Chapter - 9

Construction Program, Manpower and Plant Planning

9.0 General

The construction methodology and equipment planning for construction of various components of the project are described in this chapter. The construction methodology for each type of structure, type and sizes of the equipments to be used for the construction has been described under the relevant sub sections of this chapter. The construction/ deployment schedule for various components of the project has been prepared and based on this, the number of machines/equipments and total requirement for each type and size of the major equipments required for construction of each component of the project has been worked out. However, if, the work is executed through award of contract, the contractors may execute the work based on the equipments actually available with them by adopting the related construction techniques. The tentative requirement of machines/equipments worked out herein will help in analysis of rates of works, cost estimation and in evaluating the viability of construction techniques and equipment, within overall construction schedule and cost estimate.

9.1 Main Project Components

The Ponnaiyar - Palar intra state link has been planned to enhance the ground water recharge and to stabilise the existing tank irrigation in the drought prone area of Krishnagiri and Vellore districts of Tamil Nadu state. The flood water available at Krishnagiri dam is proposed to be diverted from Nedungal anicut, located 16 km d/s of the dam through the 54.15 km long link canal during floods in Ponnaiyar river.

9.1.1 Salient Features of Main Components of the Project

The salient features of the main components of the project are indicated in **Table - 9.1.**

Table - 9.1

The Salient Features

Sl. No.	**Particulars**	
1.0	**Head works**	1 No. Existing Nedungal anicut
2.0	**Link canal**	
(i)	Length	54.15 km
(ii)	Flow	Gravity
(iii)	Type	Trapezoidal section, unlined
(iv)	Design discharge at head	68 cumec
(v)	Design discharge at tail	63 cumec
(vi)	Full supply depth at head	2.45 m
(vii)	Full supply depth at tail	2.45 m
(viii)	Bed width at head	25 m
(ix)	Bed width at tail	25 m
(x)	Side slopes	1(V):1.5(H)
(xi)	Bed slope of link canal	1:4500
3.0	**No. of structure across link canal**	
(i)	Road bridges (SLRB and DLRB)	34 Nos.
(ii)	Railway bridge	1 No.
(iii)	Aqueduct	6 Nos.
(iv)	Canal syphon	5 Nos.
(v)	Super Passage	2 Nos.
(vi)	Cross regulator	1 Nos.
(vii)	Head regulator	1 No.
(viii)	Under tunnels	6 Nos.
(ix)	Escape	1 No.
(x)	Canal outlets	10 Nos.

9.2 Basis for Study

9.2.1 General

Methodology for construction of Ponnaiyar - Palar link project has been adopted with due consideration of the construction schedule, the compatibility of the construction equipment to site conditions, the quantities and utilization factor of the equipment within the scheduled construction period. Number of machines required for

construction of each component of the project has been worked out and the total requirement for each type and size of machine for the project as a whole has been arrived at after drawing up the construction/deployment schedule for the main components of the project.

Mechanized construction has been planned for almost all types of construction jobs so as to achieve consistent quality at a faster rate and also to minimize the requirement of skilled manpower. Sequencing of construction activities, wherever possible, has been attempted in such a way that equipment from one activity, on its completion can be moved to the other. Thus, the total requirement of equipment at a time would be reduced and also sufficient utilization of equipment on the project would be ensured.

9.2.2 Construction Material Sources

Locations of different borrow areas and quarries for construction material with respect to the site locations have been described in the **Chapter - 4 'Surveys & Investigations'.**

Suitable fill material for the link canal has been found in the borrow area located on either side of link canal. Borrow areas with minimum lead have been proposed for utilisation during construction. It is also proposed to utilise the excavated material from the cutting section also for filling if found suitable. However, during construction, appropriate decision will be taken to select the borrow areas which meet the requisite specifications.

Construction material for concrete, viz., sand/fine aggregate, rock/coarse aggregate, for cross masonry/drainage structures are identified. The hard rock found along the link canal is of metamorphosed crystalline rocks of the Charnockite Group and the Migmatite Complex. The no. of structures along the canal are very limited as such the coarse aggregates can be procured either from local quarry or obtained from the spoils of the deep cut reaches.

Total concrete requirement of different grades for the main components of the project has been estimated to be approximately 1,10,000 m^3. The distance for transportation of coarse aggregate/boulders is considered as 5 km on an average whereas for fine aggregates, it is considered as 35 km on an average as the source is Palar river. The area for disposal of excavated material has been considered adjoining to the canal and

stacked as spoil bank. An average distance of 50 m from the point of excavation to disposal site/embankment (reusable) is considered for equipment planning purpose.

