-Pinjal Link Project prepared by National Water Development Agency formed the basis for proceeding further for preparation of Detailed Project Report and make suitable changes based on detailed survey and investigations and updated hydrological and other studies.

1.8.1 Data Collection

The preparation of Detailed Project Report of Damanganga-Pinjal Link Project requires various data / information. The rainfall and meteorological data were collected from India Meteorological Department (IMD), Pune; hydrological data collected from Central Water Commission and State Water Resources Departments; Remote sensing data (LISS- IV) from NRSC, Hyderabad; Topo-sheets from Survey of India. The data / information required by various Designs Directorates of Central Water Commission were collected during the field surveys.

Laboratory testing of rock cores samples and various construction material samples were carried out by Central Soil & Material Research Station; geological mapping and investigations were carried out by Geological Survey of India, Nagpur. These data formed the inputs for design of various components of the project. Simulation analysis was carried out for optimising the height of Bhugad and Khargihill dams. The simulation analysis formed

inputs for the power potential studies carried out by Tehri Hydro Development Corporation (THDC) and the output given by THDC in the form of power potential studies formed input for civil designs of hydel structures. Thus, there were many activities apart from the normal data collection and these activities were successfully managed by National Water Development Agency officers and various data required by the consultants were supplied to them for carrying out various consultancy works for preparation of Detailed Project Report of Damanganga-Pinjal Link assigned to them.

1.8.2 Planning and Layout

The objective of Damanganga-Pinjal Link Project is to transfer surplus waters available in Damanganga and Pinjal river basins to Mumbai city for augmentation of its domestic water supply. For this purpose a dam at Bhugad across river Damanganga; a dam at Khargihill across river Vagh along with a saddle dam have been proposed by NWDA. In addition, a dam across river Pinjal has been proposed by Government of Maharashtra. Two tunnels: (i) Connecting Bhugad reservoir with Khargihill reservoir; and (ii) Connecting Khargihill reservoir with Pinjal reservoir are also proposed. The Power houses at the toe of both Bhugad and Khargihill dams are also planned to generate the hydro-power by utilising waters proposed to be released to meet the water requirements downstream of the respective dam sites. The details of various components are given below:

1.8.2.1 Bhugad Dam

Bhugad dam is proposed across river Damanganga near village Bhugad in Trimbak taluka of Nasik district of Maharashtra state. The total length of Bhugad dam is 851.50 m of which 527.5 m is concrete face rock fill dam (CFRD) and remaining 324 m length will be of concrete. The length of spillway is 149.5 m and has been proposed in the river portion. A penstock is proposed in extreme left of the concrete portion of the dam for taking water to the power house located at the toe of the dam.

The surplus water available at Bhugad reservoir is to be transferred to proposed Khargihill reservoir through a tunnel. The tunnel will take-off from the left flank of the Bhugad reservoir upstream of Bhugad dam. The diameter of the tunnel is 3.2 m and the bed slope is 1:1342. The layout plan of Bhugad dam and appurtenant works is at Plate 2.12 in Volume –VI.

1.8.2.2 Khargihill Dam

Khargihill dam is proposed across river Vagh, a tributary of river Damanganga near village Behadpada in Jawhar taluka of Thane district of Maharashtra state. The total length of Khargihill dam is 618.20 m of which 341.0 m is concrete faced rock fill dam (CFRD) and remaining 277.20 m length will be of concrete. The length of spillway is 104.0 m and has been proposed in the river portion.

A penstock is proposed in extreme left side of the concrete portion of the dam for taking water to the power house located at the toe of the dam.

A Saddle dam is proposed on the left flank of the Khargihill reservoir near village Vavar. The length of the saddle dam is about 400 m and the maximum height above NSL is 25.92 m. The top width of the saddle dam is 8 m.

The combined surplus water available at Khargihill reservoir is to be transferred to proposed Pinjal reservoir through a tunnel. The tunnel will off take from the left flank of the Khargihill reservoir upstream of Khargihill dam. The diameter of the tunnel is 4.00 m and the bed slope is 1:1717. The layout plan of Khargihill dam and appurtenant works is at Plate 2.14 in Volume –VI.

