

Chapter – 1

Introduction

1.0 General

The erstwhile Union Ministry of Irrigation and Central Water Commission (CWC), formulated a National Perspective Plan (NPP) for Water Resources Development for the country in the year 1980, 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. Par – Tapi - Narmada link project is one of the 16 link proposals of Peninsular Rivers Development Component.

The Feasibility Report of Par – Tapi – Narmada Link project was prepared by NWDA during the year 1995 and circulated among all concerned State Government and members of Technical Advisory Committee (TAC) of NWDA. The link project envisages transfer of 1350 MCM of water from 7 reservoirs contemplated on Par, Auranga, Ambica and Purna rivers and 1554 MCM from the existing Ukai reservoir on Tapi river. However, the water balance study of Tapi basin at Ukai dam carried out by NWDA in the year 2002 revealed that Tapi basin is water deficit. The Government of Gujarat had also indicated that there is no surplus water in Tapi basin at Ukai and suggested to revise the feasibility study. Accordingly, the Feasibility Report of Par – Tapi – Narmada link was revised during 2005 and again circulated to all concerned. Since then continuous efforts were made by National Water Development Agency, Central Water Commission (CWC) and Ministry of Water Resources to arrive at the consensus between 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 Par – Tapi – Narmadalink 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 Par – Tapi – NarmadaLink Project.

NWDA has prepared the DPR of Par – Tapi - Narmada 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 (THDCIL), India Meteorological Department (IMD), National Remote Sensing Center (NRSC), Hyderabad, Water & Power Consultancy Services (WAPCOS), Regional Remote Sensing Centre (RRSC), Jodhpur etc.

The DPR of Par-Tapi-Narmada Link Project was completed by NWDA in August, 2015 and sent to the Government of Gujarat and Maharashtra vide NWDA, New Delhi D.O Letter No. NWDA/Tech-I/200/44-I/Vol.V/12269 dated 25.08.2015 for their views.

The issue of water sharing and power sharing between the States of Gujarat and Maharashtra has been discussed at the level of Chief Engineers of the States of Gujarat and Maharashtra and NWDA. Further matter in this regard is taken up at the Senior Officers level of the two States and MoWR, RD&GR, Government of India. Hon'ble Union Minister for WR, RD&GR held meeting with the Hon'ble Chief Minister, Government of Maharashtra on 7th January 2015, 9th January 2016 and 3rd May, 2016 where in Damanganga-Pinjal and Par-Tapi-Narmada Link Projects were discussed among other issues. The Secretary WR, RD&GR held meeting with the Hon'ble Chief Minister, Government of Gujarat on 31-12-2016 at Gandhi Nagar regarding DPR of Par-Tapi-Narmada Link. Government of Gujarat suggested, to include more tribal areas in the beneficiary areas of PTN Link. The DPR has been modified considering the modification /suggestions of Government of Gujarat. The modification in the proposal as per the suggestion of Government of Gujarat are detailed in para 1.7.1.

1.1 Outline of the Project

Par-Tapi-Narmada Link Project now envisages to transfer the surplus waters (after providing the waters to the people in the vicinity of the reservoirs to meet all the requirements in ultimate stage of development) of West flowing Par, Auranga, Ambica and Purna river basins of South Gujarat and neighbouring Maharashtra to north Gujarat for utilisation in drought affected Saurashtra and Kutch region, tribal areas in Chhota Udepur and Panchmahal districts by substitution, tribal areas in the vicinity of proposed reservoirs and other areas enroute of link canal including tribal areas right side of link canal .

The requirements of the people in the vicinity will be always met by assigning the first priority. The Par – Tapi – Narmada link project will provide waters for irrigation and drinking purposes in its en-route and take over the part command area of existing Miyagam Branch Canal of Narmada Canal System. The Narmada waters so saved in Sardar Sarovar Project would be utilized in Saurashtra and Kutch region of Gujarat and tribal areas in Chhota Udepur and Panchmahal districts by substitution through Narmada Canal System to meet irrigation, domestic and other requirements.

While preparation of Feasibility Report the Par-Tapi-Narmada Link Project proposal comprises construction of seven dams: namely Jheri dam across river Par in Peint taluka of Nasik district in Maharashtra State; Mohankavchali dam across river Par, Paikhed dam across river Nar – a tributary of river Par, Chasmandva dam across river Tan – tributary of river Auranga – all in Dharampur taluka of Valsad district in Gujarat State; Chikkar dam across river Ambica, Dabdar dam across river Khapri – a tributary of river Ambica and Kelwan dam across river Purna – all in Ahwa taluka of Dang district in Gujarat State. Also, Construction of 3 nos. of diversion weirs – one each in the downstream of Paikhed, Chasmandva and Chikkar dam; six power houses; and construction of 400 km long link canal (including 2 tunnels of total 5.5 km) passing through Dharampur taluka of Valsad district, Ahwa taluka of Dang district, Vansda taluka of Navsari district, Vyara and Songadh talukas of Tapi district, Mandvi and Mangrol talukas of Surat district, Valia, Jhagadia and Nandod talukas of Bharuch district, Tilakwada Mahal and Sankheda talukas of Vadodara district of Gujarat State connecting all seven dams with existing Miyagam Branch Canal of Narmada Canal System are envisaged. The surplus water proposed

for diversion through Par-Tapi-Narmada link shall take over the part command of existing Miyagam Branch Canal of Narmada Canal System and the Narmada water so saved shall be utilized to extend the irrigation facilities and also to meet the drinking water and other requirements in the drought prone Saurashtra and Kutch region of north Gujarat. The project will provide irrigation to a total area of 1.69 lakh hectare annually which includes 0.52 lakh hectare new command area in its enroute region in Navsari, Surat, Dang and Bharuch districts of Gujarat State and take over about 1.17 lakh hectare area in the command area of existing Miyagam Branch Canal of Narmada Canal System. The project will also generate about 93 Mkw of hydropower from the power houses proposed at various dams and canal falls, besides providing drinking water to the villages in the region.

The objective of the proposed Par-Tapi-Narmada link project is to divert surplus water available in the west flowing rivers between Par and Tapi (including Par but excluding Tapi) of south Gujarat and neighbouring Maharashtra for utilization in the drought prone Saurashtra and Kutch region of north Gujarat by substitution.

NWDA and CWC jointly carried out hydrological studies of Par basin and at proposed Jheri, Mohankavchali and Paikhed dam sites; Auranga basin and at proposed Chasmandva dam site; Ambica basin and at proposed Chikkar and Dabdar dam sites; and Purna basin and at proposed Kelwan dam site during March, 2012 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 Par basin up to Railway Bridge has been developed for the period from 1975 to 2006 using the virgin discharge data of Nanivahiyal G&D site for the period from 1966 to 2004. As per the study, the average, 50% and 75% dependable annual gross yields of the whole Par basin at railway bridge site are assessed to be 2160 MCM, 1922 MCM and 1726 MCM respectively. The gross annual yield series at proposed Jheri, Mohankavchali (free catchment) and Paikhed dam sites have also been developed for the period from 1975 to 2006 based on observed discharge data at Nanivahiyal G&D site. As per the study, the average, 50%, and 75% dependable annual gross yields at: Jheri dam site

are assessed to be 528 MCM, 467 MCM and 391 MCM respectively; at Mohankavchali dam site (from free catchment downstream of Jheri dam site) 284 MCM, 268 MCM and 213 MCM respectively; and at Paikhed dam site 380 MCM, 335 MCM and 264 MCM respectively.

The gross annual yield series for the entire Auranga basin has been developed for the period from 1975 to 2006 using the virgin discharge data of Bhervi G&D site for the period from 1974 to 2006. As per the study, the average, 50% and 75% dependable annual gross yields of the whole Auranga basin are assessed to be 1092 MCM, 983 MCM and 858 MCM respectively. The gross annual yield series at proposed Chasmandva dam site has been developed for the period from 1975 to 2006 based on observed discharge data at Amba G&D site located in the downstream of the Chasmandva dam site. As per the study, the average, 50% and 75% dependable annual gross yields at Chasmandva dam site are assessed to be 102 MCM, 91 MCM and 70 MCM respectively.

The gross annual yield series for the entire Ambica basin has been developed for the period from 1975 to 2006 using the virgin discharge data of Gadat G&D site (maintained by CWC) for the period from 1979 to 2004. As per the study, the average, 50% and 75% dependable annual gross yields of the whole Ambica basin are assessed to be 2800 MCM, 2430 MCM and 1914 MCM respectively. The gross annual yield series at proposed Chikkar and Dabdar dam sites have been developed for the period from 1975 to 2006 based on observed discharge data at Kudkas G&D site located just upstream of Dabdar dam site. As per the study, the average, 50% and 75% dependable annual gross yields at Chikkar dam site are 304 MCM, 257 MCM and 220 MCM respectively and that of at Dabdar dam site are assessed to be 488 MCM, 455 MCM and 323 MCM respectively.

The gross annual yield series for the entire Purna basin has been developed for the period from 1975 to 2006 using the virgin discharge data of Mahuva G&D site (maintained by CWC) for the period from 1974 to 2006. As per the study, the average, 50% and 75% dependable annual gross yields of the whole Purna basin are assessed to be 1667 MCM, 1419 MCM and 1101 MCM respectively. The gross annual yield series at proposed Kelwan dam site has been developed for the period from 1975 to 2006

based on observed discharge data at Kalibel G&D site located just in the upstream of the Kelwan dam site. As per the study, the average, 50% and 75% dependable annual gross yields at Kelwan dam site are assessed to be 497 MCM, 445 MCM and 362 MCM respectively.

