Chapter 1
Introduction

1.1 General

Water is the most essential natural resource next to air, required for sustaining life on the earth. It is required for drinking and industrial uses, for irrigation to meet the growing food and fiber needs, for power generation, navigation and recreation. The development, use and conservation of water, therefore, play a vital role in the country's development planning. The water resources in the country are, however, limited considering the future demands. The rainfall in the country is mostly confined to monsoon season and is unevenly distributed with respect to both space and time. As a result, some parts of the country are affected by frequent droughts whereas floods affect other parts. Nearly one third of the country is drought prone. In the very near future, water will become a scarce resource due to increasing thrust of population and increasing demands for various uses. Therefore, it need not be emphasized that water should be harnessed in the most scientific and efficient manner.

The monsoon flood waters should be conserved to the maximum extent possible to meet the demands for irrigation, power generation, domestic and other uses. The water availability and requirements in the various river basins need to be assessed realistically. The reasonable basin requirements should be provided for and the surplus water, if any should be transferred to the needy areas. The National Water Policy, 2002 adopted by the Government of India emphasizes that water should be made available to water short areas by transfer from other areas including transfers from one basin to another, based on a national perspective, after taking into account the requirements of the areas/basins.

1.2 National perspective 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 Godavari (Inchampalli) - Krishna (Pulichintala) Link

The National Water Development Agency took up and completed hydrological analysis of various river basins to assess the water balance position in the basins at the ultimate stage of water resources development (by the year 2050). As per the water balance studies of NWDA, there are considerable surplus waters in Mahanadi and Godavari river basins. On the other hand, Krishna, Pennar, Cauvery and Vaigai basins were found to be water deficit. It has been estimated that there will be a net surplus of 22058 Mm^3 at the proposed Manibhadra dam site on Mahanadi and surplus of 15852 Mm^3 at the proposed Polavaram dam site on Godavari at 75% dependability after meeting the existing and projected future water requirements within these basins at the ultimate stage of development.

Linking Mahanadi and Godavari to the deficit Krishna, Cauvery and Vaigai rivers is the most important part of the various proposals for inter-basin transfer of water under the Peninsular Rivers Development Component of the National Perspective Plan. The Godavari (Inchampalli) – Krishna (Pulichintala) link is one of the link forming part of linking Mahanadi-Godavari-Krishna-Pennar-Cauvery link system.

This report deals with the feasibility studies for diversion of 4370 Mm^3 of waters from Godavari to Krishna through the proposed Godavari (Inchampalli) – Krishna (Pulichintala) link canal for its optimum utilization. The project comprises of the following components:

i) A storage reservoir on Godavari river at Inchampalli with FRL 112.77 m, gross storage capacity of 10374 Mm^3, live storage capacity of 4285 Mm^3 and minimum draw down level of 106.98 m.

ii) A lined conveyance system of length 312.20 km from Inchampalli dam to Pulichintala reservoir (including a tunnel of 12.5 km length for crossing the ridge between Godavari and Krishna basins).

iii) The proposed Pulichintala dam with FRL 53.34 m, MDDL 42.7 m and live storage capacity of 1296 Mm^3

The details of areas to be served and command wise quantity of water proposed through the conveyance system are furnished in Table - 1.1.

Table – 1.1
Command areas proposed to be served under the link canal

Sl. No.	Areas proposed to be served	CCA ha	Intensity of Irrigation %	Annual Irrigation ha	Annual Utilisation Mm^3
1.	Inchampalli Right Bank Canal	48230	150	72345	470
2.	Part command of NSLBC	55725	140	78015	491
	a) by gravity				
	b) by lift upto Tammileru	100975	140	141365	891
	c) by lift beyond Tammileru	37000	100	37000	190
3.	Part command of NSRBC by lift (The proposed PRBC)	203369	140	284717	1623
4.	Municipal & Industrial Demands				413
5.	Transmission losses				292
	Total	**445299**		**613442**	**4370**

1.4 Description of the project area

(a) Inchampalli dam

As per the National Perspective Plan, a reservoir at Inchampalli on the river Godavari is to be constructed with FRL 118.67 m and gross storage capacity of 15640 Mm^3. The Government of Andhra Pradesh has proposed to construct a reservoir at Inchampalli with less storage capacity, as a joint project between the States of Andhra Pradesh, Maharashtra and erstwhile Madhya Pradesh as per the inter-state agreement. It was agreed by the three states to construct the dam with FRL 112.77 m with gross storage capacity of 10374 Mm^3.

