5.3.3 River Improvement Plan

River improvement plan of Batu Merah River is summarized in Table-D.5.9 and Figure-D.5.14 based on the following study:

(1) River Improvement Range

River improvement range is set from river mouth to 1k500, i.e. 1,500m length. V-shape valley is extended in the upstream of 1k500 and there are houses along both side of the river. These houses are protected against flood by raising their houses by about 1 m. Therefore, the upstream of 1k500 is not planned to be improved.

River Improvement Range : 0k000 - 1k500 (Length 1,500m)

(2) River Course Alignment

River course alignment basically followed current river course but new diversion tunnel is planned from 1k400 to the sea 850 m north of Batu Merah River Mouth.

(3) Planned River Bed (Slope, Excavation)

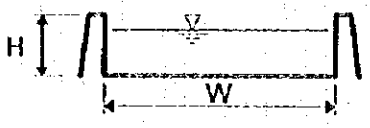
Planned riverbed slope of the downstream from 0k000 to 0k250 was set level at EL.-1.00m, which is the nearly current deepest river bed level. Because the river section is enough wide and high so that it is not necessary to be excavated and heightened.

Planned riverbed of the upstream from 0k250 was set at I=1/320 in line with the current riverbed slope. Three cases of excavation depth, 1.0m, 0.5m and 0.0m below the deepest riverbed, were studied. Of these the case of 0.5m excavation depth was adopted because of following reasons:

- More than 1m flood walls heightening is needed in the case of 0.0m excavation depth and it costs more due to structural strengthening, comparing with the case less than 1 m flood wall heightening.
- The case of 1.0m excavation depth needs structural strengthening to existing flood walls and it cost very much, even though river bed excavation has advantage for enlarging discharge capacity and facilitating inner water drainage.
- Then the medium case of 0.5m excavation depth was adopted.

(4) Standard Cross Section (Heightening, Widening)

According to the current river section with flood walls, the planned standard cross section was set rectangular as follows:



0k000-0k200	: W=20.0m, H=2.4-2.7m
0k250-0k390	: W=16.0m, H=2.4-2.7m
0k400-0k850	: W=10.0m, H=2.6m
0k900-1k250	: W= 8.0m, H=3.0m
1k300-1k400	: W= 7.0m, H=2.8m
1k450-1k500	: W=10.0m, H=3.1m

Based on uniform and non-uniform flow calculation on the design discharge 90 m^3/sec for 0k000-1k250, 70 m^3/sec for 1k250-1k400, and 130 m^3/sec for 1k400-1k500,equivalent to 5-year return period, the following flood wall heightening and section widening were planned.

- As for the river sections from 0k300 to 1k500, both side of flood walls are planned to be heightened at almost all of the section by 0.1-1.0m (0.5 m on average).
- Along the right side of the river from 0k400 to 0k800, urban redevelopment plan, which includes construction of river inspection road with the width of 2.5m. This project is planned to start from 1998/99. Therefore the river sections from 0k450 to 0k750, of which width is very narrow with 6.7 - 7.7 m, were planned to be widened to 10m at the right side, in line with the said project.
- The river sections from 1k100 to 1k350 need to be widened to 7-8m width because of too narrow sections with 4.5-7.0m.
- The river sections from 1k400 to 1k500 need to be widened to 10m width because the diversion tunnel inlet is planned to be installed
- Three-sided concrete channel is planned from 0k400 to 1k500, in order to enlarge discharge capacity so as to be reduce roughness.

(5) Bridge Improvement

The list of bridges in Batu Merah River is shown in Table-D.5.7. The clearance between bridge underside elevation and H.W.L. is judged to be enough (more than 0.6m) but the bridge of No.4 is necessary to be improved.

Table-D.5.7 List of Bridges in Batu Merah River

No.	Distance (m)	Bridge Underside Elevation (EL.m)	Bridge Pier		Bridge Width (m)	*1 Objec-tives	Clearance (m)		Depth of *2 Excavation at Pier (m)		Remarks
			Number	Width (m)							
1	0k009	2.50	-	-	8.00	VR	1.68	O	0.45	O	
2	0k116	1.75	-	-	7.00	VR	0.75	O	-	O	
3	0k377	3.50					2.40	O	-	O	Telecom pipe
4	0k386	2.60	1	1.80	9.00	VR	1.48	O	1.00	X	
5	0k636	3.50	-	-	1.00	FPB	1.29	O	-	O	Suspension bridge
6	0k993	5.40	-	-	2.00	FPB	1.68	O	-	O	

*1 Objectives (Vehicle Road, Foot Path Bridge, Water Pipe, Others)
*2 Excavation Depth below Deepest Riverbed

(6) Drainage Improvement

The list of drainage in Batu Merah River is shown in Table-D.5.8. The method of drainage improvement will be studied in the chapter of facility design.

Table-D.5.8 List of Drainage in Batu Merah River

No.	Distance (m)	Side	Bottom Elevation (EL.m)	Section Width (m)	Section Height (m)	Objectives	Remarks
1	0k110	L	0.28	0.50	0.60	CD	
2	0k110	R	0.99	0.40	0.60	CD	
3	0k185	L	0.76	2.00	1.20	CD	
4	0k221	L	0.53	0.60	0.50	HD	
5	0k394	L	0.22	0.80	1.50	CD	
6	0k394	R	0.22	1.00	1.20	CD	
7	0k404	L	0.35	2.00	1.50	HD	
8	0k474	L	0.49	1.10	0.85	HD	
9	0k548	L	0.69	0.70	0.80	HD	
10	0k649	L	1.14	0.60	0.70	CD	
11	0k651	L	1.14	1.00	1.00	HD	
12	0k756	L	1.30	0.70	0.60	HD	
13	1k434	R	4.43	0.60	0.60	HD	
14	1k442	L	5.35	0.60	0.60	HD	

* Objectives (1:City Drainage, 2: Home Drainage, 3:Toilet, 4:Others)

5.3.4 Diversion Inlet Plan

The diversion inlet was planned as follows:

- Planned Diversion Section : 1k400
- Discharge Distribution : Upstream : 130 m^3/sec
  Diversion : 60 m^3/sec
  Downstream : 70 m^3/sec
- Diversion Works : Side Weir
- Initial discharge to start diversion : 20 m^3/sec

The upstream river of planned diverted section was planned as 7.0 m width, 3.50 m high water level, 4.10 m flood wall height and 1/320 riverbed slope. Assuming that frequency of flow down to the diversion is set at 3 times a year, initial discharge to start diversion is set at 20 m3/sec. In this case, the water depth is calculated to be 0.94 m in the upstream before diversion and 0.6 - 1.0 m in the downstream section.

Table-D.5.9 Batu Merah River Improvement Plan

Section No.	Profile No.	Cumulative Distance (m)	Current Condition: Dpst.Bed Level (EL.m)	Ave. Bed Level (EL.m)	River Width (m)	Left Bank (m)	Right Bank (m)	Planning Condition: Riverbed Level (EL.m)	Water Level (EL.m)	Top of Dike (EL.m)	Design Qp (m3/s)	River Width (m)	Water Height (m)	Slope 1 :	R.bed at Wall Left (EL.m)	R.bed at Wall Right (EL.m)	Dike Height (m)	Excavation Depth Ave. (m)	Deepest (m)	R.bed at Wall L (m)	R (m)	Heightneing Left (m)	Heightneing Right (m)	Widening Length (m)	Concrete Channel
1	BM0	0.00	-1.29	-0.95	25.60	2.29	2.28	-1.00	0.80	1.40	90	20.00	1.80	-	-1.00	-0.65	2.40	0.05	-	0.00	0.35	-	-	-	-
2	B1	8.90	-1.38	-0.79	25.40	2.55	2.68	-1.00	0.82	1.42	90	20.00	1.82	-			2.42	0.21	-			-	-	-	-
3	BM0A	50.00	-1.14	-0.70	23.25	2.11	2.37	-1.00	0.90	1.50	90	20.00	1.90	-	-1.10	-0.60	2.50	0.30	-	-	0.40	-	-	-	-
4	BM1	100.00	-1.08	-0.58	22.35	2.06	2.32	-1.00	0.98	1.58	90	20.00	1.98	-	-0.60	-0.10	2.58	0.42	-	0.40	0.90	-	-	-	-
5	B2	116.30	-0.93	-0.48	22.10	2.82	2.90	-1.00	1.00	1.60	90	20.00	2.00	-			2.60	0.52	0.07	1.00	1.00	-	-	-	-
6	BM1A	150.00	-1.10	-0.28	20.20	2.13	1.94	-1.00	1.04	1.64	90	20.00	2.04	-	-0.35	0.95	2.64	0.72	-	0.65	1.95	-	-	-	-
7	BM2	200.00	-0.54	0.04	21.65	1.82	1.68	-1.00	1.10	1.70	90	20.00	2.10	-	1.10	0.45	2.70	1.04	0.46	2.10	1.45	-	0.02	-	-
8	BM2A	250.00	-0.12	0.11	18.40	1.72	1.62	-1.00	1.10	1.70	90	16.00	2.10	-	0.05	0.45	2.70	1.11	0.88	1.05	1.45	-	0.08	-	-
9	BM3	300.00	-0.08	0.33	18.60	1.41	1.65	-0.84	1.10	1.70	90	16.00	1.95	320	0.05	0.95	2.55	1.17	0.76	0.89	1.79	0.29	0.05	-	-
10	BM3A	350.00	0.20	0.45	16.20	1.55	1.79	-0.69	1.10	1.70	90	16.00	1.70	320	0.25	1.10	2.39	1.14	0.89	0.94	1.79	0.15	-	-	-
11	B3	377.00	0.20	0.40	16.20	1.55	1.79	-0.60	1.10	1.70	90	16.00	1.70	320				1.00	0.80			0.15	-	-	-
12	B4	386.00	-0.43	0.43	16.90	3.24	3.22	-0.58	1.12	1.72	90	16.00	1.70	320				1.01	0.15			-	-	-	-
13	BM4	400.00	-0.03	0.34	12.90	1.81	1.33	-0.53	1.47	2.07	90	10.00	2.00	320	-0.20	1.15	2.60	0.87	0.50	0.33	1.68	0.26	0.74	-	Concrete
14	BM4A	450.00	0.17	0.42	8.65	1.85	1.83	-0.38	1.63	2.23	90	10.00	2.00	320	1.05	0.05	2.60	0.80	0.55	1.43	0.43	0.38	0.40	1.35	Concrete
15	BM5	500.00	0.28	0.51	8.75	2.14	2.04	-0.22	1.78	2.38	90	10.00	2.00	320	0.70	0.15	2.60	0.73	0.50	0.92	0.37	0.24	0.34	1.25	Concrete
16	BM5A	550.00	0.58	0.72	8.80	2.03	2.01	-0.06	1.94	2.54	90	10.00	2.00	320	0.80	0.50	2.60	0.78	0.64	0.86	0.56	0.51	0.53	1.20	Concrete
17	BM6	600.00	0.66	0.91	9.70	2.31	2.11	0.09	2.09	2.69	90	10.00	2.00	320	1.00	0.90	2.60	0.82	0.57	0.91	0.81	0.38	0.58	0.30	Concrete
18	B5	635.60	0.76	0.86	9.00	2.52	2.52	0.21	2.21	2.81	90	10.00	2.00	320			2.60	0.66	0.56			0.29	0.29	1.00	Concrete
19	BM6A	650.00	0.66	1.02	7.00	2.82	2.29	0.25	2.25	2.85	90	10.00	2.00	320	1.10	0.80	2.60	0.77	0.41	0.85	0.55	0.03	0.56	3.00	Concrete
20	BM7	700.00	0.21	0.47	6.70	2.40	2.25	0.41	2.41	3.01	90	10.00	2.00	320	2.40	0.60	2.60	0.06	-	1.99	0.19	0.61	0.76	3.30	Concrete
21	BM7A	750.00	0.86	1.02	5.50	2.57	2.54	0.56	2.56	3.16	90	10.00	2.00	320	2.30	0.85	2.60	0.46	0.30	1.74	0.29	0.59	0.62	4.50	Concrete
22	BM8	800.00	1.32	1.34	10.70	2.69	2.54	0.72	2.72	3.32	90	10.00	2.00	320	1.30	1.10	2.60	0.62	0.60	0.58	0.38	0.63	0.78	-	Concrete
23	BM8A	850.00	1.38	1.86	14.60	3.83	3.08	0.88	2.88	3.48	90	10.00	2.00	320	1.40	2.15	2.60	0.99	0.51	0.53	1.28	-	0.40	-	Concrete
24	BM9	900.00	1.77	2.00	8.50	2.97	3.86	1.03	3.43	4.03	90	8.00	2.40	320	1.90	2.15	3.00	0.97	0.74	0.87	1.12	1.06	0.17	-	Concrete
25	BM9A	950.00	2.08	2.16	9.50	4.12	3.24	1.19	3.59	4.19	90	8.00	2.40	320	2.05	2.05	3.00	0.97	0.89	0.86	0.86	0.07	0.95	-	Concrete
26	B6	992.55	1.54	1.94	8.00	5.03	5.02	1.32	3.72	4.32	90	8.00	2.40	320			3.00	0.62	0.22			-	-	-	Concrete
27	BM10	1000.00	1.48	1.97	9.00	3.37	3.45	1.34	3.74	4.34	90	8.00	2.40	320	2.50	1.60	3.00	0.63	0.14	1.16	0.26	0.97	0.89	-	Concrete
28	BM10A	1050.00	1.55	2.17	8.60	3.60	4.24	1.50	3.90	4.50	90	8.00	2.40	320	2.50	2.45	3.00	0.67	0.05	1.00	0.95	0.90	0.26	-	Concrete
29	BM11	1100.00	1.85	2.23	7.00	3.66	3.65	1.66	4.06	4.66	90	8.00	2.40	320	1.90	2.85	3.00	0.57	0.19	0.24	1.19	1.00	1.01	1.00	Concrete
30	BM11A	1150.00	2.40	2.44	6.20	3.82	3.77	1.81	4.21	4.81	90	8.00	2.40	320	2.40	2.40	3.00	0.63	0.59	0.59	0.59	0.99	1.04	1.80	Concrete
31	BM12	1200.00	2.60	2.78	7.80	4.01	4.92	1.97	4.37	4.97	90	8.00	2.40	320	2.50	2.95	3.00	0.81	0.63	0.53	0.98	0.96	0.05	0.20	Concrete
32	BM12A	1250.00	2.62	2.90	9.00	5.17	4.27	2.13	4.53	5.13	90	8.00	2.40	320	2.50	3.00	3.00	0.78	0.50	0.38	0.88	-	0.86	-	Concrete
33	BM13	1300.00	3.01	3.27	6.60	4.51	4.54	2.28	4.53	5.13	70	7.00	2.20	320	3.20	3.50	2.84	0.99	0.73	0.92	1.22	0.62	0.59	0.40	Concrete
34	BM13A	1350.00	3.60	3.58	4.50	4.86	4.75	2.44	4.64	5.24	70	7.00	2.20	320	3.50	3.00	2.80	1.14	1.16	1.06	0.56	0.38	0.49	2.50	Concrete
35	BM14	1400.00	3.64	3.73	5.55	4.96	4.86	2.59	4.79	5.39	70	7.00	2.20	320	3.75	3.60	2.80	1.14	1.05	1.16	1.01	0.43	0.53	1.45	Concrete
36	BM14	1400.00	3.64	3.73	5.55	4.96	4.86	2.59	5.09	5.69	130	10.00	2.50	320	4.00	3.95	3.10	1.14	1.05	1.41	1.36	0.73	0.83	4.45	Concrete
37	BM14A	1450.00	3.72	3.78	6.40	5.25	5.14	2.75	5.25	5.85	130	10.00	2.50	320	4.00	3.95	3.10	1.03	0.97	1.25	1.20	0.60	0.71	3.60	Concrete
38	BM15	1500.00	3.49	3.76	6.00	5.31	5.19	2.91	5.41	6.01	130	10.00	2.50	320	3.50	4.90	3.10	0.85	0.58	0.59	1.99	0.70	0.82	4.00	Concrete
39	B7	1534.60	3.32	3.63	8.50	7.35	7.27																		
40	BM15A	1550.00	3.37	3.58	5.40	5.62	5.60																		
41	BM16	1600.00	3.75	3.90	5.00	5.72	5.82																		
Average																	2.70	0.72	0.50	0.88	0.91	0.52	0.52	1.72	

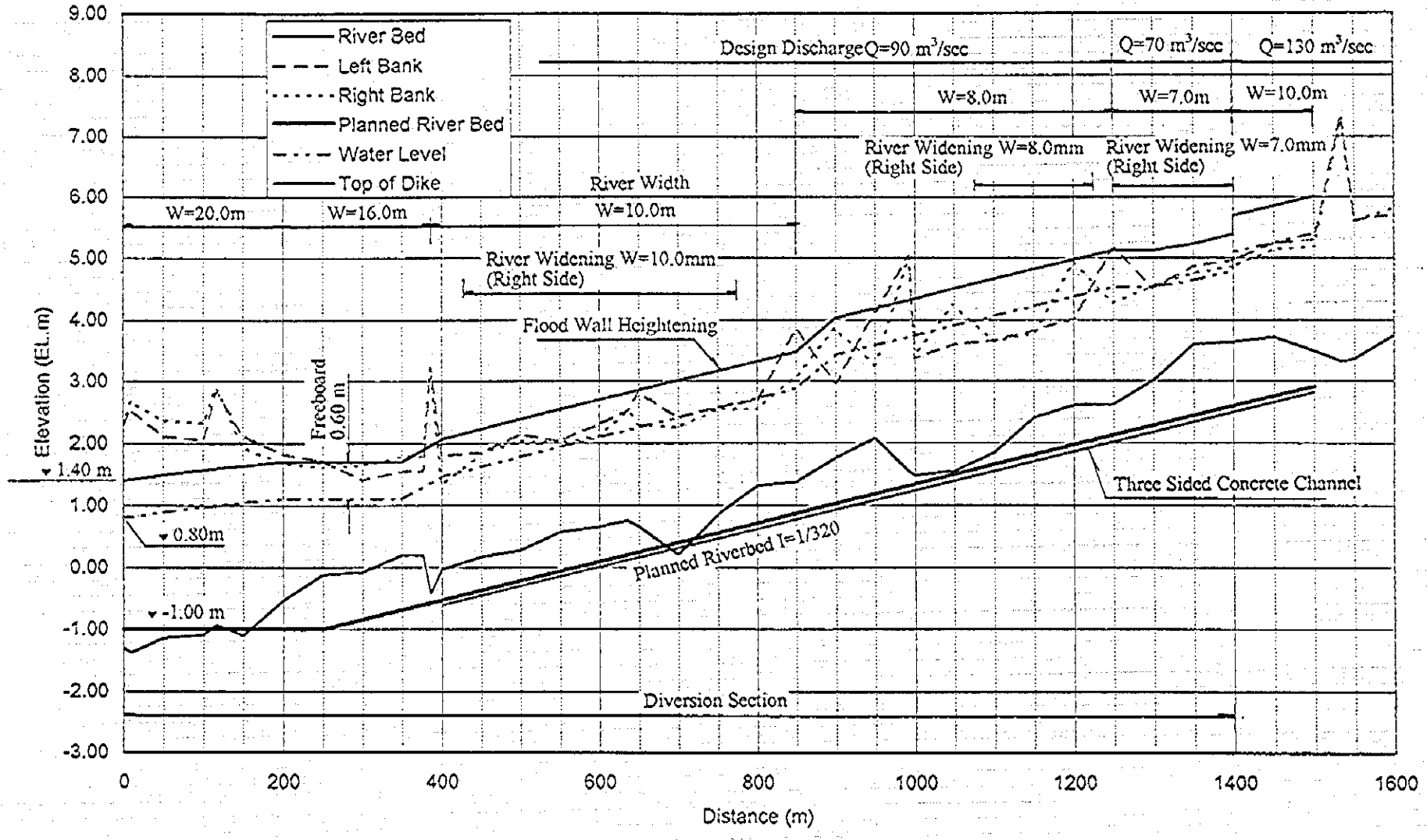


Figure-D.5.14 Longitudinal Section of Batu Merah River Improvement Plan

5.4 Tomu River Project

5.4.1 Basic Policy

Tomu River is improved with 30-year return period. From the fact that sedimentation is progressing in the river course, and is one of flood causes, a check dam is planned at 3k500 from the river mouth. Refer to Figure-D.5.15.

- 0k000 - 2k700 : River improvement with 30-year return period
- 3k500 : Check dam

5.4.2 Planning Criteria

(1) Design Scale

30-year return period

(2) Reference Point, Basin Division and Runoff Model

Reference points are set as shown in Table-D.5.10 and the basin division is shown in Figure-D.5.16. The runoff model is shown in Figure-D.5.14.

