CONSTRUCTION PLANNING

CHAPTER 1 GENERAL DESCRIPTION

1.1 Scope of Works

Construction works of this study section are conveyance canal from KM 86.50 to KM 132.50 including No.7 pumping station and appurtenant structures and three routes of access roads.

1.2 Tender Packages

Tender and contract for this section will be divided into four packages, consisting of three packages manage by NSDO and one package control by REA. Major facilities for each contract packages are summarized as follows;

Table 1.2-1 Major Facilities for Each Packages

Package	Beginning and End Point	Major Facilities
No.1 Package	KM86.50 – KM108.47	No.1 open canal (7.80 km), box culvert (7.50km), No.2 open canal (6.67 km), spillway with spillway outlet channel (2.10 km) and 2 units bridges, No.1 access road (1.00 km) and No.2 access road (2.80 km)
No.2 Package	KM108.48 (KM 108.47) – KM108.86	Sand settling basin (0.38 km), No.7 pumping station (0.13 km), delivery pressured pipeline(3 rows 9.35 km and 3 units x 2 places one-way surge tank), discharge tank (0.20 km) and No.3 access road (5.06 km)
No.3 Package	KM108.86 – KM132.50	No.3 open canal (13.94 km) and 3 units bridges
No.4 Package	At No.7 pumping station	Main substation and administration building

1.3 Preliminary Project Implementation Plan

Preliminary project implementation plan can be illustrated taking into account tender procedures, actual construction periods of the canal and pump equipment in the following table.

Table1.3-1 Preliminary Project Implementation Plan
(Conveyance Canal Systems)

Tender Item	1st year (2000)	2nd year (2001)	3rd year (2002)	4th year (2003)	5th year (2004)	6th year (2005)
Preparation of Document	———					
Tendering Procedure	———	———				
No.1 Package		———	———	———	———	———
No.2 Package		———	———	———	———	———
No.3 Package			———	———	———	———
No.4 Package			———	———	———	———

CHAPTER 2 CONVEYANCE CANALS

2.1 Earth Works of Open Canal and Box Culvert

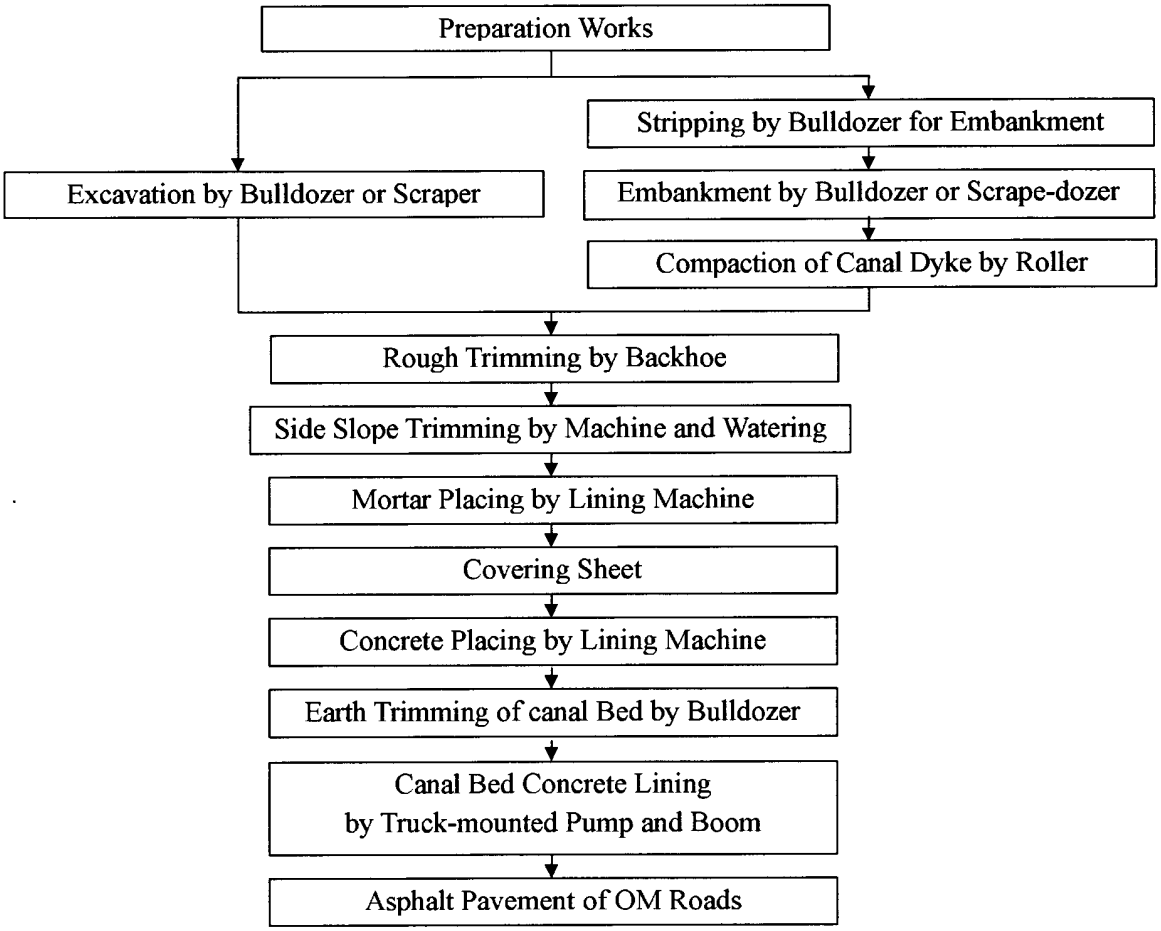
(1) Concepts of Construction Process of Conveyance Canal

The major points of the earth work process are summarized as follows;

1) In considering the earth works of the conveyance canal are large-volume with the soil moving, the excavation and embankment works will be carried out by 21 tons class bulldozer combination with 12 m^3 class scraper.
2) The rough trimming on the slope of the open canal will be carried out by 1.0 m^3 class backhoe after excavation and embankment works.
3) The trimming on the slope of the open canal will be carried out by exclusive slope finisher.

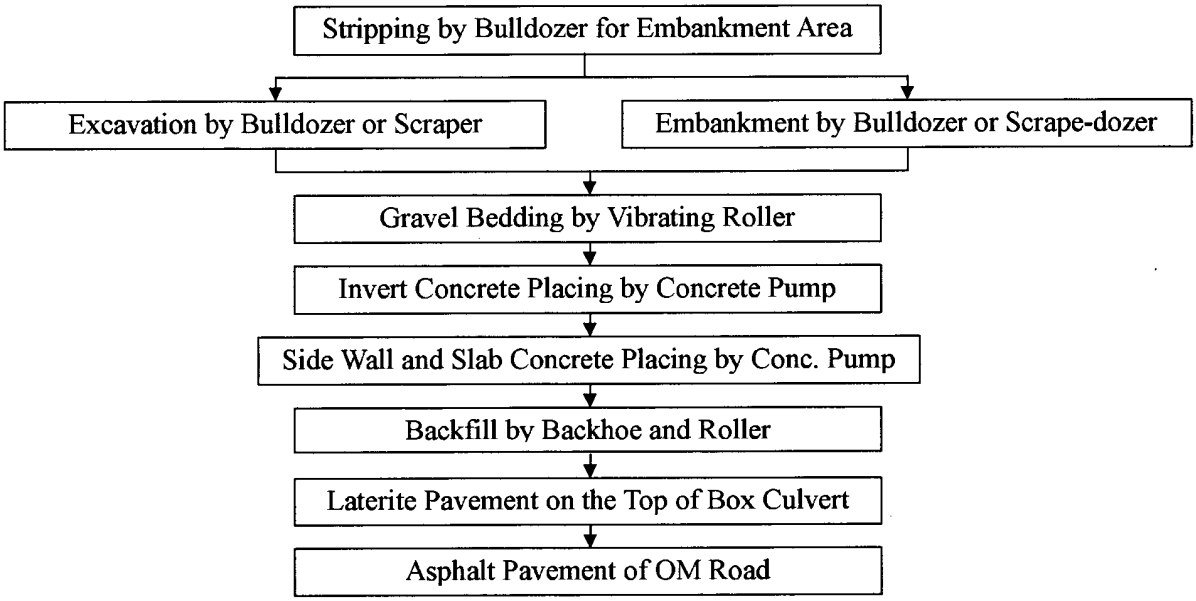
(a) Open Canal :

The flowchart of the open canal is as follow ;



(b) Box Culvert

The flowchart of the box culvert is as follow ;



(2) Workability of Construction Equipment

The workability of construction equipment is shown as the following table.

Table 2.1-1 Workability of Construction Equipment

Construction Equipment	Specification	Workability
Bulldozer (for excavation)	21 ton class, hauling distance = ave. 50 m, cycle time =2.13 min. working eff. = 0.85 (sand, moderate), f = 1.00	480 m^3/day
Scraper (for excavation)	26 ton self-loading (q_0=12.0 m^3), hauling distance = ave. 200m, cycle time = 4.49 min. working eff. = 0.80	385 m^3/day
Backhoe (for excavation)	1.0 m^3 crawler type	520 m^3/day
Bulldozer (for compaction)	21 ton class, compaction thick = 0.30m, compaction = 5 times, working eff. = 0.85 (sand, moderate), f = 1.00	370 m^3/day
Vibrating Roller (for compaction)	5 ton class, speed = 1,000 m/hr, width = 0.8 m, thick = 0.3m, compaction = 5 times, working eff. = 0.40	100 m^3/day
Earth trimming machine (for trimming of side slope)	For one side	350 m/day
Concrete placing machine (for mortar lining)	For one side	280 m/day
Concrete placing machine (for concrete lining)	For one side	140 m/day
Asphalt finisher (for paved asphalt)		2,600 m^2/day

(3) Construction Period

The construction periods of the earth works are shown as the following table.

