

Chapter – 8

Irrigation Planning and Command Area Development

8.0 General

While planning for a major water resources development project, it is essential to ensure proper utilisation of water resources proposed to be conserved in the storage duly accounting for the prioritization of various demands viz. domestic, industrial, irrigation etc.

The main objective of the Godavari (Inchampalli) - Cauvery (Grand Anicut) link project is to transfer surplus waters of Godavari basin at proposed Inchampalli barrage which includes of unused waters of Chhattisgarh in Indravati sub basin to utilize in needy areas of Telangana, Andhra Pradesh and Tamil Nadu States.

The Godavari (Inchampalli) – Cauvery (Grand Anicut) link canal off-takes from the foreshore of the proposed Inchampalli pond by an approach channel of about 10 km long. An initial 55 m static lift (stage – I) is proposed at the end of the approach channel i.e. from where the actual link canal commences at RD 0.00 km with full supply level 141.00 m at the head. The link canal traverses a distance of about 1210.841 km before outfalling into the existing Grand Anicut on Cauvery river. The canal is envisaged to divert 7000Mm³ of surplus waters of Godavari to the deficit areas lying in Krishna, Pennar and Cauvery basins in Telangana, Andhra Pradesh and Tamil Nadu. The link will utilize the existing Nagarjunasagar and Somasila reservoirs enroute as balancing reservoirs for regulated supply of water. The link canal will be supported by number of branch canals /direct sluices to facilitate irrigation of command areas.

8.1 Existing/proposed irrigation facilities in the proposed project command area

The Godavari (Inchampalli) - Cauvery (Grand Anicut) link canal is aligned through Warangal, Khammam and Nalgonda districts of Telanagna, Krishna, Guntur, Prakasam, Nellore and Chittoor districts of Andhra Pradesh

and Tiruvallur, Kancheepuram, Vellore, Tiruvannamalai, Villupuram and Cuddalore districts of Tamil Nadu. The command area proposed en-route the link canal lies in almost all these districts. Presently, the main source of irrigation in the proposed command area under the link project is ground water through open wells, tanks and other sources and releases from the existing projects of Nagarjunasagar, Somasila and Grand Anicut, which are inadequate. Therefore, the command areas under these existing projects are planned to be stabilized through the link canal. The details of some existing irrigation projects in the vicinity of en-route command area of the link canal are given in **Table-8.1**.

Table-8.1
Irrigation facilities from some existing projects in the vicinity of the project area (Godavari – Krishna reach)

Sl. No.	District	Project	GCA (ha)	CCA (ha)	Annual irrigation (ha)	Annual utilization (Mm ³)
Existing Projects						
1.	Khammam	Kinnerasani		4050	4050	42
2		Taliperu	14175	10000	10000	124
3		Dummu gudem LIS/ Sitarama LIS		37106+	33686+	149+
4		Murredu vagu		3000	3000	24
5		Aluguvagu		3021	3021	28
6		Peddavagu		3896	4870	32
7		Kanperu		3262	4078	27
8		Sriramsagar project Stage II	189905	155258	111135	584
9		Wyra		7043	7037	105
10		Munneru	-	4913	6141	41
11		Lanka sagar		2977	2974	28
12.		Palleru	-	12545	7952	113
13		Nagarjuna-sagar LBC	64989	54227	75918	590

14	Nalgonda	Musi	-	14337	6929	266
15.		Asifnagar	-	5060	6170	62
16		Srisailam LBC	43056	26607	26607	186
17.		NSLBC	70974	59221	82909	647
18		SRSP Flood flow	-	-	14165	91
19		SRSP Stage II	42234	34529	24716	130
20		JC Devadula LIS	-	-	116129	499

Source: Water balance studies of NWDA

8.2 Proposed command area under the link canal

The area envisaged for irrigation under the Godavari (Inchampalli) - Cauvery (Grand Anicut) link project is proposed to be irrigated through 30 branch canals and seven direct sluices depending on the quantum of water to be fed from the link canal to individual command areas at different locations.

The total culturable command area under the link project is 887022 ha, of which (i) 367305 ha lies in the initial reach between Godavari (Inchampalli) & Krishna (Nagarjunasagar), (ii) 258017 ha will be in the middle reach between Krishna (Nagarjunasagar) and Pennar (Somasila) (iii) 261700 ha in the last reach between Pennar (Somasila) and Cauvery (Grand Anicut) rivers. The area is proposed to be irrigated with 100% intensity for new areas of 453017 ha and with 138% to 140% intensity of irrigation for stabilization of the existing command areas. In all, the link project provides irrigation to an area of 887022 ha annually.

8.2.1 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 planned keeping in view the locations of command areas along the link canal. The total command area proposed under link project is about 4.53 lakh ha for which about 2259 Mm³ of water is allocated. The details of command area and the canal distribution network viz., the location of each branch/ direct sluices, area that

is likely to be served and the quantum of water supply through each branch/direct sluice in different reaches are furnished in **Table - 8.2**.

Table-8.2 Locations of new command area benefited under various branch canals of the link project

Branch canal	RD on Main canal	Command area (ha)		Supply to the branch (Mm ³)	District
		CCA	AI		
Reach-I: Inchampalli to Nagarjunasagar (299.256 km)					
Gottimukkala	199.15	80000	80000	44	Nalgonda
Reach-II: Nagarjunasagar to Somasila (393.120 km)					
Mangapuram	570.15	9997	9997	53.0	Prakasam
Kellampaly	588.05	24614	24614	130.0	Prakasam
Kuchipudi	599.00	35302	35302	187.0	Prakasam
Kanigiri	631.05	17268	17268	91.0	Prakasam
Chundi	643.55	73943	73943	392.0	Prakasam
Pamur	651.55	1891	1891	10.0	Prakasam
Varikuntapadu	662.20	2173	2173	12.0	Nellore
Narravada	674.12	2829	2829	15.0	Nellore
Reach-III. Somasila to Grand Anicut (518.465 km)					
BC1	758.02	26905	26905	140.6	Nellore
DS1	783.02	1092	1092	5.7	Chittor
DS2	791.55	1285	1285	6.7	Tiruvallur
DS3	797.00	857	857	4.5	Vellore
DS4	799.53	823	823	4.3	Kancheepura m
DS5	806.92	2093	2093	10.9	Tiruvanmalai
BC2	818.35	9755	9755	51.0	Villupuram
BC3	822.65	2963	2963	15.5	Cuddalore
BC4	836.12	3383	3383	17.7	Tiruvallur
DS6	844.32	2098	2098	11.0	
BC5	890.07	27687	27687	869.8	
DS7	909.55	3398	3398	17.8	
BC6	924.60	17763	17763	92.8	

Branch canal	RD on Main canal	Command area (ha)		Supply to the branch (Mm ³)	District
		CCA	AI		
BC7	977.80	12229	12229	79.2	
BC8	989.80	3900	3900	25.3	
BC9	996.48	4486	4486	29.0	
BC10	1001.18	9625	9625	62.3	
BC11	1005.70	4760	4760	30.8	
BC12	1017.70	6016	6016	33.7	
BC13	1018.73	4958	4958	27.8	
BC14	1026.70	2374	2374	13.3	
BC15	1036.11	13055	13055	73.1	
BC16	1048.70	12800	12800	71.7	
BC17	1050.70	4083	4083	22.9	
BC18	1055.07	1204	1204	6.7	
BC19	1066.20	13502	13502	75.6	
BC20	1076.70	8122	8122	45.5	
BC21	1088.48	3785	3785	21.2	
Total		453017	453017		

a) Command area under the proposed Inchampalli right bank canal (IRBC)