The net annual yields available at Jheri dam site in Par basin at average, 50% and 75% dependabilities are assessed to be 509 MCM, 446 MCM and 371 MCM respectively keeping a provision for upstream utilizations planned by the States for irrigation (19.16 MCM), domestic requirement (1.30 MCM), Industrial requirement (3.94 MCM) and regeneration from domestic and industrial uses (4.19 MCM).

The net annual yields available at Mohankavchali dam site (free catchment between Jheri and Mohankavchali dam sites) in Par basin at average, 50% and 75% dependabilities are assessed to be 281 MCM, 265 MCM and 209 MCM respectively keeping a provision for upstream utilizations planned by the States for irrigation (2.72 MCM), domestic requirement (0.78 MCM), Industrial requirement (2.37 MCM) and regeneration from domestic and industrial uses (2.52 MCM).

The net annual yields available at Paikhed dam site across Nar river in Par basin at average, 50% and 75% dependabilities are assessed to be 367 MCM, 321 MCM and 250 MCM respectively keeping a provision for upstream utilizations planned by the States for irrigation (12.93 MCM), domestic requirement (1.83 MCM), industrial requirement (3.99 MCM) and regeneration from domestic and industrial uses (4.65 MCM). In addition, the environmental and ecological needs in the downstream will be 3.06 MCM.

The net annual yields available at Chasmandva dam site across Tan river in Auranga basin at average, 50% and 75% dependabilities are assessed to be 96 MCM, 85 MCM and 64 MCM respectively keeping a provision for upstream utilizations planned by the States for irrigation (5.80 MCM), domestic requirement (0.27 MCM), industrial requirement (0.85 MCM) and regeneration from domestic and industrial uses (0.90 MCM). In addition, the environmental and ecological needs in the down-stream will be 0.59 MCM.

The net annual yields available at Chikkar dam site in Ambica basin at average, 50% and 75% dependabilities are assessed to be 255MCM, 206 MCM and 170 MCM respectively keeping a provision for upstream utilizations planned by the States for irrigation (52.79 MCM), domestic requirement (0.64 MCM), industrial requirement (2.20 MCM) and regeneration from domestic and industrial uses (4.77 MCM). In addition, the environmental and ecological needs in the down-stream will be 2.42 MCM.

The net annual yields available at Dabdar dam site across Khapri river in Ambica basin at average, 50% and 75% dependabilities are assessed to be 430MCM, 394 MCM and 262 MCM respectively keeping a provision for upstream utilizations planned by the States for irrigation (61.54 MCM), domestic requirement (3.88 MCM), industrial requirement (5.53 MCM) and regeneration from domestic and industrial uses (10.39 MCM). In addition, the environmental and ecological needs in the down-stream will be 3.93 MCM.

The net annual yields available at Kelwan dam site in Purna basin at average, 50% and 75% dependabilities are assessed to be 444MCM, 390 MCM and 308 MCM respectively keeping a provision for upstream utilizations planned by the States for irrigation (52.47MCM), domestic requirement (5.22 MCM), industrial requirement (7.53 MCM) and regeneration from domestic and industrial uses (10.20 MCM). In addition, the environmental and ecological needs in the down-stream will be 4.10 MCM.

About 1634 MCM of surplus water at 75% dependability is available at the 7 reservoirs proposed in Par, Auranga, Ambica and Purna river basins. The dam wise details are given in **Table – 1.1**:

Table – 1.1
Net Water Availability

S. No.	Dam	Net Water Available At 75% Dependability (MCM)
1	Jheri dam	371
2	Mohankavchali dam*	209
3	Paikhed dam	250
4	Chasmandva dam	64

5	Chikkar dam	170
6	Dabdar dam	262
7	Kelwan dam	308
	Total	1634

**Note: Mohankavchali dam has not been considered in the present planning of Par – Tapi – Narmada link*

Due to public hindrance in carrying out field survey and investigations during preparation of Detailed Project Report of Par – Tapi – Narmada link project, the required field investigations could not be carried out at proposed Mohankavchali dam. This aspect was viewed during the meeting of Director General, NWDA with the concerned Chief Engineer of CWC on dated 18.02.2012 regarding completion of various design consultancy works for preparation of Detailed Project Report. It was decided that the NWDA shall examine the possibility of transfer of water directly from Jheri reservoir to Paikhed reservoir /barrage by avoiding Mohankavchali dam. As such, the Mohankavchali dam has not been considered in the present planning of Par – Tapi – Narmada link. However, at later stage when the public hindrance is resolved and the required field survey and investigations are carried out the proposed Mohankavchali dam will also be dovetailed with Par – Tapi – Narmada link. The diverted water will be utilised enroute of link canal to provide domestic water and irrigation facilities in the new areas and take over part command of existing Miyagam Branch Canal of Narmada Canal System. The Narmada waters so saved will be utilised by substitution in the Saurashtra and Kutch region of North Gujarat for providing domestic water supply and irrigation facilities through Narmada Canal System.

To work out the quantity that can be diverted from Jheri, Paikhed, Chasmandva, Chikkar, Dabdar and Kelwan reservoirs for use in enroute and in Saurashtra and Kutch region of Gujarat by substitution, 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 the total water demand of the link project is about 1330 MCM. The Details are given in **Table-1.5**. The dam wise quantity of water diversion is given in **Table – 1.2**. The index map of Par – Tapi – Narmada link project is at **Plate 1.1** of Volume –VII.

Table – 1.2
Diversion Quantity from reservoirs

S. No.	Dam	Diversion Quantity (MCM)
1	Jheri	176
2	Paikhed	250
3	Chasmandva	64
4	Chikkar	150
5	Dabdar	262
6	Kelwan	308
	Total	1210

1.2 Justification and Objective of the Project

The rainfall in Saurashtra and Kutch regions of Gujarat is very scanty and the area is frequently affected by droughts. The annual normal rainfall (1951-2000) in Saurashtra & Kutch region is 507 mm and whereas the average annual Rainfall in Par, Auranga, Ambica and Purna river basins is assessed to be 2217, 2063, 1833 and 1472 mm respectively. The rivers in Saurashtra & Kutch region are mostly dry throughout the year. Whereas, sizable quantum of flows of Par, Auranga, Ambica and Purna rivers are going to sea unutilised every year. The water availability studies of these basins carried out by CWC indicates availability of sizable surplus waters as mentioned in Table: 1.1. The available surplus waters shall be stored in the reservoirs to be constructed on these rivers and diverted to Saurashtra & Kutch regions for meeting irrigation, drinking and other needs. However, before considering any water transfer from these basins the water requirements of the peoples in the vicinity of the proposed reservoirs and en-route of link canal will be met on first priority. The Par-Tapi-Narmada link project is one of the viable options to divert the surplus flows of Par, Auranga, Ambica and Purna rivers to drought prone Saurashtra & Kutch regions of Gujarat.

Accordingly, Preliminary Feasibility study to ascertain whether the project is feasible, was carried out for diversion of surplus waters of West flowing Par, Auranga, Ambica and Purna rivers of South Gujarat to drought affected Saurashtra and Kutch region of Gujarat State. 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 Par-Tapi – Narmada link, the in-basin requirements of water up-stream and down-stream of dams for ultimate stage of development have been considered, as such the diversion of water through the proposed Par- Tapi – Narmada link project is 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 Government 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 Srisaillam 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 en-route. 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 & Kutch 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

Par-Tapi-Narmada Link Project envisages transferring the surplus waters of West flowing Par, Auranga, Ambica and Purna river basins of South Gujarat and neighbouring Maharashtra to north Gujarat for utilisation in drought affected Saurashtra and Kutch region by substitution. The Feasibility Report of Par – Tapi – Narmada link was prepared by NWDA during the year 2005 and circulated to the concerned State Government and members of Technical Advisory Committee (TAC) of NWDA. The Par, Auranga, Ambica and Purna rivers involved in Par – Tapi – Narmada link project are interState rivers spreading their catchment area in the Gujarat and Maharashtra States. 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 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:

1.6.1 Earlier Proposals

The Government of Gujarat in the year 1973 has carried out a broad study with particular reference of meeting the needs of the drought prone areas of the State. The study contained proposals to inter-link the river of the State with the object of better utilisation of water resources in the State. This study was submitted to the Government of India.

Thereafter, the Government of India requested Gujarat to furnish a master plan, incorporating studies regarding the availability of water, its committed and projected utilisation and proposals for diversion of surplus waters to the needy areas. Accordingly, a report titled “National Perspectives for Water Resources Development – Master plan of Gujarat for utilisation of surplus water of west flowing rivers south of Tapi” was prepared by Irrigation Department, Government of Gujarat in 1981.

The proposal envisaged a link canal inter-connecting the Damanganga, the Tapi and the Narmada rivers. This link canal proposed transfer of surplus waters from the west flowing rivers, south of Tapi viz, Damanganga, Par, Auranga, Ambica and Purna, to the Ukai left bank canal, thereby releasing 2580 MCM (2.09 MAF) of waters for utilisation in the needy areas of both Tapi and Narmada basins releasing in turn an equal quantity of water as an exchange from Ukai reservoir. Out of this quantity, about 380 MCM (0.31 MAF) of water was proposed to be utilized for irrigating C.C.A. of about 50000 hectares between the proposed link canal and Ukai Right Bank Main Canal which does not have any other sources of irrigation. Culturable command area of about 25,000 hectares to the right of the canal was proposed to be brought under lift irrigation utilising about 190 MCM (0.15 MAF) of water. The remaining quantity of 2010 MCM (1.63 MAF) was proposed to be transferred further north for extension of irrigation in the Saurashtra and Kutch areas through the Narmada high level canal.

