

### 5.3.5. Basic Design Drawing

The basic design which illustrates the layout and dimensions of various structures and facilities as described in the previous paragraph are shown in the following list of drawings:

1-1	Musaverema Dam
1-2	Musaverema Conveyance Facilities
2-1	Magudu Dam
2-2	Magudu Conveyance Facilities
3-1	Munjauganja Dam
3-2	Munjauganja Conveyance Facilities
4-1	Chinyamatumwa Dam
4-2	Chinyamatumwa Conveyance Facilities
5-1	Mashoko Dam
5-2	Mashoko Conveyance Facilities
6-1	Mabvute Dam
6-2	Mabvute Conveyance Facilities
G-1	Appurtenant Structure of Conveyance Facilities
G-2	Night Storage Reservoir

### 5.3.6. Construction Machines and Equipment

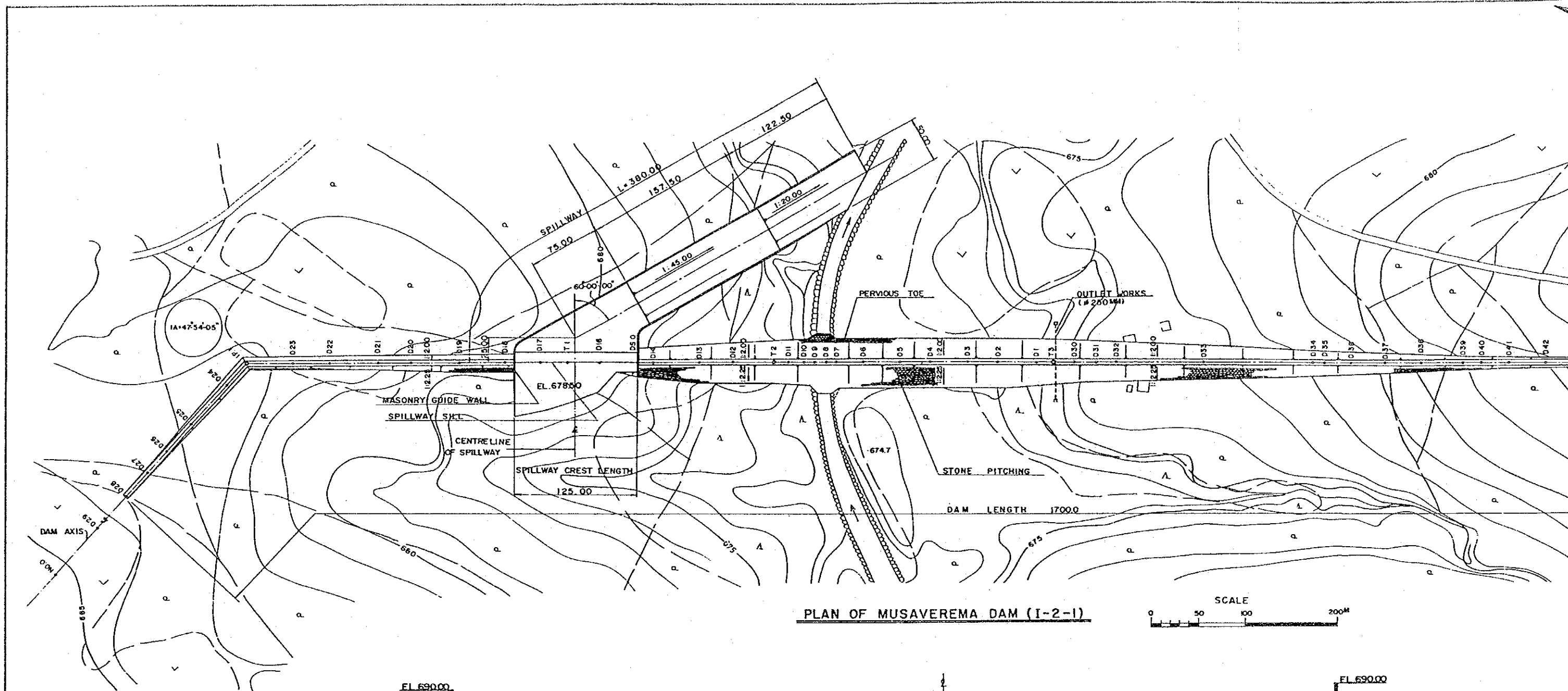
#### (1) Construction Period

Contractor will commence the main construction works followed by temporary works when the construction contract is enforced. The construction period will be 14 months taking into consideration the extension of Exchange of Note and the period of the detail design work.

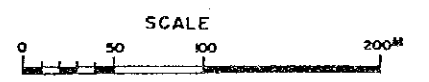
#### (2) Construction Work Volume

In order to examine the required number of construction machines, the work volume of the Musaverema project, which has the largest work volume among the designated six projects is selected.

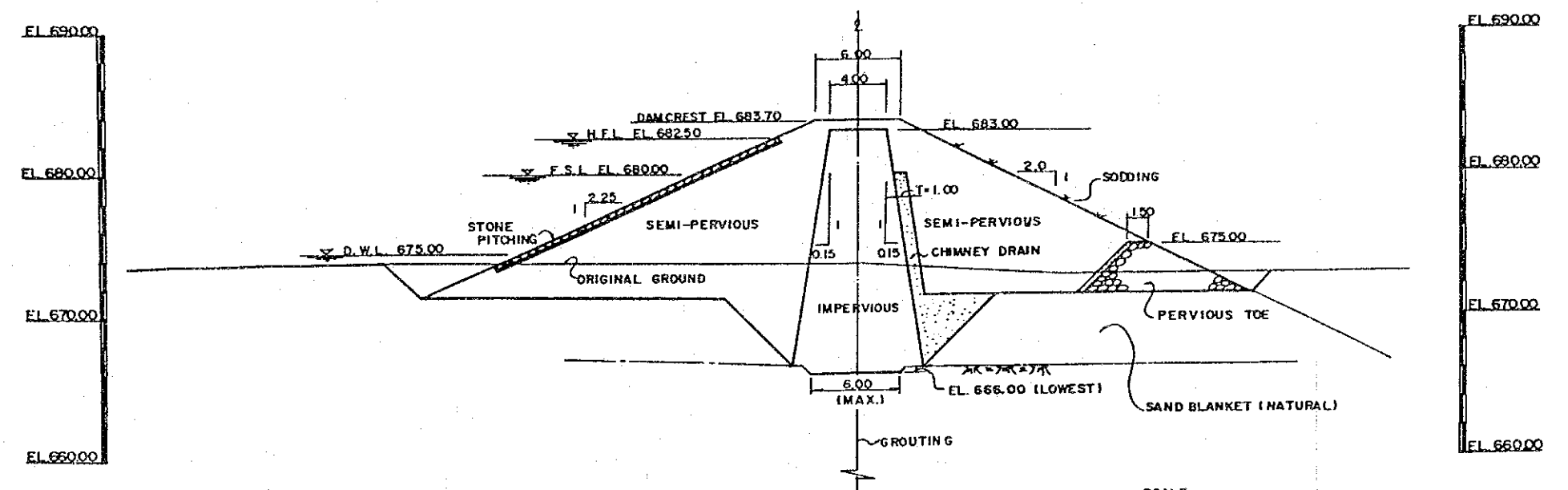




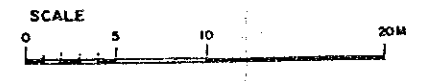
PLAN OF MUSAVEREMA DAM (I-2-1)

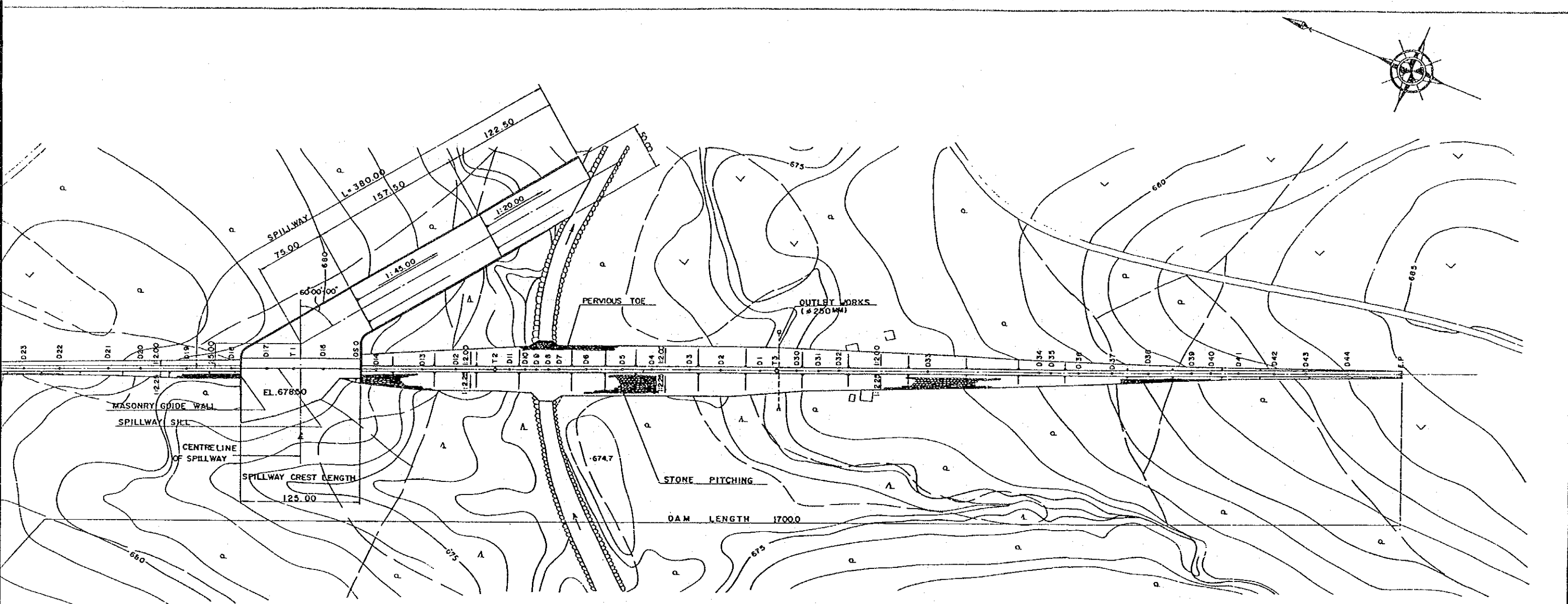


DAM DIMENSION	
CATCHMENT AREA	131.0 KM <sup>2</sup>
GROSS STORAGE CAPACITY	7.526 MCM
FULL SUPPLY CAPACITY	6.653 MCM
TOTAL VOLUME OF SEDIMENT	0.873 MCM
HIGH FLOOD LEVEL	682.5 M
FULL SUPPLY LEVEL	680.0 M
DEAD WATER LEVEL	675.0 M
DAM TYPE	ZONE TYPE FILL DAM
DAM HEIGHT	12.7 M
DAM LENGTH	1700.0 M
DAM CREST ELEVATION	683.7 M
EMBANKMENT VOLUME	231300.0 M <sup>3</sup>
DESIGN FLOOD DISCHARGE	835.0 M <sup>3</sup> /SEC
DESIGN SPILLWAY CAPACITY	835.0 M <sup>3</sup> /SEC
SPILLWAY TYPE	NON-GATED OVER FLOW TYPE
OVERFLOW DEPTH	2.5 M
SPILLWAY CREST LENGTH	125.0 M
INTAKE CAPACITY	54.0 L/SEC

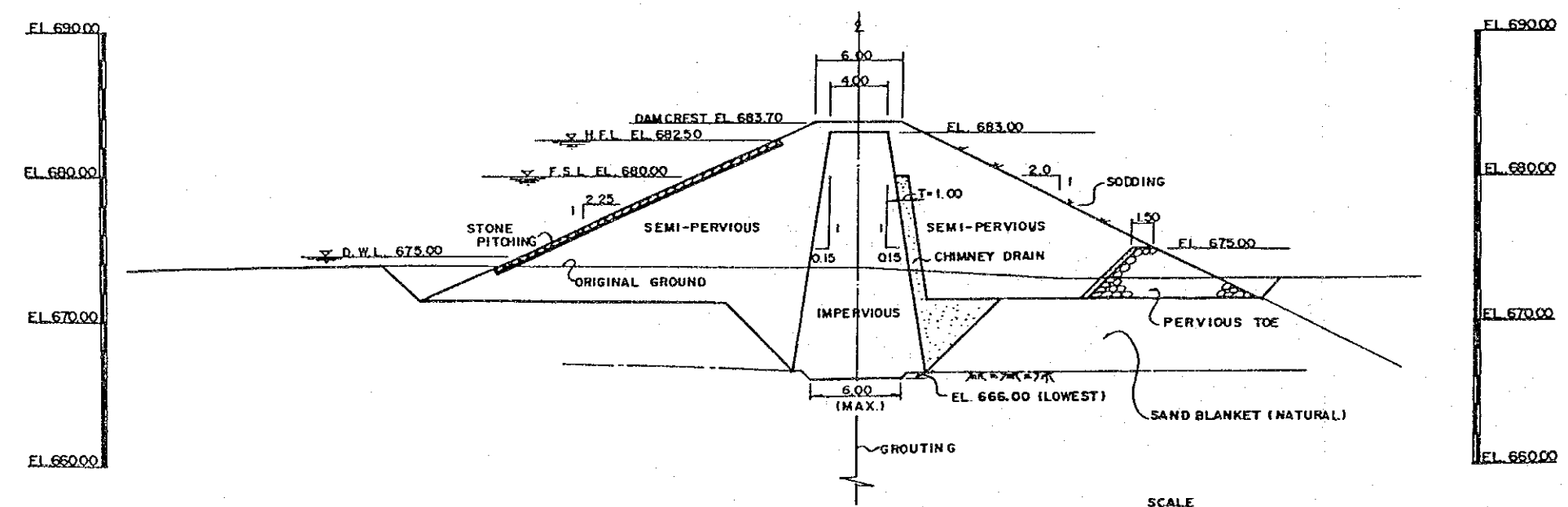
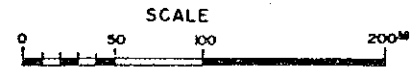


TYPICAL CROSS SECTION OF DAM

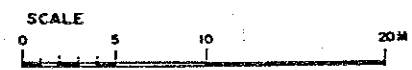




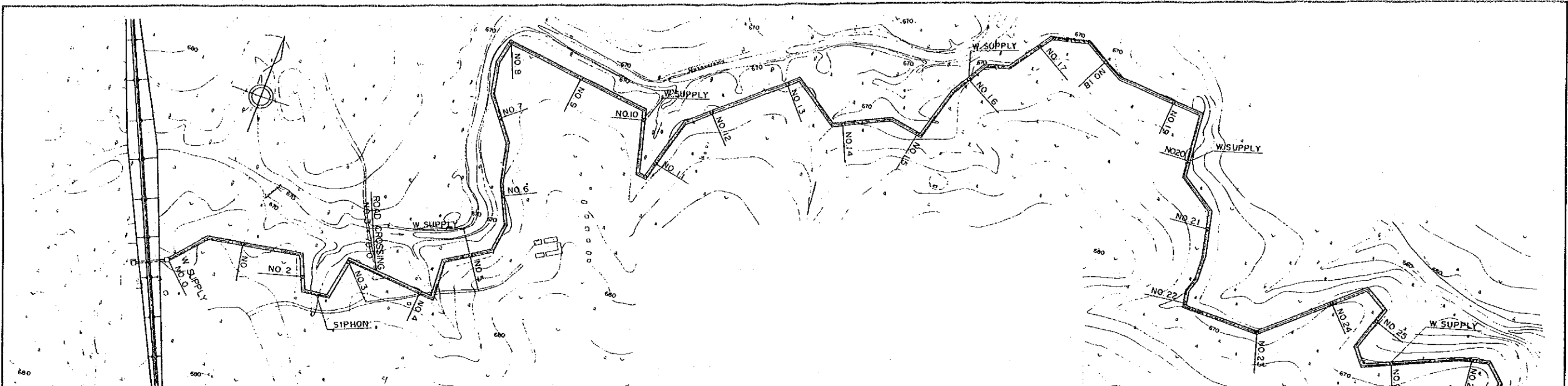
PLAN OF MUSAVEREMA DAM (I-2-1)



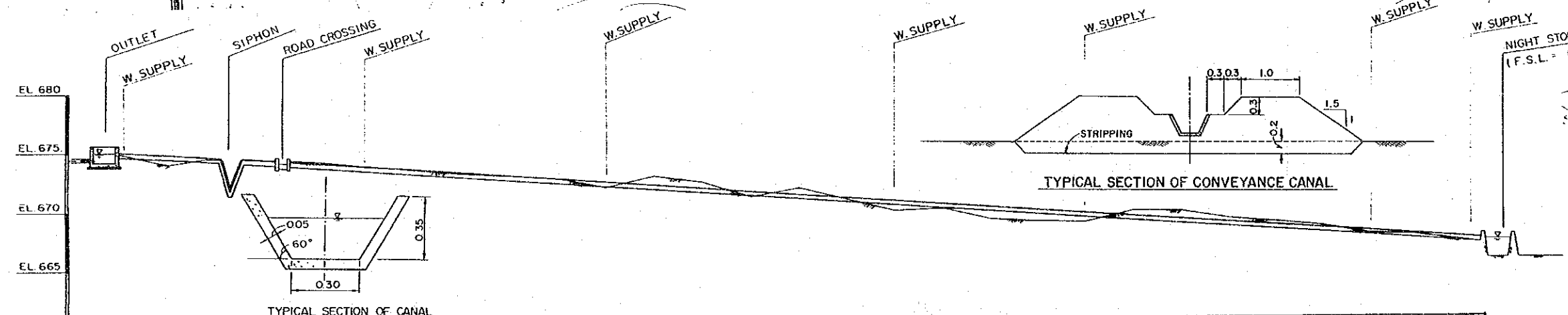
TYPICAL CROSS SECTION OF DAM



I-1 MUSAVEREMA DAM



PLAN OF CANAL

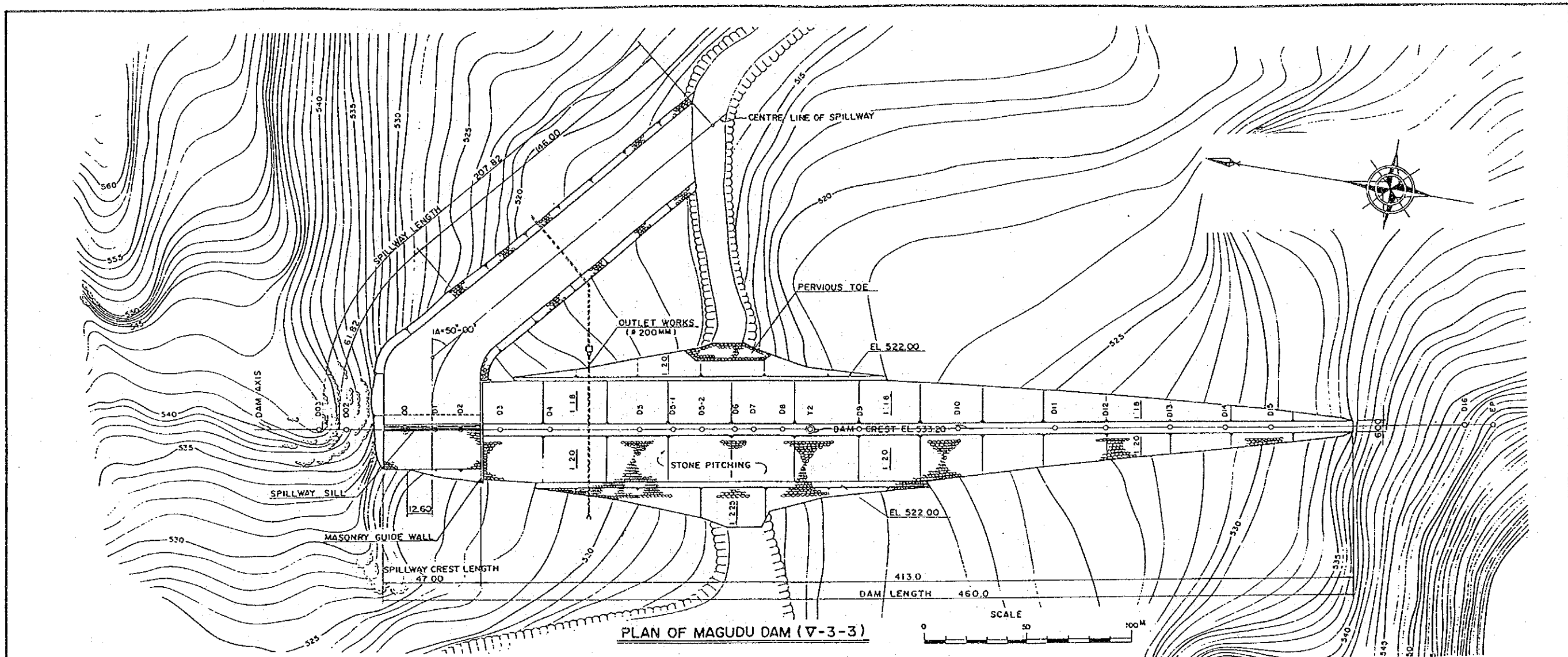


TYPICAL SECTION OF CONVEYANCE CANAL

STATION NO	DISTANCE	ACCUMULATED DISTANCE	GROUND ELEVATION	CANAL BOTTOM ELEVATION	WATER LEVEL	CANAL SLOPE
NO 0	0.0	0.0	674.2	673.60	673.85	1:1000
NO 1	200.0	200.0	673.2	673.40	673.65	
NO 2	200.0	400.0	673.7	673.20	673.45	
+35.0	35.0	435.0	673.3	673.17	673.42	
+60.0	60.0	460.0	672.0	671.00	673.35	
+100.0	100.0	500.0	673.7	673.10	673.35	
NO 3	100.0	600.0	673.6	673.00	673.25	
+70.0	70.0	670.0	674.6	672.93	673.18	
NO 4	130.0	800.0	673.6	672.80	673.05	
NO 5	200.0	1000.0	673.3	672.60	672.85	
NO 6	200.0	1200.0	673.0	672.40	672.65	
NO 7	200.0	1400.0	672.8	672.20	672.45	
NO 8	200.0	1600.0	672.7	672.00	672.25	
NO 9	200.0	1800.0	672.5	671.80	672.05	
NO 10	200.0	2000.0	671.8	671.60	671.85	
NO 11	200.0	2200.0	672.8	671.40	671.65	
NO 12	200.0	2400.0	672.4	671.20	671.45	
NO 13	200.0	2600.0	671.2	671.00	671.25	
NO 14	200.0	2800.0	672.0	670.80	671.05	
NO 15	200.0	3000.0	671.1	670.60	670.85	
NO 16	200.0	3200.0	670.2	670.40	670.65	
NO 17	200.0	3400.0	670.6	670.20	670.45	
NO 18	200.0	3600.0	669.6	670.00	670.25	
NO 19	200.0	3800.0	669.4	669.80	670.05	
NO 20	200.0	4000.0	669.3	669.60	669.85	
NO 21	200.0	4200.0	670.3	669.40	669.65	
NO 22	200.0	4400.0	670.3	669.20	669.45	
NO 23	200.0	4600.0	669.6	669.00	669.25	
NO 24	200.0	4800.0	669.3	668.80	669.05	
NO 25	200.0	5000.0	669.0	668.60	668.85	
NO 26	200.0	5200.0	668.3	668.40	668.65	
NO 27	200.0	5400.0	668.1	668.20	667.45	
NO 28	200.0	5600.0	667.7	668.00	668.25	
+30.0	30.0	5630.0	667.5	667.97	668.22	

