

CHAPTER - VIII

CONSTRUCTION PROGRAMME, MANPOWER DEPLOYMENT & PLANT PLANNING

8.1 General

This chapter describes the construction methodology and equipment planning for construction of the main components of the project. The construction methodology for each type of structure has been described under the relevant sub sections of this chapter. The type and sizes of the equipment to be used have also been indicated while describing the construction methodology. The number of machines required for construction of each component of the project has been worked out and total requirement for each type and size of the major equipment has been arrived after preparing the construction/ deployment schedule for main components of the project. In case, the work is executed through award of contract, the contractors in all probability may suggest their own construction techniques and equipment for execution of the job based on equipment actually available with them. The tentative requirement of machines as worked out herein will help in analysis of rates of works, cost estimation and in evaluating the reasonableness of the participating bidders' construction techniques and equipment, within overall construction schedule and cost estimate.

8.2 Main project components

An earth fill cum concrete barrage across river Burhi Gandak near Muriaro village in Samastipur district with pond level of 49.0 m and crest level 35 m has been proposed to be constructed.

8.2.1 Salient features of the project

1.0 Headworks

Burhi Gandak Barrage

(i) Location	Near village Muriaro in Samastipur district
Latitude	25 ⁰ 49'35"N
Longitude	85 ⁰ 53'45" E
(ii) Hydrology	
Total catchment area	12,500 sq km
(a) In India	10,150 sq km
(b) In Nepal	2,350 sq km
Mean annual rainfall	1,300 mm
Estimated flood discharge considering 50 years' return period at Sikandarpur G&D site	4920 cumec
Designed discharge	4920 cumec
(iii) Pandage	
Pond level of barrage	49.0 m
Sill level of barrage	35 m
(iv) Barrage	
Type of barrage	Earth fill cum concrete
Top of barrage	54 m
Total length of barrage	611 m
Gates	
Number	16
Size	8 m x 12.8 m
Type	Radial
Height of barrage above the bed level	16 m
Height of barrage above deepest foundation level	36 m
(v) Undersluice	
(a) Length of waterway	28 m
(b) Gates	
Number	3
Size	8 m x 14 m
type	Radial
(c) Design flood	4920 cumec

2.0 Link canal

(a) Length of canal	28.95km
(b) Flow	By gravity
(c) Lining	Lined
(d) Full supply level	
(i) At offtake point	47.50 m
(ii) At outfall point	44.655 m
(e) Full supply depth	5 m
(f) Bed width	
(i) At offtake point	82.10 m
(ii) At outfall point	94.30 m
(g) Side slope	1.1:5
(h) Bed slope	1:20,000
(i) Design discharge	492 cumec

8.3 Basis for study

8.3.1 General

Methodology adopted for construction of Burhi-Gandak-Noon-Baya-Ganga link Project keeping in view the proposed construction schedule, the compatibility of the construction equipments to site conditions and the quantities as well as the utilization factor of the equipments within the scheduled construction period has been described in the foregoing paras . 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 shifted to the other. This way, the total requirement of equipment at a time would be reduced and also, sufficient utilization of equipment on the project would be ensured.

8.3.2 Construction material sources

Locations of different borrow areas and quarries for construction materials have been described in the Chapter II viz. “**Survey and Investigation**”.

8.3.3 Basic considerations

Based on past experience, about 8 working months in a year are available in the area where the project is situated. All the works are proposed to be executed in two shifts.

8.3.3.1 Scheduled working hours

The requirement of equipments has been planned in reference to the “Guidelines for preparation of Detailed Project Report of Irrigation and Multipurpose Projects, MoWR, Govt of India,2010. Requirement of equipments is based on the number of working days available, which further depends upon climatic conditions of the project area. In the project area, the monsoon sets in during June and continues till October in the project area. For equipment planning purpose the monsoon season has been considered from 15th June to 15th October.

As per the standard guidelines, the following assumptions have been made to work out the scheduled working hours considering 25 working days per month

Accordingly, schedule working hours in a year with 200 available working days should be taken as given in **Table 8.1**

Table-8.1

Type of shift	Schedule working hours
Single shift work/day	1200 Hrs (8x25x6)
Two shift work/day	2000 Hrs (8x25x10)
Three shift work/day	2500 Hrs (8x25x12.5)

Two shifts working of equipment is normally considered most economical in view of the high cost of three shift working on account of low availability of equipment and higher stand-by equipment requirement. Thus planning for construction of all the components of Burhi Gandak-Noon-Baya Ganga link canal project works have been carried out based on two shifts per day working.

