

Chapter – 8

Irrigation Planning and Command Area Development

8.1 General

The Par-Tapi-Narmada link takes off from the Mohankavchali dam. The initial part of the link consists of a 5 km long tunnel connecting Mohankavchali to Nar river upstream of Paikhed weir. The canal part of the link starts from Paikhed weir, which is located downstream of the Paikhed dam. The FSL of the canal at Paikhed weir is 140.70 m. The link canal on its way to Ukai reservoir on Tapi river is fed by the Chasmandva, Chikkar, Dabdar and Kelwan reservoir through feeder canals. The link canal, after irrigating the command enroute, outfalls into the Ukai reservoir at FSL 108.31 m and takes off from the reservoir with FSL 81.79 m and finally outfalls into the Miyagam Branch canal of the Narmada main canal system. The F.S.L. of the link canal at its tail end is 54.38 m.

The total culturable command area under the link canal is 1,88,414 ha, of which 17,411 ha is enroute command in the reach between Par and Tapi, 23,940 ha enroute command in the reach between Tapi and Narmada and the balance 1,47,063 ha lies entirely in the Narmada command under the ongoing Sardar Sarovar project. Most of the area lying in the basins between Par and Tapi is already under irrigation by the existing schemes viz Ukai left bank canal and Kakrapar left bank canal and other projects. As the link canal runs at a higher elevation compared to the Ukai left bank canal, a little area of about 17,411 ha lying in between the link and Ukai left bank canal will be irrigated by the link. The main objective of the Par-Tapi-Narmada Link canal is to extend irrigation in the drought prone areas of Saurashtra and Kutch. This will be possible by taking over part of Narmada command so that the water saved in Narmada main canal is used to extend irrigation in Saurashtra and Kutch region. The intensity of irrigation in the portion of Narmada command has been taken as 80% as adopted in the Sardar Sarovar project. However, for the enroute irrigation of the areas, which are in small patches, the intensity has been considered as 125% to keep it uniformly with the neighbouring medium schemes. The total CCA and annual irrigation from the Par-Tapi-Narmada link are given in Table - 8.1.

Table - 8.1
Abstract of CCA and area to be irrigated in Par-Tapi-Narmada link

Sl. No.	Link canal reach	C.C.A. (ha)	Irrigation intensity (%)	Annual irrigation (ha)
1.	Par-Tapi reach	17411	125	21764
2.	Tapi-Narmada reach	23940	125	29925
3.	Narmada canal system	147063	80	117650
	Total	188414		169339

The canal runs through five basins lying in the districts of Valsad, Navsari, Surat and Dang in Gujarat state.

8.2 Existing cropping pattern

The enroute command area coming under the reach of the canal upto Narmada lies in Valsad, Navsari, Surat, Dang (Ahwa) and Bharuch districts of Gujarat. The command coming under the reach of canal beyond Narmada upto its out fall into Miyagam branch which is covered under the ongoing Sardar Sarovar project command system lies in Bharuch district of Gujarat. The cropping pattern varies from district to district. Paddy is the predominant crop which forms 31.78% of the cropped area followed by fodder crop which forms 30.99% in Valsad district. In the case of Surat district jowar is the predominant crop which forms 23.60% followed by fodder and paddy. In Dang district Ragi is the main crop which forms 30.92% of the cropped area followed by other cereals, pulses and rice. The command areas of Ukai left bank canal, Kakrapar left bank canal and Karjan project are lying adjacent to the command of the link canal upto Tapi river.

8.3 Soil surveys

8.3.1 Soil capability classification

So far as the soils of the area lying in the reach between Par and Tapi basins are concerned, these may be broadly classified into two main groups viz inceptisols and vertisols. Inceptisols are found on the hilly areas as well as along the hill slopes. These soils are shallow to moderately deep and highly eroded. Their texture varies from loamy to clay. Their water holding capacity is moderate. They are moderate to high in nitrogen, low in phosphoric acid and high in potash content.

The vertisols are found in the midlands and flood plains. These soils are very deep and silty to clay in texture. Their water holding capacity varies with clay content. These soils crack on drying and have poor drainage characteristics. These are moderate in nitrogen, low to medium in phosphoric acid and high in potash content.

As far as the soils in the command area lying in the reach between Tapi and Narmada and beyond Narmada are concerned, the soil survey had been conducted by the Agricultural department of Gujarat for the Sardar Sarovar project. The cropping pattern proposed in Sardar Sarovar project is being adopted in the command of the link canal.

