Chapter –1

Introduction

1.0 General

In the year 1980, the erstwhile Union Ministry of Irrigation and Central Water Commission (CWC), formulated National Perspective Plan (NPP) for Water Resources Development in the country which comprises 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 on 17th July, 1982 to study the feasibility of the proposals of inter linking of rivers under Peninsular Component of National Perspective Plan and give concrete shape to these proposals. Subsequently in 1990, NWDA Society resolved to take up the studies of the Himalayan Component also. Further, on 28th June, 2006, preparation of Detailed Project Reports (DPRs) of link projects and pre-feasibility / feasibility reports of Intra-state links as proposed by States were also included in the functions of NWDA. Accordingly, the then Ministry of Water Resources (MoWR) vide Resolution No. 2/18/2005-BM dated 30th November, 2006 has modified the functions of NWDA Society. The functions of NWDA were further modified vide MoWR Resolution dated 19th May, 2011 to undertake the works of preparation of DPRs of Intra-state links. The Gazette notification of the enhanced mandate of NWDA was issued on 11th June, 2011.

On the basis of enhanced mandate, NWDA requested all the State Governments to identify the intra-state link proposals in their states and send details to NWDA for taking up prefeasibility / feasibility studies. In response, Govt. of Tamil Nadu proposed the ‘Ponnaiyar-Palar Intra-state link project’ to assess the feasibility of diverting the flood water from the Ponnaiyar river to the water deficit Palar basin.

1.1 Proposal Received from Government of Tamil Nadu

Govt. of Tamil Nadu requested NWDA to study one or two Intra-state link proposals in Tamil Nadu. Subsequently, the Director General, NWDA, New Delhi requested the Commissioner-cum-Secretary, Public Works Department, Chennai, Govt. of Tamil Nadu vide letter No. NWDA/Tech-III/152/2/2005/638-42 dated 29.07.2005, (Annexure 1.1) to furnish the details of Inter-basin/Intra-basin links other than the proposals already under study by NWDA, so that the NWDA can examine the proposals in order to take up the feasibility studies of the same on merit basis. In response, Govt. of Tamil Nadu proposed
the ‘Ponnaiyar-Palar Intra-state link project’ vide their letter No.175 dated 24.08.2009 (Annexure 1.2) to assess the feasibility of diverting the flood water from the Ponnaiyar river to the water deficit Palar basin.

Consequently, NWDA had prepared the PFR of Ponnaiyar (Krishnagiri) – Palar Intra-state link. The project envisages diversion of flood waters available as spills at Krishnagiri dam to feed enroute system tanks for irrigation and recharging the Ground water potential enroute the link canal in Krishnagiri and Vellore districts as well as Vaniyambadi taluka of Vellore district in Palar basin at the tail end for stabilizing the existing ayacut, presently being irrigated under open wells/bore wells, thereby benefitting a total area of 9500 ha annually, besides providing drinking water supply to the enroute villages.

1.1.1 Aim and Justification of the Project

Tamil Nadu State receives 80% of its annual rainfall from North East monsoon from October to December, while the rest of India remains dry. The normal annual rainfall of Tamil Nadu State is about 945 mm. But the uneven distribution of rainfall over time and space during the monsoon have indicated that it is normal or even excess in some districts of the State and it is ‘deficit & scanty’ in some other districts leading to acute water shortage and severe drought for both drinking as well as agriculture. Rivers are major source of irrigation in Tamil Nadu, but none of them have good storage. With the State facing a deficit of 62% rainfall in North East monsoon, the groundwater levels have plummeted to record low for many years, repeatedly. The stress on the groundwater table due to recurring droughts has resulted in overexploitation of groundwater resources in many districts of the State.

Many of the districts of Tamil Nadu state face drought prone conditions relatively frequently. The frequent deficit in annual rainfall occurrence and consequent increase in dependence on groundwater for drinking water and irrigation purposes in Tamil Nadu state, resulted in overexploitation of groundwater resources. As per available Central Ground Water Board (CGWB), statistics -2009, 12 out of 32 districts in Tamil Nadu recorded more than 100% groundwater development i.e., the annual groundwater use is more than the annual replenishable groundwater potential. Over the years, the occurrence of severe drought prone conditions had been a recurring phenomena in Tamil Nadu and the State Government had to take up several measures to mitigate the drought situation.
The Ponnaiyar is a major inter-state river amongst the streams between Palar and Cauvery river basins. It rises in the Hills of Nandidurg in Kolar district of Karnataka at an elevation of about 900m above MSL. Ponnaiyar river has practically no flow in the river except during North East monsoon months between October and December with flash floods during the rainy spells.

On the other side, the scenario in the Palar basin is different. The Palar basin is also an inter-state river originates in Kolar district of Karnataka state near Kaivara village at an altitude of 900 m. The basin is fully dependent on rainfall where the existing irrigation is being done under bore wells/open wells/tanks. Over exploitation of groundwater in last few decades coupled with occurrence of scanty rainfall for longer periods has resulted in faster depletion of groundwater in Palar basin. The Central Ground Water Board (CGWB) studies indicate that the Groundwater usage has increased abnormally in Krishnagiri & Vellore districts of Tamil Nadu. Especially in Vaniyambadi taluk of Vellore district, the groundwater utilization is found to be almost twice the annual replenishable groundwater and has categorized it as over exploited for future groundwater development. It has been observed that during October, November and December months, the Ponnaiyar river is usually in floods, while the Palar river mostly remains dry, even though these two rivers originate from the same place and both traverse closely in neighbouring districts of Tamil Nadu.