It is a multipurpose project envisaging irrigation benefits for the upland areas, generation of Hydel power, navigation facilities in the river, development of pisciculture and providing recreation benefits besides mitigating the flood hazards. The power benefits will be shared by all the three states. The entire surplus available upto Inchampalli dam site is proposed to be transferred to Krishna for meeting deficit in Krishna basin and for further transfer to Pennar, Cauvery, and Vaigai through various link canals. As such power generation at Inchampalli would be limited to peaking demand for which reversible turbines and a pondage downstream of Inchampalli have been planned in this proposal. To accommodate this, a pond with capacity of 34.20 Mm^3 is proposed in the down stream of dam, which is additional to the head works proposed in the Inchampalli joint project. The Government of Andhra Pradesh conducted field investigations and prepared a Detailed Project Report for the Inchampalli joint project in June, 1988. A brief description of the headworks of the project is as follows.

The dam is proposed across Godavari River at about 12 km downstream of the confluence of Indravati with Godavari River. The river Godavari forms the boundary between the States of Chhattisgarh and Andhra Pradesh at the dam site. The right flank is located in Mahadevpur mandal of the Karimnagar district of Andhra Pradesh and the left flank is located in Chhattisgarh.

(b) Pulichintala project

Pulichintala project has been contemplated by the state of Andhra Pradesh with an objective of stabilization of existing ayacut in Krishna delta for paddy crop. The erstwhile Andhra Pradesh State Electricity Board was also formulating proposals for hydel power generation under

the project. The gross storage capacity of reservoir will be 1296 Mm^3 at FRL of 53.34m.

The dam is proposed to be constructed near Pulichintala village about 30 km from Jaggayyapet town in Rajupalem mandal of Guntur district. The project comprises of the spillway portion of 466.0 m length proposed to dispose off the maximum flood discharge of 39530 cumecs, non-overflow sections of 91.4 m and 182.9 m in length on the right and left flanks respectively, earth dam on left flank of 860.0m length.

(c) Godavari (Inchampalli) - Krishna (Pulichintala) link canal

Godavari (Inchampalli) - Krishna (Pulichintala) link canal is aligned to take off from the proposed Inchampalli dam across Godavari river as a contour canal running for a length of 312.20 km before it falls into the proposed Pulichintala reservoir on Krishna river. All the head works and the total canal system lie in the state of Andhra Pradesh. The canal is aligned to pass through Mahadevpur mandal of Karimnagar district, Eturunagaram, Mangapet mandals of Warangal district, Pinapaka, Mangur, Aswapuram, Burgampahad, Palvancha, Kothagudem, Julurpad, Enkur, Tallada, Wyra, Bonakal, Chintakani, Mudigonda, Nelakondapalli mandals of Khammam district and Kodada and Medlacheruvu mandals of Nalgonda district. The proposed canal is designed to discharge 304 cumec at head and 187 cumec at tail end. The entire length of the canal is proposed to be lined. On its way, the canal crosses number of rivers and streams viz. Laknavaram River, Kodipunjula vagu, Kinnerasani River, Mureru, Munneru, Palleru River and several state highways and district roads.

1.5 Climate

The climate of semi arid to arid Telangana region, in which major portion of the Inchampalli - Pulichintala link traverses is mostly tropical rainy. The summers are hot but winters are relatively pleasant. The mean maximum temperature in the command area ranges from 30 to 33^oC in January and 39 to 44 ^{o} C in May. Mean minimum temperature varies widely from 13 to 19^oC in December to 27 ^{o} C in May.