Table-D.5.10 Reference Point and Basin Division

Basin Name	Catchment Area. (km^2)	Reference Point	Catchment Area (km^2)
[1] Upper Basin	3.99	Staff Gauge	3.99
[2] Lower Basin	1.65	River Mouth	5.64
Total	5.64		

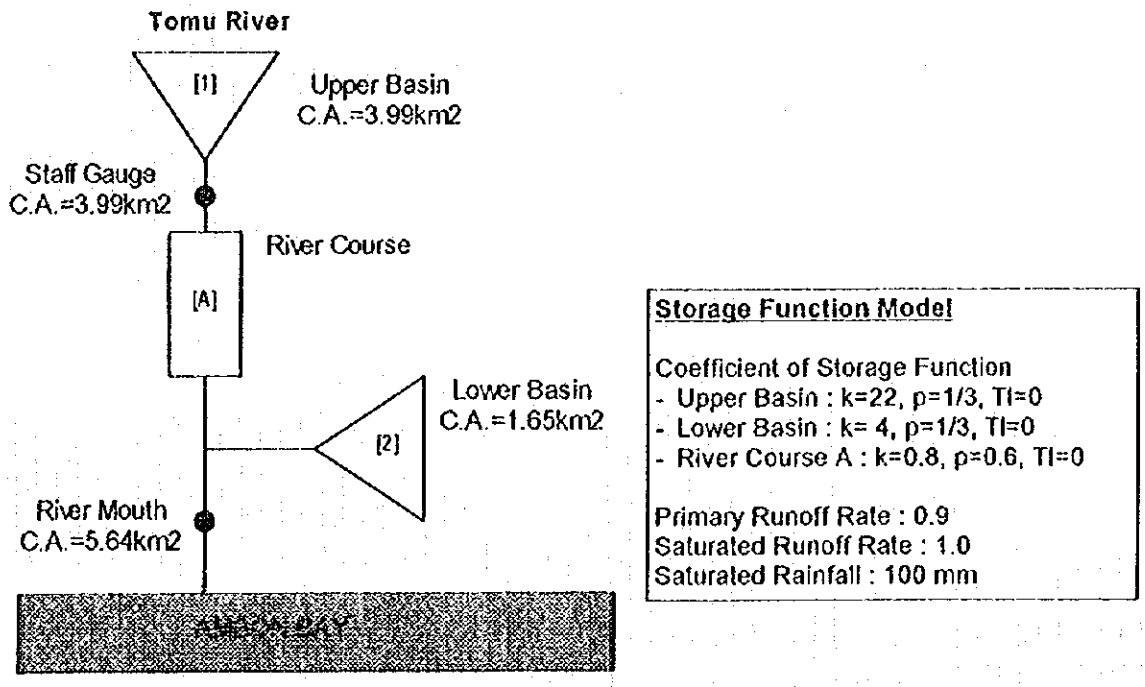


Figure-D.5.14 Runoff Model of Tomu River

River Improvement Range (0k000-2k700)

Tomu Check Dam Site

Staff Gauge

AMBON

Figure-D.5.15 Tomu River

Scale 1:10,000

0 600m

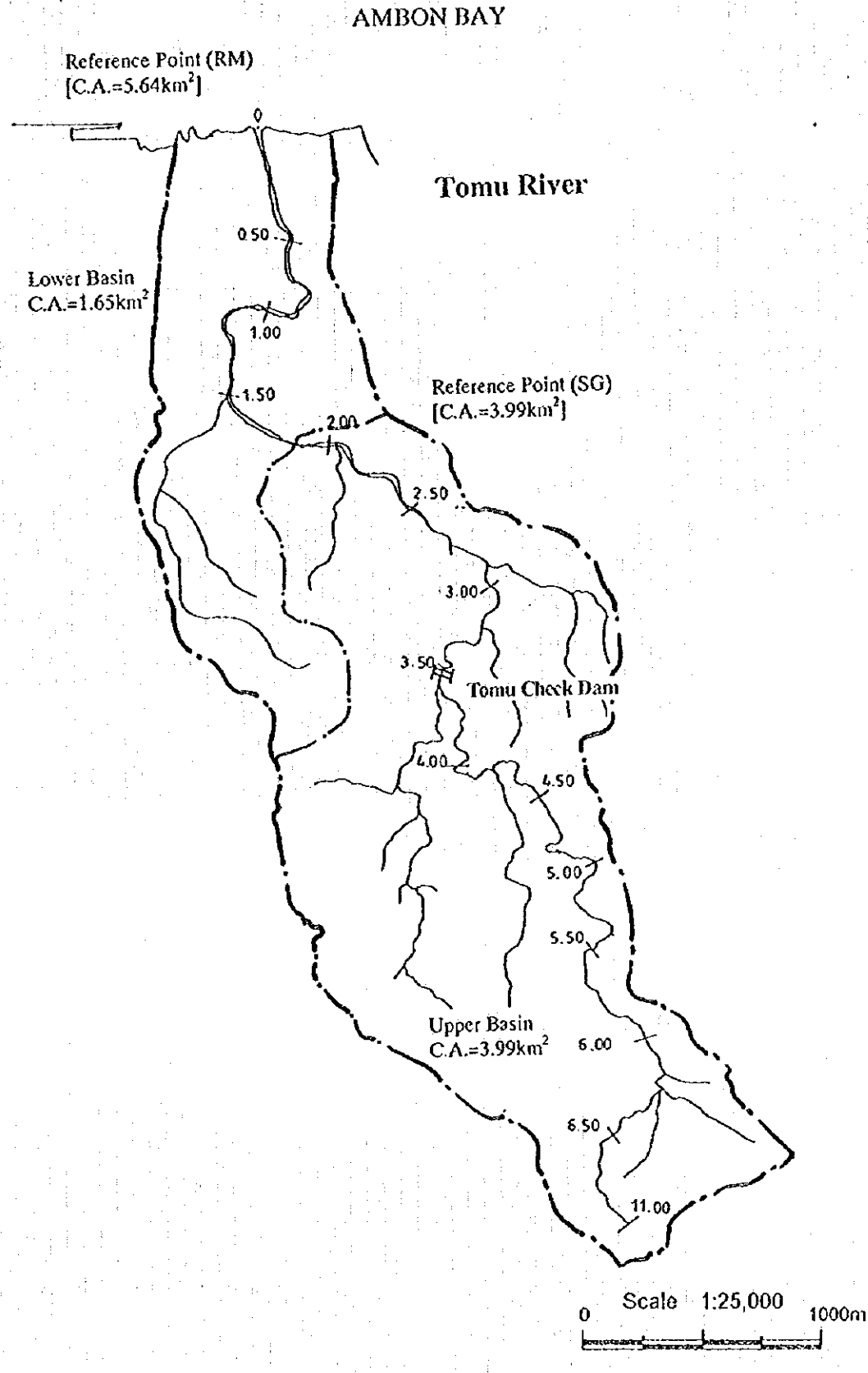


Figure-D.5.16 Tomu River Basin

(3) Design Flood Discharge and Design Hydrograph

Design Flood Discharge

30-year Return Period

- Staff Gauge Reference Point : 90 m^3/sec
- River Mouth Reference Point : 120 m^3/sec

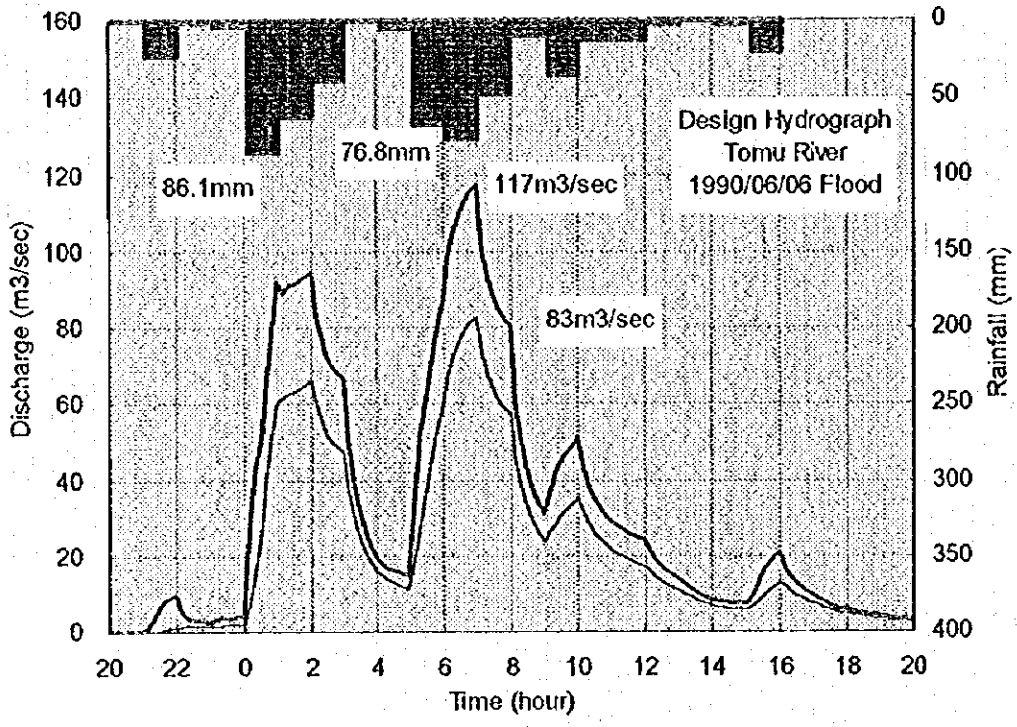


Figure-D.5.17 Design Hydrograph at Reference Points (Tomu River)

(4) Design Discharge Distribution

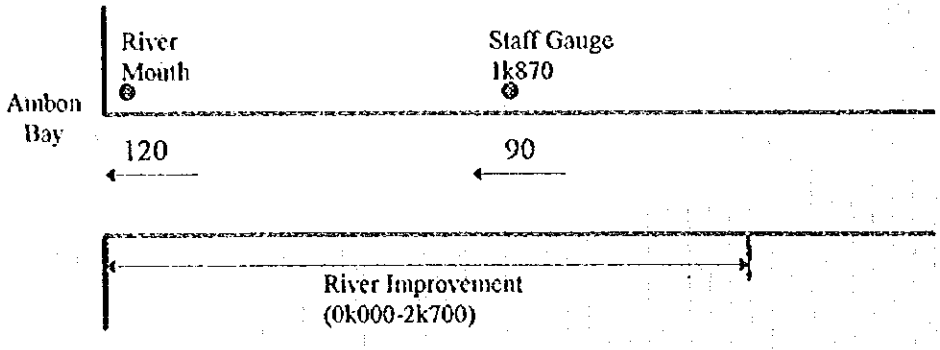


Figure-D.5.18 Design Discharge Distribution (Tomu River)

5.4.3 River Improvement Plan

River improvement plan of Tomu River is summarized in Table-D.5.13 and Figure-D.5.19 based on the following study:

(1) River Improvement Range

River improvement range is set from river mouth to 2k700 i.e. 2,700m length. There are currently no flood walls constructed upstream of 2k700, which is like a natural river. The houses upstream are located in relatively higher place and the upstream river from 2k700 is judged not to be necessary to be improved.

River Improvement Range : 0k000 - 2k700 (2,700m)

(2) River Course Alignment

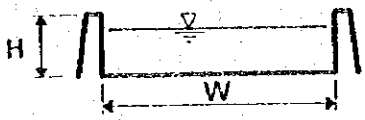
River course alignment followed current river course with no new channel.

(3) Planned River Bed (Slope, Excavation)

Planned riverbed slope (I) was set at I=1/250 from the river mouth to 2k100 and at I=1/100 in the upstream of 2k100, in line with the current riverbed slope. Three cases of excavation depth, 1.0m, 0.5m and 0.0m below the deepest riverbed, were studied. Of these cases the shallowest excavation case was adopted because of economical reason, even though river bed excavation has advantage for enlarging discharge capacity and facilitating inner water drainage.

(4) Standard Cross Section (Heightening, Widening)

According to the current river section with flood walls, the planned standard cross section was set rectangular as follows:



0k000-0k600	: W=14.0m, H=2.0-2.9m
0k650-1k050	: W=12.0m, H=2.5-2.6m
1k100-1k500	: W=15.0m, H=1.9-2.6m
1k550-2k200	: W= 8.0m, H=2.1-2.7m
2k250-2k700	: W= 7.0m, H=2.4m

Based on uniform and non-uniform flow calculation on the design discharge 120 m^3/sec for 0k000-1k500 and 90 m^3/sec for 1k500-2k700, equivalent to 30-year return period, the following flood wall heightening and section widening were planned.

- Flood wall heightening is planned to be less than 1.0m mainly at the upstream of 1k550. Average raised height of flood walls is 0.6m in the right side and 0.7m in the left side.
- As for the river section from 0k650 to 1k000, river alignment is winding and width is narrowest, as well as riverside land elevation is so low that residents have suffered from flood damage. It could be judged that these sections are necessary to be improved drastically although resettlement is requested. Thus river widening is planned to 12.0m width on the right side where there is some room for widening.
- Three-sided concrete channel is planned in all the improved sections, in order to enlarge discharge capacity so as to be reduce roughness.

(5) Bridge Improvement

The list of bridges in Tonu River is shown in Table-D.5.11. Considering clearance between bridge underside elevation and H.W.L.(more than 0.6m) and excavation condition, the bridges of No.1, 2, 7 and 9 are necessary to be improved.

Table-D.5.11 List of Bridges in Tonu River

No.	Distance (m)	Bridge Underside Elevation (EL.m)	Bridge Pier		Bridge Width (m)	*1 Objec-tives	Clearance (m)		Depth of *2 Excavation at Pier (m)		Remarks
			Number	Width (m)							
1	0k008	1.50	-	-	7.00	VR	0.70	O	1.30	X	
2	0k309	1.70	-	-	5.00	VR	0.32	X	-	O	to Hotel under construction
3	0k347	3.90	-	-	-	O	2.36	O	-	O	
4	0k406	2.70	1	1.20	7.00	VR	0.95	O	0.45	O	
5	1k033	5.40	1	1.40	7.00	VR	0.76	O	0.25	O	
6	1k404	6.25	2	1.00	7.00	VR	0.76	O	0.35	O	
7	1k750	7.60	-	-	1.00	FPB	-0.03	X	-	O	
8	1k823	8.50	-	-	1.00	FPB	0.60	O	-	O	
9	2k007	8.65	-	-	2.00	FPB	0.20	X	-	O	
10	2k308	11.55	-	-	2.00	FPB	1.42	O	-	O	
11	2k645	14.95	-	-	1.50	FPB	1.42	O	-	O	

*1 Objectives (Vehicle Road, Foot Path Bridge, Water Pipe, Others)
*2 Excavation Depth below Deepest Riverbed

(6) Drainage Improvement

The list of drainage in Ruhu River is shown in Table-D.5.12. The method of drainage improvement will be studied in the chapter of facility design.

Table-D.5.12 List of Drainage in Tonu River

No.	Distance (m)	Side	Bottom Elevation (EL.m)	Section		Objectives	Remarks
				Width (m)	Height (m)		
1	0k016	L	0.075	0.60	1.20	CD	
2	0k028	R	0.390	0.90	0.40	CD	
3	0k050	L	0.520	0.80	1.20	CD	
4	0k137	L	0.050	0.90	0.80	CD	
5	0k319	L	-	1.20	1.20	CD	
6	0k413	R	1.170	0.90	0.50	CD	
7	0k638	R	1.280	0.60	0.90	HD	
8	0k771	R	1.430	1.00	0.50		
9	0k882	R	2.780	0.90	0.60	HD	
10	1k123	L/R	2.760	0.80	0.70	CD	
11	1k159	L	3.010	0.50	0.60	HD	
12	1k277	L	3.680	1.00	0.50		
13	1k478	R	3.743	0.70	0.90	HD	
14	1k869	L	6.100	0.90	0.60	HD	
15	2k050	L	7.210	0.90	0.70	HD	
16	2k100	L	7.600	0.80	0.60	HD	
17	2k169	R	7.870	0.90	1.20	HD	
18	2k497	L	10.890	1.20	0.90	HD	

* Objectives (1:City Drainage, 2: Home Drainage, 3:Toilet, 4:Others)

Table-D.5.13(1) Tomu River Improvement Plan

Section No.	Profile No.	Cumulative Distance	Current Condition: Dpst.Bed Level (EL.m)	Ave. Bed Level (EL.m)	River Width (m)	Left Bank (EL.m)	Right Bank (EL.m)	Planning Condition: Riverbed Level (EL.m)	Water Level (EL.m)	Top of Dike (EL.m)	Design Qp (m3/s)	River Width (m)	Water Height (m)	Slope 1/	R.bed at Wall: Left (EL.m)	R.bed at Wall: Right (EL.m)	Dike Height (m)	Excavation Depth: Ave. (m)	Excavation Depth: Deepest (m)	Excavation Depth: R.bed at Wall L (m)	Excavation Depth: R.bed at Wall R (m)	Heightneing: Left (m)	Heightneing: Right (m)	Widening Length (m)	Concrete Channel
1	TM0	0.00	-1.00	-0.52	25.60	1.82	2.82	-1.50	0.80	1.40	120	14.00	2.30	250	-1.05	-0.80	2.90	0.98	0.50	0.45	0.70	-	-	-	Concrete
2	B1	8.40	-1.11	-0.55	27.20	3.35	3.35	-1.47	0.80	1.40	120	14.00	2.27	250			2.87	0.92	0.36			-	-	-	Concrete
3	TM0A	50.00	-0.93	-0.63	16.45	1.97	2.04	-1.30	0.80	1.40	120	14.00	2.10	250	-0.40	-0.50	2.70	0.67	0.37	0.90	0.80	-	-	-	Concrete
4	TM1	100.00	-0.87	-0.48	16.05	2.09	1.91	-1.10	0.80	1.40	120	14.00	1.90	250	-0.20	-0.75	2.50	0.62	0.23	0.90	0.35	-	-	-	Concrete
5	TM1A	150.00	-0.82	-0.42	15.35	2.24	2.00	-0.90	0.80	1.40	120	14.00	1.70	250	0.05	-0.20	2.30	0.48	0.08	0.95	0.70	-	-	-	Concrete
6	TM2	200.00	-0.64	-0.25	16.25	1.87	1.96	-0.70	0.97	1.57	120	14.00	1.67	250	-0.25	0.05	2.27	0.45	0.06	0.45	0.75	-	-	-	Concrete
7	TM2A	250.00	-0.55	-0.24	14.60	2.06	2.07	-0.50	1.16	1.76	120	14.00	1.66	250	0.15	0.15	2.26	0.26	-	0.65	0.65	-	-	-	Concrete
8	TM3	300.00	-0.21	0.00	14.95	2.29	2.15	-0.30	1.36	1.96	120	14.00	1.66	250	0.06	0.15	2.26	0.30	0.09	0.36	0.45	-	-	-	Concrete
9	B2	308.50	-0.27	-0.08	14.70	2.31	2.05	-0.27	1.38	1.98	120	14.00	1.65	250			2.25	0.19	-			-	-	-	Concrete
10	B3	347.40	-0.46	0.37	22.45	3.28	2.78	-0.11	1.54	2.14	120	14.00	1.65	250			2.25	0.48	-			-	-	-	Concrete
11	TM3A	350.00	0.01	0.17	16.40	2.56	2.22	-0.10	1.55	2.15	120	14.00	1.65	250	0.25	0.20	2.25	0.27	0.11	0.35	0.30	-	-	-	Concrete
12	TM4	400.00	-0.47	0.46	25.90	3.25	3.56	0.10	1.74	2.34	120	14.00	1.64	250	0.30	0.30	2.24	0.36	-	0.20	0.20	-	-	-	Concrete
13	B4	406.10	0.10	0.56	20.80	3.21	3.18	0.12	1.75	2.35	120	14.00	1.62	250			2.22	0.44	-			-	-	-	Concrete
14	TM4A	450.00	-0.19	0.60	16.15	3.61	3.51	0.30	1.90	2.50	120	14.00	1.60	250	1.10	0.05	2.20	0.30	-	0.80	-	-	-	-	Concrete
15	TM5	500.00	0.71	0.82	12.40	4.32	3.81	0.50	2.06	2.66	120	14.00	1.56	250	1.50	1.70	2.16	0.32	0.21	1.00	1.20	-	-	1.60	Concrete
16	TM5A	550.00	0.94	1.13	18.00	4.62	3.97	0.70	2.20	2.80	120	14.00	1.50	250	1.05	0.95	2.10	0.43	0.24	0.35	0.25	-	-	-	Concrete
17	TM6	600.00	0.67	1.05	14.60	4.00	3.87	0.90	2.33	2.93	120	14.00	1.43	250	1.10	1.85	2.03	0.15	-	0.20	0.95	-	-	-	Concrete
18	TM6A	650.00	0.93	1.04	8.85	3.90	4.04	1.10	2.97	3.57	120	12.00	1.67	250	1.80	2.00	2.47	-	-	0.70	0.90	-	-	3.15	Concrete
19	TM7	700.00	0.80	1.48	14.10	4.24	4.15	1.30	3.17	3.77	120	12.00	1.67	250	2.25	1.30	2.47	0.18	-	0.95	0.00	-	-	-	Concrete
20	TM7A	750.00	1.19	1.73	10.10	4.56	4.27	1.50	3.38	3.98	120	12.00	1.68	250	2.50	2.50	2.48	0.23	-	1.00	1.00	-	-	1.90	Concrete
21	TM8	800.00	1.47	1.52	7.75	4.44	4.35	1.70	3.58	4.18	120	12.00	1.68	250	2.20	2.50	2.48	-	-	0.50	0.80	-	-	4.25	Concrete
22	TM8A	850.00	1.60	1.78	9.25	4.81	4.44	1.90	3.78	4.38	120	12.00	1.68	250	1.90	2.60	2.48	-	-	0.00	0.70	-	-	2.75	Concrete
23	TM9	900.00	1.80	2.03	9.20	5.04	4.70	2.10	3.99	4.59	120	12.00	1.69	250	2.85	3.10	2.49	-	-	0.75	1.00	-	-	2.80	Concrete
24	TM9A	950.00	2.04	2.22	10.95	5.12	4.89	2.30	4.21	4.81	120	12.00	1.91	250	3.00	3.10	2.51	-	-	0.70	0.80	-	-	1.05	Concrete
25	TM10	1000.00	2.16	2.56	13.85	5.15	4.92	2.50	4.45	5.05	120	12.00	1.95	250	1.40	2.95	2.55	0.06	-	-	0.45	-	0.13	-	Concrete
26	B5	1033.10	2.75	3.01	16.20	5.93	5.99	2.63	4.64	5.24	120	12.00	2.00	250			2.60	0.38	0.12			-	-	-	Concrete
27	TM10A	1050.00	2.61	2.73	12.70	5.04	5.02	2.70	4.87	5.47	120	12.00	2.17	250	3.10	3.25	2.77	0.03	-	0.40	0.55	0.43	0.45	-	Concrete
28	TM11	1100.00	2.77	3.04	17.85	5.30	5.54	2.90	4.87	5.47	120	15.00	1.97	250	2.80	4.60	2.57	0.14	-	-	1.70	0.17	-	-	Concrete
29	TM11A	1150.00	2.77	3.28	28.55	3.40	5.86	3.10	4.87	5.47	120	15.00	1.77	250	3.10	4.00	2.37	0.18	-	0.00	0.90	2.07	-	-	Concrete
30	TM12	1200.00	3.13	3.42	23.85	5.88	5.51	3.30	4.87	5.47	120	15.00	1.57	250	3.30	3.85	2.17	0.12	-	0.00	0.55	-	-	-	Concrete
31	TM12A	1250.00	3.65	3.90	23.00	6.14	6.14	3.50	5.04	5.64	120	15.00	1.54	250	4.05	3.95	2.14	0.40	0.15	0.55	0.45	-	-	-	Concrete
32	TM13	1300.00	3.79	4.08	26.65	6.29	6.41	3.70	5.20	5.80	120	15.00	1.50	250	4.10	3.95	2.10	0.38	0.09	0.40	0.25	-	-	-	Concrete
33	TM13A	1350.00	4.01	4.19	24.30	6.45	6.34	3.90	5.35	5.95	120	15.00	1.45	250	4.10	4.35	2.05	0.29	0.11	0.20	0.45	-	-	-	Concrete
34	TM14	1400.00	4.15	4.50	23.70	6.62	6.11	4.10	5.49	6.09	120	15.00	1.39	250	4.05	4.60	1.99	0.40	0.05	-	0.50	-	-	-	Concrete
35	B6	1403.50	4.31	4.53	32.50	6.95	6.93	4.11	5.49	6.09	120	15.00	1.38	250			1.98	0.42	0.20			-	-	-	Concrete
36	TM14A	1450.00	4.29	4.62	11.00	7.02	6.95	4.30	5.61	6.21	120	15.00	1.31	250	5.00	4.15	1.91	0.32	-	0.70	-	-	-	4.00	Concrete
37	TM15	1500.00	4.54	5.09	15.70	7.08	7.18	4.50	5.72	6.32	120	15.00	1.22	250	4.65	5.65	1.82	0.59	0.04	0.15	1.15	-	-	-	Concrete
38	TM15A	1550.00	4.74	4.90	8.60	6.53	6.78	4.70	6.84	7.44	90	8.00	2.14	250	5.00	5.00	2.74	0.20	0.04	0.30	0.30	0.91	0.66	-	Concrete
39	TM16	1600.00	5.00	5.14	10.00	7.09	7.01	4.90	7.04	7.64	90	8.00	2.14	250	5.00	5.10	2.74	0.24	0.10	0.10	0.20	0.55	0.63	-	Concrete
40	TM16A	1650.00	5.40	5.48	13.10	7.10	7.10	5.10	7.24	7.84	90	8.00	2.14	250	5.30	5.30	2.74	0.38	0.30	0.20	0.20	0.74	0.74	-	Concrete
41	TM17	1700.00	5.53	5.58	9.60	7.17	7.15	5.30	7.44	8.04	90	8.00	2.14	250	5.55	5.55	2.74	0.28	0.23	0.25	0.25	0.87	0.89	-	Concrete
42	B7/17A	1750.00	5.63	5.65	8.40	7.50	7.52	5.50	7.63	8.23	90	8.00	2.13	250	5.65	5.65	2.73	0.15	0.13	0.15	0.15	0.73	0.71	-	Concrete