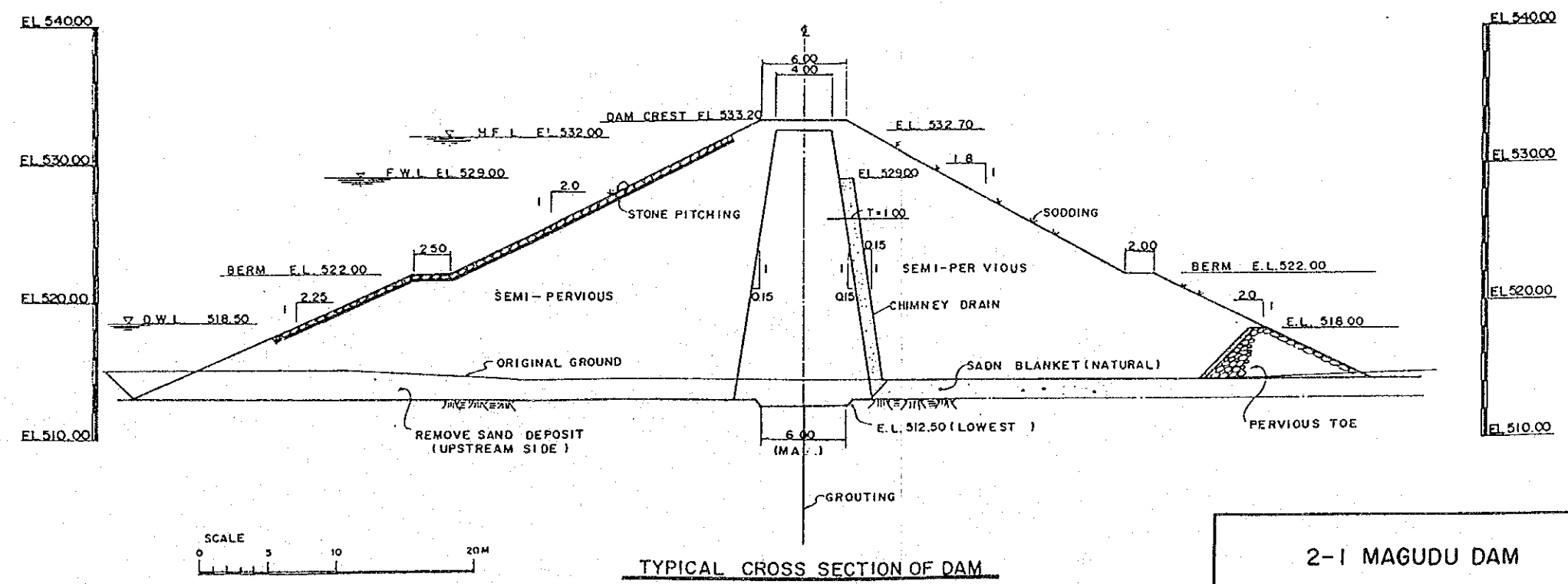
LONGITUDINAL SECTION OF CANAL

I-2 MUSAVEREMA  
CONVEYANCE FACILITIES



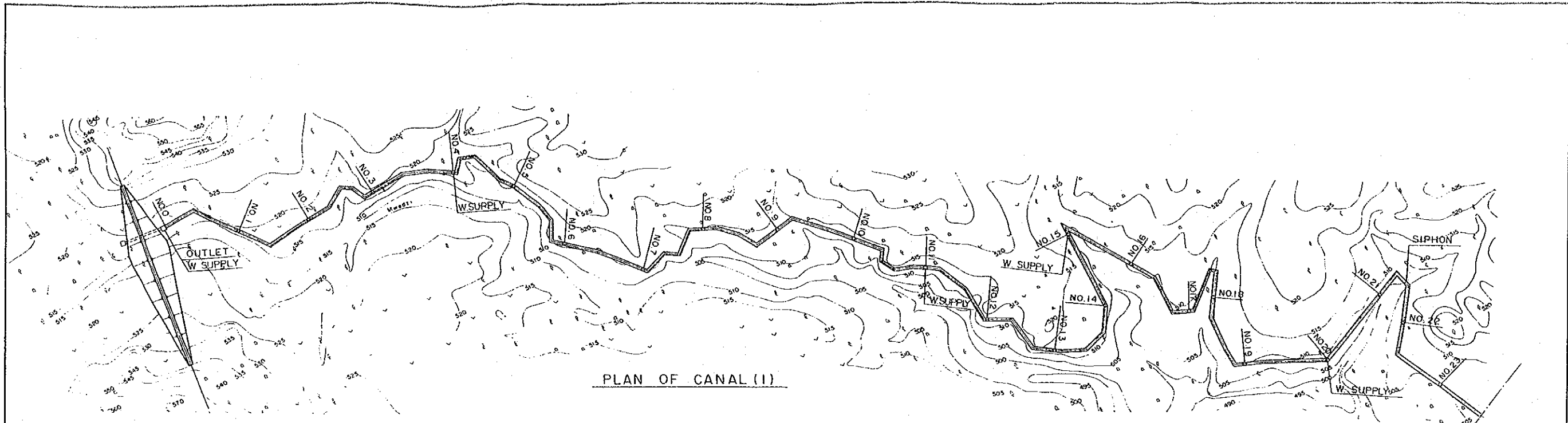
PLAN OF MAGUDU DAM (V-3-3)

DAM DIMENSION	
CATCHMENT AREA	41.9 KM <sup>2</sup>
GROSS STORAGE CAPACITY	5.840 MCM
FULL SUPPLY CAPACITY	5.672 MCM
TOTAL VOLUME OF SEDIMENT	0.168 MCM
HIGH FLOOD LEVEL	532.0 M
FULL SUPPLY LEVEL	529.0 M
DEAD WATER LEVEL	518.5 M
DAM TYPE	ZONE TYPE FILL DAM
DAM HEIGHT	18.8 M
DAM LENGTH	460.0 M
DAM CREST ELEVATION	533.2 M
EMBANKMENT VOLUME	160,400.0 M <sup>3</sup>
DESIGN FLOOD DISCHARGE	415.0 M <sup>3</sup> /SEC
DESIGN SPILLWAY CAPACITY	415.0 M <sup>3</sup> /SEC
SPILLWAY TYPE	NON-GATED OVER FLOW TYPE
OVERFLOW DEPTH	3.0 M
SPILLWAY CREST LENGTH	47.0 M
INTAKE CAPACITY	76.0 L/SEC

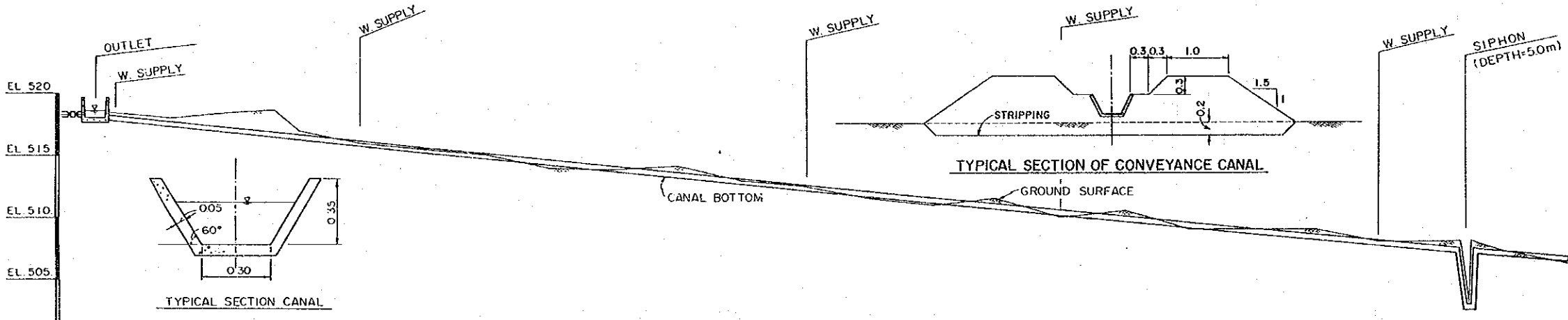


TYPICAL CROSS SECTION OF DAM

2-1 MAGUDU DAM



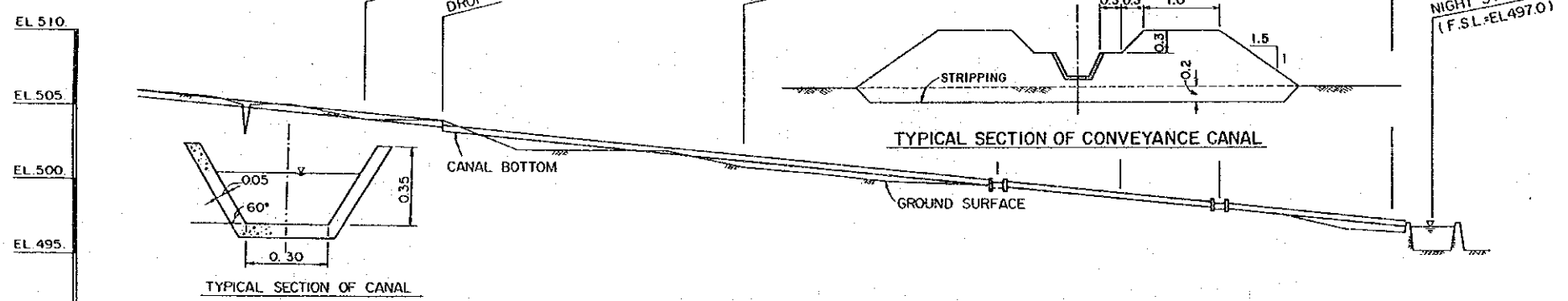
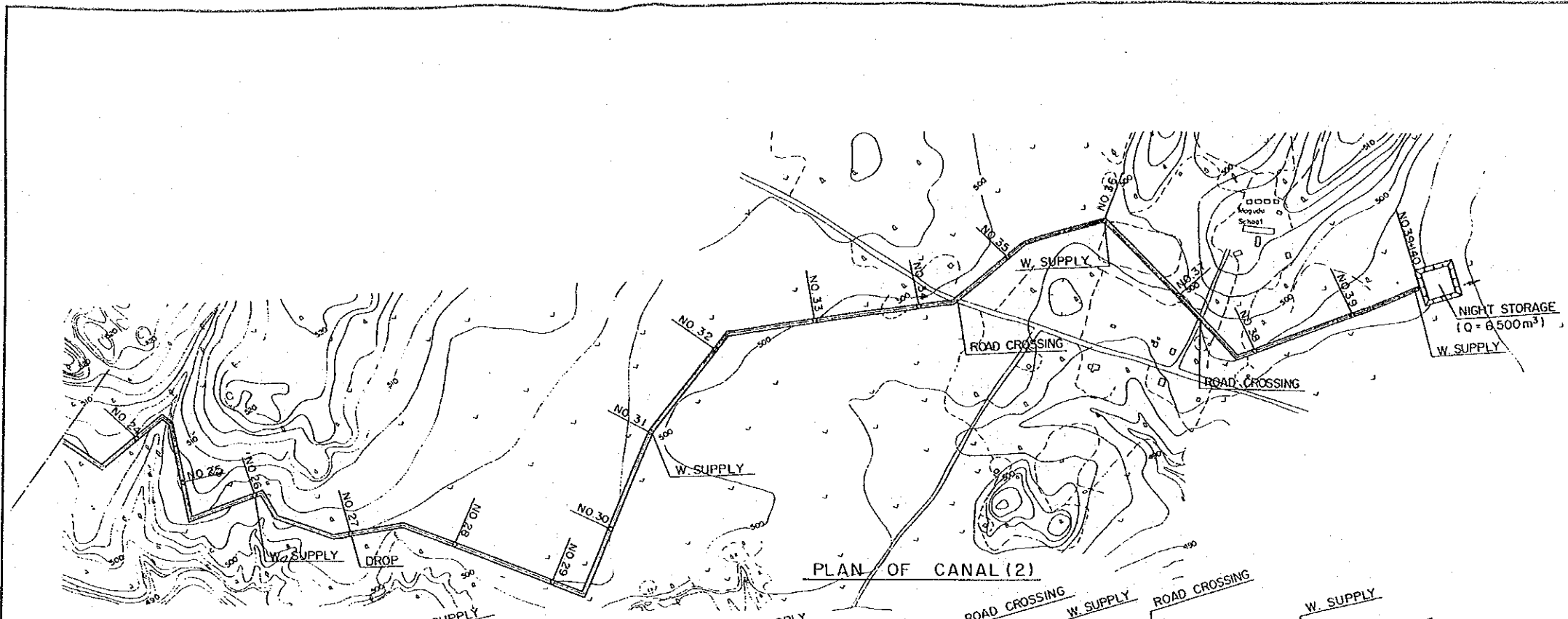
PLAN OF CANAL (I)



LONGITUDINAL SECTION OF CANAL (I)

STATION NO.	DISTANCE	ACCUMULATED DISTANCE	GROUND ELEVATION	CANAL BOTTOM ELEVATION	WATER LEVEL	CANAL SLOPE
NO. 0	0.0	0.0	517.2	517.10	517.33	1:1/400 L=4290m
NO. 1	200.0	200.0	517.1	516.60	516.83	
NO. 2	200.0	400.0	517.1	516.10	516.33	
NO. 3	200.0	600.0	516.1	515.60	515.83	
NO. 4	200.0	800.0	516.0	515.10	515.33	
NO. 5	200.0	1000.0	514.5	514.60	514.87	
NO. 6	200.0	1200.0	514.6	514.10	514.33	
NO. 7	200.0	1400.0	513.6	513.60	513.83	
NO. 8	200.0	1600.0	513.5	513.10	513.33	
NO. 9	200.0	1800.0	513.9	512.60	512.83	
NO. 10	200.0	2000.0	512.7	512.10	512.33	
NO. 11	200.0	2200.0	512.2	511.60	511.83	
NO. 12	200.0	2400.0	511.2	511.10	511.33	
NO. 13	200.0	2600.0	510.7	510.60	510.83	
NO. 14	200.0	2800.0	510.7	510.10	510.33	
NO. 15	200.0	3000.0	509.7	509.60	519.83	
NO. 16	200.0	3200.0	510.2	509.10	509.33	
NO. 17	200.0	3400.0	506.7	508.60	508.83	
NO. 18	200.0	3600.0	508.7	508.10	508.33	
NO. 19	200.0	3800.0	508.7	507.60	507.83	
NO. 20	200.0	4000.0	507.6	507.10	507.33	
NO. 21	200.0	4200.0	507.6	506.60	506.83	
+50.0	60.0	4260.0	507.6	506.45	506.68	
+50.0	30.0	4290.0	503.0	506.35	506.58	
+100.0	10.0	4300.0	507.3	506.35	506.58	
NO. 22	100.0	4400.0	507.3	506.10	506.33	

2-2 MAGUDU CONVEYANCE FACILITIES (1/2)

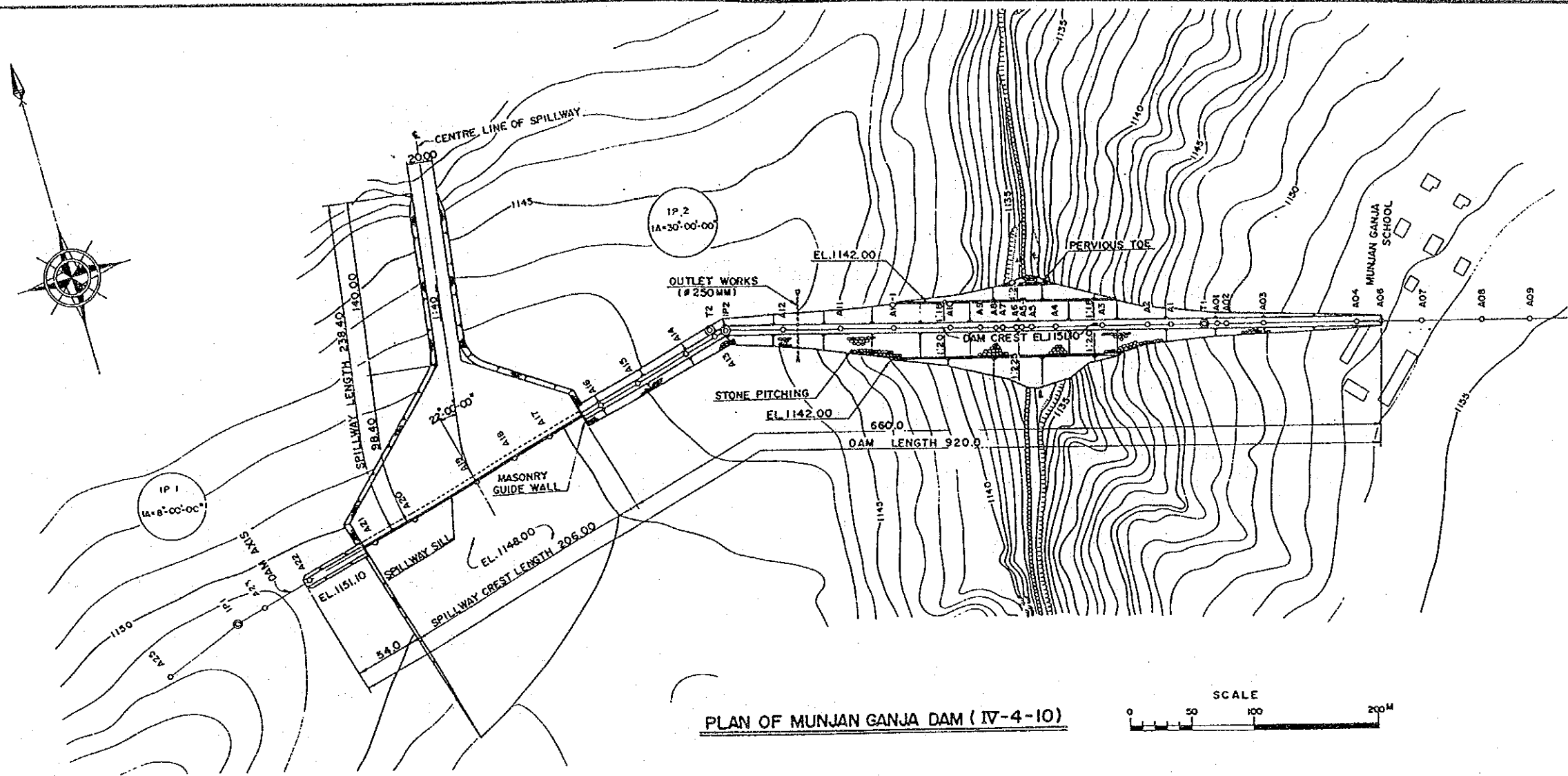


STATION NO.	DISTANCE	ACCUMULATED DISTANCE	GROUND ELEVATION	CANAL BOTTOM ELEVATION	WATER LEVEL	CANAL SLOPE
NO. 23	200.0	4600.0	506.3	505.60	505.83	$1:1/400$ $L = 3640m$
NO. 24	200.0	4800.0	505.8	505.10	505.33	
+70.0	70.0	4870.0	505.3	505.60	505.83	
+80.0	10.0	4880.0	505.3	504.60	504.83	
NO. 25	110.0	5000.0	505.3	504.10	504.33	
NO. 26	200.0	5200.0	504.3	503.60	503.83	
NO. 27	200.0	5400.0	504.3	503.30	503.53	
NO. 28	200.0	5600.0	502.3	502.80	503.03	
NO. 29	200.0	5800.0	502.3	502.30	502.53	
NO. 30	200.0	6000.0	502.3	501.80	502.03	
NO. 31	200.0	6200.0	501.3	501.30	501.53	
NO. 32	200.0	6400.0	500.3	500.80	501.03	
NO. 33	200.0	6600.0	500.3	500.30	500.53	
NO. 34	200.0	6800.0	499.3	499.80	500.03	
+75.00	75.0	6875.0	500.5	499.00	499.23	
NO. 35	125.0	7000.0	499.8	499.30	499.53	
NO. 36	200.0	7200.0	498.8	498.80	499.03	
NO. 37	200.0	7400.0	497.8	498.30	498.53	
+60.00	60.0	7460.0	498.0	497.50	497.73	
NO. 38	140.0	7600.0	498.3	497.80	498.03	
NO. 39	200.0	7800.0	497.3	497.30	497.53	
+140.0	140.0	7940.0	496.8	497.95	497.18	

LONGITUDINAL SECTION OF CANAL (2)

