(2) Drainage of inland

When the surrounding dike is constructed, the drainage of inland would be more difficult than in the case the surrounding dike is not constructed depending on the places.

(3) Depth, duration and area of inundation in the retarding basin

(a) Widas retarding basin

According to the design of the Widas retarding basin, the design high water level and the capacity are 38.6 m SHVP and 13.6 x 10^6 m^3 each for 25 year probable flood.

And the capacity of the present retarding basin below 38.6 m SHVP is almost the same as the design capacity of the retarding basin.

Accordingly the depth, duration and the area of inundation in the retarding basin does not change so much whether the surrounding dike is constructed or not.

But the design high water level for 25 year probable flood is lower than that in the present condition of the retarding basin. Because owing to the construction of river dike and side overflow dike along the Widas river, the volume of flood water overflowing into the design retarding basin is around 9.9 x 10^6 m^3. But without the river dike and the side overflow dike, volume of flood water to be retarded in the retarding basin would be around 18 x 10^6 m^3.

(b) Ulo retarding basin

The conditions are the same on the Ulo retarding basin. The design high water level and the capacity are around 44.4 m SHVP and 4.8 x 10^6 m^3 each for 25 year probable flood, and the capacity of the present retarding basin below 44.4 m SHVP is almost the same as the design capacity.

Accordingly the depth, duration and the area of inundation in the retarding basin does not change so much whether the surrounding dike is constructed or not.

But similar to the case of the Widas retarding basin, the inundation conditions are much improved with the construction of river dike and the side overflow dike whether or not the surrounding dike is constructed.

(c) Kedungsoko retarding basin

The conditions are the same on the Kedungsoko retarding basin. The design high water level and the capacity are around 44.6 m SHVP and around 5.1 x 10^6 m^3 each for 25 year probable flood, and the capacity of the present retarding basin below 44.6 m SHVP is almost the same as the design capacity.

Accordingly the depth, duration and the area of inundation in the retarding basin does not change so much whether the surrounding dike is constructed or not.

But similar to the case of the other retarding basins, the inundation conditions are much improved with the construction of river dike and the side overflow dike whether or not the surrounding dike is constructed.

(4) Effective capacity

(a) Widas retarding basin

In the present condition, A1 canal flows into the Widas retarding basin. If canal dike along A1 canal on its left bank is not constructed, certain amount of flood water of A1 canal would flow into the retarding basin. According to the Warujayeng - Turi Tunggorono irrigation project, the design discharge of A1 canal is 70 m^3/s for 5 year probable flood. And some 3 or 4 MCM of flood water from A1 canal would be retarded in the retarding basin decreasing the effective capacity of the retarding basin before the flood water of the Widas river overflow into the retarding basin, or flood water overflowing the side overflow dike of the Widas river to be retarded in the retarding basin would go into the Brantas river through A1 canal even if the rivermouth of A1 canal is moved to the Brantas river separately from the Widas river.

(b) Ulo retarding basin

According to the design of river improvement, the Ulo river, that directly inflows into the Ulo retarding basin at present, is to be moved before entering into the retarding basin to join the Widas river. The other small channels inflowing into the Ulo retarding basin at present have only small drainage areas.

Accordingly, the effective capacity of the Ulo retarding basin does not change so much even if the surrounding dike is not constructed.

(c) Kedungsoko retarding basin

According to the design, the Kuncir river is to join the Kedungsoko river upstream of the side overflow dike site. Accordingly, on the left side of the Kedungsoko river, the run-off is almost going to join the Kedungsoko river upstream of the side overflow dike site.

But on the right side of the Kedungsoko river the run-off from the drainage area of about 34 km^2 of Warujayeng irrigation area directly runs into the retarding basin at present.

A part of this run-off could be made join theKedungsoko river upstream of the side overflow dike site. But a part cannot be made so, decreasing the effective capacity of the retarding basin for reducing flood peaks. But the volume of this run-off is not so large as in the case of A1 canal in the Widas retarding basin. A1 canal has a drainage area of about 191 km^2. The design capacity of the Kedungsoko retarding basin can include the run-off volume from some tributaries of Warujayeng irrigation area.

In this sense, the construction of surrounding dike has no much meaning from the view point of securing the effective capacity of the retarding basin.

(5) Operation and maintenance of sluices on the surrounding dike

(a) Widas retarding basin

When the surrounding dike is constructed, certain number of sluices should be constructed on the surrounding dike. On the left side of the Widas river, sluices should be constructed in order to drain the inland water. On the other hand, sluices on the dike along Al canal should be constructed in order to drain the retarded water in the retarding basin after a flood or just to drain the local flow in the retarding basin to Al canal except during floods.

When the Widas retarding basin is not filled with the excess water from the Widas river, the opening of the sluices to drain local water coincides with the interests of the farmers nearby.
But the sluices along Al canal should be closed when the retarding basin is being filled with the excess water from the Widas river to attenuate the peak rate to the Brantas river so that the retarded water would not flow out to the Brantas river through Al canal. This does not coincide with the interests of the farmers nearby in the retarding basin.

Even on the left side of the Widas river, sluices might be needed to be closed when the water level in the retarding basin is very high to prevent the retarded water from intruding to the inland side.
This does not always coincide with the interests of the farmers inside the retarding basin. From the above-mentioned conditions, the sluices on the surrounding dike seem to be som times rather difficult to operate properly and timely.

(b) Ulo retarding basin

The design high water in the Ulo retarding basin is around 44.4 m SHVP. And when the surrounding dike is constructed roughly along the contour line of the elevation of 44.4 m SHVP, there would be no serious problem on the operation of sluices on the surrounding dike. Even when the retarding basin is filled with the excess flood water, there would be no intrusion of flood water to the inland side except during extreme floods.

Accordingly the sluices can almost always be opened to drain the inland water.

(c) Kedungsoko retarding basin

Depending on places, some difficulties on the operation of sluices on the surrounding dike might occur. Because of the terrain of the retarding basin, the surrounding dike may run in the midst of farmland. During floods, the water level in the retarding basin may high and the water level in the inland side may low. In this case, farmers in the retarding basin may hope to open the sluices and the farmers on the inland side may hope to close the sluices. If there is no surrounding dike, there would occur no such proble, and the inundation condition just depends on the topographical conditions. Then the farmers can accept it as the natural conditions.

(6) Administration

(a) Widas retarding basin

When the surrounding dike is constructed, the boundary of inundation is very clear to the farmers in and ground the retarding basin.

Accordingly the farmers can easily make an annual cropping plan on the inland side because there is no more any fear of inundation. At the same time, conditions are understandable for the farmers inside the retarding basin because the area is the habitual inundation area and the inundation conditions would be improved much by the construction of river dike and the side overflow dike.

It may also be understandable for the farmers that the government has to limit the inundation area as the responsible body for flood control.

But when the surrounding dike is not constructed, there is no clear boundary of inundation. In that case people might ask the responsibility of the government as the responsible body for flood control.

(b) Ulo retarding basin

From the view point of administration, it may be the same with the Widas retarding basin.

(c) Kedungsoko retarding basin

From the view point of administration, it might be better to make clear the boundary of inundation. But in the case of the Kedungsoko retarding basin, there are so many houses in the retarding basin area.

In the case so many houses are enclosed with the surrounding dike as the retarding basin, people might oppose the construction of the surrounding dike, even though the inundation conditions are much improved with the river improvement works.