Table-D.5.13(2) Tomu River Improvement Plan

Section No.	Profile No.	Cumulative Distance	Current Condition: Dpst.Bed Level (EL.m)	Current Condition: Ave. Bed Level (EL.m)	Current Condition: River Width (m)	Current Condition: Left Bank (EL.m)	Current Condition: Right Bank (EL.m)	Planning Condition: Riverbed Level (EL.m)	Planning Condition: Water Level (EL.m)	Planning Condition: Top of Dike (EL.m)	Planning Condition: Design Qp (m3/s)	Planning Condition: River Width (m)	Planning Condition: Water Height (m)	Planning Condition: Slope	R.bed at Wall: Left (EL.m)	R.bed at Wall: Right (EL.m)	Dike Height (m)	Excavation Depth: Ave. (m)	Excavation Depth: Deepest (m)	Excavation Depth: R.bed at Wall L (m)	Excavation Depth: R (m)	Heightneing: Left (m)	Heightneing: Right (m)	Widening Length (m)	Concrete Channel
43	TM18	1800.00	5.66	5.77	8.90	7.48	7.65	5.70	7.82	8.42	90	8.00	2.12	250	5.75	5.80	2.72	0.07	-	0.05	0.10	0.94	0.77	-	Concrete
44	B8	1822.50	5.75	6.00	8.20	7.50	7.64	5.79	7.90	8.50	90	8.00	2.11	250			2.71	0.21	-			1.00	0.86	-	Concrete
45	TM18A	1850.00	5.73	6.06	11.10	7.84	7.93	5.90	8.00	8.60	90	8.00	2.10	250	5.70	6.20	2.70	0.16	-	-	0.30	0.76	0.67	-	Concrete
46	TM19	1900.00	6.15	6.33	8.80	7.97	7.99	6.10	8.16	8.76	90	8.00	2.06	250	6.15	6.75	2.66	0.23	0.05	0.05	0.65	0.79	0.77	-	Concrete
47	TM19A	1950.00	6.44	6.59	8.55	8.18	8.18	6.30	8.30	8.90	90	8.00	2.00	250	7.00	6.60	2.60	0.29	0.14	0.70	0.30	0.72	0.72	-	Concrete
48	TM20	2000.00	6.69	6.77	12.45	9.08	8.60	6.50	8.42	9.02	90	8.00	1.92	250	6.80	6.90	2.52	0.27	0.19	0.30	0.40	-	0.42	-	Concrete
49	B9	2006.50	6.32	6.41	11.80	9.32	9.35	6.53	8.45	9.05	90	8.00	1.92	250			2.52	-	-			-	-	-	Concrete
50	TM20A	2050.00	7.03	7.22	12.75	8.70	11.36	6.70	8.53	9.13	90	8.00	1.83	250	6.95	7.35	2.43	0.52	0.33	0.25	0.65	0.43	-	-	Concrete
51	TM21	2100.00	6.89	7.19	13.45	8.47	10.65	6.90	8.62	9.22	90	8.00	1.72	250	7.30	7.20	2.32	0.29	-	0.40	0.30	0.75	-	-	Concrete
52	TM21A	2150.00	7.42	7.52	9.20	8.63	10.38	7.10	8.70	9.30	90	8.00	1.60	100	7.60	7.60	2.20	0.42	0.32	0.50	0.50	0.67	-	-	Concrete
53	TM22	2200.00	7.42	7.69	12.40	10.12	9.11	7.30	8.77	9.37	90	8.00	1.47	100	7.65	8.00	2.07	0.39	0.12	0.35	0.70	-	0.26	-	Concrete
54	TM22A	2250.00	7.67	8.05	7.70	9.62	11.00	7.80	9.55	10.15	90	7.00	1.75	100	8.50	9.60	2.35	0.25	-	0.70	1.80	0.53	-	-	Concrete
55	TM23	2300.00	8.10	8.72	8.55	11.12	11.91	8.30	10.05	10.65	90	7.00	1.75	100	8.05	10.30	2.35	0.42	-	-	2.00	-	-	-	Concrete
56	B10	2307.70	8.17	8.29	10.40	12.34	12.34	8.38	10.13	10.73	90	7.00	1.75	100			2.35	-	-			-	-	-	Concrete
57	TM23A	2350.00	8.51	8.84	12.55	10.76	13.15	8.80	10.55	11.15	90	7.00	1.75	100	8.45	9.50	2.35	0.04	-	-	0.70	0.39	-	-	Concrete
58	TM24	2400.00	8.59	9.13	7.00	11.23	12.46	9.30	11.05	11.65	90	7.00	1.75	100	11.20	10.80	2.35	-	-	1.90	1.50	0.42	-	-	Concrete
59	TM24A	2450.00	9.25	9.75	8.35	12.69	11.66	9.80	11.55	12.15	90	7.00	1.75	100	11.35	10.40	2.35	-	-	1.55	0.60	-	0.49	-	Concrete
60	TM25	2500.00	10.52	10.67	7.95	12.70	12.61	10.30	12.06	12.66	90	7.00	1.76	100	10.55	10.95	2.36	0.37	0.22	0.25	0.65	-	0.04	-	Concrete
61	TM25A	2550.00	10.56	10.78	8.60	13.91	13.99	10.80	12.56	13.16	90	7.00	1.76	100	12.60	12.60	2.36	-	-	1.80	1.80	-	-	-	Concrete
62	TM26	2600.00	11.39	11.43	7.00	14.76	14.20	11.30	13.07	13.67	90	7.00	1.77	100	13.20	13.20	2.37	0.13	0.09	1.90	1.90	-	-	-	Concrete
63	B11	2644.50	11.42	11.76	7.40	14.22	14.35	11.75	13.53	14.13	90	7.00	1.79	100			2.39	0.02	-			-	-	-	Concrete
64	TM26A	2650.00	11.48	11.69	8.65	13.90	14.04	11.80	13.58	14.18	90	7.00	1.78	100	11.90	11.90	2.38	-	-	0.10	0.10	0.28	0.14	-	Concrete
65	TM27	2700.00	11.73	12.24	8.75	13.58	13.86	12.30	14.10	14.70	90	7.00	1.80	100	11.85	12.15	2.40	-	-	-	-	1.12	0.84	-	Concrete
66	TM27A	2750.00	13.38	13.75	14.90	18.29	17.69																		
67	TM28	2800.00	13.93	14.39	19.35	18.51	17.95																		
68	TM28A	2850.00	14.05	15.81	28.55	19.22	19.66																		
69	TM29	2900.00	15.08	15.75	12.65	18.01	18.42																		
Average																	2.39	0.32	0.18	0.55	0.68	0.73	0.57		

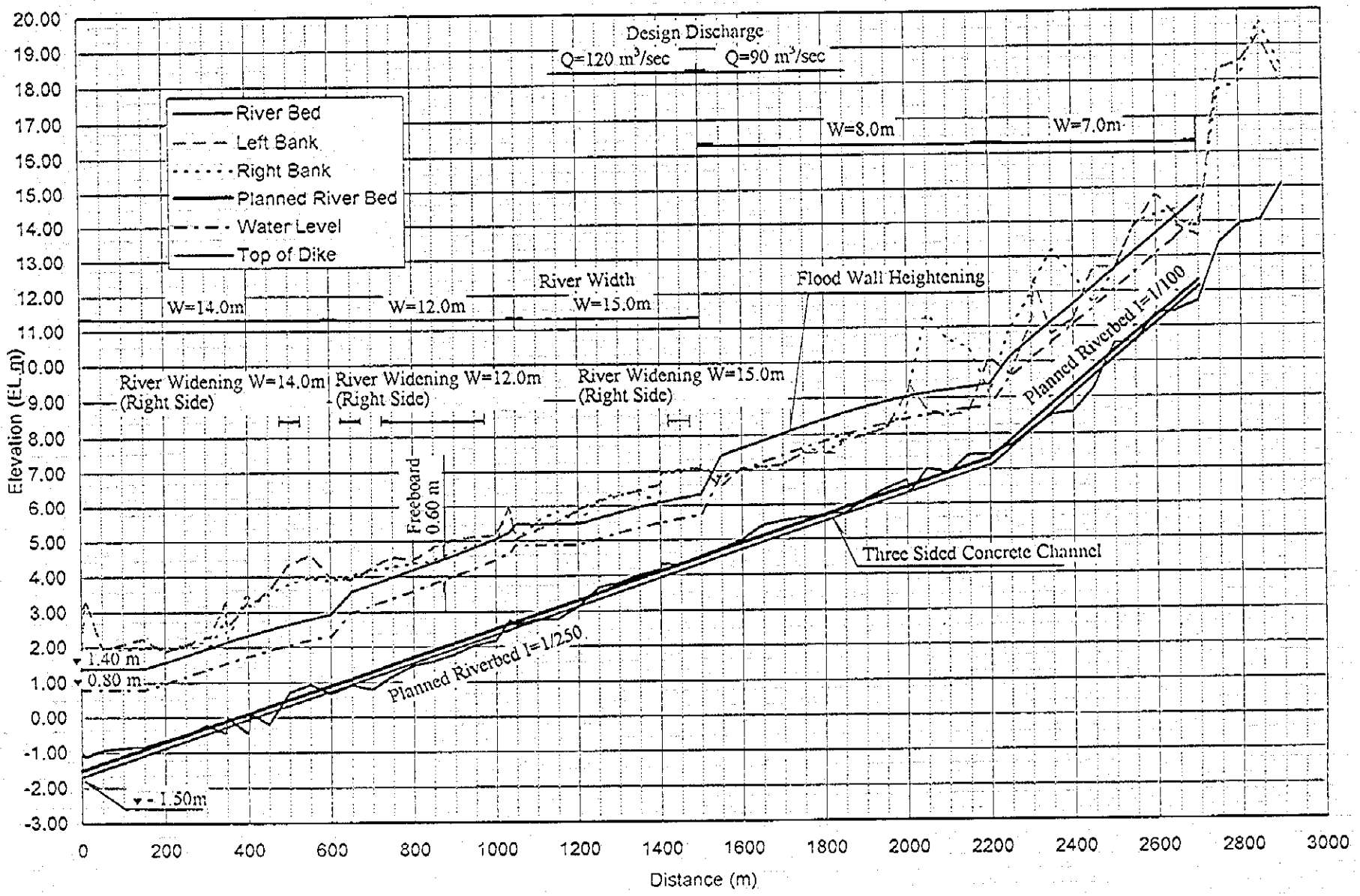


Figure-D.5.19 Longitudinal Section of Tomu River Improvement Plan

5.4.4 River Amenity Improvement

(1) Location and Current Condition

Tomu River is the small river which flows down to the sea in the center of Ambon city. As Mardika Bus Terminal, Victoria Park and Mardika Market are located along the downstream of Tomu River, this seems to be the best place for river amenity improvement.

This area can be seen in the photo shown below. Mardika Bus Terminal is at the right side and the Victoria Park at the left side. The current river and river water are not clean. However many people gather to the bus terminal and the area has a waterfront atmosphere due to the sea and river water. Also this area has a plan of river improvement with excavation. Therefore the Study Team has planned this area, the downstream of Tomu River, to improve river amenity.

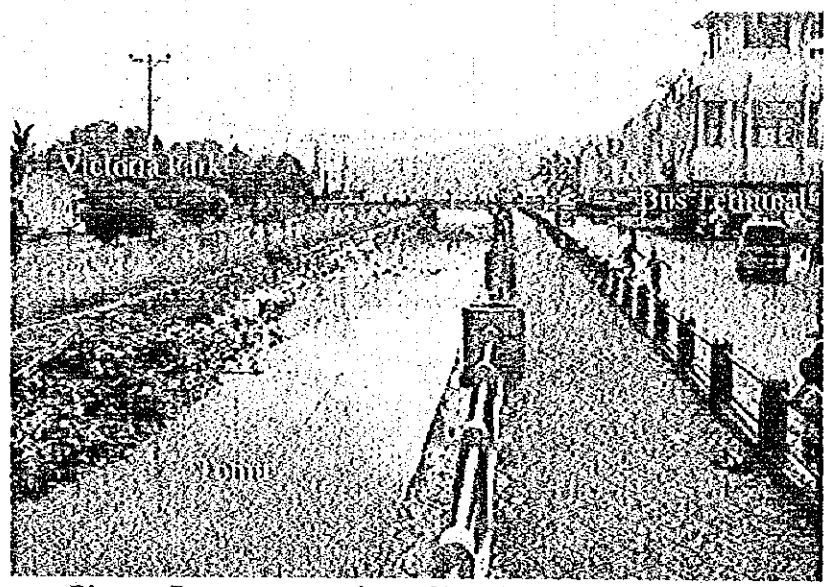


Photo : Downstream view of Tomu River near the sea

(2) Concept and Contents of River Amenity Improvement

Tomu River amenity improvement would be implemented as a monument of the Ambon flood control project. The contents of Tomu River amenity improvement are set as follows:

- To setup wide foot bridges in order to connect both sides of the river, Mardika Bus Terminal and Victoria Park.
- To arrange trees for shade and flowering plants for amenity.
- This area should be a breathing area or a oasis for city people.
- Flood walls should not be concrete but natural.

(3) River Amenity Improvement Image

Amenity improvement image of Tomu River is shown in Figure-D.5.20 and Figure-D.5.21.

