Chapter 1
Introduction

1.1 General

Peninsular India receives rainfall both from South-West and North-East monsoons. The South-West monsoon currents coming from the Arabian Sea strike against the mountains of the Western Ghats along the west coast of India and rain heavily in Kerala, western parts of Karnataka, Gujarat and Maharashtra. The monsoon currents coming from Bay of Bengal after covering northern parts of the country gradually weaken and cause less and less rainfall in the southern peninsula. At the retreat of south-west monsoon, north easterly flow of air picks up moisture from low pressure areas of Bay of Bengal and strike against east coast bringing rain to Tamil Nadu and south coastal Andhra Pradesh.

The occurrence of rainfall in Peninsular India is never uniform owing to several reasons. The topography of heavy rainfall regions does not permit utilisation of entire waters. This leads to a paradoxical situation; abundant waters and no land to utilise them on western side and vast areas of arable land and no water to irrigate them on eastern side. While the areas on the western side of Western Ghats are endowed with abundant rainfall, the areas along the east coast of Tamil Nadu receive scanty rainfall from north east monsoon. The areas in the eastern side of western ghats sandwiched between western ghats and coastal areas of Tamil Nadu do not have the benefit of receiving significant rainfall from either of the two monsoons and is being situated in a rain shadow area and hence affected by chronicle droughts in almost every year.

1.2 National Perspective Plan for Water Resources Development

The erstwhile Union Ministry of Irrigation (now Ministry of Water Resources) and the Central Water Commission in the year 1980 formulated the National Perspectives for Water Resources Development, which comprises two main components, viz. Himalayan Rivers Development and Peninsular Rivers Development. Himalayan Rivers Development envisages construction of storage reservoirs on the main Ganga and the Brahmaputra and their principal tributaries in India and Nepal alongwith 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 with the Ganga. Peninsular Rivers Development of the National Perspectives Plan includes interlinking of major rivers flowing in the Peninsular India including the southern tributaries of Yamuna. The major parts of this components are (i) interlinking of Mahanadi-Godavari-Krishna-Pennar-Cauvery, (ii) interlinking of west flowing rivers, north of Bombay and south of Tapi, (iii) interlinking of Ken with Chambal and (iv) diversion of west flowing rivers. The interlinking of these rivers will envisage construction of storage reservoirs at potential sites and canal systems for transferring the waters from surplus to deficit basins/areas. The canals will also include tunnels and lifts, wherever necessary.

1.3 Aim (s) of the project and description of works

The rivers of Western Ghats carry abundant discharges during the monsoon months. Due to steep slopes and short lengths of these rivers entire quantities flow down to the Arabian Sea. These waters if harnessed at suitable locations could be transferred to deficit areas.

The Vaippar basin to which the surplus waters of Pamba and Achankovil rivers are envisaged for diversion for utilization in the water short areas lies in Tamil Nadu covering an area of 5255 km^2 in the districts of Madurai, Virudhunagar, Tuticorin and Tirunelveli. The annual yield of the Vaippar river at 75% and 50% dependability is 399 Mm^3 and 447 Mm^3 respectively. The basin has a culturable area of 3.95 lakh ha and net sown area of 2.64 lakh ha. There are no major projects in the basin. Existing and ongoing irrigation is mainly through minor irrigation schemes involving tanks and other sources. The existing and ongoing projects provide annual irrigation benefits to a CCA of 34966 ha forming 8.7% of the culturable area. There are a few medium projects proposed by Tamil Nadu Government irrigating an area of 4613 ha. Thus, the area annually benefited by all the projects in the basin comes to 39579 ha, which is around 10% of culturable area. Thus, 90% of culturable area is still left to the vagaries of rainfall, which is of the order of only 630 mm per annum. Some of these areas could have been brought under assured irrigation provided sufficient water resources are available from out side of the basin. Considering the meager resources of the basin, it is imperative to import water from adjacent basins to meet its present and future essential needs. The basins adjacent to Vaippar basin being water short do not provide any scope for export of water. The nearest conceivable source is from west flowing rivers of Kerala.