The Govt. of erstwhile Andhra Pradesh has proposed to provide irrigation to an extent of 178055 ha in the drought prone Warangal Plateau (48842 ha), Nalgonda (102991 ha) and Khammam (26222 ha) districts by utilizing 684 Mm³ of water through the Kakatiya canal stage –II of Sri Ram Sagar Project stage –II (RD 284.00 to 346.00 km of Kakatiya canal). The Godavari basin upto Sri Ram Sagar Project would be water deficit at the ultimate development scenario which may lead to shortage of water to the command area of Sri Ram Sagar Project. As such, the above command is proposed to be taken over by the Inchampalli – Nagarjunasagar link canal enroute. To facilitate this proposal, a lead canal is proposed for transferring 241 Mm³ of water from the link canal to the Kakatiya canal in order to provide irrigation to an extent of 56860 ha (Warangal district: 28692 ha, Nalgonda district: 28168 ha) which lies to the right of the link canal using its own distributary system as planned by the Irrigation Department, Govt. of

erstwhile Andhra Pradesh. It off-takes from RD 97.50 km of the link canal where its FSL is 204.90 m. After traversing a distance of 21.85 km, it outfalls at RD 260.70 km of the Kakatiya canal (FSL of the Kakatiya canal is 256.15 m) involving a lift of around 55 m. The FSL of lead canal at its out fall point is 256.53 m. The remaining 514 Mm³ of water required for the balance command area of 121195 ha which lies to the left of the link canal pertaining to the Kakatiya canal stage-II (Warangal district: 20150 ha, Nalgonda district: 74823 ha, Khammam district: 26222 ha) would be provided directly from the link canal. District-wise command area benefited under Kakatiya canal stage - II is given below in **Table 8.3**.

Table-8.3
District-wise command area under Kakatiya canal stage-II

S.No	District	Command area (ha)		
		On right side of the link canal	On left side of the link canal	Total
1	Warangal	28692	20150	48842
2	Nalgonda	28168	74823	102991
3	Khammam	-	26222	26222
	Total	56860	121195	178055

The link canal while passing through the enroute command area is crossing three major branch canals of the Kakatiya canal. The particulars of the branch canals are given below in **Table 8.4**.

Table-8.4
Particulars of the Branch Canals

Sl. No.	Name of branch canal, ayacut & length	RD at off-take at Kakatiya canal (km)	Length upto its crossing with link (km)	Particulars of link canal at the crossing		
				RD (km)	FSL (m)	NSL (m)
1	Thallampadu (52409 ha, 71km)	310.02	18.60	162.70	201.70	203.53
2	Chinna Nemulla (22700 ha, 39 km)	334.51	17.40	177.70	200.57	209.02
3	Viblapuram (65969 ha, 72 km)	345.93	19.30	192.70	199.53	221.34

Hence, by utilising the above branch canals and other distributary system as planned by the Irrigation Department, Government of Andhra Pradesh, the command area which lies to the right and left side of the link canal can be irrigated as described above. The crop water requirements for the enroute irrigation under the link project comprising of command area of Kakatiya canal Stage-II, Srisailam LBC and Gottimukkala feeder are given in **Annexure 8.14**. The computations of month-wise gross irrigation requirements based on climatological approach in respect of Kakatiya canal command are given in **Annexures 8.10 & 8.11**. **Plate 8.8** shows the command area of Kakatiya canal Stage -II of Sriramsagar project to be taken over by the diverted waters from the Inchampalli pond through the proposed link canal.

b) Command area under Srisailam left bank canal (SLBC)

The erstwhile Govt. of Andhra Pradesh has proposed to provide irrigation to 109250 ha of endemically drought prone upland areas in Nalgonda district by lifting 743 Mm³ of water from the Nagarjunasagar reservoir through Alimineti Madhava Reddy Lift Irrigation Scheme (AMRLIS). This area has originally been proposed under Srisailam left bank canal. About 72 MW of power is needed to lift the water to a static head of about 67 m to command the area. The water balance status of the Krishna

basin upto Nagarjunasagar dam indicates water deficit of 1525 Mm³ at 75% dependability at the ultimate stage of development as is seen from Chapter – 5 and the deficit is proposed to be partly met from the link canal. In order to economise and effective use, a part of the Nagarjuansagar command area en route the link canal is proposed to be taken over by the link command as the proposed Inchampalli – Nagarjunasagar link canal is passing through this command area. In the present proposal, it is assessed that out of 109250 ha, an extent of 51304 ha that lies to the left side of the proposed link canal spreading between the link canal and the existing NSLB canal could be irrigated en route directly by the link canal by utilising 218 Mm³ of water. The canal distributor network system of the AMRLIS as planned by the Irrigation Department and being executed can be utilized without major modifications to command this area. The balance requirement of 411 Mm³ of water will be lifted from the Nagarjunasagar reservoir utilizing the existing pumping system to cater to the irrigation needs of the balance ayacut of 57946 ha that has been proposed under AMRLIS high level canal. The month-wise gross irrigation requirements based on climatological approach are given in **Annexure 8.12 & 8.13. Plate 8.9** shows the command area of SLBC to be covered by the diverted waters from the Inchampalli pond.

c) Command area under Gottimukkala feeder branch

Govt. of Telangana has proposed with NWDA to consider providing irrigation to new areas in the water short Nalgonda district from the link. Accordingly, a feeder canal is proposed to take off from the existing Musi reservoir upto ongoing Gottimukkala project to irrigate a new upland area of about 80000 ha situated at about 392 m. The feeder canal will be about 116 km and the lift involved would be 196.5 m which will be executed in three stages of 64.5 m, 58 m & 74 m at RDs 0.00 km, 75 km & 95 km of the feeder respectively. The annual utilization in the proposed command would be 339 Mm³. The computation of month-wise gross irrigation requirements based on climatological approach are given in **Annexure 8.14. Plate 8.3** shows the command area envisaged under Gottimukkala feeder.

The district-wise area benefitted under the Reach-I of the link canal is given below.

District-wise area benefitted under the link canal

S.No.	District	Ayacut benefitted (ha)
1	Warangal	48842
2	Nalgonda	292241
3	Khammam	26222
	Total	367305

d) New area between Nagarjunasagar and Somasila

The 1: 25000 scale toposheets with contours at 5 m interval of the command area prepared and supplied by the Survey of India were used for the purpose of identifying the command area. Considering the ground elevation available on these maps, the branch canals network was drawn with the branch canals/distributaries running mostly along the ridges between the local streams, with their commands on both the sides extending upto the streams, which in turn form the exterior boundaries of the command under each of the branches. The layout of the branch canals/distributaries so finalised was then transposed to the land irrigability maps of the same area in 1:50000 scale prepared and supplied by the NRSC. The irrigable area under each of the branch canals was then measured by planimeter on the NRSC maps. The areas under each of the branches so measured were adjusted to match with the gross irrigable area of 2.03 lakh ha (given by NRSC) in the entire command area, so as to finally arrive at the branch-wise irrigable areas. After deducting the forest, scrub and barren land, the net irrigable area is determined to be 168017 ha.