The total water resources of these west flowing rivers were assessed at 11,991 MCM (9.72 MAF), out of which the quantity of about 5,738 MCM (4.65 MAF) could be utilized in Gujarat. The transfer of surplus waters from these west flowing rivers was proposed to be effected by building storage reservoirs across these rivers and constructing a link canal of about 290 Km length from Damanganga to Karjan. The contemplated

link canal was to be a contour canal with its alignment roughly determined on the basis of quick toposheet studies. Three alternative alignments as mentioned below were thought of:

Alternative I: The waters from the reservoirs on these rivers can be fed to the existing Ukai left bank canal system and the equivalent quantity of 720 MCM (0.6 MAF) would become available at Ukai. This quantity plus 1860 MCM (1.49 MAF) i.e. 2580 MCM of surplus waters available in the reservoirs would be available for further transfer to the areas north of Tapi.

Alternative II: A parallel canal linking these reservoirs and opposite in direction to the Ukai left bank canal may be run to feed the Ukai reservoir itself.

Alternative III: An arterial canal carrying surplus waters from these reservoirs may be runcrossing the Tapi and the Narmada on its way and emptying in Narmada command.

Detailed feasibility studies and accurate cost estimates based on surveys and designs could only give a correct idea about the relative merits of the three alternatives. However, a transfer of 2580 MCM (2.09 MAF) of water was envisaged from the storages on these rivers and this quantity of water seemed to be adequate to irrigate an area of about 3.44 lakh hectares (8.5 lakh acres) considering an overall delta of 0.76 m (2.5 ft.).

When NWDA came into existence and the study of the Damanganga to Tapi link was carried out, it was found that major portion of yield from the catchment of Damanganga in Gujarat was being developed for utilisation in Gujarat itself through Madhuban dam and very little surplus water from the Gujarat portion of catchment were left for diversion through the Damanganga-Tapi Link. With this in view, toposheet studies and later prefeasibility studies of Par-Tapi-Narmada Link were carried out by NWDA, where the link starts from Par river instead of Damanganga River.

Pre-Feasibility Report on Par – Tapi-Narmada Link (Technical study No.PFR/5/90) circulated in March 1991 envisaged diversion of 1389 MCM surplus water of Par, Auranga, Ambica and Purna basins to Narmada

command system besides enroute irrigation. As per this study, the link canal originates from river Par and terminates at Ukai reservoir on Tapi river. Further the proposed link canal takes off from the right side of the Ukai reservoir and terminates at Vadodara Branch Canal of Narmada Canal System after crossing Narmada river.

1.6.2 Proposal at Feasibility Report Stage

The Pre-Feasibility Report prepared by NWDA was discussed and accepted by the TAC of NWDA. Thereafter, the feasibility study of Par-Tapi-Narmada Link was carried out and the report was circulated to the concerned State Government and the Members of TAC of NWDA during August, 1995. As per this report a total quantity of 2904 MCM was considered for diversion which includes: 1554 MCM of water assumed to be surplus in Tapi basin at Ukai reservoir; and 1350 MCM of water available as surplus at the seven dams proposed under Par - Tapi – Narmada link project. However, the water balance study of Tapi basin at Ukai dam carried out by NWDA in the year 2002 revealed that Tapi basin is water deficit at Ukai dam. Hence, the transfer of 1554 MCM of water of Tapi basin from Ukai reservoir will not be available for diversion through Par-Tapi-Narmada link. Water Resources Department, Government of Gujarat, Gandhinagar vide their letter No. NWDA-1095/2538/(1)/k3 dated 01.02.1996 had also indicated that there is no likelihood of surplus water in Tapi basin at Ukai and suggested to revise feasibility study of Par-Tapi-Narmada link without considering augmentation of water from Tapi basin.

In view of the above, the FR of Par-Tapi-Narmada link (circulated in the year 1995) was revised considering only the surplus water of 1350 MCM available from the 7 reservoirs proposed in Par – Tapi – Narmada link project. As per the revised study it is found that Par-Tapi portion of the link canal will remain unchanged and in the Tapi-Narmada portion of the link canal the length of the canal will be reduced to 190 km from earlier 225 km and the link canal will now terminate at Miyagam Branch Canal instead of Vadodara Branch canal of Narmada Canal System.

The proposal at FR stage consists of the following components:

- (i) A 773.50 m long composite earth - cum - concrete dam at Jheri across river Par in Peint taluka of Nasik district of Maharashtra State with FRL 246 m and corresponding gross storage capacity of 186 MCM;
- (ii) A 947 m long composite earth - cum - concrete dam at Mohankavachali across river Par in Kaprada taluka of Valsad district of Gujarat State with FRL 158 m and corresponding gross storage capacity of 347 MCM;
- (iii) A 1306 m long composite earth - cum - concrete dam at Paikhed across river Nar, a tributary of river Par in Dharampur taluka of Valsad district of Gujarat State with FRL 248 m and corresponding gross storage capacity of 217 MCM.
- (iv) A 2837 m long composite earth - cum - concrete dam at Chasmandva across river Tan, a tributary of Auranga river in Dharampur taluka of Valsad district of Gujarat State with FRL 214 m and corresponding gross storage capacity of 79 MCM;
- (v) A 1656 m long composite earth - cum - concrete dam at Chikkar across river Ambica in Ahwa taluka of Dang district of Gujarat State with FRL 210 m and corresponding gross storage capacity of 129 MCM;
- (vi) A 1046 m long composite earth - cum - concrete dam at Dabdar across river Khapri, a tributary of Ambica river in Ahwa taluka of Dang district of Gujarat State with FRL 169 m and corresponding gross storage capacity of 204 MCM;
- (vii) A 1284 m long composite earth - cum - concrete dam at Kelwan across river Purna in Ahwa taluka of Dang district of Gujarat State with FRL 164 m and corresponding gross storage capacity of 255 MCM;
- (viii) Construction of three diversion barrages one each in the downstream of Paikhed, Chasmandva and Chikkar dams.
- (ix) Six power houses: one each at the toe of Jheri, Paikhed, Chasmandva and Chikkar dams; and two power houses, one each at the falls of Dabdar feeder canal and Kelwan feeder canal.
- (x) A 400 km long link canal (including feeder canals and two tunnels of total about 5.5 km long).

The Par – Tapi – Narmada link will provide irrigation to a total area of 1.69 lakh hectare annually which includes 0.52 lakh hectare new

command areas in its en-route in Vandsa and Chikhali talukas of Navsari district; Valod, Vyara, Songadh, Uchhal, Mandvi and Mangrol talukas of Surat district (undivided); Ahwa taluka of The Dang district; and Valia, Ankleshwar and Jhagadia talukas of Bharuch district of Gujarat State; and take over about 1.17 lakh hectare areas in the command area of existing Miyagam Branch Canal of Narmada canal system. The Narmada water so saved will be utilized in drought affected Saurashtra and Kutch region of North Gujarat by substitution for providing irrigation, domestic water supply etc through Narmada canal System. The project will also generate about 93 MkwH of hydropower from the 6 power houses proposed at various dams and canals fall, besides providing drinking water to the villages in the vicinity of the reservoirs and en -route of link canal.

1.6.3 Proposal at DPR Stage

The topographical survey and other investigations have been carried out during the preparation of DPR. 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. Due to resistance from local public while carrying out the field survey and Investigations works at DPR stage no surveys could be carried out at Mohankavchali dam, As such the Mohankavchali dam has not been considered in the planning of Par – Tapi – Narmada link. However at later stage when required field investigations at Mohankavchali may be carried out as this dam can also be dovetailed with the Par – Tapi – Narmada link. In the present planning the waters from Jheri reservoir will be directly transferred to Paikhed reservoir through a tunnel.

The Proposal at DPR stage consists of following components:

- i) A 808.32 m long composite embankment (concrete face rock fill) cum concrete dam across river Par near village Jheri with FRL 246.00 m and corresponding gross storage capacity 206.03 MCM. The length of concrete face rock fill portion of the dam is 663.32 m and the length of concrete non-overflow section and spill way is 145.00 m. The dam axis is located at Latitude 20°22'25" N and Longitude 73°25'51" E.

- ii) A 1431.85 m long composite embankment (concrete face rock fill) cum concrete dam across river Nar (a tributary of Par river) near village Paikhed with FRL 248.00 m and corresponding gross storage capacity of 229.53 MCM. The length of concrete face rock fill portion of the dam is 1310.85 m and the length of concrete non-overflow section and spill way is 121.00 m. The dam axis is located at Latitude 20°27'42" N and Longitude 73°23'37" E;
- iii) A power house of 9.0 MW installed capacity at the toe of Paikhed dam with 3 units each of 3 MW.
- iv) A 2781.00 m long composite embankment (concrete face rock fill) cum concrete dam across river Tan (a tributary of Auranga river) near village Chasmandva with FRL 214.00 m and corresponding gross storage capacity of 83.63 MCM. The length of concrete face rock fill portion of the dam is 2703.00 m and the length of concrete non overflow section and spill way is 78.00 m. The dam axis is located at Latitude 20°37'02" N and Longitude 73°22'36" E.
- v) A power house of 2.0 MW installed capacity at the toe of Chasmandva dam with 2 units each of 1 MW.
- vi) A 1887.00 m long composite embankment (concrete face rock fill) cum concrete dam across river Ambica near village Chikkar with FRL 210.00 m and corresponding gross storage capacity of 141.99 MCM. The length of concrete face rock fill portion of the dam is 1736.00 m and the length of concrete non overflow section and spill way is 151.00 m. The dam axis is located at Latitude 20°42'00" N and Longitude 73°30'50" E.
- vii) A power house of 2.0 MW installed capacity at the toe of Chikkar dam with 2 units each of 1 MW.
- viii) A 1170.00 m long composite embankment (concrete face rock fill) cum concrete dam across river Kapri (a tributary of Ambica river) near village Dabdar with FRL 169.00 m and corresponding gross storage capacity 222.38 MCM. The length of concrete face rock fill portion of the dam is 1035.00 m and the length of concrete non overflow section and spill way is 135.00 m. The dam axis is located at Latitude 20°48'58" N and Longitude 73°32'05" E.