In light of the above scenario and due to non-availability of canal irrigation facilities where the farmers mainly depend on rainfall and groundwater for irrigation and domestic uses, it is proposed to transfer 86 Mm$^3$ of flood waters of Ponnaiyar river available, annually, at existing Krishnagiri dam, from the existing Nedungal Anicut (located 16 km d/s of Krishnagiri dam) to the Palar river during October to December. This quantity has been assessed based on the monthly flood waters available for diversion at Krishnagiri dam for the period from 1958-59 to 2009-10. The Ponnaiyar-Palar Intra-state link project acts as a flood flow canal.

Since the proposed intrastate link project envisages diversion of flood waters to mitigate severe drought prone conditions in the Vaniyambadi taluk of Vellore district, the scheme has been considered as a special case for DPR stage study.

The objective of the Ponnaiyar (Nedungal) - Palar link project is to divert the flood flow water from Ponnaiyar river available at Krishnagiri dam mainly for stabilising the
existing command area being irrigated presently through open wells and bore wells, by improving/augmenting the groundwater potential from the spills of divertible flood waters, in Krishnagiri and Pochampalli taluks of Krishnagiri district and Tirupattur and Vaniyambadi taluks of Vellore district of Tamil Nadu, besides supply of drinking water to the enroute villages.

Presently the main source of irrigation in the proposed command area under the Ponnaiyar (Nedungal) - Palar Link Project is only ground water through bore wells and open wells. Tank irrigation practices by harvesting rainwater is also there upto limited extent. The open wells account for more than 90% of the area being irrigated in the vicinity of the proposed link project. Besides irrigation use, groundwater is the only source for domestic use in Krishnagiri and Vellore districts of Tamil Nadu in the vicinity of Ponnaiyar (Nedungal) - Palar link Project.

The enroute command area of 1900 ha proposed under the link project in Krishnagiri and Pochampalli taluks of Krishnagiri district and Tirupattur taluk of Vellore district will be stabilised by feeding the enroute existing system tanks (Eris). About 3.882 Mm³ of water will be utilized for domestic water supply benefitting about 1.52 lakh population in the enroute villages. At the tail end of link canal, about 7950 ha is proposed to be stabilised in Vaniyambadi taluk of Vellore district by way of groundwater recharge.

This link project will bring economic prosperity to the acute water short, drought-prone command area lying in the vicinity of the link project by way of stabilising the existing command area.

1.2 Location of Project Area

The existing Krishnagiri dam is located in Krishnagiri district of Tamil Nadu near Krishnagiri town. The latitude and longitude of the Krishnagiri dam are 12° 28’ N and 78° 11’ E respectively. The existing Nedungal Anicut is also located about 16 km downstream of Krishnagiri dam in Krishnagiri taluka of Krishnagiri district of Tamil Nadu, near Nedungal village at latitude 12° 22’ N and Longitude 78° 16’ E. The Ponnaiyar (Nedungal) - Palar link canal off-takes from the existing Nedungal Anicut across Ponnaiyar river. The flood water flowing down the Krishnagiri dam to the Nedungal Anicut will be regulated from the Nedungal Anicut to the Ponnaiyar-Palar link canal.
Total length of the link canal is about 54.150 km and planned to traverse through Krishnagiri and Vellore districts of Tamil Nadu. The link canal will finally outfall into Godd Ar with an FSL of 419.676 m near village Makhanpur in Natrampalli Taluka of Vellore district. The stream Godd Ar joins Kal Ar, a major tributary of Palar river, after traversing a distance of 7.400 km from canal outfall. The Kal Ar runs for a distance of about 8.600 km further and confluences with the river Palar. Thus, the Godd Ar and Kal Ar will form part of the link canal and lead the diverted water into Palar river. The narrow reaches of river course of god Ar will be widened suitably in order to carry the designed discharge of the link canal. Outfall regulator coupled with single lane road bridge is proposed at outfall point (RD 53.584 km) of the link canal. The Krishnagiri and Pochampalli talukas of Krishnagiri district and Tirupattur and Vaniyambadi talukas of Vellore district of Tamil Nadu will be benefitted by this project. The existing command areas in the above talukas which are presently being irrigated under tanks (Eris), open wells/bore wells will be benefitted/stabilised, by recharging the Ground water besides supply of drinking water to about 1.52 lakh human population enroute the link canal.

1.3 Communication Facilities

The entire project area is easily approachable through National/State Highways, major district roads and village roads. All the villages/towns in the vicinity of the project area are 100% electrified and are well connected by Telephone lines/communication network. Domestic and International Airport of Bengaluru city is the nearest Airport located at a distance of about 100 km from the project area. Jolarpet and Tirupattur are the nearest railway stations to the link project, connecting Bengaluru/Chennai. The NH-7 (Bengaluru - Salem) passes through Krishnagiri district headquarters, which is at a distance of about 3 km from the Krishnagiri dam site. The NH-46 (Bengaluru - Chennai) traverses very closely to the out-fall point of the link canal at Natrampalli village, Vellore district at RD 54.150 km. Also, the NH-66 (Bengaluru-Pondicherry / Uttangarai) passes through the link project area near Kannadahalli / Athiganur villages, at about RD 24.000 km of the link canal. The Nedungal Anicut, which is the off-take point of the proposed link canal is well approachable at a distance of 14 km from the Krishnagiri Municipal Corporation.