The annual rainfall in the command area varies from 600 to 1300 mm. The districts lying in the command area receives maximum rainfall from South-West monsoon in June–September. The Warangal and Khammam districts have hot climate. The summer season starts by about March and

continues till May. Thereafter, the southwest monsoon season follows and extends upto September. North-east monsoon sets in by mid October. During the northeast monsoon period, the coastal belt is particularly prone to damages due to cyclonic storms. The cold weather period from December to February is a season of generally fine weather.

1.6 Topography, physiography and geology of the area

The link canal is aligned along the Eastern Ghat, skirting reserved forests and associated hill ranges of Nagaram, Chittial, Mangapet, Janapeta, Borgampad, Palvancha, Chatakonda, Ramavaram and Kannegiri. The canal mostly runs in plain area except at the crossings of ridges between basins of various rivers and streams enroute.

The state of Andhra Pradesh has been divided into three physiographic regions viz. south Deccan plateau (53.6%) covering major part of Telangana and Rayalaseema, eastern ghats (33.4%) and coastal plains (13%). The link canal and the command area mostly fall in south Deccan plateau and to some extent in other two categories.

Geologically, the command area falls in cuddapahs (Warangal, Khammam, West Godavari & Guntur), dharwars (Prakasam, Guntur, Krishna & Khammam), upper gondwanas (Krishna), lower gondwanas (Khammam) and peninsular gneisses & granite (Khammam and Warangal). Major soil types encountered along the alignment and the command area are black cotton, red, red sandy, red loamy, forest and deltaic alluvium.

1.7 Population

People living in the enroute command area are mostly dependent on agriculture and extending irrigation facilities to an extent of 6.13 lakh ha will not only increase agricultural production but also create all-round prosperity. The scheme is intended to provide irrigation facilities to enroute areas lying in the districts of Warangal, Khammam, Krishna, West Godavari, Guntur and Prakasam where either the water shortage is much severe or the existing irrigation facilities are inadequate. Total work force comprises agricultural labourers, cultivators, workers of household industry, marginal workers and other miscellaneous categories.

1.8 Natural resources

The major minerals available along the alignment are coal, iron ore, mica, limestone, copper, graphite, marble, granite, sand stone, quartz, clay, serpentine, feldspars, kaoline and barites. The forest produces such as bamboo, eucalyptus, beedi leaves, gum, bark, tamarind, mango, mohwa, tadi, charcoal and burgu (salia melfaricum used for preparation of matches) are available in the command area.

1.9 Land use and socio-economic aspects

The land use pattern in Warangal, Khammam, West Godavari, Krishna, Guntur and Prakasham districts in which the link canal command area located comprises the forest and culturable command area at 22% and 59 % respectively. More than 70% of the population in the command area is dependent on agriculture. The literacy rate is less than 50 %. More than 80 % of the agricultural land holdings are small.

1.10 Choice of the project

The water balance studies of the Godavari basin upto the Inchampalli dam site and the Krishna basin upto the Pulichintala dam site, carried out by NWDA, reveal that after full development by 2025 AD, there will be surface water surplus to an extent of 20327 Mm^3 and surface water deficit to the tune of 671 Mm^3 respectively at 75% dependability, in these basins. The river basins located further south including Pennar, Cauvery are also established to be much more deficient in water resources. Hence, only option available to meet the deficits of Krishna and other southern basins is by diverting surplus Mahanadi and Godavari waters to Krishna and from there to further south. The Godavari (Inchampalli) – Krishna (Pulichintala) is one of the vital links, which connects Godavari and Krishna, contemplated in the overall Peninsular rivers link proposal.

Out of the total surplus Godavari waters of 20327 Mm^3 that was assessed at Inchampalli reservoir a quantity of 16426 Mm^3 is proposed to be transferred through Godavari (Inchampalli) – Krishna (Nagarjunasagar) link for use in the deficit river basins of Krishna, Pennar, Cauvery, Vaigai and other small basins. Thus it is proposed to transfer the remaining surplus Godavari waters through Inchampalli – Pulichintala link (a gravity canal) which makes a better choice for using these surplus waters in the needy areas of adjoining Godavari and

Krishna basins. With the coming up of this proposal, Khammam, Warangal, Krishna, Guntur, Prakasham and West Godavari districts of Andhra Pradesh will be benefited.