- ix) A power house of 3.2 MW installed capacity at the toe of Dabdar dam with 2 units each of 1.60 MW.
- x) A 1330.00 m long composite embankment (concrete face rock fill) cum concrete dam across river Purna near village Kelwan with FRL 164.00 m and corresponding gross storage capacity of 282.17 MCM. The length of concrete face rock fill portion of the dam is 1141.00 m and length of concrete non overflow section and spill way is 189.00 m. The main dam axis is located at Latitude 20°55'30" N and Longitude 73°32'00" E.
- xi) A power house of 2.5 MW installed capacity at the toe of Kelwan dam with 2 units each of 1.25 MW.
- xii) A power house of 2.0 MW installed capacity at the fall of feeder pipe line connecting Kelwan dam with main link canal with 2 units each of 1 MW.
- xiii) A tunnel of about 12.70 km long with 3.00 m diameter (D shape) and bed slope of 1:875 connecting Jheri reservoir with Paikhed reservoir.
- xiv) A 147.50 m long barrage in the downstream of Paikhed dam with crest level of 136.00 m.
- xv) A 128.00 m long barrage in the downstream of Chasmandva dam with crest level of 123.00 m.
- xvi) A 369.043 km long link canal off-taking from Paikhed barrage at FSL 142.80 m.
- xvii) A 100 m long tunnel No.1 at RD 14.650 to 14.750 km; A 350 m long tunnel No.2 at RD 24.000 to 24.350 km; A 200 m long tunnel No.3 at RD 32.350 to 32.550 km; A 50 m long tunnel No.4 at RD 37.750 to 37.800 km; and A 450 m long tunnel No.5 at RD 51.500 to 51.950 km;
- xviii) A 2.859 km feeder canal connecting main canal with Chasmandva barrage.
- xix) A 14.342 km inter connecting canal Chikkar and Dabdar reservoirs.
- xx) A 12.258 km feeder canal connecting main canal with Dabdar dam.

- xxi) A 7.616 km feeder canal connecting main canal with Kelwan dam.
- xxii) Cross Drainage / Cross Masonry works including Regulators, Escapes, Road/Railway bridges

The creation of six reservoirs will submerge an area of 6065 ha in Nasik district of Maharashtra, Valsad and Dang districts of Gujarat State.

1.7 Proposed Modifications in Command area of Par-Tapi-Narmada

Link Project

1.7.1 Need for Modification

The DPR of the Par-Tapi-Narmada Link Project was completed by NWDA in August, 2015 and sent to the Govts. of Gujarat and Maharashtra vide Director General, NWDA, New Delhi D.O Letter No.NWDA/Tech-I/200/44-I/Vol.V/12269 dated 25.08.2015 for their views.

In response, Government of Gujarat have conveyed their observations on DPR of Par-Tapi-Narmada Link Project vide letter No.Gen/2010/GoI-3/Part-I/MI Cell dated 21.05.2016 and letter No. S/2015/NWDA/2540/J dated 29.07.2016. Government of Gujarat suggested (i) to explore possibilities for providing maximum irrigation facilities to Tribal areas on right side of the canal by lift (ii) to take over the five projects proposed by the Government of Gujarat on left side of the canal in addition to enroute command and target command in Saurashtra etc. to the extent possible.

In this context, Chief Engineers level meeting was held between NWDA and NWRWS & Kalpasar Department, Government of Gujarat at Gandhinagar on 11th November, 2016 for firming up of modifications in DPR of Par-Tapi-Narmada Link Project. Also, discussions were held between the then OSD now the Secretary, MoWR, RD&GR, Government of India and the Chief Secretary, Government of Gujarat on 11th November, 2016 and 9th February, 2017 regarding Par-Tapi-Narmada Link Project. Secretary, MoWR, RD&GR vide D.O Letter No. 2/7/2007-BM(pt) dated 25.11.2016 requested to convey the consent of Government of Gujarat for new irrigation Planning of Par-Tapi-Narmada Link Project so as to modify the DPR and facilitate early implementation of the project. To finalise the

issues for modifications of DPR, Secretary, MoWR, RD&GR alongwith the officers of NWDA and Gujarat Department held a meeting with the Hon'ble Chief Minister on 31.12.2016. It was suggested to modify the DPR by inclusion of following tribal and other areas in the beneficiary area of PTN link proposal

(i) Inclusion of command areas of the Projects proposed by the Government of Gujarat on left side of the canal in South Gujarat.

To include the command area of five projects proposed by the Government of Gujarat namely i) Ugta ii) Sidhumber iii) Khata Amba iv) Zankhari and v) Khuntali.

(ii) Providing irrigation to the Tribal areas enroute right side of Link Canal by lift.

Providing water for irrigation by lift for possible maximum Tribal areas on right side of the Link Canal.

(iii) Irrigation in Tribal areas in the vicinity of reservoirs.

Providing irrigation in tribal areas of Dangs and Valsad districts of Gujarat and Nasik district of Maharashtra directly from the all six reservoirs under link by lift.

(iv) Irrigation in Tribal areas right side of the Narmada Main Canal by lift in Chhota Udepur and Panchmahal Districts.

Provide irrigation in the tribal areas of Chhota Udepur and Panchmahal districts of the Gujarat State from Narmada Main Canal on substitution basis.

(v) Provision for drinking water

Provision for drinking water for all villages of Dang and Navsari districts, Kaprada and Dharampur taluks of Valsad district and the villages located on the periphery of Jheri Reservoir in Nasik district.

(vi) Filling of Panchayat and village tanks in the periphery of Reservoirs.

Provision for filling all possible tanks in benefitted areas.

A line diagram showing the modified water planning of Present Detailed Project is given at Figure 1.1.

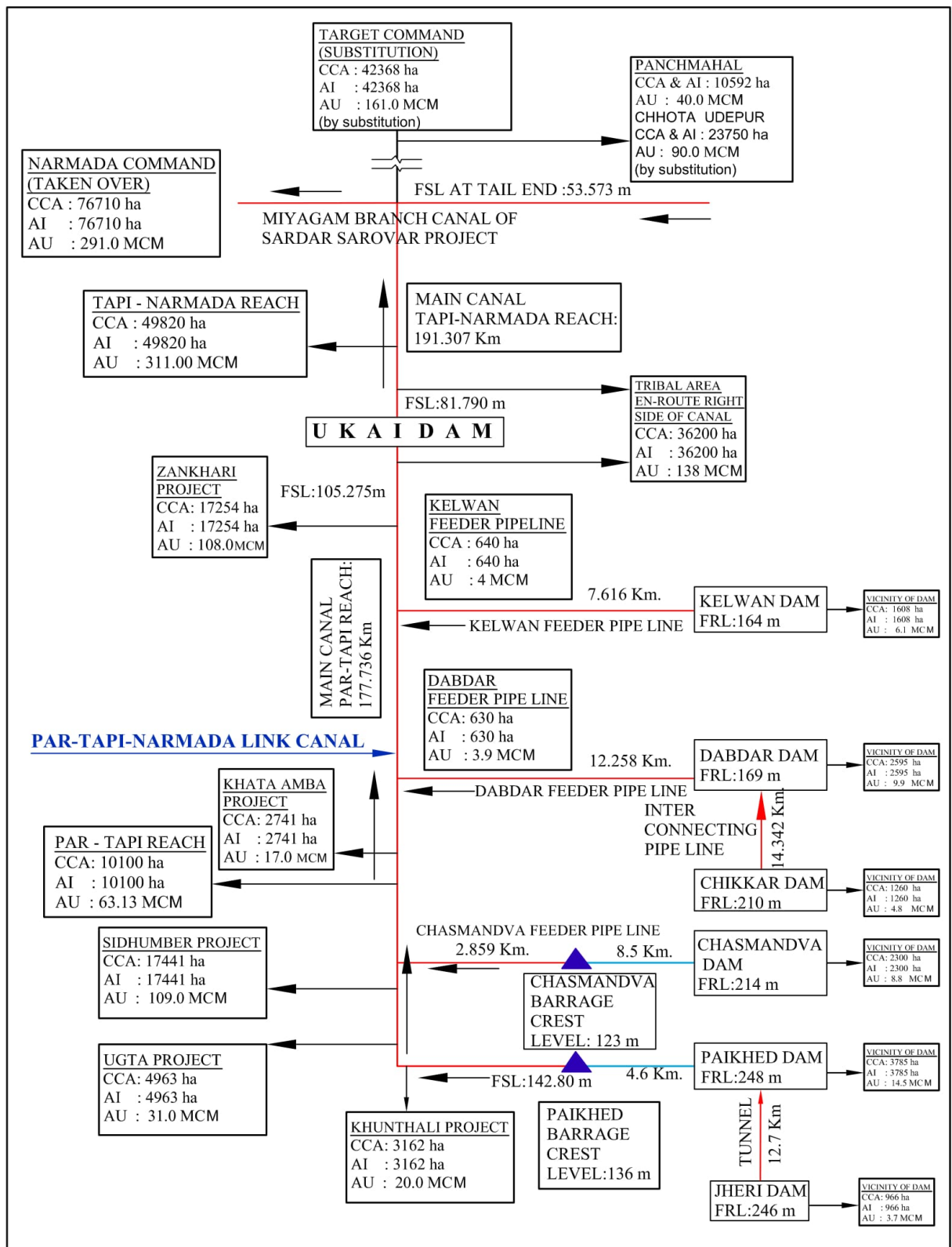


FIGURE - 1.1: LINE DIAGRAM OF PAR-TAPI-NARMADA LINK CANAL SYSTEM

It was also suggested to explore techno-economic feasibility for providing pipe line system instead of open canal for main canal of the link to avoid/minimize the land acquisition in tribal areas as well as to reduce evaporation/seepage losses under Par-Tapi-Narmada Link Project. Secretary, Government of Gujarat also vide letter No. Gen/2010/GoI-3/(3)/Part/MI Cell(K-1) dated 18.01.2017 requested NWDA to explore the above possibility, while revising the DPR.