Table 4.4.1 DESIGN PROFILE OF RIVERS (1/4)

Reach	Sect. No.	Distance (m) Single	Accum	Slope of H.W.L	Elevation (m.SHVL) River bed	DHWL	Dike	Remarks
Widas river								
-	0.0	0	0	-	32.47	37.59	39.60	confluence
	0.3	303	303		32.59	37.59	39.60	
	0.7	405	708		32.68	37.68	39.60	
	1.1	415	1,123		32.80	37.80	39.60	
	1.1+400	400	1.523		32.92	37.92	39.60	c.o.c
I	+900	500	2.023		33.07	38.07	39.60	"
	+1400	500	2,523		33.21	38.21	39.60	"
	+1900	500	3.023		33.36	38.36	39.60	"
	+2400	500	3.523		33.51	38.51	39.60	"
	5.1	450	3,973		33.64	38.64	39.64	
	5.5	412	4,385		33.76	38.76	39.76	
	5.5+400	400	4,785		33.88	38.88	39.88	c.o.c
-	6.7	450	5,235	1/3400	34,01	39.01	40.01	side overflow
	7.5	881	6,116		34.27	39.27	40.27	dike, Pohbuntu r
	7.9	431	6,547		34.40	39.40	40.40	
	8.3	415	6,962		34.52	39.52	40.52	
	8.7	438	7,400		34.65	39.65	40.65	
II	9.1	466	7,866		34.78	39.78	40.78	
	9.1+300	300	8,166		34.87	39.87	40.87	c.o.c
	10.7	800	8,966		35.11	40.11	41.11	
	10.7+300	300	9,266		35.20	40.20	41.20	c.o.c
	11.5	250	9,516		35.27	40.27	41.27	
	11.9	309	9,825		35.36	40.36	41.36	Lengkong bridge,
-	12.3	433	10,258	-	35.50	40.50	41.50	Nglempoh r
	12.3+250	250	10,508		35.58	40.58	41.58	c.o.c
	12.3+750	500	11,008		35.74	40.74	41.74	"
	12.3+1250	500	11,508		35.90	40.90	41.90	"
	15.1	300	11,808		36.00	41.00	42.90	
	15.5	392	12,200		36.13	41.13	42.13	
	15.5+500	500	12,700	1/3100	36.29	41.29	42.29	c.o.c
III	15.5+1000	500	13,200		36.45	41.45	42.45	"
	15.5+1900	900	14,100		36.74	41.74	42.74	
	19.9	800	14,900		37.00	42.00	43.00	
	20.3	191	15,091		37.06	42.06	43.06	
	20.7	599	15,690		37.25	42.25	43.25	
	21.1	424	16,115		37.39	42.39	42.39	
-	21.1+350	350	16,464	-	37.50	42.50	43.50	Tretes r.
	21.5	50	16,514		37.52	42.52	43.52	
	21.9	422	16,936		37.71	42.71	43.71	
	22.3	400	17,336		37.88	42.88	43.88	
	22.7	350	17,686		38.03	43.03	44.03	
	23.1	375	18,061		38.19	43.19	44.19	
IV	23.5	350	18,411	1/2300	38.35	43.35	44.35	
	23.9	450	18,861		38.54	43.54	44.54	
	24.3	550	19,411		38.78	43.78	44.78	
	25.1	650	20,061		39.06	44.06	45.06	
	25.5	450	20,511		39.26	44.26	45.26	

Table 4.4.1 DESIGN PROFILE OF RIVERS (2/4)

Reach	Sect. No.	Distance (m) Single	Distance (m) Accum	Slope of H.W.L	Elevation (m. SHVP) River bed	Elevation (m. SHVP) DHWL	Elevation (m. SHVP) Dike	Remarks
	25.9	300	20,811		39.39	44.39	45.39	
-	26.1	250	21,061	-	39.50	44.50	45.50	K.soko r
V	26.1+900	900	21,961		40.07	45.07	46.07	c.o.c, side overflow dike
-								
	26.1+1400	500	22,461		40.38	45.38	46.38	c.o.c
	29.6	600	23,061	1/1590	40.76	45.76	46.76	
	29.6+650	650	23,711		41.17	46.17	47.17	c.o.c
	30.6	400	24,111		41.42	46.42	47.42	
VI	31.1	500	24,611		41.73	46.73	47.73	
	33.1-800	900	25,511		42.30	47.30	48.30	c.o.c
	33.1-300	500	26,011		42.61	47.61	48.61	"
	33.1	300	26,311		42.80	47.80	48.80	
-	33.4	300	26,611	-	43.00	48.00	49.00	
	33.4+400	400	27,011		43.30	48.30	49.30	c.o.c
	35.1	550	27,561		43.71	48.71	49.71	
	35.6	500	28,061		44.09	49.09	50.09	
	36.1	500	28,561		44.47	49.47	50.47	
	37.1	750	29,311	1/1330	45.03	50.03	51.03	
VII	37.6	500	29,811		45.41	50.41	51.41	
	38.6	700	30,511		45.93	50.93	51.93	
	39.6	1000	31,511		46.68	51.68	52.68	
	40.1	300	31,811		46.92	51.92	52.92	c.o.c
-	39.6+400 (40.1+100)	100	31,911	-	47.00	52.00	53.00	diversion c.
	40.6	300	32,211	1/890	47.34	52.34	53.34	
VIII	41.1	500	32,711		47.90	52.90	53.90	
	41.6	500	33,211		48.46	53.46	54.46	
Lower Ulo river								
-	29.9+200	0	0	-	41.1	46.1	47.1	confluence
	30.1	200	200		41.2	46.1	47.1	
					42.2	(drop structure)		
	30.1+500	500	700		42.3	"	"	c.o.c
	4.0	750	1,450	Level	42.6	"	"	existing c.
	4.5	500	1,950		42.6	"	"	"
	5.0	500	2,450		41.8	"	"	"
	5.5	500	2,950		42.6	"	"	"
-	6.0	500	3,450	-	44.0	"	"	"
Diversion channel + Upper Ulo river								
-	39.6+400	0	0	-	47.00	52.00	53.00	confluence
	0.0+300	300	300		47.25	52.25	53.25	new channel
	1.0	700	1,000	1/1180	47.84	52.84	53.84	"
	1.5	500	1,500		48.26	53.26	54.26	"
I	2.0	500	2,000		48.68	53.68	54.68	"
	2.5	500	2,500		49.10	54.10	55.10	"
-	2.9 =15.5+ 250	400	2,900	-	49.50	54.50	55.50	diversion of old Ulo

Table 4.4.1 DESIGN PROFILE OF RIVERS (3/4)

Reach	Sect. No.	Distance (m)		Slope of H.W.L	Elevation (m.SHVP)			Remarks
		Single	Accum		River bed	DHWL	Dike	
					50.50 (drop structure)			
	16.0	250	3,150		50.78	54.78	55.78	
	16.5	500	3,650		51.34	55.34	56.34	
II	17.0	500	4,150	1/890	51.90	55.90	56.90	
	17.5	500	4,650		52.46	56.46	57.46	
	18.0	500	5,150		53.02	57.02	58.02	
-	18.0+ 300	300	5,450	-	53.30	57.30	58.30	
	18.5	200	5,650		53.86	57.86	58.86	
	19.0	500	6,150		55.24	59.24	60.24	
III	19.5	500	6,650	1/400	56.63	60.63	61.63	
	20.0	500	7,150		58.02	62.02	63.02	
	20.5	500	7,650		59.41	63.41	64.41	
-	20.5+200	200	7,850	-	59.90	63.90	64.90	Tiripan dam
Kedungsoko river								
-	0	0	0	-	39.50	44.50	45.50	confluence
	0.5	500	500		39.68	44.53	45.53	
	1.0	500	1,000		39.86	44.56	45.56	
	1+500	500	1,500	1/2800	40.03	44.59	45.59	c.o.c
	2.0	250	1,750	(for uni-	40.13	44.61	45.61	
I	2.5	500	2,250	form flow)	40.30	44.63	45.63	
	3.0	500	2,750		40.49	44.67	45.67	c.o.c
	3.0+250	250	3,000		40.58	44.68	45.68	"
	3.5	150	3,150		40.63	44.69	45.69	
-	3.5+200	200	3,350	-	40.70	44.70	45.70	h bridge
II	3.5+220	20	3,370		40.71	44.71	45.71	r bridge
	3.5+500	280	3,650		40.85	44.85	45.85	c.o.c
-	3.5+1000	500	4,150		41.11	45.11	46.11	side overflow dike
III								
	3.5+1500	400	4,650		41.37	45.37	46.37	c.o.c
-	5.0+250	200	4,850		41.47	45.47	46.47	Kuncir r.
	5.5	250	5,100		41.60	45.60	46.60	
	6.0	500	5,600		41.85	45.85	46.85	
	6.5	500	6,100		42.11	46.11	47.11	
	7.0	500	6,600	1/1950	42.37	46.37	47.37	
IV	7.5	500	7,100		42.62	46.62	47.62	
	8.0	500	7,600		42.88	46.88	47.88	
	8.5	500	8,100		43.14	47.14	48.14	
	9.0	500	8,600		43.39	47.39	48.39	
	9.5	500	9,100		43.65	47.65	48.65	
	10.0	500	9.600		43.91	47.91	48.91	
-	10.0+150	150	9,750	-	44.00	48.00	49.00	Malangsari dam
Kuncir river								
-	0	0	0	-	41.47	45.47	46.47	confluence
	0.5	500	500		41.83	45.83	46.63	
I	1.0	500	1,500		42.19	46.19	46.99	
	1.5	500	1,500		42.56	46.56	47.36	

