

EXECUTIVE SUMMARY

Godavari (Inchampalli)- Cauvery (Grand Anicut) link project

General

The river link projects are engineering panacea that aim at reducing persistent water shortages in some parts of the co-basin States and can address the water issues arising out of climate change. The rate of expansion of irrigated land is the most important determinant of water stress, at least the stress related to quantity. There are diverse views on how the trend in irrigated agriculture's expansion will continue or bend, with important stakeholders weighing in on both sides. The conventional wisdom in agriculture, based on the need to produce food for the growing population is that irrigated agriculture will have to keep pace.

Whether the water crisis intensifies - or whether key trends can be bent towards sustainable management of water resources - depends on many interacting trends in a complex basin system. Real solutions to this require an integrated approach to provide strategic assistance in developing policies, regulations, and the technical and scientific competencies through inter linking of rivers to manage the resources base and water services in a fully integrated fashion. Concordantly, the National Perspective Plan (NPP) for water resources development has given a motivation for translating it to action to make water resource management more sustainable.

1.0 National Perspective Plan (NPP) for Water Resources Development

Realizing the need for achieving a balanced regional development, the erstwhile Union Ministry of Irrigation and the Central Water Commission (CWC), formulated in the year 1980, a National Perspective Plan (NPP) for water resources development which comprises two components viz. the Himalayan rivers development and the Peninsular rivers development.

Peninsular rivers development

This scheme envisages, as its first part, the diversion of surplus flows of the Mahanadi to the Godavari system and further transfer along with the surplus water from Godavari system to the Krishna, Pennar, Cauvery, Vaigai and Gundar basins through the ninelink system.

This would benefit areas of Andhra Pradesh, Karnataka, Odisha, Tamil Nadu, Telangana and Puducherry.

Proposed link canals between Godavari and Vaigai as per NPP

The hydrological analysis of various river basins by NWDA revealed that the surplus in the Mahanadi basin near Manibhadra is about 12165Mm³ and that in Godavari basin at Polavaram is about 15020 Mm³ at 75% dependability duly considering the demands at the ultimate stage of development (i.e. by the year 2050 AD).

On the other hand, the deficits in Krishna at Nagarjunasagar and Pulichintala will be of the order of 1525 Mm³ and 671 Mm³ respectively and the same at Prakasam barrage will be 3235 Mm³. Considering these water balance scenarios, it has been proposed to divert 12165Mm³ of water from the Mahanadi river to the south through the Mahanadi - Godavari link, the first of the nine link system. The transferred water will be partly used for irrigation enroute in the States of Odisha, Andhra Pradesh and the remaining quantity of 6500 Mm³ will be received in Godavari. About 21520 Mm³ of water including 6500 Mm³ received from Mahanadi and the 15020Mm³ of surplus available in Godavari at Polavaram, will be transferred to Krishna river system through three links, viz.,

1. Polavaram - Vijayawada link,
2. Inchampalli -Pulichintala link, and
3. Inchampalli - Nagarjunasagar link.

These link canals cater to the requirements of irrigation, domestic and industrial uses enroute besides meeting the deficits in the Krishna basin. Part of the water received in Krishna from Godavari is further diverted to Pennar, Cauvery, Vaigai and Gundar river systems through a network of the following link canal projects.

4. Krishna (Almatti) - Pennar link
5. Krishna (Srisailam) - Pennar link
6. Krishna (Nagarjunasagar) - Pennar (Somasila) link
7. Pennar (Somasila) - Palar - Cauvery (Grand Anicut) link
8. Cauvery (Kattalai) - Vaigai - Gundar link

The flow diagram of the link canals proposed in peninsular component is furnished in **Plate 1**.

1.1 Aim of the link project and description of works

The nine link system has been planned based on the proposed storages at Manibhadra on Mahanadi & Inchampalli on Godavari. These two dams have not been taken up so far by the State Governments in view of submergence and inter-state issues.

The planning of Mahanadi - Godavari link is under revision in consultation with Government of Odisha. Once the issue of surplus water in Mahanadi basin is finalized with

the concurrence of Government of Odisha, the amount of water that can be transferred to Godavari basin can be quantified. Further, the supplementation from Himalayan component to Mahanadi basin is also proposed which is yet to be finalized.

1.1.1 Firming up of the proposal for DPR

Keeping in view the above, it is proposed that the originally contemplated nine link system will be taken up in two phases.

- a) Phase I: Identifying surplus waters in Godavari basin without affecting the interests of the co-basin States and transferring these waters upto Cauvery through Godavari - Krishna - Pennar - Palar – Cauvery link system while meeting the requirements of the areas enroute, to the extent possible.
- b) Phase II: Linking Brahmaputra - Ganga - Subernarekha - Mahanadi - Godavari rivers, thus enriching the Phase I with suitable modifications.

Phase I comprises the following links:

1. Godavari (Inchampalli)- Krishna (Nagarjunasagar) link
2. Krishna (Nagarjunasagar) - Pennar (Somasila) link
3. Pennar (Somasila) - Cauvery (Grand Anicut) link

Phase II comprises the following additional links:

1. Mahanadi (Manibhadra) - Godavari (Dowlaiswaram) link
2. Godavari (Polavaram) - Krishna - Pennar link (being planned by Government of AP)
3. Godavari (Inchampalli) - Krishna (Pulichintala) link project
4. Krishna (Almatti) - Pennar link
5. Krishna (Srisailam) - Pennar link
6. Cauvery (Kattalai) - Vaigai - Gundar link

1.1.2 Water availability for revised planning

The net water availability in Godavari basin between Sriramsagar project (SRSP) and Inchampalli, after deducting all the upstream requirements and the committed downstream requirements is worked out to be 5002 Mm³ at 75% dependabilities per NWDA studies.

While working out the surplus water at Inchampalli, about 2978 Mm³ is estimated as requirement of proposed major and medium irrigation projects of Chhattisgarh in Indravati

sub-basin. Further, about 1477 Mm³ of water is earmarked for evaporation losses from the proposed hydropower projects of Chhattisgarh in Indravati sub-basin. These projects in Chhattisgarh are likely to take a few more years for their implementation. Thus, the total water available in Godavari basin for planning in peninsular component of inter-basin water transfer will be about $(5002+2978+1477-266)=9191\text{Mm}^3(324\text{ TMC})$ after duly deducting the regeneration (266 Mm³) from the proposed major & medium irrigation projects which was estimated to be available while assessing the water balance. However, conservatively, about 7000 Mm³(247 TMC) only is proposed to be diverted during monsoon season from river Godavari to Krishna and further south.