NWDA examined the feasibility of pipe line system instead of open canal for Par-Tapi-Narmada Link Canal. As per the study, it reveals that the gradient vis-à-vis ideal velocity of flows in pipe lines have become the constraints in laying the pipe line system due to prevailing large difference of head between the canal off-take point and out-fall point at Ukai reservoir. As the link canal runs mostly in cutting, laying a number of gravity pipe lines with very flatter gradients and lesser velocities for diversion of large discharges lead to heavy excavation which escalates the project cost leading to no significant reduction in land acquisition for the Par-Tapi-Narmada link canal. The note on techno-economic feasibility of providing pipe line in lieu of main canal has been sent to the NWRS & Kalpsar Department, Government of Gujarat vide Letter No. NWDA/IC/V/T-143/504-10 dated 14.03.2017. However, NWDA suggested that gravity pipe line can be adopted in place of feeder canals as discharges are small and lies in hilly terrain. Copy of the minutes of the Chief Engineers level meeting dated 09.02.2017 is enclosed at **Annexure – 1.18**.

Based on the discussions with the Government of Gujarat from time to time during the above meetings, NWDA modified the DPR of the Par-Tapi-Narmada Link Project.

1.7.2 Project Planning and Optimisation of Benefits

The DPR of Par-Tapi-Narmada Link Project has been modified considering the views / suggestions of Government of Gujarat as mentioned in the preceding pages at para 1.7.1. The optimised project benefits of PTN link are as below:

I. Irrigation Benefits

1. Provision of irrigation to tune of 61190 ha new command area in enrout of link canal in Navsari, Tapi, Dang and Bharuch districts.(No change from August-2015 DPR)
2. Providing irrigation in the 45561 ha command area of Ugtā, Sidhumber, Khata Amba, Zankhari and Khuntali projects proposed by Government of Gujarat in Valsad, Navsari and Tapi districts. The details are in Table 1.3 below:

Table – 1.3

Details of Proposed projects of Government of Gujarat

Sl. No	Name of Reservoir	River	Taluka Benefitted	District Benefitted	Culturable Command Area (ha)	Annual Irrigation (ha)
1	Sidhumber	Man river	Dharampur Chikhli	Valsad Navsari	17441	17441
2	Ugtā	Par river	Dharampur	Valsad	4963	4963
3	Khuntali	Dholdo / Par river	Dharmpur	Valsad	3162	3162
4	Khata Amba	Kaveri	Vansada	Navsari	2741	2741
5	Zankari	Zankari river	Songadh & Vyara	Tapi	17254	17254
Total					45561	45561

3. An area of about 36,200 ha benefitting the tribal areas on the right side of PTN link canal by lift in Tapi, Surat and Bharuch districts. The details are in Table 1.4 below:

Table – 1.4

Additional irrigation in the tribal areas lying right side of Par-Tapi-Narmada Link Canal by lift

Sl. No.	Name of Command Area	CCA (ha)	Annual Irrigation at 100% intensity of irrigation (ha)	Taluka / District benefitted
1	Area-1	900	900	Vyara / Tapi
2	Area-2	13100	13100	Songadh / Tapi
3	Area-3	6500	6500	Mandvi & Mangrol / Surat
4	Area-4	15700	15700	Valia / Bharuch
	Total	36200	36200	

4. An area of about 23750 ha and 10592 ha in the command area in Chhota Udepur and Panchmahal districts respectively by lift from Narmada Main Canal on substitution basis.

5. Command area of 12514 ha in the vicinity of six reservoirs through lift from reservoirs in Dang and Valsad districts of Gujarat and Nasik district of Maharashtra.

II. Drinking Water:

6. A provision of 76 MCM of water is made to supply drinking water for about 27.5 lakh populations for most of the villages of Dang and Navsari Districts, Kaprada and Dharampur talukas of Valsad District and the villages located on the periphery of Jheri reservoir in Nasik district.

Distribution of above water to all villages by pipeline system will be planned by the Government of Gujarat on its own at the time of execution of the project.

7. Provision for filling all possible tanks in tribal areas.

A Provision of about 50 MCM water is made for filling 2226 Panchayat tanks and village tanks/check dams in all the tribal areas in the vicinity of the project.

Thus the Par-Tapi-Narmada link Project will provide water to meet the domestic and Industrial water requirements of the villages enroute the link canal along with the villages located in the vicinity of all the proposed reservoirs.

Details of irrigation / drinking water benefits /water demands under Par-Tapi-Narmada link Project considering all the above modifications are given at Table 1.5:

Table – 1.5

Irrigation / Drinking water benefits and water Demand of Par-Tapi-Narmada Link project

Sl. No.	Reach / Feedar	CCA (ha)			Annual Irrigation (ha)	Annual Utilisation in (MCM)
		In Tribal areas	Non-Tribal	Total		

1	Enroute command	51173	10017	61190	61190	382
2	Project proposed by Government of Gujarat on the left side of link canal	40631	4930	45561	45561	285
3	Tribal area enroute right side of link canal by lift	36200	0	36200	36200	138
4	Tribal area in the vicinity of reservoirs	12514	0	12514	12514	48
5	Tribal areas on right side of Narmada Main Canal by lift					
	a.Chhota Udepur dist.	14940	8810	23750	23750	90
	b.Panchmahal dist.	1833	8759	10592	10592	40
6	Supply of drinking water for all villages of Dang District and Villages of Kaprada & Dharpur taluka of Valsad	Provision of 76 MCM made for about 27.5 lakh population of these areas.				76

	District.					
7	Filling all possible tanks in benefitted areas.	Provision of 50 MCM water has been kept for filling 2226 Panchayat and village tanks/ check dams in benefit.				50
8	Target command in Saurashtra region	0	42368	42368	42368	161
	Sub Total	157291	74884	232175	232175	
9	Environmental releases					20
10	Evaporation losses					40
	Total					1330 MCM

II. Power Benefits

Six power houses: one each at the toe of Paikhed, Chasmandva, Chikkar, Dabdar and Kelwan dams and one at the fall of the feeder pipe line connecting Kelwan reservoir to the main canal are proposed. The power potential study of the powerhouses proposed in Par – Tapi – Narmada link project has been carried out by THDCIL. The details such as number of generating units, installed capacity and annual energy generation in the 90% dependable year and at 95 % plant availability are given in **Table – 1.6:**

**Table – 1.6
Power Potential**

S No.	Powerhouse	Installed Capacity (MW)			Annual Energy Generation (MU)
		Number of Units	Installed Capacity of each Unit (MW)	Total	
1	Paikhed dam PH	3	3.00	9.00	45.53
2	Chasmandva dam PH	2	1.00	2.00	5.67
3	Chikkar dam PH	2	1.00	2.00	8.35
4	Dabdar dam PH	2	1.60	3.20	16.60
5	Kelwan dam PH	2	1.25	2.50	13.07
6	Kelwan feeder canal PH	2	1.00	2.00	12.48
				Total	20.70
				Say	21.00
					101.70
					102.00

III. Flood Control Benefits

Though no flood cushion has been provided in the proposed six reservoirs they will provide incidental benefit of flood moderation in the rivers where reservoirs are identified viz. Par, Auranga, Ambica and Purna rivers.

IV. Other Benefits

Besides above benefits, many other incidental benefits such as pisciculture, recharge of ground water in downstream areas of the proposed dams and in the command area, 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 Par – Tapi - Narmada 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 Par – Tapi - Narmada 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, Jaipur. These data formed the inputs for design of various components of the project. The Hydrological studies and Irrigation Planning was carried out by Central Water Commission. Simulation analysis was carried out for optimising the height of various dams. The simulation analysis formed inputs for the power potential studies carried out by Tehri Hydro Development Corporation of India Ltd. (THDCIL) and the output given by THDCIL in the form of power potential studies formed input for civil designs of hydel structures. The designs of various components of the project were carried out by Central Water

Commission. 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 Par-Tapi-Narmada Link assigned to them.

1.8.2 Planning and Lay-out

The Par-Tapi-Narmada Link Project has been planned to transfer the surplus waters of West flowing Par, Auranga, Ambica and Purna river basins of South Gujarat and neighbouring Maharashtra to provide maximum possible irrigation facilities to tribal areas enroute on right side of the Par-Tapi-Narmada link canal; tribal dominant Dang and Valsad district of Gujarat and Nasik district of Maharashtra; tribal areas of Naswadi, Kavant, Sankheda, Jetpur Pavi, Chhota Udepur taluks of Chhota Udepur district, and Halol, Ghogamba and Kalol talukas of Panchmahal district by lift directly from Narmada Main Canal on substitution basis. The link project will also provide irrigation to the command areas of five projects proposed by the Government of Gujarat in its initial reaches and cater the water demands for irrigation & drinking purposes on its enroute. The link project also takesover the part command area of existing Miyagam Branch Canal of Narmada Canal System. The Narmada waters so saved in Sardar Sarovar Project would be utilized for Chhota Udepur and Panchmahal district and in drought affected Saurashtra area of Gujarat through Narmada Canal System to meet irrigation, domestic and other requirements.

