Chapter - 1
Introduction

1.1 General

Water is the most precious gift of nature, the most crucial for sustaining life and is required in almost all the activities of man - for drinking and municipal use, for irrigation, to meet the growing food and fibre needs, for industries, power generation, navigation and recreation. The development, conservation and use of water, therefore, form the main elements in the country's developmental planning. The water resources in the country are, however, limited considering the future demands. Moreover, the rainfall is mostly confined to the monsoon season and is unevenly distributed both in space and time even during the monsoon season. As a result, the country is affected by frequent droughts. Nearly one third of the country is drought prone. In the very near future, water will be a scarce resource and therefore, needs to be harnessed in the most scientific and efficient manner.

Realizing the need for achieving a uniform development of the water resources of the country to reduce regional imbalances, the Union Ministry of Irrigation (now Ministry of Water Resources) and the Central Water Commission formulated, in the year 1980, the National Perspectives for Water Resources Development proposing therein various long distance inter-basin water transfer links for transferring water from water surplus basins of the country to deficit areas. The National Perspective Plan (NPP) comprises of two components, viz., the Himalayan Rivers Development and the Peninsular Rivers Development. The distinctive feature of NPP is that the transfer of water would essentially be by gravity and only in some unavoidable reaches it would be by lift which is also limited to a maximum of 120 m. The proposals were considered to be technically viable.

The Union Ministry, after the formulation of the NPP, held discussions in the same year with the State Governments concerned. The initiative taken by the Government of India in preparing the NPP benefiting various regions was welcomed by the States. The general consensus was that the monsoon flood water, which otherwise runs waste into the sea, should be conserved in various storage reservoirs, big and small, and the water so conserved should be utilised for irrigation, power generation, etc. It was felt that the water availability and requirement of the various river basins should be assessed realistically and the requirements should be met adequately. It was agreed that the Central Government on its own will take-up studies regarding possibilities of development within the basins as well as outside in order to firm up the quantum of water, if any, available for transfer outside the basin. Agreement regarding allocation of water to different areas would have to be reached at the political level at an appropriate time within the broad framework of national policy for development and use of water. As a follow-up action on the decisions taken during these discussions, the National Water Development Agency (NWDA) was set up in July, 1982 as a registered society to give concrete shape to the Peninsular Rivers Development component of the NPP. In 1990 NWDA was entrusted with the task of Himalayan Rivers Development component also.

The Peninsular Rivers Development component envisages, as its first part, diversion of surplus flows of the Mahanadi to the Godavari system and further transfer of the surplus waters from the Godavari system to the water short Krishna, Pennar and

Cauvery basins. This would benefit the drought prone areas of Andhra Pradesh, Karnataka, Maharashtra, Orissa and Tamil Nadu. The second part is to construct storages and to inter link the small rivers flowing along the west coast, north of Mumbai and south of Tapi, for additional supplies to the Mumbai city and partial release of waters from the Tapi to the Saurashtra and Kutch areas. The third part envisages inter linking of the southern tributaries of the Yamuna and a dam on the Yamuna at Panchanad besides construction of small storages in the system to benefit the Ujjain and Indore areas of Madhya Pradesh and the Bundelkhand region of Uttar Pradesh. The fourth part of the proposal is to divert a part of the waters of the west flowing rivers of Kerala and Karnataka to the east for benefiting drought areas, east of the Western Ghats apart from bringing new areas on the western side under irrigation. The Peninsular Rivers Development component envisages additional irrigation benefits of 13 million ha in Andhra Pradesh, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Tamil Nadu and Uttar Pradesh besides generation of power.

1.2 Polavaram - Vijayawada Link Canal Project - Overview

This report is on the feasibility of Godavari (Polavaram) - Krishna (Vijayawada) link canal project. This is one of the link canals proposed in the interlinking of Mahanadi – Godavari – Krishna – Pennar – Cauvery - Vaigai rivers which is the most important and major part of the inter-basin water transfer proposal in Peninsular India.