Table 2.1-2 Construction Period of Earth Works (1/2)

Item	Quantity	Workability	Working Rate	Total Period (days)	Set	Const. Period (months)
1. No.1 Open Canal ; 7,800m and Minimum period of 18 months (540 days)						
Excavation (1)	743,000 m^3					**12**
Bulldozer	297,000 m^3	480 m^3/d	20/30	928	3	11
Scraper	446,000 m^3	385 m^3/d	20/30	1,738	5	12
Excavation (2)	899,000 m^3					**12**
Bulldozer	539,000 m^3	480 m^3/d	20/30	1,684	5	12
Scraper	360,000 m^3	385 m^3/d	20/30	1,403	4	12
Stripping	74,000 m^3					**8**
Bulldozer	74,000 m^3	480 m^3/d	20/30	231	1	8
Fill (1)	971,000 m^3					**12**
Bulldozer	583,000 m^3	370 m^3/d	20/30	2,364	7	12
Scraper	388,000 m^3	385 m^3/d	20/30	1,512	5	11
Vibratory roller	388,000 m^3	100 m^3/d	20/30	5,820	17	12
Fill (2)	1,262,000 m^3					**12**
Bulldozer	505,000 m^3	370 m^3/d	20/30	2,047	6	12
Scraper	757,000 m^3	385 m^3/d	20/30	2,949	9	11
Vibratory roller	757,000 m^3	100 m^3/d	20/30	11,355	32	12
Trimming	15,600 m					**3**
Earth trimming machine	15,600 m	350 m/d	20/30	67	1	3
Asphalt pavement	101,400 m^2					**2**
Asphalt finisher	101,400 m^2	2,600 m^2/d	20/30	59	1	2
2. Box Culvert; 7,500m and Minimum period of 18 months (540 days)						
Excavation (1)	1,090,000 m^3					**12**
Bulldozer	436,000 m^3	480 m^3/d	20/30	1,363	4	12
Scraper	654,000 m^3	385 m^3/d	20/30	2,548	8	11
Excavation (2)	1,370,000 m^3					**12**
Bulldozer	822,000 m^3	480 m^3/d	20/30	2,569	8	11
Scraper	548,000 m^3	385 m^3/d	20/30	2,135	6	12
Stripping	109,000 m^3					**3**
Bulldozer	109,000 m^3	480 m^3/d	20/30	341	4	3
Laterite Bedding	160,000 m^3					**3**
Bulldozer	112,000 m^3	370 m^3/d	20/30	454	6	3
Vibratory roller	48,000 m^3	100 m^3/d	20/30	720	8	3
Fill (1)	1,230,000 m^3					**12**
Bulldozer	861,000 m^3	370 m^3/d	20/30	3,491	10	12
Scraper	369,000 m^3	385 m^3/d	20/30	1,438	4	12
Vibratory roller	369,000 m^3	100 m^3/d	20/30	5,535	16	12
Asphalt pavement	97,500 m^2					**2**
Asphalt finisher	97,500 m^2	2,600 m^2/d	20/30	56	1	2

Table 2.1-2 Construction Period of Earth Works (2/2)

Item	Quantity	Workability	Working Rate	Total Period (days)	Set	Const. Period (months)
3. No.2 Open Canal ; 6,670m and Minimum period of 18 months (540 days)						
Excavation (1)	1,435,000 m^3					**12**
Bulldozer	574,000 m^3	480 m^3/d	20/30	1,794	5	12
Scraper	861,000 m^3	385 m^3/d	20/30	3,355	10	12
Excavation (2)	898,000 m^3					**12**
Bulldozer	539,000 m^3	480 m^3/d	20/30	1,684	5	12
Scraper	359,000 m^3	385 m^3/d	20/30	1,399	4	12
Stripping	144,000 m^3					**3**
Bulldozer	144,000 m^3	480 m^3/d	20/30	450	5	3
Fill (1)	606,000 m^3					**11**
Bulldozer	364,000 m^3	370 m^3/d	20/30	1,476	5	10
Scraper	242,000 m^3	385 m^3/d	20/30	943	3	11
Vibratory roller	242,000 m^3	100 m^3/d	20/30	3,630	11	11
Fill (2)	924,000 m^3					**12**
Bulldozer	370,000 m^3	370 m^3/d	20/30	1,500	5	10
Scraper	554,000 m^3	385 m^3/d	20/30	2,158	6	12
Vibratory roller	554,000 m^3	100 m^3/d	20/30	8,310	24	12
Trimming	13,300 m					**2**
Earth trimming machine	13,300 m	350 m/d	20/30	57	1	2
Asphalt pavement	87,100 m^2					**2**
Asphalt finisher	87,100 m^2	2,600 m^2/d	20/30	50	1	2
4. No.3 Open Canal ; 13,940m and Minimum period of 24 months (720 days)						
Excavation (1)	1,850,000 m^3					**17**
Bulldozer	740,000 m^3	480 m^3/d	20/30	2,313	5	16
Scraper	1,110,000 m^3	385 m^3/d	20/30	4,325	9	17
Excavation (2)	1,660,000 m^3					**18**
Bulldozer	996,000 m^3	480 m^3/d	20/30	3,113	6	18
Scraper	664,000 m^3	385 m^3/d	20/30	2,587	5	18
Stripping	185,000 m^3					**5**
Bulldozer	185,000 m^3	480 m^3/d	20/30	578	4	5
Fill (1)	1,720,000 m^3					**18**
Bulldozer	1,032,000 m^3	370 m^3/d	20/30	4,184	8	18
Scraper	688,000 m^3	385 m^3/d	20/30	2,681	5	18
Vibratory roller	688,000 m^3	100 m^3/d	20/30	10,320	20	18
Fill (2)	2,270,000 m^3					**18**
Bulldozer	908,000 m^3	370 m^3/d	20/30	3,681	7	18
Scraper	1,362,000 m^3	385 m^3/d	20/30	5,306	10	18
Vibratory roller	1,362,000 m^3	100 m^3/d	20/30	20,430	38	18
Trimming	27,900 m					**4**
Earth trimming machine	27,900 m	350 m/d	20/30	120	1	4
Asphalt pavement	182,000 m^2					**2**
Asphalt finisher	182,000 m^2	2,600 m^2/d	20/30	105	2	2

2.2 Concrete Placing of Open Canal and Box Culvert

The major points of the concrete placing work process are summarized as follows ;

1) The mortar and concrete lining will be carried out by exclusive concrete placing machine for side slope of open canal.
2) The concrete works of the box culvert consists trimming of excavated surface, gravel bedding, plain concrete placing, reinforcement and form arrangement, reinforced concrete placing, and curing.
3) For the both dikes of the open canal will be used for the temporary road, the embankment and lower subgrade works will be carried out in parallel.

(1) Workability of Concrete Placing

The workability of concrete placing is shown as the following table.

Table 2.2-1 Workability of Concrete Placing

	Concrete Works	Specification	Workability
Open canal (span length :30m)	Mortar lining (side wall)	L = 30 x 2 = 60m, Workability = 280 m/day	0.21 day/span
	Mortar lining (invert)	L = 30m, Workability = 280 m/day	0.11 day/span
	Concrete lining (side wall)	L = 30 x 2 = 60m, Workability = 140 m/day	0.43 day/span
	Concrete lining (invert)	L = 30 x 2 = 60m, Workability = 140 m/day	0.43 day/span
	Total		**1.2 day/span**
Box culvert (span length :12 m)	Plain concrete placing	45 m^3/span, Workability = 200 m^3/day	0.23 day/span
	Rein. arrangement (invert)	6 ton/span, 10 man/set Workability = 0.30 t/man・day	2.00 day/span
	Concrete placing (invert)	100 m^3/span, Workability = 200 m^3/day	0.50 day/span
	Rein. arrangement (side wall and top slab)	11 ton/span, 10 man/set Workability = 0.30 t/man・day	3.67 day/span
	Concrete placing (side wall and top slab)	190 m^3/span, Workability = 200 m^3/day	0.95 day/span
	Total		**7.4 day/span**

(2) Construction Period

The construction periods are shown as the following table.

Table 2.2-2 Construction Period of Concrete Placing

Item	Quantity	Workability	Working Rate	Total Period (days)	Set	Const. Period (months)
1. No.1 Open canal : 7,800m / 30m = 260 spans						**12**
Mortar lining (side)	260 span	0.21 day/span	20/30	82	1	3
Mortar lining (invert)	260 span	0.11 day/span	20/30	43	1	2
Concrete lining (side)	260 span	0.43 day/span	20/30	168	1	6
Concrete lining (invert)	260 span	0.43 day/span	20/30	168	1	6
2. Box Culvert : 7,500m /12m = 625 spans						**24**
Concrete works	625 span	7.4 day/span	20/30	6,938	10	24
3. No.2 Open canal : 6,670m / 30m = 223 spans						**10**
Mortar lining (side)	223 span	0.21 day/span	20/30	70	1	3
Mortar lining (invert)	223 span	0.11 day/span	20/30	37	1	2
Concrete lining (side)	223 span	0.43 day/span	20/30	144	1	5
Concrete lining (invert)	223 span	0.43 day/span	20/30	144	1	5
4. No.3 Open canal : 13,940m / 30m = 465 spans						**20**
Mortar lining (side)	465 span	0.21 day/span	20/30	146	1	5
Mortar lining (invert)	465 span	0.11 day/span	20/30	77	1	3
Concrete lining (side)	465 span	0.43 day/span	20/30	300	1	10
Concrete lining (invert)	465 span	0.43 day/span	20/30	300	1	10

2.3 Construction of Spillway

(1) Workability of Earth Works

The workability of the earth works is shown in the Table 2.1-1.

(2) Workability of Concrete Placing

The workability of concrete placing is shown as the following table.

Table 2.3-1 Workability of Concrete Placing (1/2)

	Concrete Works	Specification	Workability
Spillway (span length :12 m)	Plain concrete placing	170m^3/span, Workability = 200 m^3/day	0.85 day/span
	Rein. arrangement (invert)	25 ton/span, 10 man/set Workability = 0.30 t/man・day	8.33 day/span
	Concrete placing (invert)	430 m^3/span, Workability = 200 m^3/day	2.15 day/span
	Rein. arrangement (side wall and top slab)	6 ton/span, 10 man/set Workability = 0.30 t/man・day	2.00 day/span
	Concrete placing (side wall and top slab)	100 m^3/span, Workability = 200 m^3/day	0.50 day/span
	Total		**13.8 day/span**

Table 2.3-1 Workability of Concrete Placing (2/2)

Discharge canal (span length :12 m)	Plain concrete placing	15 m^3/span, Workability = 100 m^3/day	0.15 day/span
	Rein. arrangement (invert)	4 ton/span, 5 man/set Workability = 0.30 t/man・day	2.67 day/span
	Concrete placing (invert)	65 m^3/span, Workability = 100 m^3/day	0.65 day/span
	Rein. arrangement (side wall)	2 ton/span, 5 man/set Workability = 0.30 t/man・day	1.33 day/span
	Concrete placing (side wall)	35 m^3/span, Workability = 100 m^3/day	0.35 day/span
	Total		**5.2 day/span**
Box culvert (span length :12 m)	Plain concrete placing	15 m^3/span, Workability = 50 m^3/day	0.30 day/span
	Rein. arrangement (invert)	3 ton/span, 5 man/set Workability = 0.30 t/man・day	2.00 day/span
	Concrete placing (invert)	45 m^3/span, Workability = 50 m^3/day	0.90 day/span
	Rein. arrangement (side wall and top slab)	6 ton/span, 5 man/set Workability = 0.30 t/man・day	4.00 day/span
	Concrete placing (side wall and top slab)	95 m^3/span, Workability = 50 m^3/day	1.90 day/span
	Total		**9.1 day/span**

(3) Construction Period

The construction periods are shown as the following table.