1.4 General Climatic Conditions of the State and Project Area

The Ponnaiyar (Nedungal) - Palar link project lies in the state of Tamil Nadu and passes through Krishnagiri and Vellore districts. The climate of Tamil Nadu is tropical in nature with little variation in summer and winter temperatures. The highest temperature is often registered in May which is the hottest month in the state. While April to June is the
hottest summer period with the temperature rising up to the 40° C, November to February is the coolest winter with temperature hovering around 20° C, making the climate quite pleasant. The days are bright and warm and the sun is not too hot. The hot winds of the plains blow during April and May with an average velocity of 8-16 km/hour.

Tamil Nadu gets all its rains from the North–East Monsoon between October and December, while the rest of India remains dry. The average annual rainfall in Tamil Nadu ranges between 635 and 1905 mm. The mountainous and hilly areas, especially in the extreme western part of the state receive the most precipitation, while the low lying southern and south-eastern regions receive the least rainfall.

The command area of the project area is in Krishnagiri and Vellore districts of Tamil Nadu. The average annual rainfall of Krishnagiri district varies from 750 mm to 900 mm. The maximum rainfall occurs in the month of September whereas minimum rainfall occurs in the month of July. The average monthly maximum and minimum rainfall of Krishnagiri station which is very close to the head works of the link project are 183 mm and 29 mm during September and December respectively. Summer season prevails in April and May months and January to March, it is dry season. The maximum temperature during summer season is about 37° C. The maximum relative humidity is about 78% during November and December months, where as it is minimum of about 31% during March and April months.

The annual normal rainfall of Vellore is 1023 mm and monsoon rainfall is about 748 mm. The mean annual rainfall of Vaniyambadi station which lies in Palar basin and where 80% of the proposed command area is identified is about 800 mm, of which mean monsoon rainfall is about 668 mm. Monthly maximum and minimum rainfall at Vaniyambadi is 157 mm and 33 mm during September and December respectively. The mean annual rainfall of Tirupattur which is located close to the enroute command area is about 878 mm, of which 724 mm is during monsoon. Vellore district has a tropical climate. The highest temperatures are recorded during May and June. Vaniyambadi is hot in summer with highest day temperature in the range of 31° C to 41° C. The relative humidity ranges from 37% to 86% at Vellore.

1.5 Topography, Physiography and Geology of the Area

The link canal passes through Krishnagiri and Vellore districts of Tamil Nadu. The project area is covered by isolated hills and hillocks with bushes at some places. The
proposed canal alignment mostly passes through undulating plains with mango and coconut plantation. Recent alluvium, weathered and fractured gneissic rocks, granite and charnockites are the predominant geological formations in the vicinity of the project area in Krishnagiri and Vellore districts. The rock types of charnockites, granite gneiss/grey migmatite, pinkmigmatite, epidote hornblende gneiss, pyroxenites, quartz veins and pegmatites are observed along the proposed Ponnaiyar (Nedungal) - Palar link canal alignment.

The command area enroute the link canal is drained by major tributaries like Bargur and Mattur and many other streams and nallas of Ponnaiyar river. The project area is densely covered with tanks (Eris) /dug wells/bore wells and check dams constructed on natural streams. At tail end command area in Vaniyambadi, the Palar with major tributaries viz., Godd Ar/ Kal Ar, Cheyyar, etc., constitute main natural drainage. All these streams in the command are ephemeral in nature and structurally controlled. The river Palar is dry for major part of the year with critical drought-prone condition.

1.6 Population Affected/Benefitted etc.

No submergence is involved in the proposed link project, since the existing Krishnagiri reservoir/Dam and Nedungal Anicut are planned as head works of the link canal, except the land acquisition required for construction of the link canal. The proposed link canal passes through the rural areas in Krishnagiri and Vellore districts and it was aligned with due care, not to affect/damage any existing dwellings/residential areas. Therefore, no population is affected by the proposed project.

The existing command area consists of small and marginal and medium groups of land holdings lies in Krishnagiri and Pochampalli talukas of Krishnagiri district and Tirupattur and Vaniyambadi talukas of Vellore district. The same will be stabilised through the link project upto an extent of 9850 ha, since the scheme is intended to recharge the ground water in the above areas. Besides, about 1.52 lakh human population will be benefitted enroute the link canal in Krishnagiri and Vellore district as about 3.882 Mm³ of water is planned to utilise enroute the link canal for providing drinking water.

In Krishnagiri district, out of 1879809 human population, the occupation of 236038 persons is mainly agriculture, 263328 persons are working as agricultural labourers, and 378413 persons are involved as household workers and other workers. In case of Vellore district, out of 3936331 human population, the occupation of 175108 persons (4.5%)
is mainly cultivation. About 391955 persons are engaged as labourers in agriculture sector and 1122267 persons are involved as household workers and other workers. Due to stabilization of existing irrigation the agricultural and allied activities get impetus and people involved in agricultural related activities get benefitted due to increased economic activities.