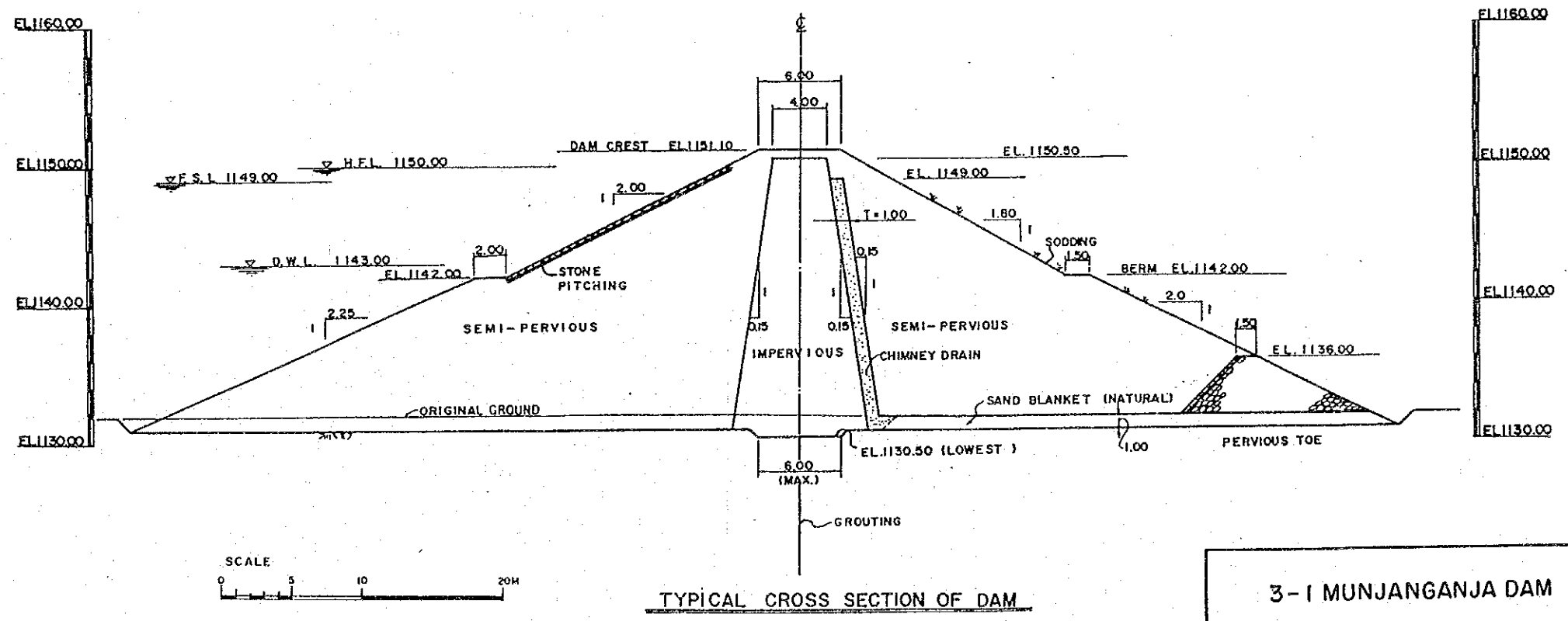
2-2 MAGUDU CONVEYANCE FACILITIES (2/2)





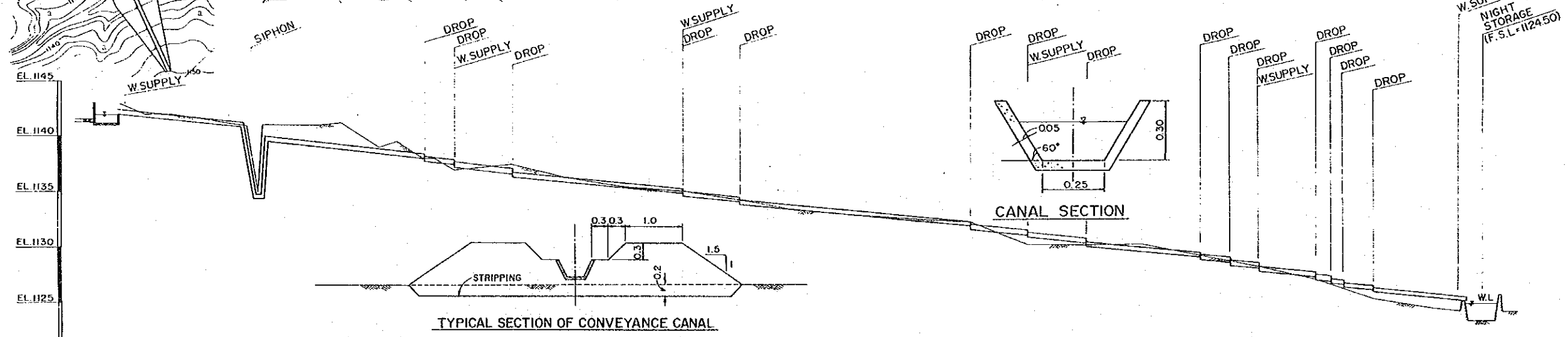
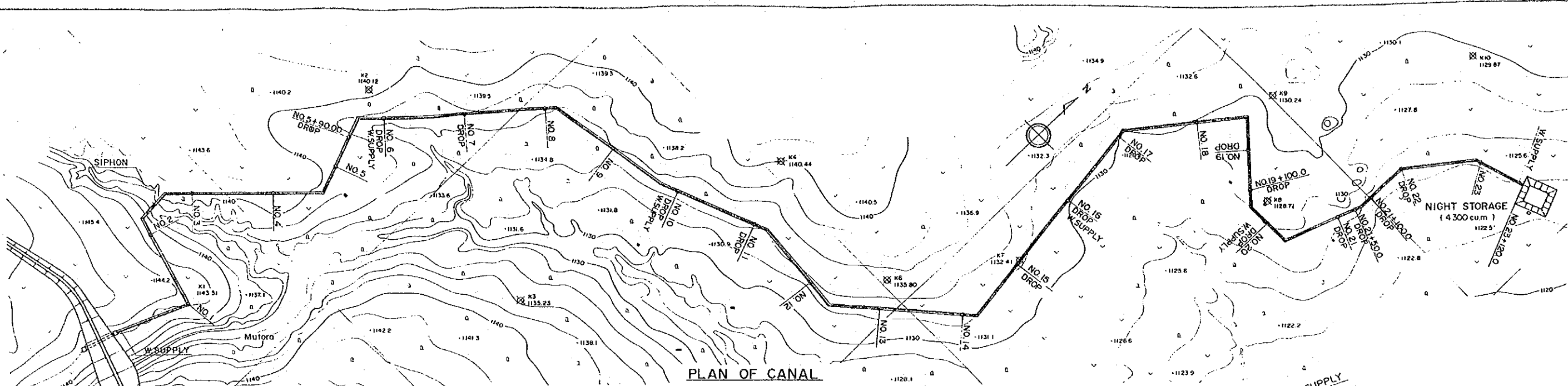
PLAN OF MUNJAN GANJA DAM (IV-4-10)

DAM DIMENSION	
CATCHMENT AREA	52.8 KM <sup>2</sup>
GROSS STORAGE CAPACITY	2,082 MCM
FULL SUPPLY CAPACITY	1,831 MCM
TOTAL VOLUME OF SEDIMENT	0.251 MCM
HIGH FLOOD LEVEL	1150.0 M
FULL SUPPLY LEVEL	1149.0 M
DEAD WATER LEVEL	1143.0 M
DAM TYPE	ZONE TYPE FILL DAM
DAM HEIGHT	18.7 M
DAM LENGTH	920.0 M
DAM CREST ELEVATION	1151.1 M
EMBANKMENT VOLUME	164,300.0 M <sup>3</sup>
DESIGN FLOOD DISCHARGE	349.0 M <sup>3</sup> /SEC
DESIGN SPILLWAY CAPACITY	349.0 M <sup>3</sup> /SEC
SPILLWAY TYPE	NON-GATED OVER FLOW TYPE
OVERFLOW DEPTH	1.0 M
SPILLWAY CREST LENGTH	206.0 M
INTAKE CAPACITY	49.0 L/SEC



TYPICAL CROSS SECTION OF DAM

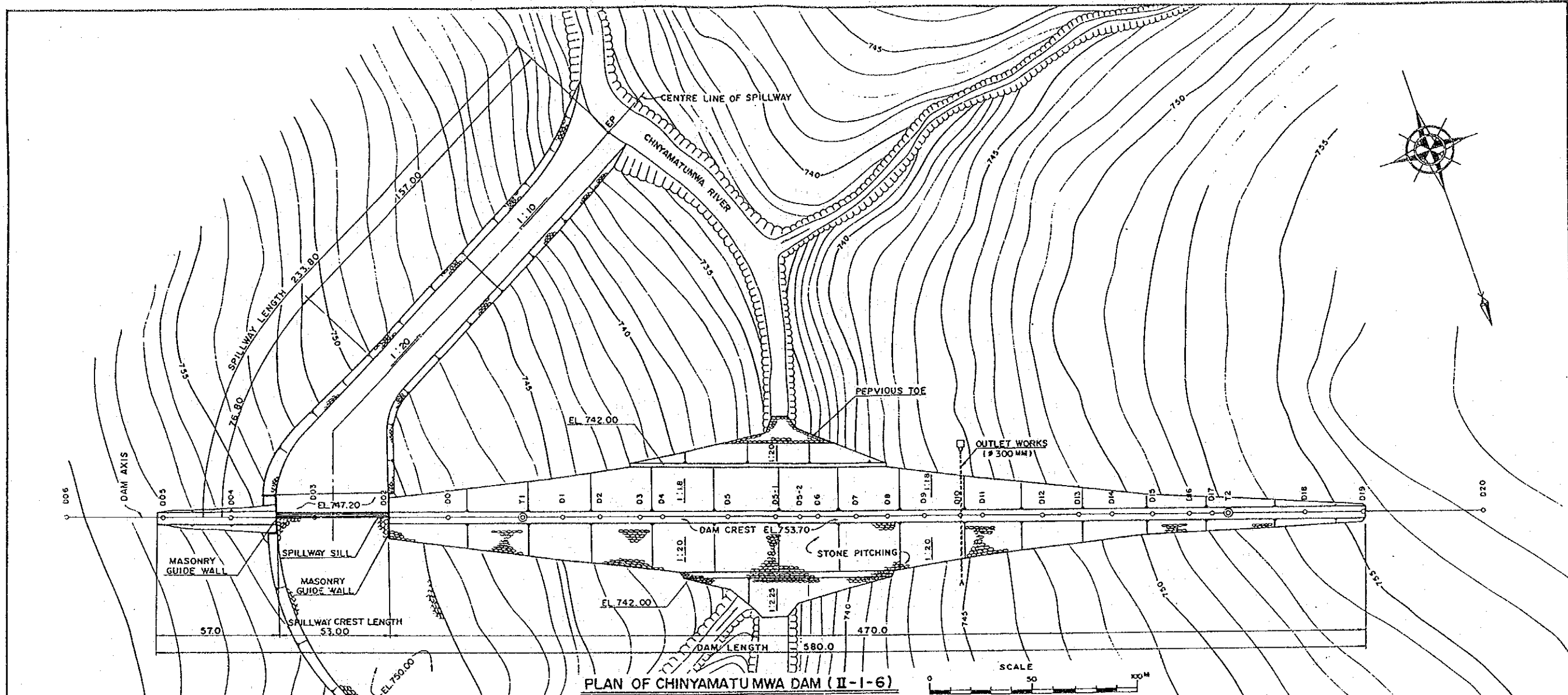
3-1 MUNJANGANJA DAM



STATION NO	DISTANCE	Accumulated DISTANCE	GROUND ELEVATION	CANAL BOTTOM ELEVATION	WATER LEVEL	CANAL SLOPE
NO. 0	0.0	0.0	1143.1	1141.60	1142.80	1:1/400
+100	100.0	100.0	1142.1	1141.35	1141.55	
NO. 1	100.0	200.0	1142.1	1141.10	1141.30	1:1/400
+90.0	90.0	290.0	1143.1	1140.88	1141.08	
NO. 2	110.0	400.0	1141.3	1140.60	1140.80	1:1/400
+70.0	70.0	470.0	1140.43	1140.43	1140.63	
+100.0	100.0	500.0	1135.3	1134.00	1140.55	1:1/400
+120.0	120.0	520.0	1139.15	1139.35	1139.35	
NO. 3	70.0	600.0	1141.0	1138.85	1139.05	1:1/400
+120.0	120.0	720.0	1141.2	1138.65	1138.85	
NO. 4	80.0	800.0	1139.0	1138.33	1138.53	1:1/400
+130.0	130.0	930.0	1139.5	1138.15	1138.35	
NO. 5	70.0	1000.0	1138.3	1137.93	1138.13	1:1/400
+190.0	90.0	1090.0	1138.3	1137.78	1137.98	
+130.0	40.0	1130.0	1137.3	1137.68	1137.88	1:1/400
NO. 6	70.0	1200.0	1137.3	1137.50	1137.70	
NO. 7	200.0	1400.0	1137.8	1136.70	1136.90	1:1/400
NO. 8	200.0	1600.0	1136.6	1135.90	1136.10	
NO. 9	200.0	1800.0	1135.8	1135.40	1135.60	1:1/400
NO. 10	200.0	2000.0	1135.3	1134.90	1135.10	
NO. 11	200.0	2200.0	1134.6	1134.60	1134.80	1:1/400
NO. 12	200.0	2400.0	1133.5	1134.10	1134.30	
NO. 13	200.0	2600.0	1133.1	1133.50	1134.00	1:1/400
NO. 14	200.0	2800.0	1132.7	1133.30	1133.50	
NO. 15	200.0	3000.0	1132.4	1132.80	1133.00	1:1/400
NO. 16	200.0	3200.0	1132.4	1132.30	1132.50	
NO. 17	200.0	3400.0	1130.4	1131.00	1131.20	1:1/400
NO. 18	200.0	3600.0	1130.3	1129.90	1130.10	
NO. 19	200.0	3800.0	1129.3	1129.50	1129.70	1:1/400
+100.00	100.0	3900.0	1129.3	1128.90	1129.10	
NO. 20	100.0	4000.0	1128.8	1128.60	1128.80	1:1/400
NO. 21	200.0	4200.0	1128.3	1128.05	1128.25	
+50.00	50.0	4250.0	1127.3	1127.50	1127.70	1:1/400
+100.00	100.0	4300.0	1127.0	1127.00	1127.20	
NO. 22	100.0	4400.0	1126.5	1126.50	1126.70	1:1/400
NO. 23	200.0	4600.0	1126.5	1126.00	1126.20	
+120.0	120.0	4720.0	1124.5	1125.30	1125.50	1:1/400
NO. 24	120.0	4840.0	1124.2	1124.80	1125.00	

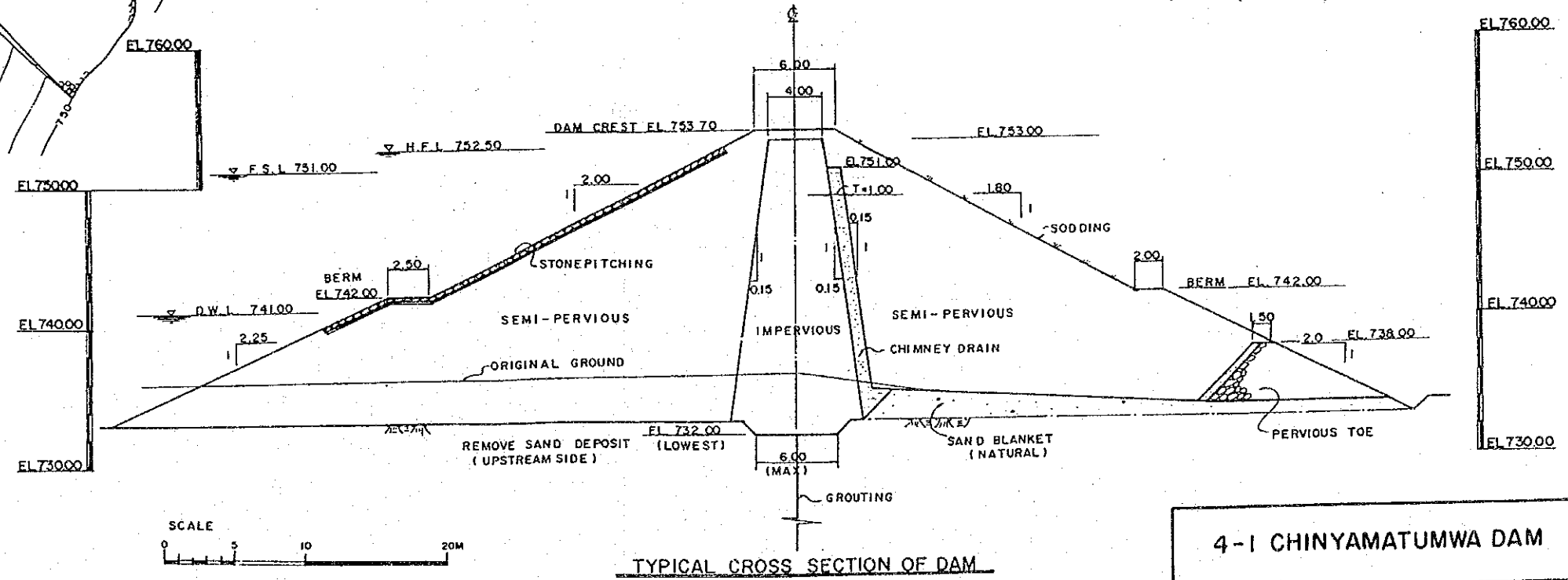
LONGITUDINAL SECTION OF CANAL

3-2 MUNJANGANJA CONVEYANCE FACILITIES



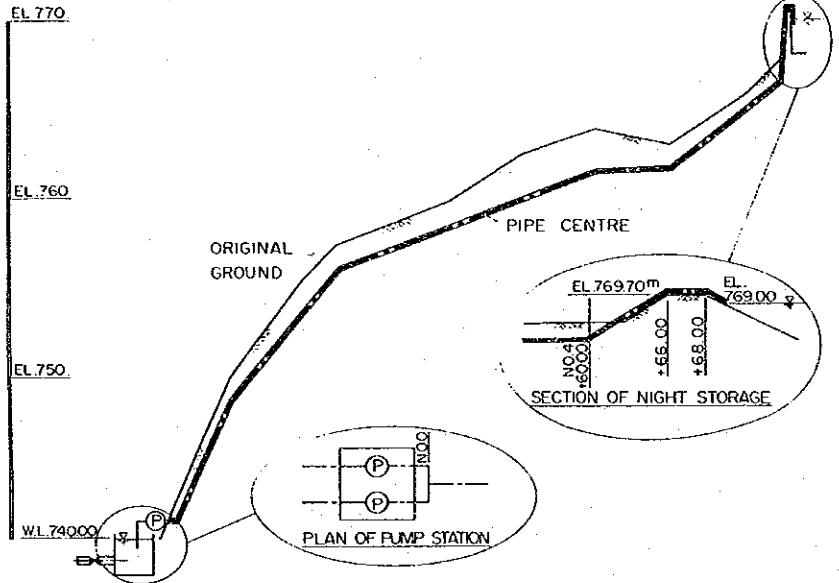
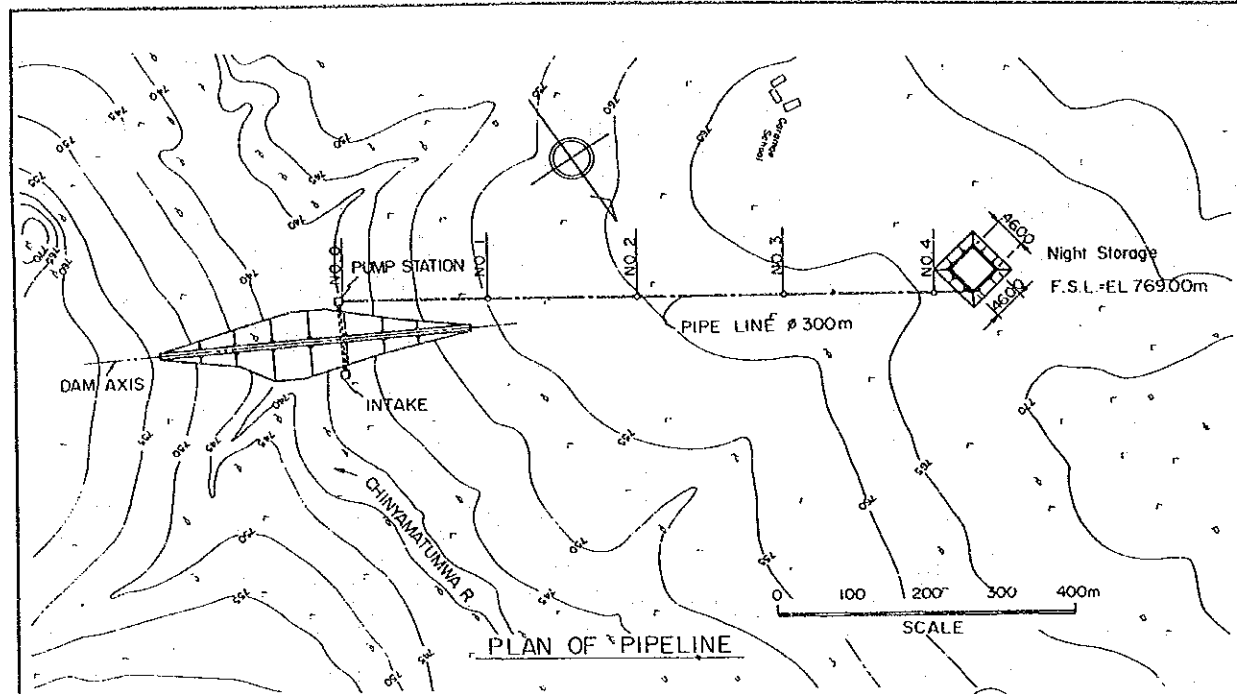
PLAN OF CHINYAMATUMWA DAM (II-1-6)

DAM DIMENSION	
CATCHMENT AREA	16.4 KM <sup>2</sup>
GROSS STORAGE CAPACITY	2.338 MCM
FULL SUPPLY CAPACITY	2.255 MCM
TOTAL VOLUME OF SEDIMENT	0.083 MCM
HIGH FLOOD LEVEL	752.5 M
FULL SUPPLY LEVEL	751.0 M
DEAD WATER LEVEL	741.0 M
DAM TYPE	ZONE TYPE FILL DAM
DAM HEIGHT	18.8 M
DAM LENGTH	580.0 M
DAM CREST ELEVATION	753.7 M
EMBANKMENT VOLUME	186,400.0 M <sup>3</sup>
DESIGN FLOOD DISCHARGE	163.0 M <sup>3</sup> /SEC
DESIGN SPILLWAY CAPACITY	163.0 M <sup>3</sup> /SEC
SPILLWAY TYPE	NON-GATED OVER FLOW TYPE
OVERFLOW DEPTH	1.5 M
SPILLWAY CREST LENGTH	53.0 M
INTAKE CAPACITY	74.0 L/SEC