Of the various alternatives considered, the present proposal involving construction of storages on the tributaries of Achankovil and Pamba rivers of Kerala and interlinking them for transferring their waters to Vaippar basin to

benefit the drought affected areas of Tamil Nadu is appeared to be viable and feasible.

Apart from irrigating the drought affected areas of Tamil Nadu, the proposal will benefit Kerala through augmentation of lean season flows into Vembanad lake to combat salinity intrusion and power generation for augmentation of peaking power, which will be helpful in controlling the power shortages.

The present proposal involves transfer of 635 Mm^3 of surplus water available at the diversion points of Pamba and Achankovil rivers to Vaippar basin for irrigating an area of 91400 ha. In addition to providing irrigation benefits, the project will generate 1114 million units of power annually and provide regulated releases of 150 Mm^3 water during lean season. A pumped storage plant with an installed capacity of 500 MW would meet the peaking power requirements of the region.

The Pamba-Achankovil-Vaippar link project consists of Punnamedu dam on Pamba Kal Ar, Achankovil Kal Ar dam on Achankovil Kal Ar and Achankovil pumped storage dam on Achankovil River. The Punnamedu and Achankovil Kal Ar dams are interconnected by a tunnel of 8.0 km length. The water stored in Punnamedu reservoir will be diverted to Achankovil Kal Ar depending on the irrigation requirement and reservoir level at Achankovil Kal Ar dam. The water from Achankovil Kal Ar reservoir will be diverted through a 9 km tunnel to cross the Western Ghats. The main canal will take off from the tunnel exit and runs for a length of 50.68 km before reaching Alagar Odai, a tributary of Vaippar. The link canal will provide irrigation benefits to 91400 ha. Seven powerhouses are provided; first at the inlet of interconnecting tunnel between Punnamedu and Achankovil Kal Ar, the second at the toe of Achankovil Kal Ar dam, the third at the toe of Achankovil pumped storage scheme, and four to seven at canal drops available on the main canal. The Achankovil pumped storage scheme acts as a balancing reservoir for pumping the yield of the independent catchment of Achankovil river upto the dam site (excluding the catchment of Achankovil Kal Ar) to Achankovil Kal Ar reservoir. The pumped storage scheme also provides economic benefits to the integrated grid by absorbing and utilizing the energy when not, otherwise needed to the system for pumping back and generating the power to supplement the system during peak load periods. The 10 Mm^3 of water released from Achankovil Kal Ar reservoir for power generation during 6 hour peak load period through out the year will be pumped back to Achankovil Kal Ar reservoir in 16 hour period. Since considerable off-peak surplus energy would be available when large nuclear and thermal stations are operated in the region at higher load factors in the grid, this idle energy can be utilised for pumping.

1.4 Location of the Project

The head works of Punnamedu dam are located in Kerala on Pamba Kal Ar, a tributary of Pamba River, 11 km upstream of Thekkuthodu village of Kozhencherry taluk of Pathanamthitta district. The head works of Achankovil Kal Ar dam are located on Achankovil Kal Ar, a tributary of Achankovil river in Kozhencherry taluk of Pathanamthitta district, 11 km from Achankovil village and 6 km upstream of Tura village and the head works of Achankovil Pumped storage scheme are located on the Achankovil river in Pathanapuram taluk of Kollam district, 9 km from Achankovil village and 2 km upstream of Tura village. The link canal starting from the exit of the Achankovil Kal Ar – Tamil Nadu tunnel near Mekkarai village of Shenkottai taluk traverses through Sankarankovil and Tenkasi taluks of Tirunelveli district and tails into Alagar Odai, a tributary of Vaippar river near Sevalkulam village of Sankarankovil taluk of Tirunelveli district of Tamil Nadu.

1.5 Access to project sites

The head works of all the three dam sites are located in reserve forests of Kollam and Pathanamthitta districts of Kerala.