As per the Guidelines, it is also suggested that if old machines are to be used, schedule working hours should be taken as 80% of those given in the above table.

Provision of standby equipment has been considered as follows:

1. Single shift working	10%
2. Two shift working	20%
3. Three shift working	30%

8.3.3.2 Construction period

A total period of three years has been considered for completion of the project. The 'year' in the context with reference to the construction programme mean the calendar year . It is planned to complete all the works within three years. A cushion of four months is kept i.e. about 10% of the proposed construction period of 3 years in order to complete the delayed works, if any; due to unforeseen reasons/circumstances. The pre-construction surveys and investigations, infra-structural works would be carried out from January of the first year and to finish by first quarter of second year. Preparation of designs & drawings to be completed during second and third quarter of the first year. In case the works are to be executed through award of contract it is planned to award the contract of all the major works .Inviting tenders/bids etc. are proposed to be completed during last quarter of the first year and first quarter of second year. The works pertaining to the diversion of river Burhi Gandak for the purpose of construction of the barrage are proposed to be competed within a stipulated time of 6 months commencing from 4th quarter of 1st year and to be completed by 1st quarter of 2nd year. The work on infrastructure facilities like project colonies, road widening , workshop, stores, office buildings etc. are proposed to be carried out during first full year and first quarter of second year .Some times ,it is very likely that these works may continue for some more time during the second year. The construction of all civil structures head works, canal including CD & CM structures is proposed to be completed by 3rd year. Remaining miscellaneous / delayed works, if any could be taken up in the 4 months time , kept as the cushion .

The detailed construction schedule for the project in the form of a bar chart is attached as **Annexure 8.1**.

8.4 Construction methodology and equipment

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

8.4.1 River diversion works

To facilitate construction of barrage, the river Burhi Gandak will be diverted through left flank so as to avoid the displacement of the inhabitants of Muriaro village by constructing diversion channels. The excavations will be limited to the extent required for diversion of the river.

For diversion works, excavations will have to be carried out. It is planned to complete this work during last quarter of 1st year and 1st quarter of 2nd year. The following construction methods have been considered for river diversion works:

- Excavation and loading of the material by 2.5 cum hydraulic excavator.
- Transport to the disposal area by means of 18/20t rear dumpers.

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

8.4.2 Earth fill portion of barrage

The work of earth filling and the construction of barrage involves surface excavation, placement of fill material, spreading & wetting and compaction of the fill material. The quantities involved are given in **Table 8.2**

Table-8.2

Quantities of earth work involved in construction of the barrage

Item	Quantity	Unit
Excavation	7,97,659	Cum
Earthwork filling placement	1,01,411	Cum

8.4.2.1 Surface excavation

The work of excavation for barrage and earth fill portion across river Burhi Gandak is proposed to be completed in 2nd quarter of 2nd year. The quantity of excavation for which has to be worked out is given in **Table 8.3**.

Table-8.3
Estimation of hourly quantity of excavation

Description	Soil Excavation
Total volume (cum)	797659
Time period (months)	3
Shift proposed	2
Total operational hours (hour)	750
Volume to be handled in-situ (cum/hr)	1063
Volume to be handled loose (cum/hr)	1329

Peak quantity 1661 cum/hr

Following construction methods are proposed for surface excavations

- Stripping and excavation for trenching & preparation of base of barrage by 2.5 cum hydraulic excavators assisted by 180 HP crawler dozer.
- Transportation to the disposal area by 18/20t capacity rear dumper.
- A 180 HP bulldozer is also considered to stay in the disposal area for spreading of the unloaded materials.

8.4.2.2 Fill placement

The work of earth filling and construction of barrage involves placement of 1,01,411 cum of fill materials. As per construction schedule the fill placement is to be undertaken in a period of 3 months during the

non- monsoon period. It is planned to complete this work during the last quarter of 2nd year.

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.

As mentioned above, the fill quantities are to be placed in two working seasons. The hourly placement quantities for filling material have been worked out and given in **Table 8.4**.