The Par-Tapi-Narmada Link Project comprises construction of six dams: namely Jheri dam across Par river, Paikhed dam across river Nar – a tributary of river Par, Chasmandva dam across river Tan –a tributary of river Auranga, Chikkar dam across river Ambica, Dabdar dam across river Khapri – a tributary of river Ambica and Kelwan dam across river Purna. Also, Construction of 2barrages – one each in the downstream of Paikhed and Chasmandva dams; a tunnel inter connecting Jheri and Paikhed reservoirs; six power houses; and construction of 406.118km long link canal (including 5tunnels along the canal and feeder pipe lines) connecting all six dams with existing Miyagam Branch Canal of Narmada Canal System are envisaged. The details of various components are given below:

1.8.2.1 Jheri Dam

Jheri dam is proposed across river Par near village Jheri in Peint taluka of Nasik district of Maharashtra. The total length of Jheri dam is 808.32m of which 663.32m is concrete face rock fill dam (CFRD) and remaining 145.0 m length will be of concrete. The length of spillway is 91.0 m and has been proposed in the river portion.

The surplus waters available at Jheri reservoir will be transferred to Paikhed reservoir through a tunnel of 12.70km length.

1.8.2.2 Paikhed Dam

Paikhed dam is proposed across Nar river a tributary of Par river near village Paikhed in Dharampur taluka of Valsad district of Gujarat. The total length of Paikhed dam is 1431.85 m of which 1310.85 m is concrete face rock fill dam (CFRD) and remaining 121.0m length of dam will be of concrete. The spillway has been proposed in the right flank of the dam. 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 waters available at Paikhed reservoir is to be released into the river through powerhouse and will be picked-up at Paikhed barrage from where the Par – Tapi – Narmada link canal will offtake and carry the surplus waters of Jheri and Paikhed reservoirs.

1.8.2.3 Chasmandva Dam

Chasmandva dam is proposed across river Tan, a tributary of Auranga river near village Chasmandva in Dharampur taluka of Valsad district of Gujarat. The total length of Chasmandva dam is 2781.0m of which 2703.0 m is concrete face rock fill dam (CFRD) and remaining 78.0 m length of dam will be of concrete. The chute spillway has been proposed in the right flank of the dam. A penstock is proposed in extreme left of the concrete portion of the dam for taking water to the power house.

The surplus water available at Chasmandva reservoir is to be released into the river through powerhouse and will be picked-up at

Chasmandvabarrage, from where a feeder pipelines will carry the surplus water of Chasmandva reservoir upto main Par - Tapi – Narmada link canal.

1.8.2.4 Chikkar Dam

Chikkar dam is proposed across river Ambica near village Chikkar in Ahwa taluka of Dang district of Gujarat. The total length of Chikkar dam is 1877.0 m of which 1736.0 m is concrete face rock fill dam (CFRD) and remaining 151.0 m length of dam will be of concrete. The chute spillway has been proposed in the right flank of the dam. A penstock is proposed in extreme left the concrete portion of the dam for taking water to the power house.

The Chikkar and Dabdar reservoirs will be inter-connected by a pipeline. The surplus water available at Chikkar reservoir will be released into inter-connecting canal through the powerhouse and will be taken to Dabdar reservoir.

1.8.2.5 Dabdar Dam

Dabdar dam is proposed across river Khapri a tributary of Ambica river near village Dabdar in Ahwa taluka of Dang district of Gujarat. The total length of Dabdar dam is 1170 m of which 1035 m is concrete face rock fill dam (CFRD) and remaining 135 m length of dam will be of concrete. The spillway has been proposed in the right flank of the dam. 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.

A feeder pipeline will carry the combined surplus waters of Chikkar and Dabdar reservoirs upto main Par – Tapi – Narmada link canal after power generation at its head.

1.8.2.6 Kelwan Dam

Kelwan dam is proposed across river Purna near village Kelwan in Ahwa taluka of Dang district of Gujarat. The total length of Kelwan dam is 1330 m of which 1141 m is concrete face rock fill dam and remaining 189m

length of dam will be of concrete. The spillway has been proposed in the river portion. A penstock is proposed in extreme right of the concrete portion of the dam for taking water to the power house located at the toe of the dam.

After the power generation in dam toe power house, a feeder pipeline will carry the surplus water available at proposed Kelwan reservoir upto main Par – Tapi – Narmada link canal. Hydro-power will also be generated at the end of feeder pipeline.

1.8.2.7 Paikhed Barrage

Paikhed barrage is proposed across river Nar about 4.60Km downstream of proposed Paikhed dam to facilitate the release of combined surplus waters of Jheri and Paikhed reservoirs into the link canal. The total length of Paikhed barrage is 147.50 m.

1.8.2.8 Chasmandva Barrage

Chasmandvabarrage is proposed across river Tan about 8.50 Km downstream of proposed Chasmandva dam to facilitate the off take of the feeder pipeline to release the surplus water of Chasmandva reservoir into the link canal. The total length of Chasmandvabarrage is 128.0m.

1.8.2.9 Link Canal

The Par – Tapi – Narmada link canal will off take from proposed Paikhed barrage with Full Supply Level (FSL) of 142.800m. The feeder pipelines from Chasmandva barrage to transfer surplus waters of Chasmandva reservoir; from Dabdar reservoir to transfer Surplus waters of proposed Chikkar and Dabdar reservoirs; and from proposed Kelwan reservoir to transfer surplus water at Kelwan reservoirs will join link canal at RD 62.072 km, 108.250 km and 129.600 km respectively.

The canal will out fall in existing Ukai reservoir at FSL of 105.275 m. The Par – Tapi – Narmada link canal will further off takes from saddle of Ukai dam in the right flank at FSL81.790 m. The link canal will cross Kim, Amravati, Karjan, Narmada, Orsang and Hiren rivers, besides other small

streams, before joining existing Miyagam Branch Canal at RD16.70 km and will take over its part command area.

1.8.2.10 Powerhouse

A power house is proposed at the toe of Paikhed dam to generate the hydro power from the combined surplus waters of Jheri and Paikhed reservoirs. For generation of hydro power from the surplus Chasmandva waters, a power house has been proposed at the toe of proposed Chasmandva dam. A power house is proposed at the toe of proposed Chikkar dam. After hydro power generation the Chikkar water will be transferred to proposed Dabdar reservoir through an inter connecting pipe line. The power house proposed at the toe of Dabdar dam will generate the hydro power by utilizing combined waters of proposed Chikkar and Dabdar reservoirs. At Kelwan dam a power house is proposed at the dam toe and another power house at the fall of feeder pipe line. Total 6 power houses are proposed.

1.8.3 Survey & 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 Par-Tapi-Narmada link project was taken up by National Water Development Agency utilising one Circle Office located at Valsad. One division office located at Valsad has been utilized and erstwhile Investigation Sub Division, NWDA, Vadodara has been upgraded to division office. The works for carrying out Survey & Investigations for preparation of Detailed Project Report of Par-Tapi-Narmada Link Project was taken-up during the year 2009, jointly by division offices located at Valsad and Vadodara.

The permission for carrying out the Survey & Investigations work in the forest area was obtained from Principal Chief Conservator of Forest, Government of Gujarat, Gandhinagar vide their letter No. Land/29/B/3034-36/08-09 date 12th December, 2008 (Annexure – 1.6). Similar permission for Maharashtra area has been obtained from Deputy Conservator of Forest (West), Government of Maharashtra, Nasik vide their letter No. Land/CA/4294 Date 25th November, 2008 (Annexure – 1.7) for Surgana and Peint taluka of Nasik district. The details of the Survey & Investigation works carried out departmentally are listed in Para 1.8.3.1 and 1.8.3.2.

1.8.3.1 Survey & Investigations 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 Par-Tapi-Narmada 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:

- i. Topographical Surveys along dam axis of Paikhed, Chasmandva, Chikkar and Dabdar dam sites. The similar survey at Jheri and Kelwan reservoirs was carried out at the time of preparation of Feasibility Report and the same data has been used in preparation of DPR;
- ii. Topographical surveys along barrage axis of Paikhed and Chasmandvabarrages (carried out at the time of preparation of Feasibility Report and the same data has been used in preparation of DPR);
- iii. Reservoir submergence area surveys for Jheri and Paikhed reservoirs (carried out at the time of preparation of Feasibility Report and the same data has been used in preparation of DPR);
- iv. Reservoir submergence area survey of Chasmandva reservoir carried out by NWDA through Survey of India at the time of preparation of

- Feasibility Report and the same data has been used in preparation of DPR;
- v. Reservoir submergence area survey of Chikkar, Dabdar, and Kelwan reservoirs carried out by Government of Gujarat through Survey of India during the year 1975 and the same data has been used in preparation of DPR;
 - vi. Topographical Surveys along the alignment of Par - Tapi portion for a length of about 100 km from Par river to Ambica river (carried out at the time of preparation of Feasibility Report and the same data has been used in preparation of DPR);
 - vii. Topographical Surveys along the alignment of Tapi- Narmada portion for a length of 61.595 km from Ukai dam;
 - viii. Sample Command Area survey for enroute command - 4200 ha;
 - ix. Topographical surveys along river course upstream and downstream of Jheri dam; upstream and downstream of Paikhed dam; upstream and downstream of Paikhed barrage; upstream and downstream of Chasmandva dam and barrage; upstream and downstream of Chikkar dam; upstream and downstream of Dabdar dam; upstream and downstream of Kelwan dam (carried out at the time of preparation of Feasibility Report and the same data has been used in preparation of DPR);
 - x. NWDA has established three gauge sites during preparation of DPR, one gauge site across river Nar (a tributary of Par river) on the cause-way at a location between proposed Paikhed dam site and barrage site and two gauge sites across river Tan (a tributary of Auranga river) at location just downstream of proposed Chasmandva dam site and on the cause way at a location between Chasmandva dam site and barrage site. Hourly gauge observations during monsoon period were carried out at these sites for the period from July 2009 to October 2012. No Gauge sites could be established at the remaining dam sites viz. Jheri, Chikar, Dabdar, and Kelwan due to opposition from the local people.