1.2.1 Proposed Link Canals Between Godavari and Krishna

The NWDA had taken up and completed scientific hydrological analysis of various river basins to assess the water balance position in the basins at the ultimate stage of development (by the year 2025 AD). As per the water balance studies of NWDA, there are sizeable surplus waters in the Mahanadi and Godavari basins. On the other hand, the Krishna, Pennar and Cauvery basins were found to be deficit. Based on these studies, it has been estimated that, considering the ultimate development scenario in these basins, the Mahanadi basin will have a net surplus of 11176 Mm^3 at 75% dependability at Manibhadra and the Godavari basin will have a surplus of 15020 Mm^3 at 75% dependability at Polavaram. The deficit in Krishna basin at Prakasam barrage will be of the order of 3235 Mm^3. Considering these water balance assessments, it has been proposed to divert 11176 Mm^3 of water from the Mahanadi river to the south through the Mahanadi - Godavari link. The transferred water will be partly used for irrigation en route in the States of Andhra Pradesh and Orissa and the remaining quantity of 6500 Mm^3 will be received in the Godavari. About 21520 Mm^3 of water including 6500 Mm^3 received from Mahanadi will be transferred to further south to meet the enroute irrigation and domestic water requirement in the Krishna, Pennar, Cauvery and Vaigai basins.

1.2.2 Water Transfer Through Polavaram - Vijayawada Link Canal

The Godavari Water Disputes Tribunal (GWDT) award stipulates, among other provisions, diversion of 2265 Mm^3 (80 TMC) of Godavari waters from the Polavaram project proposed by Andhra Pradesh to Krishna above Prakasam barrage at Vijayawada. The Polavaram project has been planned by the State of Andhra Pradesh as a multi-purpose project to provide irrigation benefits to the upland areas, water supply to the industries in Visakhapatnam city including the Steel Plant, for the generation of hydropower and for the development of navigation and recreation

facilities. The project will also cater to the transfer of the above specified quantity of Godavari waters to Krishna through the Right Main Canal of the project.

The Godavari (Polavaram) - Krishna (Vijayawada) link canal project will become a part of the Polavaram project of Andhra Pradesh. The Polavaram - Vijayawada link canal as conceived by NWDA will replace the Right Main Canal of the Polavaram project. The link canal is designed to carry 5325 Mm^3 of water, comprising of 3501 Mm^3 for transfer to the Krishna delta (2265 Mm^3 as per GWDT award and additional transfer of 1236 Mm^3); 1402 Mm^3 for providing irrigation to an extent of 139740 ha (CCA) en route; 162 Mm^3 for meeting domestic and industrial needs of the command area with 260 Mm^3 of transmission losses. The transferred water in Krishna delta facilitates utilisation of an equal quantity of Krishna water, so saved, in the drought prone upper reaches of Krishna basin and for further transfer to water short Pennar and Cauvery basins.

1.3 The Project Proposals

As stated earlier, the Godavari (Polavaram) - Krishna (Vijayawada) Link Canal Project envisages the construction of a link canal with a capacity for carrying 5325 Mm^3 from the Polavaram reservoir replacing the Right Main Canal of Polavaram project proposed by Andhra Pradesh.

1.3.1 Polavaram Project

The Polavaram project as proposed by the State of Andhra Pradesh envisages the construction of an earth-cum-rockfill dam 1600 m long across Godavari river at Polavaram, about 42 km upstream of Godavari barrage at Dowlaiswaram. The dam will have a maximum height of 50 m in the deep course of the river and 38 m above average bed level. A 754 m long spillway on the right flank saddle is designed to regulate a flood discharge of 1.02 lakh cumec. A 560 m long and 58 m high masonry non-overflow dam accommodates the power house and river sluices on the left flank. A reservoir of 2130 Mm^3 live storage capacity will be created by the dam.

The project envisages two canals, one on the left side and the other on the right side. The Left Main Canal will be 208 km long and will provide irrigation to a CCA of 1.75 lakh ha in the upland area of East Godavari and Visakhapatnam districts. The canal will also provide water supply to Visakhapatnam. In addition, the Left Main Canal will also have provision for navigation.

The Right Main Canal will be 174 km long and is envisaged to provide irrigation to a CCA of 1.40 lakh ha besides transfer of 2265 Mm^3 of Godavari waters to Krishna (as per GWDT award).

A power house with an installed capacity of 720 MW is envisaged on the left flank of the dam near the non-overflow section generating 60 MW of firm power.

1.3.2 Polavaram - Vijayawada Link Canal

The head sluice proposed in the right flank by the side of the spillway of Polavaram dam, releases water from the main reservoir into two subsidiary reservoirs. From these subsidiary reservoirs water will be let into the tunnel and then into a stilling basin. The Polavaram - Vijayawada Link Canal starts from the head regulator proposed in the stilling basin, and runs for 174 km and terminates into Budameru

river (which flows into Kolleru lake) at a point upstream of an existing regulator at Velagaleru village.