Table- 8.4
Estimation of hourly quantity of filling material placement

S.No	Description	Quantity	Unit
1.	Total volume	1,01,411	cum
2.	Time period	3	month
3.	Shift proposed	2	-
4.	Operational hours/month	250	hour
5.	Total operational hours	750	hour
6.	Volume to be handled (in-situ)	135	cum/hour
7.	Volume to be handled (loose)	169	cum/hour

Peak quantity 211 cum /hr

The following construction methods have been considered for filling material placement

- Excavation and loading by means of 2.5 cum hydraulic excavator.
- Transport to the embankment by means of 18/20t capacity rear end dumpers.
- Spreading by 180 HP bulldozer.
- Moisture adjustment by 8000 L water sprinklers.
- Compaction by 8 passes of 10 ton pad foot vibrating roller.

An average distance of 4 km from barrage site has been considered for the borrow areas for fill material.

8.4.2.3 Major plant & equipment for excavation & earth filling

Based on above methodology and equipment planning the list of equipments required for construction of barrage (excavation & earth filling) is given in **Table-8.5**.

Table- 8.5
Equipment required for excavation and earth filling .

S. No.	Description	Size/capacity	Quantity
1.	Hydraulic excavator	2.5 cum	29
2.	Crawler/wagon drill	600 cfm	8
3.	Front end loader	2.5 cum	1
4.	Rear end dumper	18/20t	13
5.	Crawler dozer	180 HP	2
6.	Water sprinklers	8000 L	1
7.	Truck	8/10 ton	2

8.4.2.4 Construction programme of barrage

Main activities to be undertaken for construction of barrage across river Burhi Gandak are discussed below:

The excavation is proposed to be carried out during 2nd quarter of 2nd year. Excavations comprise of common excavation in soil mixed with moorum. Fill placement is proposed to be carried out during 4th quarter of 2nd year. Concreting of barrage is proposed to begin from 1st quarter of 3rd year and to be finished by 3rd quarter by 3rd year. Installation of gates is proposed to be carried out during 4th quarter of 3rd year.

8.4.2.5 Concreting of barrage

The quantities of concrete involve in construction of barrage are given in **Table-8.6**

Table- 8.6**Quantities of concrete involved in construction of barrage**

S. No.	Description	Concrete (cum)
1	Lean concrete (1:4:8) using 3.40 bags of cement/cum below foundation	15985
2	Laying cement concrete (1:3:6) using 4.30 bags of cement/cum	29632
3	Laying cement concrete (1:2:4) using 6.1 bags cement /cum in raft, abutment piers, wing wall	383135
4	Laying cement concrete (1:2:4) using 6.10 bags of cement/cum	38042
5	Laying cement concrete block using 3.4. bags of cement for one cum (1:4:8) M-80	1,0,002
	Total	4,76,796

For concreting of barrage the total quantity of the order of 4.77 lakh cum will have to be placed. A period of 1 working season has been planned for the placement. The concrete required for barrage is proposed to be produced in a centralized Batching and Mixing Plant of capacity 180 cum/hour. The plant shall be located in the vicinity of the proposed barrage site. In addition, one numbers mobile batching & mixing plant each of capacity, 18 cum/hour will be provided. The concrete from the plant will be transported with the help of transit mixers, 4.5 cum capacity.

Following construction equipments have been considered for concreting of barrage

- Placing of concrete with the help of traveling type cranes.
- Concrete transportation by transit mixers of 4.5 cum capacity.
- Batching and mixing plant of capacity 180 cum/hr to be located preferably within a radius of 2 km from the concrete barrage.
- The aggregate crushing and screening plant of 350 tph for preparation of coarse and fine aggregates.

8.4.2.6 List of major construction plant and equipment for barrage

Based on above construction methodology, major construction plant and equipment required for construction of concrete barrage are given in **Table 8.7**

Table- 8.7
Major construction plant & equipment required for construction (concreting) of barrage

S. N0.	Equipments	Size/capacity	Quantity
1	Tippers	4.5 cum	22
2	Aggregate processing plant	350 tph	1
3	Batching & mixing plant	180 cum/hour	1
4	Mobile Batching & mixing plant	18 cum/hour	1
5	Transit mixers	4.5 cum	20
6	Concrete pump with 25m boom	38 cum/hour	3
7	Concrete Vibrator (electrical/pneumatic)	Nos.	34
8	Compressed air	cfm	9600
9	Grout pump	20 kg/m ²	5
10	Trucks	8/10 ton	10

8.5 The link canal

The construction of link canal involves surface excavation in some reaches and placement of fill material in others. The excavations include common excavation. In addition, the canal has to be lined using cement concrete of grade M15 (1:2:4). The quantities involved in construction of the link canal shown in the **Table 8.8**.