8.3.2 Land irrigability classification

In general, deep to very deep soils can be brought under irrigation provided the depth of water table, soil slope and drainage do not become limiting factors. Shallow soils are unfit for cultivation and they should be put under pastures and grazing land in order to check soil erosion hazards. While proposing the cropping pattern the soil erosion hazards. While proposing the cropping pattern, the soils in the command area, the existing cropping pattern, local cultural practices prevailing in the area, marketability of the produce etc. have been taken into consideration. Appropriate soil and water management practices have to be adopted to make irrigated agriculture success.

8.4 Proposed cropping pattern

8.4.1 Proposed cropping pattern under the link

As most of the command area of the link canal falls under the zones A & B of the command area of the Sardar Sarovar project, the cropping pattern for the command under link canal has been evolved based on the cropping pattern of the Zones 'A' and 'B' of the command under Sardar Sarovar project. The details of the cropping pattern under the link canal is furnished below in Table – 8.1.

Table – 8.1

S.No.	Crop	Enroute Command		Narmada Command	
		% w.r.to CCA	Area (ha)	% w.r.to CCA	Area (ha)
1.	Perennial	5	2067	3	4412
2.	Kharif	55	22743	35	51472
3.	Rabi	31	12818	20	29413
4.	Two seasonal	30	12406	19.5	28677
5.	Hot weather	4	1655	2.5	3676
	Total	125	51689	80	117650

8.4.2 Agro climatic conditions

The average annual rainfall in the command area varies from 1431 mm to 2160 mm. About 94% of rainfall is received during south west monsoon i.e. from June to September. The daily minimum temperature varies from about 13° C to 27° C during winter and summer and daily maximum temperature varies from 28° C to 40° C during winter and summer respectively. The relative humidity is more than 75% during monsoon and varies between 40% to 70% during winter.

8.4.3 Irrigated crops in the adjoining area

The irrigated crops in the adjoining command areas under Kakrapar LBC and Ukai LBC are kharif paddy, kharif jowar, kharif vegetables, rabi wheat, rabi paddy, rabi pulses / oil seeds and vegetables and cotton, fodder, jowar which are two seasonal crops and sugarcane which is a perennial crop.

8.5 Crop water requirements

The crop water requirements for different crops for the command of Narmada canal system of Sardar Sarovar project worked on the basis of Modified Penman's method is shown in Vol. IV "Canal & canal system of Sardar Sarovar Project Report-1980" prepared and published by Narmada Project Dam Design Circle, Vadodara. As most of the command area proposed to be irrigated by the link canal is covered under the command of Narmada canal system, the monthly crop water requirements as worked out for the Narmada command system are considered for working out the crop water requirements for the command under the link canal. It is seen that the CCA under zone 'A' is 3,95,697 ha of which 76,161 ha is proposed to be commanded through the link canal. The CCA under zone 'B' is 75,628 ha, the whole of which is proposed to be covered under the link canal. The weighted delta has been worked out considering the total water requirement and area irrigated and found to be 0.63 m. This delta is for the command area of the Narmada canal system which is covered under the link canal. However, for enroute irrigation between Par-Tapi and Tapi-Narmada, the weighted average delta has been computed considering the gross irrigation requirements of the crops worked out by climatological approach. (Considering evaporation losses at 20% of gross irrigation requirement for crops, the value of weighted average delta has been computed and found to be 0.89 m. The total water requirement for irrigating the entire command proposed under the link canal has been worked out to 1201 Mm³,

which becomes 1350 Mm³ at canal head considering transmission loss of 149 Mm³.

8.6 Water planning

As per the simulation studies carried out, the total quantity of surface water available from the seven reservoirs is 1470 Mm³. After accounting for the committed d/s requirement of 120 Mm³, the net yield available for diversion is 1350 Mm³. As described in above para, the water utilization in the enroute command and Narmada command will be 460 Mm³ and 741 Mm³ respectively and the transmission losses along the link canal will be to the tune of 149 Mm³. Thus, the quantity of water saved in Sardar Sarovar project to the tune of 741 Mm³ will be available for irrigation in Saurashtra and Kutch regions.

8.7 Transmission losses

Considerable amount of water is lost through evaporation and seepage in the canal system from the head of the canal upto the canal outlet where the water is delivered to farmers water course. These losses are commonly known as conveyance losses or transmission losses. These losses have been considered at the rate of 0.6 cumec/M Sq m wetted area of the canal as per IS : 4745 – 1964 for lined canals. Accordingly the losses in feeder canals and the main canal are worked out.

