Chapter 6
Designs And Layout

6.1 Structure, Layout and Design Features of the Head Works

6.1.1 Location of the Head Works

The link canal proposes to connect the proposed Kattalai barrage on Cauvery and the Gundar River. As such, the Kattalai barrage is at its head and the Gundar is at its tail end.

6.1.1.1 Kattalai Barrage

A new barrage is proposed about 500m d/s of the existing Kattalai bed regulator. The components of the proposed barrage are as follows:

(i) Providing a weir with crest level of 99.500m.
(ii) Providing 6 bays in under sluice portion and 45 bays in river sluice portion of 15 m span each making overall length of waterway to 874 m.
(iii) All other related works.

A typical design of the barrage & head regulator carried out indicates the need of 6 numbers of vents for under sluice portion and 45 numbers of bays of 15 m each in river sluice portion with 2 m thick piers in river portion and 2.25 m thick piers in under sluice portion, providing a overall length of waterway of 874 m.

The existing South bank canal, the Kattalai high level canal, Krishnarayapuram channel and the New Kattalai high level canal takeoff on the right flank of regulator in that order. Considering the size, FSL and slope of these existing canals, none of them may be suitable for the purpose of this proposal without extensive remodeling works and so it is advantageous to have an independent off take for the proposed canal.

The Cauvery – Vaigai – Gundar link canal is proposed to take off from the right flank of the Kattalai barrage. The required discharging capacity of the link canal has been worked out to be 180.30 cumec. Hence it is proposed that the canal could have a head regulator with 4 bays of 10.75 m x 1.8 m (to pass a discharge of 180.30 cumec into the link canal as

per hydraulic design) located beyond the off take point of New Kattalai high level canal.

6.1.1.2 Tail end at Gundar

The link canal terminates at the Gundar River at RD 255.600 km near Pudupatti village of Kariyapatti taluk of Virudhunagar district. The NSL of left bank of Gundar is 69.140 m and the FSL of the link canal is 75.688 m. From this point, a branch canal takes off by crossing Gundar River as an aqueduct.

6.2 Design Features of Cauvery (Kattalai) – Vaigai – Gundar Link Canal

6.2.1 Description of the Canal System

The proposed link canal takes-off from the right flank of the Kattalai barrage through a canal head regulator with FSL 100.750 m. The general topography of the area through which the Cauvery (Kattalai) – Vaigai - Gundar link canal traverses is mostly plain with a few hillocks. In the initial reach of 70 km, the canal runs in south-east direction and then takes a right turn and runs in south-westerly direction up to the tail end. The alignment of link canal runs mostly in cutting. Maximum depth of cutting in the entire reach of the canal is 33.0 m and maximum height of filling is 12 m.

A uniform bed slope of 1 in 13000 is adopted for the entire alignment. The canal is designed as a trapezoidal section with bottom corners rounded and is proposed to be lined. The velocity at the head and tail end of the link canal are 1.173 m/s and 0.794 m/s respectively. The full supply depth is 5.0 m at the head. Sections of the canal at head and tail end are 20.4 m x 5.0 m and 4.10 m x 3.4 m respectively. The discharge at head and tail end of the link canal are designed to be 180.30 cumecs and 30.03 cumecs respectively. The canal has been designed for 1.1 times the peak discharge. A free board of 1.0 m is provided throughout the length of the link canal.

6.2.2 Utilisation of Water Potential from the Streams Crossed by the Canal

Many streams and rivulets crossed by the Cauvery (Kattalai) – Vaigai - Gundar link canal are not perennial. The yields are undependable and the streams are not prone to flash floods in general. The possibility of

providing additional storage on these streams is remote because of the nature of the topography and likely submersion of large tracts of cultivable lands. In view of the above, utilisation of water from these streams may not be feasible.

6.2.3 Evaluation of the Design Parameters based on Samples Collected Enroute

The canal alignment generally runs in partial cutting and in embankment in its first half length and mostly in cutting in the remaining half length with embankments in the vicinity of the cross-drainage works. The soils as available from cutting are considered to be generally suitable for embankment purposes.

6.2.4 Lining

100 mm thick CC (1:3:6) lining is proposed for both bed and sides throughout the length of the canal.

6.2.5 Transmission Losses

The transmission losses are assumed as 0.60 cumecs per million m^2 of wetted area as per Bureau of Indian Standard Code IS: 10430 – 1982.

6.2.6 Design Calculations for Adequacy of Canal Section

a) Formulae Used

The canal sections for various reaches are designed using Manning's formula for velocity,

$$V = (1/n)\, R^{2/3}\, S^{1/2}$$

Where

V = Velocity

n = Rugosity co – efficient

S = Bed slope

R = Hydraulic mean depth (A/P)

A = Area of cross section = $bd + d^2 (\varnothing + \cot \varnothing)$

P = Wetted perimeter = $b + 2d (\varnothing + \cot \varnothing)$

b = bed width

d = depth of water

$\varnothing$ = Angle of the side slope

The formula adopted for critical velocity is $V_o = 0.55\ d^{0.64}$

The Rugosity co-efficient for the lined canal is taken as 0.018. Side slope of 1.5H: 1V is adopted except for deep cutting in hard rock where the slope adopted is 0.25H: 1V. A uniform bed slope of 1 in 13000 is adopted for the entire canal alignment.

b) Design of Canal Sections in Various Reaches

The Cauvery – Vaigai - Gundar link is planned to divert a total quantity of 2252 Mm^3. The maximum diversion proposed is 439 Mm^3 during the month of December (Ref. para 5.7.1) and the corresponding peak discharge works out to 163.91 cumecs.