1.8.3.2 Survey and Investigation Works Carried Out by Other Agencies

1.8.3.2.1 Topographical Surveys

Topographical surveys of about 72 km in Par – Tapi reach from Ambica river crossing up to its out fall into Ukai reservoir, 132 km of canal

alignment in Tapi-Narmada reach starting from RD 61.595 km and upto Miyagam Branch Canal, at the left side periphery of Ukai reservoir to decide the out fall location of link canal, Alternative link canal alignment to cross the river Tapi downstream of Ukai dam for a length of about 15 km and the river surveys for Purna and Ambica rivers (except the small portion of rivers near the dam sites, which could not be surveyed due to public hindrance) were completed by outsourcing the works.

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

The work of Borrow Area Survey for Paikhed, Chasmandva, Chikkar and Kelwan dams; petrographic analysis of sand samples and testing of construction material has been carried out by Gujarat Engineering Research Institute (GERI), Surat at Feasibility Report stage. Testing of rock core samples was carried out by Geological Survey of India, Jaipur and Central Soil & Material Research Station (CSMRS), New Delhi. The rock samples for use as crushed were collected from various quarries located in the project area and testing of these samples to ascertain their suitability to be used as crushed sand has been carried out by Central Soil and Material Research Station (CSMRS), New Delhi

1.8.3.2.3 Geological Survey

The geological survey along the Jheri, Paikhed, Chasmandva, Chikkar, Dabdar and Kelwan dam sites has been carried out by Geological Survey of India, Jaipur.

1.8.3.2.4 Drilling Work

The drilling work along the Chasmandva and Paikhed dam axis was carried out through private firm during preparation of DPR. The drilling work at Jheri, Chikkar and Dabdar dam axis was carried out by engineering Geology Division, WRI, Government of Gujarat, Vadodara. The logging of rock cores recovered from these drill holes was done by GSI, Jaipur. The laboratory testing of rock core samples was carried out by GSI, Jaipur and Central Soil and Material Research Station, New Delhi.

1.8.3.2.5 Demarcation of Command Area Enroute of the Link Canal

Demarcation of enroute command area has been got done through Regional Remote Sensing Centre (RRSC), Jodhpur by using Remote Sensing Technology.

1.8.3.3 Technical Studies

1.8.3.3.1 Design of Important Project Components and Writing of Design Chapter

The Par-Tapi-Narmada link Project envisages construction of six dams,two diversion barrages, about 406.118km long link canal (including feeder pipelines and 5 tunnels of 1.150km length along the canal), a tunnel of about 12.70 km length connecting Jheri and Paikhed reservoirs, and six power houses. The design of the important structures and the preparation of design chapter have been carried out by Central Water Commission involving the following Design Directorates:

1. HCD(N&W) Directorate
2. CMDD (N&W) Directorate
3. Embankment Design (N&W)Directorate
4. Gates Design (N&W)Directorate
5. Barrage and Canal Design (N&W) Directorate

Four Feeder pipelines are proposed under the Link Project as detailed below:

- i) Feeder pipe line from Chasmandva barrage to Main Canal
- ii) Feeder pipe line interconnecting Chikkar & Dabdar reservoirs
- iii) Feeder pipe linefrom Dabdar reservoir to Main Canal
- iv) Feeder pipe linefrom Kelwan reservoir to Main Canal

Preliminary design of feeder pipelines has been done by NWDA. Detailed design of feeder pipelines will be carried out at the time of execution of the project.

1.8.3.3.2 Irrigation Planning

Irrigation planning studies of the link project were carried out by Irrigation Management Organization, CWC, New Delhi at original DPR stage. The same has been modified by NWDA incorporating the suggestions of Government of Gujarat. However basic planning of project remained unchanged. The alignment of the link canal kept unchanged.

1.8.3.3.3 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) Directorates of Central Mechanical Organisation, Central Water Commission, New Delhi.

1.8.3.3.4 Hydrological Studies

The hydrological studies of Par-Tapi-Narmada link Project have been carried out by Hydrology (South) Directorate of Central Water Commission, New Delhi.

1.8.3.3.5 Power Potential and Electrical & Mechanical Studies

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

1.8.3.3.6 Study of Seismic Parameters

The Seismic study of Par-Tapi-Narmada link Project has been carried out by Central Water & Power Research Station (CW&PRS), Pune.

1.8.3.3.7 Morphological Study

Morphological study of the Par, Nar, Tan, Ambica, Khapri and Purna rivers has been carried out by Regional Remote Sensing Centre, Nagpur

1.8.3.3.8 Mineral Surveys

Mineral Surveys are carried out by GSI, Jaipur.

1.8.3.3.9 Archaeological Surveys

Archaeological Surveys were carried out through Archaeological Survey of India (ASI), Vadodara for Gujarat part and ASI, Aurangabad for Maharashtra part.

1.8.3.3.10 Cadastral Surveys

Cadastral maps for both Maharashtra and Gujarat portion have been collected from concerned district authorities. Based on the data and with the help of BISAG, Gandhinagar the cadastral maps of all the 7 reservoirs and canal alignment have been prepared.

1.8.3.3.11 Soil Surveys

The taluka wise reports of the soil survey carried out by Gujarat Government in respect of the districts falling in the en-route command area have been collected from the Agriculture Department, Government of Gujarat. Reports on land irrigability and soil classification of Banni area of Kutchh region and SSNNL phase I (Upto Mahi river), Soil classification report and soil maps for the talukas lying in reservoir submergence areas and link alignment have also been collected. Using this information the soil map of the enroute command area has been prepared.

1.8.3.4 Socio-economic Survey and Environmental Impact Assessment Studies

These studies have been carried out by M/s WAPCOS Ltd. 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

-1.8 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 - 1.9 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-12011/55/2008-IA.I dated 08-06-2009 has accorded the clearance for pre-construction activities at the proposed site and TORs for preparation of EIA report (Annexure -1.10 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 -1.11 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 -1.12 in Volume - II).

1.8.4 Engineering Assessment and Front End Engineering

1.8.4.1 Dam and Head Works

(i) Jheri Dam

The height of the Jheri dam has been designed as 73.00m high with top width as 10.0m. The FRL of the Jheri dam has been kept as 246.00 m. The concrete portion of the dam will be 145.00 m long whereas concrete

faced rock fill portion will be 663.32m. The spillway will have 5 nos. of gates of size 15 X 12 m.

(ii) Paikhed Dam

The height of the Paikhed dam has been designed as 93.0m high with top width as 10.0m. The FRL of the Paikhed dam has been kept as 248.0 m. The concrete portion of the dam will be 121.0 m long whereas concrete faced rock fill portion will be 1310.85 m. The spillway will have 4 nos. of gates of size 15 X 12 m. The power house of 9.0 MW installed capacity at dam toe is proposed with 3 units of 3 MW each.

(iii) Chasmandva Dam

The height of the Chasmandva dam has been designed as 52.0m high with top width as 10.0m. The FRL of the Chasmandva dam has been kept as 214.0m. The concrete portion of the dam will be 78 m long whereas concrete faced rock fill portion will be 2703 m. The spillway will have 3 nos. of gates of size 12 X 12 m. The power house of 2.0 MW installed capacity at dam toe is proposed with 2 units of 1 MW each.

(iv) Chikkar Dam

The height of the Chikkar dam has been designed as 63.0m high with top width as 10.0m. The FRL of the Chikkar dam has been kept as 210.0m. The concrete portion of the dam will be 151.0 m long whereas concrete faced rock fill portion will be 1736.0 m. The spillway will have 4 nos. of gates of size 15 X 12 m. The power house of 2.0 MW installed capacity at dam toe is proposed with 2 units of 1 MW each.

(v) Dabdar Dam

The height of the Dabdar dam has been designed as 65.0 m high with top width as 10.0 m. The FRL of the Dabdar dam has been kept as 169 m. The concrete portion of the dam will be 135.0 m long whereas concrete faced rock fill portion will be 1035 m. The spillway will have 5 nos. of gates of size 15 X 12 m. The power house of 3.2 MW installed capacity at dam toe is proposed with 2 units of 1.60 MW each.

(vi) Kelwan Dam

The height of the Kelwan dam has been designed as 58.0m high with top width as 10.0 m. The FRL of the Kelwan dam has been kept as 164 m. The concrete portion of the dam will be 189.0 m long whereas concrete faced rock fill portion will be 1141.0 m. The spillway will have 5 nos. of gates of size 15 X 12 m. The power house of 2.5 MW installed capacity at dam toe is proposed with 2 units of 1.25 MW each. The power house proposed at fall of the feeder pipe line connecting Kelwan dam with link canal will have 2 units of 1MW each

1.8.4.2 Tunnel Connecting Jheri and Paikhed Reservoirs

The total length of tunnel from Jheri and Paikhed reservoirs will be about 12.7 Km with diameter as 3.0 m and bed slope 1:875 The tunnel will be of D shaped.

1.8.4.3 Barrages

(i) Paikhed Barrage

This barrage will be 147.50 m long with spillway of 138.50 m (7 bays of 15 m width with 5 nos. of piers of 4.5 m thick and 1 no. of double pier of 11 m thick). A head regulator is provided at the upstream right side of the barrage. Par-Tapi-Narmada link canal will offtake from this head regulator at crest level of 136.0 m.