Table 4.4.1 DESIGN PROFILE OF RIVERS (4/4)

Reach	Sect.	Distance (m)		Slope of H.W.L	Elevation (m.SHVP)			Remarks
		Single	Accum		River bed	DHWL	Dike	
	2.0	500	2,000		42.92	46.92	47.72	
	2.5	500	2,500	1/1380	43.28	47.28	48.08	
	3.0	500	3,000		43.64	47.64	48.44	
I	3.5	500	3,500		44.01	48.01	48.81	
	4.0	500	4,000		44.37	48.37	49.17	
	4.5	500	4,500		44.73	48.73	49.53	
	5.0	500	5,000		45.09	49.09	49.89	
	5.5	500	5,500		45.46	49.46	50.26	
	6.0	500	6,000		45.82	49.82	50.62	
-	6.5	500	6,500	-	46.20	50.20	51.00	Kapas dam
	7.0	500	7,000		46.92	50.92	51.72	
	7.0+200	200	7,200		47.21	51.21	52.01	c.o.c
	7.0+700	500	7,700	1/690	47.94	51.94	52.74	"
II	7.0+1200	500	8,200		48.66	52.66	53.46	"
	9.5	550	8,750		49.46	53.46	54.26	Kramat dam
	10.0	500	9,250		50.19	54.19	54.99	
-	10.5	500	9,750	-	50.90	54.90	55.70	
	11.0	500	10,250		52.01	55.67	56.47	

Table 4.4.2 MAJOR DIMENSIONS OF PROPOSED RIVER CHANNEL OF COMPREHENSIVE PLAN (1/2)

Item	Widas river I Lower	Widas river I Upper	II	III	IV	V	VI	VII	VIII
1. Design discharge (m^3/s)	270	240	570	570	530	370	640	590	440
2. Design water slope	1/3,400	1/3,400	1/3,400	1/3,100	1/2,300	1/1,590	1/1,590	1/1,330	1/890
3. River width (m)	100	100	260	300	180	110	110	110	80
4. Low-water channel width (m)	43	39	74	74	64	44	67	61	44
5. Bottom width (m)	23.4	19.4	54	53.2	43.2	22.8	45.8	38.2	20.0
6. Total water depth (m)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
7. Low-water channel depth (m)	3.9	3.9	4.0	4.2	4.2	4.3	4.3	4.7	5.0
8. Bank slope	1 : 2	1 : 2	1 : 2	1 : 2	1 : 2	1 : 2	1 : 2	1 : 2	1 : 2
9. Total flow area (m^2)	245	229	522	514	376	228	329	275	170
10. Velocity (m/s)	1.2	1.1	1.1	1.2	1.5	1.8	2.1	2.2	2.7
11. Discharge (m^3/s)	292	261	586	594	557	400	670	617	452

Item	Diversion channel I Lower	Diversion channel I Upper	Upper Ulo river II	Upper Ulo river III
1. Design discharge (m^3/s)	230	230	220	190
2. Design water slope	1/1,180	1/1,180	1/890	1/400
3. River width (m)	35(50)	46(50)	50	50
4. Low-water channel width (m)	25	30	30.5	24.0
5. Bottom width (m)	11.0	8.0	16.1	8.0
6. Total water depth (m)	5.0 (single	5.0	4.0	4.0
7. Low-water channel depth (m)	3.5 section)	4.5	3.6	4.0
8. Bank slope	1 : 2	1 : 2	1 : 2	1 : 2
9. Total flow area (m^2)	111	118	103	64
10. Velocity (m/s)	2.2	2.1	2.2	3.1
11. Discharge (m^3/s)	246	243	225	195

Item	Kedungsoko river I /1	Kedungsoko river II	Kedungsoko river III	Kedungsoko river IV	Kuncir river I	Kuncir river II
1. Design discharge (m^3/s)	200	200	470	460	95	95
2. Design water slope	1/2,800	1/1,950	1/1,950	1/1,950	1/1,390	1/900
3. River width (m)	90	90	100	100	40	40
4. Low-water channel width (m)	48	33	67	64	16	16
5. Bottom width (m)	36	20.6	55.8	53.6	5.2	3.6
6. Total water depth (m)	4	4.0	4.0	4.0	4.0	4.0
7. Low-water channel depth (m)	3	3.1	2.8	2.6	2.7	3.1
8. Bank slope	1 : 2	1 : 2	1 : 2	1 : 2	1 : 2	1 : 2
9. Total flow area (m^2)	214	162	289	289	77	65
10. Velocity (m/s)	1.3	1.3	1.6	1.6	1.4	1.6
11. Discharge (m^3/s)	268	208	473	464	105	105

Note : /1 Required cross-sectional area in this reach is determined based on the estimated water levels by non-uniform flow calculation

Table 4.4.2 MAJOR DIMENSIONS OF PROPOSED RIVER CHANNEL OF FIRST STAGE PLAN (2/2)

Item	Widas river								
	I Lower	I Upper	II	II	IV	V	VI	VII	VIII
1. Design discharge (m^3/s)	270	240	500	500	470	320	580	570	380
2. Design water slope	1/3,400	1/3,400	1/3,400	1/3,100	1/2,300	1/1,590	1/1,590	1/1,330	1/890
3. River width (m)	100	100	260	300	180	110	110	110	80
4. Low-water channel width (m)	43	39	66	66	58	39	62	60	41
5. Bottom width (m)	23.4	19.4	46	45.2	37.2	17.8	40.8	37.2	17.0
6. Total water depth (m)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
7. Low-water channel depth (m)	3.9	3.9	4.0	4.2	4.2	4.3	4.3	4.7	5.0
8. Bank slope	1 : 2	1 : 2	1 : 2	1 : 2	1 : 2	1 : 2	1 : 2	1 : 2	1 : 2
9. Total flow area (m^2)	245	229	490	481	351	207	306	270	155
10. Velocity (m/s)	1.2	1.1	1.1	1.1	1.4	1.7	2.0	2.2	2.6
11. Discharge (m^3/s)	292	261	522	526	498	343	613	603	405

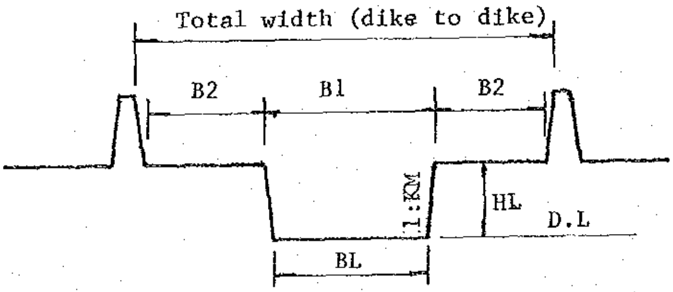
Item	Diversion channel		Upper Ulo river	
	I Lower	I Upper	II	III
1. Design discharge (m^3/s)	190	230	180	170
2. Design water slope	1/1,180	1/1,180	1/890	1/400
3. River width (m)	32(50)	46 (50)	50	50
4. Low-water channel width (m)	22	30	27.0	22.5
5. Bottom width (m)	8.0	8.0	12.6	6.5
6. Total water depth (m)	5.0 (Single section)	5.0	4.0	4.0
7. Low-water channel depth (m)	3.5 (Single section)	4.5	3.6	4.0
8. Bank slope	1 : 2	1 : 2	1 : 2	1 : 2
9. Total flow area (m^2)	96	118	91	58
10. Velocity (m/s)	2.1	2.1	2.1	3.0
11. Discharge (m^3/s)	205	243	188	173