From Velagaleru regulator, water proposed for transfer to Krishna will flow through the Budameru Diversion Channel (BDC) to fall into the Krishna, 8 km upstream of Prakasam barrage at Vijayawada.

The link canal has been designed as a lined canal having trapezoidal section with a bed slope of 1 in 20000. The other details are given in Table 1.1.

Table 1.1

Item	At head reach	At tail reach
Capacity (Cumec)	405.120	279.530
Bed width (m)	68.500	68.500
FSD (m)	4.900	3.950
Velocity (m/sec)	1.050	0.922
FSL (m)	40.232	27.965

The alignment of the link canal is proposed to be same as that of Right Main Canal of the Polavaram project proposed by the Government of Andhra Pradesh. But the link canal is designed to carry a discharge marginally less than the discharge of the Right Main Canal.

As the region through which the link canal passes is fully developed in respect of communication facilities, navigation proposals have not been considered in this link canal project.

1.4 General Description of the Project Area

1.4.1 Location of the Project

The head works of Polavaram project from where the Polavaram - Vijayawada Link Canal takes-off are located in Andhra Pradesh on river Godavari near Polavaram village in West Godavari district at about 34 km upstream of Kovvur - Rajahmundry road-cum-railway bridge and at about 42 km upstream of Dowlaiswaram barrage.

The link canal taking off from the head regulator proposed in the stilling basin near Thotagondi village, passes through the Polavaram, Kovvur, Gopalapuram, Devarapalli, Nallajerla, Dwaraka Tirumala, Pedavegi, Denduluru, Peddapadu mandals of West Godavari district and Bapulapadu, Gannavaram, Vijayawada rural mandals of Krishna district.

1.4.2 Access to the Project

The head works of Polavaram project are connected to Kovvur town in West Godavari district by a black topped road on the right side flood bank of Godavari river. The railway line from Chennai to Howrah and NH-5 run through the command area of Polavaram - Vijayawada link. There is a network of important district roads in the area connecting villages and taluk headquarters with NH-5 and various railway stations in the region. The area is also served by aerodromes at Gannavaram and Madhurupudi and minor ports at Machilipatnam and Kakinada.

1.4.3 Climatic Condition

The general climate prevailing in the command area of the Polavaram - Vijayawada link canal is hot summer and general dry weather (except during south-west monsoon season). The temperature varies from about 44°C (maximum) in May to about 22°C (minimum) in December. The average annual rainfall in the canal command area is about 1000 mm.

1.4.4 Topography, Physiography and Geology

The general topography of the area through which the Godavari (Polavaram) - Krishna (Vijayawada) link is aligned and the enroute command area, is mostly plain with a few local high mounds and sporadic hills. The top soils generally met with in the area, are mainly red earth, black cotton soils and river alluvium. The bottom soils involved in excavation of canal and foundations for structures are generally hard gravelly soils mixed with fair sized cobbles and boulders.

1.4.5 Population

The overall density of population in the command area of the link canal is 579 persons per km^2 as per 1991 census. Due to the submergence by the reservoir, about 23000 families comprising 1.45 lakh people would be affected. Population of over eleven lakh is likely to be benefited by the project.

The work force in the area constitutes about 40% of the population, out of which 60% are cultivators and agriculture labourers. The remaining work force is engaged in coir industry, brick manufacturing, fisheries, hand looming, leather industries, woodwork, etc.

1.4.6 Natural Resources

Except agricultural land resources, there are no significant mineral or other natural resources available in the command area. However, a few stone quarries are available feeding the local construction activity.

1.4.7 Land use and Socio-Economic Aspects

The gross en route command area of the Polavaram - Vijayawada Link Canal is 162691 ha of which 29178 ha lies in Godavari basin and remaining 133513 ha lies in Kolleru lake catchment. The corresponding CCA is 139740 ha (25060 ha in Godavari basin and 114680 ha in Kolleru catchment).

Agriculture is the predominant occupation of the people of the region. Cultivation at present is mainly dependent upon rain-fed tanks, open wells, bore wells and channels from hill streams during kharif. The tanks and channels from hill streams dwindle down and almost get dried up during summer and hence the agriculture activities are limited.