The Punnamedu dam site lies on eastern side of Punalur – Pathanamthitta state highway. The dam site is connected to state highway passing through Konni town, which is located at a distance of 31.5 km from dam site by seasonal forest paths to some distance and further by all weather metalled roads. The nearest railway station is Punalur, 62 km away from dam site. The Achankovil Kal Ar dam site lies towards north east of Punalur town and is connected by seasonal forest paths and road to Punalur – Pathanamthitta state highway at Alimukku, 46 km from dam site. The nearest railway station is Punalur, 50 km away from dam site. The Achankovil pumped storage scheme is connected to Punalur – Pathanamthitta road at a distance of 35 km from dam site. The nearest airport to all the three project sites is at Trivandrum and nearest harbor at Kochi. As regards the main canal and branches, they are approachable by all weather roads from Tenkasi, Shenkottai and Tirunelveli towns. The nearest railway station is Shenkottai on the Madras – Kollam meter gauge line. The National Highway No.7 passes through the command.

1.6 General climatic conditions

Kerala state is characterized by tropical climate with high humidity and rainfall. The mean temperature varies from 29^{o}C in summer to around 26^{o}C

in winter. The maximum and minimum temperatures are of the order of 33^{o}C and 28^{o}C respectively. The proposed head works are located in the reserve forests on the western slopes of Western Ghats, which are hot and humid. The Pamba and Achankovil river basins are influenced by both south-west as well as north-east monsoons. Generally, the period from June to November can be considered as monsoon season. The south-west monsoon contributes more than 2/3rd of the annual rainfall. The annual rainfall varies from 2276 mm to 4275 mm in Pamba basin, and 2215 mm to 6924 mm in Achankovil basin.

In contrast to the climate of Kerala, the Tamil Nadu (where the command area of the project lies) has hot summer, mild winter and average monsoon. The Vaippar basin experiences both south-west and north-east monsoons. Of the two, north-east monsoon is heavier. The Vaippar basin experiences an average annual rainfall of 630 mm. The mean monthly temperature varies from 25^{o}C in January to 32^{o}C in May. The maximum and minimum temperatures are of the order of 37^{o}C and 21^{o} C respectively.

1.7 Topography, Physiography and Geology

Topographically and physiographically, the basins in Kerala can be divided into three distinct zones viz. the highland region (above 75 m contour), the mid-land region (between 75 m and 15 m contours) and the low-land region (below 15 m contour), which form almost parallel belts running across the length of the basin. The highland region comprises mostly reserved forests. The lowland region is a narrow strip of land along the west coast. The mid-land region is rugged and rolling. While the dam on Pamba Kal Ar lies in high land region, other dams on Achankovil lie in mid-land regions. A number of low Laterite hills in this region are interspersed with paddy fields, coconut and arecanut groves. The basin comprises various types of rock formations including the crystalline rocks of the Archaean (Charnockites and Khondalites), the sedimentary rocks, laterites and recent to sub-recent formations of alluvium.

The general topography of the area in Tamil Nadu through which link canal is aligned and the command area under the canal is either flat or gently sloping from about 260 m elevation in the west to the sea level in the east with a few hillocks in the extreme west. The slope of the terrain in the project area varies west to east from 3.65 m/km to 2.3 m/km. The plains of Vaippar basin comprises vast stretches of culturable land dotted with tanks. The area is underlain by geological formations ranging in age from the Archaean to recent. Archaean rocks mainly belong to composite gneisses, quartzites,

Charnockites, Khondalites and unclassified gneisses comprising calogranite and crystalline limestone.

1.8 Population

a) Affected and Benefited

(i) Kerala: All the works of the proposed project in Kerala are located in Konni – Kal Ar valley and Achankovil reserve forest divisions. Except the reservoir area of the pumped storage scheme on Achankovil river, other areas are devoid of any population. About 75 families comprising 297 persons in Achankovil village are likely to be affected by the project.

(ii) Tamil Nadu: The main canal on the Tamil Nadu side traverses through cultivated areas and does not pass through any populated village or town. A population of over six lakhs in the command area is likely to be benefited by the project.