The prevailing cropping pattern in the region is judiciously adopted and the irrigation intensity is kept at 100%. The crop water requirements are worked out on climatological basis considering the IMD observatories at Ongole and Nellore. The annual utilization works out to 891 Mm³.

In all, the total command area between Nagarjunasagar and Somasila is divided into 8 branch canals and branch-wise CCA & AI are given in **Table 8.2**. The command area is shown in **Plate 8.4 to Plate 8.6**.

e) **New area between Pennar and Cauvery**

Keeping in view the needs of the intermittent sub catchments, the command area between Pennar and Cauvery has been sub divided into the following three parts.

1. New areas in Pennar and streams between Pennar and Palar
2. New areas in Palar basin
3. New areas between Palar and Cauvery

The 1: 50000 scale toposheets with contours at 20 m interval of the command area prepared and supplied by the Survey of India were used for the purpose. In the initial reach, as the Kandaleru Flood Flow Canal is running closer to the proposed link canal, one branch canal is proposed at RD 758.02 km for irrigating areas in Pennar delta sub basin. Further, the Kandaleru - Poondi Canal is running close to the proposed canal alignment and hence, 7 direct sluices are provided in those areas for irrigating isolated patches between RD 783 km to RD 844 km. Considering the information on ground elevation available in these maps, a net work of branch canals was drawn with the branch canals/distributaries aligned mostly along the ridges between the local streams, with their commands on both the sides extending upto the streams, which in turn form the exterior boundaries of the command under each of the branches. The layout of the branch canals/ distributaries so finalised was then transposed on to the land irrigability maps of the same area in 1:50000 scale. The CCA under each of the branch canals was planimetered and then worked out proportionately based on the land use statistics. The areas under each of the branches so measured were adjusted to match with the gross command area of 840218 ha after deducting the forest land. The culturable command area is identified to be about 599010 ha. Out of this, however, an area of 205000 ha is proposed for irrigation under the link canal with 100% intensity of irrigation. The annual water utilisation works out to 1142 Mm³.

In all, the total command area between Pennar and Cauvery is divided into area under 7 direct sluices and 21 branch canals and branch-wise irrigable areas are given in **Table 8.2**. The command area is shown in **Plate 8.7 (1/4 to 4/4)**.

8.2.2 Stabilization of existing commands

There are several existing commands all along the 1211 km long link canal which are frequently facing water shortage due to monsoon vagaries and upstream developments. These areas need to be assured with timely and reliable water supplies. The command areas under the Nagarjunasagar, Somasila and Grand Anicut projects are identified for such stabilization. The saved water, in these existing command systems, if any, on account to stabilization, can be utilized by the respective States in the upstream catchments of these projects.

a) Part command under NSLBC

The link canal crosses the Godavari - Krishna ridge through 12.50 km long twin tunnels, each of dia 14m from RD 107.60 to 120.10 km. The link canal crosses the existing NSLBC at about RD 121 km, immediately after the tunnel. The areas under NSLBC are planned to be supplied water enroute the link canal as far as possible, instead of transferring water to Nagarjunasagar and then releasing the same from reservoir into NSLBC. This will also reduce link canal size and the power requirement for lifting the waters to Nagarjunasagar.

Accordingly, the command area of NSLBC that can be irrigated through this link is trifurcated on the basis of the topographical convenience.

1. Part command under NSLBC by gravity enroute
2. Part command under NSLBC by lift enroute
3. Part command under NSLBC by gravity from Nagarjunasagar

Part command under NSLBC by gravity

About 79440 ha of CCA is considered for stabilization by link canal, under NSLBC by gravity. This is out of the command area of 136961 ha, available from the tunnel exit to Nagarjunasagar reservoir along the link canal, which comprises part block Nos. 1, 4, 5, 10, 14, 20 & 21/5 and the full block Nos. 13, 16, 21/6, 21/7, 21/8, 21/9, 21/10A, 21/10B and 21/11. The intensity of irrigation is kept intact at 140% as envisaged in the

Nagarjunasagar Project report. The annual irrigation will be 111216 ha and annual utilization works out to 701 Mm³.

Part command under NSLBC by lift

About 56660 ha of CCA is considered for stabilization, by the link canal under NSLBC, by lift through NSLBC Feeder branch, proposed at RD 105 km from link canal. This is out of the second part of 100975 ha available between meeting point of link canal & NSLBC and the terminal point of NSLBC, i.e Tammileru. A lift of about 30m is proposed at RD 105 km to feed the NSLBC Feeder branch that runs for about 50 km and joins NSLBC. The intensity of irrigation is kept intact at 140%. The annual irrigation will be 79324 ha and the annual utilization works out to 500 Mm³.

The above two commands will be served by link canal enroute during kharif season and their rabi season requirement will be served directly from the Nagarjunasagar reservoir through releases into NSLBC.

Part command under NSLBC by gravity from Nagarjunasagar reservoir

About 33996 ha of CCA is considered for stabilization by link canal, under NSLBC by gravity through releases from the Nagarjunasagar reservoir into NSLBC. The intensity of irrigation is kept intact at 140%. The annual irrigation will be 47595 ha and the annual utilization works out to 300 Mm³.

Thus, the total CCA under NSLBC proposed to be covered from the link canal works out to 170096 ha. The water requirements for 238135 ha considering a delta of 0.63m and 140% irrigation intensity works out to 1501 Mm³ for the above three parts of the NSLBC command. The command area under the NSLBC is shown at **Plate 8.1**.

b) Part command under NSRBC

The requirement of the part command area of about 90000 ha of the existing NSRBC is proposed to be met from link canal. Adopting the net delta of 0.57 m worked out by climatological approach considering the designed cropping pattern of NSRBC and annual intensity of irrigation as 140%, the

annual irrigation would be 126000 ha and the annual water utilisation of this part command works out to 846 Mm³. The command area under the NSRBC is shown at **Plate 8.2**.

c) Part command under Cauvery delta

Based on the request of Govt. of Tamil Nadu, The Cauvery Water Disputes Tribunal (CWDT) ordered the tentative deliveries during a normal year to be made available by the State of Karnataka at the inter State contact point presently identified as Billigundulu gauge and discharge station located on common border as furnished in **Table 8.5**.

**Table 8.5 Monthly stipulation as per CWDT
at the inter State contact point**

Sl.No.	Month	Allocation in	
		Mm ³	TMC
1.	June	283.17	10
2.	July	962.77	34
3.	August	1414.84	50
4.	September	1132.67	40
5.	October	622.97	22
6.	November	424.75	15
7.	December	226.53	8
8.	January	84.95	3
9.	February	70.79	2.5
10.	March	70.79	2.5
11.	April	70.79	2.5
12.	May	70.79	2.5
	Total	5436.81	192

The above quantum of 192 TMC of water comprises of 182 TMC for the allocated share of Tamil Nadu and 10 TMC of water allocated for environmental purposes. The above monthly releases shall be broken in 10 daily intervals by the regulating authority.

Keeping in view the above requirements and the stressed water scenario in almost every season in Cauvery basin, it is proposed to augment the water availability at Grand Anicut through the link project. The link project will take over a CCA of about 56700 ha in Cauvery delta. The annual irrigation will be about 78250 ha and with 0.72m delta (as normally applicable for major project commands), the water requirement would be 560 Mm³. In addition, about 150 Mm³ of water would be released to meet the municipal and industrial water needs in Cauvery delta. The present application of water at 1.0 m in Cauvery delta has to be optimised adopting efficient irrigated agricultural projects in view of water deficit in the basin which is being met through transfer of water from the distant source on Godavari involving even lifting of water. Accordingly, the delta has been optimised to 0.72m for irrigation in Cauvery delta.