Table 2.3-2 Construction Period of Earth Works (1/2)

Item	Quantity	Workability	Working Rate	Total Period (days)	Set	Const. Period (months)
1. Spillway and Spillway Outlet Channel ; 100 + 2,100m and Minimum period of 18 months (540 days)						
Excavation (1)	370,000 m^3					**10**
Bulldozer	148,000 m^3	480 m^3/d	20/30	463	2	8
Scraper	222,000 m^3	385 m^3/d	20/30	865	3	10
Excavation (2)	230,000 m^3					**12**
Bulldozer	138,000 m^3	480 m^3/d	20/30	431	2	8
Scraper	92,000 m^3	385 m^3/d	20/30	358	1	12
Stripping	35,000 m^3					**2**
Bulldozer	35,000 m^3	480 m^3/d	20/30	109	2	2
Fill and Backfill	91,000 m^3					**12**
Bulldozer (compaction)	91,000 m^3	370 m^3/d	20/30	369	2	7
Bulldozer (spread)	91,000 m^3	480 m^3/d	20/30	284	1	10
Vibrating Roller	91,000 m^3	100 m^3/d	20/30	1,365	4	12
Gravel Bedding	9,600 m^3					**3**
Backhoe	9,600 m^3	520 m^3/d	20/30	28	1	1
Vibrating Roller	9,600 m^3	100 m^3/d	20/30	144	2	3

Table 2.3-2 Construction Period of Earth Works (2/2)

Item	Quantity	Workability	Working Rate	Total Period (days)	Set	Const. Period (months)
2. Dike and Emergency Spillway; 1520m + 200m and Minimum period of 12 months (360 days)						
Excavation (1)	48,000 m^3					**5**
Bulldozer	48,000 m^3	480 m^3/d	20/30	150	1	5
Stripping	4,600 m^3					**1**
Bulldozer	4,600 m^3	480 m^3/d	20/30	16	1	1
Embankment(1)	58,000 m^3					**6**
Bulldozer	35,000 m^3	370 m^3/d	20/30	142	1	5
Scraper	23,000 m^3	385 m^3/d	20/30	90	1	3
Vibrating Roller	23,000 m^3	100 m^3/d	20/30	345	2	6
Embankment(2)	150,000 m^3					**10**
Bulldozer	90,000 m^3	370 m^3/d	20/30	365	2	6
Scraper	60,000 m^3	385 m^3/d	20/30	234	1	8
Vibrating Roller	60,000 m^3	100 m^3/d	20/30	900	3	10
Gravel Bedding	33,000 m^3					**4**
Backhoe	33,000 m^3	520 m^3/d	20/30	95	4	2
Vibrating Roller	33,000 m^3	100 m^3/d	20/30	495	5	4

Table 2.3-3 Construction Period of Concrete Placing

Item	Quantity	Workability	Working Rate	Total Period (days)	Set	Const. Period (months)
1.Spillway : 100m / 12m = 9 spans						**7**
Concrete works	9 span	13.8 day/span	20/30	186	1	7
2. Spillway Outlet Channel; (1,013m + 48m)/12m = (85 + 4) spans						**12**
Discharge canal	85 span	5.2 day/span	20/30	663	2	12
Box culvert	4 span	9.1 day/span	20/30	55	1	2
3. Emergency Spillway : 22m + 13m = (1 +1) spans						**1**
Box culvert	1 span	13.8 day/span	20/30	21	1	1
Concrete flume	1 span	5.2 day/span	20/30	8	1	1

2.4 Construction of Access Road

(1) Workability of Earth and Pavement Works

The workability of the earth works is shown in the Table 2.1-1.

(2) Construction Period

The construction periods are shown in the Table 2.4-1.

Table 2.4-1 Construction Period of Access Road

Item	Quantity	Workability	Working Rate	Total Period (days)	Set	Const. Period (months)
1. No.1 Access Road ; 1,003m and Minimum period of 3 months (90 days)						
Excavation	1,400 m^3					**1**
Bulldozer	1,400 m^3	480 m^3/d	20/30	4	1	1
Stripping	17,500 m^3					**2**
Bulldozer	17,500 m^3	480 m^3/d	20/30	55	1	2
Fill	60,300 m^3					**2**
Bulldozer (compaction)	36,200 m^3	370 m^3/d	20/30	147	3	2
Bulldozer (spread)	24,100 m^3	480 m^3/d	20/30	75	2	2
Vibrating Roller	24,100 m^3	100 m^3/d	20/30	362	7	2
Subgrade	7,400 m^3					**1**
Bulldozer (spread)	7,400 m	480 m/d	20/30	23	1	1
Vibrating Roller	7,400 m^3	100 m^3/d	20/30	111	4	1
Asphalt Pavement	13,000 m^2					**1**
Asphalt Finisher	13,000 m^2	2,600 m^2/d	20/30	8	1	1
2. No.2 Access Road ; 2,796m and Minimum period of 6 months (180 days)						
Excavation	159,000 m^3					**4**
Bulldozer	159,000 m^3	480 m^3/d	20/30	497	5	4
Stripping	44,000 m^3					**3**
Bulldozer	44,000 m^3	480 m^3/d	20/30	138	2	3
Fill	305,000 m^3					**4**
Bulldozer (compaction)	183,000 m^3	370 m^3/d	20/30	742	7	4
Bulldozer (spread)	122,000 m^3	480 m^3/d	20/30	381	4	4
Vibrating Roller	122,000 m^3	100 m^3/d	20/30	1,830	16	4
Subgrade	20,800 m^3					**2**
Bulldozer (spread)	20,800 m	480 m/d	20/30	65	2	2
Vibrating Roller	20,800 m^3	100 m^3/d	20/30	312	6	2
Asphalt Pavement	36,300 m^2					**1**
Asphalt Finisher	36,300 m^2	2,600 m^2/d	20/30	21	1	1
3. No.3 Access Road ; 5,060m and Minimum period of 6 months (180 days)						
Excavation	20,200 m^3					**3**
Bulldozer	20,200 m^3	480 m^3/d	20/30	63	1	3
Stripping	77,200 m^3					**3**
Bulldozer	77,200 m^3	480 m^3/d	20/30	241	3	3
Fill	333,400 m^3					**4**
Bulldozer (compaction)	200,000 m^3	370 m^3/d	20/30	811	7	4
Bulldozer (spread)	133,400 m^3	480 m^3/d	20/30	417	4	4
Vibrating Roller	133,400 m^3	100 m^3/d	20/30	2,001	17	4
Subgrade	37,600 m^3					**2**
Bulldozer (spread)	37,600 m	480 m/d	20/30	118	2	2
Vibrating Roller	37,600 m^3	100 m^3/d	20/30	564	10	2
Asphalt Pavement	65,800 m^2					**2**
Asphalt Finisher	65,800 m^2	2,600 m^2/d	20/30	38	1	2

2.5 Overall Construction Schedules

The overall construction schedules of 1st and 3rd package are shown in the Figure 2.5-1 and 2.5-2.

Description	1st year				2nd year				3 rd year				4th year				Note
	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	
1.Temporary works																	
1.1 Office / workshop																	
1.2 Access roads																	
2.Access road																	
2.1 No.1 Access road																	
2.2 No.2 Access road																	
3.No.1 Open canal																	
3.1 Earth works																	
3.2 Concrete lining																	
3.3 Asphalt pavement																	
4. Box culvert																	
4.1 Earth works																	
4.2 Concrete placing																	
4.3 Asphalt pavement																	
5.No.2 Open canal																	
5.1 Earth works																	
5.2 Concrete lining																	
5.3 Asphalt pavement																	
6. Spillway																	
6.1 Earth works																	
6.2 Dyke embankment																	
6.3 Concrete placing																	
6.4 Gate installation																	
7. Appurtenant facilities																	
7.1 Bridges																	
7.2 Sand settling pits																	

Figure 2.5-1 Construction Schedule of Package 1

Description	1st year				2nd year				3 year				4 year				Note
	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	
1.Temporary works																	
1.1 Office / workshop																	
1.2 Access road																	
2. No.3 open canal																	
2.1 Earth works																	
2.2 Concrete lining																	
2.3 Asphalt pavement																	
3. Appurtenant facilities																	
3.1 Bridges																	
3.2 Sand settling pits																	