(ii) Chasmandva Barrage

This barrage will be 128 m long with spillway of 122 m (8 bays of 12 m width with 6 nos. of piers of 3.0 m thick and 1 no. of double pier of 8 m thick). A head regulator is provided at the upstream right side of the barrage. Chasmandva feeder pipe line will offtake from this head regulator at crest level of 123.0 m.

1.8.4.4 Link Canal

Total length of Par-Tapi-Narmada link canal is 406.118 km including feeder pipelines and tunnels along the link canal. The length of Par-Tapi reach link canal is 177.736 km off taking from the Paikhed barrage. The head reach of canal has been designed for a capacity of **38.17**cumec. The canal will have **8.5m** bed width & **2.80 m** full supply depth at its head and **16.5m** bed width & **2.80m** full supply depth at its tail end. The length of Tapi-Narmada reach of link canal is 191.307 km off taking from the Ukai reservoir. The head reach of canal has been designed for a capacity of **46.64**cumec. The canal will have **8.80m** bed width & **3.22 m** full supply depth at its head and **5.0m** bed width & **2.65m** full supply depth at its tail end. The design details are summarized below in Table- 1.7:

Table – 1.7
Design details of Par-Tapi-Narmada link canal

Hydraulic particulars of Main canal of Par-Tapi-Narmada link canal						
Sl. No	Reach		Design discharge of canal	Bed slope 1 in	Bed width	Fully supply depth
	From	To				
	km	km	cumec		m	m
1	2	3	4	5	6	7
<u>PAR-TAPI- REACH</u>						
1	0.000	62.072	38.170	7500	8.500	2.800
2	62.072	108.250	46.640	7500	10.500	2.800
3	108.250	129.600	46.640	8000	10.950	2.800
4	129.600	177.736	63.690	8500	16.500	2.800
<u>TAPI-NARMADA REACH</u>						
1	0.000	51.043	46.640	10000	8.800	3.220
2	51.043	69.150	36.400	10000	7.500	3.120
3	69.150	82.171	31.890	10000	5.600	3.060
4	82.171	191.07	17.260	10000	5.000	2.650

Four feeder pipe lines are also proposed. Details of these feeder pipe lines are also summarized in **Tables -1.8:**

Table – 1.8
Design details of feeder pipe lines

Sl. No.	Feeder pipe line	Length Km	Bed slope	Design Discharge in cumec	Dia. of Pipe	Nos. of pipe
1	Feeder Pipe line from Chasmandva weir to Main Canal	2.8591	1 in 5500	8.50	2.6 m	2
2	Feeder Pipe line interconnecting Chikkar & Dabdar Reservoirs	14.342	1 in 7500	6.40	2.5m	2
3	Feeder Pipe line from Dabdar Reservoir to main canal	12.258	1 in 5000	17.00	2.9m	3
4	Feeder Pipe line from Kelwan Reservoir to main canal	7.62	1 in 5500	17.00	2.6m	4

1.8.5 Ecological, Socio-economic and Financial Aspects

WAPCOS Ltd, Gandhinagar has carried out the Environmental Impact Assessment Studies of Par – Tapi – Narmada 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, Command Area Management, 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 any of the proposed reservoirs is anticipated. Necessary minimum flows in the Par, Nar, and Tan, Ambica, Khapri and Purna 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

About 6065 ha of land will be submerged due to creation of 6 reservoirs proposed in Par – Tapi – Narmada link project. Total 61 villages will be affected by these reservoirs. Two barrage proposed under the link project will submerge an area of about 79 ha. 406.118 Km long link canal (including feeder canals) will require 4399ha land area. The impact on Project Affected People (PAP) in the affected villages as well in influenced villages has been studied while carrying out the Environmental Impact

Assessment studies. The reservoir wise details are described in the following paragraphs:

i Jheri Reservoir

Jheri reservoir will submerge an area of about 836.0ha of land which includes 408.0ha of forest land, 256.0ha of culturable land and the remaining 172.0ha is other land including river portion. Total 6villages will be partially affected due to creation of Jheri reservoir. The impact on all project affected people in all 6affected villages has been studied while carrying out the Environmental Impact Assessment studies. Total 98house-holds will be affected by Jheri reservoir. The average literacy rate in the area is 88%. 73% of the house-holds in the submergence area of Jheri reservoir are belong to Scheduled Tribe category. The primary schools are available in 6 affected villages, middle schools are available in 6 affected villages and college facility is available at average distance of more than 10 km. 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 less than 10 km, except for one village 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 Paikhed Reservoir

Paikhed reservoir will submerge an area of about 994.00 ha of land which includes 317.0 ha of forest land, 589.0 ha of culturable land and the remaining 88.0 ha is other land including river portion. Total 11villages will be affected due to creation of Paikhed reservoir. The impact on all project affected people in all 11affected villages has been studied while carrying out the Environmental Impact Assessment studies. Total 331house-holds will be affected by Paikhed reservoir. The average literacy rate in the area is 63 %. 97 % of the house-holds in the submergence area of Paikhed reservoir are belong to Scheduled Tribe category. The primary schools are available in 11

affected villages, middle schools are available in 3 affected villages and college facility is available at average distance of more than 10 km. 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 10 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. 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 Chasmandva Reservoir

Chasmandva reservoir will submerge an area of about 615.0 ha of land which includes 300.0 ha of forest land, 255.0 ha of culturable land and the remaining 60.0 ha is other land including river portion. Total 7 villages will be partly affected due to creation of Chasmandva reservoir. The impact on all project affected people in all 7 affected villages has been studied while carrying out the Environmental Impact Assessment studies. Total 379 house-holds will be affected by Chasmandva reservoir. The average literacy rate in the area is 58 %. 99 % of the house-holds in the submergence area of Chasmandva reservoir are belong to Scheduled Tribe category. The primary schools are available in 7 affected villages, middle schools are not available in 7 affected villages and college facility is available at average distance of more than 10 km. 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 except in one village. 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.

iv Chikkar Reservoir

Chikkar reservoir will submerge an area of about 742.0 ha of land which includes 300.0 ha of forest land, 332.0 ha of culturable land and the remaining 110.0 ha is other land including river portion. Total 9 villages will be partly affected due to creation of Chikkar reservoir. The impact on all project affected people in all 9 affected villages has been studied while carrying out the Environmental Impact Assessment studies. Total 345 households will be affected by Chikkar reservoir. The average literacy rate in the area is 63 %. 99.77 % of the house-holds in the submergence area of Chikkar reservoir are belong to Scheduled Tribe category. The primary schools are available in 9 affected villages, middle schools are available in 9 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.

v Dabdar Reservoir

Dabdar reservoir will submerge an area of about 1249.0 ha of land which includes 614.0 ha of forest land, 482.0 ha of culturable land and the remaining 153.0 ha is other land including river portion. Total 11 villages will be partly affected due to creation of Dabdar reservoir. The impact on all project affected people in all 11 affected villages has been studied while carrying out the Environmental Impact Assessment studies. Total 563 households will be affected by Dabdar reservoir. The average literacy rate in the area is 65 %. 99 % of the house-holds in the submergence area of Dabdar reservoir are belong to Scheduled Tribe category. The primary schools are available in 11 affected villages, middle schools are not available in 11 affected villages and college facility is available at average distance of more than 10 km. 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.

vi Kelwan Reservoir

Kelwan reservoir will submerge an area of about 1629.0 ha of land which includes 890.0 ha of forest land, 450.0 ha of culturable land and the remaining 289.0 ha is other land including river portion. Total 17 villages (1 fully and 16 partly) will be affected due to creation of Kelwan reservoir. The impact on all project affected people in all the affected villages has been studied while carrying out the Environmental Impact Assessment studies. Total 793 house-holds will be affected by Kelwan reservoir. The average literacy rate in the area is 62 %. 99.60 % of the house-holds in the submergence area of Kelwan reservoir are belong to Scheduled Tribe category. The primary schools are available in 17 affected villages, middle schools are not available in 17 affected villages and college facility is available at average distance of more than 10 km. 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 available in one 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. 445 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. 1126 Crores. The details of the Environmental Impact Assessment studies and Socio-economic studies of Par – Tapi – Narmada link Project are furnished in Chapter 11 and 12 respectively.

IV Financial and Economic Analysis

The total cost of Par – Tapi – Narmada link project including Rehabilitation & Resettlement plan for the project affected people has been worked out to be Rs. **10211.21** Crores at 2014-15 price level. Annual cost of the project including cost of maintenance of head works, dam appurtenants, power house, tunnels, canal, CD structures etc works out to be Rs. **1223.65** Crores. The benefits from Irrigation, power generation, water supply and fishries works out to be Rs. **1265.87** Crores. The benefit-cost ratio and the Internal Rate of Return (IRR) of the project works out to be **1.035 and 10.172%** 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 -1.13 in Volume - II). The Committee consisted representatives of State Government 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 June, 2006 (Annexure –1.14 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 Par – Tapi - Narmada link project.

1.9 Clearances Required

The Par-Tapi-Narmada Link Project will require the following clearances:

Sl.no.	Clearances	Agency
(i)	Techno-economic	Central Water Commission, TAC of MoWR, RD & GR
(ii)	Forest Clearance	Ministry of Environment, Forest and Climate Change
(iii)	Environmental clearance	Ministry of Environment, Forest and Climate Change
(iv)	R&R Plan of Tribal Population	Ministry of Tribal Affairs

Based on the above, investment clearance will be accorded by the Ministry of Water Resources, RD & GR.