8.2.3 Net increase in irrigation facilities due to the link project

The Godavari (Inchampalli) - Cauvery (Grand Anicut) link project envisages to bring new areas under irrigation enroute the link canal. Further, stabilization of existing project commands is contemplated from the link project. In exchange, new areas in the upstream of these commands/projects can be covered under irrigation by the respective State governments. Therefore, the net increase in irrigation facilities due to the link project will be its CCA of 887022 ha out of which about 453017 ha is totally its new command. Reach wise benefitted areas and their water requirements are discussed in the subsequent paras.

8.3 Existing cropping pattern

8.3.1 Existing area under rainfed cultivation

The district wise details of the rainfed cultivated area in the proposed command area of all the districts have been collected from Bureau of Economics and Statistics of the respective States.

Rainfall during monsoon

Based on the IMD Publication 'Climatological Normals (1981-2010), the monthly maximum, minimum and normal rainfall during the monsoon period (June to October) in the districts of the proposed command areas is

furnished in **Annexure 8.1**. The monsoon normal rainfall in and around the command varies from 588 mm to 887 mm.

Rainfall during non-monsoon

Based on the IMD Publication ‘Climatological Normals (1981-2010), the monthly maximum, minimum and normal rainfall during the non-monsoon period in the districts of the proposed command areas is given in **Annexure 8.2**. The non-monsoon normal rainfall in and around the command varies from 86 mm to 717 mm.

8.3.2 Existing area under irrigation

The district wise details of the area under irrigation for all the districts falling in the proposed command area have been collected from Bureau of Economics and Statistics of the respective States.

8.3.3 Source wise irrigation

The district wise details of the source wise irrigation for all the districts falling in the proposed command area have been collected from Bureau of Economics and Statistics of the respective States.

8.4 Soil surveys

8.4.1 Soil capability classification

The detailed soil surveys are not carried out for the first reach between Godavari and Krishna. However, the command area considered in this reach is either under an existing irrigation system or planned under a proposed project by Telangana State Govt. for which soil surveys might have already been carried out. Hence, these surveys may not be required at this stage.

The soil classification has been carried out by NRSC, Hyderabad for the new areas between Krishna and Pennar. In case of the reach between Pennar and Cauvery, the details furnished in the soil survey reports prepared by Soil Survey & Landuse Organisation, Department of Agriculture, Govt. of Tamil Nadu on the land irrigability are considered.

Table 8.6 Soil capability classification

Sl.No.	Category	Area (lakh ha)
A	Godavari – Krishna reach	Notified command areas
B	Krishna - Pennar reach	
1	Area of land with moderate limitations for sustained use under irrigation	2.03
2	Area of land with moderate to severe limitation for sustained use under irrigation	1.43
3	Area of land with severe to very severe limitation for sustained use under irrigation	0.30
	Sub-total	3.76
C	Pennar - Somasila reach	
1	Area of land with moderate limitation for sustained use under irrigation	4.62
2	Area of land with moderate to severe limitation for sustained use under irrigation	3.44
3	Area of land with severe to very severe limitation for sustained use under irrigation	0.34
	Sub-total	8.40

8.4.2 Land Irrigability Classification

Soil suitability for irrigation depicts the differentiation of the soils into different classes based on the limitations of physical soil and land properties. Among Land Irrigability classes, Class 1 to Class 4 come under ‘Irrigable Land class’, Land under Class 5 is ‘temporarily non-irrigable’ (further investigations needed) and Class 6 is ‘land not suitable for irrigation’. The soils belonging to Soil Irrigability Classes from A to D come under Irrigable Land class, while Class ‘E’ is not suitable for irrigation. The lands having slopes less than 10% and depth of water table more than 1.5 m come under Irrigable Land class. The soils of texture “Sandy loam to clay loam” come under Soil Irrigability class “A”. The soils of texture “Loamy sand and clay” come under Soil irrigability class “B”. The soils of texture “Sand and clay” come under Soil irrigability classes “C&D”. As slope of the land in the proposed command area is mostly less than 5% and ground water depth is

more than 1.5 m, the area can be put under irrigation without any major constraints.

8.5 Agro-climatic conditions

The agro climatic conditions influence the cropping pattern to be adopted and the crop water requirements in the command area.

8.5.1 Rainfall

The rainfall in and around the command area varies from 1399 mm to 745 mm. The monthly normal rainfalls of IMD observatories (1981-2010) in the vicinity of the command area are furnished in **Annexure 8.3**.

8.5.2 Temperature

The annual mean maximum temperature varies between 36.9 °C to 44.9 °C while the annual mean minimum temperature varies between 18.2 °C to 11.9 °C in and around the command area. **Annexure 8.4** gives the monthly normal maximum and minimum temperature data (1981-2010) of IMD observatories in the vicinity of the command area.

8.5.3 Humidity

The annual mean relative humidity varies between 80% and 49% in and around the command area. **Annexure 8.5** gives the monthly relative humidity observed at 08:30 hrs and 17:30 hrs at various IMD observatories in the vicinity of the command area.

8.5.4 Sunshine

As is typical with peninsular India, the project area is endowed with mostly sunny weather. There will be sunshine throughout the year, its intensity varying from mild in winter to severe in summer. July is the cloudiest month in almost all the districts with little sunshine.

8.5.5 Wind Velocity

The annual mean wind speed varies between 8.1 and 2.6 km/hr in and around the command area. The maximum wind speed recorded is about 10.2 km/hr during June. **Annexure 8.6** gives the monthly mean wind speed of various IMD observatories in the vicinity of the command area.

8.5.6 Evaporation

The potential evapo-transpiration of different IMD stations in and around command area is furnished in **Annexure 8.7**. The annual potential evapo-transpiration varies between 2032 mm and 1518 mm in the region. The PET values of these stations have been used for assessment of crop water requirements in the command area of the link project.

8.5.7 Cloud cover

The annual mean cloud cover varies between 5.1 and 2.2 oktas in and around the command area. **Annexure 8.8** gives the monthly cloud amounts (in oktas) observed at various IMD observatories at 0830 hrs and 1730 hrs in the vicinity of the command area.

8.5.8 Frost free days

Generally, this region does not experience any frost conditions.

8.6 Proposed cropping pattern

8.6.1 Approved cropping pattern

The feasibility reports of the three components of the Godavari (Inchampalli) - Cauvery (Grand Anicut) link project were earlier circulated to all the concerned States and organizations. Observations were received from various States and organizations for which clarifications were sent. There have not been any observations on the cropping patterns adopted in these reports. Hence, the same have been considered for the proposed new commands in the present report in anticipation of approved cropping patterns from the respective State Agriculture Authorities. The cropping pattern spanned over four crop seasons viz. perennial, two seasonal, kharif and rabi. For existing

commands, the cropping patterns as available in the respective project reports are considered.

8.6.2 Cropping pattern adopted under the link project

The suggested cropping pattern for each of the districts under the project command area is arrived at, more or less on the same lines of the cropping pattern adopted in the respective feasibility reports. An intensity of irrigation of 100% is considered in the new command area of the link project with a view to provide benefits to as much new areas as possible. The intensity of irrigation of the existing commands is kept intact as per the respective project reports. Mostly, the irrigated dry crops are preferred to the high water consuming crops in the spirit of extensive irrigation (rather than intensive irrigation).