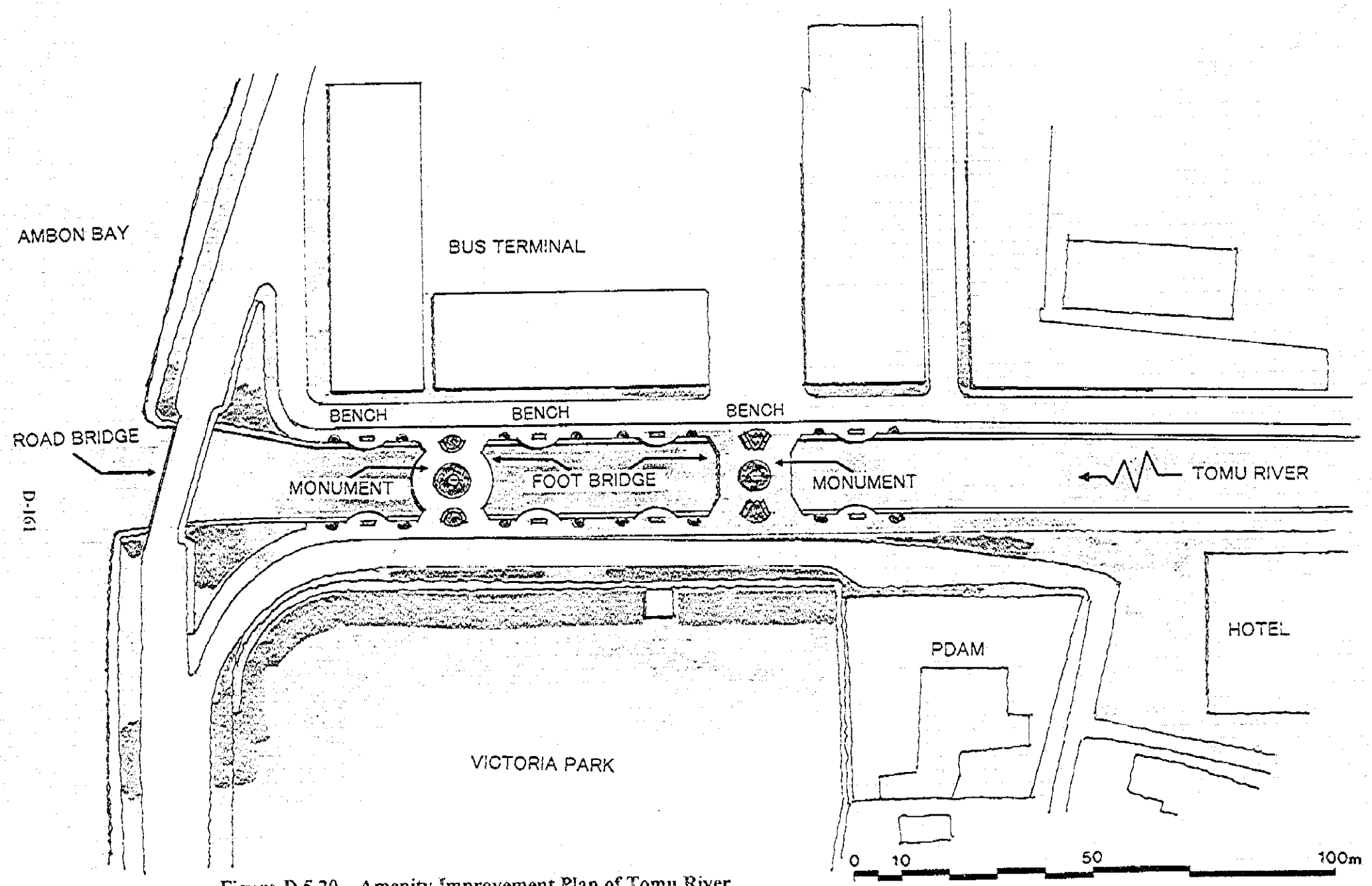


Figure-D.5.20 Amenity Improvement Plan of Tomu River

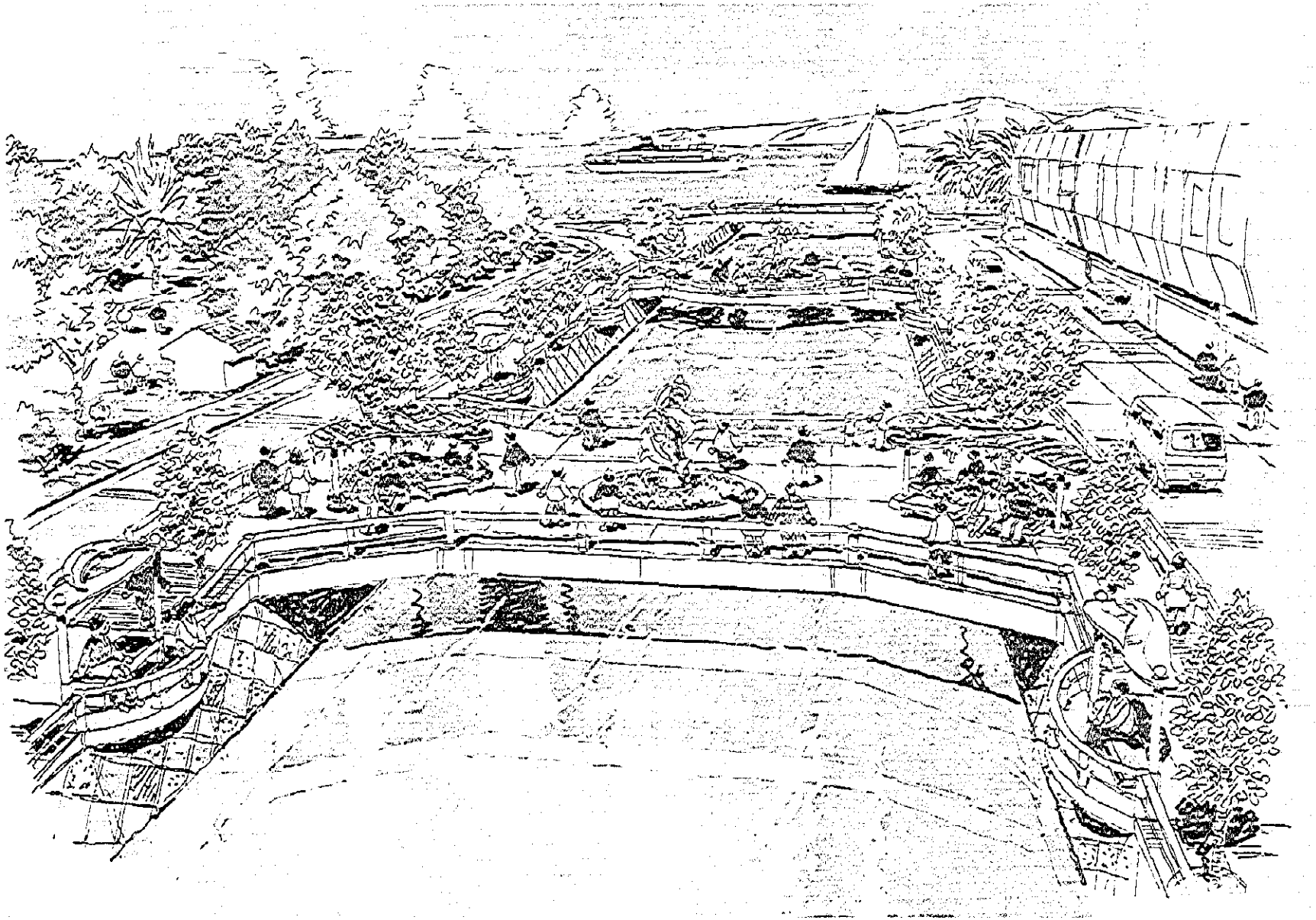


Figure-D.5.21 Amenity Improvement Image of Tomu River

5.5 Batu Gajah River Project

5.5.1 Basic Policy

The downstream of Batu Gajah River is improved with 10-year return period. In order to achieve the security against flood with 30-year return period, a multi-purpose dam is planned to be constructed at 3k100 from the river mouth. This multi-purpose dam has the function of flood control, city water supply and river water maintenance. In order to reduce the sedimentation into the dam reservoir, a check dam is planned at 4k250 from the river mouth. Refer to Figure-D.5.23.

- 0k000 - 2k200 : River improvement with 10-year return period
- 3k100 : Multi-purpose dam
- 4k250 : Check dam

5.5.2 Planning Criteria

(1) Design Scale

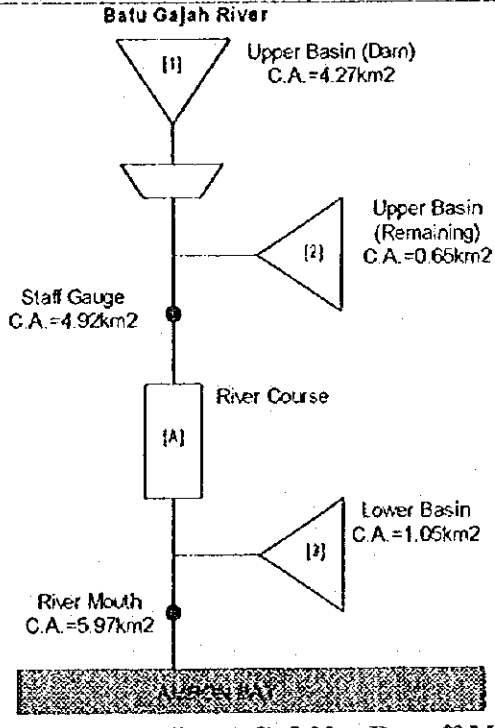
30-year return period

(2) Reference Point, Basin Division and Runoff Model

Reference points are set as shown in Table-D.5.14 and the basin division is shown in Figure-D.5.24. The runoff model is shown in Figure-D.5.22.

Table-D.5.14 Reference Point and Basin Division

Basin Name	Catchment Area. (km^2)	Reference Point	Catchment Area (km^2)
[1] Upper Basin (Dam)	4.27	Staff Gauge	4.92
[2] Upper Basin (Remaining)	0.65	River Mouth	5.97
[3] Lower Basin	1.05		
Total	5.97		



Storage Function Model

Coefficient of Storage Function
- Upper Basin : k=23, p=1/3, Tl=0
- Lower Basin : k= 4, p=1/3, Tl=0
- River Course A : k=0.7, p=0.6, Tl=0

Primary Runoff Rate : 0.9
Saturated Runoff Rate : 1.0
Saturated Rainfall : 100 mm

Figure-D.5.22 Runoff Model of Batu Gajah River

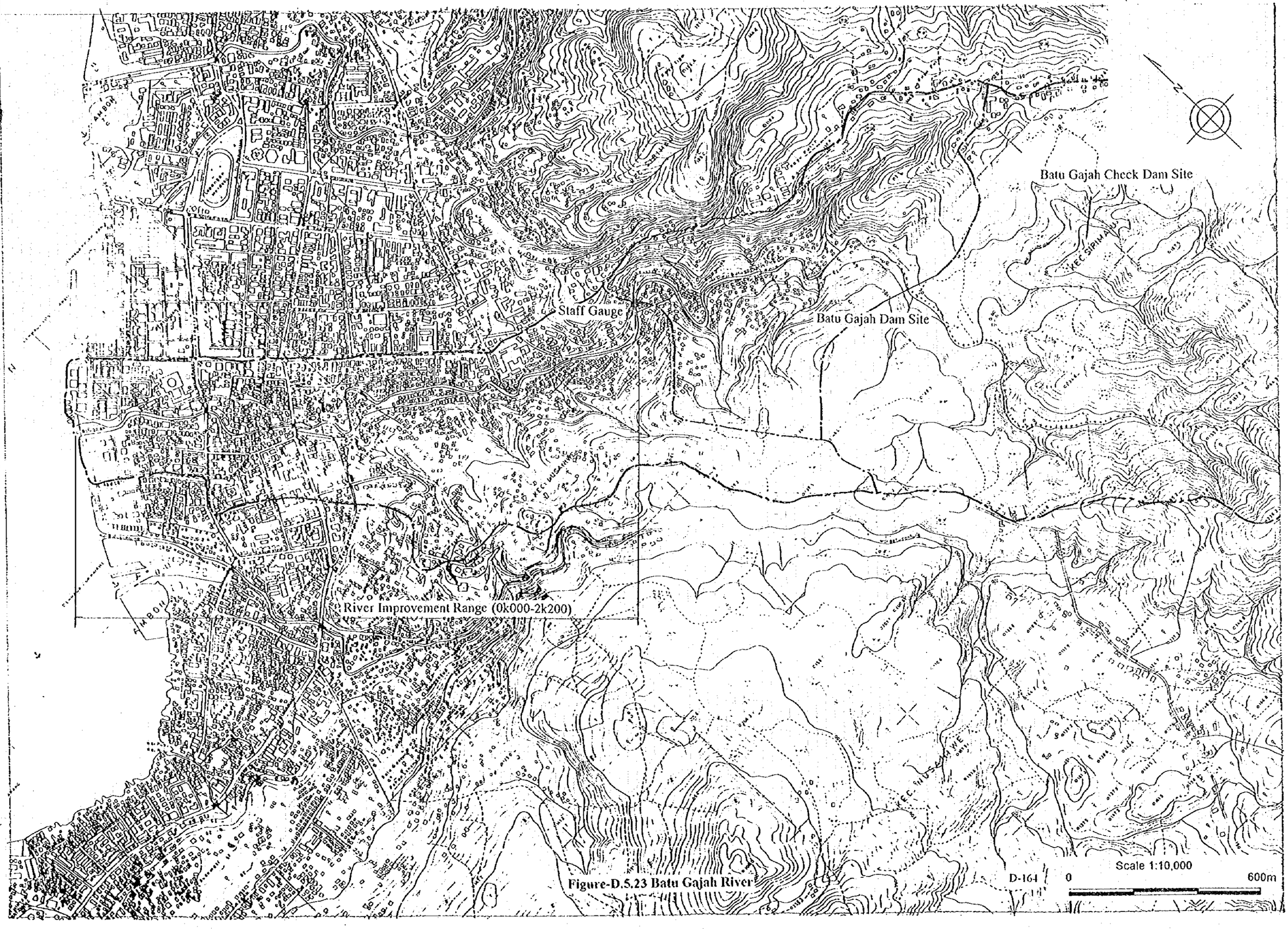


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Figure-D.5.23 Batu Gajah River

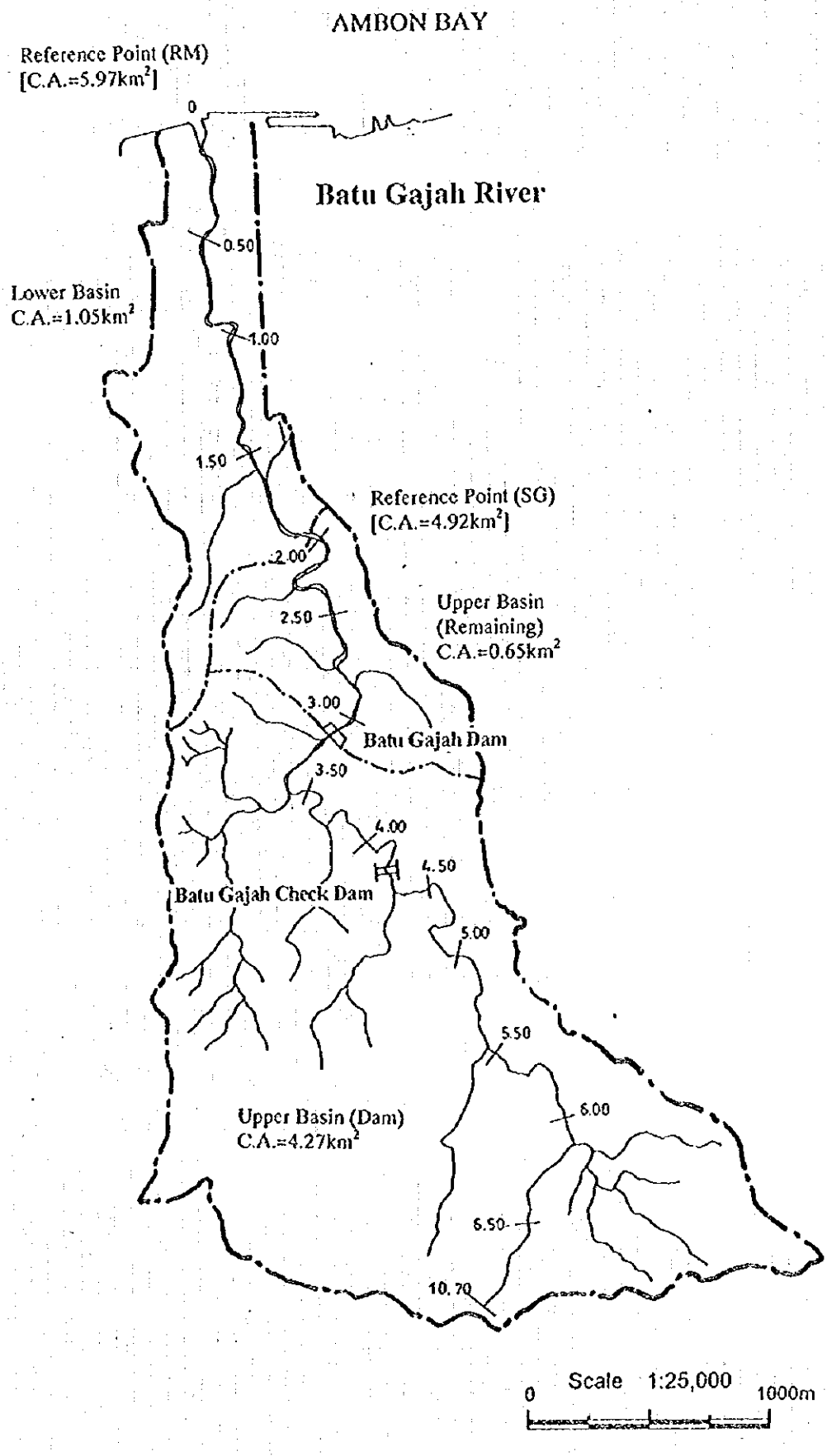


Figure-D.5.24 Batu Gajah River Basin

(3) Design Flood Discharge and Design Hydrograph

Design Flood Discharge

		10-year Return Period	30-year Return Period
- Batu Gajah Dam Point	:	70 m^3/sec	90 m^3/sec
- Staff Gauge Reference Point	:	80 m^3/sec	110 m^3/sec
- River Mouth Reference Point	:	100 m^3/sec	130 m^3/sec

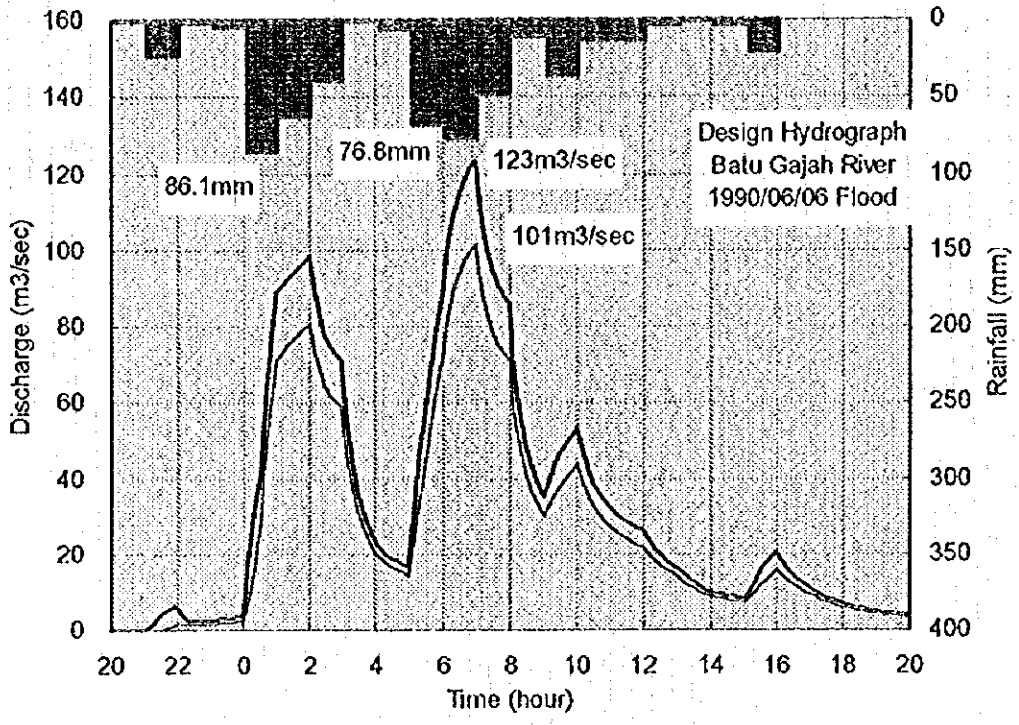


Figure-D.5.25 Design Hydrograph at Reference Points (Batu Gajah River)

(4) Design Discharge Distribution

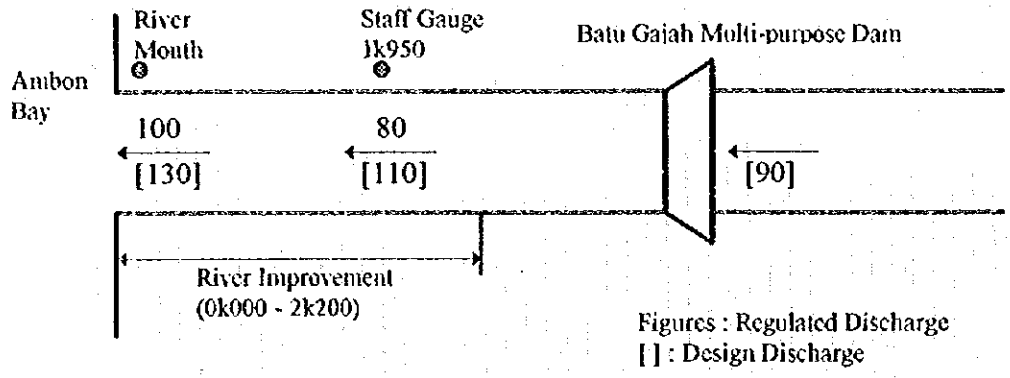


Figure-D.5.26 Design Discharge Distribution (Batu Gajah River)

5.5.3 River Improvement Plan

River improvement plan of Batu Gajah River is summarized in Table-D.5.17 and Figure-D.5.27 based on the following study:

(1) River Improvement Range

River improvement range is set from river mouth to 2k200 i.e. 2,200m length. There are currently no flood walls constructed upstream of 2k800, which is like a natural V-shape river and houses are located on higher land. On the other hand, flood inundated area is the downstream from around 2k000 and the upstream river from 2k200 has steep river bed slope (I=1/65) and a few line of houses in low land along the river. Thus the upstream river from 2k200 is judged not to be necessary to be improved.

River Improvement Range : 0k000 - 2k200 (2,200m)

(2) River Course Alignment

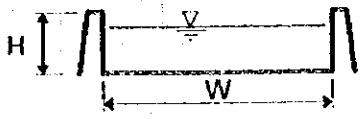
River course alignment followed current river course with no new channel.

(3) Planned River Bed (Slope, Excavation)

Planned riverbed slope (I) was set at I=1/240 for 0k000-0k900 and I=1/160 for 0k900-2k200, in line with the current riverbed slope. Three cases of excavation depth, 1.0m, 0.5m and 0.0m below the deepest riverbed, were studied. Of these cases the shallowest excavation case was adopted because of economical reason, even though river bed excavation has advantage for enlarging discharge capacity and facilitating inner water drainage.

(4) Standard Cross Section (Heightening, Widening)

According to the current river section with flood walls, the planned standard cross section was set rectangular as follows:



0k000-0k200	: W=15.0m, H=2.3-2.4m
0k250-0k450	: W=10.0m, H=2.1-2.4m
0k500-1k200	: W= 8.0m, H=2.6-2.9m
1k250-1k950	: W= 9.0m, H=2.1-2.6m
2k000-2k200	: W= 7.0m, H=2.8m

Based on uniform and Non-uniform flow calculation on the design discharges of 100 m^3/sec equivalent to 10-year return period, the following flood wall heightening and section widening were planned.