9.2.3 Basic Considerations

Based on past experience, about 9 working months in a year are available in the area where the project is situated. Other projects in the region have also been planned with this consideration. All the works are proposed to be executed in two shifts and during 9 working months.

9.2.3.1 Scheduled Working Hours

Equipment planning for calculating requirement of equipment is carried out based on the number of working days available, which further depends upon climatic conditions of the project area. For equipment planning purpose the monsoon season has been considered from 15th September to 15th December. In the present scenario, the monsoon sets in during September and continues till December in the project area. Thus, for link canal, a working season of nine months would be available. The scheduled working hours considering 25 working days per month are given in **Table - 9.2**.

Table - 9.2

Schedule Working Hours

Type of Work/ Shift	**Surface/Over Ground Works (hour)**
Single shift work/ day	9 x 25 x 6 = 1350
Two shifts work/ day	9 x 25 x 10 = 2250
Three shifts work/ day	9 x 25 x 12.5 = 2813

Two shifts working of equipment is normally considered most economical in view of the high cost of three shifts working on account of low availability of equipment and higher stand-by equipment requirement. Thus planning for all surface/over ground works has been carried out based on two shifts per day working. Provision of standby equipment has been considered as follows:

i. Single shift working 10%
ii. Two shifts working 20%
iii. Three shifts working 30%

9.2.3.2 Construction Period

A total period of four years has been considered for completion of the project. The infra-structural development, pre-construction surveys and investigations, preparation of design/ specifications and tender documents are proposed to be taken up during the 1st year and completed in the III quarter of the 1st year. The land acquisition for canal right of way and CD/CM works are proposed to be taken up from II quarter of 1st year to III quarter of 2nd year. In case the works are to be executed through award of contract, it is planned to award contracts for all major works by the IV quarter of 1st year. The area through which the link canal passes has good network of roads and communications system. Thus, the work on infrastructure facilities like temporary colonies, approach roads, workshop, haul roads, stores, office buildings etc. will be started during IV quarter of 1st year and completed in the I quarter of 2nd year itself. The excavation of canal in soft soil starts during the II quarter of 2nd year and is proposed to be completed by III quarter of 3rd year. The excavation of canal in Murum and weathered rock starts during the III quarter of 2nd year and is proposed to be completed by III quarter of 4th year. The excavation of canal for hard rock starts during the III quarter of 2nd year and is proposed to be completed by IV quarter of 4th year. The construction of embankment portion of canal starts during the IV quarter of 2nd year and is proposed to be completed by IV quarter of 4th year.

The construction of cross masonry works shall commence during the III quarter of 2nd year and will be completed by I quarter of 4th year. The construction of cross drainage works shall commence during the IV quarter of 3rd year and will be completed by IV quarter of year 4th year. Remoulding of Godd Ar/ Kal Ar to pass desired discharge will be carried out during IV quarter of 3rd year and completed by 2nd quarter of 4th year. The bar chart showing the activities are shown at **Annexure: 9.1**.

9.3 Construction Methodology and Equipment Planning

The construction methodology and equipment planning along with construction programme for different components of the project have been described in the succeeding sub-sections:

9.3.1 River Diversion Work

The head works for diversion is an existing Anicut. The head regulator is proposed about 60 m U/S of the existing head regulator of Barur channel and under sluices of anicut, where deep channel is seen. Thus, the proper diversion arrangement during project construction will be evolved depending upon the requirement.

Separate provision for the equipment for this activity has not been kept as some of the equipments to be deployed for canal can be utilized on this activity.

9.3.2 Conveyance System

The construction of the conveyance system involves excavation, placement of fill materials, spreading and wetting and compaction of the fill materials. Total quantity of canal excavation is about 5768826 m^3. The excavation of 5412195 m^3 quantity which does not involve blasting operation is considered as common excavation which includes soft soil, murum / weathered rock and dense medium rock requiring no blasting. The remaining 356631 m^3 which requires blasting is considered as rock excavation. Reuse of murum and soils to the extent of 50% of their quantity required for filling is also proposed with a lead of 2.0 km. Following assumptions have been made while working out the quantities of different activities for the construction of canal. The details are in **Table - 9.3**.