(b) Occupation

Of the six lakh persons being benefited about 4 lakh are engaged in agriculture and others are engaged in cottage industries such as match factories, beedi rolling industries and fire cracker industries and a few are engaged in cotton mills. The economy of the basin is mainly agro based and the people living in the command area are depending on agriculture for their sustenance; even people engaged in other industries are employed there, only during non-agricultural season. More than 2/3rd of the farming population is having holdings less than 1 ha each and 97% of the holdings are below 5 ha.

1.9 Natural resources

Minerals of economic importance are not located in any of the project areas. The only natural resources are of the forest produce like timber, bamboo, reed etc. in the head works area. Limestone, shell lime and coal are quarried on small scale in the command area.

1.10 Land use and socio-economic aspects

The particulars of land use in the command area of the link canal are given below:

Gross command	145569 ha
Culturable command area	101555 ha
Ayacut	91400 ha
Net area sown	56233 ha

The cultivation in the command area is mainly dependant on rainfall. Irrigation from existing minor irrigation schemes provided to 21298 ha area. The command area has irrigation facilities only during Kharif season and has low irrigation intensity.

The tanks and wells dry up during summer and hence the agricultural activities are limited and subjected to the vagaries of rainfall. Consequently, the per capita income is low in the command area.

1.11 History

a) Earlier proposals

The Kerala State Electricity Board had proposed a comprehensive plan to tap the potential of Achankovil and Pamba rivers for power generation. The proposal envisaged construction of three reservoirs, two on tributaries of Achankovil and one on Pamba Kal Ar at Punnamedu with combined live storage capacity of 242 Mm^3. These three reservoirs were proposed to be interconnected by tunnels. A powerhouse was proposed on the banks of Achankovil River to generate 271 million units with installed capacity of 60 MW. The tailrace waters were to be utilised for irrigation in both the basins to an extent of 79,490 ha. The technical feasibility of the scheme did not appear to have been thoroughly investigated.

The peninsular river development component of the national perspective envisaged construction of a contour canal along the west coast taking off from Malampuzha reservoir at about an elevation of 152.4 m (500 ft.) to transfer 6,228 Mm^3 (220 TMC) of water eastwards after providing adequate supplies to meet the basin needs. Interlinking of all the west flowing rivers of Kerala and transferring the surplus to east by a single link was found to be neither economical nor feasible. Hence, attempt has been made by NWDA for transfer from one basin or group of basins direct to the east. With this in view, toposheet studies were carried out to determine the most suitable proposal. Detailed water balance studies were carried out for the whole basin as well as at the diversion points to assess the surplus waters if any. Diverting the surplus waters of Pamba and Achankovil rivers to areas east of Western Ghats is one of such ventures where the drought prone Chittar, Vaippar and Vaigai basins would be immensely benefited. The various proposals studied by NWDA for transfer of surplus waters of Pamba and Achankovil rivers are detailed under the sub-head 1.11 (a) Alternative proposals.

b) Present proposal

The present proposal envisages construction of a dam on Pamba Kal Ar with FRL 246.0 m at Punnamedu, another dam on Achankovil Kal Ar, a tributary of Achankovil river with FRL 210 m and a pumped storage scheme across Achankovil River, a little downstream of the confluence of Achankovil Kal Ar with Achankovil with an FRL of 65.0 m.

1.12 Choice of project

a) Alternative proposals

Three alternative proposals including the present one for which report is being prepared, were studied by NWDA for transfer of surplus waters from Pamba and Achankovil rivers to the east. These alternative proposals are detailed below:

i) Alternative - I

Studies were carried out for a proposal consisting of a dam on Pamba river, 1.5 km upstream of Mulakkayam village with FRL 159.05 m and another dam on Achankovil River, 3 km upstream of Tura village with FRL 130.93 m. These two dams were to be interconnected by a contour canal. The combined yield of these reservoirs was planned to be transferred to Chittar by a tunnel. The FSL of outfall tunnel at Chittar was fixed at 85 m considering the elevation of the areas to be irrigated. With the construction of dam on Pamba, at the specified location the route to famous Sabarimala temple gets submerged. Hence this proposal of diverting water from Pamba river was not pursued further. Instead, studies were undertaken to increase the yield of Achankovil reservoir by shifting the location of dam to downstream and diverting the yield of Ambanad Ar, a tributary of Kallada, by constructing a diversion dam on Ambanad Ar, to the Achankovil reservoir. However, this proposal was also abandoned considering that the targeted areas, which are located at higher elevations, could not be provided irrigation benefits.