1.5 Choice of the Project Site

a) Head Works

The Godavari river after flowing through a gorge across the Eastern Ghats emerges in the plains near Polavaram and thereafter widens as it approaches the delta. The narrow sections higher up in the interior of the hilly tracks could not be considered for locating a dam, since the off take of canals from these reaches would be very difficult and costly involving a number of tunnels and deep cuttings for considerable length because of rugged terrain. Instead, a location at 42 km upstream of Dowlaiswaram has been found suitable. The layout of head works has been proposed by the State of Andhra Pradesh on topographical, geological and economic considerations giving due relevance to submergence and rehabilitation problems.

The full reservoir level of Polavaram dam has been proposed to be 45.72 m (150 ft.). This level has been agreed to by the States of Madhya Pradesh and Orissa on considerations of submergence of area in the territories of these States, subject to the conditions laid down for rehabilitation and resettlement and reservoir operation policies. The interstate aspect of the project is dealt with in detail in the **Chapter - on Interstate Aspects**. As this is a terminal reservoir across the river Godavari, all the balance water available in the Godavari is proposed to be utilised under this project. Since the live storage available is less in comparison to the yield available in the river at the dam site, the project will function as a barrage combined with storage, the size of the project being constrained by the territorial restrictions and geological considerations.

b) Alternative Studies and Alignment of the Link Canal

For aligning the Polavaram - Vijayawada Link Canal, three alternatives have been studied by various organisations as detailed in the following paras:

(i) The CWC proposed alignment of the canal as a contour canal with an off take level at 33.53 m (110 ft.) and outfall level at 18.29 m having a length of 202 km.

(ii) The NWDA has studied another alignment as a contour canal with an off take level of 36.58 m and tail end level (into Budameru diversion channel) of 20.63 m with 180 km length. Since, the maximum flood level of Budameru is higher than that of full supply level of the link canal near Velagaleru regulator, the canal has to cross Budameru, downstream of the regulator which, after 8 km, meets the Budameru diversion Channel.

(iii) The Government of Andhra Pradesh for its Polavaram multipurpose project, has aligned the Right Main Canal with off take level of 40.23 m and tail end level of 27.97 m with a length of 174 km. This alignment which is designed as an unlined as well as lined canal out falls into Budameru near Velagaleru regulator and then, the waters flow through the Budameru diversion channel.

In view of more command area under the canal due to higher off take level, the alignment studies by State Government for Polavaram Right Main Canal has been considered for Polavaram - Vijayawada Link Canal for the purpose of this study. The alignment has been selected on the following criteria:

(i) To have maximum command area (for the purpose of which a flatter bed slope of 1 in 20000 is considered).
(ii) To cross minimum number of streams by aqueducts.
(iii) To run the canal in Budameru diversion channel as far as possible.
(iv) To avoid interference with the villages and tank beds en route.

Beyond RD 162.500 km, two alternatives were examined, one directly falling into Krishna river just upstream of the Prakasam barrage and the other falling into Budameru river upstream of the existing regulator near Velagaleru. The former alignment was not found feasible mainly in view of the following:

(i) The alignment is passing through Vijayawada Urban Development Area where there is mounting pressure for land with many developmental activities taking place rapidly in and around, besides formation of canal through costly lands.
(ii) The alignment has to cross Budameru where a costly structure would be necessary.
(iii) The alignment has also to cross railway line and National Highway involving construction of costly structures.

Obviously on account of the above mentioned reasons the choice was to adopt the present alignment, out falling into Budameru river on upstream of the existing Velagaleru regulator. The water meant for diversion into Krishna river will then pass through the Budameru diversion channel and join Krishna river at about 8 km upstream of the Prakasam barrage. The Budameru diversion channel has been constructed by the State Government to carry flood discharge of 425 cumec (15000 cusec), which is sufficient to carry the waters from the Polavaram - Vijayawada link whose design discharge at its outfall in the Budameru is only 250.52 cumec. This aspect is dealt with in detail in **Chapter on Hydrology** and **Chapter on Structure and Layout.**

1.6 Stages of Development of the Project

The Polavaram project is under the active consideration of the State Government of Andhra Pradesh. The project has been proposed to be completed in 12 years. The Polavaram - Vijayawada link project will also have to be phased accordingly.

In the first year, infrastructure works like land acquisition, construction of buildings and electrical lines will be taken up. Canal sections in deep cutting and embankments will be started in the second year and completed in the seventh year. The construction of three major and other minor cross drainage works will be taken up in the third year and completed in the ninth year. The canal in the balanced sections also will be taken up in the second year and will be completed in the tenth year. Other works, like lining, etc., will be completed by the twelfth year. Modernisation of Krishna delta will have to be completed concurrently.