Table - 9.3

Quantities of Different Activities for Construction of Canal

Description of Work	**Type / Material**	**Quantity, in-situ**	**Unit**
Excavation			
	Soft soil	2100739	m^3
	Murum and weathered rock	3044487	m^3
	Dense medium rock not requiring blasting	266969	m^3
	Hard Rock requiring blasting	356631	m^3
Fill placement			
	Total Qty	5516017	m^3
	Met from spoils	1039630	m^3
	Net required from borrow area	4476387	m^3

9.3.2.1 Surface Excavation

The earth excavation involves both common and rock excavations. Two working seasons have been earmarked for undertaking excavation. The requirement for which provision of equipment for the surface excavation is to be made is estimated and given in **Table –9.4**.

Table – 9.4

Estimation of Hourly Quantity of Excavation

Description	Soft soil	Murum/ Weathered/ dense medium rock	Hard Rock
Total volume (cum)	2100739	3311456	356631
Time period (months)	13.5	20.25	22.5
No. of years	1.5	2.25	2.5
Shift proposed	2	2	2
Total operational hours (hour) for one season	2250	2250	2250
Volume to be handled in-situ (cum/hr)	622	654	63
Volume to be handled loose (cum/hr)	732	817	86
Total quantity	1339 m^3/hour		
Peak quantity	1674 m^3/hour		

Following construction methods are proposed for surface excavations:

- Stripping and excavation for canal section and loading of the soft material (earth) by 2.0 m^3 hydraulic excavators assisted by front end loader 1.5 cum capacity.
- Stripping and excavation for canal section and loading of the murum by 1.0 m^3 Excavator cum loader (Shoval).
- The rock excavation to be undertaken by drilling and blasting. Jack hammers and wagon/crawler drill with hole patterns of 1m c/c and 2.75 m c/c respectively to be deployed for drilling of charge holes. Loading is considered with 1.0 m^3 Excavator cum loader (Shoval).
- Transportation to the disposal area by 10t capacity Tipper.
- A 90 HP Angle dozer is also considered to stay in the disposal area for spreading of the unloaded materials

9.3.2.2 Fill Placement

The construction of embankment portion of canal involves placement of 5516017 m^3 of fill materials which includes the reuse of 1039630 m^3 spoil material obtained from the deep cut reaches. As per construction schedule, the fill placement is to be undertaken in period of two working seasons. The average distance of borrow area is about 2.0 km.

The fill placement will require excavation and loading of material at the borrow areas/quarries, transportation of the material to the placement site and unloading. It is necessary that various alternative methods and equipment are evaluated and appropriate construction methods and suitable construction equipment are selected.

Hydraulic excavator-rear dumper combination is the most commonly used method of material transportation. The selection of hydraulic excavators depends on the quantities to be handled, limitations of space at the site and the availability of standard equipment. Matching rear dumpers are estimated taking into account the distance to be traveled, the load ratings of haul roads and traffic intensity. This method is considered quite flexible as this allows introduction of additional equipment to supplement the capacity, if required. These equipments are available as standard items and most of the sizes which may be required on river valley projects are manufactured indigenously.

The following construction methods have been considered for hearting fill:

- Excavation by means of 2.0 m^3 hydraulic excavator and proposed to be carried out once in 2 days.
- Loading with front end loader of 1.5 m^3 capacity.
- Transport to the embankment by means of 18/20t capacity rear end dumpers.
- Spreading in layers up to 30 cm thick by 90 HP angle dozer.
- Moisture adjustment by 8000 L water sprinklers.
- Compaction by 8 passes of 10t pad foot vibrating roller.

9.3.2.3 Major Construction Plants and Equipment

Based on above methodology and equipment planning the list of equipment required for construction of canal is given in **Table – 9.5.**

Table – 9.5

Major Construction Plant and Equipments

Sl. No.	Description	Size/ Capa-city	Quantity (Nos.)					
			Soil	Murum	Rock with jack ham-mer	Rock with wagon driller	Emban-kment	Total
1	Hydraulic excavator	2.0 m^3	7	-	-	-	21	28
2	Excavator cum loader (Shoval)	1.0 m^3	-	31	2	4	-	37
3	Crawler/ wagon drill	600 cfm	-	-	-	3	-	3
4	Jack hammer	120 cfm	-	-	9	-	-	9
5	Front end loader	1.5 m^3	7	-	-	-	8	15
6	Rear end Dumper	18/20t	31	-	-	-	59	90
7	Angle dozer	90 HP	4	4	0	1	6	15
8	Vibratory compactor (pad foot)	10t	3	4	1	1	8	17
9	Water sprinklers	8000 L	-	-	-	-	46	46
10	Air compressor	cfm	-	-	5	3	-	8
11	Truck	8/10 ton	-	58	3	9	-	70
12	Water pumps	-	-	5	5	5	5	20

9.3.2.4 Cross Masonry and Cross Drainage Structures

These components normally involves construction of head/cross regulators, outlets, road and railway bridges, canal escapes, cross drainage structures like aqueducts, super passages and canal syphons etc. The structures are located along the canal. The list of structures are shown in **Table-9.6**.