1.8.2.3 Pinjal Dam

The Govt. of Maharashtra and MCGM proposed the Pinjal dam across river Pinjal, a tributary of river Vaitarna near village Khidse in Wada taluka of Thane district of Maharashtra. The Pinjal dam has been proposed as Roller Compact Concrete Gravity dam and the total length of Pinjal dam will be 545

m and the length of the saddle dam will be 190 m. Length of spillway will be 80 m, with 5 no. gates of size 14 m X 12 m. Provision for construction of penstock has been made to generate hydro- power through the release of water to Mumbai city and also for meeting irrigation requirements. The layout plan of Pinjal dam and appurtenant works is at Plate 2.16 in Volume – VI.

The surplus waters available at proposed Pinjal reservoir along with the water to be transferred from proposed Bhugad and Khargihill reservoirs of Damanganga basin is to be taken upto Mumbai city through suitable conveyance system as per the planning of Municipal Corporation of Greater Mumbai (MCGM) and Mumbai Metropolitan Region Development Authority(MMRDA).

As per the MoU signed by Gujarat and Maharashtra Governments with Central Government for preparation of DPRs of Par – Tapi – Narmada link and Damanganga – Pinjal link projects, the possibility of extending Damanganga – Pinjal link upto Tansa is to be explored while preparation of DPR. Subsequently, Municipal Corporation of Greater Mumbai (MCGM) requested to consider extension of link beyond Tansa upto a point near Pogaon. Accordingly, a note on the conveyance system from Pinjal to Pogaon was sent to MCGM and Water Resource Department (WRD), Government of Maharashtra by NWDA on 25th August, 2011 (Annexure – 1.4 in Volume - II) for suggestions. WRD, Government of Maharashtra vide CE, WRD Konkan region letter no. KRM/Misc/River Link/T-4(3)/7226 dated 20th September 2011 (Annexure -1.5 in Volume - II) indicated that the MCGM is studying the conveyance system beyond Pinjal through the consultant. The MCGM has finalised the alignment of conveyance system beyond Pinjal dam and upto Gundovali to take waters upto Mumbai.

1.8.3 Surveys & Investigations

On receipt of concurrence from Government of Maharashtra and Gujarat, the work for preparation of Detailed Project Reports of Par-Tapi-Narmada and Damanganga-Pinjal Link Projects were taken-up by National

Water Development Agency during January, 2009. Subsequently, the Memorandum of Understanding has also been signed by States of Gujarat and Maharashtra with Union Government for preparation of Detailed Project Reports of Par-Tapi-Narmada and Damanganga-Pinjal Link Projects on 3rd May, 2010.

The work for preparation of Detailed Project Report of Damanganga-Pinjal link project was taken-up by National Water Development Agency utilising one Circle Office located at Valsad. Based on the location of the various components of the project and accessibility, one division office at Nasik was opened during January, 2009 for carrying out Survey & Investigation works for preparation of Detailed Project Report of Damanganga-Pinjal link project.

The permission for carrying out the Survey & Investigation works in the forest area was obtained from forest department of Gujarat vide office of Principal Chief Conservator of Forest, Gandhinagar letter No. Land/29/B/2756/08-09 dated 21st November, 2008(Annexure -1.6 in Volume - II). Similar permission for Maharashtra area has been obtained from Forest Department of Maharashtra vide Deputy Conservator of Forest (West), Nasik letter No. Land/CA/4294/2008-09 Dated 25th November, 2008 (Annexure -1.7 in Volume - II) for Nasik district and vide Deputy Conservator of Forest, Jawhar letter No. B/20/Land/CA/ 4714/2008-09 date 2nd January 2009 (Annexure-1.8 in Volume - II) for Thane District. In the beginning the dam axis survey of Bhugad and Khargihill dam sites was taken-up and completed during first field season of 2009. Later on the topographical surveys for both the tunnel alignments, power house areas and alternative tunnels alignments were completed. The details of Survey & Investigation works carried out are listed in Paras 1.8.3.1 to 1.8.3.4.