8.8 Command area development

8.8.1 Command area details

The command area consists of enroute command area in Par-Tapi reach, enroute command area in Tapi-Narmada reach and target command area of Miyagam branch of Sardar Sarovar project to be takeover by the link.

8.8.2 Command area in Par-Tapi reach

The Ukai Left Bank Canal (U.L.B.C) and Kakrapar Left Bank Canal (K.L.B.C) start from Tapi river and terminate on the right bank of Par river. These contour canals are on the valley side of the proposed link and irrigate the area upto Arabian sea. Hence, the area to be proposed for enroute irrigation is between the link and U.L.B.C. Out of this, some of the areas are proposed to be commanded by some on-going and proposed schemes such as Sidhumber, Khata Amba, Dodipada project etc. The remaining area lying unirrigated in

Ambica, Purna, Mindhola and part of Tapi basin is proposed to be irrigated by the link. The C.C.A. area irrigated in various basins assuming 125% irrigation intensity and the water requirement considering a delta of 0.89 m are furnished in Table - 8.2.

Table - 8.2
Basinwise, CCA and irrigated areas enroute between Par-Tapi

Basin	CCA (ha)	Annual irrigation (ha)	Water requirement (Mm³)
Par	-	-	-
Auranga	-	-	-
Ambica	5518	6898	61.39
Purna	3563	4454	39.64
Mindhola	1886	2357	20.97
Tapi(part)	6444	8055	71.69
Total	17411	21764	193.69

Say 194.00 Mm³

8.8.3 Command area in Tapi-Narmada reach

The area between Tapi and Narmada is covered by two existing major canal systems namely the Kakrapar Right Bank Canal (KRBC) and the Karjan Left Bank Canal. Two branch canals are proposed to take off from the main Tapi-Narmada Link canal at RD 51.9 km and RD 63.26 km to irrigate the command areas lying between Tapi and Kim rivers and Kim and Amravati rivers. The total CCA in this reach is 23,940 ha. The annual irrigation and the water requirement have been worked out on the lines of the Par-Tapi portion and are furnished in Table - 8.3.

Table 8.3
Enroute CCA and annual irrigation between Tapi-Narmada reach

Branch canal for enroute command	CCA (ha)	Annual irrigation (ha)	Water requirement (Mm³)
Branch canal At 51.9 km	7700	9625	85.66
Branch canal At 63.26 km	16240	20300	180.67
Total	23940	29925	266.33

Say 266.00 (Mm³)

8.8.3.1 Command area of Sardar Sarovar Project (SSP) to be taken over by Link

The link canal after crossing Tapi river at Ukai reservoir and Narmada river downstream of Sardar Sarovar, finally out falls into the Miyagam branch canal of Sardar Sarovar Project. The link canal beyond Narmada river runs through SSP command crossing its canal network viz Wadia branch, Tilakwada branch, Mandva branch, Bhilodia branch, before finally joining Miyagam branch. The total CCA proposed under the link in this reach is 1,47,063 ha. Adopting an irrigation intensity of 80% and a delta of 0.63 m, the annual irrigation and the water requirement have been worked out. The details are furnished in Table - 8.4.

Table - 8.4
C.C.A. and annual irrigation in Narmada command

Sr. No	Particulars of command	C.C.A. (ha)	Annual irrigation (ha)	Water requirement (Mm ³)
1.	Wadia branch	2900	2320	14.60
2.	Tilakwada branch	5100	4080	25.70
3.	Mandva branch	8700	6960	43.85
4.	Bhilodia branch	8000	6400	40.30
5.	Miyagam branch	122363	97890	616.70
	Total	147063	117650	741.15

Say 741.00 Mm³

The total C.C.A and area irrigated annually from the Par-Tapi-Narmada link are furnished in Table - 8.5.

Table - 8.5
Abstract of CCA and area to be irrigated under Par-Tapi-Narmada link

Sr. No.	Link Reach	C.C.A. (ha)	Irrigation intensity (%)	Annual irrigation (ha)	Water requirement (Mm ³)
1.	Par-Tapi	17411	125	21764	193.69
2.	Tapi-Narmada	23940	125	29925	266.33
3.	Narmada command	147063	80	117650	741.15
	Total	188414		169339	1201.17

Say 1201.00 Mm³

Thus it is seen that the Par-Tapi-Narmada link will cover a total C.C.A. of 1,88,414 ha and provide annual irrigation of 1,69,339 ha.