8.6.3 Proposed irrigation facilities

The abstract of annual irrigation and utilisation from Godavari (Inchampalli) - Cauvery (Grand Anicut) link project under different command areas is furnished in **Table-8.7**.

Table-8.7
Abstract of annual irrigation and utilisation from the link canal

Sl. No.	Name of the command area	Annual irrigation (ha)	Annual utilisation (Mm ³)
1	Area under Kakatiya stage II (SRSP)	178055	755
2	New area under Gottimukkala feeder	80000	339
3	Area under SLBC feeder	109250	629
4	Part command under NSRBC	126000	846
5	New area between Nagarjunasagar and Somasila	168017	891
6	New area between Somasila and Cauvery	205000	1029
7	Cauvery delta	78250	560
	Total	944572	5049

8.6.4 Scope for double & multiple cropping pattern and change in cropping pattern

As the soils in the command area are mainly red soils medium to heavy in texture, no limitations are anticipated for adopting double and multiple cropping patterns in the proposed command area as far as soils are concerned. In the present project proposal, double and multiple cropping pattern is planned spanned over four crop seasons.

In light of suitable fertile soils associated with favourable agro-climatic conditions in the proposed command area, double and multiple cropping patterns are feasible.

8.6.5 Attitude of farmers towards modern irrigated agricultural practices

As the farmers in the command area will get assured irrigation through the link canal which improves their socio-economic status, most of the farmers may support and adopt modern irrigated agricultural practices, so as to derive maximum benefits.

8.7 Water planning

Water resources development projects should as far as possible be planned and developed as multi-purpose projects. Irrigation and multi-purpose projects should invariably include a drinking water component. Drinking water needs of human beings and animals should be the first choice on any available water resource. Also, the project should be able to cater to the industrial water supply in the region, wherever possible. The Godavari (Inchampalli) - Cauvery (Grand Anicut) link project is conceived as a multi-purpose project envisaging irrigation, domestic and industrial water supply benefits in its command area.

The water availability studies at the proposed Inchampalli barrage revealed that about 7000 Mm³ of water can be diverted through the link canal. Hence, based on the mean daily flows, it is proposed to transfer a maximum

quantity of 62.30 Mm³ (2.2 TMC) daily from mid June to October spanning over a period of 143 days through the proposed Godavari (Inchampalli) - Cauvery (Grand Anicut) link project to meet the enroute irrigation, domestic and industrial water supply requirements in the proposed as well as the existing command areas.

8.7.1 Irrigation water requirement

The annual crop water requirement for each crop under the proposed command area has been computed adopting Modified Penman's method. Potential Evapotranspiration and normal rainfall data of eight IMD observatories in the vicinity of the command area has been considered for working out the crop water needs in the command. The command area of the link project is spread in three States of Telangana, Andhra Pradesh and Tamil Nadu. The command area is falling in Warangal, Khammam, Nalgonda districts of Telangana; Guntur, Prakasam, Nellore, Chittoor districts of Andhra Pradesh; Tiruvallur, Kancheepuram, Vellore, Tiruvannamalai, Villupuram, Cuddalore and Thanjavur districts of Tamil Nadu.

The data of the nearest IMD station to the command area in each district as detailed below in **Table-8.8** is used for working out the crop water requirements.

Table-8.8
IMD Observatories for working out the crop water needs in the newly proposed command area

Sl. No.	Name of the command	Command area (ha)	IMD Observatory
1	NSLBC feeder command	80000	Hanamkonda & Khammam
2	New area between Nagarjunasagar and Somasila	168017	Ongole, Nellore Cuddapah
3	New area in the basins of Pennar and streams between Pennar and Palar	100000	Nellore
4	New area in Palar basin	35000	Tirupati
5	New area in the basin of streams between Palar and Cauvery	70000	Bengaluru, Chennai
	Total	453017	

The intensity of irrigation is considered as 100% for the new areas while keeping the designed intensity of irrigation for the existing command areas. The crop calendars and crop coefficients of various proposed crops are considered as adopted in the feasibility studies. For additional crops, the same are considered as prevalent in the area or judiciously derived from the available information.

Pipe distribution network is proposed in the command area under each command for which a conveyance efficiency of 95% is adopted. Field application efficiency of 80% for all the crops is considered as per the latest norms for overall efficiency approved by the Task Force on ILR and being adopted in NWDA. Thus, the gross irrigation requirement of each crop in the command area is worked out adopting a combined efficiency of 76% (0.95×0.80). Detailed computations of crop water requirements (IMD observatory) in the command area of the link project are presented in **Annexures 8.9**. The computation of branch canal wise GIR are furnished in **Annexures 8.10 to 8.15**. The details of district wise irrigation water requirement in the command area are given below in **Table 8.9**.

Table 8.9
Irrigation water requirement in the command area

Sl. No.	State/ district	Culturable command area (ha)	Annual irrigation (ha)	Water requirement (Mm ³)
	Telangana			
1	Warangal	48842	48842	207
2	Khammam	26222	26222	111
3	Nalgonda	292241	292241	1405
	Sub total	367305	367305	1723
	Andhra Pradesh			
1	Guntur	90000	126000	846
2	Prakasam	163015	163015	864
3	Nellore	38057	38057	186
4	Chittoor	18199	18199	87
	Sub total	309271	345271	1983

	Tamil Nadu			
1	Tiruvallur	31085	31085	149
2	Kancheepuram	17558	17558	97
3	Vellore	12434	12434	60
4	Thiruvannamalai	8386	8386	46
5	Villupuram	58874	58874	302
6	Cuddalore	25409	25409	129
7	Thanjavur	56700	78250	560
	Sub total	210446	231996	1343
	Total	887022	944572	5049

8.7.2 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 the per capita daily requirement of 70, 135 and 50 litre for the rural, urban and livestock population respectively.

The district-wise population from Census 2011 is used for computing the total population lying in the command area on proportionate area basis. The total population 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 existing urban population is deducted from the projected urban population presuming that its domestic requirement is already being met from the existing sources and the remaining urban population only is considered for working out the urban domestic requirement to be provided from the link canal. The total livestock in the command area is estimated on proportionate area basis from district wise census data of 2012 and it is projected to 2050 AD assuming a uniform annual compound growth rate of 1%. The total human population to be served by 2050 will be 14058262, of which 9091631 will be urban and 4966631 will be rural. The total livestock population that is likely to be served by 2050 will be 3814444. The population likely to be benefitted from domestic water supply in NSRBC and Cauvery delta

command areas is worked out proportionately from the estimated population and quantity of domestic water in the respective reaches.

The water requirement of entire urban and 50% of the rural population is proposed to be met from the surface water resources. The domestic & industrial surface water requirement in reach-I i.e. from Inchampalli to Nagarjunasagar works out to 140 Mm³, while the same in the enroute new command between Nagarjunasagar and Somasila (reach-II) and between Somasila and Grand Anicut (reach-III) works out to 218 Mm³ and 1098 Mm³ respectively. This includes 202 Mm³ and 500 Mm³ for domestic and industrial use for Chennai. The details are furnished in **Annexure 8.19 & 8.20**. Thus, the total municipal & industrial water requirement under the link project is worked out to be 1456 Mm³.

8.7.3 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 barrage to Grand Anicut have been estimated considering about 7 percent of the total utilization based on the estimated losses in various studies in the past 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 495 Mm³.