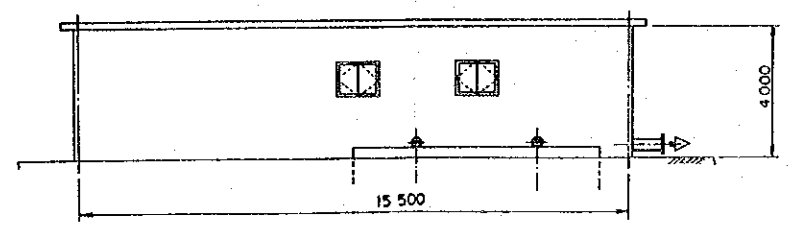
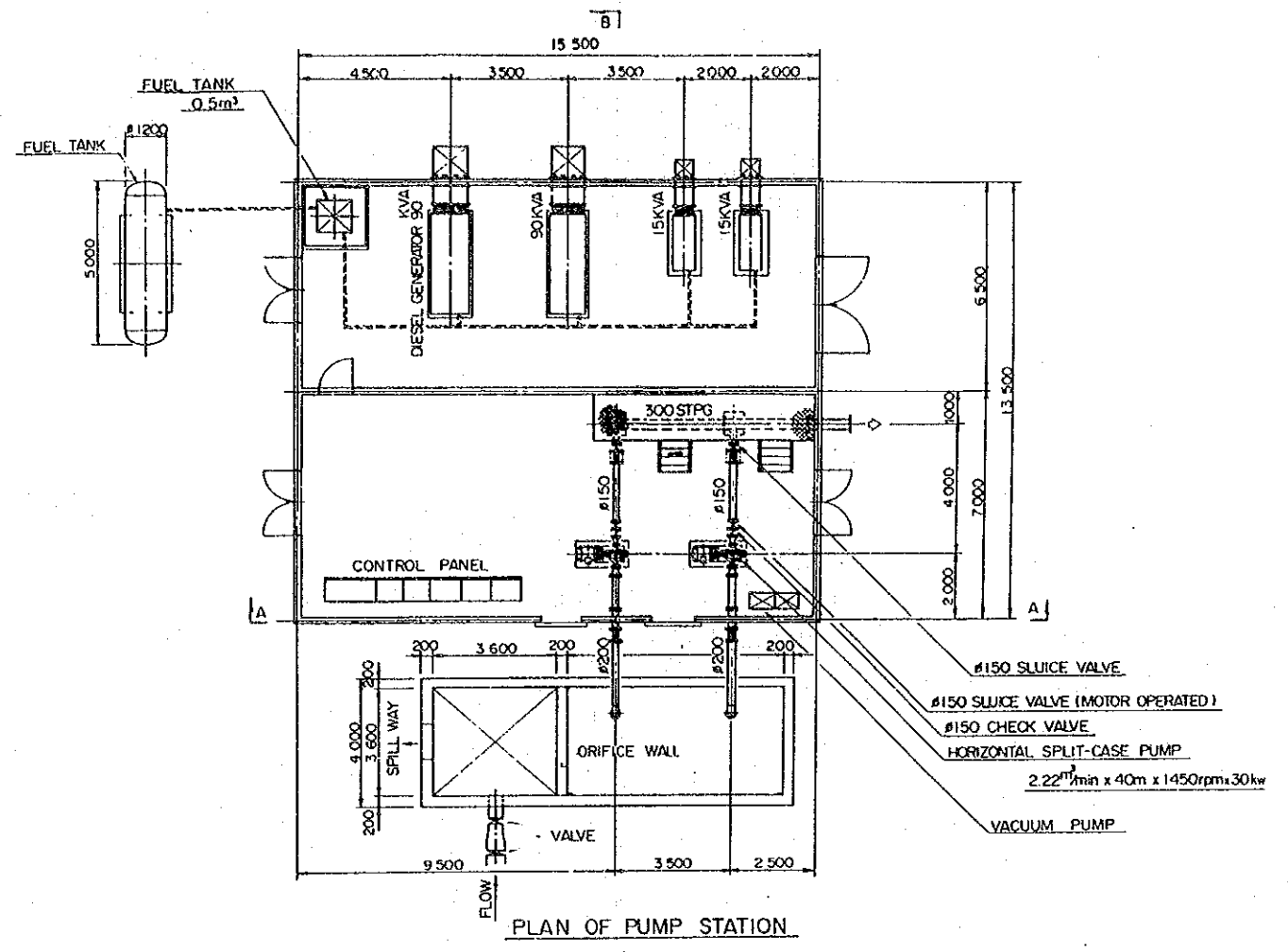
TYPICAL CROSS SECTION OF DAM

4-1 CHINYAMATUMWA DAM

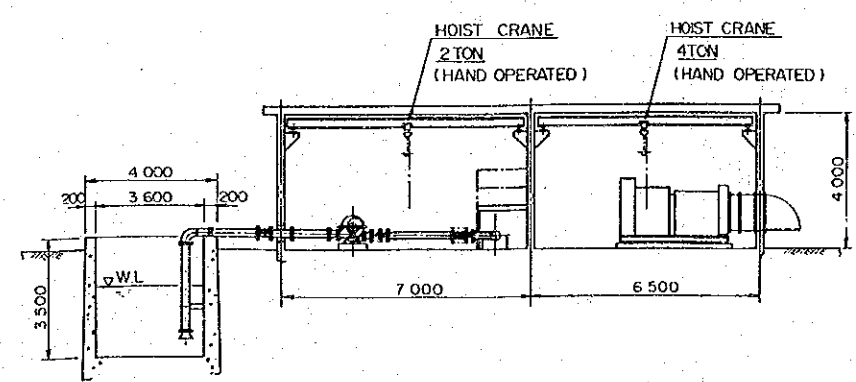


STATION	DISTANCE (m)	ACCUMULATED DISTANCE (m)	GROUND ELEVATION (m)	ELEVATION OF PIPE CENTRE (m)	ENERGY HEAD (m)
NO. 0	0.00	0.00	741.00	742.00	
+25.00	25.00	25.00	743.20	742.00	
+100.00	75.00	100.00	750.00	748.60	
NO. 1	100.00	200.00	755.40	753.33	
+50.00	50.00	250.00	757.40	756.00	
NO. 2	150.00	400.00	759.80	758.31	
+100.00	100.00	500.00	762.40	759.86	
NO. 3	100.00	600.00	763.80	761.40	
+100.00	100.00	700.00	763.00	761.60	
NO. 4	100.00	800.00	765.80	764.73	
+60.00	62.00	862.00	766.00	766.60	
+88.00	2.00	868.00	766.50	768.90	

LONGITUDINAL SECTION OF PIPELINE

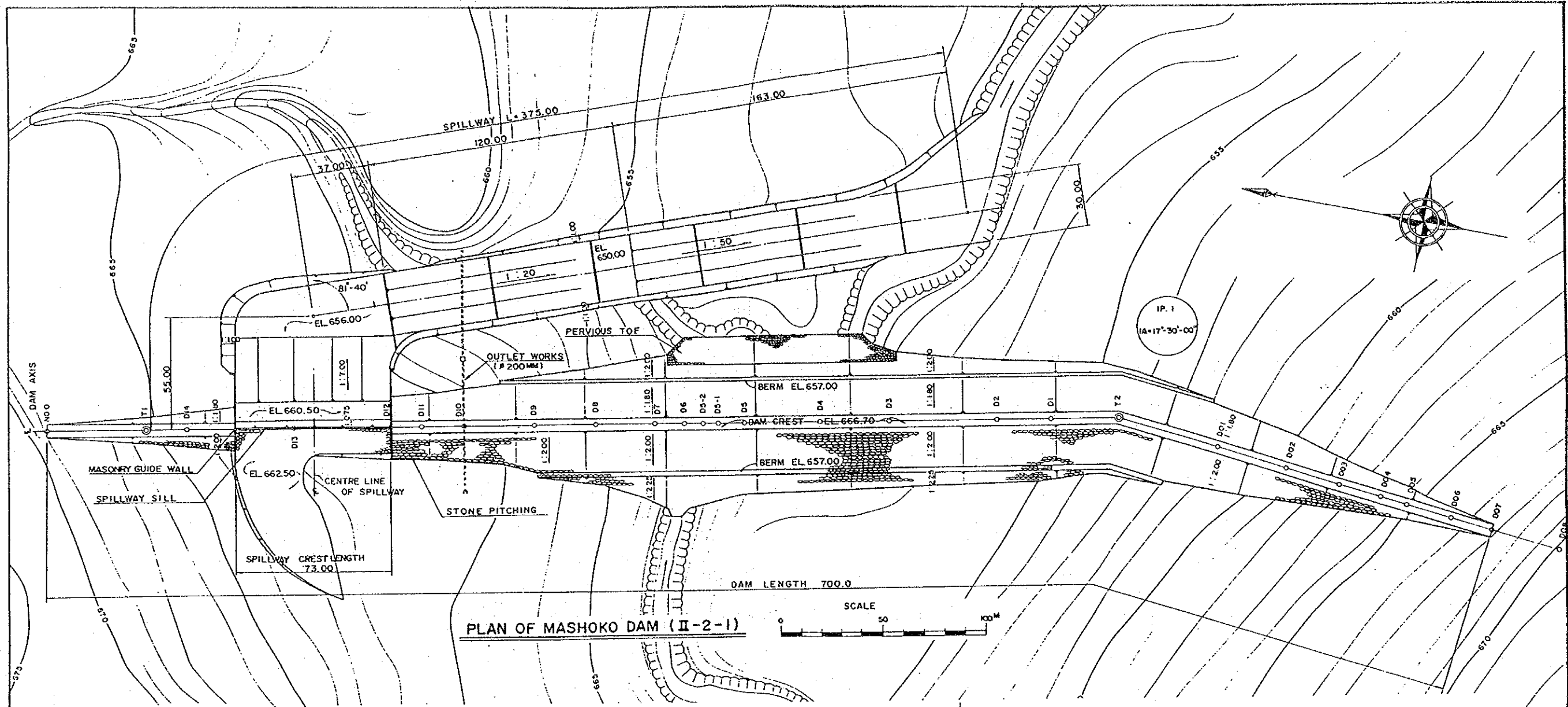


SECTION A-A

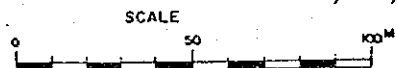


SECTION B-B

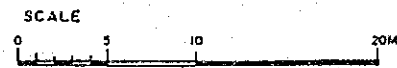
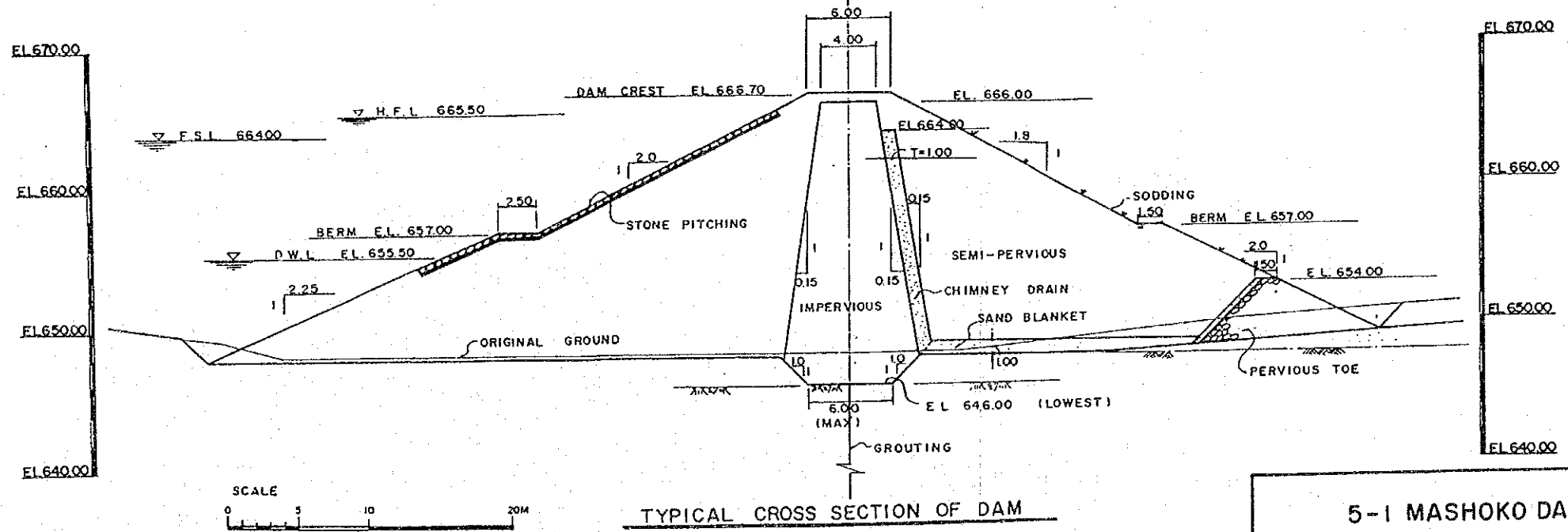
4-2 CHINYAMATUMWA CONVEYANCE FACILITIES



PLAN OF MASHOKO DAM (II-2-1)

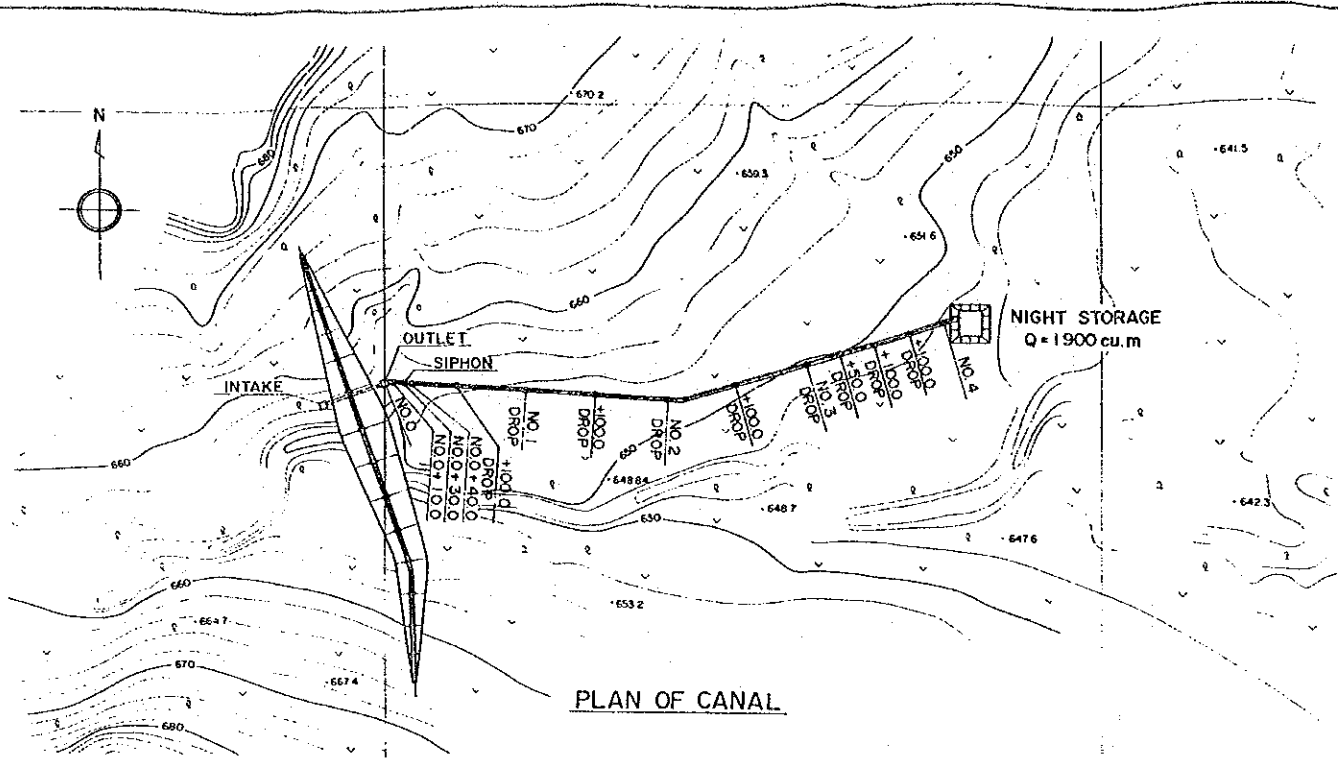


DAM DIMENSION	
CATCHMENT AREA	27.2 KM <sup>2</sup>
GROSS STORAGE CAPACITY	1.546 MCM
FULL SUPPLY CAPACITY	1.453 MCM
TOTAL VOLUME OF SEDIMENT	0.093 MCM
HIGH FLOOD LEVEL	665.5 M
FULL SUPPLY LEVEL	664.0 M
DEAD WATER LEVEL	655.5 M
DAM TYPE	ZONE TYPE FILL DAM
DAM HEIGHT	18.4 M
DAM LENGTH	700.0 M
DAM CREST ELEVATION	666.7 M
EMBANKMENT VOLUME	220,900.0 M <sup>3</sup>
DESIGN FLOOD DISCHARGE	228.0 M <sup>3</sup> /SEC
DESIGN SPILLWAY CAPACITY	228.0 M <sup>3</sup> /SEC
SPILLWAY TYPE	NON-GATED OVER FLOW TYPE
OVERFLOW DEPTH	1.5 M
SPILLWAY CREST LENGTH	73.0 M
INTAKE CAPACITY	23.0 L/SEC

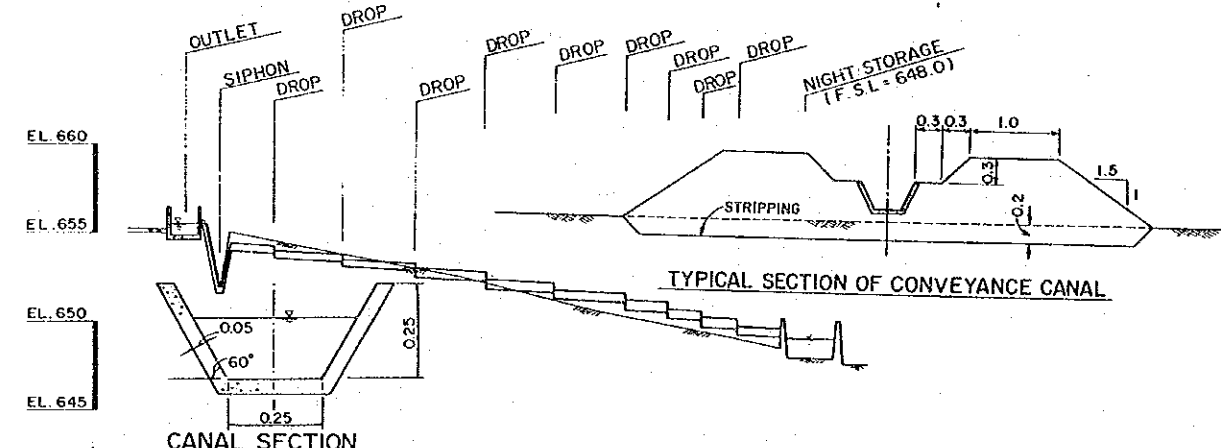


TYPICAL CROSS SECTION OF DAM

5-1 MASHOKO DAM



PLAN OF CANAL



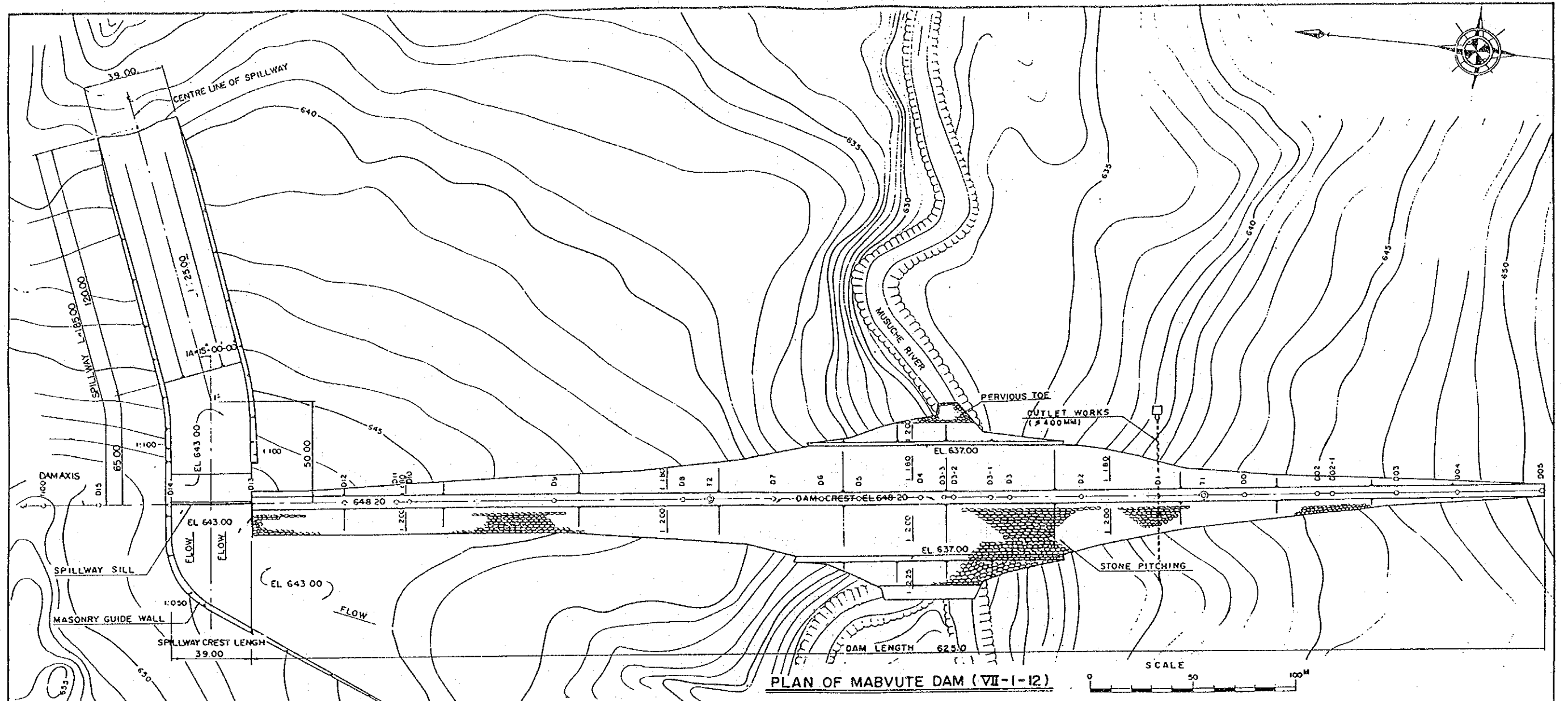
TYPICAL SECTION OF CONVEYANCE CANAL

CANAL SECTION

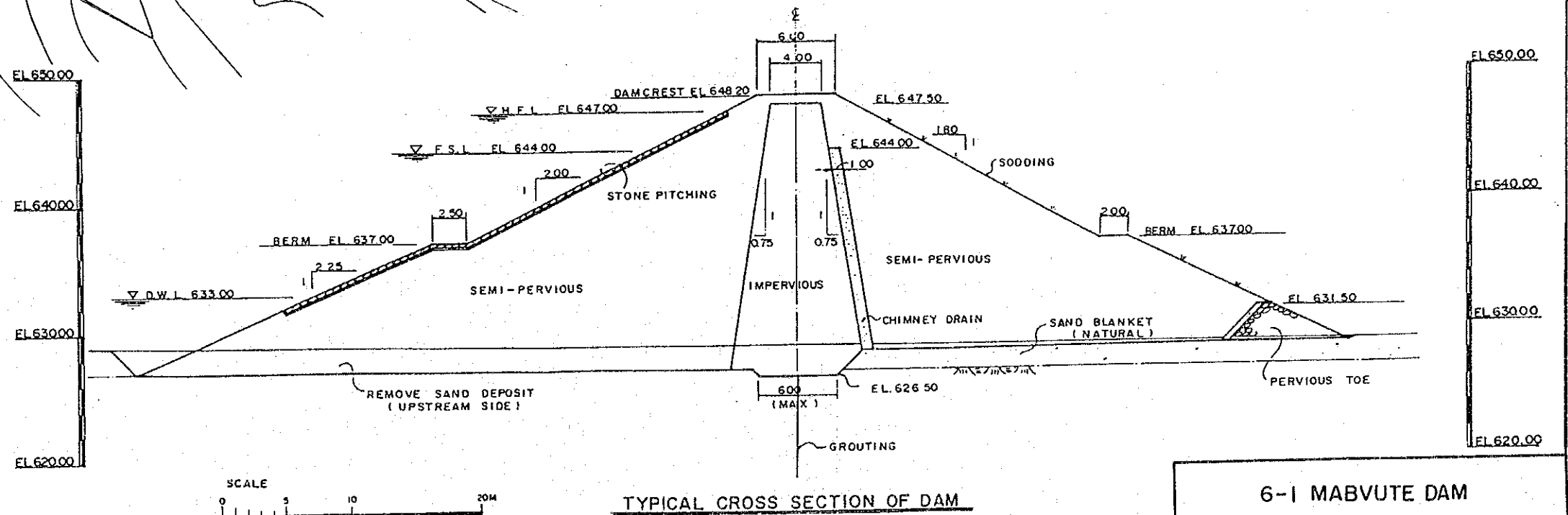
STATION NO.	DISTANCE	Accumulated DISTANCE	GROUND ELEVATION	CANAL BOTTOM ELEVATION	WATER LEVEL	CANAL SLOPE
NO. 0 +000 +200 +400 +1000	00	00	654.6	654.1	654.2	1/300
	100	100	654.0	654.0	654.3	
	200	200	653.5	654.0	654.4	
	300	300	654.0	654.0	654.1	
NO. 1 +1000	600	1000	654.0	653.80	653.8	
	1000	2000	653.5	652.87	652.88	
+1000	1000	3000	652.9	652.84	652.65	
	1000	4000	652.6	652.34	652.35	
NO. 2 +1000	1000	5000	651.4	651.80	652.01	
	1000	6000	650.0	651.27	651.38	
NO. 3 +500	1000	7000	649.5	650.97	651.08	
	500	7500	649.0	650.64	650.75	
+1000	500	8000	648.5	650.34	650.45	
	100	8100	648.1	650.17	650.28	
NO. 4 +1000	500		647.9	649.87	649.98	
	100		647.9	649.70	649.81	