Table- 8.8
Quantities involved for lining of link canal.

Item	Quantity	Unit
Excavation	2,59,730	cum
Lining of link canal	2,59,730	cum

The estimation of hourly quantity of excavation is given in **Table 8.9**

Table- 8.9

Estimation of hourly quantity of excavation

Type /description	Common excavation
Total volume (cum)	259730
Time period (months)	6
Shift proposed	2
Total operational hours (hour)	1500
Volume to be handled in-situ (cum/hr)	173
Volume to be handled loose (cum/hr)	216

Peak quantity 270 cum/hr

The construction methodology and equipments for the activities involved in the construction of link canal are as follows. It is proposed to carry out the excavation of link canal during the last quarter of the 2nd year and 1st quarter of 3rd year. The works of lining of canal and construction of CD & CM structures are proposed to be carried out simultaneously and would commence in first quarter of the third year and will be completed by the end of last quarter of the third year.

8.5.1 List of major construction plant and equipment for link canal

Based on above construction methodology, major construction plant and equipments required for construction work of excavation and concreting for lining the link canal are given in **Table 8.10**.

Table- 8.10
Major construction plant and equipment required for
construction of link canal

S. no.	Equipments	Size/capacity	Quantity
1	Hydraulic excavator	2.5 cum	2
2	Front end loader	1.5 cum	1
3	Crawler dozer	180 hp	1
4	Rear dumper	18/20t	10
5	Tippers	4.5 cum	3
6	Aggregate processing plant	100 tph	3
7	Batching & mixing plant	90 cum/hour	1
8	Mobile batching & mixing plant	18 cum/hour	1
9	Transit mixers	4.5 cum	5
10	Concrete pump with 25m boom	38 cum/hour	1
11	Concrete vibrator (electrical/pneumatic)	Nos.	7
12	Compressed air	cfm	1000
13	Grout pump	20 kg/m ²	1
14	Trucks	8/10 ton	3
15	Vibratory compactor (pad foot)	10t	1
16	Vibratory compactor (smooth drum)	10t	1
17	Water sprinklers	8000 L	1

8.5.2 Construction programme of the link canal

The sequence of construction of link canal takes into account the following aspects:

- A period six months has been planned for undertaking the surface excavation beginning from 4th quarter of year 2 and to finish by the end of 1st quarter of 3rd year.
- Concreting for lining is proposed to be carried out in 3rd year full and to be completed by the end December .
- The construction work of CD/CM structures is proposed to be carried out during the same period as above.

8.5.3 Construction programme as a whole

The sequence of construction of Burhi Gandak-Noon-Baya-Ganga link canal project takes into account the following aspects. The same is explained in Annexure 8.1 in Bar chart .

All the pre constructional surveys would be undertaken in the first six month of 1st year .

1. Access of road widening would be carried out in the first quarter of 1st year.
2. The construction of temporary/permanent office cum residential complexes would be carried out from second quarter of the 1st year and to finish by the end of first quarter 2nd year.
3. The preparation of detailed designs & drawings is proposed to be completed during 2nd & 3rd quarter of 1st year.
4. Inviting tenders & award the work is proposed to be completed in six months time commencing from the last quarter of 1st year positively, so that the field work could be under taken in order to complete the project work in the stipulated time frame.
5. The diversion of the river Burhi Gandak is proposed to be carried out during last quarter of 1st year and the first quarter of 2nd year.
6. The construction of barrage across river Burhi Gandak and earth filling is planned subsequently as follows
 - (a) Excavation of foundation is proposed during second quarter of 2nd year.
 - b) Earth filling is proposed to carry out during last quarter of second year.
 - c) Concreting is planned to be completed during first three quarters of third year.
 - (d) Gate installation is planned to be completed during the first three quarters of 3rd year.
7. The construction of link canal and the construction of CD & CM structures is proposed to carry out in the following manner
 - (a) The excavation of link canal is proposed to commence from the forth quarter of second year and to complete by the first quarter

of third year, being non monsoon period.

- (b) The work of lining the link the canal and the construction of CD & CM structures is proposed to be carried out in third year simultaneously.
- (c) The miscellaneous works , partially completed works and delayed works if any, could be completed in the rest of the time of four months provided as cushion .