1.1.3 Technical feasibility note and views of concerned States

NWDA prepared a technical feasibility note for diversion of 7000 Mm³ from Godavari to Cauvery and sent to Govt. of Chhattisgarh, Telangana, Andhra Pradesh, Tamil Nadu, Puducherry, Karnataka, Odisha in December, 2017 for their views. In response to the above, Governments of Chhattisgarh, Tamil Nadu, Puducherry and Telangana submitted their views/comments, the salient points of which are given below:

Chhattisgarh opined that the fulfillment of water demand of the state in summer months shall be ensured while implementing the proposal. Government of Tamil Nadu expressed that the state has no objection and stated that the DPR has to be prepared without waiting for the concurrence of co-basin states. Government of Telangana is of the view that it is required to establish the availability of surplus water after duly considering all the requirements of basin states and advised that the hydrological studies should be conducted by Central Water Commission. The Government of Puducherry requested that the interests of the state may be protected by ensuring additional quantum of water.

1.1.4 Views of Central Water Commission (CWC)

The Central Water Commission (CWC) carried out the water availability studies of Indravati subbasin of Godavari basin (Nov, 2016) considering inflows at Pathagudem G&D site for the period from 1985 to 2014 according to which, the gross yield at 75% dependability is 23170 Mm³. This is against the corresponding yield of 21166 Mm³ as estimated by NWDA. Thus, the yield as assessed by NWDA is on the conservative side and the same is used for water planning.

Further, Central Water Commission submitted their report on the technical feasibility note circulated by NWDA in December 2017 stating that the study carried out by NWDA is in order and advised to carry out consistency checks for homogeneity. Further CWC clarified that after complete utilization of its share by Chhattisgarh, the availability of 247 TMC may only be possible at 50% dependability.

1.1.5 Decision by Ministry of WR, RD& GR

A meeting was held on 17.05.2018 under the Chairmanship of Hon'ble Minister (WR,RD& GR) with Hon'ble Minister, Water Resources, Government of Chhattisgarh to discuss the various issues involved in the technical feasibility note of Godavari - Cauvery link project. Hon'ble Minister, WR Govt of Chhattisgarh suggested that the NWDA should carry out survey & investigations (S&I) and prepare DPR. Thereafter, the issue of implementation of the project can be discussed with all the concerned States for concurrence. The Hon'ble Minister, (WR,RD& GR) felt that S&I and preparation of DPR are part of consensus building process and NWDA should first undertake and complete DPR by March 2019.

1.1.6 The link proposal

The Godavari - Cauvery link project comprises the following three components.

1. *Godavari(Inchampalli) - Krishna (Nagarjunasagar) link*
2. *Krishna (Nagarjunasagar) - Pennar (Somasila) link*
3. *Pennar (Somasila) -Cauvery (Grand Anicut) link*

The proposal is rechristened as **Godavari (Inchampalli) - Cauvery (Grand Anicut) link project** for diversion of 7000 Mm³ from Godavari to Cauvery for utilization in the states of Telangana, Andhra Pradesh and Tamil Nadu.

Government of Telangana suggested to take up the conveyance from Inchampalli with reduced dam height and to follow the alignment as considered in the feasibility report of Godavari (Inchampalli) - Krishna (Nagarjunasagar) link project. Further, the State suggested considering irrigation and water supply to the fluoride affected mandals of Munugodu and Chandur in Nalgonda district vide Letter No. ENC (I)/ DCE-I/OT-1/AEE-4/ NWDA Akinepalli-Cauvery / 2019 dated 16.01.2019. Accordingly, NWDA has taken up the link project in the first reach between Inchampalli and Nagarjunasagar.

The link canal takes off through an approach channel of 10 km from the proposed Inchampalli barrage with full pond level of 87 m, traverses over 299.26 km including a tunnel of 9.15 km length for crossing the ridge between Godavari and Krishna basins and falls into the existing Nagarjunasagar reservoir. via Musi reservoir. The link canal crosses Peddavagu, Tummalagutta and Musi reservoirs enroute. Further, the link canal takes off from Nagarjunasagar reservoir and falls into Somasila reservoir across Pennar at RD 692.276 km. The link canal then takes off from the Somasila reservoir and eventually falls into the Grand Anicut across the Cauvery river at RD 1210.84 km

The proposal comprises the following components:

- i) Head works at proposed Inchampalli barrage across river Godavari in Mahadevpurmandal of JayashankarBhupalapally district with full pond level (FPL) of 87m so as not to affect Kaleswaram project upstream and restrict the submergence to river portion.
- ii) Link canal of length about 1211 km from the proposed Inchampalli barrage to Grand Anicut via existing Musi, Nagarjunasagar, Somasila reservoirs, comprising open canal, lifting arrangements and tunnels.
- iii) Lifting arrangements through 4 stages of 57m (RD 0.0 km), 38m (RD 18.0 km), 23.2m (RD 26.50 km) and 11.0m (RD 60.50 km) totaling to 129.20m of static lift on main canal; a lift of 52.63m for Kakatiya Stage II feeder branch (at RD 97.50km on main canal), lifting through 3 stages of 64.50m (RD 0.00km), 58.0m (RD 75.00 km) and 74m (RD 95.00km) for the 116 km long Gottimukkala feeder branch canal (taking off at RD 199.15km on main canal) totaling to 196.50m; a lift of 67.14m for Srisailam LBC feeder branch (Alimineti Madhava Reddy LIS) from Nagarjunasagar reservoir.
- iv) One tunnel each at RD 86.35 km of 9.15 km length in the reach from Inchampalli to Nagarjunasagar; 1.3 km long tunnel from RD 302.786 to RD 304.101km; 4 km long tunnel at the offtake of link canal near headworks of Somasila; one km tunnel from RD 700.976 km to RD 701.976 km; and 3.1 km long tunnel from RD 826.776 to RD 829.876 km.
- v) Two powerhouse complexes one on canal at Musi reservoir with a head of about 9.70m and another powerhouse at canal head at Nagarjunasagar reservoir with a head of about 20m.
- vi) Existing Nagarjunasagar on river Krishna, Somasila on river Pennar as balancing reservoirs enroute.
- vii) In all, 30 branch canals and 7 direct sluices / feeders to facilitate irrigation enroute and in the existing irrigation systems through piped distribution.