LONGITUDINAL SECTION OF CANAL

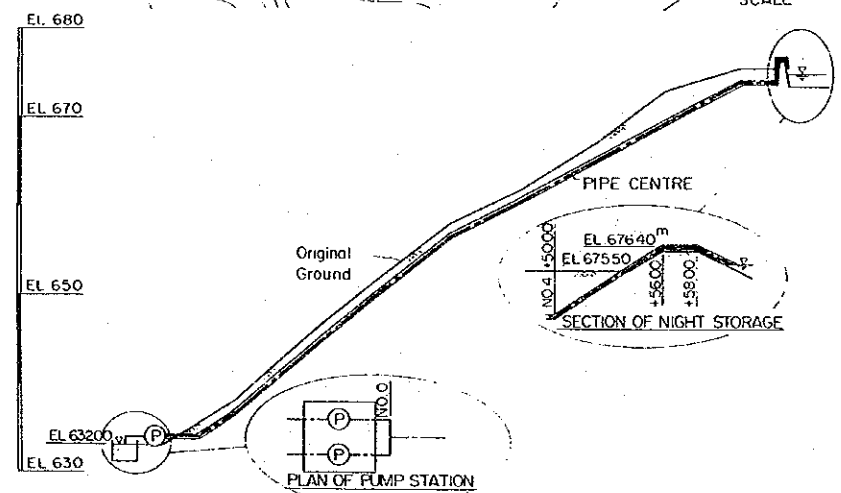
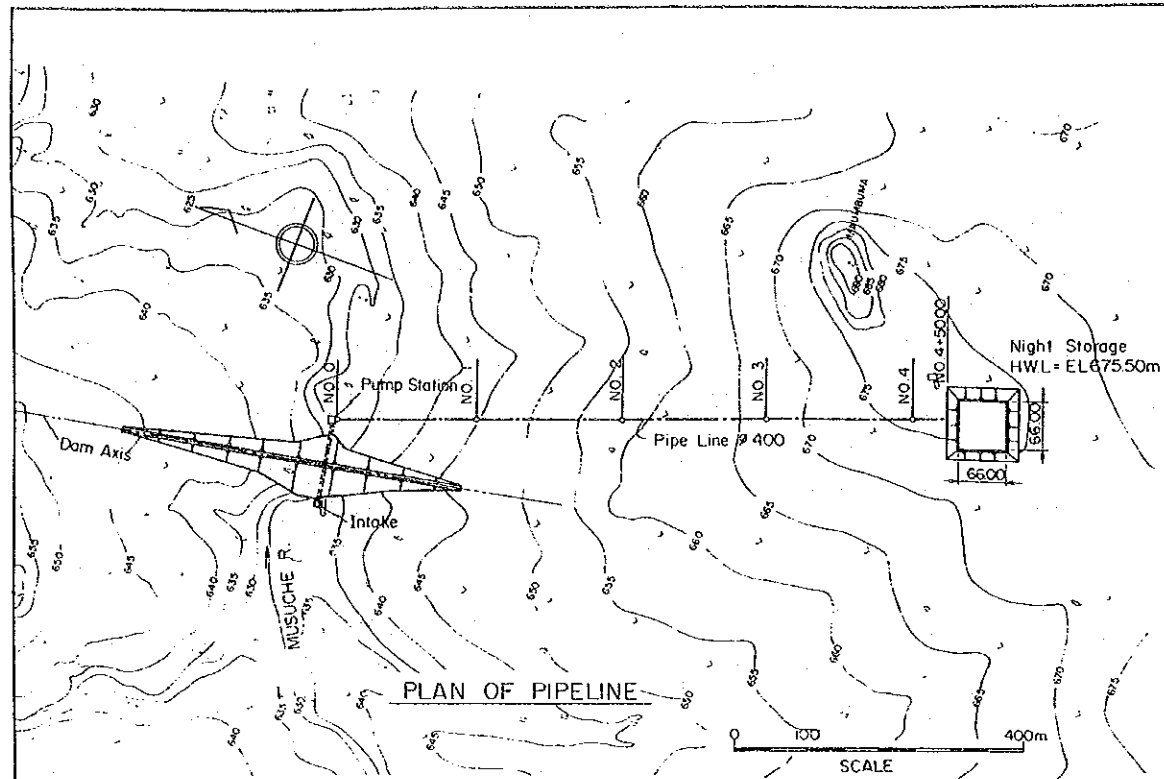
5-2 MASHOKO  
CONVEYANCE FACILITIES



DAM DIMENSION	
CATCHMENT AREA	31.1 KM <sup>2</sup>
GROSS STORAGE CAPACITY	3.238 MCM
FULL SUPPLY CAPACITY	3.132 MCM
TOTAL VOLUME OF SEDIMENT	0.106 MCM
HIGH FLOOD LEVEL	647.0 M
FULL SUPPLY LEVEL	644.0 M
DEAD WATER LEVEL	633.0 M
DAM TYPE	ZONE TYPE FILL DAM
DAM HEIGHT	19.3 M
DAM LENGTH	625.0 M
DAM CREST ELEVATION	648.2 M
EMBANKMENT VOLUME	192,800.0 M <sup>3</sup>
DESIGN FLOOD DISCHARGE	343.0 M <sup>3</sup> /SEC
DESIGN SPILLWAY CAPACITY	343.0 M <sup>3</sup> /SEC
SPILLWAY TYPE	NON-GATED OVER FLOW TYPE
OVERFLOW DEPTH	3.0 M
SPILLWAY CREST LENGTH	39.0 M
INTAKE CAPACITY	151.0 L/SEC

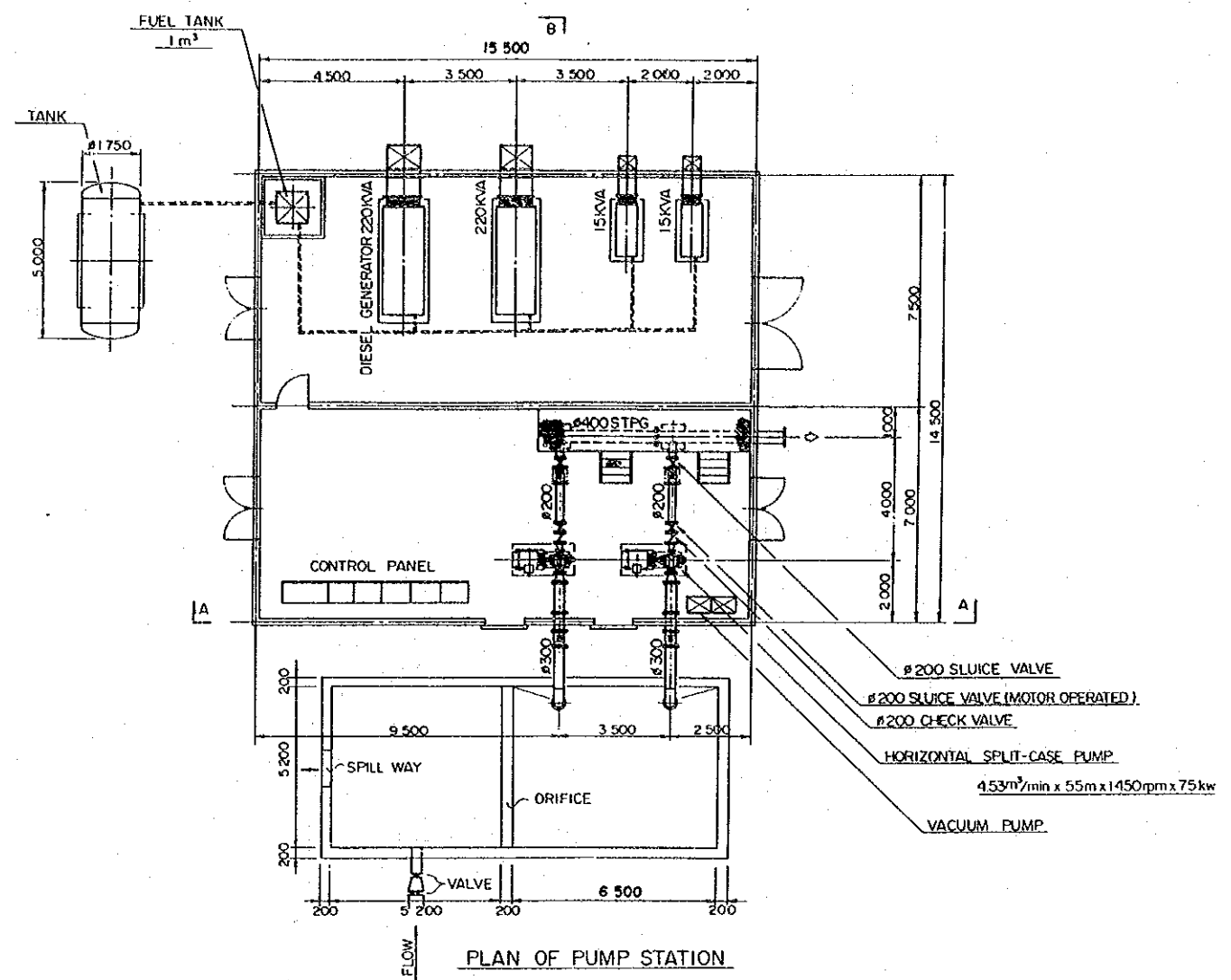


6-1 MABVUTE DAM

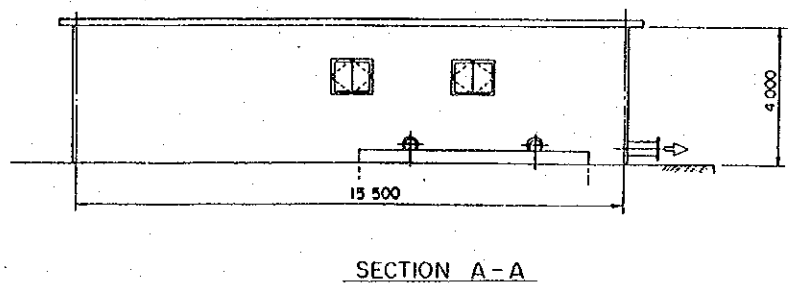


STATION	DISTANCE (m)	ACCUMULATED DISTANCE (m)	GROUND ELEVATION (m)	ELEVATION OF PIPE CENTRE (m)	ENERGY HEAD (m)
NO. 0	0.00	0.00	633.00	634.00	
+50.00	50.00	50.00	635.00	634.00	
+110.00	60.00	110.00	638.00	636.60	
NO. 1	90.00	200.00	645.00	669.96	
NO. 2	200.00	400.00	658.50	657.10	
+100.00	100.00	500.00	662.00	660.60	
NO. 3	100.00	600.00	667.00	665.07	
+100.00	100.00	700.00	673.00	669.53	
NO. 4	100.00	800.00	675.50	674.00	
+50.00	50.00	850.00	675.50	674.10	
+56.00	6.00	856.00	675.50	676.40	
+58.00	2.00	858.00	675.50	676.40	