The canal sections are designed for the above peak discharge increased by a capacity factor of 1.1 to take care of any future eventualities. The designed discharge at the head works out to 180.30 cumecs for the link canal. The canal is broadly divided into suitable hydraulic reaches and sections and are designed as a lined canal of trapezoidal cross section with rounded corners to carry the required discharge in the particular reach. The hydraulic design is done as per Manning's formula with values of co-efficient of rugosity as 0.018. The typical section of the canal as given in IS 10430-1982 "Criteria for design of lined canals and guidelines for selection of type of lining" is adopted.

The entire canal along its length is divided into 17 reaches for designing the canal section, considering the following:

1) Taking-off a major branch canal,
2) Discharge of canal falling by 10%,
3) Canal running in full cutting in hard rock.

Salient features of the link canal at its head are given in Table 6.1.

Table 6.1
Salient features of the link canal at head

Link canal at head	
Type of canal	Lined (Trapezoidal with rounded corners)
Design discharge	180.30 cumec
Bed width	20.40 m
Full supply depth	5.0 m
Velocity	1.173 m/s
Bed slope	1 in 13000
Side slope	1.5 H to 1 V
Manning's 'n'	0.018

The values of head loss provided at different structures are given in Table 6.2.

Table 6.2
Head Losses Provided at Different Structures

S.No.	**Name of structure**	**Head loss (m)**
1.	Canal syphon	0.30
2.	Syphon aqueduct/Aqueduct	0.15
3.	Super passage	0.00
4.	Road bridge	0.00
5.	Cross regulator	0.20
6.	Escape regulator & cross regulator	0.10
7.	Under tunnel	Nil

The total head loss due to structures has been worked out to be 5.40 m in the entire 255.600 km length of the canal and that due to bed fall is 19.66 m.

6.3 Canal structures

6.3.1 General

The link canal is aligned as a contour canal and it crosses a number of major and minor rivers / streams enroute. It crosses several roads as it passes through fairly developed and densely populated areas. It also crosses nine railway tracks of the Southern Railway at nine locations. The type of cross drainage work is decided based upon the physical features of the stream such as its catchment area and bed level with

reference to the bed and full supply levels of the link canal at the crossing.

Based on field survey, the locations of the cross drainage works and cross masonry works have been identified. In general, aqueducts, syphon aqueducts & canal syphons are proposed across major rivers / streams and under tunnels across small drains. Super passages have been provided where the drains are to be taken over the canal. Cross regulators have been proposed at the off-take points of the branch canals and at the points where there is a change in the section of the canal to facilitate negotiation of variation in the bed width and levels.

6.3.2 Cross Drainage Works

In its entire run of 255.600 km, the link canal has been provided with 52 cross drainage works, of which 9 are aqueducts (excluding the aqueduct at tail end), 4 are syphon aqueducts, 6 are canal syphons, 2 are super passages and the rest 31 are under tunnels. The design flood value of each drain has been worked out using the empirical formulae given in Table 6.3, which were adopted by the Irrigation Department of the Government of Tamil Nadu.

Table 6.3
Formulae for computing design flood

S.No.	Catchment area (km^2)	Design flood value (cumec)
1.	<7.8	3.50 A
2.	>7.8	8.30 $A^{2/3}$
Where A is the catchment area of the drain in km^2		

6.3.2.1 Aqueducts & Canal Syphons

Aqueducts have been proposed at the crossings of the major streams where the bed level of the canal is above the high flood level of the drain. A head loss of 0.15 m has been assumed at each aqueduct. In all, 10 aqueducts have been proposed. Wherever the FSL of the link canal is above the bed level of the drainage trough but below the HFL of the drain, canal syphons have been proposed. In all, there are 6 canal syphons for which a head loss of 0.3 m has been assumed at each canal syphon.

6.3.2.2 Syphon Aqueduct

Syphon aqueducts have been proposed at the crossings, where the bed level of the canal is below the high flood level of the drain. A head loss of 0.15 m has been assumed at each syphon aqueduct. In all, 4 syphon aqueducts have been proposed.

6.3.2.3 Super Passages

Super passages have been proposed at the crossings, wherever the bed level of the intersecting drain is well above the FSL of the link canal. There are 2 such crossings where super passages are proposed. No head loss has been proposed at super passages.

6.3.2.4 Under Tunnels

Under tunnels have been proposed along the link canal at crossings of small drains. No head loss has been assumed at under tunnels. A total number of 31 under tunnels have been identified. Provision has also been made in the cost estimate for small hill side drains and diversion of nalas.

6.3.2.5 Typical Hydraulic Designs of Cross Drainage Works

Typical hydraulic designs of (1) Under tunnel at RD 17.350 km, (2) Aqueduct across Koraiyar river at RD 58.500 km and (3) Canal syphon across Vaigai river at RD 222.210 km have been done to verity the head losses so provided..

6.3.3 Cross Masonry Works

6.3.3.1 Bridges

The link canal crosses a few district roads and a number of village roads at various points. A total of 133 road bridges have been proposed across the link canal, of which 2 are four lanes, 13 are double lane and 118 are single lane bridges. No head loss is provided for these bridges, since they are considered as single span bridges.

The link canal crosses the Southern Railway line at nine places. Single track railway bridges are proposed at all the nine crossings.

6.3.3.2 Cross / Escape Regulators

In all, 7 cross regulators are proposed along the link canal. A head loss of 0.20 m has been considered for each cross regulator.

Similarly 4 escape regulators are also proposed along the canal at suitable places where natural streams are available to release the discharges of the link canal. The discharging capacity of the escape regulator has been considered at half the discharge of the canal at that point. A head loss of 0.10 m has been considered for each escape regulator.