- The river sections at which flood wall heightening is planned, are mainly from 0k500 to 0k750 and from 1k400 to 1k600. The flood walls was planned to be heightened by 0.1-1.3m of right side (0.5m on average) and 0.1-1.2m of left side (0.5m on average).
- There are partly narrow sections with the width of 5.9-7.5m, where widening works were planned, to the width of 8.0m in the river sections at 0k500, 0k700, 1k200, to the

width of 9.0m at 1k500 and to 7.0m at 2k050 and 2k150.

- Three sided concrete channel is planned in the river sections from 0k250 to 2k200, which is gentle in slope and narrow in width, in order to enlarge discharge capacity and to lessen flood wall heightening so as to reduce roughness.

(5) Bridge Improvement

The list of bridges in Batu Gajah River is shown in Table-D.5.15. Considering clearance between bridge underside elevation and H.W.L.(more than 0.6m) and excavation condition, the bridges of No.1 to No.8 are necessary to be improved.

Table-D.5.15 List of Bridges in Batu Gajah River

No.	Distance (m)	Bridge Underside Elevation (EL.m)	Bridge Pier		Bridge Width (m)	*1 Objec-tives	Clearance (m)		Depth of *2 Excavation at Pier (m)		Remarks
			Number	Width (m)							
1	0k424	3.20	-	-	7.00	VR	0.87	O	1.40	X	
2	0k744	5.25	1	-	-	O	0.95	O	1.50	X	Telkom pipe
3	0k750	4.40	1	1.20	7.00	VR	0.07	X	1.80	X	
4	1k344	7.50	-	-	4.00	FPB	0.20	X	-	O	
5	1k629	10.25	1	25.00	2.00	FPB	1.18	O	1.25	X	
6	1k835	10.75	1	0.20	1.56	FPB	0.50	X	0.30	O	
7	1k919	10.85	-	-	1.20	FPB	0.16	X	-	O	
8	2k007	12.45	-	-	0.80	FPB	0.57	X	-	O	
9	2k070	13.50	-	-	1.00	FPB	1.23	O	-	O	
10	2k130	14.75	-	-	1.50	FPB	2.09	O	-	O	
11	2k344	18.40	-	-	2.00	FPB	-	-	-	-	1 motorcycle only
12	2k586	21.30	-	-	2.00	FPB	-	-	-	-	1 motorcycle only
13	2k650	21.05	-	-	2.00	FPB	-	-	-	-	1 motorcycle only
14	2k801	22.10	-	-	1.50	FPB	-	-	-	-	

*1 Objectives (Vehicle Road, Foot Path Bridge, Water Pipe, Others)

*2 Excavation Depth below Deepest Riverbed

(6) Drainage Improvement

The list of drainage in Batu Gajah River is shown in Table-D.5.16. The method of bridge improvement will be studied in the chapter of facility design.

Table-D.5.16 List of Drainage in Batu Gajah River

No.	Distance (m)	Side	Bottom Elevation (EL.m)	Section		Objectives	Remarks
				Width (m)	Height (m)		
1	0k105	L	0.846	0.40	0.70	HD	
2	0k115	L	0.845	0.40	0.70	HD	
3	0k146	L	0.769	0.60	0.70	CD	
4	0k193	L	0.769	1.00	1.00	HD	
5	0k441	R	2.134	0.60	0.55	CD	
6	0k765	R	2.622	0.50	0.90	CD	
7	0k859	L	2.820	0.60	0.90	HD	
8	0k901	L	3.848	1.10	0.65	HD	
9	0k962	L	3.547	1.50	1.30	HD	
10	1k098	R	4.090	0.40	0.60	HD	
11	1k105	R	5.902	0.40	0.60	HD	
12	1k485	L	6.690	1.90	1.20	HD	
13	1k496	R	6.440	1.00	0.80	HD	
14	1k524	R	6.630	0.60	0.60	HD	
15	1k608	L	7.793	0.70	0.80	HD	
16	1k665	R	7.990	0.53	0.80	-	
17	1k743	L	8.760	0.89	0.65	HD	
18	1k953	L	9.820	1.10	0.68	HD	
19	2k064	L	11.814	0.70	0.70	HD	
20	2k098	L	11.640	0.60	0.80	HD	Covered by garbage
21	2k154	L	12.080	0.63	0.70	-	

* Objectives (City Drainage, Home Drainage, Toilet, Others)

Table-D.5.17(1) Batu Gajah River Improvement Plan

Section No.	Profile No.	Cumulative Distance	Current Condition: Dpst.Bed Level	Ave. Bed Level	River Width	Left Bank	Right Bank	Planning Condition: Riverbed Level	Water Level	Top of Dike	Design Qp	River Width	Water Height	Slope 1/	R.bed at Wall: Left	Right	Dike Height	Excavation Depth: Ave.	Deepest	R.bed at Wall		Heightening: Left	Right	Widening Length	Concrete Channel
1	GJ0	0.00	-0.91	-0.51	54.30	1.87	1.90	-1.00	0.80	1.40	100	15.00	1.80	240	-1.00	-0.50	2.40	0.49	0.09	0.00	0.50	-	-	-	-
2	GJ0A	50.00	-0.98	-0.09	38.05	2.19	2.22	-0.79	0.87	1.47	100	15.00	1.66	240	-0.09	0.60	2.26	0.70	-	0.70	1.39	-	-	-	-
3	GJ1	100.00	-0.75	-0.20	37.15	2.05	1.95	-0.58	1.10	1.70	100	15.00	1.69	240	-0.75	0.20	2.29	0.38	-	-	0.78	-	-	-	-
4	GJ1A	150.00	-0.50	0.09	21.45	2.09	2.00	-0.38	1.32	1.92	100	15.00	1.70	240	-0.05	0.20	2.30	0.47	-	0.33	0.58	-	-	-	-
5	GJ2	200.00	0.12	0.48	15.70	2.17	2.18	-0.17	1.49	2.09	100	15.00	1.65	240	0.80	0.95	2.25	0.65	0.29	0.97	1.12	-	-	-	-
6	GJ2A	250.00	0.32	0.55	10.35	2.57	1.38	0.04	1.84	2.44	100	10.00	1.80	240	0.40	1.00	2.40	0.49	0.28	0.36	0.96	-	1.06	-	Concrete
7	GJ3	300.00	0.20	0.70	11.55	2.64	2.56	0.25	2.01	2.61	100	10.00	1.76	240	0.25	1.45	2.36	0.45	-	0.00	1.20	-	0.95	-	Concrete
8	GJ3A	350.00	0.67	1.00	12.20	2.72	2.81	0.46	2.16	2.76	100	10.00	1.70	240	0.90	1.40	2.30	0.54	0.21	0.44	0.94	0.04	-	-	Concrete
9	GJ4	400.00	0.87	1.22	17.90	3.45	3.00	0.67	2.29	2.89	100	10.00	1.62	240	1.40	0.95	2.22	0.55	0.20	0.73	0.28	-	-	-	Concrete
10	B1	423.50	0.93	1.81	20.60	5.01	5.03	0.76	2.33	2.93	100	10.00	1.57	240			2.17	1.05	0.17			-	-	-	Concrete
11	GJ4A	450.00	1.00	1.54	12.40	3.33	3.22	0.88	2.41	3.01	100	10.00	1.53	240	2.05	1.40	2.13	0.67	0.13	1.18	0.53	-	-	-	Concrete
12	GJ5	500.00	1.45	1.61	7.00	3.43	3.38	1.08	3.34	3.94	100	8.00	2.26	240	1.50	2.00	2.86	0.53	0.37	0.42	0.92	0.51	0.56	1.00	Concrete
13	GJ5A	550.00	1.55	1.85	8.95	3.88	3.60	1.29	3.55	4.15	100	8.00	2.26	240	1.60	2.50	2.86	0.56	0.26	0.31	1.21	0.27	0.55	-	Concrete
14	GJ6	600.00	1.91	2.14	9.30	3.76	3.67	1.50	3.76	4.36	100	8.00	2.26	240	2.50	2.20	2.86	0.64	0.41	1.00	0.70	0.60	0.69	-	Concrete
15	GJ6A	650.00	2.03	2.14	8.00	3.80	3.90	1.71	3.96	4.56	100	8.00	2.25	240	2.10	2.20	2.85	0.43	0.32	0.39	0.49	0.76	0.66	-	Concrete
16	GJ7	700.00	1.92	2.18	6.80	3.99	3.98	1.92	4.16	4.76	100	8.00	2.24	240	2.20	1.60	2.84	0.26	0.00	0.28	-	0.77	0.78	1.20	Concrete
17	B2	744.35	2.09	2.28	19.30	4.41	3.55	2.10	4.30	4.90	100	8.00	2.19	240			2.79	0.18	-			0.49	1.35	-	Concrete
18	B3/7A	750.00	2.11	2.34	20.20	5.15	4.38	2.13	4.33	4.93	100	8.00	2.21	240			2.81	0.22	-			-	0.55	-	Concrete
19	GJ8	800.00	2.56	2.78	11.38	6.03	6.21	2.33	4.47	5.07	100	8.00	2.14	240	2.85	2.90	2.74	0.45	0.23	0.52	0.57	-	-	-	Concrete
20	GJ8A	850.00	2.03	2.86	8.16	6.21	6.29	2.54	4.61	5.21	100	8.00	2.07	240	3.60	2.10	2.67	0.32	-	1.06	-	-	-	-	Concrete
21	GJ9	900.00	2.80	3.37	9.59	6.36	6.60	2.75	4.73	5.33	100	8.00	1.98	240	2.80	3.45	2.58	0.62	0.05	0.05	0.70	-	-	-	Concrete
22	GJ9A	950.00	3.26	3.67	11.57	6.68	6.89	3.06	5.05	5.65	100	8.00	1.98	160	2.20	3.99	2.58	0.61	0.20	-	0.95	-	-	-	Concrete
23	GJ10	1000.00	3.57	3.82	9.10	6.70	7.37	3.38	5.39	5.99	100	8.00	2.01	160	4.10	3.55	2.61	0.45	0.20	0.73	0.18	-	-	-	Concrete
24	GJ10A	1050.00	4.06	4.21	9.25	7.10	7.58	3.69	5.71	6.31	100	8.00	2.03	160	5.50	3.90	2.63	0.52	0.37	1.81	0.21	-	-	-	Concrete
25	GJ11	1100.00	3.95	4.40	9.40	6.96	7.36	4.00	6.05	6.65	100	8.00	2.05	160	4.80	3.95	2.65	0.40	-	0.80	-	-	-	-	Concrete
26	GJ11A	1150.00	4.44	4.88	10.60	8.07	7.40	4.31	6.42	7.02	100	8.00	2.11	160	4.14	5.50	2.71	0.57	0.13	-	1.19	-	-	-	Concrete
27	GJ12	1200.00	4.71	4.98	7.50	8.07	7.72	4.63	6.92	7.52	100	8.00	2.30	160	6.05	4.60	2.90	0.36	0.09	1.43	-	-	-	0.50	Concrete
28	GJ12A	1250.00	5.24	5.35	9.10	7.44	7.31	4.94	6.92	7.52	100	9.00	1.98	160	5.50	5.25	2.58	0.41	0.30	0.56	0.31	0.08	0.21	-	Concrete
29	GJ13	1300.00	5.21	5.57	10.70	7.85	7.88	5.25	7.04	7.64	100	9.00	1.79	160	5.15	5.80	2.39	0.32	-	-	0.55	-	-	-	Concrete
30	B4	1343.50	5.49	5.73	11.40	8.22	8.21	5.52	7.30	7.90	100	9.00	1.78	160			2.38	0.21	-			-	-	-	Concrete
31	GJ13A	1350.00	5.53	5.85	10.30	8.73	8.09	5.56	7.34	7.94	100	9.00	1.78	160	6.10	5.50	2.38	0.29	-	0.54	-	-	-	-	Concrete
32	GJ14	1400.00	5.96	6.07	9.30	7.03	7.32	5.88	7.67	8.27	100	9.00	1.79	160	6.15	6.75	2.39	0.20	0.09	0.28	0.88	1.24	0.95	-	Concrete
33	GJ14A	1450.00	5.93	6.47	12.95	7.68	7.97	6.19	7.97	8.57	100	9.00	1.79	160	6.10	7.00	2.39	0.28	-	-	0.81	0.89	0.60	-	Concrete
34	GJ15	1500.00	6.40	6.71	11.45	7.97	8.24	6.50	8.28	8.88	100	9.00	1.78	160	6.90	6.40	2.38	0.21	-	0.40	-	0.91	0.64	-	Concrete
35	GJ15A	1550.00	6.73	7.20	13.30	8.49	8.85	6.81	8.58	9.18	100	9.00	1.77	160	7.75	6.90	2.37	0.39	-	0.94	0.09	0.69	0.33	-	Concrete
36	GJ16	1600.00	7.13	7.50	7.50	9.21	9.29	7.13	8.90	9.50	100	9.00	1.78	160	7.20	8.00	2.38	0.38	0.00	0.08	0.88	0.29	0.21	1.50	Concrete
37	B5	1629.40	7.04	7.99	14.50	10.26	10.15	7.31	9.07	9.67	100	9.00	1.76	160			2.36	0.68	-			-	-	-	Concrete
38	GJ16A	1650.00	6.98	8.00	13.55	10.17	9.49	7.44	9.20	9.80	100	9.00	1.76	160	8.80	7.60	2.36	0.56	-	1.36	0.16	-	0.31	-	Concrete
39	GJ17	1700.00	8.01	8.48	13.85	10.45	10.07	7.75	9.49	10.09	100	9.00	1.74	160	8.00	8.80	2.34	0.73	0.26	0.25	1.05	-	0.02	-	Concrete
40	GJ17A	1750.00	8.33	8.28	14.35	10.61	9.82	8.06	9.78	10.38	100	9.00	1.71	160	8.15	8.20	2.31	0.22	0.27	0.09	0.14	-	0.56	-	Concrete
41	GJ18	1800.00	8.43	8.85	9.65	11.24	12.16	8.38	10.07	10.67	100	9.00	1.70	160	9.20	8.60	2.30	0.48	0.05	0.82	0.23	-	-	-	Concrete
42	B6	1835.00	8.85	9.16	15.20	11.69	11.72	8.59	10.25	10.85	100	9.00	1.65	160			2.25	0.57	0.26			-	-	-	Concrete
43	GJ18A	1850.00	9.02	9.39	13.70	11.25	11.25	8.69	10.34	10.94	100	9.00	1.65	160	9.05	9.05	2.25	0.70	0.33	0.36	0.36	-	-	-	Concrete

Table-D.5.17(2) Batu Gajah River Improvement Plan

Section No.	Profile No.	Cumulative Distance	Current Condition: Dpst.Bed Level	Ave. Bed Level	River Width	Left Bank	Right Bank	Planning Condition: Riverbed Level	Water Level	Top of Dike	Design Qp	River Width	Water Height	Slope 1:	R.bed at Wall: Left	Right	Dike Height	Excavation Depth: Ave.	Deepest	R.bed at Wall		Heightneing: Left	Right	Widening Length	Concrete Channel
44	GJ19	1900.00	9.25	9.74	14.40	11.31	11.85	9.00	10.59	11.19	100	9.00	1.59	160	9.20	10.00	2.19	0.74	0.25	0.20	1.00	-	-	-	Concrete
45	B7	1918.90	9.34	9.72	12.32	12.12	12.24	9.12	10.69	11.29	100	9.00	1.57	160			2.17	0.60	0.22			-	-	-	Concrete
46	GJ19A	1950.00	9.47	9.91	9.25	11.75	11.45	9.31	10.83	11.43	100	9.00	1.52	160	9.60	10.95	2.12	0.60	0.16	0.29	1.64	-	-	-	Concrete
47	GJ20	2000.00	9.88	9.98	7.10	12.68	13.09	9.63	11.85	12.45	100	7.00	2.22	160	10.10	9.80	2.82	0.36	0.26	0.48	0.18	-	-	-	Concrete
48	B8	2007.40	9.90	9.97	7.40	12.68	12.68	9.67	11.88	12.48	100	7.00	2.21	160			2.81	0.30	0.23			-	-	-	Concrete
49	GJ20A	2050.00	10.05	10.55	6.40	12.73	12.83	9.94	12.16	12.76	100	7.00	2.22	160	10.15	11.00	2.82	0.61	0.11	0.21	1.06	0.03	-	0.60	Concrete
50	B9	2070.00	10.26	10.75	9.20	13.87	13.86	10.06	12.27	12.87	100	7.00	2.21	160			2.81	0.69	0.20			-	-	-	Concrete
51	GJ21	2100.00	10.46	10.76	8.00	12.85	14.87	10.25	12.46	13.06	100	7.00	2.21	160	11.30	11.60	2.81	0.51	0.21	1.05	1.35	0.21	-	-	Concrete
52	B10	2129.90	10.75	11.06	7.00	15.26	15.32	10.44	12.66	13.26	100	7.00	2.22	160			2.82	0.62	0.31			-	-	-	Concrete
53	GJ21A	2150.00	10.94	11.22	5.85	13.18	14.92	10.56	12.77	13.37	100	7.00	2.21	160	11.60	11.15	2.81	0.66	0.38	1.04	0.59	0.19	-	1.15	Concrete
54	GJ22	2200.00	11.21	11.39	7.40	13.84	13.64	10.88	13.10	13.70	100	7.00	2.23	160	11.90	11.90	2.83	0.52	0.34	1.03	1.03	-	0.06	-	Concrete
55	GJ22A	2250.00	12.39	12.89	8.80	15.00	16.05																		
56	GJ23	2300.00	13.21	13.53	12.60	15.13	15.70																		
57	B11	2343.90	13.72	14.26	10.00	18.86	18.77																		
58	GJ23A	2350.00	13.79	14.23	10.60	16.36	17.69																		
59	GJ24	2400.00	13.45	14.44	14.00	17.65	17.01																		
Average																	2.52	0.49	0.22	0.60	0.73	0.50	0.53		

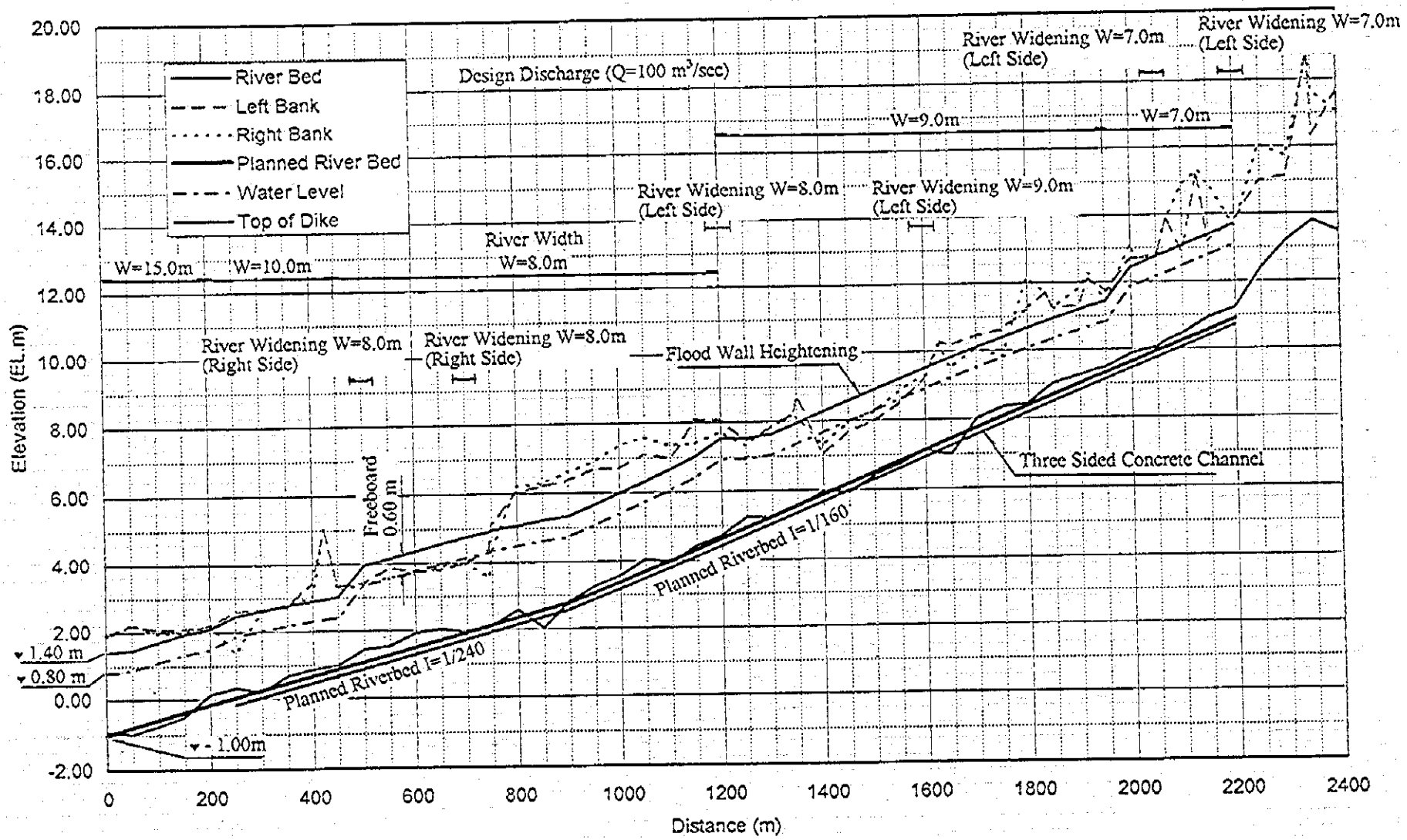


Figure-D.5.27 Longitudinal Section of Batu Gajah River Improvement Plan

5.5.4 Flood Regulation Plan by Dam

(1) Flood Regulation System and Calculation Method

The most reliable and effective method shall be applied for flood regulation system by dam. There are the four methods, namely 1) Natural Control Method, 2) Constant Discharging Method, 3) Constant Rate Control Method, and 4) Constant Rate and Discharging Method. In view of the small dam basin area (less than 20 km^2) and ease of operation and maintenance, the Natural Control Method has been adopted as the flood regulation system. Spillways are gate-less type, i.e. not fitted with gates for flood control.