Item	Kedungsoko river				Kuncir river	
	I /1	II	III	IV	I	II
1. Design discharge (m^3/s)	180	180	410	400	80	80
2. Design water slope	1/2,800	1/1,950	1/1,950	1/1,950	1/1,390	1/900
3. River width (m)	90	90	100	100	40	40
4. Low-water channel width (m)	45	30	59	56	14	135
5. Bottom width (m)	33	17.6	47.8	45.6	3.2	1.1
6. Total water depth (m)	4	4.0	4.0	4.0	4.0	4.0
7. Low-water channel depth (m)	3	3.1	2.8	2.6	2.1	3.1
8. Bank slope	1 : 2	1 : 2	1 : 2	1 : 2	1 : 2	1 : 2
9. Total flow area (m^2)	205	153	267	268	72	57
10. Velocity (m/s)	1.2	1.2	1.6	1.5	1.2	1.4
11. Discharge (m^3/s)	250	187	417	409	89	81

Note : /1 Required cross-sectional area in this reach is determined based on the estimated water levels by non-uniform flow calculation

Table 4.4.3 ESTIMATED WATER LEVEL BY NON UNIFORM FLOW (1/5)
(For river channel of comprehensive plan)

Explanation



Data items and its definition

n_1	:	Manning's coefficient roughness of low-water channel (0.030)
n_2	:	Manning's coefficient roughness of high-water channel (0.050)
B_1	:	Low-water channel width (m)
B_2	:	Hig-water channel width (Total-B_1)/2 (m)
B_L	:	Bottom width of low-water channel (m)
H_L	:	Low-water channel depth (m)
KM	:	Bank slope of low-water channel (m)
L	:	Distance between sections (m)
D.L	:	Elevation of river bed (m.SHVP)
h	:	Water level at downstream section (m.SHVP)
Q	:	Design discharge (m^3/s)
H	:	Estimated water level (m.SHVP)
A	:	Flow area (m^2)
R	:	Hydraulic mean water depth (m)

Table **4.4.3** ESTIMATED WATER LEVEL BY NON UNIFORM FLOW (2/5)

Widas river

SECTION	H	Q	A	R	N	D
W 0.0	37.590	270.0	324.064	3.755	30.637	1.464
W 0.3	37.605	270.0	276.088	3.232	31.064	1.708
W 0.7	37.654	270.0	199.895	3.270	30.676	1.554
W 1.1	37.827	270.0	258.376	3.382	32.756	1.661
W 1.1+400	37.928	240.0	243.732	3.221	32.754	1.649
W 1.1+900	38.033	240.0	223.604	3.086	32.083	1.653
W 1.1+1400	38.162	240.0	210.313	3.078	31.635	1.616
W 1.1+1900	38.307	240.0	209.886	3.076	31.627	1.615
W 1.1+2400	38.450	240.0	196.013	3.107	31.175	1.554
W 5.1	38.597	240.0	198.536	3.100	31.010	1.523
W 5.5	38.725	240.0	204.956	3.098	31.436	1.592
W 5.5+400	38.853	240.0	225.770	3.080	32.135	1.663
W 6.7	38.959	570.0	528.075	2.912	32.732	1.938
W 7.5	39.219	570.0	493.676	2.984	32.055	1.875
W 7.9	39.352	570.0	479.371	3.063	31.723	1.828
W 8.3	39.464	570.0	383.603	3.528	30.412	1.466
W 8.7	39.644	570.0	452.267	3.172	31.253	1.741
W 9.1	39.799	570.0	464.533	3.071	31.263	1.824
W 9.1+300	39.896	570.0	450.026	3.215	31.185	1.722
W 10.7	40.168	570.0	571.891	2.882	32.770	2.076
W 10.7+300	40.238	570.0	520.208	3.062	32.237	1.895
W 11.5	40.308	570.0	523.426	3.048	32.271	1.907
W 11.9	40.400	570.0	565.605	2.879	32.709	2.067
W 12.3+250	40.579	570.0	525.392	2.887	32.217	2.003
W 12.3+750	40.727	570.0	521.856	2.883	32.183	1.998
W 12.3+1250	40.877	570.0	518.910	2.881	32.153	1.994
W 15.1	40.969	570.0	523.312	2.847	32.198	2.021
W 15.5	41.081	570.0	494.080	2.983	31.685	1.916
W 15.5+500	41.242	570.0	513.046	2.866	32.095	1.991
W 15.5+1000	41.389	570.0	462.270	2.979	31.370	1.851
W 15.5+1900	41.702	570.0	466.802	2.986	31.403	1.859
W 19.9	41.971	570.0	411.147	3.457	30.952	1.531
W 20.3	42.024	570.0	365.167	3.779	30.295	1.342
W 20.7	42.249	570.0	338.236	4.000	30.074	1.219
W 21.1	42.440	570.0	443.948	3.328	31.234	1.653
W 21.5	42.569	530.0	435.019	2.902	32.002	1.951
W 21.9	42.713	530.0	379.236	3.187	31.341	1.685
W 22.3	42.887	530.0	413.304	3.091	31.942	1.789
W 22.7	43.005	530.0	379.992	3.132	31.357	1.709
W 23.1	43.159	530.0	372.781	3.178	31.270	1.672
W 23.5	43.307	530.0	370.296	3.175	31.243	1.667
W 23.9	43.504	530.0	383.752	3.180	31.528	1.687
W 24.3	43.723	530.0	366.792	3.210	31.242	1.640
W 25.1	44.002	530.0	362.654	3.242	31.190	1.617
W 25.5	44.196	530.0	366.160	3.141	31.157	1.674
W 25.9	44.325	530.0	355.244	3.200	30.991	1.624
W 26.1	44.457	530.0	417.268	2.851	31.797	1.936
W 26.1+900	44.870	370.0	191.210	3.184	30.379	1.360
W 26.1+1400	45.200	640.0	292.640	3.855	30.151	1.207
W 29.6	45.630	640.0	298.052	3.880	30.179	1.216
W 29.6+650	46.077	640.0	300.443	3.908	30.181	1.217

Table 4.4.3 ESTIMATED WATER LEVEL BY NON UNIFORM FLOW (3/5)

Widas river

SECTION	H	Q	A	R	N	D
W 30.6	46.344	640.0	298.753	3.940	30.149	1.206
W 31.1	46.680	640.0	301.487	3.952	30.162	1.211
W 33.1-800	47.267	640.0	313.649	3.903	30.306	1.253
W 33.1-300	47.595	640.0	401.346	4.617	30.612	1.315
W 33.1	47.640	640.0	315.502	3.765	30.462	1.286
W 33.4+400	48.106	590.0	256.082	3.696	30.126	1.210
W 35.1	48.567	590.0	267.494	3.670	30.279	1.268
W 35.6	48.958	590.0	259.252	3.725	30.150	1.230
W 36.1	49.369	590.0	270.159	3.664	30.270	1.280
W 37.1	49.952	590.0	245.401	3.983	30.002	1.109
W 37.6	50.371	590.0	250.572	3.989	30.000	1.100
W 38.6	50.915	590.0	268.968	3.812	30.166	1.226
W 39.6	51.655	590.0	262.678	3.848	30.100	1.198
W 40.1	51.881	590.0	260.650	3.854	30.088	1.189
W 40.6	52.155	440.0	151.960	3.525	30.000	1.100

Flood diversion channel and upper Ulo river

SECTION	H	Q	A	R	N	D
COC 0	52.000	230.0	112.750	3.306	30.000	1.100
COC 0+300	52.226	230.0	111.949	3.293	30.000	1.100
COC 1.0	52.774	230.0	113.914	3.238	30.000	1.100
COC 1.5	53.162	230.0	116.391	3.190	30.000	1.100
COC 2.0	53.542	230.0	101.251	3.010	30.000	1.116
COC 2.5	54.063	230.0	106.268	3.059	30.000	1.160
U 16.0	54.692	220.0	103.752	2.863	30.371	1.256
U 16.5	55.199	220.0	98.432	2.974	30.101	1.184
U 17.0	55.741	220.0	95.662	2.828	30.138	1.203
U 17.5	56.338	220.0	95.070	2.900	30.097	1.175
U 18.0	56.921	220.0	97.533	2.892	30.152	1.199
U 18.5	57.612	190.0	58.164	2.528	30.000	1.100
U 19.0	58.953	190.0	63.934	2.418	30.465	1.302
U 19.5	60.249	190.0	60.586	2.368	30.352	1.276
U 20.0	61.720	190.0	56.984	2.499	30.000	1.100