ii) Alternative – II

In this alternative, a dam was proposed on Achankovil River, 9 km downstream of Achankovil village and 32 km upstream of Konni town with a FRL of 136.8 m and gross storage of 460 Mm^3. Another dam was proposed on Pamba Kal Ar, a tributary of Pamba River near Punnamedu with FRL of 198.5 m and gross storage of 23 Mm^3. These two reservoirs were proposed to be connected by a 12 km long tunnel and the combined surpluses were proposed to be diverted from Achankovil reservoir to the drought prone areas

east of Western Ghats through a 17 km long tunnel and an open canal of 272.9 km. The entire diverted water was to be lifted by 60 m before letting into a gravity canal. The command area in this proposal extends upto Vaigai basin and the link outfalls into Vaigai River. Three power houses were proposed in this alternative viz. (1) the first power house to utilise the available head between Punnamedu and Achankovil reservoirs with an installed capacity of 7 MW, (2) the second power house to utilise the mandatory releases downstream during lean season to combat salinity intrusion with an installed capacity of 4 MW and (3) the third power house to utilise the storage of Achankovil reservoir for power generation with an installed capacity of 7 MW. The reservoir on Achankovil would have submerged Achankovil village displacing about 1875 persons. A preliminary feasibility report of this alternative was circulated to all the concerned during 1989.

This proposal though attractive had a few major deficiencies viz. 1) need for pumping entire transferred water 2) submergence of inhabited areas 3) inadequate power benefits 4) lower elevation at the delivery end and 5) longer water conductor system. Due to these deficiencies this proposal was abandoned in favour of the present proposal described under Alternative-III.

iii) Alternative - III

Keeping in view the deficiencies highlighted in Alternatives I & II, further studies were made to find better alternative, which while minimizing the deficiencies in Alternatives I & II would enhance the benefits of the scheme. The present alternative comprises of three dams, one each on Pamba Kal Ar at Punnamedu at the same location of Punnamedu dam as in Alternative-II another on Achankovil Kal Ar, a tributary of Achankovil and another on Achankovil, a little downstream of the confluence of Achankovil Kal Ar with Achankovil river, at the same location of Achankovil dam as in Alternative-II. The Achankovil Kal Ar reservoir acts as main storage reservoir from which the combined yield of Achankovil and Pamba basins will be diverted to Tamil Nadu for irrigation. With the shifting of main dam to Achankovil Kal Ar, the quantum of water available for diversion gets reduced due to the inability of tapping the yields of main Achankovil river from its independent catchment and to compensate this loss, the reservoir on Achankovil river is proposed to supplement the yields at Achankovil Kal Ar by pumping the available yields of Achankovil river. The Achankovil Kal Ar and Punnamedu reservoirs are proposed to be interconnected by a tunnel of 8.0 km length. The FRL of the Punnamedu dam has been increased to 246.0 m, keeping in view the FRL of Achankovil Kal Ar and the elevation at which the water is to be delivered. The water required for irrigation will be diverted through a 9.0 km long tunnel and

let into an open canal at the end of tunnel. The length of the canal is 50.68 km and the command area is restricted to Vaippar basin considering the limited quantity of water available for diversion and vast area needing irrigation in the command. The Achankovil reservoir will have a FRL of 65.0 m and act as a balancing reservoir supplementing the yields at Achankovil Kal Ar during monsoon and acts as a pumped storage scheme pumping the water released for power generation from Achankovil Kal Ar. Seven power houses are provided in this alternative, viz., (1) at the inlet of Punnamedu – Achankovil Kal Ar interlinking tunnel with an installed capacity of 3 MW utilizing releases from Punnamedu to Achankovil Kal Ar (2) at the toe of Achankovil Kal Ar dam with an installed capacity of 500 MW utilizing a quantity of 10 Mm^3 daily for peak power generation in 6 hours a day. The same 10 Mm^3 water will be pumped back to Achankovil Kal Ar in 16 hours and (3) at the toe of Achankovil reservoir with an installed capacity of 1.5 MW utilizing the mandatory releases downstream for combating salinity intrusion, and (4) four mini power stations of installed capacity 1.059 MW (2 Nos.) and 0.805 MW (2 Nos.) at canal drops on the main canal.