In case of the Inchampalli dam with FRL 112.77 m fail to materialize due to socio-economic and environmental constraints, this proposal could be suitably modified as Godavari (Inchampalli) low dam – Krishna (Nagarjunasagar) tail pond link through which additional command to the tune of 481154 ha can be brought under irrigation apart from the command contemplated under Godavari (Inchampalli) – Krishna (Pulichintala) link project.

1.11 Stages of development of the project

The Godavari (Inchampalli) – Krishna (Pulichintala) link canal project is an integral part of the Peninsular rivers development component of NPP. The Inchampalli dam is an important structure for the success of the entire peninsular river development component.

The time schedule for the construction of this link project will be about 10 years. The construction of headworks for the Inchampalli project is programmed to be completed in 9 years. Accordingly, the construction of headworks and powerhouse of Inchamaplli joint project is programmed to start in the second year so that the same would be completed by the 10^{th} year. It is expected that the preliminary works such as pre-construction surveys & investigations would be completed in the first and second years. The designs and preparations of drawings will be finalized by the end of the third year. The land acquisition, construction of colonies, procurement of machinery and T&P will be completed by third year. The canal and tunnel excavation will be started in third and fourth year respectively and will be completed in the ninth year. Construction of all the major and minor canal structures will also be started in fourth year and will be completed in the ninth year. Also, the lining works of the canal and tunnel will be started in the beginning of the fourth and fifth years respectively and will be completed in the tenth year. The construction and installation of pumping system and the canal power house will be taken up in the 6^{th} year and will be completed by 10^{th} year.

1.12 Fitment of the scheme in overall development of the region

The Mahanadi – Godavari – Krishna – Pennar – Cauvery – Vaigai – Gundar link proposal will be a boon to the entire peninsular region covering the states of Orissa, Chhattisgarh, Andhra Pradesh, Karnataka, Maharashtra, Tamil Nadu and Pondicherry. The main aim of the project is to divert the waters from the surplus basins to the deficit basins, for the overall development of the region. For its part, the Godavari (Inchampalli) – Krishna (Pulichintala) link is proposed to serve as one of the carriers from Godavari to Krishna to divert the surplus waters of Mahanadi and Godavari (by substitution) besides taking over the command under Inchampalli right bank canal, part command of Nagarjunasagar left and right bank canals. It also provides the domestic and industrial water requirement enroute the link. Thus, the Godavari (Inchampalli) – Krishna (Pulichintala) link project forms an integral part of the whole Peninsular rivers development component. And the enroute irrigation component of the link would enhance the overall development of the regions.

1.13 Inter-state aspects

The Godavari (Inchampalli) – Krishna (Pulichintala) link project lies entirely in the state of Andhra Pradesh and does not pose any serious constraint from the inter state disputes point of view. However, as this link is meant for inter basin water transfer from Godavari basin to Krishna basin, a broad consensus among the riparian states of Godavari and Krishna basins have to be reached before taking up the project.

1.14 Cost and benefits of the scheme

The total estimated cost of link project is Rs. 5046 crores. (2003-2004 price level). The unitwise cost is as under:

Unit I:	Head works	Rs.306 crore
Unit II:	Canal System	Rs. 4252 crore
Unit III:	Power	Rs.53 crore
Unit IV:	Lifting arrangement	Rs.409 crore
Unit V:	On farm development	Rs. 26 crore

The annual benefits to be accrued from the project due to irrigation,

power and water supply for domestic and industrial uses contemplated under the link has been worked out to be about 2202 crores.

While working out the total cost, cost of headworks, conveyance system, power component, lifting arrangements and cost of command area development are considered.

Thus, the B.C ratio is works out to be 3.41. The internal rate of return works out to be 19.26%.