Table 4.4.3 ESTIMATED WATER LEVEL BY NON UNIFORM FLOW (4/5)

Kedungsoko river Q = 200 (design discharge)
H = 43.5 (water level estimated as uniform flow)

SECTION	H	Q	A	R	N	D
K 0.0	43.500	200.0	246.000	2.765	31.720	1.596
K 0.5	43.586	200.0	234.889	2.710	31.540	1.578
K 1.0	43.680	200.0	209.318	2.791	31.133	1.484
K 1.0+500	43.791	200.0	188.025	2.954	30.654	1.335
K 2.0	43.854	200.0	184.994	2.948	30.553	1.305
K 2.5	43.983	200.0	181.541	2.905	30.569	1.321
K 3.0	44.122	200.0	179.070	2.884	30.444	1.280
K 3.0+250	44.189	200.0	174.213	2.881	30.459	1.294
K 3.5	44.232	200.0	170.688	2.926	30.380	1.262
K 3.5+500	44.393	200.0	127.650	2.358	30.959	1.520
K 3.5+1000	44.729	470.0	251.535	3.115	30.447	1.235
K 3.5+1500	45.081	470.0	260.191	3.190	30.502	1.242
K 5.5	45.370	460.0	258.711	3.199	30.630	1.271
K 6.0	45.683	460.0	264.675	3.249	30.673	1.275
K 6.5	45.978	460.0	267.945	3.277	30.696	1.278
K 7.0	46.263	460.0	270.298	3.296	30.713	1.280
K 7.5	46.540	460.0	270.439	3.340	30.677	1.269
K 8.0	46.814	460.0	277.819	3.326	30.838	1.291
K 8.5	47.077	460.0	278.057	3.328	30.840	1.291
K 9.0	47.337	460.0	275.015	3.370	30.754	1.273
K 9.5	47.599	460.0	275.178	3.372	30.755	1.273
K 10.0	47.860	460.0	275.301	3.373	30.756	1.273

Kedungsoko river Q = 160 (inflow at design condition)
H = 44.5 (DHWL)

SECTION	H	Q	A	R	N	D
K 0.0	44.500	160.0	367.000	3.478	33.339	1.669
K 0.5	44.520	160.0	347.338	3.355	33.118	1.666
K 1.0	44.541	160.0	299.760	3.368	32.437	1.587
K 1.0+500	44.569	160.0	253.824	3.501	31.462	1.422
K 2.0	44.586	160.0	245.335	3.470	31.252	1.387
K 2.5	44.626	160.0	235.565	3.343	31.253	1.405
K 3.0	44.671	160.0	223.937	3.266	30.958	1.351
K 3.0+250	44.694	160.0	215.398	3.216	30.975	1.368
K 3.5	44.709	160.0	207.122	3.256	30.793	1.325
K 3.5+500	44.769	160.0	159.510	2.536	31.812	1.637
K 3.5+1000	44.896	376.0	267.243	3.250	30.546	1.247
K 3.5+1500	45.089	376.0	260.912	3.196	30.506	1.243
K 5.5	45.273	368.0	249.574	3.123	30.563	1.263
K 6.0	45.496	368.0	247.032	3.101	30.545	1.260
K 6.5	45.725	368.0	244.163	3.078	30.524	1.258
K 7.0	45.962	368.0	241.985	3.060	30.507	1.256
K 7.5	46.204	368.0	239.457	3.072	30.464	1.244
K 8.0	46.450	368.0	243.396	3.034	30.587	1.265
K 8.5	46.694	368.0	241.857	3.021	30.575	1.264
K 9.0	46.941	368.0	238.715	3.048	30.508	1.246
K 9.5	47.191	368.0	237.827	3.040	30.502	1.245
K 10.0	47.444	368.0	237.170	3.084	30.497	1.245

Table **4.4.3** ESTIMATED WATER LEVEL BY NON UNIFORM FLOW (5/5)

Kuncir river

SECTION	H	Q	A	R	N	D
KC 0.0	45.470	95.0	73.460	2.756	31.032	1.430
KC 0.5	45.710	95.0	58.719	2.272	31.321	1.509
KC 1.0	46.132	95.0	72.690	2.319	32.646	1.638
KC 1.5	46.432	95.0	68.875	2.292	32.387	1.607
KC 2.0	46.763	95.0	65.515	2.317	32.085	1.558
KC 2.5	47.118	95.0	67.630	2.269	32.321	1.603
KC 3.0	47.465	95.0	67.150	2.260	32.295	1.601
KC 3.5	47.817	95.0	64.277	2.293	32.021	1.553
KC 4.0	48.190	95.0	69.203	2.216	32.521	1.644
KC 4.5	48.536	95.0	68.677	2.206	32.492	1.642
KC 5.0	48.889	95.0	68.390	2.201	32.476	1.641
KC 5.5	49.245	95.0	66.770	2.212	32.332	1.618
KC 6.0	49.609	95.0	63.674	2.281	31.989	1.550
KC 6.5	49.960	95.0	88.144	3.343	30.090	1.143
KC 7.0	50.271	95.0	39.539	1.837	30.413	1.366
KC 7.0+200	50.764	95.0	46.225	1.924	30.848	1.459
KC 7.0+700	51.579	95.0	48.746	1.980	31.002	1.476
KC 7.0+1200	52.310	95.0	49.698	1.966	31.084	1.501
KC 9.5	53.102	95.0	49.387	1.962	31.063	1.497
KC 10.0	53.828	95.0	48.186	1.999	30.946	1.456
KC 10.5	54.473	95.0	70.252	3.128	30.023	1.117
KC 11.0	54.893	95.0	36.805	1.986	30.000	1.100

Table 4.4.4 LOCATION OF BANK PROTECTION WORKS

River	Location	Left Bank or Right Bank	Length (m)	Area (m^2)
Lower Widas river	Reach I	R	300	2,700
		L	600	5,400
	Reach II	R	1,000	9,000
		R	1,000	9,000
		L	900	8,100
	Reach III	R	500	4,500
		R	800	7,200
	Reach IV	R	900	8,100
		R	1,200	10,800
		L	600	5,400
		L	1,700	15,200
	Sub-total		9,500	85,400
Upper Widas river	Reach VI	R	500	4,500
	Reach VII	R	700	6,300
		L	700	6,300
	Reach VIII	L	300	2,700
	Sub-total		2,200	19,800
Diversion Channel + Upper Ulo	Diversion C (Reach I)	R	2,900	26,000
		L	500	4,500
	Sub-total		3,400	30,500
	Reach II	R	2,500	18,000
		L	500	3,600
	Reach III	R	500	3,600
		L	300	2,000
	Upper Ulo	–	500	3,600
	Sub-total		4,300	30,800
Kedungsoko river	Reach I	R	300	2,160
		R	600	4,320
		R	150	1,080
		L	150	1,080
	Reach II III IV	–	500	3,560
	Sub-total		1,700	12,200
Kuncir river	Reach I	–	1,000	7,200
	Reach II	R	300	2,160
		L	300	2,160
		L	200	1,440
		L	400	2,840
	Sub-total		2,200	15,800
	Grand-total		23,300	194,500

(20% against total length of both banks)