- viii) Command area of 887022 ha is proposed to be brought under irrigation in Telangana, Andhra Pradesh and TamilNadu. This will fetch about 944572 ha of irrigation annually as detailed below.
- a) New areas of 453017 ha as detailed below :
- i) New area of 80000ha under the proposed Gottimukkala branch canal to irrigate fluoride affected mandals of Munnugodu and Chandur in Nalgonda district as requested by Govt of Telangana.
 - ii) New area of 168017 ha of area between Krishna and Pennar rivers in Prakasam and Nellore districts
 - iii) New area of 205000 ha of area between Pennar and Cauvery in Nellore, Chittoor districts of Andhra Pradesh and Tiruvallur, Vellore, Kancheepuram, Tiruvannamalai, Villupuram Cuddalore districts of TamilNadu
- b) Stabilisation of existing commands to an extent of 434005ha (491555 ha of annual irrigation) as detailed below:
- i) Stabilisation of command under SRSP to an extent of 178055ha in the drought prone Warangal Plateau, Nalgonda and Khammam districts in Telangana, partly by gravity and partly by lift.
 - ii) Stabilisation of 109250 ha of endemically drought prone upland areas under the Srisailem left bank canal (SLBC) in Nalgonda district in Telangana by lifting from offshore of Nagarjunasagar reservoir through AMRLIS.
 - iii) Stabilisation of 90000 ha under Nagarjunasagar right bank canal (NSRBC) to irrigate 126000 ha annually in Guntur district of AP
 - iv) Stabilisation of Cauvery delta to an extent of 56700 ha to irrigate 78250ha annually in Thanjavur district of TamilNadu
- ix) Number of cross drainage/ cross masonry and regulating works across the link canal.
- x) Canal top solar power generation arrangement at appropriate reaches along the link canal alignment.
- xi) The existing Grand Anicut as outfall structure on river Cauvery with Full Pond Level 59.22 m.

1.1.7 Godavari(Inchampalli) - Cauvery (Kattalai) link project

The Government of Tamil Nadu conveyed that the link canal may be taken at higher elevation after crossing Palar river by pumping from DusiMamandur Tank and terminate at Kattalai instead of Grand Anicut in Phase -I itself. Further, the Government of Tamil Nadu requested that the Poondi reservoir (meeting the domestic requirement of Chennai city) may be linked with AraniAr reservoir so that 609 tanks with a capacity of 15 TMC can be filled. The Government of Tamil Nadu have been consistently requesting NWDA in every forum to consider an alternate canal alignment to make water available at higher elevation to benefit the area lying at higher contour and to take proposed link canal to Kattalaibarrage instead of Grand Anicut, so that the mid land region which is not benefitted much compared to coastal area during the monsoon should be irrigated through this project. Further, the water meant for Cauvery - Vaigai - Gundar link project can be delivered at Kattalai from where the CVG link proposed to take off.

Accordingly, NWDA is preparing DPR of Pennar (Somasila) - Palar - Cauvery (Kattalai) link project and the same will be circulated separately as and when it is ready

1.2 Location of project area

The Godavari (Inchampalli) - Cauvery (Grand Anicut) link project traverses through Godavari, Krishna, Pennar, Palar and Cauvery basins and lies in the states of Telangana, Andhra Pradesh and Tamil Nadu. The alignment of the link canal passes through the districts of JayashankarBhoopalapally, Warangal, Nalgonda of Telangana, Guntur, Prakasm, Nellore, Chittoor districts of Andhra Pradesh and Tiruvallur, Kancheepuram, Tiruvannamalai, Villupuram,Cuddalore, Perambalur and Tiruchirapalli districts of Tamil Nadu.

1.2.1 Intimation to other development authorities regarding the scheme

The technical feasibility note of the link project was circulated to Govt. of Madhya Pradesh, Chhattisgarh, Maharashtra, Odisha, Telangana, Andhra Pradesh, Tamil Nadu, Karnataka, Kerala and Puducherry in the month of December 2017. The draft DPR of Godavari (Inchampalli)- Cauvery (Grand Anicut) link project was circulated in March/May, 2019. Observations are received from the Governments of Telangana, Chhattisgarh, Andhra Pradesh, Karnataka, Maharashtra, Madhya Pradesh, Odisha, Tamil Nadu, Kerala and Puducherry. Most of these observations are attended while carrying out the Detailed Project Report (DPR).

1.2.2 Godavari basin

The Godavari basin extends over an area of 312813km² which is nearly 10% of the total geographical area of the country. The basin comprises areas in the states of Maharashtra, Madhya Pradesh, Chhattisgarh, Andhra Pradesh, Telangana, Karnataka and Odisha. Catchment area upto proposed Inchampalli barrage site is 269000km². State-wise distribution of the Godavari basin is given below.

State-wise distribution of the area of the Godavari basin

State	Drainage area (km²)	Percentage of total Drainage area
Andhra Pradesh	15372	4.92
Chhattisgarh	33434	10.69
Karnataka	4406	1.41
Madhya Pradesh	31821	10.17
Maharashtra	152199	48.65
Odisha	17752	5.67
Telangana	57829	18.49
Total	312813	100.00

The proposed Inchampalli barrage site is considered for diversion of waters from Godavari and the water availability is assessed at this point.

1.3 Inter-state aspects

The Godavari (Inchampalli) - Cauvery (Grand Anicut) link project will traverse through Godavari, Krishna, Pennar, Palar and Cauvery basins. The stipulations made in GWDT, KWDT, CWDT Awards and the inter-state agreements are duly considered. Further, by enriching the water resources in various basins, the link project will ease the pressure on upstream States by timely augmentation of water supplies to the downstream states.

1.3.1 Impact of link project on Tribunal Awards

The Godavari Water Dispute Tribunal in their report (1979) ordered that the inter-state agreements concluded among riparian states be observed and carried out. The award did not specify exact quantities of allocations to each state in each sub-basin. The following table shows allocations to Maharashtra, Andhra Pradesh, Chhattisgarh and Odisha in respect of the

Indravati sub-basin, which is reproduced from Godavari Water Disputes Tribunal Award (GWDT).