Flood regulation effect by a dam is calculated applying the following equations, using a relationship between water level and reservoir volume.

$$\frac{I_1 + I_2}{2} \times \Delta t = \frac{O_1 + O_2}{2} \times \Delta t + (S_2 - S_1)$$

$$\frac{O_2}{2} \times \Delta t + S_2 = \frac{I_1 + I_2}{2} \times \Delta t - \frac{O_1}{2} \times \Delta t + S_1$$

where,

I_1, I_2	: Inflow to reservoir at the time of t_1 and t_2
O1, O2	: Outflow from reservoir at the time of t_1 and t_2
S1, S2	: Reservoir volume at the time of t_1 and t_2
Δt	: Calculation time interval

Discharge from spillway (weir/conduit) is calculated using following equations:

$H/h \leq 1.3$: $Q = 1.8 \cdot b \cdot H^{1.5}$

$H/h \geq 2.0$: $Q = 0.9 \cdot b \cdot h \cdot \sqrt{2g(H - h/2)}$

1.3<H/h<2.0 : to complement with straight line and take Q using both above equations

where,

H	: Water height over spillway weir (m)
h	: Spillway height (m)
b	: Spillway width (m)
Q	: Discharge (m^3/sec)

(2) Flood Regulation Calculation

<Water Level and Reservoir Volume>

The relationship between Water Level and Reservoir Volume of Batu Gajah Dam is shown in Figure-D.5.28.

<Flood Regulation Calculation>

Flood regulation calculation was carried out changing the size of the spillway, so as to become less than 100 m^3/sec and 80 m^3/sec at the reference points of river mouth and staff gauge points. The calculation results are shown in Table-D.5.18. Discharge characteristics of the main spillway including the emergency spillway are shown in Figure-D.5.29.

Flood control plan of Batu Gajah Dam (hydrograph) and flood discharge distribution of Batu Gajah River are shown in Figure-D.5.30 and Figure-D.5.31

Elevation (EL.m)	Height (m)	Area ('000m²)	Volume ('000m³)	Accumulated Volume ('000m³)
35	-	0.000	0.000	0.000
40	5	3.236	8.090	8.090
45	5	7.465	26.753	34.843
50	5	24.073	78.845	113.688
55	5	47.367	178.600	292.288
60	5	66.847	285.535	577.823
65	5	89.178	390.063	967.885
70	5	114.805	509.958	1,477.843
75	5	147.265	655.175	2,133.018

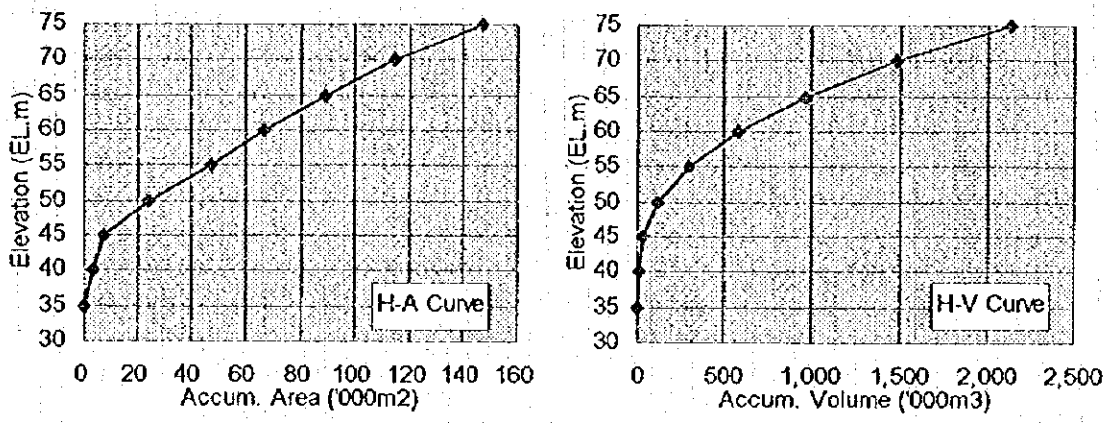


Figure-D.5.28 Water Level and Reservoir Volume of Batu Gajah Dam

Table-D.5.18 Flood Regulation Calculation Result

Item		Unit	1990/06 Flood
<Reference Points>			
River Mouth	Peak Discharge	m^3/sec	123
	Regulated Peak Discharge	m^3/sec	98
	Regulated Amount	m^3/sec	25
Staff Gauge	Peak Discharge	m^3/sec	101
	Regulated Peak Discharge	m^3/sec	80
	Regulated Amount	m^3/sec	21
<Dam>			
Peak Inflow		m^3/sec	88
Maximum Discharge from Spillway		m^3/sec	70
Discharge from Spillway at Peak Inflow		m^3/sec	64
Regulated Amount		m^3/sec	24
Net Flood Storage Capacity Vn		m^3	338,000
Design Flood Storage Capacity (Vd=1.2Vn)		m^3	406,000
Rainfall Depth Equivalent to Vd		mm	95
Surcharge Water Level		EL.m	70.50
<Main Spillway>			
Type		-	Overflow
Crest Level		EL.m	66.60
Width		m	6.5
Height (Water Height)		m	3.3

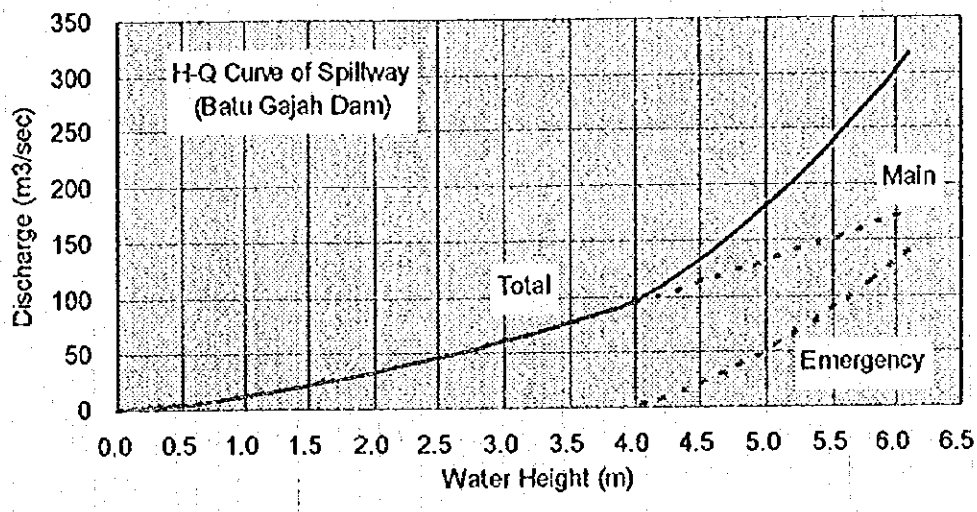


Figure-D.5.29 Spillway H-Q Curve of Batu Gajah Dam

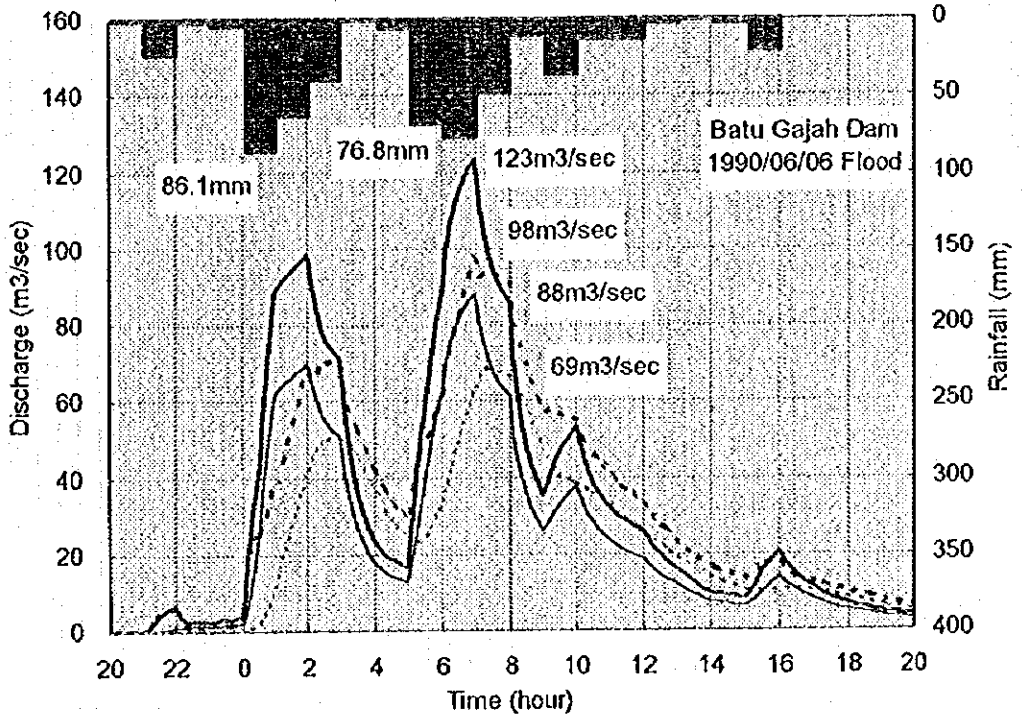


Figure-D.5.30 Flood Control Plan of Batu Gajah Dam

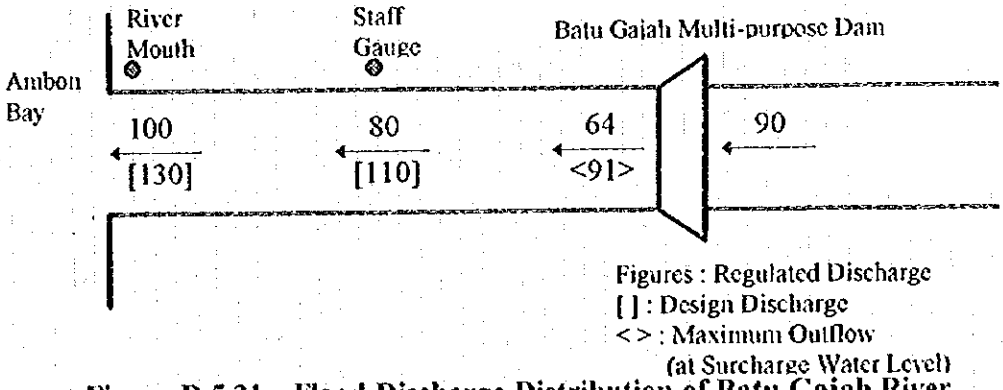


Figure-D.5.31 Flood Discharge Distribution of Batu Gajah River

5.5.5 Batu Gajah Multi-Purpose Dam Plan

Based on the flood regulation plan by the dam and water utilization plan explained in Section 3.4, Batu Gajah Multi-purpose Dam were planned. The specification of the dam is determined as shown in Table-D.5.19 and the dam reservoir volume allocation is shown in Figure-D.5.32.

Table-D.5.19 Specification of Batu Gajah Multi-purpose Dam

Items		Unit	Specification	Remarks
Reservoir	Catchment Area	km^2	4.27	
	Reservoir Area	m^2	144,000	
	Total Storage Capacity	m^3	1,532,000	
	Effective Storage Capacity	m^3	1,361,000	
	Flood Storage Capacity	m^3	406,000	
	Water Utilization Capacity	m^3	955,000	
	: River Maintenance Capacity	m^3	70,000	3,700 m^3/day
	: New Development Capacity	m^3	885,000	8,000 m^3/day
	Sediment Capacity	m^3	171,000	400 m^3/km^2/year
	Design High Water Level (H.W.L.)	EL.m	71.50	
	Surcharge Water Level (S.W.L.)	EL.m	70.50	
	Normal Water Level (N.W.L.)	EL.m	66.60	
	Low Water Level (L.W.L.)	EL.m	51.60	
Dam	Dam Type	-	Rock Fill	
	Dam Top Level	EL.m	75.00	
	Dam Foundation Level	EL.m	25.00	
	Dam Height	m	50.00	
Spillway	Main Spillway : Type	-	Free Overflow	
	: Structure - Width	m	6.50	
	- Height	m	3.90	
	Emergency Spillway : Type	-	Free Overflow	Qp=190 m^3/sec
	: Structure - Width	m	24.00	(2,000-year)
	- Height	m	1.50	

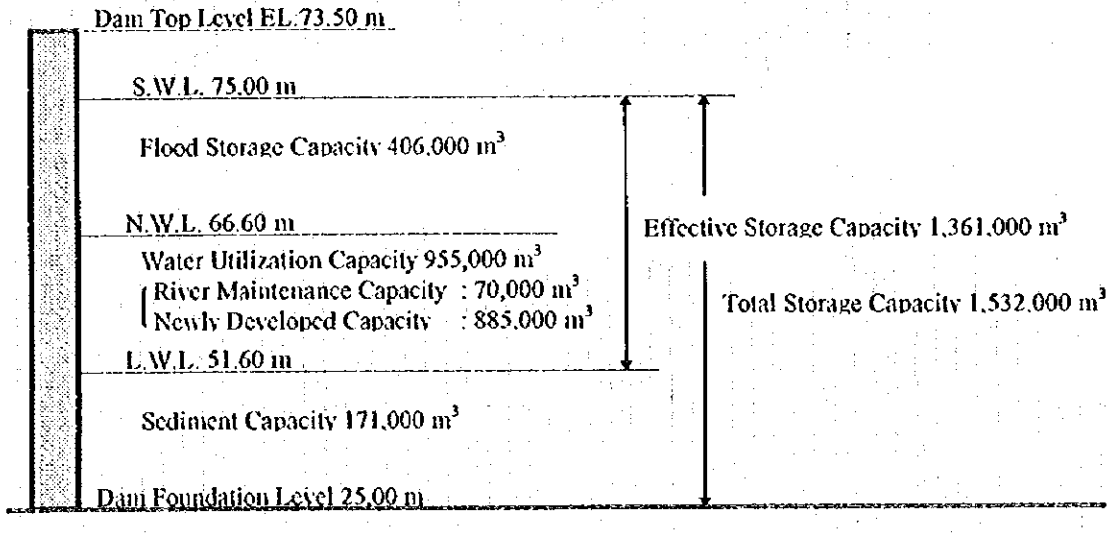


Figure-D.5.32 Reservoir Volume Allocation for Batu Gajah Dam

5.6 Batu Gantung River Flood Control Plan

5.6.1 Basic Policy

The downstream of Batu Gantung River is improved with 10-year return period. In order to achieve the security against flood with 30-year return period, a multi-purpose dam is planned to be constructed at 2k950 from the river mouth. In order to reduce the sedimentation into the dam reservoir, a check dam is planned at 4k000 from the river mouth. Refer to Figure-D.5.33.

- 0k000 - 1k450 : River improvement with 10-year return period
- 2k950 : Multi-purpose dam
- 4k000 : Check dam

5.6.2 Planning Criteria

(1) Design Scale

30-year return period

(2) Reference Point, Basin Division and Runoff Model

Reference points are set as shown in Table-D.5.20 and the basin division is shown in Figure-D.5.35. The runoff model is shown in Figure-D.5.34.

Table-D.5.20 Reference Point and Basin Division

Basin Name	Catchment Area. (km^2)	Reference Point	Catchment Area (km^2)
[1] Upper Basin 1 (Dam)	4.76	Staff Gauge	5.89
[2] Upper Basin 1 (Remaining)	1.13	River Mouth	6.87
[3] Lower Basin 1	0.18		
[4] Upper Basin 2	0.45		
[5] Lower Basin 2	0.35		
Total	6.87		