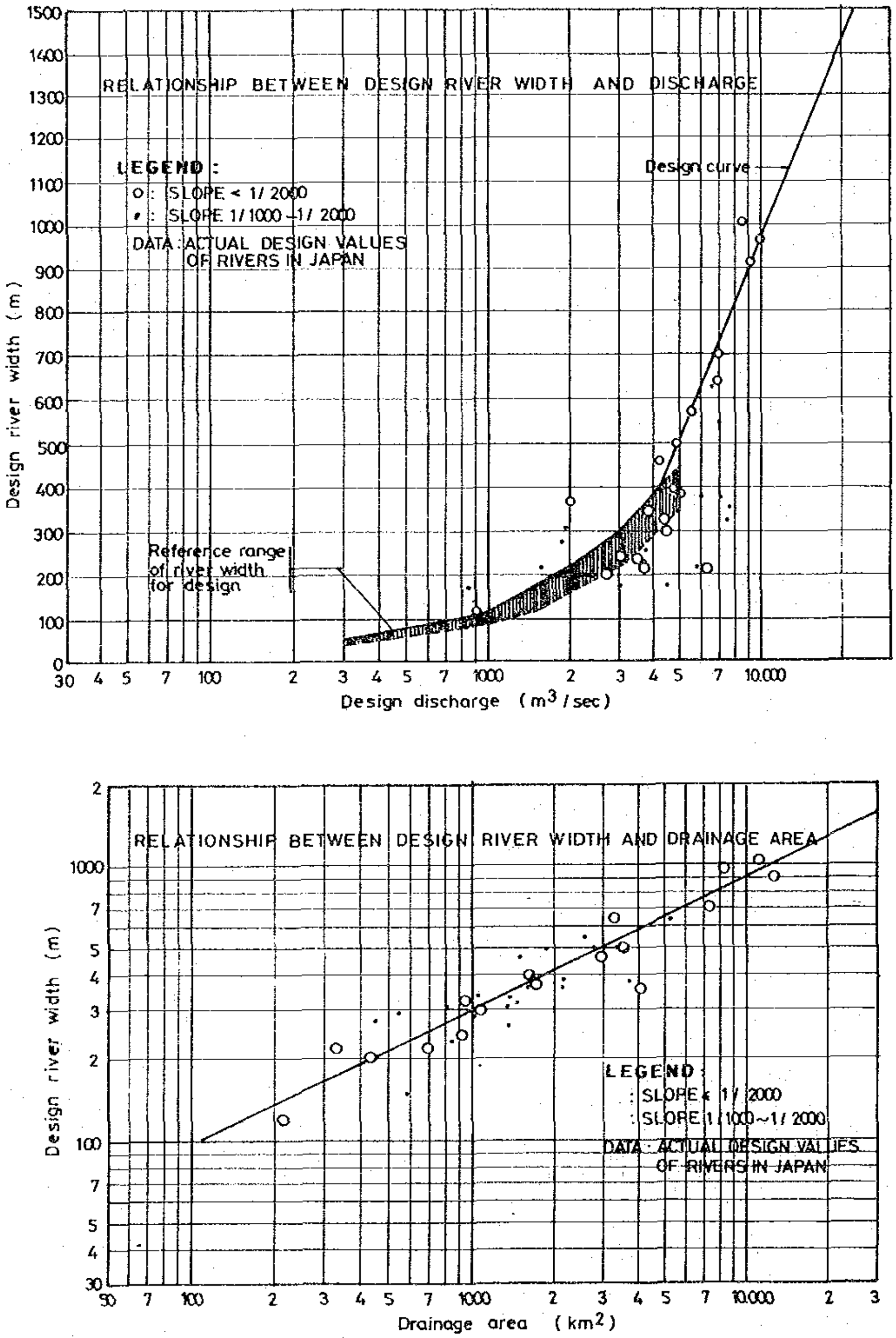


Fig. 4.4.1 DESIGN STANDARD OF RIVER WIDTH

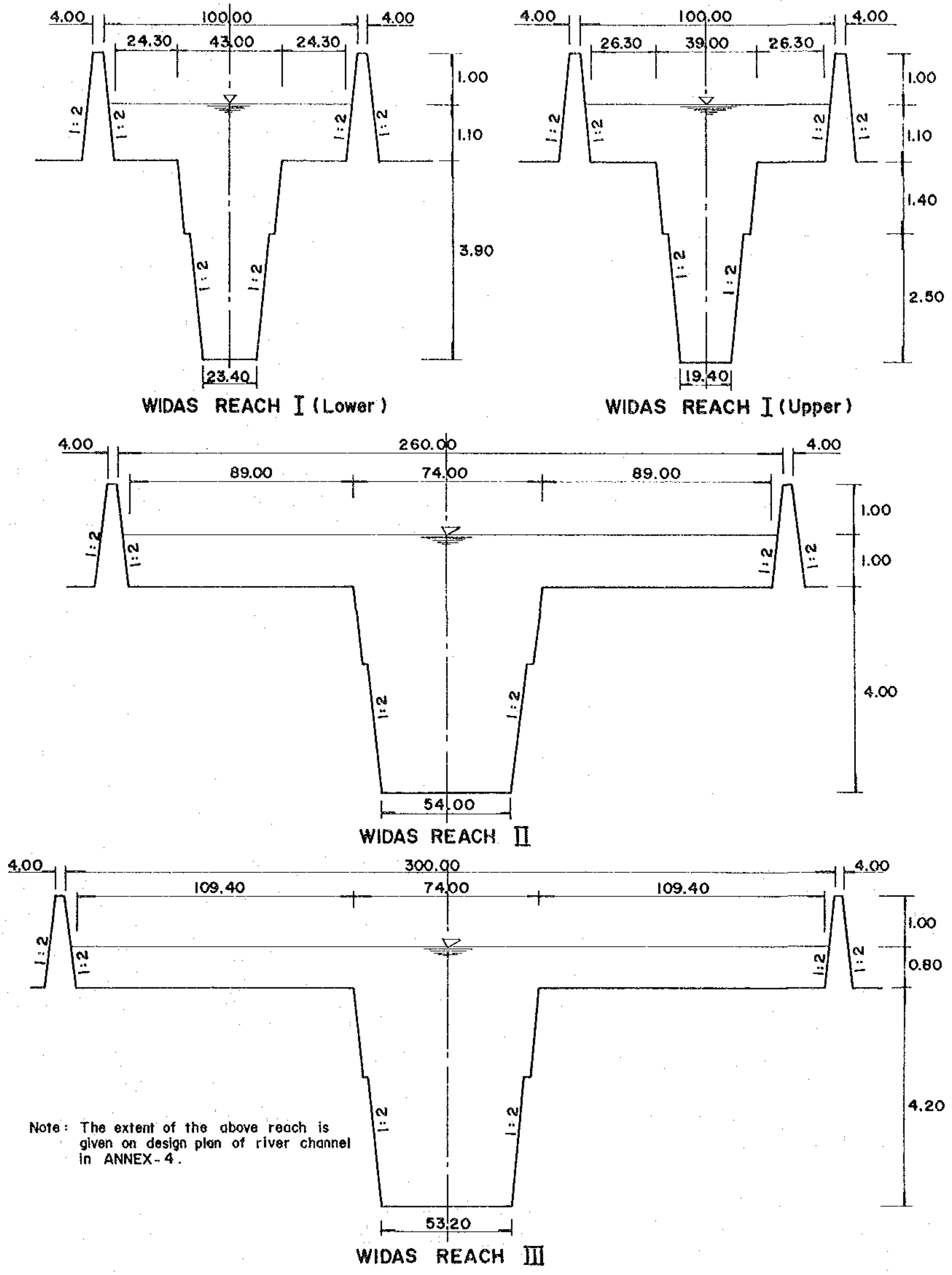


Fig. 4.4.2 TYPICAL RIVER CROSS-SECTIONS FOR COMPREHENSIVE PLAN (1/5)