Figure 2.5-2 Construction Schedule of Package 3

CHAPTER 3 No.7 PUMPING STATION

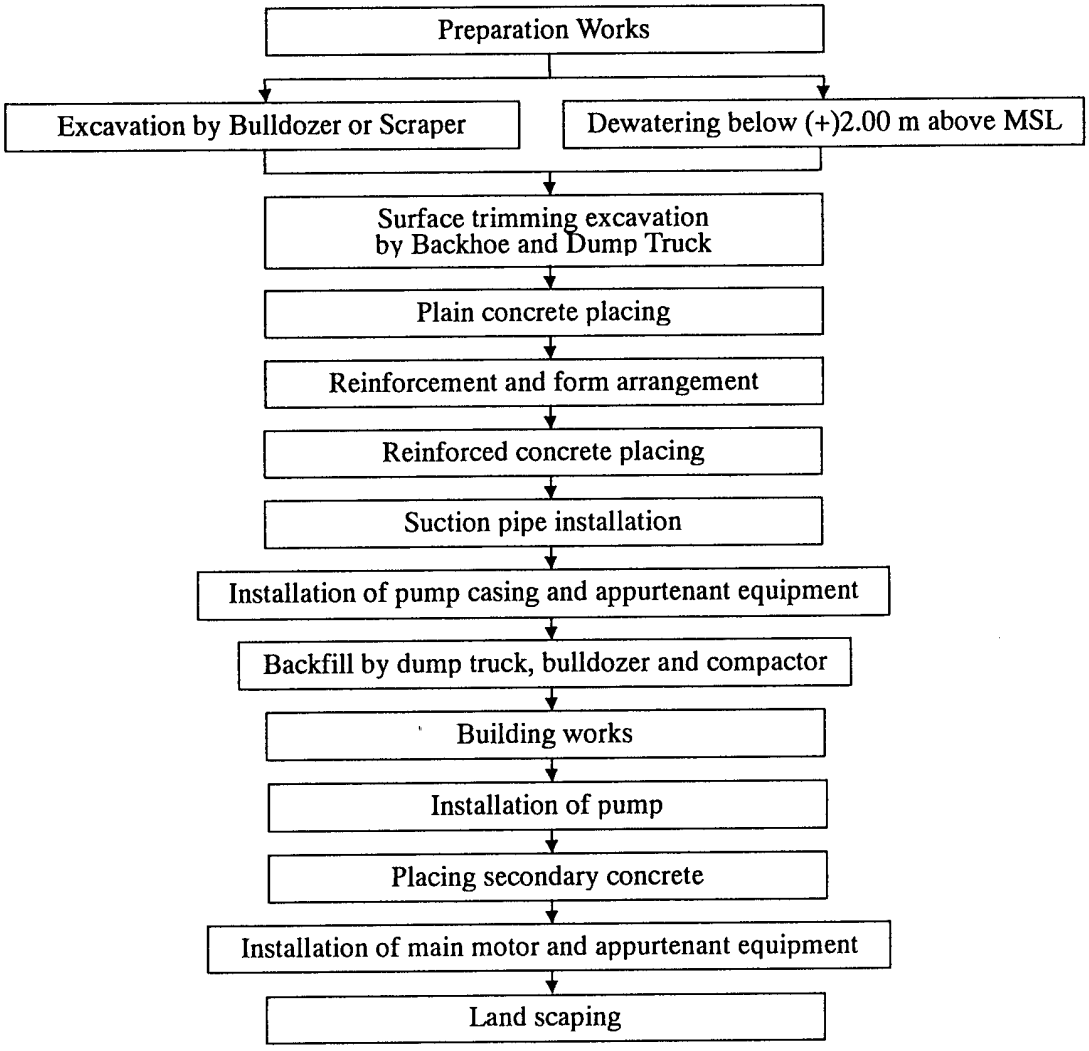
3.1 Earth Works of No.7 Pumping Station

(1) Concepts of Construction Process of No.7 Pumping Station

The major points of the earth work process are summarized as follows;

1) Elevation of ground water is at 2.3 meters in the site. Then it is necessary to keep ground water table at EL. (-) 7.9 meters during construction works below EL. 2.7 meters. After reaching level at EL. (-) 7.4 meters in excavation, gravel treatment and concrete works for lower structure and backfilling will be followed.
2) The excavation and embankment works will be carried out by 21 tons class bulldozer combination with 12 m^3 class scraper.

The flowchart of the No.7 Pumping Station is as follow ;



(2) Workability of Construction Equipment

The workability of construction equipment is shown as the following table.

Table 3.1-1 Workability of Construction Equipment

Construction Equipment	Specification	Workability
Bulldozer (for excavation)	21 ton class, hauling distance = ave. 50 m, cycle time =2.13 min. working eff. = 0.85 (sand, moderate), f = 1.00	480 m^3/day
Scraper (for excavation)	21 ton self-loading (q_0=12.0 m^3), hauling distance = ave. 300m, cycle time = 12.3 min. working eff. = 0.90	330 m^3/day
Backhoe (for excavation)	1.0 m^3 crawler type	520 m^3/day
Bulldozer (for compaction)	21 ton class, compaction thick = 0.30 m, compaction = 5 times, working eff. = 0.85 (sand, moderate), f = 1.00	370 m^3/day
Vibrating Roller (for compaction)	5 ton class, speed = 1,000 m/hr, width = 0.8 m, thick = 0.3m, compaction = 5 times, working eff. = 0.40	100 m^3/day
Dump truck (for transportation)	10 ton class, hauling distance = ave. 500 m, combination with 1.0 m^3 backhoe	170 m^3/day
Earth trimming machine (for trimming of side slope)	For one side	350 m/day
Concrete placing machine (for mortar lining)	For one side	280 m/day
Concrete placing machine (for concrete lining)	For one side	140 m/day
Asphalt finisher (for Paved asphalt)		2,600 m^2/day

(3) Construction Period

The construction periods of the earth works are shown as the following table.

Table 3.1-2 Construction Period of Earth Works (1/2)

Item	Quantity	Workability	Working Rate	Total Period (days)	Set	Const. Period (months)
1. Sand Settling Basin ; 375m and Minimum period of 12 months (360 days)						
Excavation (1)	452,000 m^3					**8**
Bulldozer	271,000 m^3	480 m^3/d	20/30	847	4	8
Scraper	181,000 m^3	330 m^3/d	20/30	823	4	7
Excavation (2)	174,000 m^3					**3**
Bulldozer	87,000 m^3	480 m^3/d	20/30	272	4	3
Scraper	52,000 m^3	330 m^3/d	20/30	236	3	3
Backhoe	35,000 m^3	520 m^3/d	20/30	101	2	2
Fill (2)	109,000 m^3					**6**
Bulldozer	76,000 m^3	370 m^3/d	20/30	308	2	6
Vibrating Roller	33,000 m^3	100 m^3/d	20/30	495	3	6

Table 3.1-2 Construction Period of Earth Works (2/2)

Item	Quantity	Workability	Working Rate	Total Period (days)	Set	Const. Period (months)
Backfill	52,300 m^3					**4**
Bulldozer	36,600 m^3	370 m^3/d	20/30	148	2	3
Vibrating Roller	15,700 m^3	100 m^3/d	20/30	236	2	4
Trimming	750 m					**1**
Earth trimming machine	750 m	350 m/d	20/30	3	1	1
Asphalt pavement	9,400 m^2					**1**
Asphalt finisher	9,400 m^2	2,600 m^2/d	20/30	5	1	1
2. Pumping Station; 130m and Minimum period of 21 months (630 days)						
Excavation (1)	241,000 m^3					**3**
Bulldozer	145,000 m^3	480 m^3/d	20/30	453	5	3
Scraper	96,000 m^3	330 m^3/d	20/30	436	5	3
Excavation (2)	130,000 m^3					**3**
Bulldozer	65,000 m^3	480 m^3/d	20/30	203	3	3
Scraper	39,000 m^3	330 m^3/d	20/30	177	2	3
Backhoe	26,000 m^3	520 m^3/d	20/30	75	1	3
Excavation (3)	27,400 m^3					**1**
Bulldozer	11,000 m^3	480 m^3/d	20/30	34	2	1
Backhoe	16,400 m^3	520 m^3/d	20/30	47	2	1
Fill (2)	2,100 m^3					**1**
Bulldozer	1,500 m^3	480 m^3/d	20/30	5	1	1
Vibrating Roller	600 m^3	100 m^3/d	20/30	9	1	1
Backfill (1)	91,300 m^3					**7**
Bulldozer	63,900 m^3	480 m^3/d	20/30	200	1	7
Vibrating Roller	27,400 m^3	100 m^3/d	20/30	411	2	7
Backfill (2)	7,800 m^3					**2**
Bulldozer	5,500 m^3	480 m^3/d	20/30	17	1	1
Vibrating Roller	2,300 m^3	100 m^3/d	20/30	35	1	2
Trimming	4,000 m^2					**1**
Backhoe	4,000 m^2	500 m^2/d	20/30	12	1	1
Asphalt pavement	6,900 m^2					**1**
Asphalt finisher	6,900 m^2	2,600 m^2/d	20/30	4	1	1

3.2 Dewatering of No.7 Pumping Station

Construction works will be basically conducted according to criteria for canal construction. First step to construction is land clearing and excavation to the level at EL. 13.4 meters. Elevation of ground water table is at EL. 2.3 meters in the site. Then it is possible to proceed excavation without dewatering below to the stage at EL. 2.7 meters. Foundation of the No.7 Pumping Station with gravel treatment will be made on the layer at EL (-) 7.4 meters. Therefore, it is necessary to keep ground water table at EL. (-) 7.9 meters during construction works below EL. 2.7 meters. After reaching level at EL. (-) 7.4 meters in excavation, gravel treatment and concrete works for lower structure and backfilling will be followed.

On the other hand, elevation of settling basin foundation is EL. 1.80 meters and dry work is considered to be difficult. Then, construction works for the bottom of settling basin should be started during dewatering in the period of concrete works for lower structure. Here, it is supposed that dewatering by shallow sump will be necessary in addition. After finishing civil works of pumping station and settling basin, construction of pumping house will be started after those works.

As the method of dewatering mentioned above, deep well and well point should be recommended. However, it is unsuitable to reduce water table by well point system beyond 6.0 m in depth. If well point system is selected, it will be costly in the sake of necessity that well points should be installed in many rows by its limited capacity of suction head. In addition, it is suspected to collapse excavated slope in consideration of high excavation slope, no cohesion and high permeability of soil. Then deep well system should be selected.

At the site of No. 7 pumping station, aquifer is thick and it is difficult to penetrate bottom of well into impermeable layer. Then, to design deep well system, following formula by Dupuit will be adopted to estimate well yields and draw down depth of groundwater table. Numbers of proposed well can be estimated by Q_{max} and q.

$$Q_{max} = C_1 \cdot C_2 \cdot \pi \cdot k \cdot (H^2 - h^2) / 2.3 \cdot (\log_{10} R - \log_{10} A)$$

$$q = 2\pi \cdot r \cdot h_0 \cdot \sqrt{k} / 15$$

Here, Q_{max} : maximum yield of wells (m^3/s)
q : yield of single well (m^3/s)
H : height of static water table (m)
S : proposed draw down depth (m)
h : H – S (m)
k : permeability coefficient (m/s)
R : radius of influence by Sichalt formula ($3000 \times S \times k^{1/2}$ m)
A : radius of image well (m)
C_1: coefficient of allowance (=1.1)
C_2: coefficient of premium for not penetrating into permeable layer (=1.25)

h_0: screen length (m)
r : radius of single well (m)

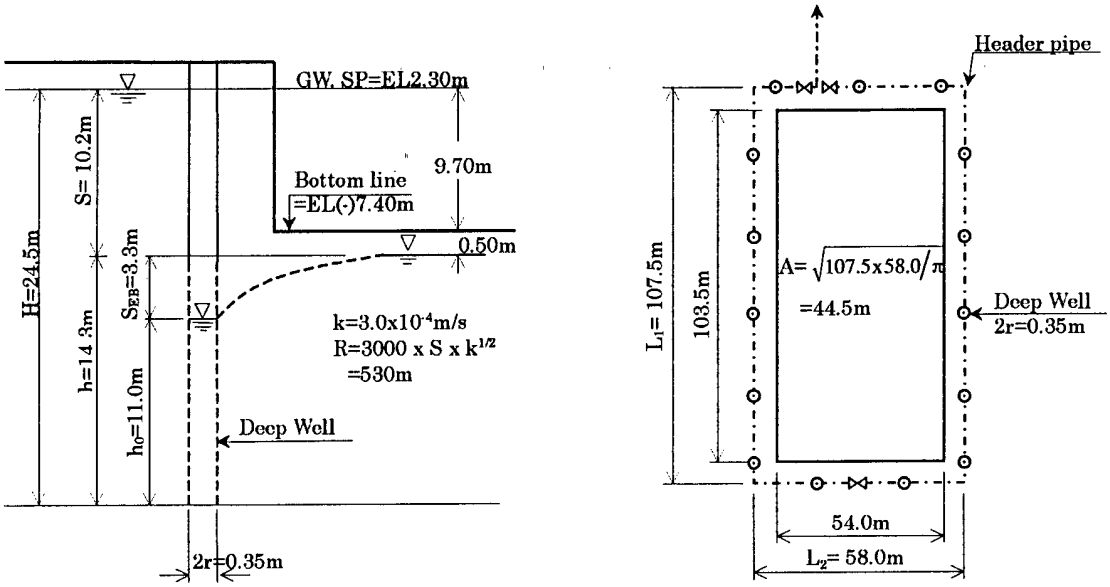


Figure 3.2-1 Dimension of Deep Well

Numbers and dimensions of wells which are necessary for construction will be estimated as follows by these formulas:

Maximum yield of wells : 0.207m^3/s
Diameter of wells : 350 mm
Depth of wells : 28.0 m (including sand trap)
Proposed yield of single well : 13.8 lit./s
Number of wells : 15 nos.