Extracts from GWDT Award in respect of Indravati sub-basin

Sl No	Sub-basin	Maharashtra	Andhra Pradesh (Pre bifurcation)	Chhattisgarh	Odisha
1	Indravati	i) 962.78 Mm ³ (34 TMC) upto Bhopalapatnam project	i) All remaining waters of Indravati sub-basin downstream of Bhopalapatnam project	i) 7730.54 (Mm ³) (273 TMC) upto Bhopalapatnam Project	i) All waters upto Chhattisgarh border
		ii) 198.22 Mm ³ (7 TMC) below Bhopalapatnam		ii) All waters upto Chintavagu, Jallavagu and Kothapalli	ii) (-) 45 TMC to be let at Odisha / Chhattisgarh border
				iii) 19 TMC additional water d/s of the sites at (ii) given above	

There will not be any negative impacts of the link canal on the Tribunal Award as

- a) The water balance is assessed at Inchampalli after duly considering requirement of all the existing, ongoing and future projects in upstream sub basins
- b) The link project stabilizes vast areas of existing command of Nagarjunasagar and Grand Anicut projects which are suffering from inadequate inflows
- c) The link canal serves the upper reaches of Cauvery basin on the left flank of Coleroon river, thus meeting the demands of one of the most chronic drought areas in the country.
- d) Balanced development of all the regions is an essential feature of Indian planning process. The link canal is supporting this idea and serving those areas, which could not possibly be served through conventional projects due to non-availability of storage sites and on account of the areas lying in upper reaches.

1.3.2 Requirements of Telangana

The state of Telangana initiated several projects all along the river Godavari. These projects irrespective of their status and stage of development are considered while assessing

the transferable quantity. As stated by Govt. of Telangana, the continuous development of water resources in Telangana till its allocated share by GWDT is exhausted is duly recognized while preparing this DPR. Further, the majority share of the proposed diversion comes from the unused share of Chhattisgarh in Indravati sub-basin and significant quantity (1103 Mm³) from the balance assessed by NWDA at Inchampalli will be utilized in the state of Telangana.

1.4 Survey and investigations

Detailed surveys and investigations such as topographical surveys, geological, geophysical & geotechnical investigations including foundation investigations i.e. drilling bore holes at identified major CD/CM structures, tunnels etc for obtaining rock cores; Construction materials investigations; Geotechnical investigations (soil) including borrow area surveys; Command area surveys etc., have been undertaken departmentally as well as through various specialized organizations during the feasibility studies of different reaches of the link project.

1.5 Hydrological studies

The hydrological studies are carried out for the Godavari basin at Inchampalli barrage site. The area of the Godavari basin upto the Inchampalli barrage site is taken to be comprising of the areas of the following sub-basins of Godavari basin namely (i) part of the Middle Godavari sub-basin below Sri Ram Sagar Project (ii) Maner (iii) Penganga (iv) Wardha (v) Pranhita (vi) Indravati and (vii) part of Lower Godavari upto Inchampalli barrage site. The catchment area of river Godavari between Sri Ram Sagar project and Inchampalli barrage site is 177249 km². The water balance study at the Inchampalli barrage site shows a net surplus of 5002 Mm³ at 75% dependability and 19481 Mm³ at 50% dependability. The entire surplus along with the unutilized waters of Chhattisgarh in Indravati sub-basin is proposed to be diverted through Inchampalli - Nagarjunasagar link

1.5.1 Studies by Central Water Commission

The Central Water Commission (CWC) carried out the water availability studies of Indravati sub-basin of Godavari basin (Nov 2016) according to which, the gross yield at 75% dependability is 23170 Mm³, considering inflows at Pathagudem G&D site for the period from 1985 to 2014. This is against the corresponding yield of 21166 Mm³ as estimated by NWDA. Thus, the yield as assessed by NWDA is on conservative side and the same is used for planning of the link project.

As per GWDT Award, the share of Indravati water to Chhattisgarh is about 300 TMC (8495 Mm³). If the same is not utilized, then the transferable water of 247 Mm³ (7000 Mm³) of water may be possible at 75 % dependability. Further, the surplus water available at 50% dependability works out to 387.75 TMC (10979 Mm³).

1.5.2 Augmentation of water balance with unused Indravati waters

In the water balance computed at Inchampalli across Godavari, the main source of water is river Indravati which joins just upstream of Inchampalli. There are several projects major, medium and minor proposed on Indravati and its tributaries in Chhattisgarh state and which have been pending for several years due to various reasons and further delay is anticipated in implementation of these projects. Hence, keeping water for minor projects for immediate implementation, the water provided for major and medium projects is expected to join river Godavari for a considerable period to come. It is felt, in the interest of the neighboring States and the country as a whole, to use these waters with alternate plans till such development takes place. This will help arresting huge quantity of water from going to sea and also help improving irrigation and water supply facilities in the neighboring States of Telangana, Andhra Pradesh and Tamil Nadu.

1.5.3 Proposed diversion from Godavari to Cauvery

As mentioned earlier, in the first phase of peninsular rivers development, only the Godavari waters are proposed for diversion. For this purpose, the net availability at Inchampalli, after deducting all the upstream requirements and the committed downstream requirements is worked out to be 5002 Mm³ at 75% dependability as per NWDA studies.

While working out the surplus water at Inchampalli on Godavari, about 2978 Mm³ is considered as requirement of major and medium irrigation projects of Chhattisgarh in Indravati sub-basin. Further, about 1477 Mm³ of water is earmarked for evaporation losses from the proposed hydropower projects of Chhattisgarh in Indravati sub-basin. Since, these projects in Chhattisgarh are likely to take a few more years for implementation it is proposed to consider the above allocated water for diversion through the link project, for the time being.

Thus, the estimated irrigation requirement of the future major and medium projects (2978 Mm³) and the likely evaporation losses from the future hydro power projects (1477 Mm³) of Chhattisgarh State in Indravati sub-basin of Godavari basin are also considered as available waters for diversion after duly deducting the regeneration (266 Mm³) from irrigation projects. Thus, the total water available in Godavari basin for planning in peninsular component of inter-basin water transfer will be about $(5002+2978+1477-266) = 9191$ Mm³ (324 TMC).

However, conservatively it is proposed to divert only about 7000 Mm³ (247 TMC) of water during monsoon season.

Thus, the **Godavari (Inchampalli) -Cauvery (Grand Anicut) link** is envisaged for diversion of 7000 Mm³(247 TMC) annually from Godavari basin to Krishna, Pennar and Cauvery basins.

1.5.4 Generation of daily flow series

The observed daily flows at Perur G&D site are collected for the period from 1966-67 to 2010-11. The annual surplus yield series from Indravati sub basin are converted into daily flows for all the years in proportion to the observed daily flows at Perur G&D site located in the vicinity of Inchampalli. The mean daily flows are then computed by adding the corresponding days in all the years and dividing it by the total number of years.