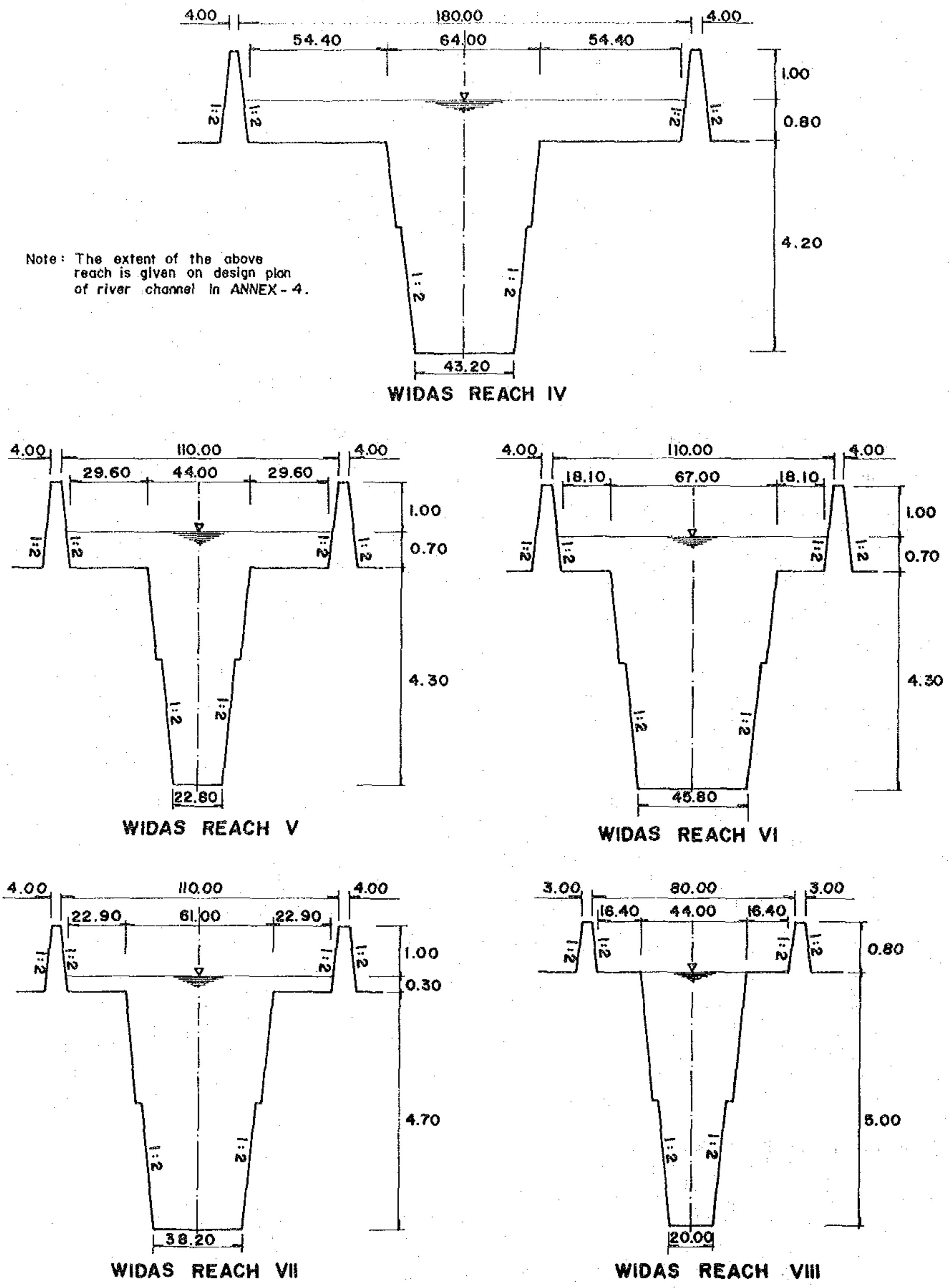


Fig. 4.4.2 TYPICAL RIVER CROSS-SECTIONS FOR COMPREHENSIVE PLAN (2/5)

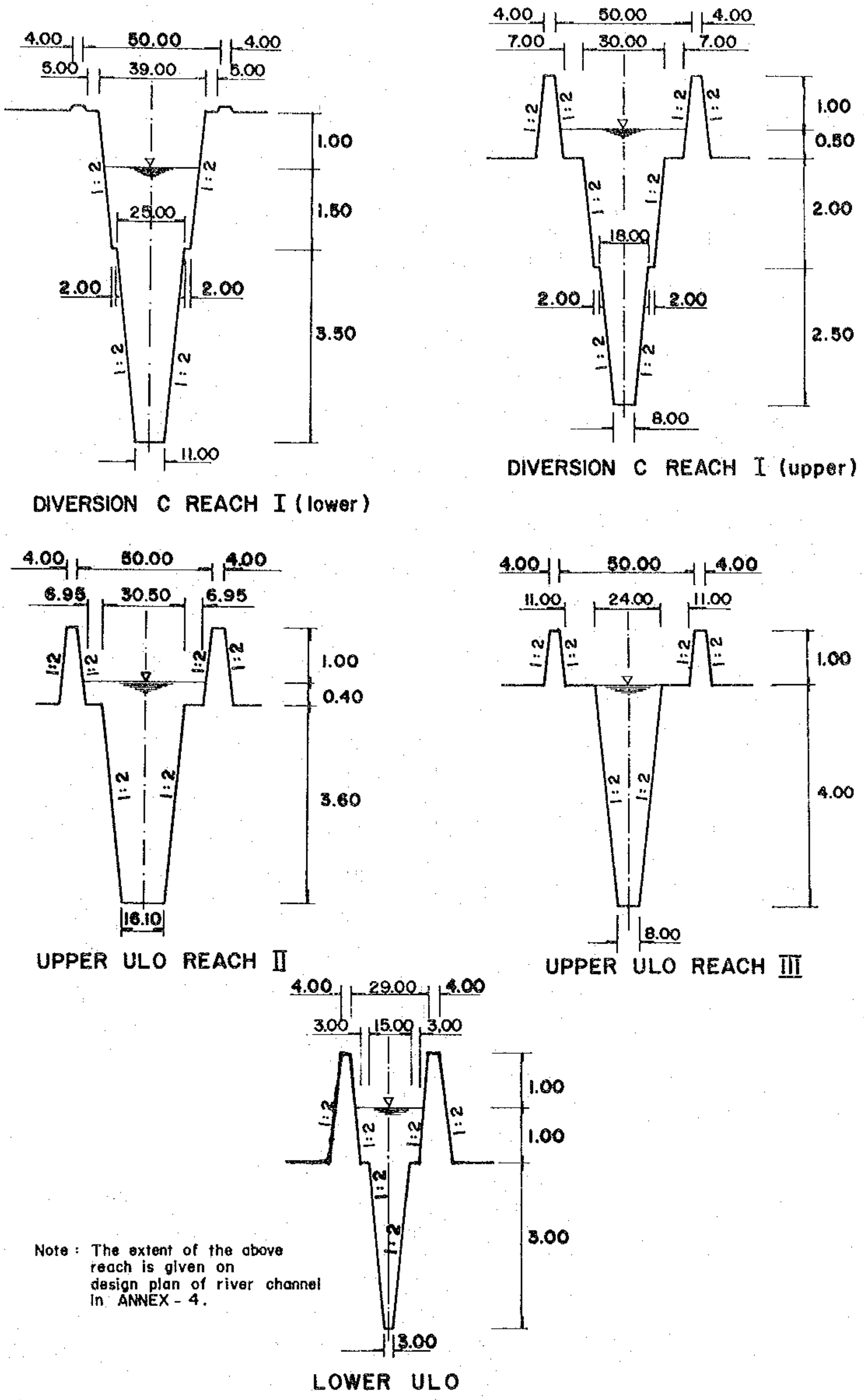
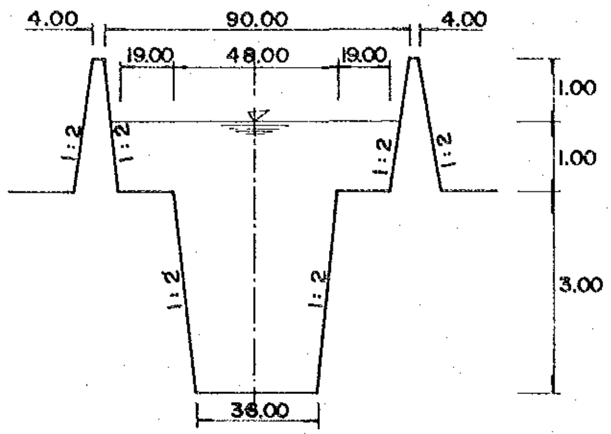
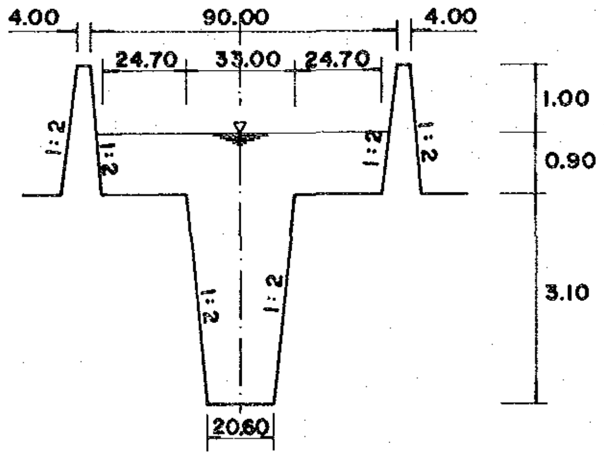