Pumped water will be drained through header pipe to lower place that located at the east-northern part of pumping station. Header pipe will be steel pipe with 350 mm in diameter and total length of 670 m. It is necessary to set up submersible pumps with total head of about 55 m and capacity of 0.828 m^3 per minute. Submersible pump will require about power supply of 15 kwh for each well by generator.

3.3 Reinforced Concrete Placing

The major points of the reinforced concrete placing work process are summarized as follows ;

1) The concrete batching plant will be planned the capacity of 400 m^3/day around the closing point of the conveyance canal and No.3 access road.
2) The concrete will be carried from the concrete batching plant to the site by agitator cars of 6 m^3 capacity.
3) The concrete placing works will be carried out by concrete pump of 100 m^3/hr capacity.

(1) Workability of Concrete Placing

The workability of concrete placing is shown as the following table.

Table 3.3-1 Workability of Concrete Placing (1/3)

	Concrete Works	Specification	Workability
Open canal (span length :30m)	Mortar lining (side wall)	L = 30 x 2 = 60m, Workability = 280 m/day	0.21 day/span
	Mortar lining (invert)	L = 30m, Workability = 280 m/day	0.11 day/span
	Concrete lining (side wall)	L = 30 x 2 = 60m, Workability = 140 m/day	0.43 day/span
	Concrete lining (invert)	L = 30 x 2 = 60m, Workability = 140 m/day	0.43 day/span
	Total		**1.2 day/span**
Sand Settling Basin Gate Section (span length :15 m)	Plain concrete placing	70 m^3/span, Workability = 100 m^3/day	0.70 day/span
	Rein. arrangement (invert)	17 ton/span, 10 man/set Workability = 0.30 t/man・day	5.67 day/span
	Concrete placing (invert)	280 m^3/span, Workability = 300 m^3/day	0.93 day/span
	Rein. arrangement (side wall and top slab)	33 ton/span, 10 man/set Workability = 0.30 t/man・day	11.00 day/span
	Concrete placing (side wall and top slab)	550 m^3/span, Workability = 300 m^3/day	1.83 day/span
	Total		**20.1 day/span**

Table 3.3-1 Workability of Concrete Placing (2/3)

	Concrete Works	Specification	Workability
Sand Settling Basin Wall Section (span length :12 m)	Plain concrete placing	15 m^3/span, Workability = 100 m^3/day	0.15 day/span
	Rein. arrangement (invert)	4 ton/span, 5 man/set Workability = 0.30 t/man・day	2.67 day/span
	Concrete placing (invert)	60 m^3/span, Workability = 100 m^3/day	0.60 day/span
	Rein. arrangement (side wall)	4 ton/span, 5 man/set Workability = 0.30 t/man・day	2.67 day/span
	Concrete placing (side wall)	60 m^3/span, Workability = 100 m^3/day	0.60 day/span
	Total		**6.7 day/span**
Suction Sump (lot length:7.1 m)	Plain concrete placing	30 m^3/lot, Workability = 100 m^3/day	0.30 day/lot
	Rein. arrangement (invert)	13 ton/lot, 10 man/set Workability = 0.30 t/man・day	4.33 day/lot
	Concrete placing (invert)	210 m^3/lot, Workability = 200 m^3/day	1.05 day/lot
	Rein. arrangement (side wall and top slab)	20 ton/lot, 10 man/set Workability = 0.30 t/man・day	6.67 day/lot
	Concrete placing (side wall and top slab)	320 m^3/lot, Workability = 200 m^3/day	1.60 day/lot
	Total		**14.0 day/lot**
Suction Sump (side wall, span length : 8m)	Plain concrete placing	40 m^3/span, Workability = 100 m^3/day	0.40 day/lot
	Rein. arrangement (invert)	5 ton/lot, 5 man/set Workability = 0.30 t/man・day	3.33 day/lot
	Concrete placing (invert)	90 m^3/span, Workability = 100 m^3/day	0.90 day/lot
	Rein. arrangement (wall)	3 ton/span, 5 man/set Workability = 0.30 t/man・day	2.00 day/lot
	Concrete placing (wall)	55 m^3/span, Workability = 100 m^3/day	0.55 day/lot
	Total		**7.2 day/lot**
Pump room (EL.-6.7m ~ -1.4m, lot length : 10.5m)	Plain concrete placing	90 m^3/lot, Workability = 100 m^3/day	0.90 day/lot
	Rein. arrangement (1^{st} lift)	21 ton/lot, 10 man/set Workability = 0.30 t/man・day	7.00 day/lot
	Concrete placing (1^{st} lift)	350 m^3/lot, Workability = 400 m^3/day	0.88 day/lot
	Rein. arrangement (2^{nd} lift)	24 ton/lot, 10 man/set Workability = 0.30 t/man・day	8.00 day/lot
	Concrete placing (2^{nd} lift)	400 m^3/lot, Workability = 400 m^3/day	1.00 day/lot
	Total		**17.8 day/lot**

Table 3.3-1 Workability of Concrete Placing (3/3)

	Concrete Works	Specification	Workability
Pump room (EL.-1.4m ~ 3.15m, lot length : 10.5m)	Rein. arrangement (1st lift)	18 ton/lot, 10 man/set Workability = 0.30 t/man・day	6.00 day/lot
	Concrete placing (1st lift)	300 m^3/lot, Workability = 200 m^3/day	1.50 day/lot
	Rein. arrangement (2nd lift)	21 ton/lot, 10 man/set Workability = 0.30 t/man・day	7.00 day/lot
	Concrete placing (2nd lift)	350 m^3/lot, Workability = 400 m^3/day	0.88 day/lot
	Total		**15.4 day/lot**
Pump room (EL.3.15m ~ 7.7m, lot length : 10.5m)	Rein. arrangement (1st lift)	24 ton/lot, 10 man/set Workability = 0.30 t/man・day	8.00 day/lot
	Concrete placing (1st lift)	400 m^3/lot, Workability = 400 m^3/day	1.00 day/lot
	Rein. arrangement (2nd lift)	27 ton/lot, 10 man/set Workability = 0.30 t/man・day	9.00 day/lot
	Concrete placing (2nd lift)	450 m^3/lot, Workability = 400 m^3/day	1.13 day/lot
	Total		**19.1 day/lot**
Pump room (EL.7.7m ~ 13.4m, lot length : 9.7m)	Rein. arrangement (1st lift)	15 ton/lot, 10 man/set Workability = 0.30 t/man・day	5.00 day/lot
	Concrete placing (1st lift)	250 m^3/lot, Workability = 200 m^3/day	1.25 day/lot
	Rein. arrangement (2nd lift)	15 ton/lot, 10 man/set Workability = 0.30 t/man・day	5.00 day/lot
	Concrete placing (2nd lift)	250 m^3/lot, Workability = 200 m^3/day	1.25 day/lot
	Total		**12.5 day/lot**
Discharge pipe (lot length : 12m)	Plain concrete placing	30 m^3/lot, Workability = 100 m^3/day	0.30 day/lot
	Rein. arrangement (1st lift)	13 ton/lot, 10 man/set Workability = 0.30 t/man・day	4.33 day/lot
	Concrete placing (1st lift)	220 m^3/lot, Workability = 200 m^3/day	1.10 day/lot
	Rein. arrangement (2nd lift)	11 ton/lot, 10 man/set Workability = 0.30 t/man・day	3.67 day/lot
	Concrete placing (2nd lift)	180 m^3/lot, Workability = 200 m^3/day	0.90 day/lot
	Total		**10.3 day/lot**

(2) Construction Period

The construction periods are shown as the following table.

Table 3.3-2 Construction Period of Concrete Placing

Item	Quantity	Workability	Working Rate	Total Period (days)	Set	Const. Period (months)
1.Sand Settling Basin : (7 +2 + 57) spans						**14**
Open canal section	7 span	1.2 day/span	20/30	13	1	1
Gate section	2 span	20.1 day/span	20/30	60	1	3
Wall section	57 span	6.7 day/span	20/30	573	2	10
2.Suction Sump : (35.5m / 7.1m + 16m / 8m) = (5 + 2) lots						**5**
Suction sump	5 lot	14.0 day/lot	20/30	105	1	4
Side wall	2 lot	7.2 day/lot	20/30	22	1	1
3. Pump room ; (52.5m / 10.5m x 3 + 68m / 9.7m) = (5 x 3 + 7) lots						**19**
EL.-6.7m ~ -1.4m	5 lot	17.8 day/lot	20/30	134	1	5
EL.-1.4m ~ 3.15m	5 lot	15.4 day/lot	20/30	116	1	4
EL.3.15 ~ 7.7m	5 lot	19.1 day/lot	20/30	143	1	5
EL.7.7m ~ 13.4m	7 lot	12.5 day/lot	20/30	131	1	5
4. Discharge pipe : 36m / 12m = 3 lots						**2**
Discharge pipe	3 lot	10.3 day/lot	20/30	46	1	2

3.4 Pump House (Building Works)

The following shall be considered for the construction planning of Pump House.

(1) Pump House building is designed to be of reinforced concrete framing, however the roof beams are designed to be of structural steel truss construction due to the long span of 19.5 m with a view to the height of the roof beams of 18.8 m from the ground level. Also construction period by steel truss must be shorter than by reinforced concrete construction. Steel truss beams construction also takes advantage in construction sequence with mechanical installation such as pumps and overhead travelling crane inside the building because it will minimize the use of staging and scaffoldings.

(2) Schedule of the concrete works shall be coordinated with the progress of pumping station civil works. Concrete works can be started when pumping station civil works and concrete works completed and back-filling of surrounding excavated area completed. Enough curing time of the substructure concrete shall be taken. Sufficient working space shall be provided for concrete works and necessary temporary works.