8.8.4 Classification of lands

Villagewise statistics of land use data for the command area of the project are not readily available. However, the land use pattern as computed from the talukawise statistics on prorata for the period from 1978-79 to 1982-83 have been considered. The land use figures of the year in which the culturable area was maximum have been considered. The basinwise land use statistics in the command area for Par-Tapi portion are given in Table - 8.6.

Table - 8.6
Land use particulars of the command area

Unit : ha

S.No.	Category	Ambica	Purna	Mindhola	Total
1.	Forest	1680	1092	328	3100
2.	Barren land	301	140	78	519
3.	Land put to non agricultural use	279	231	328	838
4.	Permanent pastures & other grazing lands	105	64	75	244
	Sub – Total	2365	1527	809	4701
5.	Land under misc. trees & crops	28	38	14	80
6.	Culturable waste	50	104	55	210
7.	Current fallows	287	184	117	588
8.	Other fallows	35	64	25	124
9.	Net area shown	5117	3173	1675	9965
	Sub – Total	5518	3563	1886	10967
10.	Area shown more Than once	370	149	157	676
11.	Gross area shown	5487	3322	1832	10641
12.	Geographical area	7883	5090	2695	15668
13.	Culturable command Area	5518	3563	1886	10967

8.9 Socio-economic aspects

The Agro-economic, Socio-economic and environmental survey aspect of the command area of proposed Par-Tapi-Narmada link was carried out by National Council of Applied Economic Research (NCAER) during 1993. Agriculture is the main occupation of the people in the command area. Most of the farmers belong to the medium or small holdings category. Though the land holding is small, land is fertile. Farmers are able to grow variety of crops like sugarcane, banana, mango, chikoo and other fruits and vegetables in addition to paddy, wheat, bajra, jowar, pulses, etc. Besides this, people in the command area, particularly in Par-Tapi reach, have earnings from live stock. They maintain farm houses for cows, buffaloes and goats and sell their milk to local dairies. Valsad, Navsari, Surat and Bharuch districts of Gujarat are highly industrialized. So, people of these areas also get employment in these industries. Thus overall economic condition of the people in this area is good in comparison to other parts of the state.

8.10 Infrastructural facilities

Important towns along the proposed link are well connected by the National highway and state highway and also railway lines. Almost all the taluka head quarters are also connected by at least state highways. Important villages are also well connected by Panchayat roads and can be accessed even during monsoon season. At each taluka and district head quarters, very good marketing facilities are available. Branches of nationalized banks and co-operative banks are available in many villages. Transportation of agricultural inputs and other items from towns to villages and that of agricultural outputs/products from villages to town is very convenient in this area. Because of many large industries in Valsad, Navsari, Surat, Bharuch and Vaododara districts, all infrastructural facilities are available in this area. Products like 'Alphanso' mango of Valsad district is exported to other countries and good communication network helps in such commercial activities. A number of agro based industries are also existing in the area.

8.11 Ground water drainage

Two distinct types of ground water regimes occur in the command area. In the northern part, aquifers with secondary inter-granular porosity and fractures control occurrence and movement of ground waters. Recent and older alluvium consisting of gravels, sand, silt and clay form the ground water regimes in the

southern areas. The primary aquifers are capable of yielding 10 to 25 liters per second and it is 1.5 - 3.0 in the secondary aquifers. However, in the northeastern parts, the ground water is saline at all levels. Hence, utility of this water in this part will be of doubtful nature. Since most of the areas adjoining Par-Tapi-Narmada link fall in only five districts of Gujarat State, Ground Water Resources availability and utilizations scenario have been arrived at for this area and are presented at Table – 8.7.

Table - 8.7
Details of ground water potential

Sr. No	Name of District	Total replenishable ground water resource Mm ³ /Yr	Utilisable ground water resources for irrigation Mm ³ /Yr	Net draft Mm ³ /Yr	Balance ground Water potential available for exploitation Mm ³ /Yr	Level of ground water development (%)
1.	Vadodara	1186.47	1008.49	146.35	862.14	14.5
2.	Bharuch	840.16	714.13	69.46	644.67	9.7
3.	Valsad	1143.18	971.70	136.24	835.46	14.0
4.	Dang	144.28	122.64	0.86	121.78	0.7
5.	Surat	1960.21	1666.16	162.41	1503.75	9.7
	Total	5274.30	4483.12	515.32	3967.80	

Source : Ground water statistics – 1991 by CGWB.