1.7 Fitting the Scheme in Overall Development of the Region

The Polavaram - Vijayawada Link Canal will form an integral part of the overall scheme proposed by NPP to transfer water from surplus regions to deficit regions. Besides the Polavaram - Vijayawada link, two other links, viz., Inchampalli - Pulichintala and Inchampalli - Nagarjunasagar links are also proposed to transfer Godavari waters to Krishna. Thus, the surplus waters will be further transferred to water short basins in the south namely Pennar, Palar, Cauvery, etc. through a network of other proposed link canals. The Godavari basin in turn will receive waters from Mahanadi through the proposed Mahanadi - Godavari link.

The Polavaram - Vijayawada link also forms an integral part of development under Polavaram barrage scheme, contemplated by the State Government of Andhra Pradesh. Fitting this scheme in overall development as well as integrated development of this river basin and inter basin network is quite affirmative.

1.8 Interstate Aspects

As explained elsewhere, the Polavaram - Vijayawada link proposal envisages transfer of Godavari water to Krishna in accordance with the interstate agreement incorporated in the GWDT award as well as additional surplus water available in Godavari up to Polavaram barrage site.

1.9 Cost and Benefits of the Scheme

The Polavaram - Vijayawada Link Canal is an integral part of the Peninsular River Development Component under the NPP. The Godavari water to be diverted to Krishna basin through the proposed Godavari (Inchampalli) - Krishna (Pulichintala) link and Godavari (Inchampalli) - Krishna (Nagarjunasagar) link will further be transferred to Pennar and Cauvery basins. The water diverted through Godavari (Polavaram) – Krishna (Vijayawada) link and also through the above two links will help conserve the Krishna river waters for use in the upper reaches as well as for transfer to further south. Further, the surplus waters available in Mahanadi will also be diverted to Godavari (through the proposed Mahanadi - Godavari link) to support the Godavari delta.

In such a situation, obviously, the transferred Godavari waters not only benefit the Krishna basin alone, but also accrue benefits further south, i.e., in Pennar, Cauvery and Vaigai basins. As such, it will be more appropriate to assess the overall benefits of the whole integrated network, after the feasibility studies of all the interlinking proposals under Peninsular Rivers Development Component of NPP are completed. The assessment of benefit-cost (B.C.) ratio for the singular link may not reflect the overall economics of the proposal.

However, since the water diverted through Polavaram - Vijayawada link will not directly go beyond Krishna basin and as the basic criteria for the analysis of proposal is to be worked out to reflect a broad general idea of the economic viability of the scheme, the B.C. ratio of this single link has been estimated on the basis of benefits that accrue due to en route irrigation contemplated under the link.

While working out the cost of the scheme, the cost of the link canal and the cost of command area development are considered as cost for this link. The total cost accordingly is estimated to be Rs. 148391 lakh based on 1994-95 schedule of rates.

The net annual benefits by en route irrigation for a CCA of 139740 ha have been worked out to be Rs. 20110 lakh.

The B.C. ratio has been worked out to be 1.22 as against 1.62 computed for Polavaram project as a whole by the State Government. Besides, the transfer of water to Krishna will indirectly benefit the drought prone areas in the upper reaches. The benefit cost ratio could be little higher, when the value of imported water to the needy areas is priced at an appropriate value.

1.10 Public Co-operation and Participation

The Polavaram - Vijayawada link canal project which is an integral part of the proposed Polavaram multipurpose project is only modified proposal of the old Ramapadasagar project which has been under consideration for the last 40 years. The people of the region are very much eager for its materialisation and are representing directly and indirectly through their elected representatives as well as print media for its early implementation. The implementation of the scheme would mean realisation of the long cherished dream of the people in the region. There would, therefore, be overwhelming public support and participation in the project.

1.11 Public Views on the Benefits and Proposed Levies

The Polavaram - Vijayawada Link Project forms a part of a multipurpose project and there can be no two opinions on the immense benefits that can be yielded from the project. The people in the region are essentially farmers by profession and agriculture is the main occupation. Developing water resources for such a region would surely be a welcome proposition and would promote industrial growth as well.

Since no fresh levy is proposed for recovery of project cost there is no scope for objection from people. However, by an attractive rehabilitation & resettlement package, the oustees from dam and the affected people in the command should be suitably compensated.

Further, the water short areas of upper reaches of Krishna basin will also be benefited from the project. And as the project is one of the components of the NPP, the water short basins of Pennar and Cauvery will also be benefited; the proposal would be widely acceptable.