1.5.5 Duration of the water diversion

Keeping in view the upstream utilizations, downstream commitments and the minimum lean season flow in the Godavari river, the diversion of water is proposed only during the monsoon months. The maximum diversion is kept at 62.3 Mm³(2.2 TMC)per day during the monsoon months from June to October. It is estimated that about 7000 Mm³(247 TMC) of water will be available for transfer during 143 days. Further, about 7876Mm³of water will spill downstream during the period from July to October. However, conservatively, the annual diversion is limited to **7000 Mm³(247 TMC)** through the link project. The monthly proposed diversion is furnished below.

Monthly proposed water diversion and duration

Month	No. of days	Quantity of diversion		Spills	
		Mm ³	TMC	Mm ³	TMC
June	20	360	12.7	-	-
July	31	1736	61.3	1303	46.0
August	31	1930	68.2	4050	143.0
September	30	1674	59.1	2421	85.5
October	31	1300	45.9	102	3.6
Total	143	7000	247.2	7876	278.1

1.6 Design aspects

1.6.1 Hydraulic design of barrage

The barrage at Inchampalli is designed for a flood of 71030cumec. The number of bays proposed in undersluices is 5 and the river sluices are 34. The full pond level of the proposed barrage is 87 m and the crest level is fixed at 76 m.

1.6.2 Design of canal

The cutoff statement of the canal considering the water requirement of branch canals and sluices and transmission losses enroute is prepared and the design of canal is carried out wherever the discharge is reduced by 10% from its previous reach. The shape of the canal has been selected as trapezoidal with rounded corners as per provisions of IS code: 10430. The fluming of canal is also considered by increasing the canal FSD by about 0.5 m wherever the deep cut reaches are encountered on hard /weathered rock strata.

Hydraulic particulars of canal at various reaches

Reach (km)		Design discharge (cumec)	Bed width (m)	FSD (m)	Area (m ²)	Wetted perimeter (m)	Velocity (m/sec)	Actual discharge (cumec)
From	To							
Inchampalli to Nagarjunasagar (Bed slope of canal 1 in 20000)								
0.00	97.50	1090	109.60	6.75	834.93	137.79	1.306	1090.17
97.50	162.70	1074	107.90	6.75	823.46	136.09	1.304	1074.16
162.70	199.15	1061	106.60	6.75	814.68	134.79	1.303	1061.93
199.15	299.256	1041	104.40	6.75	799.83	132.59	1.302	1041.22
Nagarjunasagar to Merger of link canal with existing NSRBC								
299.256	502.006	488	21.3	7	226.32	43.36	2.16	488
Merger of link canal with existing NSRBC & to Grand Anicut								
502.006	558.256	565	67.5	6	480.17	92.56	1.18	565
558.256	602.806	539	64.1	6	459.77	89.16	1.17	539
602.806	692.276	498	58.9	6	428.57	83.96	1.16	499
692.276	841.026	603	73	6	512.87	98.01	1.18	607
841.026	882.136	524	62.5	6	449.87	87.51	1.17	526
882.136	1039.426	408	47	6	357.17	72.06	1.14	408
1039.426	1210.376	379	43.5	6	335.87	68.51	1.13	381
1210.376	1210.841	351	70	4.5	357.28	88.79	0.99	355

1.6.3 Tunnels

In all, five tunnels are proposed along the link canal wherever felt necessary for all the three reaches. The tunnels are designed for varying discharge with varied bed slope. The value of Manning's coefficient adopted is 0.014 for the concrete lined tunnel. The design details are furnished below.

Hydraulic particulars of tunnels

Sl. No	RD (km)	Length (km)	Bed slope	Discharge (cumec)	Diameter (m)	Remarks
1	86.35	9.15	1/ 5000	1090	16 x 1	Reach I (I - N link)
1	302.786	1.27	1/486	488	10 x 1	Reach 2(N-Slink)
1	692.276	4.0	1/5000	601	10.3 x 2	Reach 3(S-GAlink)
2	700.976	1.0	1/5000	601	12.6 x 1	Reach 3(S - GA link)
3	826.776	3.1	1/ 5000	580	12.5 x 1	Reach 3(S - GA link)

1.6.4 Lifting arrangements

The design of lifting arrangements is made for all the three reaches and the salient features are furnished below.

Salient features of lifting arrangements on the main canal and feeder branches

Sl. No	Description	Location of pump house RD (km)									
		Main canal					Branch canal				
I	Godavari (Inchampalli) - Cauvery (Grand Anicut)	SRSP br.	RD 199.15 km Gottimukkala			SLBC Feeder					
1	RD (km)	0.0	18	26.5	60.5	692.276*	97.5	Stage I	Stage II	Stage III	299.30
2	Discharge (cumec)	721	721	721	721		64	44	44	44	31
3	Static head (m)	57	38	23	11		53	65	58	74	67
4	Pump capacity (cumec)	40	40	40	40		40	40	40	40	40
5	No. of pumps	20	20	20	20		2	2	2	2	2
6	Installed capacity (MW)	578	432	288	160		55	66	62	76	65
7	Operating head (m)	59.6	44.6	29.8	16.6		57.1	67.6	63.6	78.6	73.6
8	Power required (MU)	1296	970	647	360	115	110	90	84	104	69
		Total power requirement 3845MU									

*Pumping for varying height of 1 to 2 m during May to October at the exit of the tunnel near Somasila off-take.

1.6.5 Powerhouse at the offtake of link canal from Musi / Nagarjunasagar

The link canal on its way falls into the existing Musi balancing reservoir at RD 199.15 km from where it takes off from with a fall in head of 9.7m. It is proposed to install about 60MW of power capacity which will generate 146 MU during monsoon season. Further, the link canal takes off from the Nagarjunasagar at the same off-take level as that of the existing NSRBC and hence, it is proposed to construct a power house on the link canal similar to the existing one on NSRBC utilising available head. It is proposed to install 4 units of 30 MW each including one standby unit. The water after power generation using the available head would be guided to the link canal through 130 m long tailrace channel. Suitable modifications to both the dams are proposed to be carried out for accommodating the proposed head regulator, power block with penstocks etc., leading to the proposed power house on the link canal.

1.6.6 Canal structures

There are 1088 CD/ CM works from Inchampalli to Grand Anicut. There are aqueducts and super-passages across major rivers and streams, undertunnels across small streams. The double lane road bridges are proposed across major road crossings and single lane road bridges are proposed across roads of lesser traffic. The rail bridges are proposed wherever the canal crosses the railway lines. The design flood value of each drain has been worked out using the empirical formulae. The cost of each structure is obtained using cost curves generated for each type of structure. There are inlets, escapes and cross regulators all along the link canal.