1.7 Natural Resources in the Basin

1.7.1 Ponnaiyar Basin

The Ponnaiyar is a major river amongst the streams between Palar and Cauvery. The Catchment area of Ponnaiyar river including Gadilam river is 15679 km$^2$, out of which 3545 km$^2$ lies in Karnataka, 133 km$^2$ in Andhra Pradesh, 11961 km$^2$ in Tamil Nadu and 40 km$^2$ in Union Territory of Pondicherry.

NWDA prepared the water Balance study report of the Ponnaiyar basin during March, 2014. As per the study, the estimated 75% and 50% dependable annual gross yields of the Ponnaiyar basin (C.A : 15679 km$^2$) have been assessed to be 748 Mm$^3$ and 1117 Mm$^3$ respectively. Out of the geographical area of 1567900 ha, the maximum culturable command area (CCA) of the Ponnaiyar basin is 823746 ha (52.54% of the basin area) and annual irrigation from all the existing major, medium and minor projects is about 114813 ha including 3228 ha of CCA by the proposed minor projects. There are no ongoing or proposed major/medium projects in the basin. The annual water utilization from the above area is about 1102 Mm$^3$ which includes 379 Mm$^3$ of import.

1.7.2 Palar Basin

The catchment area of Palar river including Poini and Cheyyar is 17871 km$^2$ lying in three states: Karnataka (2813 km$^2$), Andhra Pradesh (5018 km$^2$) and Tamil Nadu (10040 km$^2$). NWDA prepared the updated water Balance study Report of Palar including Poini and Cheyyar basin during October, 2014, based on which the 75% and 50% dependable gross annual yields have been assessed to 1147 Mm$^3$ and 1504 Mm$^3$ respectively. The maximum culturable command area (CCA) of the entire Palar basin is 980626 ha (55% of the basin area). The annual irrigation under all the existing ongoing and proposed projects is about 118681 ha and the annual utilization is about 1316 Mm$^3$.

1.8 Land Use and Socio-Economic Aspects

Out of a total ayacut of 9500 ha proposed for stabilisation by recharging of ground water under the link project, about 80% of the area falls in acute drought-prone Vaniyambadi taluka of Vellore district. The geographical area of Vaniyambadi taluka is
61126 ha of which 24475 ha (40% of geographical area) is indicated as the culturable command area in the year 2013-14. An area of 3444 ha (5.63% of geographical area) is covered under non-agricultural use, and 30633 ha (50.11% of geographical area) is the forest area in Vaniyambadi taluka.

About 90% of the command area under the link project is proposed in Tirupattur and Vaniyambadi talukas of Vellore district in Tamil Nadu. Based on available statistics of Vellore district, the Socio-economic aspects are given below.

The geographical area of Vellore district is 5920 km$^2$. According to 2011 census, Vellore district had a population of 39.36 lakhs with a population density of 650 persons per sq.km. About 57% of the population is rural. The literacy rate is about 80%. About 175108 persons depend mainly on agriculture. The agricultural labour constitutes about 35% of the total workers in the district. Maximum of Land holdings, i.e., 75% belongs to marginal category owning less than 0.50 ha, and the income from agriculture is very less.

Due to non-availability of canal irrigation facilities in the existing command area, the command area is mainly rainfed and the farmers primarily depend on rainfall and ground water for agriculture.

Based on 2011 census, about 4.50% (175108) of the population are cultivators. About 10% (391955) are agricultural labourers. The main source of irrigation in the existing command area in the vicinity of the proposed link project is only ground water. As per the ground water assessment made by Central Ground Water Board (CGWB) the ground water usage increased above 100% in all the blocks lying in Vaniyambadi taluka of Vellore district. The same have been categorized as over exploited for future ground water development and the ground water use is almost twice the annual replenishable ground water. Hence the Vaniyambadi taluka area in Vellore district is treated as one of the most severe drought-prone critical areas in Tamil Nadu.

1.9 Earlier Studies
1.9.1 Pre-feasibility Report (PFR)

Initially, NWDA prepared pre-feasibility study report of Ponnaiyar (Krishnagiri)- Palar intra-state link project based on the request of Govt. of Tamil Nadu to assess the feasibility of diverting the flood waters from the existing Krishnagiri reservoir across Ponnaiyar river to the water deficit Palar basin.
As per the PFR, the Ponnaiyar (Krishnagiri) - Palar link project envisages diversion of 99 Mm³ of flood waters available annually at existing Krishnagiri dam during the months of October, November and December. Since, both the basins viz., Area covered by streams between Palar and Cauvery and Palar including Poini and Cheyyar are found to be water deficit at 75% and 50% dependabilities, it was proposed to divert spillway discharges of Ponnaiyar river available during flood occurrences to water-short Palar basin to stabilise the existing command areas to an extent of 11870 ha being irrigated through open-wells and bore wells in Vaniyambadi taluka of Vellore district in Palar basin.

1.9.2 Main Components Proposed at PFR Stage

I. Krishnagiri Dam (Head Works)

The existing Krishnagiri dam across Ponnaiyar River with FRL + 483.11 m. An off-take tunnel of 6.20 m dia of length 200 m from the existing Krishnagiri reservoir, on left flank of Krishnagiri dam for conveying water to the Ponnaiyar (Krishnagiri) - Palar link canal. The FSL of tunnel at off-take is 480.45 m.