(3) Schedule of roof truss beams construction shall be coordinated with the progress of concrete columns construction. Schedule of overhead travelling crane installation after crane girders installed shall be coordinated with roof truss beams and roof slab constructions.

(4) Considering the location of site capacity and number of concrete plant and other equipment shall be planned, provided and maintained.

(5) Scaffolding and other temporary works shall be adequately planned and provided for safety of construction.

(6) Concrete and the materials shall be tested at the authorized laboratory on regular basis. Adequate number of skilled and unskilled labors shall be provided in order to avoid any delays on construction.

(7) Sufficient capacity of batching plant and other concrete plant, such as concrete pumps and agitator cars shall be planned and provided. As to the volume of concrete, one column from GL to EL+ 18.8 and from EL+18.80 to EL+ 21.00 are estimated to be 24 m^3 and 5.5 m^3 respectively. Such figures shall be taken into the planning of numbers and capacity of concrete plants.

(8) As for steel roof trusses erection, the weight of roof truss is estimated to be 8 ton, type and capacity of crane shall be determined considering that the trusses are assembled on the ground and to be lifted and installed at the level of EL+ 18.8 m.

3.5 Installation of Mechanical and Electrical Equipment

(1) General Requirement for Erection

Following general requirements shall be taken to accomplish the good erection for satisfactory operation.

(a) Prior to erection, full knowledge of work required shall be acquired in reviewing relative drawings and readings carefully.
(b) The erection progress plans shall be drawn up and proper arrangements of workers shall be made.
(c) All packages shall be opened and checked the quantity with the packing list.
(d) Prior to erection, the correctness of shape and quantity, etc of each part shall be checked and reported to the supervisor dispatched from the machine supplier.
(e) Assembling of machine shall proceed after supervisor's confirmation.

(2) Installation of Main Pumps

The pump and related equipment must be correctly installed so that their required capacities can be satisfactorily utilized and operated smoothly for long periods.
Figure 3.5-1 shows installation sequence of the main pumps in a flow chart. (refer to Drawing No.PSM-101 outline of pump and intermediate shaft assembly)

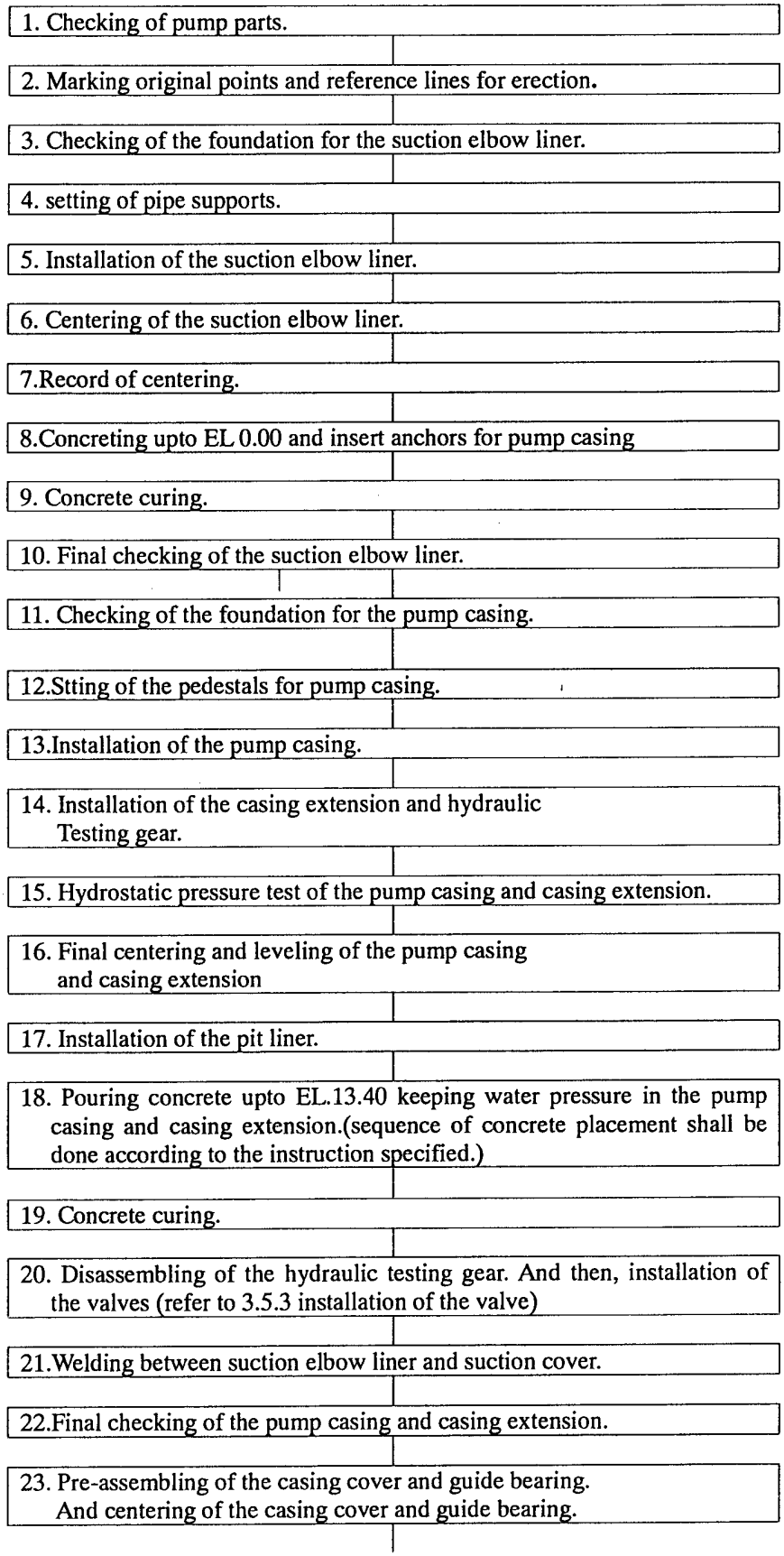


Figure 3.5-1 Flow Chart for Installation of Main Pump (1/2)

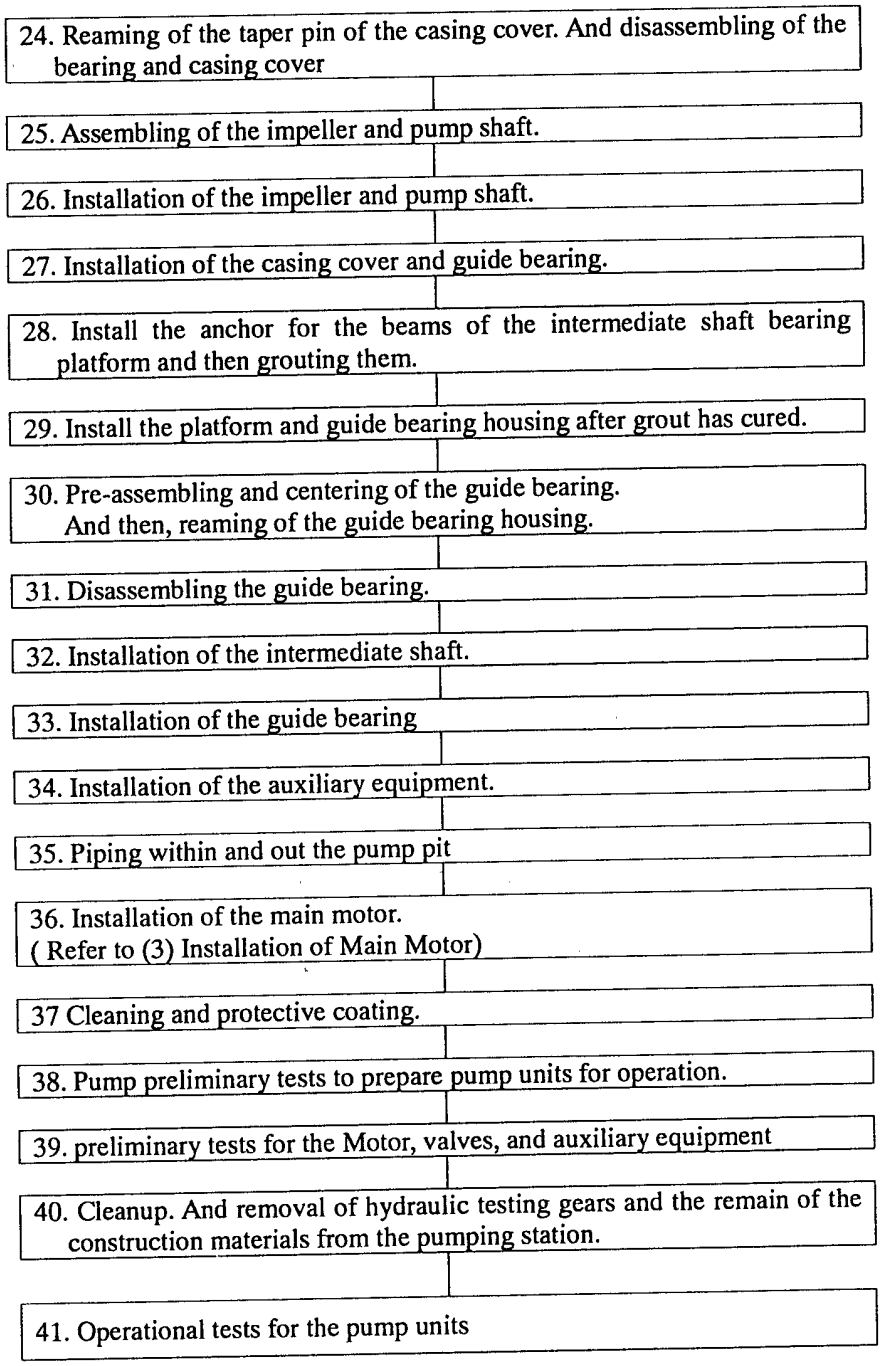


Figure 3.5-1 Flow Chart for Installation of Main Pump (2/2)

(3) Installation of Main Motors

Figure 3.5-2 shows installation sequence of the main motor in a flow chart.