1.8.3.1 Survey & Investigation Works carried out Departmentally

The NWDA has adopted two pronged strategy for carrying out the Survey & Investigation works for preparation of Detailed Project Report of Damanganga-Pinjal Link Project. The major parts of the detailed Survey &

Investigation works of the project for which in-house capability was available has been carried out by National Water Development Agency itself, whereas other specialised Survey & Investigation works and other technical studies were out sourced to the institutions of eminence in respective fields, mostly the government agencies.

Survey & Investigation works carried out departmentally by National Water Development Agency are as under:

- 1 Topographical Survey along dam axis of Bhugad and Khargihill dams.
- 2 Topographical Survey along the alignment of Bhugad – Khargihill and Khargihill – Pinjal tunnels including alternate alignments of tunnels, adits and in-let and out-let portals and adit portals.
- 3 Submergence Area Survey of Bhugad and Khargihill reservoirs (carried out at the time of preparation of Feasibility Report and the same data has been used in preparation of DPR).
- 4 Topographical Survey of the area in the down-stream of Bhugad and Khargihill dam sites for locating the Power Houses.
- 5 River Surveys for Damanganga, Vagh and Pinjal rivers both upstream and downstream of Bhugad, Khargihill and Pinjal dam axis (carried out at the time of preparation of Feasibility Report and the same data has been used in preparation of DPR)
- 6 River Survey including Cross Section of Vagh river in the downstream of proposed Khargihill dam site.

1.8.3.2 Survey and Investigation Works Carried out by other Agencies

1.8.3.2.1 Borrow Area Survey, Construction Material Survey and Testing of Rock Core Samples

The work of borrow area survey, construction material survey and testing of rock core samples was carried out by Central Soil & Material Research Station (CSMRS), New Delhi while preparation of Feasibility Report. The same data has been used for preparation of Detailed Project Report also. While carrying out Survey & Investigation works for preparation of Detailed Project Report, testing of rock cores recovered from the bore holes

drilled along the tunnel alignment has also been carried out by Central Soil & Material Research Station (CSMRS), New Delhi.

1.8.3.2.2 Geological Survey

The geological survey of the Bhugad and Khargihill dam sites and along the Bhugad – Khargihill and Khargihill – Pinjal tunnel alignment including adits and portals has been carried out by Geological Survey of India, Nagpur.

1.8.3.2.3 Drilling Works

The drilling work at Bhugad and Khargihill dams, and along Bhugad - Khargihill and Khargihill – Pinjal tunnels was carried out through private firms.

1.8.3.3 Technical Studies

1.8.3.3.1 Design of Important Project Components and Preparation of Design Chapter

The Damanganga – Pinjal Link Project envisages construction of two dams, a saddle dam, two tunnels, and two power houses. The design of these important structures and preparation of design chapter has been carried out by Central Water Commission, New Delhi involving the following Design Directorates:

1. HCD (NW&S) Directorate
2. CMDD (NW&S) Directorate
3. Embankment Design (NW&S) Directorate
4. Gates Design (NW&S) Directorate

1.8.3.3.2 Construction Planning, Equipment Planning and Man-power Planning

The Construction Planning, Equipment Planning and Man-power Planning has been carried out by Construction Machineries Consultancy

(CMC) Directorate of Central Mechanical Organisation, Central Water Commission, New Delhi.

1.8.3.3.3 Hydrological Study

The hydrological study of Damanganga-Pinjal Link Project has been carried out by Hydrology (South) Directorate of Central Water Commission, New Delhi.

1.8.3.3.4 Power Potential and Electrical & Mechanical Studies

The Power Potential and Electrical & Mechanical (E&M) studies were carried out by Tehri Hydro Development Corporation (THDC), India Ltd, Rishikesh.