Table - 8.7 shows that ground water development in Surat and Dang districts is even less than 10% whereas it is around 15% in case of Vadodara and Valsad districts. It provides ample scope for conjunctive use of ground and surface waters. It is seen that in most of the area, the depth of ground water is less than 10 m. A study carried out for command area of Kakrapar irrigation scheme, based on observation of wells during pre-monsoon of 1990, has shown that the sub soil water level in most of the wells in Valsad and Surat districts has been between 1.5 m. and 3.0 m. and p^H value varying from 7 to 8.5. Since the command area of Par-Tapi-Narmada link is at higher elevation than that of Kakrapar irrigation project, the sub soil water level will be 8 to 10 m. deep.

As considerable area of the northern part of the proposed command of Par-Tapi-Narmada link consists of highly porous alluvial sediments which facilitate higher rate of infiltration, and also water level is within 10 m. from ground levels, caution has to be exercised in introducing intensive irrigation in the command to avoid undesirable adverse ecological impacts.

8.12 Identification of problems

There are no problems of water logging, soil erosion, salinity etc. in the command area of the proposed link. As indicated in preceding paragraphs, the command area is having number of natural drains. So, there is no problem of drainage also. However, when water will start flowing through the canal, the problem of water logging/salinity will have to be observed for some years till the system stabilizes, because in most part of the command area the ground water table is at higher level. So far land slope in command of Tapi-Narmada is concerned, it is mostly flat whereas that in Par-Tapi portion is slightly steep. As such the cost of command area development in this reach will be more than that in Tapi-Narmada portion.

As described earlier, the main occupation of the people of the command area is agriculture. They are also doing livestock rearing. Normally, farmers are adopting traditional methods of agriculture. However, use of high yielding variety of seeds, improved machineries and modern agricultural technology are gradually becoming popular in this area. One of the reasons for slow adoption of modern agricultural technology is that majority of farmers are having small land holding.

8.13 Land development works

Land development works mainly consist of following five steps :-

1. Levelling of land
2. Construction of canals
3. Construction of water courses and field channels
4. Field drainage
5. Farm roads

8.13.1 Leveling of land

The terrain of Narmada command is normally flat. However the terrain of enroute commands in Par-Tapi reach is undulating at a number of places. So such portion will be required to be leveled. The cost of the land leveling will have to be borne by the beneficiaries who will be able to get credit from the respective Land Development Bank.

8.13.2 Construction of canals

A total programme of 5 years has been contemplated for canal construction work. The overall work is divided into two parts, a) Conveyance system and b) Delivery net work. The conveyance system includes main canal, branch canals and distributaries down to service area turnouts commanding 200-500 ha which would generally cover one village. The delivery network consists of minor canals within the Service area to serve chaks (water delivery units) of average 40 ha size. The chaks in turn will have sub-minor canals with turnouts to serve areas of about 8 ha size within which there will be unlined channels leading to individual fields.

8.13.3 Water courses and field channels

The construction of water courses and field channels is the liability of cultivators but they do not come forward to construct the water courses on permanent and scientific basis. Therefore, in order to expedite the construction of water courses and field channels the Government will have to provide supporting infrastructure to farmers. Alternatively, the work can be taken up by Agricultural Department at cultivator's cost.

8.13.4 Field drainage

Though possibility of water logging is very less still the rise in water table in the command area will have to be thoroughly watched after introduction of irrigation. For this purpose, it is proposed to make consumptive use of surface and ground water to enhance the irrigation intensity and also to lower down the ground water level.

8.13.5 Farm roads

At present the road network to reach the various parts of the command area is sufficient. However after construction of canal network, some new farm roads will be required to be constructed and old roads will have to be realigned for better accessibility to the site.

In addition to above land development works, marketing and warehousing facilities, credit facilities from bank, easy availability for agriculture inputs, consolidation of land holdings etc. will also have to be developed/arranged for proper command area development.

8.13.6 Financial aspect

The cost of command area development for both Par-Tapi and Tapi-Narmada portions of Par-Tapi-Narmada Link has been worked out @ Rs.35,600 per hectare, as adopted in Sardar Sarovar Project and it comes to Rs.67,075 lakhs.