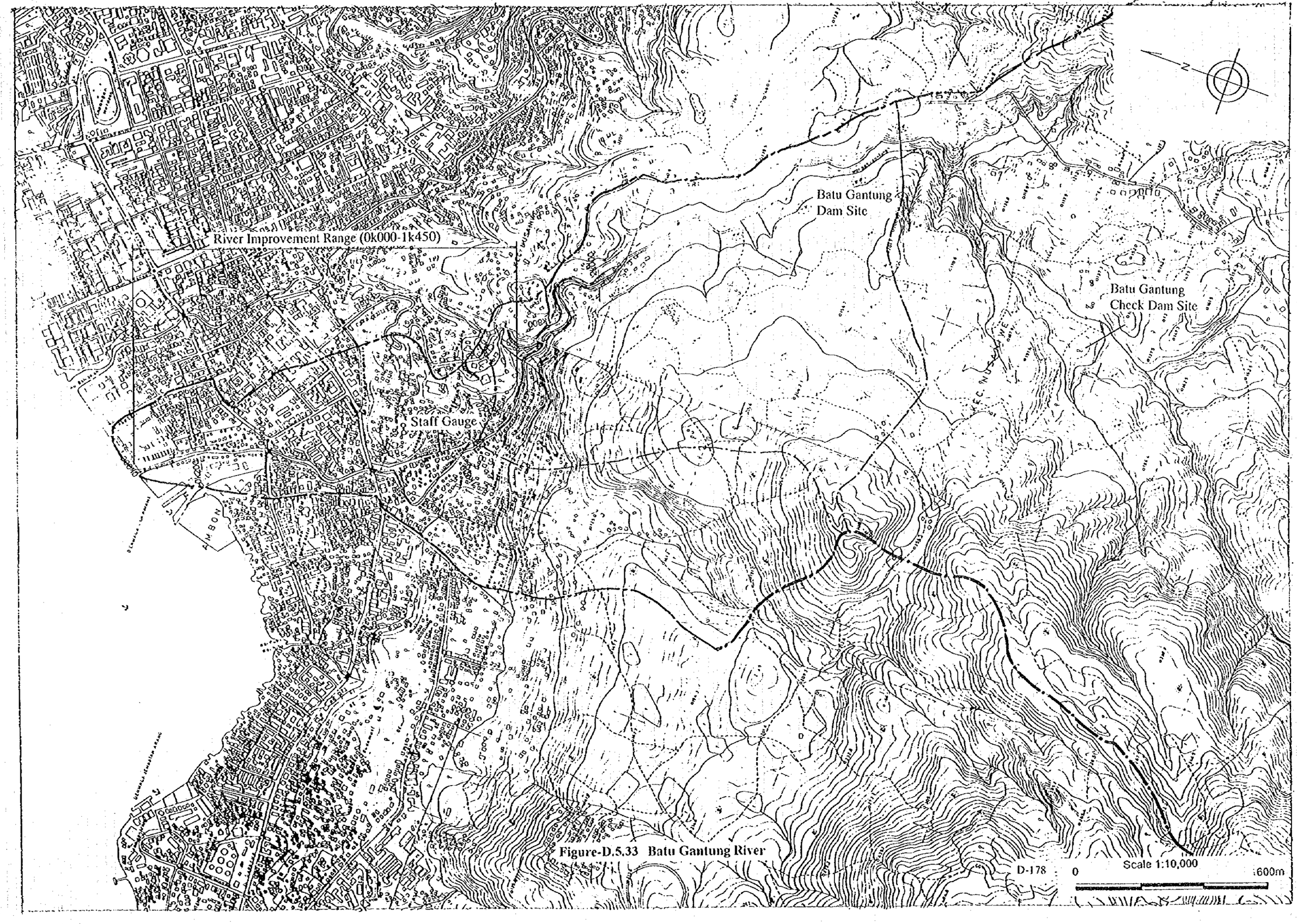


Figure-D.5.33 Batu Gantung River

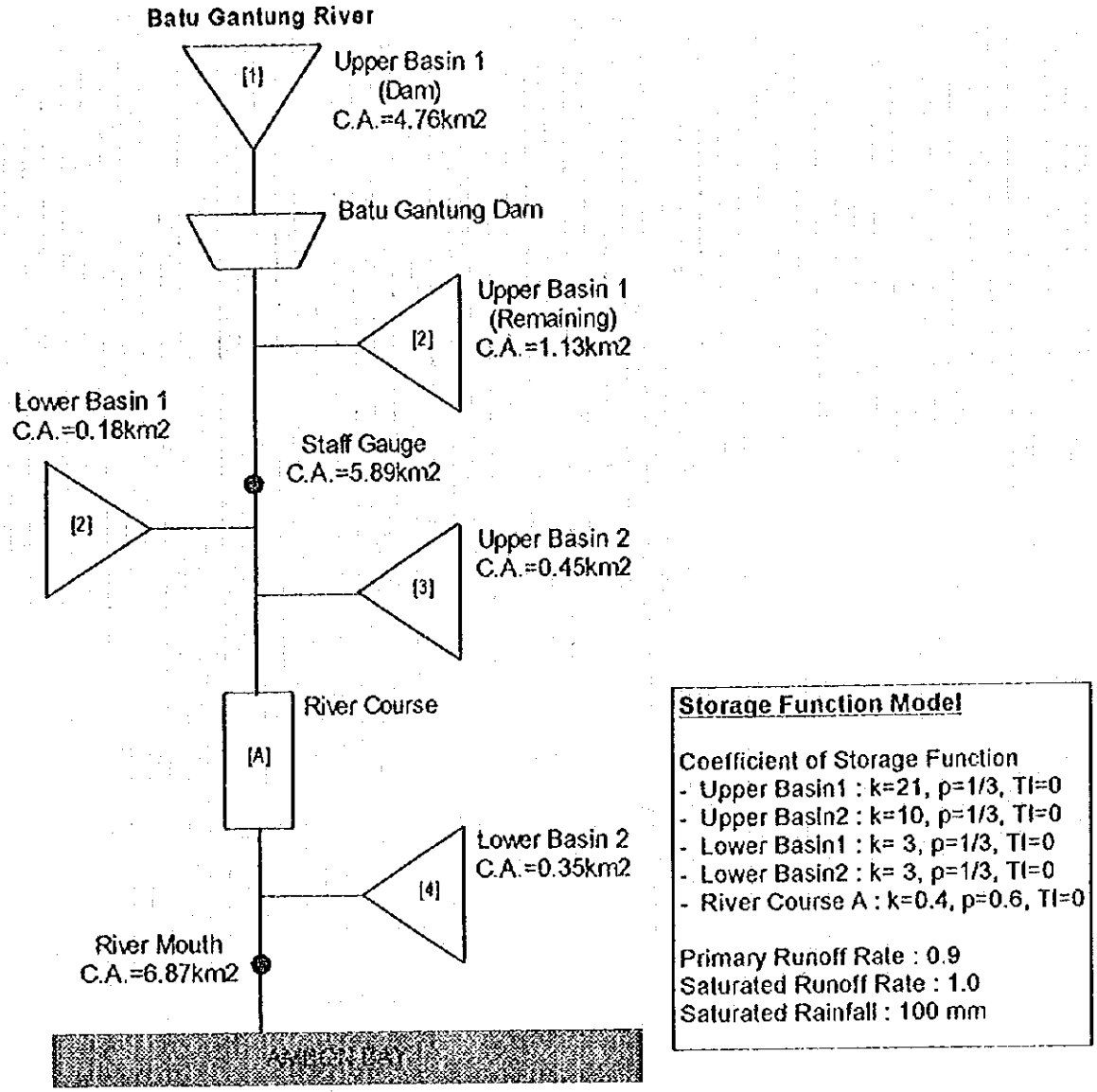


Figure-D.5.34 Runoff Model of Batu Gantung River

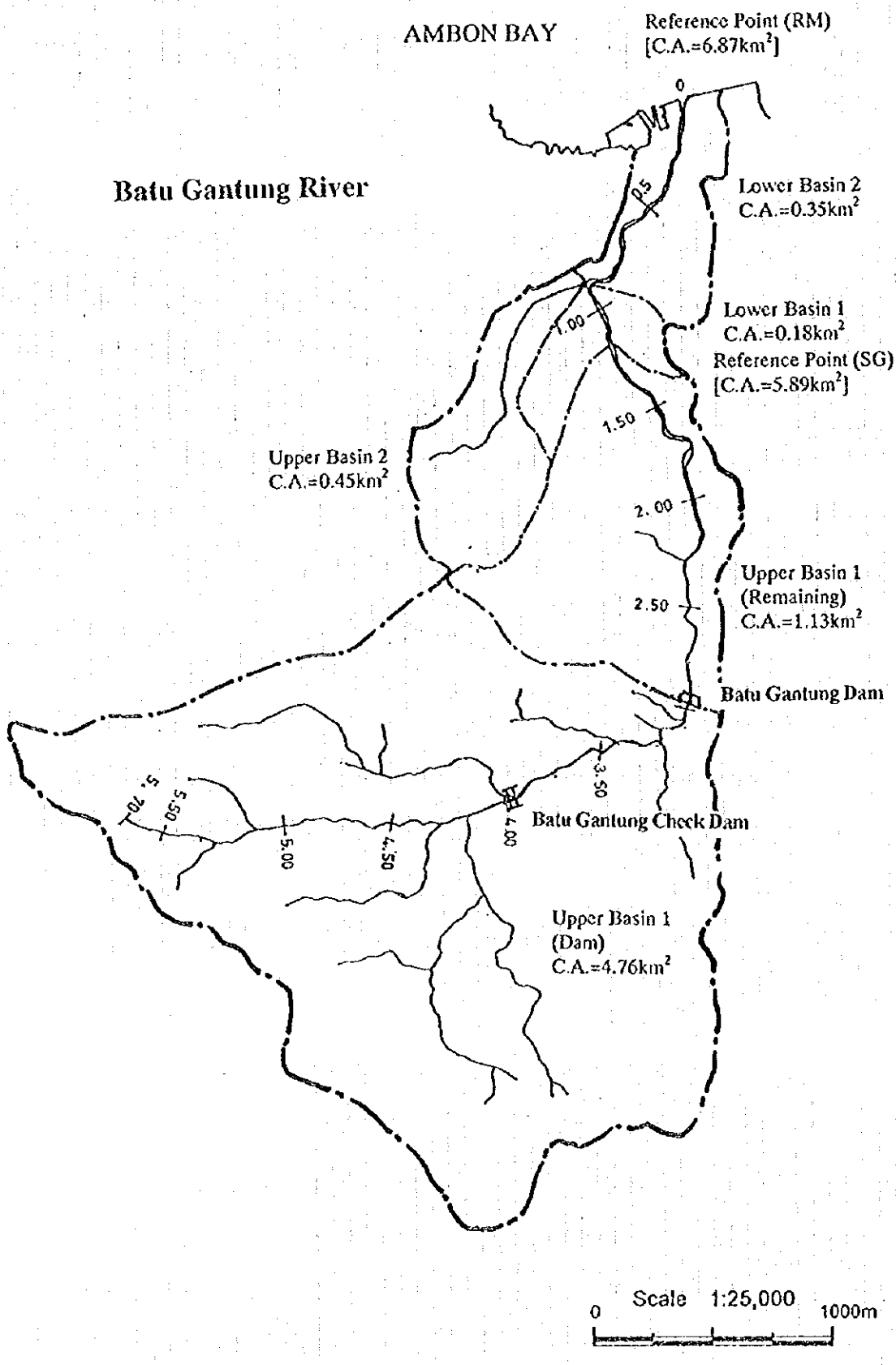


Figure-D.5.35 Batu Gantung River Basin

(3) Design Flood Discharge and Design Hydrograph

Design Flood Discharge

		10-year Return Period	30-year Return Period
- Batu Gantung Dam Point	:	80 m^3/sec	100 m^3/sec
- Staff Gauge Reference Point	:	100 m^3/sec	130 m^3/sec
- River Mouth Reference Point	:	110 m^3/sec	150 m^3/sec

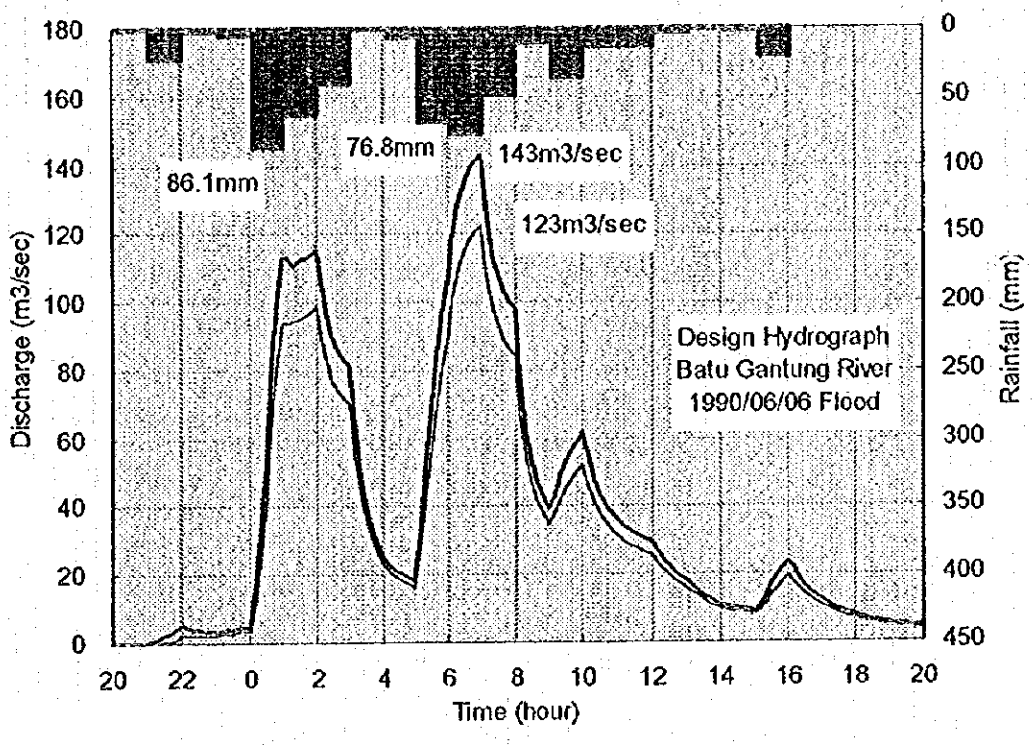


Figure-D.5.36 Design Hydrograph at Reference Points (Batu Gantung River)

(4) Design Discharge Distribution

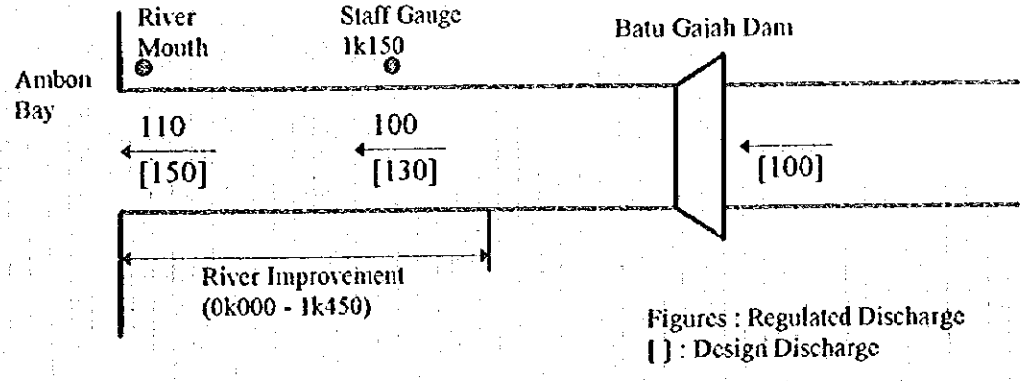


Figure-D.5.37 Design Discharge Distribution (Batu Gantung River)

5.6.3 River Improvement Plan

River improvement plan of Batu Gantung River is summarized in Table-D.5.23 and Figure-D.5.38 based on the following study:

(1) River Improvement Range

River improvement range is set from river mouth to 1k450 i.e. 1,450m length. There are currently no flood walls constructed upstream of 1k450, which is like a natural V-shape river and very few houses are located along the river. Thus the upstream river from 1k450 is judged not to be necessary to be improved.

River Improvement Range : 0k000 - 1k450 (1,450m)

(2) River Course Alignment

River course alignment followed current river course with no new channel.

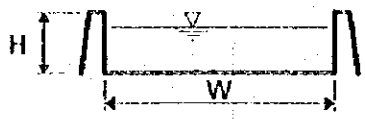
(3) Planned River Bed (Slope, Excavation)

Planned riverbed slope of the downstream from 0k000 to 0k150 was set level at EL.-1.00m, which is the nearly current deepest river bed level at the river mouth. Because the river section is enough wide and high so that it is not necessary to be excavated and heightened.

Planned riverbed of the upstream was set at I=1/230 from 0k150 to 0k400 and at 1/180 in the upstream of 0k400, in line with the current upstream riverbed slope. Three cases of excavation depth in the upstream, 1.0m, 0.5m and 0.0m below the deepest riverbed, were studied. Of these cases the shallowest excavation case was adopted because of economical reason, even though river bed excavation has advantage for enlarging discharge capacity and facilitating inner water drainage.

(4) Standard Cross Section (Heightening, Widening)

According to the current river section with flood walls, the planned standard cross section was set rectangular as follows:



0k000-0k150	: W=15.0m, H=2.4-3.0m
0k200-0k350	: W= 7.0m, H=3.3-3.5m
0k400-0k850	: W=10.0m, H=2.1-3.3m
0k900-0k950	: W= 8.0m, H=2.5-2.6m
1k000-1k100	: W= 6.0m, H=3.3-3.7m
1k150-1k450	: W= 6.0m, H=2.9-3.4m

Based on uniform and non-uniform flow calculation on the design discharges of 110 m^3/sec for 0k000-0k950 and 100 m^3/sec for the upstream of 0k950 equivalent to 10-year return period, the following flood wall heightening and section widening were planned.

- The river sections from 0k200 to 0k350 is narrower than its upstream and downstream sections with 7.85-9.85 m width, then it would be good to be widened. However

because there are many houses closely each other along the both sides of the river, it is decided that excavation and three sided concrete channel is applied to this section with no widening.

- There are partly narrow sections with the width of 5-7 m, where widening works were planned, to the width of 10.0m in the river section at 0k450, to 8.0-10.0m at 0k850-0k900, to 6.0m at 1k100, to 7.0m at 1k200 and 1k300.
- Most of sections need flood wall heightening. The height of flood walls to be raised is 0.6 m in the right side and 0.7 m in the left side on average.
- Three sided concrete channel is planned in the upstream of 0k150 with 1,350m length.

(5) Bridge Improvement

The list of bridges in Batu Gantung River is shown in Table-D.5.21. Considering clearance between bridge underside elevation and H.W.L.(more than 0.6m) and excavation condition, the bridges of No.1 and No.2 are necessary to be improved.

Table-D.5.21 List of Bridges in Batu Gantung River

No.	Distance (m)	Bridge Underside Elevation (EL.m)	Bridge Pier		Bridge Width (m)	*1 Objec-tives	Clearance (m)		Depth of *2 Excavation at Pier (m)		Remarks
			Number	Width (m)							
1	0k400	3.05	2	1.50	7.00	VR	0.25	X	1.40	X	Concrete bridge
2	0k769	6.85	1	1.50	6.00	VR	3.10	O	0.40	X	Concrete bridge
2'	1k211	8.60	-	-	1.00	FPB	1.51	O	-	O	Wooden bridge
3	1k336	8.65	-	-	2.50	FPB	1.04	O	-	O	Concrete bridge

*1 Objectives (Vehicle Road, Foot Path Bridge, Water Pipe, Others)
*2 Excavation Depth below Deepest Riverbed

(6) Drainage Improvement

The list of drainage in Batu Gantung River is shown in Table-D.5.22. The method of drainage improvement will be studied in the chapter of facility design.

Table-D.5.22 List of Drainage in Batu Gantung River

No.	Distance (m)	Side	Bottom Elevation (EL.m)	Section		Objectives	Remarks
				Width (m)	Height (m)		
1	0k140	R	0.43	0.60	1.20	CD	
2	0k189	R	0.39	0.90	0.60	HD	Drainage is not well-functioned
3	0k230	R	0.14	0.50	0.60	CD	
4	0k429	R	1.38	0.80	0.50	CD	Damaged
5	0k864	R	3.32	1.50	1.50	HD	
6	0k970	L	4.48	1.50	2.00	HD	Left side of the wall is cracked
7	1k051	L	4.89	0.60	0.80	HD	
8	1k096	L	4.92	0.80	1.20	HD	
9	1k265	R	5.40	1.20	1.20	HD	Covered by garbage

* Objectives (City Drainage, Home Drainage, Toilet, Others)

Table-D.5.23 Batu Gantung River Improvement Plan

Section No.	Profile No.	Cumulative Distance	Current Condition: Dpst.Bed Level (EL.m)	Current Condition: Ave. Bed Level (EL.m)	Current Condition: River Width (m)	Current Condition: Left Bank (EL.m)	Current Condition: Right Bank (EL.m)	Planning Condition: Riverbed Level (EL.m)	Planning Condition: Water Level (EL.m)	Planning Condition: Top of Dike (EL.m)	Planning Condition: Design Qp (m3/s)	Planning Condition: River Width (m)	Planning Condition: Water Height (m)	Planning Condition: Slope 1	R.bed at Wall: Left (EL.m)	R.bed at Wall: Right (EL.m)	Dike Height (m)	Excavation Depth: Ave. (m)	Excavation Depth: Deepest (m)	Excavation Depth: R.bed at Wall L.(m)	Excavation Depth: R.bed at Wall R.(m)	Heightening: Left (m)	Heightening: Right (m)	Widening Length (m)	Concrete Channel
1	GT0	0.00	-0.97	-0.66	18.50	2.76	2.16	-1.00	0.80	1.40	110	15.00	1.80		-0.40	0.40	2.40	0.34	0.03	0.60	1.40	-	-	-	-
2	GT0A	50.00	-0.96	-0.47	18.50	0.17	2.02	-1.000	1.26	1.86	110	15.00	2.26		-0.80	0.25	2.86	0.53	0.04	0.20	1.25	1.69	-	-	-
3	GT1	100.00	-0.65	-0.31	15.40	1.34	1.98	-1.000	1.42	2.02	110	15.00	2.42		0.40	1.30	3.02	0.69	0.35	1.40	2.30	0.68	0.04	-	-
4	GT1A	150.00	-0.50	-0.19	10.50	2.07	0.24	-1.000	1.93	2.53	110	7.00	2.93		-0.20	-0.20	3.53	0.81	0.50	0.80	0.80	0.46	2.29	-	Concrete
5	GT2	200.00	-0.44	-0.10	8.30	2.19	0.40	-0.783	1.94	2.54	110	7.00	2.72	230	0.20	0.20	3.32	0.68	0.34	0.98	0.98	0.35	2.14	-	Concrete
6	GT2A	250.00	-0.06	0.15	9.85	2.13	2.48	-0.565	2.13	2.73	110	7.00	2.70	230	-0.05	0.10	3.30	0.72	0.51	0.52	0.67	0.60	0.25	-	Concrete
7	GT3	300.00	0.17	0.28	8.60	2.42	2.61	-0.348	2.37	2.97	110	7.00	2.71	230	0.70	0.40	3.31	0.63	0.52	1.05	0.75	0.55	0.36	-	Concrete
8	GT3A	350.00	0.28	0.48	7.85	2.56	2.67	-0.130	2.80	3.40	110	7.00	2.93	230	0.75	0.60	3.53	0.61	0.41	0.88	0.73	0.84	0.73	-	Concrete
9	B1/GT4	400.00	0.58	1.02	22.60	4.02	3.98	0.087	2.80	3.40	110	10.00	2.72	230			3.32	0.93	0.49			-	-	-	Concrete
10	GT4A	450.00	0.57	0.87	7.05	2.78	2.72	0.365	2.80	3.40	110	10.00	2.44	180	2.10	2.85	3.04	0.51	0.21	1.74	2.49	0.62	0.68	2.95	Concrete
11	GT5	500.00	0.90	1.20	10.20	3.12	3.03	0.643	2.80	3.40	110	10.00	2.16	180	1.60	1.60	2.76	0.56	0.26	0.96	0.96	0.28	0.37	-	Concrete
12	GT5A	550.00	1.19	1.48	10.65	3.27	3.31	0.920	2.80	3.40	110	10.00	1.88	180	1.80	1.55	2.48	0.56	0.27	0.88	0.63	0.13	0.09	-	Concrete
13	GT6	600.00	1.36	1.53	11.75	3.48	3.57	1.198	2.96	3.56	110	10.00	1.76	180	1.40	1.85	2.36	0.33	0.16	0.20	0.65	0.08	-	-	Concrete
14	GT6A	650.00	1.66	1.93	12.30	2.90	3.26	1.476	3.21	3.81	110	10.00	1.73	180	1.70	2.00	2.33	0.45	0.18	0.22	0.52	0.91	0.55	-	Concrete
15	GT7	700.00	1.65	2.24	13.85	3.94	3.99	1.754	3.43	4.03	110	10.00	1.68	180	2.50	1.80	2.28	0.49	-	0.75	0.05	-	0.04	-	Concrete
16	GT7A	750.00	2.17	2.35	13.00	4.30	4.52	2.031	3.66	4.26	110	10.00	1.63	180	2.10	2.40	2.23	0.32	0.14	0.07	0.37	-	-	-	Concrete
17	B2	769.00	2.33	2.52	15.80	7.33	7.34	2.137	3.75	4.35	110	10.00	1.61	180			2.21	0.38	0.19			-	-	-	Concrete
18	GT8	800.00	2.21	2.57	10.95	4.53	4.69	2.309	3.88	4.48	110	10.00	1.57	180	2.60	3.15	2.17	0.26	-	0.29	0.84	-	-	-	Concrete
19	GTNA	850.00	2.75	2.91	9.50	5.91	5.62	2.587	4.08	4.68	110	10.00	1.49	180	3.50	3.40	2.09	0.32	0.16	0.91	0.81	-	-	0.50	Concrete
20	GT9	900.00	2.84	3.10	7.60	4.95	6.08	2.865	4.83	5.43	110	8.00	1.95	180	3.35	3.50	2.56	0.24	-	0.49	0.64	0.48	-	0.40	Concrete
21	GT9A	950.00	3.24	3.35	9.10	5.65	6.29	3.143	5.04	5.64	110	8.00	1.89	180	3.60	3.70	2.49	0.21	0.10	0.46	0.56	-	-	-	Concrete
22	GT10	1000.00	3.55	3.59	6.75	6.44	6.42	3.420	6.12	6.72	100	6.00	2.70	160	3.90	3.95	3.30	0.17	0.13	0.48	0.53	0.28	0.30	-	Concrete
23	GT10A	1050.00	3.70	3.74	6.25	6.82	6.84	3.698	6.44	7.04	100	6.00	2.74	160	4.20	3.95	3.34	0.04	0.00	0.50	0.25	0.22	0.20	-	Concrete
24	GT11	1100.00	3.65	3.83	5.25	6.42	6.78	3.976	7.03	7.63	100	6.00	3.05	160	5.80	5.80	3.65	-	-	1.82	1.82	1.21	0.85	0.75	Concrete
25	GT11A	1150.00	4.27	4.34	11.85	5.27	7.29	4.254	7.03	7.63	100	7.00	2.78	180	4.40	4.50	3.38	0.09	0.02	0.15	0.25	2.36	0.34	-	Concrete
26	GT12	1200.00	4.36	4.59	6.80	7.78	7.63	4.531	7.03	7.63	100	7.00	2.50	160	5.05	4.95	3.10	0.06	-	0.52	0.42	-	-	0.20	Concrete
27	GT12A	1250.00	4.57	4.85	8.20	7.06	7.99	4.809	7.12	7.72	100	7.00	2.31	180	5.00	5.40	2.91	0.04	-	0.19	0.59	0.66	-	-	Concrete
28	GT13	1300.00	4.97	5.23	6.50	7.50	7.46	5.087	7.40	8.00	100	7.00	2.32	180	4.20	4.35	2.92	0.14	-	-	-	0.50	0.54	0.50	Concrete
29	B3	1335.80	5.27	5.43	10.45	9.29	9.48	5.286	7.61	8.21	100	7.00	2.32	180			2.92	0.14	-			-	-	-	Concrete
30	GT13A	1350.00	5.56	5.75	7.00	8.06	8.11	5.365	7.66	8.26	100	7.00	2.30	180	6.45	6.90	2.90	0.39	0.20	1.09	1.54	0.20	0.15	-	Concrete
31	GT14	1400.00	5.77	5.97	7.15	8.67	8.41	5.643	7.95	8.55	100	7.00	2.30	180	6.97	6.85	2.90	0.33	0.13	1.33	1.21	-	0.14	-	Concrete
32	GT14A	1450.00	6.53	6.85	10.20	9.11	9.07	5.920	8.23	8.83	100	7.00	2.31	180	6.60	6.30	2.91	0.93	0.61	0.88	2.38	-	-	-	Concrete
33	GT15	1500.00	10.76		16.00	14.59	15.90																		
34	GT15A	1550.00	12.78		17.02	18.03	18.00																		
35	GT16	1600.00	15.26		19.52	19.53	19.73																		
Average																		0.42	0.25	0.73	0.94	0.66	0.56	0.88	