1.8.3.3.5 Study of Seismic Parameter

The Seismic study of Damanganga-Pinjal Link Project has been carried out by Central Water & Power Research Station (CW&PRS), Pune.

1.8.3.3.6 Morphological Study

Morphological study of Damanganga and Vagh rivers has been carried out by Regional Remote Sensing Centre, Nagpur.

1.8.3.4 Socio-economic Survey and Environmental Impact Assessment Studies

These studies have been carried out by M/s Water and Power Consultancy Services (WAPCOS) Ltd of MoWR. A Committee was constituted by National Water Development Agency for empanelment of consultant for socio-economic and environmental impact assessment studies under Chief Engineer, Environment Management Organisation (EMO), Central Water Commission with Director (Technical), NWDA; Director (Finance), NWDA; Superintending Engineer, NWDA and two Experts as Members. The

composition of the Committee is at Annexure -1.9 in Volume - II. The scope of the Committee was further modified and preparation of Terms of Reference (TOR), Request for Proposal (RFP) for inviting the bids, evaluation of the bids, and recommendation of suitable agency for award of work were included in the functions of the Committee (Annexure - 1.10 in Volume - II). The Expression of Interests were invited by the Committee from various consultancy firms and the eligible firms were short listed. The Terms of Reference for carrying out comprehensive EIA studies were prepared and submitted to the Ministry of Environment & Forest (MoEF) for vetting. The MoEF vide letter No.J-12011/56/2008-IA.I dated 03-12-2008 indicated that the project being a drinking water supply project does not come under the provision of EIA Notifications,2006 (Annexure -1.11 in Volume - II). Based on these Terms of References, Request for Proposal document was prepared and the proposals were invited from the short listed consultancy firms. The consultancy work for EIA studies was finally awarded to M/s Water & Power Consultancy Services (WAPCOS), Gandhinagar.

To monitor and review the progress of work of EIA studies, a Committee was constituted by NWDA under the Chairmanship of Chief Engineer (South), NWDA; with Director (MDU), NWDA; Superintending Engineer, NWDA and two out-side Experts as Members (Annexure -1.12 in Volume - II). Subsequently this Committee was reconstituted under the Chairmanship of Chief Engineer (EMO), Central Water Commission, New Delhi with Chief Engineer (South), NWDA; Representative of NWDA head office; Superintending Engineer, NWDA and two out-side Experts as Members (Annexure -1.13 in Volume - II).

1.8.4 Engineering Assessment and Front End Engineering

1.8.4.1 Dam and Head Works

(i) Bhugad Dam

The height of the Bhugad dam has been designed as 69.42 m high with top width as 16 m. The FRL of the Bhugad dam has been kept as 163.87 m. The concrete portion of the dam will be 324 m long whereas concrete faced

rock fill portion will be 527.5 m. The spillway will have 9 nos. of gates of size 13.5 X 11.51 m. The power house at dam toe is proposed with 2 units of 1.0 MW each.

(ii) Khargihill Dam

The height of the Khargihill dam has been designed as 77.92 m high with top width as 10 m. The concrete portion of the dam will be 277.20 m long whereas concrete faced rock fill portion will be 341.0 m. The FRL of the Khargihill dam has been kept as 154.52 m. The spillway will have 6 nos. of gates of size 14.0 X 16.0 m. The power house at dam toe is proposed with 2 units of 1.5 MW each.

The height of Khargihill saddle dam has been designed as 25.92 m with a top width as 8.0 m. The length of the saddle dam is 400 m.

(iii) Pinjal Dam

Pinjal dam has been proposed by Water Resources Department, Government of Maharashtra and MCGM. The DPR of Pinjal Dam project was prepared by WRD, Government of Maharashtra during the year 1981. At present MCGM is preparing the revised DPR through consultant. As such NWDA has not carried out design of Pinjal dam and the Details of Pinjal dam have been obtained from MCGM and used in the DPR of Damanganga – Pinjal Link project. The Pinjal dam has been proposed as Roller Compact Concrete Gravity dam. The maximum height of the dam is 75 m. Length of the dam will be 545 m and length of the saddle dam will be 190 m. The spillway will have 5 nos. of gates of size 14 X 12 m. Provision for construction of penstock has been made to generate hydro- power through the releases of water to Mumbai city and also for meeting irrigation requirement.