II. Link Canal

A link canal of length 55.700 km off-takes from the exit of the off-take tunnel with an FSL of 480.00 m to the proposed out-fall reservoir across Kal Ar, a tributary of Palar, after crossing a 6 lane National Highway near Natrampalli village of Vaniyambadi taluka of Vellore district. The FSL at its out-fall point is 428.625 m.

Total 71 Cross drainage/ Cross masonry structures including a 6 lane NH crossing.

Total 8 Canal Drops to negotiate the slope.

At PFR stage no survey & investigations for the link canal were carried out.

The PFR of the link project has been prepared and circulated by NWDA to Govt. of Tamil Nadu in March, 2011.

1.10 Present/Alternate Studies at DPR Stage

As part of optimization of Ponnaiyar (Krishnagiri) - Palar link proposal, further studies have been carried out by NWDA on Survey of India toposheets of 1:50000 scale to divert water at higher elevation by off taking the link canal from Krishnagiri reservoir and at
lower elevation by off-taking the link canal from the existing Nedungal Anicut, situated at 16 km d/s of Krishnagiri Dam.

As a result of further studies, certain changes in the project planning have been made by NWDA by taking-off the link canal from Nedungal Anicut as it was found to be more techno-economically feasible. Main components of the link taking-off from Nedungal Anicut are as given below.

1.10.1 Main Components of Present/Alternate Proposal

At DPR stage the Ponnaiyar-Palar link is proposed to off-take from the left flank of the existing located across the Ponnaiyar river. The link canal is proposed to outfall into Godd Ar river which lead the diverted waters into Palar river. The main components of the project at DPR stage are:

I. Nedungal Anicut/Weir (Head Works)

Existing Nedungal Anicut with crest level 434.71 m located about 16 km d/s of existing Krishnagiri Dam on Ponnaiyar river.

A Link Canal of about 54.15 km long off-taking from the left flank of the existing Nedungal Anicut at FSL of 434.450 m and out-falls into Godd Ar (a tributary of Kal Ar which in-turn is a tributary of Palar) at FSL 419.676 m.

Total 8 Major Cross drainage / Cross masonry structures.

1.10.2 Background for Changes at DPR Stage

The background for making changes/modifications in various components proposed earlier in Pre-feasibility report (PFR) stage is given below briefly.

Nedungal Anicut/Weir as Canal Head works instead of Krishnagiri Dam

During the field inspection, it has been observed that the Ponnaiyar (Krishnagiri) - Palar link canal alignment passes in its initial (head) reaches, through developed areas as well as through the existing command area under Krishnagiri dam, where land acquisition will be a major hurdle. Also the link canal passes through many high hill ranges in the vicinity of the Krishnagiri Dam. In addition, the off-take tunnel (200 m long) from Krishnagiri Dam, 8 Nos. of canal drops, a major canal crossing at NH-46 (6 Lane) and various CD/CM structures enroute that were proposed in PFR can be avoided, if the link canal takes-off from Nedungal Anicut. Also there is no scope for increasing the height of the
existing Krishnagiri Dam as there is likely submergence of historical Krishnagiri town and district head quarters. There is no possibility of storing additional flood waters in the Krishnagiri reservoir.

In light of the above facts, the alternate proposal of off-taking the link canal from existing Nedungal Anicut, instead of Krishnagiri dam had been sent to Govt. of Tamil Nadu by NWDA in July, 2012. The Govt. of Tamil Nadu had conveyed its consent to NWDA in January, 2013 for carrying out Survey & Investigations and preparation of DPR of Ponnaiyar (Nedungal) - Palar link Project, off-taking the link canal from Nedungal Anicut. (Copy of the consent letter is furnished at Annexure 1.3).

The location of head works had again been reviewed jointly by the officials of WRD, Govt. of Tamil Nadu and NWDA in March, 2013 and it has been confirmed after joint field inspection, to keep the location of canal head works at Nedungal Anicut/Weir for the proposed link canal, off-taking from the left flank of Nedungal Anicut, adjacent to the existing Barur Water Supply Feeder Channel.

1.11 Project Planning and Optimisation of Benefits

The Ponnaiyar-Palar link has been planned for diversion of 86 Mm$^3$ of flood waters available at existing Krishnagiri dam to utilise in its enroute and also at its tail end in Palar basin. The diverted water will be utilised for stabilising the existing command area by way of filling existing system tanks and recharging of Ground water.

From the observed monsoon monthly spill discharges (June to December) at Krishnagiri dam site for the period from 1958-59 to 2009-10 (52 years), the quantum of average flood spills has been assessed to be as 157 Mm$^3$. It is proposed that 86 Mm$^3$ (out of 157 Mm$^3$) of spill waters from Krishnagiri dam will be regulated through existing Nedungal Anicut to the Ponnaiyar-Palar link canal during October, November and December months to feed enroute tanks for irrigation and to recharge the ground water enroute the link canal in Krishnagiri and Vellore districts and also in Vaniyambadi taluka of Vellore district at the tail end in Palar basin for stabilising the existing ayacut.