1.7 Headworks and reservoirs

The Inchampalli barrage is proposed across river Godavari in Mahadevpurmandal of Jayashankar Bhupalapally district. The latitude and longitude of the proposed structure are 18°37'00" N and 80° 20'00" E. The length of the barrage will be about 688.50m. The crest level is fixed at 76m. The submergence area at FPL is about 9307 ha and the same is mostly confined to the river portion. The link canal will take off from the Inchampalli barrage with FPL of 87.00 m. The barrage is designed for 100 year flood using Gumbel's extreme value distribution.

1.7.1 Intermittent reservoirs

The proposed diversion of 7000 Mm³ will be in monsoon months of June to October and the maximum diversion per day is fixed at 2.2 TMC i.e 62.30 Mm³. This aspect limits the supply period of irrigation water in the initial reach. Hence, existing reservoirs of Nagarjunasagar on river Krishna and Somasila on river Pennar and the Grand Anicut pond on river Cauvery are planned to be utilised as balancing and regulating structures for spanning irrigation supplies to two seasons. The controlling levels and storages of these reservoirs are furnished below.

Principal levels and storages of reservoirs

Controlling level	Nagarjunasagar	Somasila	Grand Anicut
MWL(m)	181.05	101.80	60.84
FRL(m)	179.83	100.58	59.22
MDDL(m)	155.45	82.30	-
DSL(m)	149.05	82.30	57.70 Sill level
Storage at FRL (Mm³)	11560	2208	

1.7.2 Capacities and sufficiency of the balancing reservoirs

The capacities of the intermittent reservoirs are verified using the average ten daily storage data provided by the Central Water Commission (CWC) for the past 10 years. It is found that there is enough space in these reservoirs which can accommodate the releases from the link canal.

1.8 Water planning

The Godavari (Inchampalli) - Cauvery (Grand Anicut) link project is envisaged to provide irrigation, domestic and industrial water supply benefits in the identified new areas and existing commands, in the States of Telangana, Andhra Pradesh and Tamil Nadu.

The abstract of annual irrigation from Godavari (Inchampalli) - Cauvery (Grand Anicut) link project under different command areas is furnished hereunder.

Abstract of annual irrigation and utilisation

Sl. No.	Name of the command area	CCA (ha)	Annual irrigation (ha)
I	Godavari (Inchampalli) - Cauvery (Grand Anicut)		
1	Area under Kakatiya stage II (SRSP)	178055	178055
2	New area under Gottimukkala feeder	80000	80000
3	Area under SLBC feeder	109250	109250
4	Part command under NSRBC	90000	126000
5	New area between Nagarjunasagar and Somasila	168017	168017
6	New area between Somasila and Cauvery	205000	205000
7	Cauvery delta	56700	78250
	Total	887022	944572

1.8.1 New areas proposed enroute the link canal

Efforts are made to identify the command areas using toposheets of 1:50000 scale and Irrigation Atlas of India. The identified command area is proposed to be served through a network of branch canals and direct sluices. The details of the new areas are furnished below for all the alternate link proposals.

Details of new command areas

Sl.No.	Name of the command	CCA/AI (ha)	Quantity (Mm ³)	District benefitted
	Reach I			
1	Gottimukkala feeder	80000	339	Nalgonda
	Reach II			
2	Area between Krishna and Pennar	163015 5002	864 27	Prakasam Nellore

	Total	168017	891	
	Reach III			
3	Streams between Pennar and Palar	33055 18199 31085 12434	159 87 149 60	Nellore Chittoor Tiruvallur Vellore
4	Palar	8386 17558 4760	46 97 26	Tiruvannamalai Kancheepuram Villupuram
5	Streams between Palar and Cauvery	54114 25409	276 129	Villupuram Cuddalore
	Total	205000	1029	
		453017	2259	

1.8.2 Stabilisation of existing commands

There are several project commands all along the link canal which are frequently facing water shortage due to monsoon vagaries, upstream developments and untimely inflows. These areas need to be provided with timely and reliable supplies. The command areas under the SRSP, Srisailam, Nagarjunasagar and Grand Anicut are identified for such stabilization. The saved water, in these existing command systems, due to the stabilization, can be utilized by the respective states in the upstream of these projects.

a) Part command of ongoing SRSP (Kakatiya canal Stage II)

The command area of SRSP Kakatiya stage II is proposed to be stabilized through this link canal to an extent of 178055ha in two parts;

1. Part command under Kakatiya canal Stage II by lift through Kakatiya feeder (56860 ha)
2. Part command under Kakatiya canal Stage II by gravity through link canal (121195 ha)

b) Part command of ongoing SLBC (AMRLIS)

The command area of SLBC that can be stabilized through this link is 109250ha bifurcated on the basis of the topographical convenience.

1. Part command under SLBC by lift of AMRLIS (57946 ha)
2. Part command under SLBC by gravity through link canal (51304 ha)

c) Part command of the existing NSRBC

The requirement of the part command area (90000 ha) of the existing NSRBC is proposed to be met from the link by augmenting Nagarjunasagar reservoir.

d) Part command under Cauvery delta

About 710Mm³(560 Mm³for irrigation and 150 Mm³for M&I use) is planned to be augmented by the link canal in the Cauvery delta benefitting an area of 56700 ha. The details are shown below.

Details of stabilization of command areas of existing projects

Sl.No.	Name of the command	Annual irrigation (ha)	Quantity (Mm ³)	District benefitted
Godavari (Inchampalli) – Cauvery (Grand Anicut)				
Reach I				
1	Kakatiya canal Stage II	48842	208	Warangal
		102991	436	Nalgonda
		26222	111	Khammam
2	SLBC Feeder	109250	629	Nalgonda
	Sub total	287305	1384	
Reach II				
	Part command under NSRBC	126000	846	Guntur
Reach III				
	Part command under Grand Anicut	78250	560	Thanjavur
	Total	491555	2790	

1.8.3 Domestic & industrial water supply

The requirement of water for domestic consumption in the rural and urban areas and for livestock has been computed by projecting the rural and urban human population and livestock population of the proposed command area to 2050 AD and considering their per capita daily requirement at 70, 135 and 50 litres for the rural, urban and livestock population respectively.