1.8.4.2 Tunnels/ Conveyance System

i Bhugad – Khargihill Tunnel

The total length of Bhugad – Khargihill tunnel will be 17.488 Km with diameter of 3.2 m and bed slope as 1:1342. The tunnel will be of D - shape.

ii Khargihill - Pinjal Tunnel

The total length of Khargihill - Pinjal tunnel will be 25.224 Km with diameter of 4.0 m and bed slope as 1:1717. The tunnel will be of D – shape.

iii Conveyance System Beyond Pinjal Dam

The Conveyance System beyond Pinjal dam to carry waters upto Mumbai city is being planned by MCGM.

1.8.5 Ecological, Socio-economic and Financial Aspects

Water & Power Consultancy Services (WAPCOS), Gandhinagar has carried out the Environmental Impact Assessment Studies of Damanganga-Pinjal Link Project, the results / recommendations of the study are furnished below:

I. Ecological Aspects

The impacts on flora and fauna like increased pressure on aquatic ecology due to indiscriminate fishing, reduced productivity due to increase in turbidity, migratory fish species, spawning & breeding grounds, degradation of riverine ecology and increased potential for reservoir fishes have been studied. In addition, impacts on rare, endangered and threatened species, access to food and shelter for animals, increased pressure on wood & timber due to labour force, migratory labour population, terrestrial flora, wildlife movement, diversity and productivity of flora, economically / genetically / biologically important plant species, compensatory afforestation, reservoir rim treatment

plan, etc. were also studied. Aspects like catchment area treatment plan, Land Management Plan, Bio-diversity Management & Fisheries Development Plan, Surface and Groundwater Management, Public Health Management, Environmental Monitoring Programme, Dam Break Analysis and Disaster Management, implementation schedule have been considered and suitable provisions have been kept in the estimate.

No significant rich mineral deposits have been identified in the catchment and hence no acidification of Bhugad and Khargihill reservoirs is anticipated. Necessary minimum flows in the Damanganga and Vagh rivers during lean season will flush the untreated sewage and hence no impact is expected on river water quality.

The flooding of previously forested and agricultural land in the submergence area will increase the nutrients resulting from decomposition of vegetative matter. Enrichment of impounded water with organic and inorganic nutrients will be main water quality problem which will last for a short duration of few years from the time of filling the reservoir. The water samples' tests indicate that organic and heavy metal components in the water are within permissible limits. No major adverse impact due to the project is anticipated on environmental and ecological angle.

II. Socio-economic Aspects

i. Bhugad Reservoir

Bhugad reservoir will submerge an area of about 1903 ha of land which includes 290 ha of forest land, 810 ha of culturable land and the remaining 803 ha is other land including river portion. Total 14 villages will be partially affected due to creation of Bhugad reservoir. The impact on all project affected people in all 14 affected villages has been studied while carrying out the Environmental Impact Assessment studies. Total 1098 house-holds will be affected by Bhugad reservoir. The average literacy rate in the area is 71 %: male literacy rate 76% and female literacy rate 66%. 98 % of the house-holds in the submergence area of Bhugad reservoir are belong to Scheduled Tribe category. The primary schools are available in all the 14 affected villages,

middle schools are available in five affected villages and college facility is available at average distance of more than 10km. The main source of domestic water supply in all affected villages is from wells, few villages are having tube wells and hand pumps also. Electric power supply is available in all villages. The medical facilities such as allopathic hospitals, maternity hospital and child welfare centers, primary health centers (PHC) are available at average distance of more than 10 km, except for few villages where these facilities are available within 5 to 10 km distance. All the villages are connected with public transport and telephone facilities. Banking facilities are not available in any of the affected villages, however, credit societies are functioning in few of the affected villages.