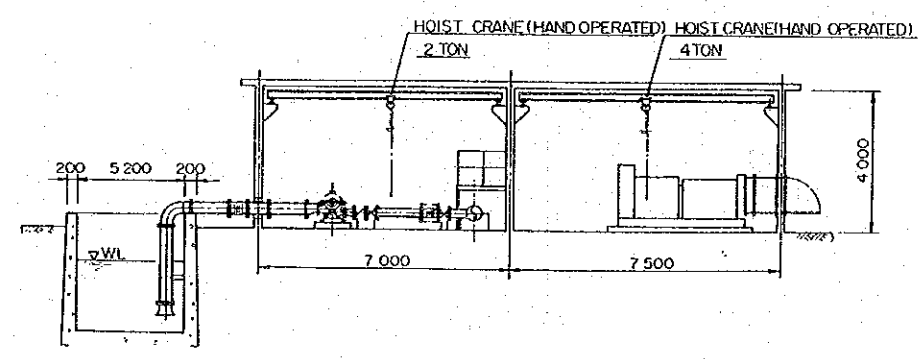
LONGITUDINAL SECTION OF PIPELINE



PLAN OF PUMP STATION



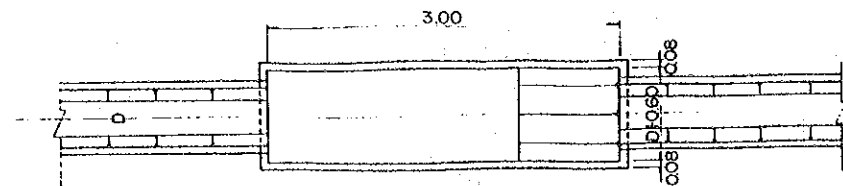
SECTION A-A



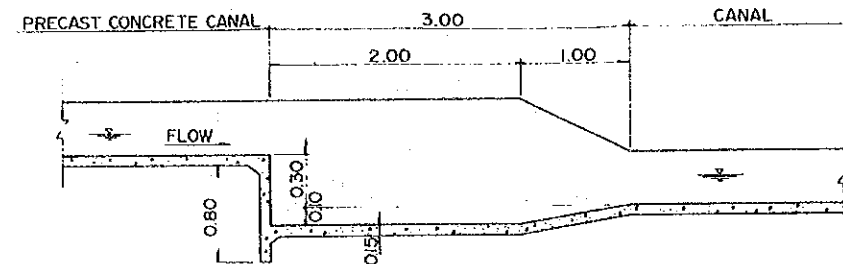
SECTION B-B

6-2 MABVUTE CONVEYANCE FACILITIES

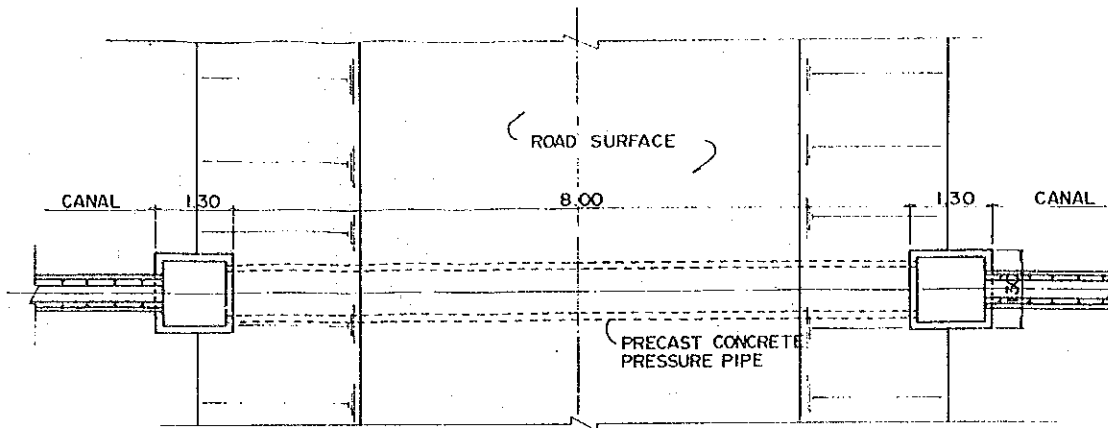




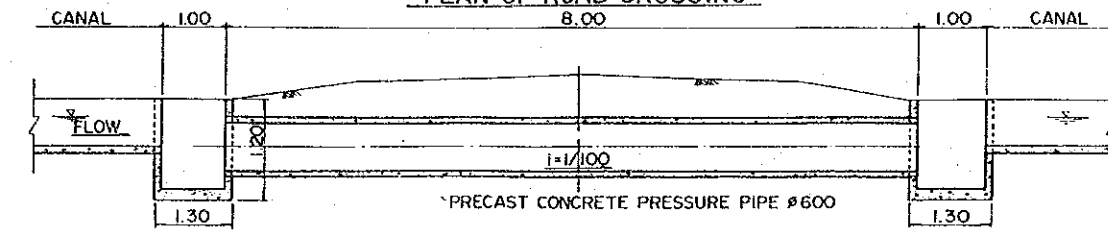
PLAN OF DROP



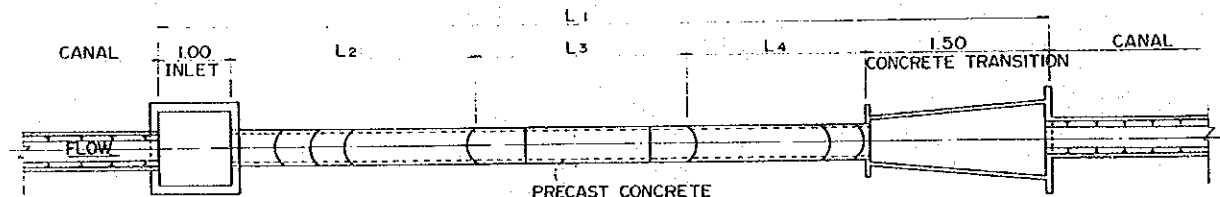
LONGITUDINAL SECTION OF DROP



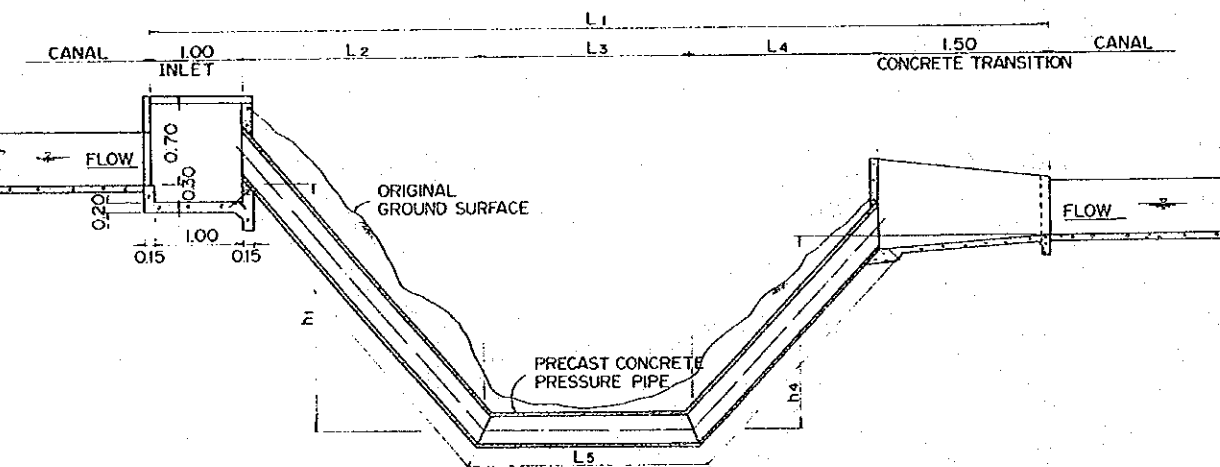
PLAN OF ROAD CROSSING



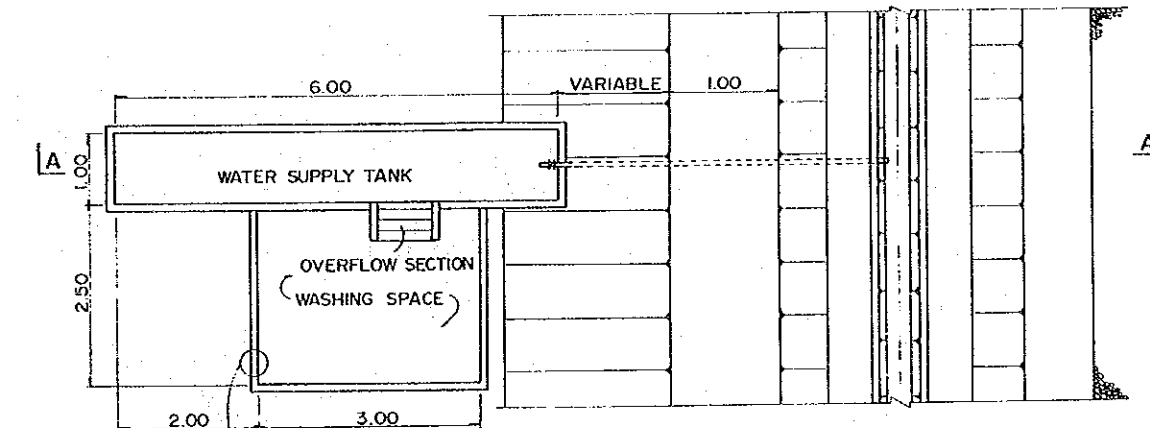
LONGITUDINAL SECTION OF ROAD CROSSING



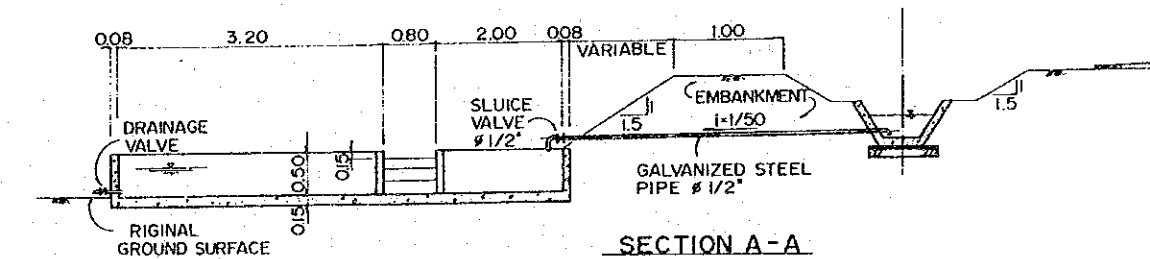
PLAN OF SIPHON



LONGITUDINAL SECTION OF SIPHON



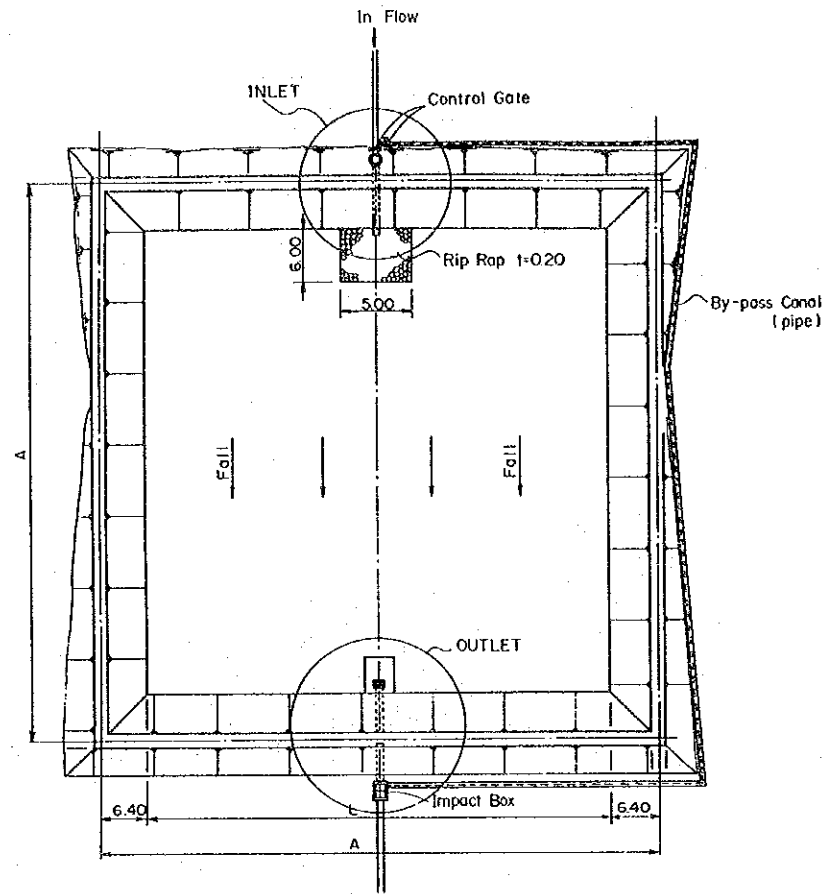
PLAN OF DOMESTIC WATER SUPPLY FACILITIES



SECTION A-A

NO. OF STATION	STATION	L1	L2	L3	L4	L5	h1	h2
I - 2 - 1	N02+35-100.0	65.00	20.00	10.0	35.00	65.39	3.17	3.09
IV - 4 - 10	N02+70-120.0	50.00	25.00	10.0	15.00	51.95	6.83	6.80
V - 3 - 3	N021+60-100.0	40.00	25.00	10.0	5.00	42.54	5.05	4.95

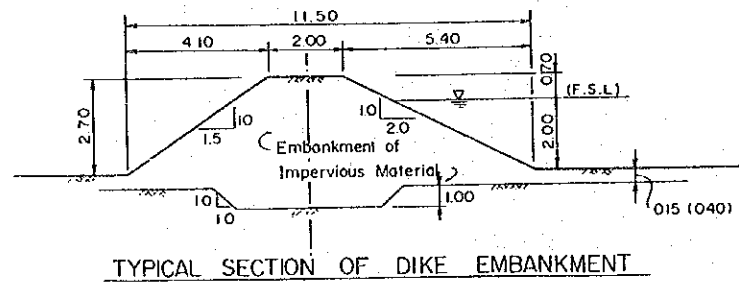
G-1 APPURTENANT STRUCTURES OF CONVEYANCE FACILITIES



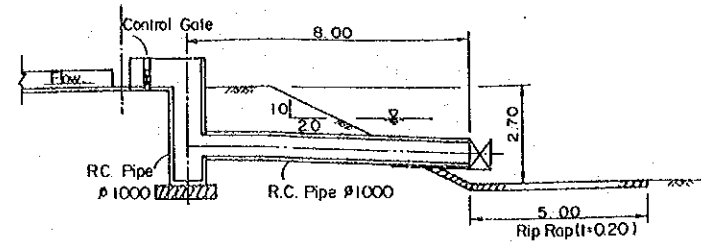
PLAN OF NIGHT STORAGE RESERVOIR

DIMENSION OF NIGHT STORAGE RESERVOIRS

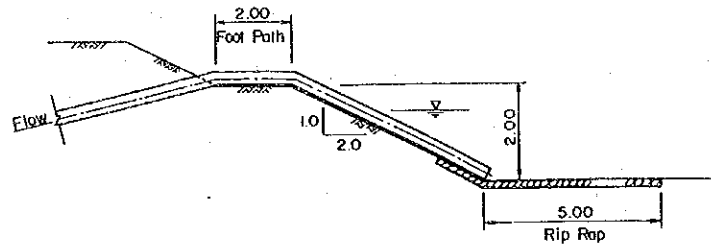
NAME OF AREA (NO.)	A (m)	L (m)	CAPACITY (m <sup>3</sup> )	INFLOW (l/s)	INLET TYPE
MUSAVEREMA	57.0	44.2	4 600	54	CANAL
CHINYAMATUMWA	55.0	42.2	4 300	74	PIPE
MASHOKO	40.0	27.2	1 900	23	CANAL
MUNLANGANJA	55.0	42.2	4 300	49	CANAL
MAGUDU	66.0	53.2	6 500	76	CANAL
MABVUTE	75.0	62.2	8 700	151	PIPE



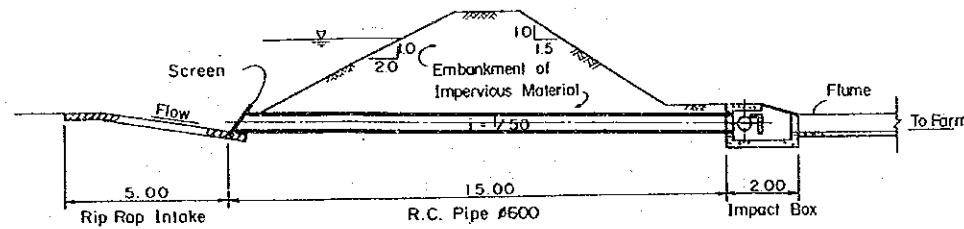
TYPICAL SECTION OF DIKE EMBANKMENT



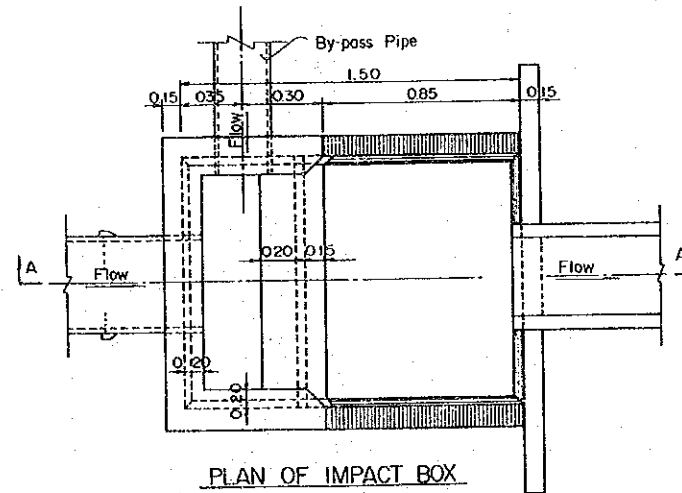
INLET STRUCTURE (CANAL TYPE)



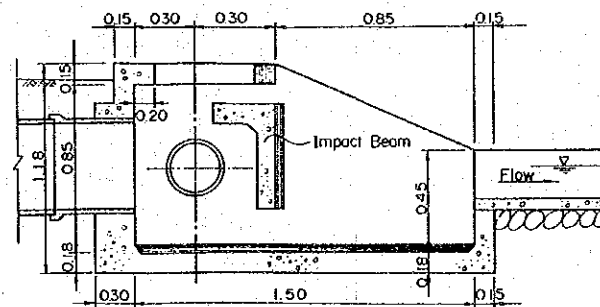
INLET STRUCTURE (PIPE TYPE)



OUTLET STRUCTURE



PLAN OF IMPACT BOX



SECTION A-A

G-2 NIGHT STORAGE RESERVOIR



(3) Construction Schedule

The actual working time is 6.5 hours a day and 25 days per month. Night work is not basically adopted except for grouting works.

The construction schedule is planned based on the work volume and the limited total construction period of 14 months. The work volume and the construction schedule are shown in Figure 5-1.

(4) Allotment of Machines

The allotment of construction machines is planned based on the monthly work quantity derived from the work volume and schedule, and the production of each machine derived from hauling distance and site condition.

The allotment of major construction machines and equipment together with the monthly work quantity and the production are shown in Figure 5-2.

(5) Supply of Machines and Equipment

All the machines and equipment shown in Figure 5-2 are required for the construction of the Musaverema project which has the largest earth work volume among the six projects.

Those machines and equipment except 1 motor scraper, 3 dump trucks will be supplied under the grant aid programme, because the work volume at the excavation and the embankment is about 1.2 times of the work volumes of ordinary average medium size dam. The list of the machines and equipment to be supplied is shown in Table 5-5.

The construction contractor may bring the supplemental machines and equipment as considered necessary by the contractor at his own expense.

Figure 5-1 Construction Schedule

Items	Quantity	1	2	3	4	5	6	7	8	9	10	11	12
Temporary Work	L.S.	[Gantt bars for Temporary Work]											
Dam Body Clearing	5 ha	[Gantt bars for Dam Body Clearing]											
Stripping	23,500 m <sup>3</sup>	[Gantt bars for Stripping]											
Earth Excavation	21,300 m <sup>3</sup>	[Gantt bars for Earth Excavation]											
Soft Rock Excavation	10,100 m <sup>3</sup>	[Gantt bars for Soft Rock Excavation]											
Hard Rock Excavation	19,500 m <sup>3</sup>	[Gantt bars for Hard Rock Excavation]											
Grouting	3,420 m	[Gantt bars for Grouting]											
Core Embankment	62,200 m <sup>3</sup>	[Gantt bars for Core Embankment]											
Shell	158,500 m <sup>3</sup>	[Gantt bars for Shell]											
Filter Drain	7,100 m <sup>3</sup>	[Gantt bars for Filter Drain]											
Riprap, Toe Rock	8,300 m <sup>3</sup>	[Gantt bars for Riprap, Toe Rock]											
Spillway Clearing	2.4 ha	[Gantt bars for Spillway Clearing]											
Stripping	11,900 m <sup>3</sup>	[Gantt bars for Stripping]											
Soft Rock Excavation	5,200 m <sup>3</sup>	[Gantt bars for Soft Rock Excavation]											
Hard Rock Excavation	12,700 m <sup>3</sup>	[Gantt bars for Hard Rock Excavation]											
Concrete	360 m <sup>3</sup>	[Gantt bars for Concrete]											
Masonry	4,810 m <sup>3</sup>	[Gantt bars for Masonry]											
Outlet	L.S.	[Gantt bars for Outlet]											
Distribution Canal	4,400 m	[Gantt bars for Distribution Canal]											
Night Storage Reservoir	L.S.	[Gantt bars for Night Storage Reservoir]											

Figure 5-2 Plan of Construction Machine Allocation

Machine	No.	Schedule (Month)											
		1	2	3	4	5	6	7	8	9	10	11	12
Bulldozer 24 tonnes	No.1	(D) EX Clearing (D) EX Stripping Q = 23,300 P = 19,300 (D) EX Earth Q = 21,300 P = 19,500 (D) EX Soft Rock Q = 10,000 P = 13,200 (D) EX Stripping Q = 40,000 (D) EX Fasher Q = 220,700 P = 33,000											
Bulldozer 17 tonnes	No.1	(D) EX Hard Rock Q = 19,300 P = 6,750 (D) EX Collection of Filter and Riprap Q = 7,100 + 4,800 = 11,900											
Bulldozer 17 tonnes	No.2	(D) EX Cofferdam By-pass (D) EX Collection of Rock Stock Q = 8,300 (D) EX Stripping Q = 11,900 P = 7,300 (D) EX Toe Rock Q = 3,300 (D) EX Earth Soft Rock Q = 1,200 + 188,900 P = 11,900 (D) EX Hard Rock Q = 6,750											
Bulldozer 13 tonnes	No.1	(D) EX Temporary Road (D) EX Canal Work (D) EX Spreading Core and Shell											
Wheel Loader 1.5 m3	No.1	(D) EX Temporary Road (D) EX Stripping Q = 23,300 TP = 7,500 (D) EX Earth Q = 21,300 TP = 7,500 (D) EX Soft Rock Q = 10,100 TP = 4,200 (D) EX Stripping Q = 11,900 P = 7,300 (D) EX Toe Rock Q = 3,300 (D) EX Soft Rock Q = 5,200 P = 4,200											
Hydraulic Excavator 1.2 m3	No.1	(D) EX Temporary Road (D) EX Stripping Q = 23,300 TP = 19,300 (D) EX Earth Q = 21,300 TP = 19,300 (D) EX Soft Rock Q = 10,100 TP = 13,200 (D) EX Hard Rock Q = 19,300 P = 6,750 (D) EX Trimming Riprap Q = 12,700 P = 8,750 (D) EX Trimming Riprap											
Hydraulic Excavator 0.6 m3	No.1	(D) EX Cofferdam By-pass (D) EX Collection of Rock Stock Q = 8,300 (D) EX Loading Filter and Riprap Q = 7,100 + 4,800 = 11,900											
Dump Truck 11 tonnes	No.1	(D) EX Temporary Road (D) EX Stripping Q = 23,300 P = 4,300 x 4.3 = 19,300 (D) EX Earth Q = 21,300 P = 3,750 x 5.7 = 11,500 (D) EX Soft Rock Q = 10,100 P = 3,000 x 4.4 = 13,200 (D) EX Hard Rock Q = 19,300 P = 2,700 x 2.3 = 6,750 (D) EX Hauling Riprap and Filter (D) EX Soft Rock Q = 5,200 P = 4,200 (D) EX Hard Rock Q = 12,700 P = 8,750											
Dump Truck 11 tonnes	No.2	(D) EX Stripping Q = 23,300 P = 4,300 x 4.3 = 19,300 (D) EX Earth Q = 21,300 P = 3,750 x 5.7 = 11,500 (D) EX Soft Rock Q = 10,100 P = 3,000 x 4.4 = 13,200 (D) EX Hard Rock Q = 19,300 P = 2,700 x 2.3 = 6,750 (D) EX Hauling Riprap and Filter (D) EX Soft Rock Q = 5,200 P = 4,200 (D) EX Hard Rock Q = 12,700 P = 8,750											
Dump Truck 11 tonnes	No.3	(D) EX Stripping Q = 23,300 P = 4,300 x 4.3 = 19,300 (D) EX Earth Q = 21,300 P = 3,750 x 5.7 = 11,500 (D) EX Soft Rock Q = 10,100 P = 3,000 x 4.4 = 13,200 (D) EX Hard Rock Q = 19,300 P = 2,700 x 2.3 = 6,750 (D) EX Hauling Riprap and Filter (D) EX Soft Rock Q = 5,200 P = 4,200 (D) EX Hard Rock Q = 12,700 P = 8,750											
Dump Truck 11 tonnes	No.4	(D) EX Stripping Q = 23,300 P = 4,300 x 4.3 = 19,300 (D) EX Earth Q = 21,300 P = 3,750 x 5.7 = 11,500 (D) EX Soft Rock Q = 10,100 P = 3,000 x 4.4 = 13,200 (D) EX Hard Rock Q = 19,300 P = 2,700 x 2.3 = 6,750 (D) EX Hauling Riprap and Filter (D) EX Soft Rock Q = 5,200 P = 4,200 (D) EX Hard Rock Q = 12,700 P = 8,750											
Dump Truck 11 tonnes	No.5	(D) EX Stripping Q = 23,300 P = 4,300 x 4.3 = 19,300 (D) EX Earth Q = 21,300 P = 3,750 x 5.7 = 11,500 (D) EX Soft Rock Q = 10,100 P = 3,000 x 4.4 = 13,200 (D) EX Hard Rock Q = 19,300 P = 2,700 x 2.3 = 6,750 (D) EX Hauling Riprap and Filter (D) EX Soft Rock Q = 5,200 P = 4,200 (D) EX Hard Rock Q = 12,700 P = 8,750											
Dump Truck 11 tonnes	No.6	(D) EX Stripping Q = 23,300 P = 4,300 x 4.3 = 19,300 (D) EX Earth Q = 21,300 P = 3,750 x 5.7 = 11,500 (D) EX Soft Rock Q = 10,100 P = 3,000 x 4.4 = 13,200 (D) EX Hard Rock Q = 19,300 P = 2,700 x 2.3 = 6,750 (D) EX Hauling Riprap and Filter (D) EX Soft Rock Q = 5,200 P = 4,200 (D) EX Hard Rock Q = 12,700 P = 8,750											
Motor Scraper 16.5 m3	No.1	(D) EX Stripping Q = 23,300 P = 4,300 x 4.3 = 19,300 (D) EX Earth Q = 21,300 P = 3,750 x 5.7 = 11,500 (D) EX Soft Rock Q = 10,100 P = 3,000 x 4.4 = 13,200 (D) EX Hard Rock Q = 19,300 P = 2,700 x 2.3 = 6,750 (D) EX Hauling Riprap and Filter (D) EX Soft Rock Q = 5,200 P = 4,200 (D) EX Hard Rock Q = 12,700 P = 8,750											
Motor Scraper 16.5 m3	No.2	(D) EX Stripping Q = 23,300 P = 4,300 x 4.3 = 19,300 (D) EX Earth Q = 21,300 P = 3,750 x 5.7 = 11,500 (D) EX Soft Rock Q = 10,100 P = 3,000 x 4.4 = 13,200 (D) EX Hard Rock Q = 19,300 P = 2,700 x 2.3 = 6,750 (D) EX Hauling Riprap and Filter (D) EX Soft Rock Q = 5,200 P = 4,200 (D) EX Hard Rock Q = 12,700 P = 8,750											
Motor Scraper 16.5 m3	No.3	(D) EX Stripping Q = 23,300 P = 4,300 x 4.3 = 19,300 (D) EX Earth Q = 21,300 P = 3,750 x 5.7 = 11,500 (D) EX Soft Rock Q = 10,100 P = 3,000 x 4.4 = 13,200 (D) EX Hard Rock Q = 19,300 P = 2,700 x 2.3 = 6,750 (D) EX Hauling Riprap and Filter (D) EX Soft Rock Q = 5,200 P = 4,200 (D) EX Hard Rock Q = 12,700 P = 8,750											
Motor Scraper 16.5 m3	No.4	(D) EX Stripping Q = 23,300 P = 4,300 x 4.3 = 19,300 (D) EX Earth Q = 21,300 P = 3,750 x 5.7 = 11,500 (D) EX Soft Rock Q = 10,100 P = 3,000 x 4.4 = 13,200 (D) EX Hard Rock Q = 19,300 P = 2,700 x 2.3 = 6,750 (D) EX Hauling Riprap and Filter (D) EX Soft Rock Q = 5,200 P = 4,200 (D) EX Hard Rock Q = 12,700 P = 8,750											
Motor Grader 3.7 m	No.1	(D) EX Canal Work (D) EX Spreading Core and Shell Q = 237,600											
Motor Grader 3.7 m	No.2	(D) EX Canal Work (D) EX Maintenance of Road											
Tyre Roller 20 tonnes	No.1	(D) EX Compaction of Core, Shell and Filter Q = 220,700 + 7,100 = 227,800 TP = 19,300 TP = 33,000 VP = 13,500											
Vibrating Roller 8 tonnes	No.1	(D) EX Canal Work (D) EX Sprinkling											
Vibrating Roller 8 tonnes	No.2	(D) EX Canal Work (D) EX Sprinkling											
Water Tank Lorry	No.1	(D) EX Temporary Road Sprinkling											
Water Tank Lorry	No.2	(D) EX Transport Water for Drinking and Others											
Water Tank Lorry	No.3	(D) EX Transport Water for Drinking and Others											
Crawler Drill Compressor 18 m3	No.1	(D) EX Collection of Rock Q = 8,300 (D) EX Hard Rock Q = 19,300 P = 6,750 (D) EX Hard Rock											
Crawler Drill Compressor 18 m3	No.1	(D) EX Driving of Grout Hole Q = 3,420 m P = 1,230 m (D) EX Hard Rock (D) EX Rock Surface Tipping Grouting Q = 3,420 m P = 1,230 m											
Jackhammer Compressor 10 m3	No.1-3	(D) EX Hard Rock (D) EX Rock Surface Tipping Grouting Q = 3,420 m P = 1,230 m											
Jackhammer Compressor 10 m3	No.1	(D) EX Hard Rock (D) EX Rock Surface Tipping Grouting Q = 3,420 m P = 1,230 m											
Jackhammer Compressor 10 m3	No.2	(D) EX Hard Rock (D) EX Rock Surface Tipping Grouting Q = 3,420 m P = 1,230 m											
Grout Pump Mixer	No.1	(D) EX Grouting Q = 3,420 m P = 1,230 m											
Grout Pump Mixer	No.1-2	(D) EX Grouting Q = 3,420 m P = 1,230 m											
Concrete Mixer 0.76 m3	No.1	(D) EX Concrete Work											
Concrete Mixer 0.76 m3	No.2	(D) EX Canal Lining											
Generator 75 kW	No.1	(D) EX Lighting and Power Supply											