8.7.4 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 downstream the Inchampalli barrage during this period. From the simulation studies, it is seen that the spills during the monsoon at 75% dependability would be of the order of 990 Mm³, which is about 19% of the 75% dependable yield of 5244 Mm³ at Inchampalli. Therefore, no additional provision is made for environmental flow in Godavari river in the simulation studies for the transferable quantity at Inchampalli barrage.

8.7.5 Evaporation losses

The proposed diversion structure is a barrage at Inchampalli barrage with just 450 Mm³ of storage. In the simulation studies, it is considered that the entire storage would be lost each year during monsoon and during post monsoon for downstream releases. As such, no specific provision towards evaporation losses at the barrage site is made.

8.7.6 Total water demands of the link project

The month-wise distribution pattern of various demands from the link canal is shown in **Annexure 8.21**. The water allocation for various uses is furnished in **Table-8.10**.

Table-8.10

Water allocation for various uses under the link canal Unit: Mm³

Sl. No.	Description	Utilisation
1.	Irrigation needs	5049
2.	Domestic & industrial needs	1456
3.	Transmission losses	495
	Total	7000

8.7.7 Designed head discharge of the link canal

The capacities of the link canal at the off-take point of Inchampallibarrage and at the head of each branch canal/direct sluice along the link alignment are worked out based on the supplementation to the command areas. The cut-off Statement is provided in Chapter 6: Design aspects. The designed head discharge of the link canal is 721 cumec corresponding to the planned peak daily transfer. Since the link diversion is planned mostly from the monsoon spills, and not according to the actual demand pattern of the command areas, the 10% additional capacity towards rush irrigation is not considered necessary for the link canal in its course from Inchampalli barrage to Nagarjunasagar. However, additional 10% capacity is considered beyond Nagarjnasagar where the operation of reservoirs is according to the monthly demands of the command areas.

8.7.8 Ground water

The proposed command area of the link canal lies in districts of Warangal, Khammam and Nalgonda of Telangana, Krishna, Guntur, Prakasam, Nellore and Chittoor of Andhra Pradesh, Tiruvallur, Kancheepuram, Vellore, Thiruvannamalai, Villupuram, Cuddalore and Thanjavur of Tamil Nadu. The groundwater quality in the command area is good and suitable for drinking and irrigation purpose. Overall, the level of groundwater development in the proposed command area of the link project can be categorized as “Safe”.

8.7.9 Conjunctive use / Ground water support

In order to make an economic and efficient use of available water resources, it is essential that a judicious mix of surface and ground water are resorted to for irrigation and other purposes. The Godavari (Inchampalli) – Cauvery (Grand Anicut) link project will provide water for irrigation to the extent of 5049 Mm³ through various branch canals. The ground water storage in command area can get recharged through irrigation in the command. Thus, there will be a considerable scope to further extend 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.

In the present planning of the link project, however, no use of ground water is proposed in the command area. The available ground water resource can be considered for utilization in future for further intensification extension or augmentation of the irrigation facilities in the enroute commands, particularly to meet the irrigation requirement during the lean season.

8.8 Command area drainage

The command area en-route the link canal is drained by a network of rivers and streams and their tributaries. The commands have quite good draining facilities. However, with the introduction of irrigation, as the command area gets developed, drainage problem may crop up in the course of time despite adoption of pipe distribution system and preference for micro

irrigation in the command. Suitable provision is, therefore, made in the project estimate towards chalk and collecting drains in the command area.

8.9 Water course / field channels

These are small channels to deliver water to each and every field in the command area of an outlet which is approximately 40 ha for a delivery system of one cusec. Capacity of a water course depends upon (a) water allowance (b) running period of outlet and (c) area to be irrigated.

Branch canals/ direct sluices from the link canal, pipe distribution system to the field outlets, water courses /field channels etc., are planned and designed to facilitate in carrying water from the link canal upto the tail end as well as within the commands. The rate per hectare is considered based on the prevalent norms in the State and the total cost of U-Pipe Distribution system and V-Water courses/field channels in the whole command area of the link project has been arrived.

The estimated cost/ha of CCA considered at Rs 0.50 lakh/- (price level 2018-19), inclusive that of U- Pipe Distribution system and V-Water courses/field channels.

8.10 Water management

Maximum gains in water use efficiency can only be made when these are combined with better water management practices. Keeping this concept in view, the Government of India is focusing on covering maximum possible command area through pipe distribution network to ensure that irrigation water is delivered timely and equitably in the command area and that it be used efficiently preferably under micro irrigation through Participatory Irrigation Management (PIM). Where Water User Associations / Irrigation Co-Operatives maintain the canal network and field channels, it helps in proper distribution among all stake holders their fair and just share of water. Rehabilitation of existing canal network through stakeholders' participation to make water available to tail-enders is given priority.

8.10.1 Proposals for participatory irrigation management including formation of water users association

The Government of India is focusing to involve beneficiaries and stakeholders in irrigation management through various State Govts.

The role of water users' association shall be

- to collect, check and either sanction or reject partly or fully water applications or water indents of members based on criteria prescribed
- to prepare detailed water distribution programme or rotational water supply of members before every rotation and ensure volumetric supply to all the members as per their entitlement;
- to maintain rotation wise or season wise Water Account in the prescribed form to remit to the canal officer, the water charges within the prescribed period against the bills received from the canal officer
- to regulate and monitor water distribution to the members;
- to assess water charges for the members and send bills in the prescribed form;
- to collect prescribed service charges for operation and maintenance
- to carry out annual maintenance and repairs to canal system falling under its jurisdiction;
- to resolve disputes, if any, amongst the members;

The same practices can be adopted in case of the link project.

8.10.2 Scope of introduction of modern technology viz sprinklers, drip Irrigation etc.

The pipe distribution network and micro irrigation is being promoted by various States these days. Drip irrigation is being promoted, especially for sugarcane, to manage the water demand with limited water available. Thus, there is adequate scope for introduction of sprinkler and drip irrigation systems in the command area.

8.10.3 Existing practice of department of agriculture for popularizing micro irrigation

Micro irrigation systems are being encouraged for efficient use of water to increase the irrigated area by the State Governments. The States give subsidy to small & marginal farmers as well as other farmers for purchase of sprinkler and drip irrigation equipments. Similar policy can be adopted for link project.

8.10.4 Facilities for training

Adequate training facilities are available to the farmers. With latest technology like television and mobile phones available in each house, farmers get to know about the latest developments in the agricultural field level practices as well as about Government schemes, subsidies etc. Training to the farmers at their native villages can be imparted on various crops suitable in area specific agro climatic zone and also on pressurized irrigation practices.

8.10.5 Existing extension activity and proposals for its improvement

Various schemes are being implemented to improve performance in agriculture in the States which include National Mission on Agriculture Extension & Technology. The State Governments provide training and extension services to educate the farmers about the use of modern agriculture technology and counseling them on soil health, organic farming, inputs, irrigation etc.

8.11 Agricultural support services

8.11.1 Agricultural marketing

The State Governments are focusing on activities such as keeping necessary coordination in working of various market committees, development & promotional activities of Agriculture Produce Marketing Committee (APMC), establishment of agro-export zones, horticultural training centres and grading & packing facilities, etc.

8.11.2 Development of horticulture

The National Horticulture Mission (NHM) has been launched with the main objective of increasing the area & productivity under horticulture and also to promote post-harvest management. States have established appropriate organizational entities to implement schemes of NHM and National Medicinal Plants Board (NMPB).