The overall benefits from the Ponnaiyar (Nedungal) – Palar link project are described below:
I  Irrigation Benefits

The link canal will stabilise the existing total command area of 9850 ha utilising 75.141 Mm$^3$ of diverted water: 1900 ha enroute in Krishnagiri and Pochampalli talukas of Krishnagiri district and Tirupattur taluka of Vellore district of Tamil Nadu by utilising 17.215 Mm$^3$ of water and 7950 ha at its tail end in Vaniyambadi taluka of Vellore district in Palar basin by utilising 57.926 Mm$^3$.

II  Drinking Water Supply

The Ponnaiyar-Palar Link Project will provide 3.882 Mm$^3$ of water for drinking water supply to enroute villagers lying right side of the link canal in Krishnagiri and Vellore districts.

III  Flood Control Benefits

Since flood cushion provided in the Krishnagiri reservoir is very less, by diverting 86 Mm$^3$ of water during flood through the proposed link canal from the head works of Nedungal Anicut, the intensity of flood will be mitigated / reduced to certain extent in the downstream. Thus, the proposed Ponnaiyar (Nedungal) - Palar link project will provide incidental benefit of flood moderation in the Ponnaiyar river in downstream area of the existing Nedungal Anicut.

IV  Other Benefits

Though not planned, many other incidental benefits like development of agro based industries, food processing units, employment generation during construction period and after, development of infrastructure, improvement of ground water table and quality of water etc will accrue from the project. The living standards along with socio-economic status of the people of the region will be improved.

1.12  Intimation to the Other Development Authorities Regarding the Scheme

In the present study, the flood water available through spill way discharges at Krishnagiri dam on Ponnaiyar river in Tamil Nadu are planned to be diverted to Palar basin of the Ponnaiyar originates in Karnataka and part of the catchment area of Ponnaiyar basin upto Krishnagiri dam site comprises of Karnataka and Andhra Pradesh also. There is an existing import from Arkavathi, Middle Cauvery and Upper Cauvery sub-basins of Cauvery basin, to the Ponnaiyar basin upstream of Krishnagiri dam through the existing water supply schemes of Bengaluru city and the same is considered as regeneration to the stream. Since the source of water comprises contribution from the upstream catchment in Karnataka state,
the PFR of the link project has been sent to the Chief Engineer, WRDO, Bengaluru, Govt. of Karnataka for offering their comments/observations/suggestions in this regard. The WRO, PWD, Govt. of Tamil Nadu which is responsible for development of water resources in the state continues to be in the knowhow of the scheme at all stages.

1.13 **Experiences of Inter linking of Rivers in India**

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

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

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

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

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

It is no exaggeration to say that the transfer of surplus waters of Ravi, Beas and Sutlej to Rajasthan right upto Jaisalmer and Barmer through Indira Gandhi Nahar Pariyojana has eliminated drought conditions, provided power benefits, transformed desert waste land into an agriculturally productive area by bringing irrigation and vegetation to about 2 million hectare area. Contribution in agricultural production due to implementation of the project is worth Rs. 1,750 crores annually. Canal water is also available for meeting domestic needs. The project has substantially changed the living standard and socio-economic conditions of the people in the area.
**Sardar Sarovar Project:** The Sardar Sarovar Project across river Narmada is a landmark project for harnessing the water resources of Narmada river basin in an integrated way to meet the in-basin water requirements as well to transfer surplus water to Saurashtra and Kachchh region of Gujarat and desert area of Jalore and Barmer districts in Rajasthan which have no other dependable water source, ensuring to minimize the ecology degradation, advancement of desert and salinity ingress in the regions. The main canal of Sardar Sarovar Project which is 458 km long in Gujarat and 75 Km in Rajasthan Crosses several river 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.

**1.14 Methodology Adopted**

The Pre-feasibility Report of Ponnaiyar (Krishnagiri) - Palar link project prepared by National Water Development Agency formed the basis for proceeding further for preparation of Detailed Project Report. Suitable changes are made based on detailed Survey & Investigations.

**1.14.1 Surveys & Investigations**

The work for preparation of Detailed Project Report of Ponnaiyar (Nedungal)-Palar link project has been taken up by National Water Development Agency during September, 2012.

The Survey & Investigation works and preparation of Detailed Project Report of Ponnaiyar (Nedungal) - Palar link project was taken up by office of the Executive Engineer, Investigation Division, National Water Development Agency, Bengaluru under the administrative control of the Superintending Engineer, Investigation Circle, Hyderabad in the jurisdiction of the Chief Engineer (South), National Water Development Agency, Hyderabad.

While the topographical surveys were carried out by NWDA, other investigations were got done through other expert outside agencies/organizations.
1.14.2 Topographical surveys

The following field surveys & investigations of the project have been carried out by NWDA, departmentally.

(i) Survey for connection of GTS Bench Marks and establishing Permanent Bench Mark (PBM) and Temporary Bench Mark (TBM) levels along the link canal and at various locations in the vicinity of the project area.

(ii) River surveys of Ponnaiyar river at Nedungal Anicut (at canal off-take point) and Godd Ar and Kal Ar of Palar river (at canal out-fall point).

(iii) Firming up of the link canal alignment and L-section and Cross section surveys over a length of 54.150 km.

(iv) Grid survey of various major CD/CM structures enroute the link canal.