LEGEND  
 (B) : Borrow Pit  
 (Q) : Quarry Site  
 (D) : Dam Body  
 (S) : Spillway  
 (C) : Canal  
 (EX) : Excavation  
 (EM) : Embankment  
 Q = Work Volume (m3)  
 P = Production (m3/month)

Table 5-5 Machines and Equipment for MEWRD

Machine	Specification	Quantity
1. Bulldozer	operating weight 24 tonnes 4 teeth ripper	2
2. Bulldozer	operating weight 17 tonnes 4 teeth ripper	3
3. Bulldozer	operating weight 13 tonnes 3 teeth ripper	2
4. Wheel Loader	front end struck 1.5 m <sup>3</sup> bucket	2
5. Dump Truck	11 tonnes struck capacity 6 m <sup>3</sup>	6
6. Motor Scraper	struck capacity 16.5 m <sup>3</sup>	6
7. Motor Grader	130 PS blade length 3.7 m	4
8. Tire Roller	self driven type operating weight 20 tonnes	2
9. Vibrating Roller	self-driven type operating weight 8 tonnes	3
10. Hydraulic Excavator	struck 1.2 m <sup>3</sup> bucket	2
11. Hydraulic Excavator	struck 0.6 m <sup>3</sup> bucket	2
12. Flat Bed Truck	15 - 20 tonnes	2
13. Flat Bed Truck	7 tonnes	4
14. Water Tank Larry	Capacity 10 m <sup>3</sup>	6
15. Crawler Drill	air consumption 10m <sup>3</sup> /min	2
16. Grout Pump	30 - 50 l/min	2
17. Grout Mixer	200 l x 2	2
18. Air Compressor	portable type 18 m <sup>3</sup> /min, 7 kg/cm <sup>2</sup>	2
19. Air Compressor	portable type 9.6 m <sup>3</sup> /min, 7 kg/cm <sup>2</sup>	2

<u>Machine</u>	<u>Specification</u>	<u>Quantity</u>
20. Tractor	25.6 tonnes pull 250 PS	2
21. Trailer	low bed, 35 tonnes	2
22. Submergible Pump	air motor driven	2
23. Centrifugal Pump	D = 100 mm diesel engine driven	2
24. Caravan Camping Gear		1
25. Generator	diesel engine driven 75 kW	2
26. Concrete Mixer	0.76 m <sup>3</sup> diesel engine driven	4
27. Pick-up Truck	lifting capacity 1 tonne diesel engine driven	6
28. Station Wagon	5 - 6 persons diesel engine driven	4



Table 5-6 Machines and Equipment for AGRITEX

Machine	Specification	Quantity
1. Bulldozer	operating weight 10 tonnes 3 teeth ripper	2
2. Bulldozer	operating weight 6 tonnes 2 teeth ripper	2
3. Wheel Loader	front end struck 0.8 m <sup>3</sup> bucket	2
4. Motor Grader	130 PS blade length 3.7 m	3
5. Tractor	86 PS	2
6. Land Grader	tow type	2
7. Land Leveller	tow type	3
8. Pick-up Truck	lifting capacity 1 tonne diesel engine driven	4
9. Caravan, Camping Gear		1
10. Disc Plough	two furrow reversible	2
11. Disc Harrow	heavy duty	2
12. Ripper	3-type	1
13. Ripper	5-type	1
14. Dump Truck	11 tonnes	2
15. Ripper Trailer	5 tonnes	2
16. Centrifugal Pump	0 - 50 mm diesel engine driven	2
17. Flot Bed Truck	10 tonnes	2
18. Fuel Bouser	tow type, 1000 l	3
19. Water Bouser	tow type, 1500 l	3
20. Generator	75 kW diesel engine driven	2
21. Concrete Mixer	0.18 m <sup>3</sup> diesel engine driven	3
22. Plate Compactor	3.7 kW petrol engine driven	4

## 5.4. Implementation Plan

### 5.4.1. Implementing Method

#### (1) Project Implementing Body

The Implementing Body for dams, conveyance canals and night storage reservoirs will be MEWRD and AGRITEX for in-field facilities. The construction machines and equipment to be procured under the grant aid programme shall be delivered to both the agencies according to their responsibilities for the implementation. Both the agencies have the provincial offices in Masvingo, and the Provincial Water Engineer of MEWRD and Provincial Agricultural Extension Officer will be directly in charge of the management of the project implementation.

Upon arrival of the construction machines and equipment in delivery site in Zimbabwe, the machines and equipment are to be inspected and tested by the Mechanical Engineer of MEWRD and Chief Irrigation Officer of AGRITEX and then they will be transferred to the Provincial Water Engineer's Office and the Provincial Agricultural Extension Offices. The contractor for the construction of dams, conveyance canals and night storage reservoirs may use those machines and equipment exclusively by giving order to the Provincial Water Engineer of MEWRD.

#### (2) Consultant

The Consultant will enter into a contract with MEWRD for the following consultant services immediately after signing of the Exchange of Notes for the grant aid assistance to the Project.

- a) Preparation of detail design and tender documents for the procurement of machines and equipment and for the construction of dams and irrigation facilities.

- b) Tendering evaluation of the offered tenders.
- c) Witnessing and advising on the negotiations between MEWRD and the successful tenderer.
- d) Other necessary technical services.

(3) Contractor

The contractor (supplier) shall procure the construction machines and equipment specified in the contract, transport them to the site designated by MEWRD and AGRITEX and assemble them at the site. The contractor shall also be responsible for these machines and equipment during the guarantee period after the acceptance inspection.

Japanese contractor for the dams and irrigation facilities would receive the construction sites which is delineated and handed over by the MEWRD, after successful bidding and necessary procedure.

The contractor shall conduct the construction works according to the specification. Upon completion of the facilities, various kinds of operation test shall be conducted under the presence of persons concerned and then the construction sites would be taken over to the MEWRD. However, those facilities would be finally accepted by the MEWRD only after expiration of the guarantee period.

(4) Undertakings of the Government of Zimbabwe

- i) To provide a yard to store the donated machines and equipment.
- ii) To prepare a spacious parts room enough to store the parts of the donated machines and equipment in the above yard.
- iii) To acquire the land required for dams and other irrigation facilities.

- iv) To ensure the land for the borrow area.
- v) To ensure the right-of-way for the temporary works.
- vi) To undertake the construction of the infield facilities in due time by making use of the machines and equipment provided under the grant.
- vii) To exempt from import duties and to take necessary measures for customs clearance of machines and equipment brought into Zimbabwe for the project.
- viii) To exempt from customs duties, internal taxes and other fiscal levies which might be imposed on Japanese who are involved in the project in Zimbabwe.

#### 5.4.2. Construction Condition

##### (1) Investment for Construction

Due to rapid increase of the construction work, the construction material price index rose by 12.5% on a yearly basis, which participated in the major cause of general escalation of price index. The increase of construction works were also due to the shortage of construction machines and equipment, and hence delayed the construction schedule.

##### (2) Construction Machines of the Zimbabwean Government

All the construction machines of the government are under the control of the Ministry of Transportation and the construction machines are delivered upon the request of the ministries which are responsible for the construction works.

However, the construction machines and equipment will be directly donated to the MEWRD and the AGRITEX under the grant aid programme, which will further promote the medium size dams project in Masvingo province after used by the Japanese contractor for the construction of designated six projects.

(3) Engineering Level of Construction Works

Zimbabwe has achieved high engineering level of construction works through the implementation of the world famous Kariba Dam, the Kyle Dam in the Masvingo Province and number of dams around the city of Burawayo, although these dams were constructed before the Independence (1980).

During the field survey, the study team visited the existing Mapauzure Irrigation Scheme which has been well planned, constructed and managed under the control of AGRITEX in Masvingo. It was judged that the AGRITEX can fully utilize the construction machines and equipment which will be supplied under the grant aid programme for the designated six projects and also proposed project in future.

(4) Supply of Construction Machines

The budget of the Zimbabwe government in the recent three fiscal years is shown below.

Unit: Z\$ Million

	1985/86	1986/87	1987/88			
			I	II	III	IV
1. Revenue and Grant	2,616.2	3,056.5	858.3	874.7	888.2	
2. Expenditure and Lending	3,307.8	4,053.3	920.5	1,372.9	1,120.7	
3. Deficit	691.6	996.8	62.3	498.2	238.5	
4. Financing	691.6	996.8	62.3	498.2	238.5	
Foreign	210.9	210.8	46.0	13.6	84.0	
Domestic	480.7	786.1	16.3	484.6	154.5	

The table shows that the Zimbabwe Government is suffering from the shortage of foreign currency and procurement of commodities and services by foreign currency is restricted by the government. Even if approved by the government, the required period for the procurement will be two or three years. Therefore, procurement of machines and equipment in Zimbabwe is not suitable due to the limited implementation period.

#### 5.4.3. Detail Design and Construction Supervision

The consultants would undertake their works according to the consulting services contract to be made between the MEWRD and consultants after the Exchange of Note for this project between the government of Zimbabwe and the government of Japan becomes effective.

The consulting services would be divided into two stages; namely detail design stage and construction supervision stage.

##### (1) Detail Design

The consultants will commence the detail design work immediately after the consulting service contract is made with the MEWRD.

The whole works in this stage would be divided into two parts; the detail design works and preparation of the bid documents. The former would cover structural calculation, preparation of detail design drawings, construction planning and construction work schedule, and estimation of construction cost based on the approved and designated standards and conditions. While the latter would include preparation of bid documents such as instruction to bidders, contract conditions (general and supplemental), technical specifications (general and particular), bill of quantities and bid drawings.

(2) Construction Supervision

The scope of works would consist of bidding works to select the most qualified Japanese contractor who would undertake the construction of the dams and irrigation facilities, and construction supervision work during the construction period.

The first part covers invitation for bids, receiving questions and response by written form, and attending the bidding conference. After opening of bids, the consultants shall then study the bids and prepare the evaluation reports.

The second part consists of the supervision of the civil works and installation of the related equipment in the site. The consultants would check and approve the construction method, construction schedule and quality of the work. They will also report the progress of the work monthly and prepare the O/M manuals at the end of the construction work.

5.4.4. Procurement Plan

(1) Construction Machines and Equipment

(a) Procurement Method

In principle, the machines and equipment supplied under the grant aid programme will be procured mainly from Japan. However the procurement from the third countries are also taken into consideration, viz., low price and good maintenance service.

The contractor for the supply of the construction machines and equipment will be selected through tender, after careful evaluation of the bidding by the consultants.

(b) Transportation

The contractor (supplier) will transport the machines and equipment to the designated place of delivery in Masvingo.

(c) Delivery and Acceptance

Upon the arrival of the machines and equipment to the delivery site in Zimbabwe, the contractor shall assemble all of them and shall inspect and test them to confirm and ensure that they are functioning properly in the presence of the representatives of MEWRD and AGRITEX.

(d) Stock Yard

Upon arrival of the construction machines and equipment, MEWRD and AGRITEX would prepare a yard in Masvingo, which will be spacious and safe enough to store them, such as the following:

	<u>MEWRD</u>	<u>AGRITEX</u>
Yard	1.5 ha	0.5 ha
Parts Room	100 m <sup>2</sup>	50 m <sup>2</sup>

(2) Construction Material

Most of the construction material can be obtained in Zimbabwe. The minimum item of construction material should be procured from Japan.



5.4.5. Implementation Schedule

The project works will be divided into four phases as follows:

Phase 1: Supply of construction machines and equipment

Phase 2: Construction of Musaverema and Magudu Projects

Phase 3: Construction of Munjanganja and Chinyamatumwa Projects

Phase 4: Construction of Mashoko and Mabvute Projects

The exchange of notes will be made in each phase and the work of the each phase will be commenced immediately after the exchange of Notes as follows:

	1st Year	2nd Year	3rd Year	4th Year	5th Year
Exchange of Notes					
Phase 1	▽				
Phase 2		▽			
Phase 3			▽		
Phase 4				▽	
Implementation					
Phase 1	—				
Phase 2		—			
Phase 3			—		
Phase 4				—	

The detailed implementation schedule of Phase 1 "Procurement of Construction Machines and Equipment" and Phase 2-4 "Construction of Two Projects" are shown in Figure 5-3 and Figure 5-4, respectively.

Figure 5-3 Implementation Schedule of Phase 1 Procurement of Machines

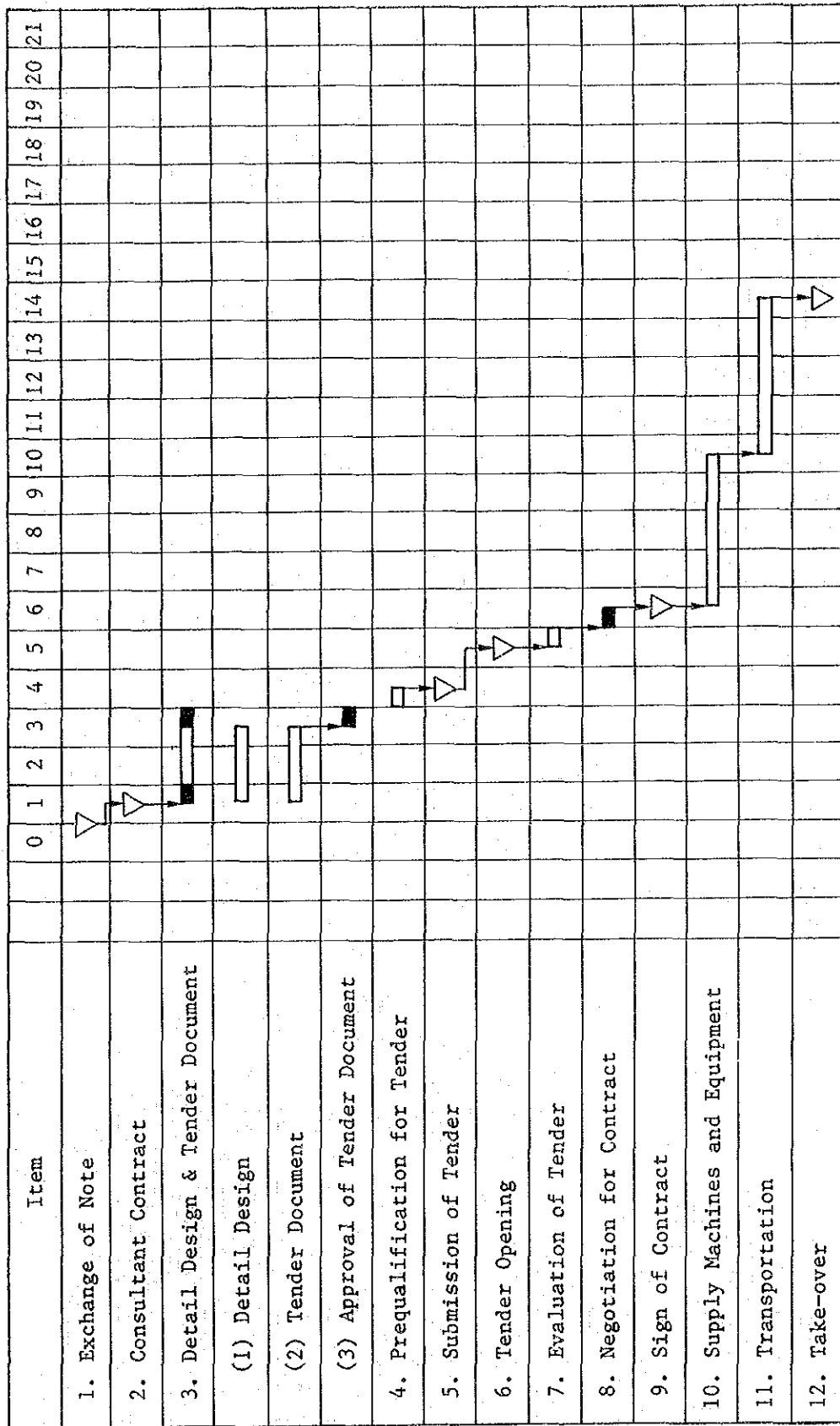
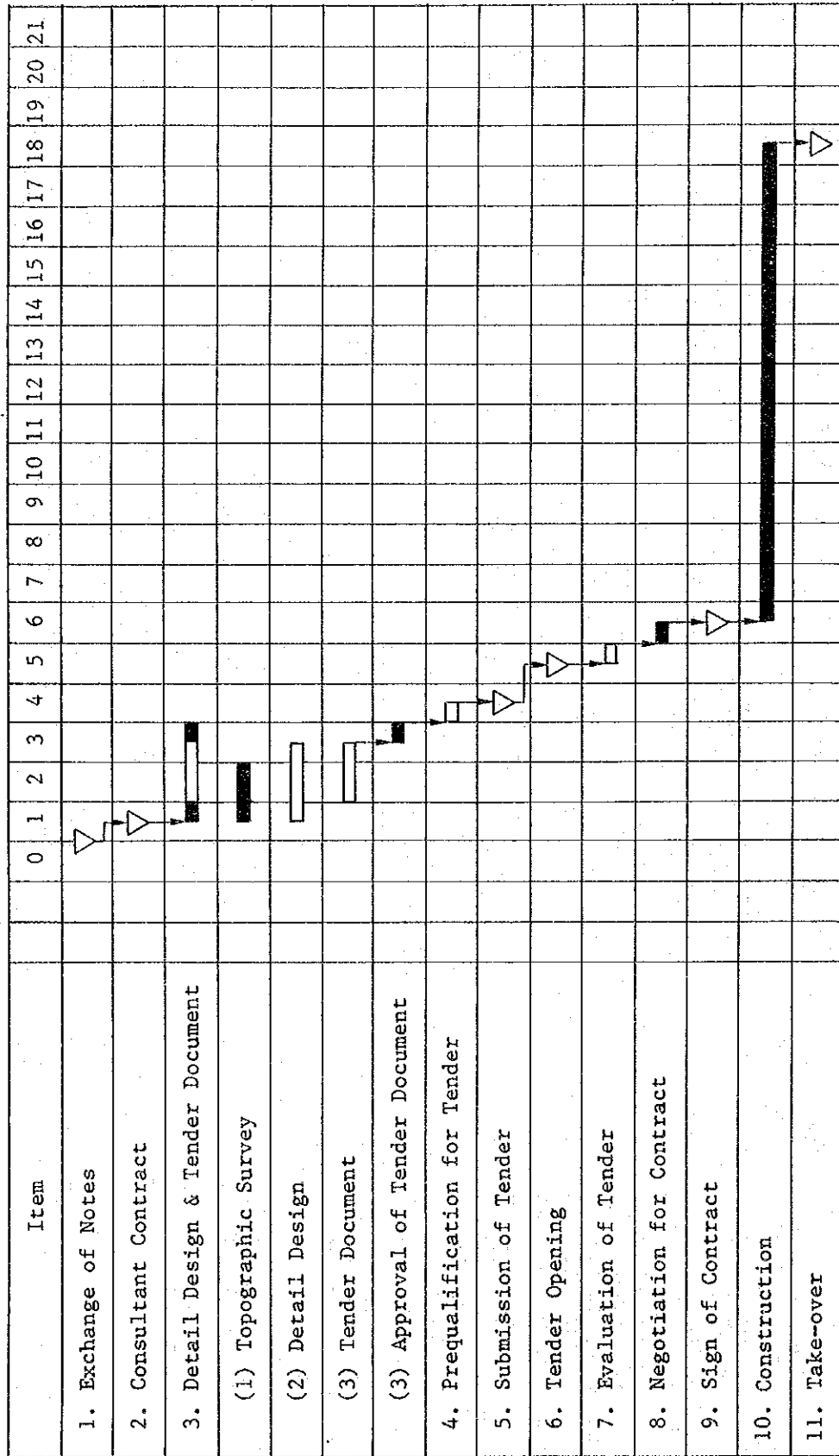


Figure 5-4 Implementation Schedule of Phase 2-4 Construction Works



## CHAPTER 6. PROJECT EVALUATION

The objectives of the project are to introduce the irrigated agriculture in the Masvingo Province and to supply drinking water for domestic animals by constructing the six medium size dams and the related irrigation facilities. The introduction of irrigated agriculture will ensure the increase of the cereal crop production to a maximum extent and secure the stable supply of fresh vegetable like lettuce and tomatoes to the inhabitants even in the dry season. The details of these project benefits are discussed below.

### (1) Increase of Crop Production

Although many kinds of crop such as maize, wheat, groundnut, etc. would be introduced in the project, the increase of crop production is evaluated, on the assumption that maize is cultivated twice a year in 80% of the total irrigable area. The unit yield of 6.9 tons/ha, which is the average yield of the existing Mapanzure Irrigation Scheme is adopted and the proposed yield is compared with the production of the existing dry land farming with the unit yield of 0.8 tonnes/ha as shown in the following table.

Project Name	Project Area (ha)	Irrigable Area (ha)	Cultivation Maize Area (ha)	Proposed Production (tonnes)	Present Production (tonnes)	Production Increase (tonnes)
Musaverema	44.0	36.2	29.0	400	23	377
Magudu	70.0	51.1	40.9	564	33	531
Mujanganja	51.0	33.3	26.6	367	21	346
Chinyamatumwa	50.0	34.7	27.8	384	22	362
Mashoko	21.0	15.2	12.2	168	10	158
Mabvute	100.0	70.5	56.4	778	45	733
<b>Total</b>	<b>336.0</b>	<b>241.0</b>	<b>192.9</b>	<b>2,661</b>	<b>154</b>	<b>2,507</b>

The above increase of crop production can be compared with the drought relief in the past.

The drought relief in the recent drought year of 1987/88 and the most severe drought year of 1984/85 is listed as follows:

<u>Project</u>	<u>Communal Land</u>	<u>Drought Relief (tonnes)</u>	
		<u>1984/85</u>	<u>1987/88</u>
Musaverema	Matibi 1	102	93
Magudu	Nyajena	373	349
Munjanganja	Gutu	602	95
Chinyamatumwa	Bikita	--	79
Mashoko	Matsai	453	6
Mabvute	Ndanga	400	216
<u>Total</u>		<u>1,930</u>	<u>838</u>

The increase of crop production by the proposed project is estimated to be more than the drought relief in the most severe drought year of 1984/85.

(2) Supply of Fresh Vegetable

The cultivation of fresh vegetable is planned in 20% of the total irrigable area. The average unit yield of 20 tonnes/ha and 2 times cultivation per year would be expected. The number of beneficial inhabitants to be supplied with the fresh vegetable by the project is estimated based on the assumption that the average consumption of fresh vegetable would increase to 20 kg/person/year.