Table - 9.6

List of Structures along the Canal

Sl. No	Details of structures	Nos.
(i)	Road bridges (one SLRB is coupled with outfall structure)	34
(ii)	Railway bridge (canal syphon)	1
(iii)	Aqueduct	6
(iv)	Canal syphon	5
(v)	Super Passage	2
(vi)	Cross regulator (coupled with escape/outlet)	1
(vii)	Head regulator	1
(viii)	Under tunnels (including one elevated trough)	6
(ix)	Canal outlets (including combined structures)	5

The construction of these structures shall be taken up simultaneously with excavation schedule of link canal. These structures are located in isolation. The quantum of excavation and concrete assessed normally is small in quantity, as such it is proposed to deploy concrete mixtures only as per need based. The following machineries are assumed for CD/CM structures.

- Excavation and loading of the soft material by 1.0 m^3 shoval, one for 3 structures
- Concrete mixer of 14/10 cft 1 for each structure
- For rock excavations requiring drilling and blasting, drilling with jack hammers, one for 3 structures
- Transportation to the disposal areas by 5m^3 tippers, one for each structures
- Dewatering pumps one for each structures

9.4 Deployment Schedule

Based on equipment planning and construction programme described in preceding Sections, a construction schedule for whole of the project has been prepared in the form of a Bar Chart and is placed at **Annexure: 9.1**. The number of equipment shown in the **Table 9.5** has been arrived at after scheduling the equipment in such a way that minimum number of equipment, in general, would be needed. As the deployment schedule may differ depending upon the number of executing agencies, the total number of equipment required will have to be reviewed at the time of project execution.

9.5 Total Requirement of Major Construction Equipment

A list of major construction equipment and plants, which would be required for construction of various components of the project and the latest budgetary prices of the equipment have been shown in **Annexure: 9.2**. The total cost of construction equipment has been worked out as Rs. 2438 lakh.

The provision on this account will not be included in the sub-head Q - Special T&P of Cost Estimate when works are to be executed by the contracting agencies.

9.6 Manpower Planning

9.6.1 Organisation Set Up

The project will be implemented by Tamil Nadu State Water Resources Department by setting up separate organisation headed by Chief Executive Officer. The Chief Executive Officer will be assisted by a General Manager and Engineer-in-Chief. The General Manager will be assisted by Director (Administration) and Director (Finance) for administrative and financial matters. The Engineer-in-Chief will assist the Chief Executive Officer in technical matters. The above set-up will be located at Chennai. The works will be executed under the overall supervision of two Superintending Engineers, one for execution and another for Design and Quality Control.

The project circle headed by Superintending Engineer (execution) will have three division offices, each headed by the Executive Engineer. Executive Engineers in turn will have Assistant Engineers as their subordinate officers who will man the Sub-Divisional offices. The Superintending Engineers of (Designs) and (Quality Control) circle will be supported by one Executive Engineer each for Design and Quality control. The Executive Engineers will be further supported by Assistant Engineers and other supporting staff. The division offices for Design, Quality Control and Electrical & Mechanical works will be located at Krishnagiri in addition to a division office for execution of the project. One more division office is proposed for execution of the project at Tirupattur.

The Executive Engineer, Krishnagiri will be responsible for execution of works related to construction of head regulator at Nedungal anicut and 25 km long canal (RD 0 to 25 km) including all structures enroute and the Executive Engineer, Tirupattur will be responsible for execution of remaining part of canal.

The organisation set up and detailed manpower requirement has been indicated in **Annexures: 9.3 to 9.5**.

9.7 General Purpose Equipment and Inspection Vehicles

In case the works are to be executed through award of contract, the general purpose equipment for infra-structure works and inspection and transport vehicles which are required to be procured and used by the project owners for the project have been estimated and indicated in the **Annexure: 9.2**. The total cost of general purpose equipment and inspection vehicles has been worked out as Rs. 313.20 lakh.

9.8 Year Wise Allocation of Cost

The total cost of the project is estimated to be Rs.60197 lakh and the year wise allocation of cost for the project is given in **Table – 9.7**.

Table- 9.7

Yearly Phasing of Expenditure

Year	**Allocation of cost (lakh Rs.)**
1st Year	6500
2nd Year	16200
3rd Year	22700
4th year	19423
Total	**64823**