8.11.3 Organic farming

For promotion of organic farming, various activities like providing guidance, getting certification, marketing of the organic farm products are included in the National Mission on Sustainable Agriculture (NMSA). “Paramparagat Krishi Vikas Yojana (PKVY)” is an elaborated component of Soil Health Management (SHM) of NMSA. Under PKVY, organic farming is promoted through adoption of organic village by cluster approach and PGS certification.

8.11.4 Minimum support price

To make the agricultural activity viable as well as to protect the farmers' economy from natural calamities and low prices offered by traders, Govt. of India declares Minimum Support Price (MSP) for selected crops. Under this scheme, procurement in the States is undertaken by the National Agricultural Co-operative Federation and State level Marketing Federation/Corporations.

8.11.5 Crop insurance

The crop insurance schemes are useful to overcome the uncertainties in agriculture. Under the National Agricultural Insurance Scheme (NAIS), 16 kharif and eight rabi crops are covered. The GoI is also aiming to cover about 50 per cent of farmers in the country in the next 2-3 years through its ambitious crop insurance scheme viz. ‘Prime Minister Fasal Bima Yojana’.

8.11.6 Agricultural credit

Agricultural credit is one of the key inputs for improving production & productivity and reducing farmers' distress. Financial assistance is provided to farmers by way of short-term loans, credit, etc. by government through various banks and co-operative agencies. The loans are disbursed through Commercial Banks (CB), Regional Rural Banks (RRB), State Co-operative Bank (MSCB), District Central Co-operative Banks (DCCB) and Land Development Banks (LDB).

The financial institutions directly associated with agricultural finance at grass root level in the State are Primary Agricultural Credit Co-operative Societies (PACS) which provide short-term crop loans to their cultivator members.

8.11.7 Use of improved seeds

The GoI has fixed seed replacement targets of 35 per cent for self pollinated crops (like paddy, wheat, tur, moong, udid, etc.), 50 per cent for cross pollinated crops (like maize, jowar, bajra, sunflower, etc.) and 100 per cent for hybrid crops.

8.11 Command Area

8.12.1 Location

The Command area proposed under Godavari (Inchampalli) _ Cauvery (Grand Anicut) link project lies in the States of Telangana, Andhra Pradesh and Tamil Nadu. The command area under the link canal is covered in three reaches. viz. i) Command Area lying in Inchampalli barrage to Nagarjunasagar reach, ii) Command Area lying in Nagarjunasagar to Somasila reach and iii) Command Area lying in Somasila to Grand Anicut reach. The culturable command area (CCA) of the link project is 887022 ha. The reach/district wise command area details are given in **Annexure 8.20**. Abstract of District wise break-up of the command area is given at **Table-8.9**.

8.12.2 Classification of Land (Forest, Grass Land, Cultivable Land, Cultivable Waste, Barren Land)

The newly proposed command area is about 4.53 lakh ha all along the alignment. The command area was measured from toposheets of scale 1:50000 of Survey of India (SOI). Thematic mapping of the proposed command area in the Nagarjunasagar – Somasila reach was got done through NRSC, Hyderabad during the feasibility study. Sample surveys in small patches of the command area are surveyed to design distributary net work and to find the cost of command area development were also carried out. It is observed that most of the command area is cultivable land.

8.12.3 Size of Land Holding

Agriculture is the main occupation of the people in the command area. The number and area of land holding by size group in the en-route command area in respect of the three reaches of the link project is given in **Table-8.11**.

Table-8.11 Land Holdings in the En-route Command Area Unit: %

Sl.no	Category	Land holdings (ha)	Godavari – Krishna	Krishna - Pennar	Pennar - Cauvery
1	Marginal	Below 2.0	74.93	72.13	92.05
2	Small	2.0 to 4.0	15.55	16.95	5.94
3	Medium	4.0 to 10.0	7.91	9.24	1.82
4	Large	10.0 and above	1.61	1.68	0.19

The land holding pattern indicates that the land holding is predominantly by marginal farmers to the extent of 72.13 % to 92.05 %.

8.12.4 Climate of Command Area

The climate of en-route command is discussed in para 8.5: Agro-Climatic Conditions.

8.12.5 Irrigation

(a) Present Sources of Irrigation in Command

The present source of irrigation in the proposed command area is mainly wells including tube wells.

(b) Methods of Irrigation Followed

At present, the conventional method of applying water through minor irrigation channels, distributaries and water courses is being followed in these areas. Electric/diesel pump sets are used to lift water from the streams and wells.

(c) Status of Land Development for Irrigated Area

(i) Condition of Channels

The condition of existing irrigation channels in the command area is generally satisfactory except in some reaches where proper maintenance is required.

(ii) Longitudinal Slope of Field

The slopes in agricultural fields where irrigation channels are located are adequate and irrigation water reaches almost every nook and corner of the fields.

(iii) Status of Field Channels

The status of field channels is satisfactory. However, proper drainage network needs to be built after introduction of canal irrigation in the area.

(iv) Assumed Field Application Efficiency with Justification

As per the latest guidelines approved by the Task Force on ILR, the irrigation efficiency for major and medium projects is 65%. This includes conveyance efficiency through conventional open canal as well as field application efficiency. The irrigation from the link canal is proposed with pipe distribution network with an efficiency of 95% for conveyance of water

to the fields. Therefore, the field application efficiency is assumed as 80% (presuming almost equal efficiencies for conveyance as well as application of the approved overall irrigation efficiency of 65%).

(v) Record of water logging, salinity and flooding

The proposed command area is mostly rainfed and is devoid of surface water irrigation facilities. At present, there is no instance of water logging, salinity and flooding occurring in the area.

8.12.6 Socio-economic Aspects

The Comprehensive Environmental Impact Assessment and Socio-economic studies of Godavari (Inchampalli) – Cauvery (Grand Anicut) link project will be carried out in due course.

8.12.7 Infrastructure Facilities

Development and management of infrastructure are key aspects for sustainable development and prosperity of the society.

(a) Roads and Railways

A well-knit transport and communication system brings people of different villages/towns within the command area closer to one another. It also facilitates movement of goods and services from their locations of supply and demand. The transport routes are, thus, the main arteries of the economy.

All the districts in the command area are endowed with a network of state highways and good all weather roads which render them easily accessible both within the district and from one another.

(b) Marketing Facilities

Good marketing facilities are available for the people of the command area. In addition, numerous fair price shops within reasonable distances are available in almost all villages.

(c) Agro-Industries

The States of Telangana, Andhra Pradesh and Tamil Nadu where in the proposed command area of the link project lies are considered as highly industrialized states. There are a number of agro-based industries based in these States. There will be ample scope for coming up of more no. of such industries on implementation of the link project due to the likely spurt in agricultural production.

(d) Banks/Credit Societies etc.

Financial institutions provide financial support to all sections of society and also to infrastructure projects. Banks are prime financial institutions. Scheduled Commercial Banks (SCBs) comprise of the State Bank of India (SBI), other nationalised banks, private banks, Regional Rural Banks (RRBs) and foreign banks. There are no. of such banking facilities in the command area.

8.12.8 Topography and Soils

(i) Topography and Relief

Topography of the command area is undulating and is of moderate slope. Isolated hill tops/hillocks and continuous hill ranges in small stretches with valleys dominate the command area that is spread in about 15 districts located in the States of Telangana, Andhra Pradesh and Tamil Nadu.