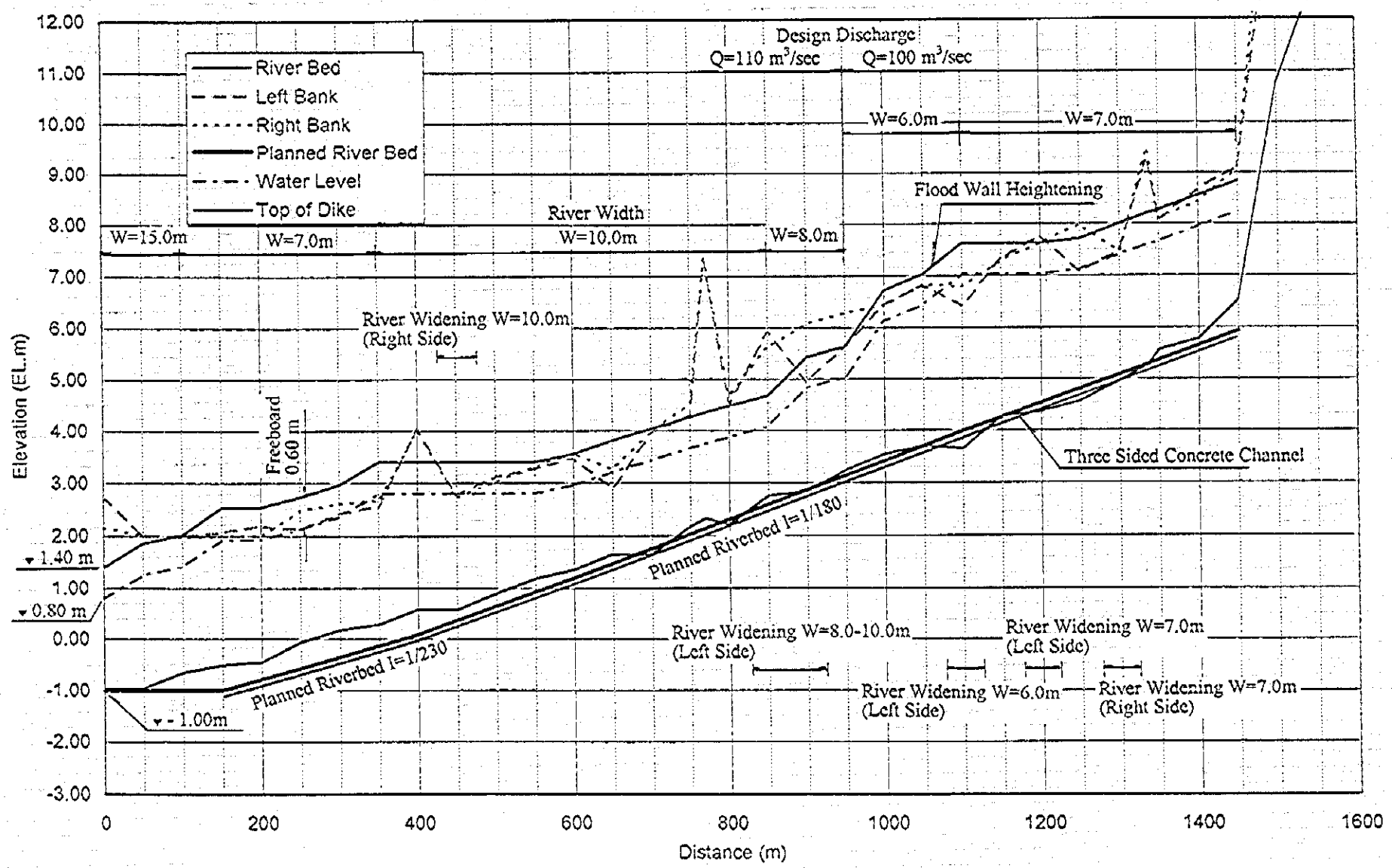


Figure-D.5.38 Longitudinal Section of Batu Gantung River Improvement Plan

5.6.4 Flood Regulation Plan by Dam

(1) Flood Regulation System and Calculation Method

The Natural Control Method is adopted as the flood regulation system for the same reasons of Batu Gajah Dam. The calculation method is also the same.

(2) Flood Regulation Calculation

<Water Level and Reservoir Volume>

The relationship between Water Level and Reservoir Volume of Batu Gantung Dam is shown in Figure-D.5.39.

Elevation (EL.m)	Height (m)	Area ('000m^2)	Volume ('000m^3)	Accumulated Volume ('000m^3)
70	-	0.000	0.000	0.000
75	5	4.580	11.450	11.450
80	5	11.678	40.645	52.095
85	5	30.202	104.700	156.795
90	5	53.457	209.148	365.943
95	5	72.782	315.598	681.540
100	5	97.454	425.590	1,107.130
105	5	122.383	549.593	1,656.723
110	5	195.927	795.775	2,452.498

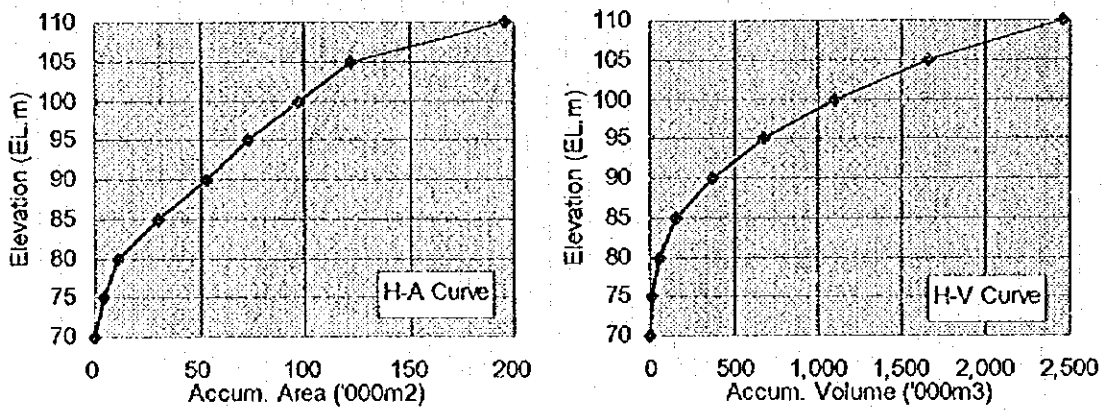


Figure-D.5.39 Water Level and Reservoir Volume of Batu Gantung Dam

<Flood Regulation Calculation>

Flood regulation calculation was carried out changing the size of the spillway, so as to become less than 110 m^3/sec and 100 m^3/sec at the reference points of rivermouth and staff gauge points. The calculation results are shown in Table-D.5.24. Discharge characteristics of the main spillway including the emergency spillway are shown in Figure-D.5.40.

Flood control plan of Batu Gajah Dam (Hydrograph) and flood discharge distribution of Batu Gajah River are shown in Figure-D.5.41 and D.5.42.

Table-D.5.24 Flood Regulation Calculation Result (Batu Gantung Dam)

Item		Unit	1990/06 Flood
<Reference Points>			
River Mouth	Peak Discharge	m^3/sec	143
	Regulated Peak Discharge	m^3/sec	110
	Regulated Amount	m^3/sec	33
Staff Gauge	Peak Discharge	m^3/sec	123
	Regulated Peak Discharge	m^3/sec	91
	Regulated Amount	m^3/sec	32
<Dam>			
Peak Inflow		m^3/sec	99
Maximum Discharge from Spillway		m^3/sec	73
Discharge from Spillway at Peak Inflow		m^3/sec	67
Regulated Amount		m^3/sec	32
Net Flood Storage Capacity		m^3	422,000
Design Flood Storage Capacity		m^3	507,000
Rainfall Depth Equivalent to Vd		mm	107
<Main Spillway>			
Type		-	Conduit
Crest Level		EL.m	96.80
Width		m	4.20
Height (Inlet Height)		m	4.20

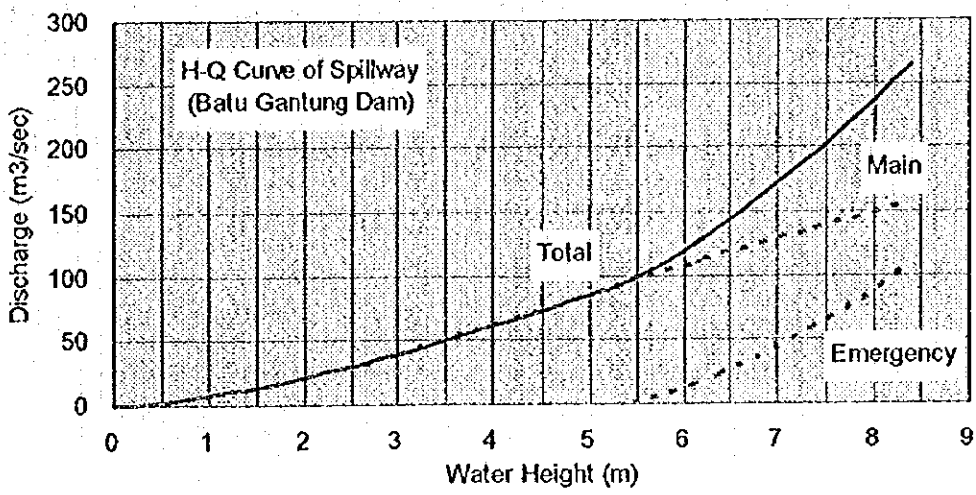


Figure-D.5.40 Spillway H-Q Curve of Batu Gantung Dam

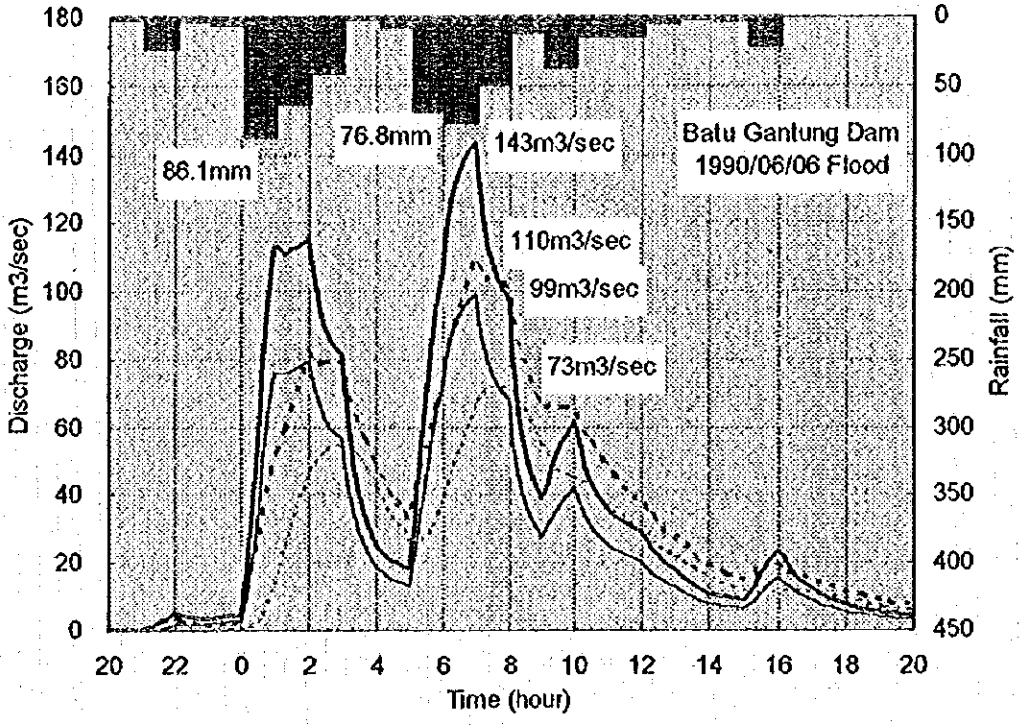


Figure-D.5.41 Flood Control Plan of Batu Gantung Dam

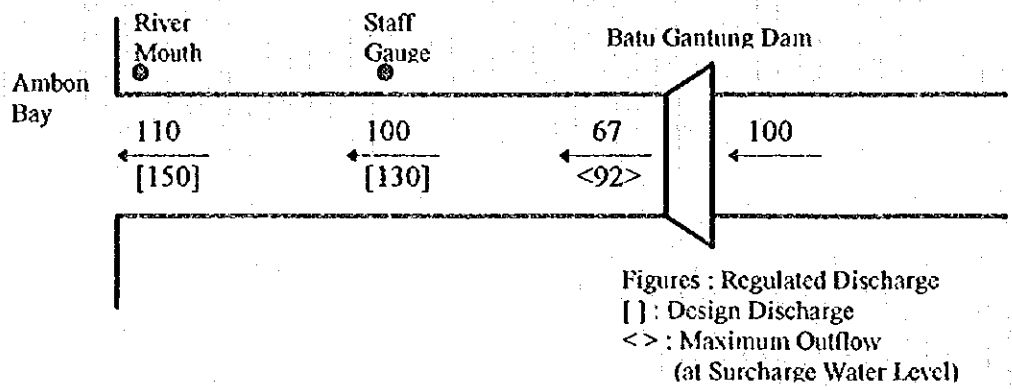


Figure-D.5.42 Flood Discharge Distribution of Batu Gantung River

5.6.5 Batu Gantung Multi-Purpose Dam

Based on the flood regulation plan by the dam and water utilization plan explained in Section 3.4, Batu Gantung Multi-purpose Dam were planned. The specification of the dam is determined as shown in Table-D.5.25 and the dam reservoir volume allocation is shown in Figure-D.5.43.

Table-D.5.25 Specification of Batu Gantung Multi-purpose Dam

Items		Unit	Specification	Remarks
Reservoir	Catchment Area	km^2	4.76	
	Reservoir Area	m^2	139,000	
	Total Storage Capacity	m^3	1,337,000	
	Effective Storage Capacity	m^3	1,146,000	
	Flood Storage Capacity	m^3	507,000	
	Water Utilization Capacity	m^3	639,000	
	: River Maintenance Capacity	m^3	249,000	2,070 m^3/day
	: Newly Development Capacity	m^3	390,000	2,500 m^3/day
	Sediment Capacity	m^3	191,000	400 m^3/km^2/year
	Design High Water Level (H.W.L.)	EL.m	104.10	
	Surcharge Water Level (S.W.L.)	EL.m	102.10	
	Normal Water Level (N.W.L.)	EL.m	96.80	
	Low Water Level (L.W.L.)	EL.m	85.90	
Dam	Dam Type	-	Rock Fill	
	Dam Top Level	EL.m	106.60	
	Dam Foundation Level	EL.m	70.00	
	Dam Height	m	36.60	
Spillway	Main Spillway : Type	-	Conduit	
	: Structure - Width	m	4.20	
	- Height	m	4.20	
	Emergency Spillway : Type	-	Free Overflow	Qp=220 m^3/sec
	: Structure - Width	m	11.00	(2,000-year)
	- Height	m	1.50	

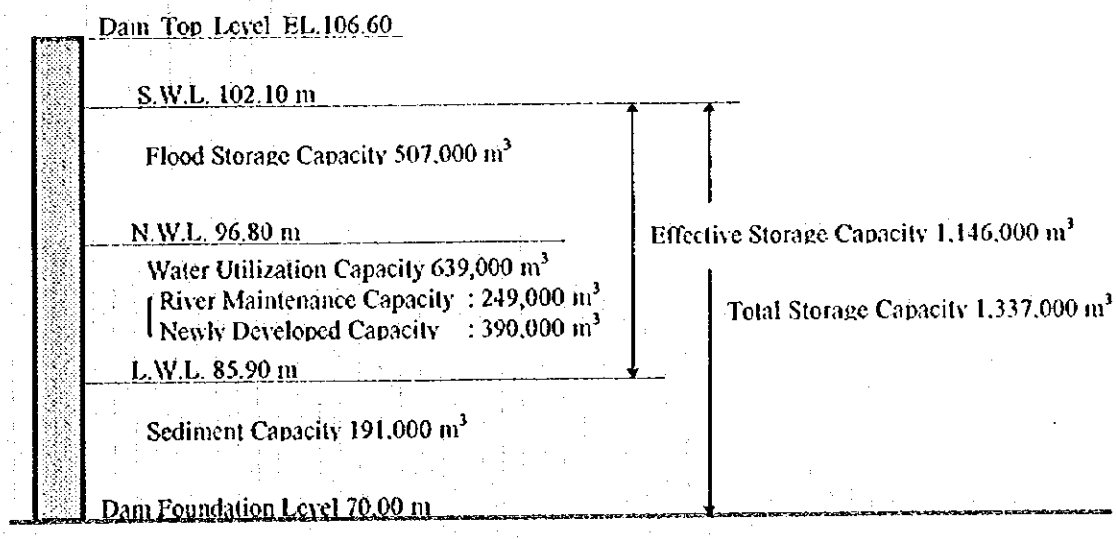


Figure-D.5.43 Reservoir Volume Allocation for Batu Gantung Dam