The total population as per Census 2011 in the command area has been projected to 2050 AD using compound growth rates as suggested in ‘World Population Prospects-2017 revision’. Out of the total projected population, 50.3% is taken as urban population as indicated in ‘World Urbanization Prospects-2014’. The livestock in the command area as estimated on proportionate area basis from district wise census data of 2012 is projected to

2050 AD assuming a uniform annual compound growth rate of 1%. The estimated total municipal and industrial water needs are furnished below.

Municipal and industrial water needs in the command area						
Name of the link		Domestic Mm³	Industrial Mm³	Total Mm³		Population served (Nos)
Godavari (Inchampalli) Cauvery (Grand Anicut)	–	512	944	1456		14058262

1.8.4 Transmission Losses

The transmission or conveyance losses i.e., the amount of water lost through evaporation and seepage in the link canal in its course from Inchampalli to Grand Anicut have been estimated considering 0.6 cumec per million square metre of wetted area of the canal as per the Bureau of Indian Standard Code. The loss on this account works out to 495Mm³.

1.8.5 Environmental releases

The diversion through the Godavari (Inchampalli) - Cauvery (Grand Anicut) link project is proposed only during the monsoon period. Adequate flows would still be available in river Godavari at Inchampalli downstream the reservoir during this period. Therefore, no provision is made for environmental flow in Godavari river while simulating the transferable quantity at Inchampalli pond.

1.8.6 Water utilization of the link project

The state wise and sector wise water allocation for various uses is furnished below

State wise water use under the link project

Unit: Mm³

Sl. No.	Name of the state	Irrigation			Domestic water supply	Industrial water supply
		New area	Stabilisation	Total		
I	Godavari (Inchampalli) - Cauvery (Grand Anicut) link project					
1	Telangana	339	1384	1723	48	92
2	Andhra Pradesh	1137	846	1983	119	161
3	Tamil Nadu	783	560	1343	345	691
	Total	2259	2790	5049	512	944

1.8.7 Conjunctive use / ground water support

The ground water storage in command area can get recharged through irrigation in the command. Thus, there will be a considerable scope to further intensify the irrigation in the command areas by conjunctive use of the available surface and ground water resources. This may inter alia help in checking the hazards of water logging and soil salinity that may crop up in the command, if better water management practices are not followed. This aspect will be studied in detail during the comprehensive environmental impact assessment (CEIA) studies.

1.9 Power

The power plays crucial role in operation of the link project as about 3845 MU will be required for lifting waters at various locations for irrigating areas enroute. On the other hand, the link project generates hydropower and solar power all along the link canal.

1.9.1 Power requirement

The link canal takes off from the proposed Inchampalli barrage on Godavari. The topography along the link canal necessitates the provision of lifting arrangements at certain places to irrigate the command area. The details are furnished below:

Lifting arrangements on link canal

RD of link canal (km)	Static head (m)	Size and No. of pumps MW x No	Operating head (m)	Power requirement (MU)
Godavari (Inchampalli) - Cauvery (Grand Anicut)				
0.00	57.0	28.9 x 20	59.6	1296
18.0	38.0	21.6 x 20	44.56	970
26.5	23.2	14.4 x 20	29.76	647
60.5	11.0	8.0 x 20	16.56	360
97.50 (SRSP Stage II branch)	52.63	27.7 x 2	57.09	110
199.15 Gottimukkala branch	64.50	32.8 x 2	67.56	90
	58.00	30.8 x 2	63.56	84
	74.00	38.10 x 2	78.56	104
299.30 (SLBC branch)	67.14	32.30 x 2	73.56	69
692.276*				115
Total				3845

*Pumping for varying height of 1 to 2 m during May to October at the exit of the tunnel near Somasila off-take.

1.9.2 Power potential of the link project

It is proposed to construct two powerhouses on the link canal one at the offtake of link canal at Musi reservoir (6 x 10 MW) and the other at the offtake of the link canal from

Nagarjunasagar (4 x 30 MW) similar to one on the NSRBC. The actual annual energy generation will be about 146 MU and 220 MU respectively.

The solar power potential of the 1210.841 km long Godavari (Inchampalli) - Cauvery (Grand Anicut) link project is 10657 MU with the installed capacity of 5328 MW. The benefits from the solar power plants are treated as additional benefits and these are not considered while evaluating the link project for its economic viability.

1.10 Construction programme

The construction of Godavari (Inchampalli) - Cauvery (Grand Anicut) link project is proposed to be completed in 5 years. The year wise schedule is discussed in Chapter 10 Construction programme, manpower and equipment planning.

1.11 Estimates

The cost of Godavari (Inchampalli) - Cauvery (Grand Anicut) link project is estimated under five main components and the total cost of the project at 2020-21 price level is furnished below.

Abstract of cost of the link project			
Sl.No	Unit	Cost component	Amount (Rs lakh)
1	I	Head works	392052
2	II	Conveyance system	6989726
3	III	Hydro power	91621
4	IV	Lifting arrangements	1105926
		Estimated cost of the Project	8579325
5	V	Onfarm development	16911
Total project cost			8596236

Unit I: Head works: Includes the cost of Inchampallibarrage, modification to the existing headworks at Nagarjunasagar and Somasila reservoirs and the head regulators at all the three reservoirs.

Unit II: Conveyance system: Includes the cost of main canal, branch canals, canal structures, tunnels, cross regulators, canal escapes, outfall regulators, feeder canal regulators/direct sluices and distribution systems.

Unit III: Hydro power: Includes the cost of hydro power generation proposed at the off take of link canal from the Musi reservoir and Nagarjunasagar project with an installed capacity of 60 MW and 120 MW respectively.

Unit IV: Lifting arrangements: Includes the cost of pumphouse, pumps, delivery mains, sump, cistern etc.on main canal and branch canals.

Unit V: Onfarm development: Includes the cost of development of new command area proposed under the link canal which is proposed to be served by the feeder canals/direct sluices etc.

1.11.1 Annual costs

The annual cost of the link project is estimated as per the prevailing norms. The details are furnished below.

Annual cost of the link system		
Sl.No	Item	Amount (Rs lakh)
I	Capital cost	
	Estimated cost of the project	8579325
	Onfarm development	16911
	Total cost of the project	8596236
II	Annual costs	
a)	Interest at 10%	859624
b)	Annual O&M command	15523
c)	Depreciation at 1%.	85793
d)	Maintenance of headworks at 1% of cost	3921
e)	Depreciation of pumping system at 8.33% of pumping system	55066
f)	Charges of power	76900
Annual cost		1096827

1.12 Sources of revenue

The benefits from the proposed Godavari (Inchampalli) - Cauvery (Grand Anicut) link canal include revenue from agriculture produce, irrigation service fee, domestic and industrial water supply, power generation, pisciculture, plantations on canal banks, animal husbandry. These are the direct benefits which are regular and expected net benefits due to implementation of the link project. The details are furnished below.