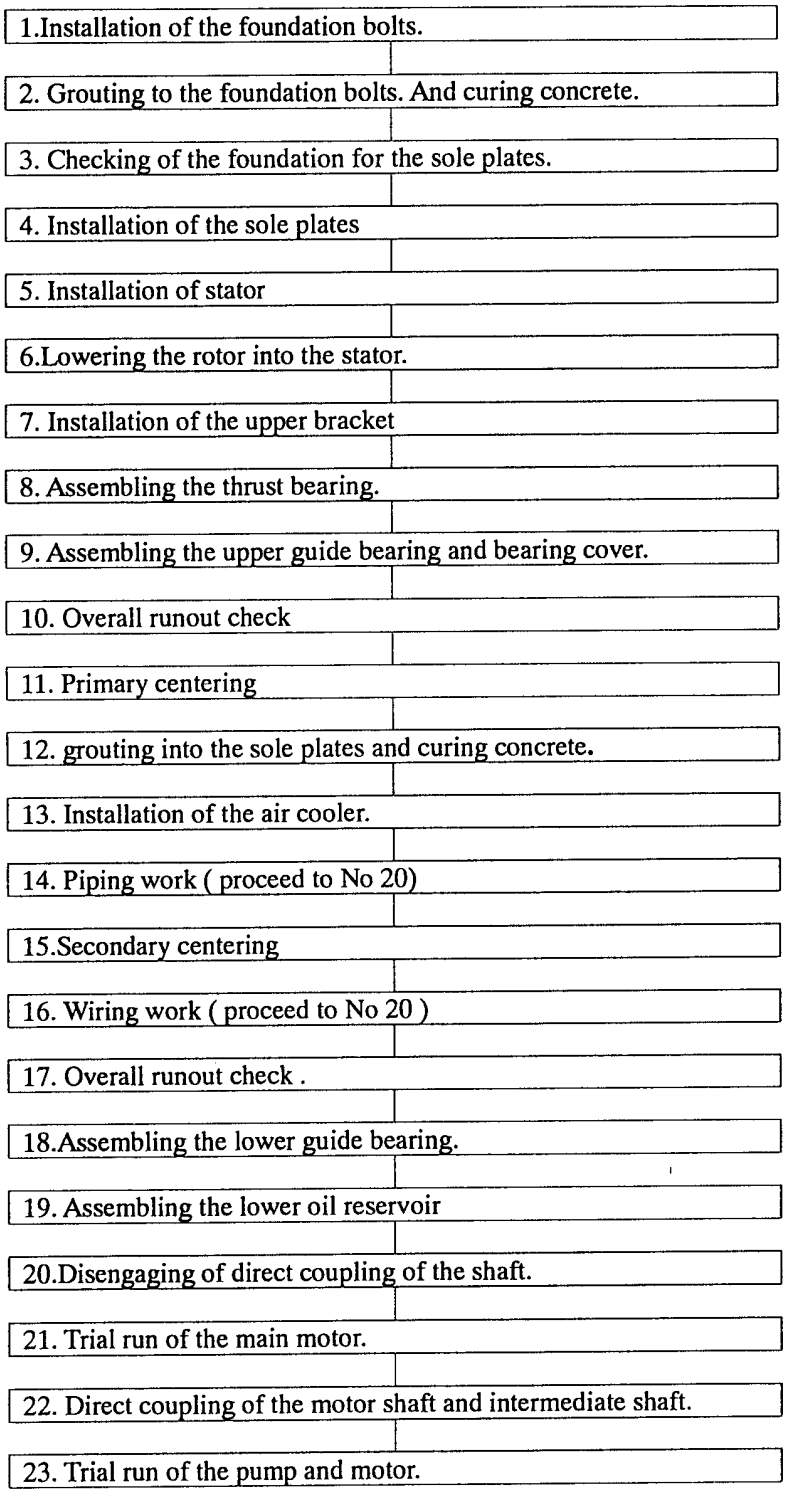


Figure 3.5-2 Flow Chart for Main Motor

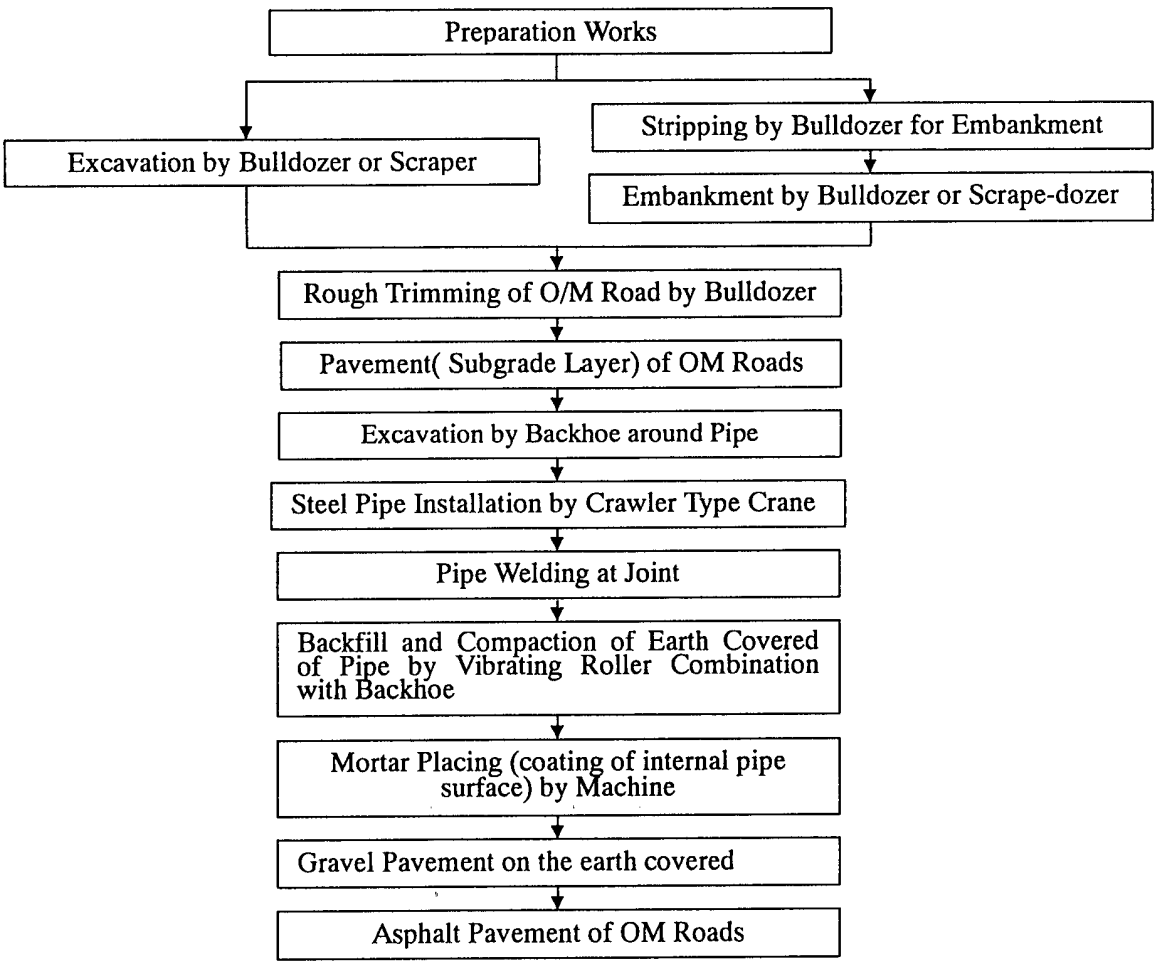
3.6 Civil Works and Installation of Delivery Pressured Pipeline and Discharge Tank

(1) Concepts of Construction Process of Delivery Pressured Pipeline

The major points of the earth works process are summarized as follows ;

1) In considering the earth works of the delivery pressured pipeline are large-volume with the soil moving, the excavation and embankment works will be carried out by 21 tons class bulldozer combination with 12 m^3 class scraper.
2) For the pipes will be protected, the backfill and embankment around the pipes will be carried out by 2.5 tons class vibrating roller combination with 1.0 m^3 class backhoe.

The flowchart of the delivery pressured pipeline is as follow ;



(2) Workability of Earth Works

The workability of earth works is shown as the following table.

Table 3.6-1 Workability of Earth Works

Construction Equipment	Specification	Workability
Bulldozer (for excavation)	21 ton class, hauling distance = ave. 50 m, cycle time =2.13 min. working eff. = 0.85 (sand, moderate), f = 1.00	480 m^3/day
Scraper (for excavation)	21 ton self-loading (q_0=12.0 m^3), hauling distance = ave. 300m, cycle time = 12.3 min. working eff. = 0.90	330 m^3/day
Backhoe (for excavation)	1.0 m^3 crawler type	520 m^3/day
Backhoe (for backfill)	1.0 m^3 crawler type	420 m^3/day
Bulldozer (for compaction)	21 ton class, compaction thick = 0.30 m, compaction = 5 times,. working eff. = 0.85 (sand, moderate), f = 1.00	370 m^3/day
Vibrating Roller (for compaction)	5 ton class, speed = 1,000 m/hr, width = 0.8 m, thick = 0.3m, compaction = 5 times, working eff. = 0.40	100 m^3/day
Vibrating Roller (for compaction)	2.5 ton class, speed = 1,000 m/hr, width = 0.7 m, thick = 0.3m, compaction = 5 times, working eff. = 0.40	80 m^3/day
Asphalt finisher (for Paved asphalt)		2,600 m^2/day

(3) Construction Period of Earth Works

The construction periods of the earth works are shown as the following table.

Table 3.6-2 Construction Periods of Earth Works (1/2)

Item	Quantity	Workability	Working Rate	Total Period (days)	Set	Const. Period (months)
1. Delivery Pressured Pipeline ; 9,400m and Minimum period of 36 months (1,080 days)						
Excavation (1)	2,032,000 m^3					**24**
Bulldozer	813,000 m^3	480 m^3/d	20/30	2,541	4	22
Scraper	1,219,000 m^3	330 m^3/d	20/30	5,541	8	24
Excavation (2)	483,000 m^3					**24**
Backhoe	483,000 m^3	520 m^3/d	20/30	1,393	2	24
Stripping	162,000 m^3					**17**
Bulldozer	162,000 m^3	480 m^3/d	20/30	506	1	17
Fill (1)	850,000 m^3					**23**
Bulldozer	680,000 m^3	370 m^3/d	20/30	2,757	4	23
Vibrating Roller	170,000 m^3	100 m^3/d	20/30	2,550	4	22
Fill (3)	113,000 m^3					**24**
Backhoe	113,000 m^3	370 m^3/d	20/30	458	1	16
Vibrating Roller	113,000 m^3	80 m^3/d	20/30	2,119	3	24
Backfill	326,000 m^3					**23**
Backhoe	326,000 m^3	370 m^3/d	20/30	1,322	2	23
Vibrating Roller	326,000 m^3	80 m^3/d	20/30	6,113	9	23
Asphalt pavement	125,000 m^2					**3**
Asphalt finisher	125,000 m^2	2,600 m^2/d	20/30	72	1	3

Table 3.6-2 Construction Periods of Earth Works (2/2)