Project Name	Vegetable Area (ha)	Production (tonnes)	Number of Beneficiaries (persons)
Musaverema	7.2	288	14,400
Magudu	10.2	408	20,400
Munjanganja	6.7	268	13,400
Chinyamatumwa	6.9	276	13,800
Mashoko	3.0	120	6,000
Mabvute	14.1	564	28,200
<b>Total</b>	<b>48.1</b>	<b>1,924</b>	<b>96,200</b>

As shown above, 96,200 inhabitants would be supplied with fresh vegetable in the project.

(3) Increase of Farm Income

The increase of farm income is estimated on the premise that the average farm household will be allocated with 0.1 ha of irrigable area as follows.

Project	Number of Household	Present Income (Z\$)	Projected Income (Z\$)	Increase of Income (Z\$)
Musaverema	362	430	635	205
Magudu	511	190	416	226
Munjanganja	333	345	601	256
Chinyamatumwa	347	444	691	247
Mashoko	152	333	560	227
Mabvute	705	518	776	258
<b>Total (Average)</b>	<b>2,410</b>	<b>(389)</b>	<b>(629)</b>	<b>(240)</b>

The average increase of farm income is estimated at Z\$240 per household which corresponds to 60% of the present farm income, although it is slightly different according to the project condition such as agricultural land, transportation of agriculture input and marketing of agriculture product.

(4) Water Supply for Domestic Animals

The supply of drinking water to domestic animals such as cattle and sheeps, which are bred in the circumference of the proposed reservoirs, will improve the hygienic condition of the domestic animals and will save the labour of the animal breeding farmers. The number of domestic animals is estimated below. This estimate was made on the premise that the domestic animals living within the distance of 5 km from the damsite would be supplied with water from the proposed reservoir.

Project Name	Beneficial Livestock (LSU)
Musaverema	1,800
Magudu	2,430
Munjanganja	1,500
Chinyamatumwa	2,000
Mashoko	790
Mabvute	3,000
Total	11,520

LSU: Livestock Unit

## CHAPTER 7. CONCLUSION AND RECOMMENDATION

### 7.1 Conclusion

As a result of the field survey and the discussion with AGRITEX and MEWRD in Zimbabwe and the study in Japan, the following items were confirmed.

- o The medium size dams project in Masvingo province coincides the policy of the Zimbabwe government to develop the communal lands with a philosophy of "Growth with Equity".
- o The studies and implementation of medium size projects in all province are being undertaken by foreign countries or an international organization. The implementation of the medium size dam project in Masvingo province is expected to be undertaken by the Japanese aid.
- o The increase of crop production, which is the major direct benefit in the Project, will contribute to food security in the communal lands. The number of the beneficial farm household to obtain allocation of the irrigated farm land is 2,400 households which corresponds to 1.5% of the total households of the communal lands in Masvingo province.
- o The project is very effective to alleviate poverty of the farmers in the communal land which is the most depressed area in the country, then the farm income is expected to increase from Z\$390 to Z\$630.
- o The beneficial population to be supplied with fresh vegetable would be 96,200 persons.
- o Judging from the management of the existing irrigation schemes (Mapanzure Irrigation Scheme, etc.) the facilities to be constructed in the project will be effectively operated and maintained by MEWRD and AGRITEX.



- o The number of civil engineers for dam construction is in shortage and the Japanese contractor should be employed under the grant aid programme to undertake the construction work, through which technical transfer to the Zimbabwe counterpart will be made. It is expected that the Zimbabwe government would continue the construction of medium size dams by their own staff.

Based on the above confirmation, it is justifiable and deemed appropriate that the government of Japan extend grant aid cooperation to the medium size dams project in Masvingo province.

## 7.2 Recommendation

Japanese contractor will undertake the construction of medium size dams and related irrigation facilities, while the AGRITEX for infield facilities. It is recommended, therefore, that the AGRITEX should undertake the construction of the in-field facilities and allocate the land to farmers in due time upon the completion of dams and related irrigation facilities in order to fully utilize the impounded water.

The number of civil engineers for dam construction and operators for construction machines are in shortage. Transfer of technology to the Zimbabwean counterparts through the on-job-training in the implementation of the project is essential. Therefore it is recommended that MEWRD should allocate the counterpart staff to participate in the implementation of the construction work of the medium size dams and the related irrigation facilities in order that MEWRD would continue the similar natured medium size dams project after the completion of six projects under the Japanese grant aid programme.

## 1. MEMBER LIST OF THE STUDY TEAM

<u>Name</u>	<u>Assignment</u>	<u>Organaization</u>
Takashi TACHIBANA	Team leader	Deputy Director , Construction Dept , Hokuriku Agricultural Administration Office. Ministry of Agricultural Forestry and Fisheries (MAFF)
Takeshi NARUSE	Coordinator	First Basic Design Study Div. Grant Aid Cooperation Planning & Survey Dept , Japan International Coperation Agency (JICA)
Hironori TAKAHASHI	Dam Engineer	Sanyu Consultants INC
Hideo HIRATSUKA	Irrigation Engineer	Sanyu Consultants INC
Michimasa MENJYO	Soil Engineer	Sanyu Consultants INC
Jiroo KAWAI	Construction Equipment Engineer	Sanyu Consultants INC

## 2. FIELD SURVEY ITINERARY

<u>Date</u>	<u>Day</u>	<u>Activities</u>
Dec 6 '88	Tue	Left Tokyo.
7	Wed	Left London.
8	Thu	Arrive in Harare. Courtesy call on Embassy of Japan.
9	Fri	Meeting with MEWRD and submission of Inception Report. Courtesy call on MFEPD.
10	Sat	Move to Masvingo. Inspection of Kyle Dam.
11	Sun	Office work.
12	Mon	Field survey on Magudu project.
13	Tue	Inspection of existing Mapanzure Irrigation Scheme.
14	Wed	Move to Harare.
15	Thu	Meeting with MEWRD and AGRITEX.
16	Fri	Exchange of Minutes of Discussion.
17	Sat	Team leader and Coordinator left Harare.
18	Sun	Move to Masvingo.
19	Mon	Meeting with the provincial offices of MEWRD and AGRITEX.
20	Tue	Borrow area survey on Mashoko project. Inspection of Mushandike and Mbindangombe project.
21	Wed	Borrow area survey on Mabvute project. Field survey on Mashoko project.
22	Thu	Borrow area survey on Chinyamatumwa project. Field survey on Munjanganja project.
23	Fri	Borrow area survey on Chinyamatumwa project. Discussion with MEWRD and AGRITEX on the questionnaire.
24	Sat	Field survey on Musaverema project.
25	Sun	Holiday.
26	Mon	Borrow area survey on Musaverema project.
27	Tue	- do -
28	Wed	Borrow area survey on Magudu project. Collection of data on agro-economy from AGRITEX.
29	Thu	Collection of data on construction.
30	Fri	Inspection of Mbindangombe project. Discussion with MEWRD on the construction machines.
31	Sat	Move to Harare.
Jan 1 '89	Sun	Holiday.

2	Mon	Office work.
3	Tue	Discussion with MEWRD and AGRITEX.
4	Wed	Preparation of field report.
5	Thu	Collection of data on foreign exchange.
6	Fri	Discussion on the selection of construction machines.
7	Sat	Analysis on the collected data.
8	Sun	Holiday.
9	Mon	Preparation of field report.
10	Tue	- do - Collection of data on transportation and agriculture.
11	Wed	Preparation of field report. Discussion on the construction machines.
12	Thu	Submission of field report.
13	Fri	Courtesy call to MEWRD and AGRITEX.
14	Sat	Office work.
15	Sun	Holiday.
16	Mon	Courtesy call to Embassy of Japan. Leave Harare.
17	Tue	Transit in London.
18	Wed	Leave London.
19	Thu	Arrive in Tokyo.

### 3. LIST OF MEMBERS CONTACTED BY THE STUDY TEAM

#### Embassy of Japan

Mr. Ken Ikebe Ambassador  
Mr. Hiroyuki Eguchi, Counselor  
Mr. Yukio Kawajiri, Secretary  
Mr. Yukiharu Matsumoto, Secretary

#### Ministry of Finance, Economic Planning and Development

Mr. O. Matshalaga Under Secretary  
Mr. W. Chirimuta Senior officer, Japanese Desk

#### Ministry of Energy, Water Resources and Development (MEWRD)

Mr. M. J. Tumbare Deputy Director (Operation)  
Mr. N. Manjonjori Assistant Chief Operation Engineer  
Mr. J. H. Remba Planning officer  
Mr. W. Ankersmit Civil Engineer (Operation)

#### Department of Agricultural, Technical and Extension Services (AGRITEX)

#### Ministry of Land, Agriculture and Rural Resettlement

Mr. R. J. Chitsiko Assistant Chief Irrigation officer  
Mr. J. T. Magange Irrigation Specialist

#### Department of Meteorological Service, Ministry of Transport

Miss. S. Mabasha Rainfall Section

#### Reserve Bank

Mr. A. Bvumbe Manager, Statics Economics Division

#### Provincial Water Engineer' Office, Masvingo

Mr. D. Z. Mazvidza Acting Provincial Water Engineer  
Mr. J. Van De Haar Acting Deputy Provincial Water Engineer  
Mr. C. Muusha Assistant Water Supply Engineer

**AGRITEX, Masvingo**

Mr. J. N. Maswaya	Provincial Agricultural Extension officer
Mr. S. Madyiwa	Irrigation Specialist
Mr. S. Alibaba	Crop Specialist
Mr. J. Shumba	Planning Specialist

**Mapanzure Irrigation Scheme**

Mr. Nusonea	Manager
Mr. Noyana	Supervisor
Mr. Rwafa	Extension Worker

**National Railway of Zimbabwe**

Mr. Ozuuke	Forward Section	Good Office, Masvingo
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**Provincial Hospital, Masvingo**

Miss. T. Kujinga	Matron
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**Post and Telephone Corporation**

Mr. Gondobwe	Supervisor, Masvingo
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List of Reference

<u>Name of Reference</u>	<u>Source</u>
Transitional National Development Plan (Vol. 1)	Central Statistical Office
Transitional National Development Plan (Vol. 2)	- do -
Report of the commission of inquiry into agricultural industry	- do -
Integrated plan for rural development July 1978	- do -
Socio-economic review 1980~1985	- do -
Statistical year book 1987	- do -
First five-year national development 1986~1990 (Vol. 1) plan	- do -
First five-year national development 1986~1990 (Vol. 2) plan	- do -
Census of registered poultry producers third quarter 1987	- do -
Census of registered deciduous fruit grower 1987	- do -
1984 Census of resettlement scheme	- do -
Agriculture and livestock survey communal land 1985/86	- do -
Report of Demographic socio economic survey (communal land of Masvingo Prov.)	- do -
Agricultural production on communal land and irrigation scheme and Arda Estates 1982	- do -
The economy of households in Zimbabwe 1985	- do -
Project report on the Mapanzure irrigation scheme 26th January 1970	Provincial Agricultural Extension Office
Design report on additional dam for Mapanzure irrigation scheme	- do -
Project report Mapanzure irrigation scheme reconstruction	- do -
Quatery economic and statical review	Reserve Bank of Zimbabwe
Exchange rate per local currency unit	- do -
Unit price for construction materials	Ministry of Water Development
Rate of labour cost	- do -
Water supply (Purificatory water)	Masvingo Municipal
Hospital	Masvingo Provincial Hospital
Communication and inland travel	Post Telephone Corporation

<u>Name of Reference</u>	<u>Source</u>
Catalogue of construction equipment for infield work	Agritex, Harare
Quotation of construction materials	Commercial Firm
Quotation of fuel and oil	- do -
Quotation of inland transportation	National Railway of Zimbabwe
Rate of telex charge	Travelworld
Rate of air ticket from Harare to Masvingo	- do -
Rate of Hotel Charge	Hotel, Harare and Masvingo
Rainfall summary (Zaka)	Department of Meteorological Service
Rainfall summary (Svuure)	- do -
Rainfall summary (Bikita, Makore)	- do -
Rainfall summary (Bikita, Mushandure)	- do -
Rainfall summary (Bikita, Agre. Stn)	- do -
Rainfall summary (Mashoko)	- do -
Rainfall summary (Vumba Hill)	- do -
Rainfall summary (Berejena Mission)	- do -
Rainfall summary (Stera)	- do -
Rainfall summary (Nyamande Sch)	- do -
Rainfall summary (Bangala Ranch)	- do -




MINUTES OF DISCUSSIONS ON THE BASIC DESIGN STUDY FOR THE CONSTRUCTION OF  
MEDIUM SIZE DAMS IN MASVINGO PROVINCE IN THE REPUBLIC OF ZIMBABWE

In response to the request by the Government of the Republic of Zimbabwe, the Government of Japan decided to conduct a Basic Design Study on the Construction of Medium Size Dams in Masvingo Province in the Republic of Zimbabwe (hereinafter referred to as "the Project") and entrusted the study to the Japan International Cooperation Agency (hereinafter referred to as "JICA"). JICA sent to the Republic of Zimbabwe the Study Team headed by Mr Takashi Tachibana (Team Leader) from December 6, 1988 to January 19, 1989.

The Japanese Study Team has carried out the field survey in the proposed project sites and had a series of discussions and exchanged views with the authorities concerned of the Republic of Zimbabwe.

As a result of the study and discussions, both parties mutually agreed to recommend to their respective governments that the major points of understanding reached between them, attached herewith, should be examined towards the realization of the Project.

At HARARE, ZIMBABWE this 16th day of DECEMBER, 1988.



TAKASHI TACHIBANA  
Leader JICA  
Basic Design Study Team

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Under Secretary  
Ministry of Finance,  
Economic Planning  
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M.J. TUMBARE  
Deputy Director  
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Energy Water Resources  
and Development

JAPAN

ZIMBABWE

ZIMBABWE

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ATTACHMENT

1. Objective of the Project

Agriculture has played a dominant role in the national economy of Zimbabwe and for its development. Communal lands are considerably less developed than urban areas, and there are no other industries than agricultural ones. Therefore, the agricultural development of the communal lands is imperative for raising the living standard of the inhabitants. However, in most areas, owing to less and uneven distribution of rainfall, water has been limited not only for agricultural use but also for domestic and livestock uses.

To overcome this problem and to improve the living standard, the objective of the Project is to construct the following six (6) medium size dams together with distribution canals, night storage reservoirs and infield works:

- (i) Musaverema
- (ii) Magudu
- (iii) Munjanganja
- (iv) Chinyamaturwa
- (v) Mashoko
- (vi) Mabvute

Procurement of necessary equipment and vehicles for construction of the above dams and machines and equipment for infield works shall be included in the Project.

Engineering technology will be transferred to Zimbabwe through the project implementation.

2. Responsible and Implementation Agency for the Project

- 1. Responsible Agency : Ministry of Energy and Water Resources and Development.

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2. Implementing Agency : Ministry of Energy and Water Resources and Development;

Department of Agricultural, Technical and Extension Services of the Ministry of Lands, Agriculture and Rural Resettlement.

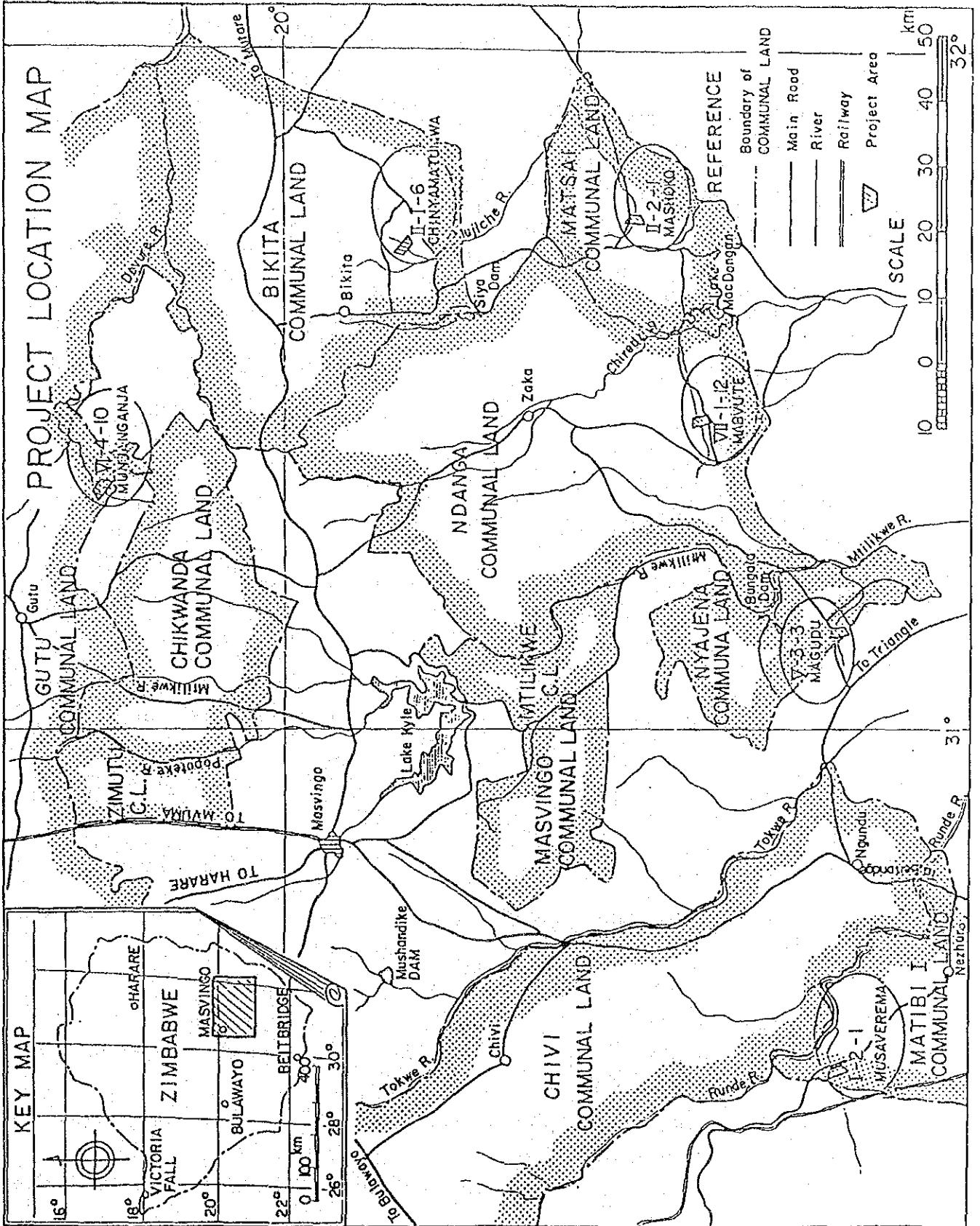
3. Project Sites

The proposed Project sites are located in the Masvingo Province as shown in Figure I (Page 4).

4. Request

The Project components requested by the Zimbabwe side are shown in ANNEX I.

5. The Zimbabwe side has understood that Japan's grant aid system explained by the team which includes the use of a Japanese consulting firm and Japanese general contractors for the implementation of the Project.
6. The Government of the Republic of Zimbabwe will take necessary measures as listed in ANNEX II on condition that grant aid by the Government of Japan would be extended to the Project.
7. The Government of the Republic of Zimbabwe has agreed to provide the necessary budget and personnel for operation and maintenance of the medium size dams including irrigation facilities after completion of the Project.
8. Draft Final Report will be submitted to the Zimbabwe Government at the beginning of April, 1989.



## ANNEX I

The scope of the cooperation for the Project will be decided upon completion of technical and financial studies for the basic design. The requested facilities, equipment and implementation by the Government of the Republic of Zimbabwe are as follows :-

1. The following sites are requested by the Government of Zimbabwe to be provided with medium size dams and irrigation facilities.

<u>Name of Site</u>	<u>Name of District</u>	<u>Priority</u>
i) Musaverema	Mwenezi	1
ii) Magudu	Bikita	1
iii) Munjanganja	Bikita	2
iv) Chinyamatumwa	Masvingo	2
v) Mashoko	Gutu	3
vi) Mabvute	Zaka	3

2. The following items are requested by the Government of Zimbabwe or grant-aid assistance :-

- (a) Machines, equipment and vehicles for the construction of medium size dams including distribution canals, night storage reservoirs and infield works in six (6) sites.
- (b) Construction of medium size dams, distribution canals and night storage reservoir in six (6) sites.
- (c) Transfer of technology during design and implementation.

3. The following implementation schedule is requested by the Government of Zimbabwe :-

- (a) Phase 1 : Donation of machines, equipment and vehicles and construction of access roads (service roads) depending on the time of arrival of equipment.
- (b) Phase 2 : Construction of two dams and other facilities as priority No. 1.
- (c) Phase 3 : Construction of two dams and other facilities as priority No. 2.
- (d) Phase 4 : Construction of two dams and other facilities as priority No. 3.

## ANNEX II

The Government of the Republic of Zimbabwe will take the following measures:

1. To acquire the land and right of way required for dams and reservoir area, canals and night storage reservoirs.
2. To ensure the land and right of way necessary for construction of the temporary roads from existing rural roads to the proposed construction sites.
3. To ensure speedy unloading, tax exemption, customs clearance at the port of disembarkment of the procured equipment and materials under the grant aid.
4. To allow transportation of vehicles, machinery and construction equipment on the existing national and rural roads.
5. To exempt from import duties and incidental expenses and to take necessary measures for customs clearance of the materials, equipment and spare parts brought into Zimbabwe for the implementation of the Project.
6. To assume the following commissions on the Japanese foreign exchange bank for banking services based on the banking arrangement :-
  - (a) Advising commission of authorization to pay;
  - (b) Payment commission.
7. To accord Japanese nationals, whose services may be required in connection with the supply of goods and the services under the verified contract such facilities as may be necessary for their entry into the Republic of Zimbabwe and stay therein for the performance of their work.

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8. The Japanese involved in the project will not be subject to any customs duties, internal taxes, and other fiscal levies which may be imposed in Zimbabwe with respect to the supply of goods and services under the verified contract.
9. To provide a yard which is spacious and safe enough to store the donated machines and equipment before their arrival.
10. To store and maintain properly the machines and equipment purchased under the grant until the Japanese contractor receives them.
11. To ensure those machines and equipment purchased under the grant to be used exclusively by the Japanese contractor during the construction period.
12. To undertake the construction of the infield facilities in due time by making use of the equipment and machine provided under the grant.
13. To maintain and use properly and effectively the facilities constructed and equipment purchased under the grant.
14. To provide necessary data and information for detailed designs.
15. To take necessary action to expedite the approval for execution by the Government of the Republic of Zimbabwe of this project .









JICA