This alternative has the following advantages over the other two alternatives:

1) The diversion of water for irrigation is largely by gravity.
2) With the reduction in the FRL of Achankovil reservoir the submergence of Achankovil village is minimal.
3) The FRL of Achankovil Kal Ar reservoir being higher than that of Achankovil reservoir proposed in Alternative-II, the water can be delivered at higher elevation, where the irrigation is most needed.
4) Increased power production to augment the peak demand and utilise the idle power for pumping the water from pumped storage reservoir
5) Length of the tunnels is reduced thereby economizing the proposal.
6) The length of main canal is reduced from 272 km to 50.68 km.
7) Firm releases of water down stream during the lean periods have been increased to 150 Mm^3.

Considering the advantages offered by this alternative, the proposals have been firmed up for further investigations. The feasibility of constructing the reservoirs at the selected locations was examined by Geological Survey of India and based on the preliminary investigations, the GSI has suggested to modify Punnamedu dam axis by 25^o askew to the river flow and to shift location of Achankovil Kal Ar and Achankovil dams by 50 m upstream and 80 m upstream of original locations respectively. The Punnamedu – Achankovil Kal Ar tunnel and Achankovil Kal Ar – Tamil Nadu tunnel outlets were also relocated with respect to their envisaged locations. The geological details of the structures are detailed in Chapter on 'Surveys and Investigations'. With

these modifications the length of interconnecting tunnel between Punnamedu and Achankovil Kal Ar reservoir is increased by 400 m to 8 km and the length of Achankovil Kal Ar – Tamil Nadu tunnel increased by 500 m to 9 km.

1.13 Stages of development of project

The entire project is proposed to be implemented in one stage only. The work is envisaged to be spread over a period of 8 years.

1.14 Fitment of the scheme in overall development of the river basin

The twin Kallar project proposed by Govt. of Kerala detailed under sub-head "Earlier proposals" is the only scheme in the immediate vicinity of the projects proposed by NWDA. The primary objective of the state's proposal i.e., power generation has been taken care of by the present proposal. The requirement for irrigating the area proposed under twin Kallar project as also the requirement of all other existing, ongoing and proposed projects downstream of present dam sites can be met from the yields available downstream of dam sites proposed by NWDA, considering that the surpluses available in these two basins are estimated after taking into account requirements of all the existing, ongoing and proposed projects. The present proposal can be further modified to cater to the drinking water needs of the area down stream.

1.15 Interstate aspects

Though the Pamba and Achankovil rivers are entirely lying in Kerala State, part of the waters of these rivers are proposed to be transferred to Vaippar basin in Tamil Nadu. The interstate aspect involved is only to the extent of reaching an agreement between the states in a spirit of co-operation and good neighborliness for implementation of the scheme and its operation for achieving the primary objective of overall water resources development of the region for the progress and prosperity of both the states.

1.16 Cost and benefits of the scheme

The cost of the scheme consisting three dams together with their power component is estimated as Rs. 1397.91 crores based on 1992 price level as given below:

Component	Direct Charges (Rs. in crores)	Indirect Charges (Rs. in crores)
Unit I – Head Works	820.87	7.47
Unit II - Canals	271.27	2.77
Unit III - Power	292.88	2.65
Total	1385.02	12.89
Grand total		Rs. 1397.91 crores.

The benefit cost ratio works out to 1.008. The following are the benefits under the project:

1) Net benefit due to additional agricultural production valued at Rs. 11844.51 lakhs per annum.

2) Power generation valued at Rs. 27568.65 lakhs per annum.