8.6 Deployment schedule, requirement of major construction equipment , power requirement and key material planning

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: 8.1. Keeping this construction schedule as one of the major criteria, a deployment schedule of major construction equipments that would be required for the project is shown in **Annexure 8.2** long with the cost of equipments as per the latest adopted rates. Accordingly, the total cost of the equipments works out to Rs 10994.00 lakh. The number of equipment shown in the list has been arrived at after scheduling the equipment in such a way that minimum number of equipment, in general, would be needed. The basis for planning, indicating the type of equipment to be used, has already been dealt with in the respective sections and sub-sections corresponding to different items 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.

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

The power requirement is assessed to be of the order of one MW during the construction period of the project. The power will be utilized for the lighting / power supply to the proposed project colonies and for the constructional activities. However, it would be necessary to establish a sub-station for assuring the power supply.

The planning for key material required for the project is carried out in the following manner

Sl No.	Material	Quantity	Yearwise requirement		
			1 st Year	2 nd Year	3 rd Year
1	Cement	65131 cum	5%	5%	90%
2	Steel	300734 tons	5%	5%	90%
3	Explosives	---	---	---	----

The cement and steel could be transported upto nearest railway station, Samastipur, which is situated at a distance of 20 km from the proposed barrage site. The Bokaro steel city, which is nearest source of steel from the project site is located at a distance of 395 km from Samstipur railway station. The other materials like sand and coarse aggregate could be transported through the local roads.

8.7 Organization set up

The project will be implemented under an organisation set-up headed by an officer of the rank of General Manager. All the project works will be executed under the overall supervision of officers of the rank of Chief Engineers who will report to General Manager. In addition, there will be four officers of the rank of Superintending Engineer/Director to assist General Manager viz., Director (personnel), Director (Finance), Director (Quality control) and Director (technical). Each will be assisted by the appropriate subordinate officers and staff. The organisation chart showing the manpower requirement of the project is appended as **Annexure: 8.3**.

There will be three Chief Engineers for the project to look after the works, viz., Chief Engineer (designs), Chief Engineer (Head works) and Chief Engineer (Canals). Each Chief Engineer will be supported by 7 officers of the rank of Superintending Engineer ,who will be heading the field circle offices. Each circle will have two division offices which will be headed by the officers of the rank of Executive Engineers. No separate sub division offices have been proposed as the link canal has small length of 28.95 kms. However, depending upon the field conditions and necessity, sub division offices could be established under the control of the relative division office.

It is proposed that the Chief Engineer (Designs) will have two subordinate offices headed by the officer of the rank of Superintending Engineer (Barrage) and Superintending Engineer (Canal). The works pertaining to the designs of the head works and CD & CM structures will be handled by these offices.

Chief Engineer (Head works) will have three subordinate offices headed Superintending Engineer. Accordingly, there will be Superintending Engineer (Barrage), Superintending Engineer (Embankment) and Superintending Engineer (Electrical & Mechanical) . Superintending Engineer (Barrage) will look after the works pertaining to the barrage construction whereas Superintending Engineer (Embankment) will be handling the works pertaining to embankment Superintending Engineer (Electrical & Mechanical) will be responsible for the arrangements and maintenance of equipments required for the construction work of the project till completion .

The Chief Engineer (Canal) will handle all the works of construction of canal . It is proposed to have two circle offices i.e. Superintending Engineer (canal) and Superintending Engineer (CD/CM structures) .

It is proposed to have two division offices under each circle office in order to look after the construction works of different components of the Burhi Gandak –Noon-Baya-Ganga link canal project.

Thus, the manpower requirement for the purpose of office establishments would be 566 number which includes the technical, administrative and other supporting staff. The abstract is given in **Annexure 8.4**. The details of requirement of staff of the various establishments have been furnished in **Annexure 8.5**. The details of the requirement of field staff have been furnished in **Annexure 8.6**.

8.8 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 8.7**. The total cost of general purpose equipment and inspection vehicles has been worked out as Rs 1081.00 lakh.

8.9 Yearwise allocation of fund

The yearwise allocation of fund for the project is enclosed as **Annexure 8.8**

Table 8.11

Year	Fund requirement in Rs. Lakhs
I year	58512.70
II year	115693.71
III year	247168.54
Total	421374.92