(ii) Land Slopes

Slopes of the lands in the command are generally moderate neither steep nor flat.

(iii) Soils

The details of soils present in the command area are already given under Para 8.4. The area has high productivity potential due to inherent fertility of soils. The soils of the area are fine to moderately fine in texture and are mostly free from salinity. However, proper water management practices need to be

adopted to prevent the development of water logging, thereby salinity and alkalinity on introduction of irrigation.

8.12.9 Ground Water and Drainage

Ground water assessment has been made for the districts in the proposed command area based on 'Dynamic Groundwater Resources of India, June, 2017' publication of Central Ground Water Board (CGWB). Details are furnished in **Table-1.6** of Chapter-I: Introduction. The annual replenishable ground water resource of various districts falling in the command area is 20.04 BCM out of which the ground water draft is 10.35 BCM which indicates about 52% of average ground water development in the region. However, it is seen that groundwater is over exploited in Vellore, Tiruvannamalai and Villupuram districts of Tamil Nadu.

As the slope of the land is less than 5% and groundwater depth is more than 1.5 m in most of the command area, no drainage problem is anticipated. The command areas of the link canal are drained by a network of rivers such as Kinnerasani, Musi, Gundlakamma, Pennar, Palar etc. and/or a no. of their tributaries, small streams and nallas. Thus, the commands have good draining facilities.

8.12.10 Agriculture

The information on the cropping pattern followed with average yield of 3 years as per the guidelines for preparation of DPR is not available. However, the cropping pattern and the average yields for pre-project (rainfed) and post-project (irrigated) scenarios in the command area are adopted as per the circulated feasibility reports of the three components of the link project. Proposed land use will change due to increase in cultivated area and a spurt in developmental activities due to the link project.

8.12.11 Farmers' Attitude towards Improved Agricultural Practices

The increase in intensity of irrigated crops in the command area leads to increase in the agricultural production which in turn makes agriculture remunerative. Therefore, the farmers will have a positive attitude towards improved agricultural practices, which are being duly promoted by the state.

(a) Use of Improved Implements and Seeds

Nearly 72 to 92 percent of agricultural holdings in the districts lying in en-route command area are marginal (less than 2 ha). Among all groups of holdings in which Tractors, Tractor drawn Seed Drill Cum Fertilizer Drills, Power Threshers were used in the districts pertaining to command area, more than 90% of them were used in small & marginal holdings for agricultural purposes. Similarly, among all groups of holdings in which Sprinklers and Drip Irrigation Sets were used, most of them were used in small & marginal holdings. Among all groups of holdings in which certified, notified and hybrid seeds were used, about three fourths of these were used in small & marginal holdings. This clearly shows that farmers are well aware of the advantage of using improved implements and quality seeds for better agricultural production and are actively using them.

(b) Use of Fertilizers, Insecticides, Pesticides, etc.

In the districts pertaining to the command area, usage of fertilizers & pesticides is very common among the farmers. Farmers in the command area are very much inclined to use fertilizers, insecticides, pesticides, etc. in their farms.

8.12.12. Identification of Problems in En-route Command Area

(i) Physical Problems (Including Hazards)

- (a) Land Slopes:** The land is generally undulating; therefore, canal distribution system has to be aligned accordingly.
- (b) Soil Depth:** There may not be any problem on this account, as sufficient soil depth is available in the area for providing canal irrigation.
- (c) Salinity/Alkalinity:** No salinity/alkalinity problem is expected in the command Area.
- (d) Water Logging:** No water-logging problem of any serious nature is reported in the command area. After introduction of irrigation, the command area shall, however, be monitored for water logging.

(e) **Drainage:** As area is undulating with moderate slopes, no drainage problem as such is anticipated. However, keeping in view the soil types present in the command, suitable drainage network shall be provided.

(ii) Financial Problems

Financial assistance is provided to farmers by way of short-term loans, credit, etc. by government through various banks and co-operative agencies. The loans are disbursed through Commercial Banks (CB), Regional Rural Banks (RRB), Maharashtra State Co-operative Bank (MSCB), District Central Co-operative Banks (DCCB) and Land Development Banks (LDB). The State Co-operative Banks and Regional Rural Banks issue Kisan Credit Cards (KCC). The financial institutions directly associated with agricultural finance at grass root level in the States are Primary Agricultural Credit Co-operative Societies (PACS) which provide short-term crop loans to their cultivator members. Since these institutions meet the credit needs of the farmers, no financial problems are expected to be faced by the farmers for carrying out their agricultural operations.

8.12.13 Proposed Cropping Pattern with Justification based on Land Irrigability Classification, Agro Climatic Conditions Developed, Irrigated Cropping Pattern in Adjoining Projects / Areas etc.

The cropping pattern adopted for each of the talukas in the command area of the link project is arrived at, more or less on the same lines as the cropping pattern approved by Agriculture Department of Maharashtra based on the Land irrigability and capability classification along with agro climatic conditions of the region. The details of proposed cropping pattern for the command area have been discussed in Irrigation Planning vide para 8.6.

8.12.14 Land development work proposals

Since the command area is already under rain-fed cultivation, no major land development works may be required. However, appropriate provision for land development works has been kept in the estimate. At the time of implementation of the link project, detailed survey of each command will be done and based on the actual requirement, appropriate land development works will be taken up.

8.12.15 Ayacut roads

There are several cart tracks connecting villages and village roads across the proposed command area. These cart tracks and village roads will be interconnected with the major roads so as to develop an integrated transport network of the region.

8.12.16 Benefits

(i) Crop-wise Increase in Yield per ha and Total Estimated Output from the Command

The irrigation under Godavari (Inchampalli) – Cauvery (Grand Anicut) link project has been planned in such a way that the diverted water will be utilized judiciously and optimally to bring more area under irrigation for benefitting as many farmers as possible. To achieve this objective, an intensity of irrigation of 100% is adopted for the entire new command area of the link project.

The cropping pattern is proposed keeping in view the existing crop practices in the command area and the need for optimum utilization of water for obtaining better yields and returns. A cropping pattern with good mix of food and commercial crops in each command has been adopted based on the prevailing cropping pattern in the region in order to maximize crop yields and returns in the post project scenario.

The Gross value of produce, Input cost of agriculture and Net annual benefits from irrigation in the reach-wise command areas are furnished in **Annexures 14.2.1, 14.2.2 and 14.2.3** respectively.

(ii) Estimated value of increased production

The net annual value of crop production under the link project is assessed as Rs. 641493 lakh as given in **Annexure 14.2.3**.

(iii) Likely socio-economic aspects

The project area is purely agro-based and agriculture development in the region through the proposed Godavari (Inchampalli) - Cauvery (Grand

Anicut) link project may bring economics into fast track. The agriculture development increases the food grain production and thereby improves financial resources of the farmers which inter alia increase the scope for investment opportunities by them. There is a scope for set up of agro-based industries in large scale and demand for more marketing facilities in the region. There are a number of technical institutes and well qualified youth in the region, apart from the agricultural labourers who can be effectively absorbed in this development process. This will improve financial condition of the respective families and the society as well. Due to improved economic condition of the families, the health conditions/facilities too will improve in the region. Further, due to supply of clean and assured drinking water, the sanitation facilities also will also improve. Thus, the socio-economic conditions of the command areas in specific and the three States in general, will improve significantly due to the implementation of the link project.