Annual benefits from the link system			
Sl No	Component	Annual benefits (Rs lakh)	Remarks
AI: 944572ha			
1	Irrigation	641493	
2	M&I	607041	
3	Power	14640	
4	Irrigation cess	14169	

5	Pisciculture	53385
6	Animal husbandry	10637
7	Plantations	18425
Total		1359790

Apart from the direct benefits, many indirect benefits would also accrue from the link project leading to tremendous development in all the socio - economic indicators in the region. These indirect benefits could be visualized or quantified in broad perspective only. Employment generation, rising living standards of people, development of agro based industries, market facilities for agricultural inputs like pesticides and fertilizers and produce, enhanced ground water availability in the region, improved communication facilities, increase in industrial activityetcare some of the indirect benefits.

1.13 BenefitCost Ratio (BCR) and Internal Rate of Return (IRR)

The benefit - cost ratio (BCR) of the Godavari (Inchampalli) - Cauvery (Grand Anicut) link is worked out considering the annual cost of the link project and the annual likely benefits from the link project at 2020-21 price level. The economic parameters of various alternatives are furnished below.

Economic parameters of the link system		
Name of the link project	BCR	IRR
Godavari (Inchampalli)	- 1.24	11.90
Cauvery (Grand Anicut)		

1.14 Other aspects

1.14.1 Extended scope of the link project

The nine link system connecting Mahanadi - Godavari - Krishna - Pennar - Cauvery - Gundar - Vaigai is planned to be implemented in two stages. The Godavari (Inchampalli) - Cauvery (Grand Anicut) link project is initiated as a first step in implementation of the peninsular component of the inter basin water transfer. The second phase of Mahanadi - Godavari will be implemented, once the storage and diversion structure at Barmulon river Mahanadi is materialized. In such case, the additional quantity will be transferred from Barmulto Dowlaiswaram, and the saved waters at Polavaram will be transferred to Nagarjunasagar. Keeping this in view, the size of canals between Nagarjunasagar and Grand Anicut is designed to accommodate these additional waters of second phase also.

1.14.2 Agreement among the states

The proposed diversion of 7000 Mm³, out of total water 9191 Mm³ is arrived after considering the part of unutilized waters of Chhattisgarh in Indravati sub-basin of Godavari basin which is about 2978 Mm³under proposed major and medium projects and 1477 Mm³of hydro power losses. In this proposal, the water from Godavari basin is to be transferred to

Krishna, Pennar & Cauvery basins for which no provision is available in the GWDT Award. Hence, concurrence of all the co-basin States of Godavari is required in the present proposal.

1.14.3 Benefits to Chhattisgarh

There is not much arable land available in Chhattisgarh in the vicinity of the proposed Inchampalli barrage. Annaram, Kotturu, Tarlaguda, Rodnila, Kumharnila and Dudheda are some villages in the vicinity of the barrage. The villages that could get benefit will be identified by Government of Chhattisgarh.

1.14.4 Statutory clearances

The detailed project report (DPR) along with the necessary CEIA studies, needs the following clearances by Govt of India and the respective agencies.

Clearances required for the project

Sl. No.	Clearance	Agency
(i)	Techno-economic	Central Water Commission, TAC of Ministry of Jal Shakti.
(ii)	Forest Clearance	Ministry of Environment, Forest and Climate Change (MoEF& CC)
(iii)	Environmental clearance	Ministry of Environment, Forest and Climate Change (MoEF& CC)
(iv)	R & R Plan of Tribal population	Ministry of Tribal Affairs (MoTA)

After obtaining the above clearances, the Detailed Project Report will be submitted to the Ministry of Jal Shakti/NITI Aayog for investment clearance.

1.14.5 Stages / phases of development of the link project

The Godavari (Inchampalli) - Cauvery (Grand Anicut) link project is a multipurpose water resources development project with several integrated components as discussed above. The development of the project can be planned in the following stages in sequence or in parallel.

1. First stage may include irrigation to the existing commands for their stabilization.
2. Second stage may include the new areas after duly developing command area and distributary network.
3. Third stage may include integration of existing infrastructure for domestic and industrial water supply

Integration of existing reservoirs is the prominent feature of this project. In each stage of development, the existing enroute reservoirs play vital role in supplying regulated flow as per the monthly demands. The benefits of the project can be partially accrued right from the completion of first stage of development.

1.14.6 Fitment of the scheme in overall development of the region

Sustainable quantity of water differs as delicate balance between natural resource utilization in irrigation, domestic and industrial sectors, environmental impacts and economics. There are vast tracks of culturable area in Telangana, Andhra Pradesh and Tamil Nadu which need to be brought under irrigation. Further, the commands under existing projects are also denied the reliable supply due to monsoon vagaries. There are abundant flows in Godavari while the flows are diminished year by year in Krishna and Cauvery basins.

Moreover, the over-exploitation in the Krishna basin has led to an increase in hydrological droughts and inter-state conflicts. Farmers are mostly dependent on open wells, tanks and other sources which usually fail during dry years. The usual practice among the farming community is to irrigate the fields through pumping of water which often leads to groundwater depletion. All these factors suggest that a water resources development project like Godavari (Inchampalli) - Cauvery (Grand Anicut) link project is essential to provide the necessary impetus to the irrigation development in southern states.

Epilogue of proliferation of effective Godavari and Krishna river basin management based on quantification models of water resources is a primal solution for envisaging the Godavari - Cauvery river inter linking project. It will try to optimize river water quantity in the co-basin States of Telangana, Andhra Pradesh and Tamil Nadu, while maintaining economic sustainability minimizing utilization of finite natural resources and minimizing impacts on the environment in the co-basin States.

1.15 Organisation of chapters

The detailed project report comprises the following chapters along with annexures and drawings.

1. Introduction
2. Physical features
3. Inter-State aspects
4. Surveys and investigations
5. Hydrology and water Assessment
6. Design aspects
7. Reservoirs and enroute storages
8. Irrigation planning and command area development
9. Power

Executive summary

10. Construction programme, manpower deployment and plant planning
11. Environmental impact assessment and environmental management plan
12. Socio - economic studies, resettlement & rehabilitation
13. Cost estimates
14. Revenues, benefit-cost ratio and IRR
15. Other aspects of the project