Item	Quantity	Workability	Working Rate	Total Period (days)	Set	Const. Period (months)
2. No.1 Surge Tank and Minimum period of 6 months (180 days)						
Excavation (2)	10,800 m^3					**2**
Backhoe	10,800 m^3	520 m^3/d	20/30	31	1	2
Backfill	6,200 m^3					**4**
Backhoe	6,200 m^3	420 m^3/d	20/30	22	1	1
Vibrating Roller	6,200 m^3	80 m^3/d	20/30	116	1	4
3. No.2 Surge Tank and Minimum period of 6 months (180 days)						
Excavation (2)	6,300 m^3					**1**
Backhoe	6,300 m^3	520 m^3/d	20/30	18	1	1
Backfill	4,000 m^3					**3**
Backhoe	4,000 m^3	420 m^3/d	20/30	14	1	1
Vibrating Roller	4,000 m^3	80 m^3/d	20/30	75	1	3
4. Discharge Tank ; 200m and Minimum period of 6 months (180 days)						
Excavation (2)	24,000 m^3					**2**
Bulldozer	12,000 m^3	480 m^3/d	20/30	38	1	2
Backhoe	12,000 m^3	520 m^3/d	20/30	35	1	2
Stripping	12,500 m^3					**2**
Bulldozer	12,500 m^3	480 m^3/d	20/30	39	1	2
Fill (1)	18,500 m^3					**3**
Bulldozer	13,000 m^3	370 m^3/d	20/30	53	1	2
Vibrating Roller	5,500 m^3	100 m^3/d	20/30	83	1	3
Fill (2)	107,000 m^3					**6**
Bulldozer	75,000 m^3	370 m^3/d	20/30	304	2	6
Vibrating Roller	32,000 m^3	80 m^3/d	20/30	600	4	5
Backfill	900 m^3					**1**
Vibrating Roller	900 m^3	80 m^3/d	20/30	17	1	1
Trimming	400 m					**1**
Earth trimming machine	400 m	350 m/d	20/30	2	1	1
Asphalt pavement	3,450 m^2					**1**
Asphalt finisher	3,450 m^2	2,600 m^2/d	20/30	2	1	1

(4) Construction Periods of Pipe Installation and Concrete Placing

The major points of the pipe installation work process are summarized as follows ;

1) The diameter, length and weight of a pipe are 2,400 mm, 12 meters and 15.8 tons per piece, respectively.
2) The pipe will be carried from pipe stockyard to installation place by truck type crane of 50 ~ 60 tons lifting capacity.
3) The pipe will be installed by crawler type crane of 50 ~ 60 tons lifting capacity.

(a) Workability of Pipe Installation and Concrete Placing

The workability of pipe installation and concrete placing are the following table.

Table 3.6-3 Workability of Pipe Installation and Concrete Placing (1/2)

	Concrete Works	Specification	Workability
Pipe Installation (length :12 m)	Adjusting and tap welding by crane	50 ~ 60 tons crane, Workability = 1.0 pcs/day	0.083 day/m
	Total		**0.083 day/m**
No.1 Surge tank (29m x 6m x 9.5m)	Plain concrete placing	35 m^3/lot, Workability = 100 m^3/day	0.35 day/pcs
	Rein. arrangement (invert)	9 ton/lot, 10 man/set Workability = 0.30 t/man · day	3.00 day/pcs
	Concrete placing (invert)	90 m^3/lot, Workability = 200 m^3/day	0.45 day/pcs
	Rein. arrangement (side wall)	51 ton/lot, 10 man/set Workability = 0.30 t/man · day	17.00 day/pcs
	Concrete placing (side wall)	510 m^3/lot, Workability = 200 m^3/day	2.55 day/pcs
	Rein. arrangement (top slab)	7 ton/lot, 10 man/set Workability = 0.30 t/man · day	2.33 day/pcs
	Concrete placing (top slab)	70 m^3/lot, Workability = 200 m^3/day	0.35 day/pcs
	Total		**26.0 day/pcs**
No.2 Surge tank (15.6mx3.6mx6.7m)	Plain concrete placing	15 m^3/lot, Workability = 100 m^3/day	0.15 day/pcs
	Rein. arrangement (invert)	2 ton/lot, 5 man/set Workability = 0.30 t/man · day	1.33 day/pcs
	Concrete placing (invert)	30 m^3/lot, Workability = 100 m^3/day	0.30 day/pcs
	Rein. arrangement (side wall)	6 ton/lot, 5 man/set Workability = 0.30 t/man · day	4.00 day/pcs
	Concrete placing (side wall)	95 m^3/lot, Workability = 100 m^3/day	0.95 day/pcs
	Rein. arrangement (top slab)	2 ton/lot, 5 man/set Workability = 0.30 t/man · day	1.33 day/pcs
	Concrete placing (top slab)	25 m^3/lot, Workability = 100 m^3/day	0.25 day/pcs
	Total		**8.3 day/pcs**
Discharge Tank (20mx23.7mx6.6m)	Plain concrete placing	50 m^3/lot, Workability = 100 m^3/day	0.50 day/pcs
	Rein. arrangement (invert)	18 ton/lot, 10 man/set Workability = 0.30 t/man · day	6.00 day/pcs
	Concrete placing (invert)	300 m^3/lot, Workability = 200 m^3/day	1.50 day/pcs
	Rein. arrangement (side wall)	6 ton/lot, 5 man/set Workability = 0.30 t/man · day	4.00day/pcs
	Concrete placing (side wall)	450 m^3/lot, Workability = 200 m^3/day	2.25 day/pcs
	Total		**14.3 day/pcs**

Table 3.6-3 Workability of Pipe Installation and Concrete Placing (2/2)

	Concrete Works	Specification	Workability
Open canal (span length :30m)	Mortar lining (side wall)	L = 30 x 2 = 60m, Workability = 280 m/day	0.21 day/span
	Mortar lining (invert)	L = 30m, Workability = 280 m/day	0.11 day/span
	Concrete lining (side wall)	L = 30 x 2 = 60m, Workability = 140 m/day	0.43 day/span
	Concrete lining (invert)	L = 30 x 2 = 60m, Workability = 140 m/day	0.43 day/span
	Total		**1.2 day/span**

(b) Construction Periods of Pipe Installation and Concrete Placing

The construction periods of pipe installation and concrete placing are shown as the following table.

Table 3.6-4 Construction Periods of Pipe Installation and Concrete Placing

Item	Quantity	Workability	Working Rate	Total Period (days)	Set	Const. Period (months)
1.Pipe installation: 9,350 m x 3 rows = 28,050 m						**24**
Pipe installation	28,050 m	0.083 m/day	20/30	3,492	5	24
2.Surge Tank: 2 places						**3**
No.1 Surge tank	1 pcs	26.0 day/pcs	20/30	39	1	2
No.2 Surge tank	1 pcs	8.3 day/pcs	20/30	12	1	1
3.Discharge tank : (1 pcs + 6 spans)						**2**
Concrete works	1 pcs	14.3 day/pcs	20/30	21	1	1
Open canal section	6 span	1.2 day/span	20/30	11	1	1

3.7 Overall Construction Schedule

The overall construction schedule of 2nd package is shown in the Figure 3.7-1.

Description	1st year				2nd year				3rd year				4 year				Note
	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	
1.Temporary works																	
1.1 Office / workshop																	
1.2 Access roads																	
1.3 Dewatering																	
1.4 Power supply																	
2.Access road																	
2.1 No.3 Access road																	
3.Sand settling basin																	
3.1 Earth works																	
3.2 Concrete placing																	
3.3 Gate installation																	
4.No.7 pumping station																	
4.1 Excavation																	
4.2 Backfill																	
4.3 Concrete placing																	
4.4 Main pump																	
4.5 Electric equipment																	
4.6 Building works																	
4.7 Appurtenant equip.																	
5. Pressured pipeline																	
5.1 Earth works																	
5.2 Pipe supply / install																	
5.3 One-way surge tank																	
5.4 Valves / fittings																	
6. Discharge tank																	
6.1 Earth works																	
6.2 Concrete placing																	
7. Land scape																	

Figure 3.7-1 Construction Schedule of Package 2

CHAPTER 4 POWER SUPPLY

4.1 Installation of Equipment and Building Works

(1) Installation of Equipment

The following maters shall be considered to make construction schedule of the installation of the equipment for power supply.

(a) The main substation building shall be completed before bring in the electrical equipment in the site.

(b) The main substation shall be completed before beginning of test running the No. 7 Pumping station to supply test power to the facilities.

(c) The 66 kV transmission lines shall be completed before beginning of test running of the Main substation to supply test power.

(2) Building Works

The following shall be considered for the construction planning of Administration Buildings and Main Substation.

(a) Site for Main Substation and Administration Building is located to the north area of Pumping Station. Both buildings are single storied and therefore, designed to be of reinforced concrete framing structure.

(b) Foundations are designed to be of spread footing and the base shall be compacted sufficiently prior to start concrete works.

(c) There would be no difficulty in construction in comparison with the Pump House in view of the buildings size and height. Construction of two building can be started as soon as site grading and temporary access completed. Building works including foundation works shall be started independently from the pump house construction.

(d) Together with foundation works, cable trench works shall be proceeded.

(e) The volume of concrete for two buildings is relatively smaller than those of pump house and the pumping station. However, it is proposed that the Fourth Package Contractor shall provide his own batching plant and the other concreting plant in order to avoid any interference with the other package contractors and maintain his construction schedule.

(f) Schedule of the building and finishing works shall be coordinated with the electrical

equipment installation works. Electrical installation can start when finishing works completed, however the finished area shall be temporarily covered and cured in order to avoid damages caused from delivery and installation of the equipment, otherwise, electrical installation works shall be started prior to completion of building finishing works.

(g) Scaffolding and other temporary works shall be adequately planned and provided for safety of construction.

(h) Considering the location of site capacity and number of concrete plant and other equipment shall be planned, provided and maintained.

(i) Concrete and the materials shall be tested at the authorized laboratory on regular basis.

(j) Adequate number of skilled and unskilled labors shall be provided in order to avoid any delays on construction.

4.2 Overall Construction Schedule

The overall construction schedule of 4th package is shown in the Figure 4.2-1.

Description	1st year				2nd year				3rd year				Note
	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	
1.Temporary works													
1.1 Office / workshop													
1.2 Access road													
2. Earth works													
2.1 Excavation													
2.2 Backfill													
3. Building works													
3.1 Substation													
3.2 Administration													
4. Substation equipment													
4.1 Manufacturing													
4.2 Transportation													
4.3 Installation													
4.4 Testing /commission													
5. Transmission line													
5.1 Equipment supply													
5.2 Tower / civil works													
5.3 Cable installation													

Figure 4.2-1 Construction Schedule of Package 4