Since the existing Krishnagiri reservoir and dam along with Nedungal Anicut are planned as main components of the water regulating system, no submergence/ reservoir surveys are involved in the present studies. Also, no new command area is proposed under the project, as such no sample command area survey has been carried out.

1.14.3 Investigations carried out by Other Agencies

Various other investigation works leading to preparation of DPR were entrusted to outside expert organizations/agencies as enumerated below.

- Geological investigations, geological mapping: GSI, Chennai
- Geophysical investigations: CSIR–NGRI, Hyderabad
- Geotechnical investigations and borrow area Survey: CSMRS, New Delhi
- Construction Material Investigations: CSMRS, New Delhi
- Testing of Rock core samples: CSMRS, New Delhi
- Drilling work including WPT tests: Private drilling agency
- Mineral Survey: GSI, Chennai
- Archaeological Surveys: Archaeological Dept. Govt. of Tamil Nadu and Archaeological Survey of India

1.14.4 Technical Studies

1.14.4.1 Hydrological Studies

NWDA has carried out the hydrological studies of Ponnaiyar basin upto Krishnagiri dam site and assessed the gross annual yield at 75% and 50% dependabilities. Based on this, the surface water balance upto Krishnagiri dam site, taking in to account the
availability, import, export, regeneration and water needs for the basin upto Krishnagiri dam site, was worked out at 75% and 50% dependabilities as 156 Mm$^3$ (5.51 TMC) and 271 Mm$^3$ (9.57 TMC) respectively.

Keeping in view the committed water utilisations from the existing projects, it is proposed to divert only the flood waters of Ponnaiyar river available at Krishnagiri dam to Palar river during monsoon season. The quantum of average monsoon flood water at Krishnagiri dam site, based on spill data for a period of 52 years from 1958-59 to 2009-10 is assessed to be as 157 Mm$^3$. It is observed that spillway discharge takes place normally during October, November and December months only. Hence diversion of flood flows to a tune of 86 Mm$^3$ is proposed during the months of October, November and December.

1.14.4.2 Irrigation Planning and Command Area

The link canal has been planned for stabilising the existing command area by way of filling existing enroute system tanks and ground water recharge. The canal will provide 17.215 Mm$^3$ of water enroute, to stabilise 1900 ha of command area. Pochampalli and Krishnagiri talukas of Krishnagiri districts and Tirupattur taluka of Vellore districts will be benefited, enroute. Also, the link canal will provide 57.926 Mm$^3$ to stabilise 7950 ha of command area in Vaniyambadi taluka of Vellore districts by recharging ground water in Palar basin. Thus, the link canal will benefit overall 9850 ha of existing command area utilising 75.141 Mm$^3$ of diverted water. Apart from the above, the existing open/bore wells along the link canal will also be recharged due to transmission/seepage losses of the canal for which the benefits have not been quantified.

As the Palar basin is in acute drought-prone condition and ground water level is at very critical stage with no balance of ground water available even to meet the present irrigation requirement being met by open wells/bore wells, no new command areas are proposed in the present study. Stabilisation of existing command by improving the ground water recharge is the priority under the proposed flood flow diversion canal.

1.14.4.3 Design of Important Project Components

Since the link canal off-takes from the existing Nedungal Anicut and the flood waters flowing down existing Krishnagiri dam is proposed for diversion, no new dam/Anicut is involved. The design of any new dam/barrage/ Anicut across the Ponnaiyar river are not involved. The design of various other components of the project involves i) design of link canal section, ii) Canal head regulator (off-take regulator), iii) Out-fall structure, iv) Typical
design of Aqueduct, v) Super-passage, vi) Canal siphon, vii) Canal escape, and viii) Double lane/single lane road bridge etc., All the above designs have been carried out following the guidelines laid down in the respective BIS codes.

1.14.4 Construction Program, Man-Power and Plant Planning

The Construction Programming, Man-Power Planning and Plant Planning have been carried out departmentally.

1.14.4.5 Socio-Economic Survey, Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP)

The State Environmental Impact Assessment Authority (SEIAA), Chennai, Govt. of Tamil Nadu has been approached for obtaining the Terms of Reference (ToR) approved to take up the comprehensive EIA studies including Socio-economic survey. The approval has been obtained from SEIAA. These studies will be carried out by the project proponent through an expert agency on consultancy basis. The details of the study will be incorporated later in the DPR.

In the project proposal no dam/barrage is proposed as such no new submergence area is involved. While fixing the canal alignment due care has been exercised to avoid the residential houses/areas, schools and temples and forest area etc. There is no displacement of the people due to the construction of the project. Only minimum extent of land is needed to be acquired for construction of the canal for which appropriate compensation as per the policy will be provided.

1.14.4.6 Ground Water Recharge Survey

The studies for identification of potential recharge areas and extent of recharge possible along the unlined link canal were carried out by the State Ground water Department, WRD, Vellore Division, Govt. of Tamil Nadu.

1.14.4.7 Cost Estimate and Economic Analysis

The cost estimate has been prepared considering the quantities worked out based on the field survey & investigations and the design of various structures involved in the project. The estimates for the project are prepared based on the 'Guidelines for Preparation of Detailed Project Report of Irrigation and Multipurpose Projects' (2010) of the then Ministry of Water Resources, Govt. of India. The cost estimates have been framed on the basis of the 2017-18 Schedule of Rates of WRD/PWD, Govt. of Tamil Nadu to the extent available and in absence of those rates, Schedule of Rates prepared by Water Resources
Department (WRD) / PWD, Govt. of Karnataka pertaining to districts adjoining the link canal are adopted.