ii. Khargihill Reservoir

Khargihill reservoir will submerge an area of about 1558 ha of land. Out of which, the forest area is 676 ha, the culturable area is 612 ha and the remaining 270 ha is other land including river portion. Total 16 villages will be affected partly due to creation of Khargihill reservoir. The impact on project affected people in all 16 affected villages has been studied while carrying out the Environmental Impact Assessment studies. Total 1204 number of households will be affected by Khargihill reservoir. The average literacy rate in the area is 71 %: male literacy rate 76 % and female literacy rate 66 %. 98 % of the affected house-holds in the submergence area of Khargihill reservoir are belong to -Scheduled Tribe category. The primary schools are available in all the 16 affected villages, middle schools are available in eight affected villages and college facility is available at average distance of more than 10km. The main source of domestic water supply in all affected villages is from wells, few villages are having tube wells and hand pumps also. Electric power supply is available in all villages. The medical facilities such as allopathic hospitals, maternity hospital and child welfare centers, primary health centers (PHC) are available at average distance of more than 10 km, except for few villages where these facilities are available within 5 to 10 km distance. All the villages are connected with public transport and telephone facilities. Banking facilities are not available in any of the affected villages, however, credit societies are functioning in few of the affected villages.

iii. Financial Aspects

After extensive survey / study of the project affected families and land acquisition, the Resettlement & Rehabilitation Plan for project affected families was suggested based on the National Resettlement and Rehabilitation Policy -2007 of Ministry of Rural Development, Government of India and also the Resettlement and Rehabilitation Policy of Sardar Sarovar Project of Gujarat. Provision of Rs. 121 Crores has been kept for Environmental Management Plan. The total cost of the Rehabilitation & Resettlement plan for the affected families has been worked out as Rs. 623 Crores. The details of the Environmental Impact Assessment studies and Socio-economic studies of Damanganga-Pinjal link Project are furnished in Chapter 8 and 9 respectively.

III Financial and Economic Analysis

The total cost of Damanganga-Pinjal link project including Rehabilitation & Resettlement plan for the project affected people has been worked out to be Rs. 274661 lakh at 2012-13 price level. Annual cost of the project including cost of maintenance of head works, dam appurtenants, power house etc and apportioned annual cost (tentative) of conveyance system beyond Pinjal dam upto Pogaon (Mumbai) works out to be Rs. 37615 lakh. The benefits from domestic water supply and power generation works out to be Rs. 72533 lakh and Rs. 688 lakh respectively. The benefit-cost ratio and the Internal Rate of Return (IRR) of the project works out to be 1.95 and 16.29 % respectively.

1.8.6 Monitoring Mechanism

In order to Monitor and Supervise, the over-all work of preparation of Detailed Project Report of Damanganga-Pinjal and Par-Tapi-Narmada Link Projects, a Monitoring Committee under the Chairmanship of the Chairman, Central Water Commission, New Delhi was constituted by Ministry of Water Resources vide letter No. 2/56/2003-BM/2036 dated 12th November, 2009 (Annexure -1.14 in Volume - II). The Committee consisted representatives of

State Governments of Maharashtra & Gujarat and various Central Government Departments.

Apart from the above, a high level Committee in the form of Steering Committee headed by the Secretary, Ministry of Water Resources was formed by Union Ministry of Water Resources vide Letter No. 2/56/2003-BM/795-800 dated 7th Jun, 2006 (Annexure –1.15 in Volume - II) to review the progress of works of DPR of Ken – Betwa link. The same Steering Committee was assigned the work of review the progress of DPR of Damanganga – Pinjal link project.

1.9 Clearances Required

The Damanganga-Pinjal link project will require the following clearances-:

S. No.	Clearance	Agencies
i.	Techno Economic Clearance	Central Water Commission
ii.	Rehabilitation & Resettlement of Tribal Population	Ministry of Tribal Affairs

Based on the above, investment clearance will be accorded by Planning Commission.