Total cost of the Ponnaiyar (Nedungal) - Palar Link Project has been worked out to Rs.648.23 crore at 2017-18 price level. The annual cost of the project including the cost of maintenance of head works, depreciation cost of the project and interest on capital cost works out to Rs.78.10 crore. The annual benefit from the link Project has been worked out to Rs.140.00 crore.

The Benefit-Cost Ratio (B.C.R) and Internal Rate of Return (IRR) of the Project have been worked out as 1.79 and 13.32% respectively, considering the life of the Project as 50 years.

The Index map of Ponnaiyar (Nedungal) - Palar intra-state link project is at Fig. 1.1 and appended as Plate 1.1 in Drawing Volume. The Schematic diagram of the Ponnaiyar – Palar river system with Irrigation Projects and the proposed Link canal is depicted in Fig.1.2.

1.15 Monitoring Mechanism

The Chief Engineer (South), NWDA, Hyderabad and the Superintending Engineer, Investigation Circle, NWDA, Hyderabad closely monitored the provision of preparation of DPR including Survey & Investigation works as well as other investigation works carried out through outside specialist agencies on consultation basis, by conducting meetings from time to time and inspecting the offices and field.

In order to monitor and supervise the overall work of preparation of Detailed Project report (DPR) of Ponnaiyar (Nedungal) - Palar link project, the following committees have been formed as per the decision taken in the meeting held between the officers of NWDA and PWD, Govt. of Tamil Nadu at Chennai on 18.02.2013.

Chief Engineers Level committee was formed for making Policy decisions in respect of the DPR Project proposals (Annexure 1.4).

Superintending Engineers Level Committee was formed for sorting technical issues and for proper co-ordination amongst the officers of NWDA and State Govt. of Tamil Nadu (Annexure 1.5).
1.16 Clearances Required

The Ponnaiyar (Nedungal) - Palar intra-state link project will require the following clearances from the departments/agencies indicated below in Table 1.1.

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<tr>
<th>Sl. No.</th>
<th>Clearance</th>
<th>Departments/Agencies</th>
</tr>
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<tbody>
<tr>
<td>(i)</td>
<td>Techno-economic clearance</td>
<td>Central Water Commission/TAC, MoWR, RD and GR, Govt. of India</td>
</tr>
<tr>
<td>(ii)</td>
<td>Environmental clearance</td>
<td>State level Environment Impact Assessment Authority (SEIAA) of Tamil Nadu</td>
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The above clearances shall be obtained by the State Government, as project proponent, before taking up the implementation of the project.

1.17 Public Announcement and Public Hearings

The proposed link canal alignment along with the associative benefits with an index Map of the scheme has been published in leading News Papers of Tamil Nadu region (The News clip giving details of News paper with edition and date are given in Annexure 1.6). The details of the proposal have also been discussed with the District Collectors of Krishnagiri and Vellore on many occasions, in order to make the proposal more popular, since the proposed canal alignment traverses in these two districts. The benefits to be accrued from the proposed project have been brought to the notice of the general public during the field survey and other investigation works of the scheme by the NWDA officials as well as by the respective district authorities from time to time bringing out the importance of scheme to meet the immediate needs of the region.

1.18 Interlinking of the Schemes with Neighbouring Schemes

Though the diversion of water for the link project is proposed from the existing Krishnagiri dam through existing Nedungal Anicut, the operation of the project (diversion) has no bearing/effect on the operation of any existing project or utilisation there off, since only flood water appearing as spills at Krishnagiri dam is proposed for diversion. As such, the present project has no direct link with the neighbouring schemes.
1.19 **Inter-state/International Aspects**

Ponnaiyar is a major river among the rivers forming part of Streams between Palar and Cauvery, originating in Karnataka state. The catchment area of the Ponnaiyar basin upto Krishnagiri dam site is 5428 km² and lies in Kolar and Bengaluru districts of Karnataka state with a catchment area of 3545 km², 94 km² in Chittoor district of Andhra Pradesh and 1789 km² in Krishnagiri district of Tamil Nadu State. No inter-state awards/agreements is available in respect of Ponnaiyar river. However, the issue of preparation of the DPR of Ponnaiyar (Nedungal) - Palar intra-state link project proposal of Govt. of Tamil Nadu has been informed to the Govt. of Karnataka.

1.20 **Public Co-operation and Participation**

The project after implementation provides impetus to all-round development of the region and reduces the socio-economic imbalance by enhancing agricultural production and employment opportunities. Hence, good co-operation and whole hearted participation is anticipated from the beneficiary areas.

1.21 **Provision for Domestic and Industrial Uses**

Out of 86 Mm³ of divertable flood water a provision of 3.882 Mm³ is kept for drinking water supply to benefit about 1.52 lakh rural human population of enroute villages in Krishnagiri and Vellore districts. No water is allocated towards industrial use.
Fig - 1.2 Schematic diagram of the Ponnaiyar – Palar river system with Major structures and link canal