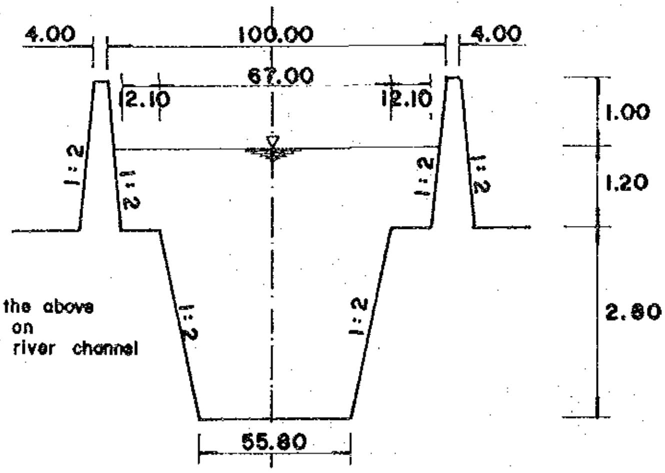
Fig. 4.4.2 TYPICAL RIVER CROSS-SECTIONS FOR COMPREHENSIVE PLAN (3/5)



KD' SOKO REACH I



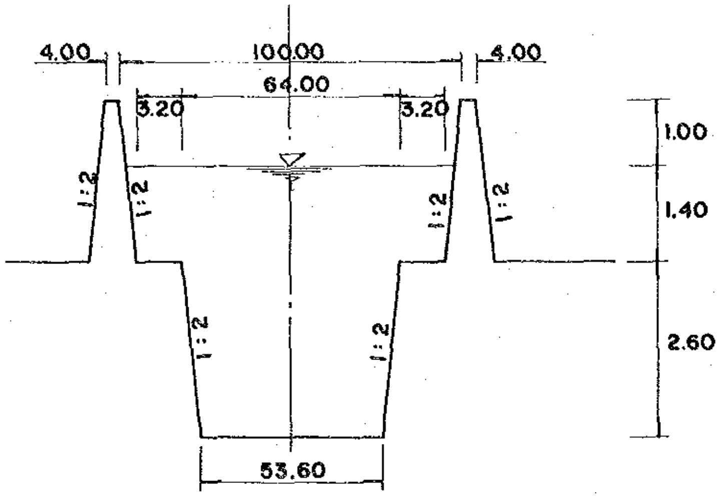
KD' SOKO REACH II



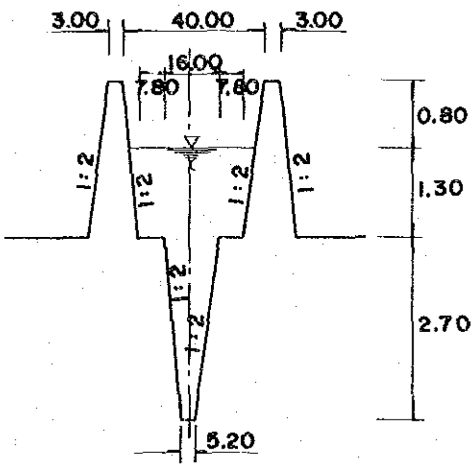
Note : The extent of the above reach is given on design plan of river channel in ANNEX- 4

KD' SOKO REACH III

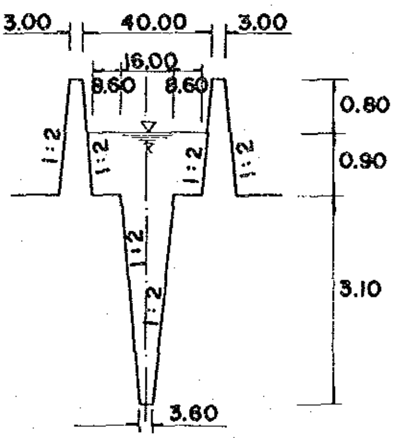
Fig. 4.4.2 TYPICAL RIVER CROSS-SECTIONS FOR COMPREHENSIVE PLAN (4/5)



KD' SOKO REACH IV



KUNCIR REACH I



KUNCIR REACH II

Note : The extent of the above reach is given on design plan of river channel in ANNEX-4

Fig. 4.4.2 TYPICAL RIVER CROSS-SECTIONS FOR COMPREHENSIVE PLAN (5/5)

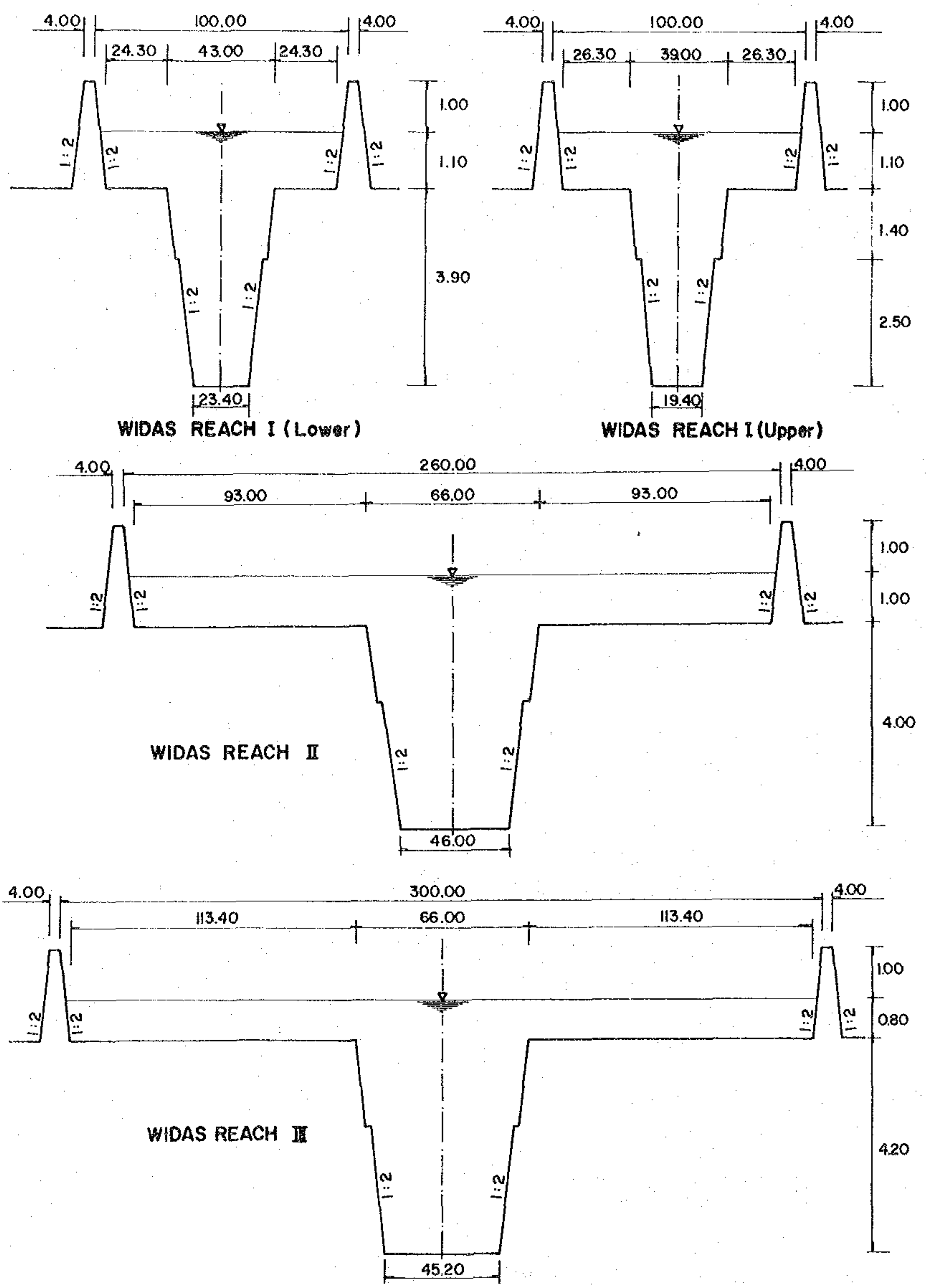


Fig. 4.4.3 TYPICAL RIVER CROSS - SECTIONS FOR FIRST STAGE PLAN (1/6)

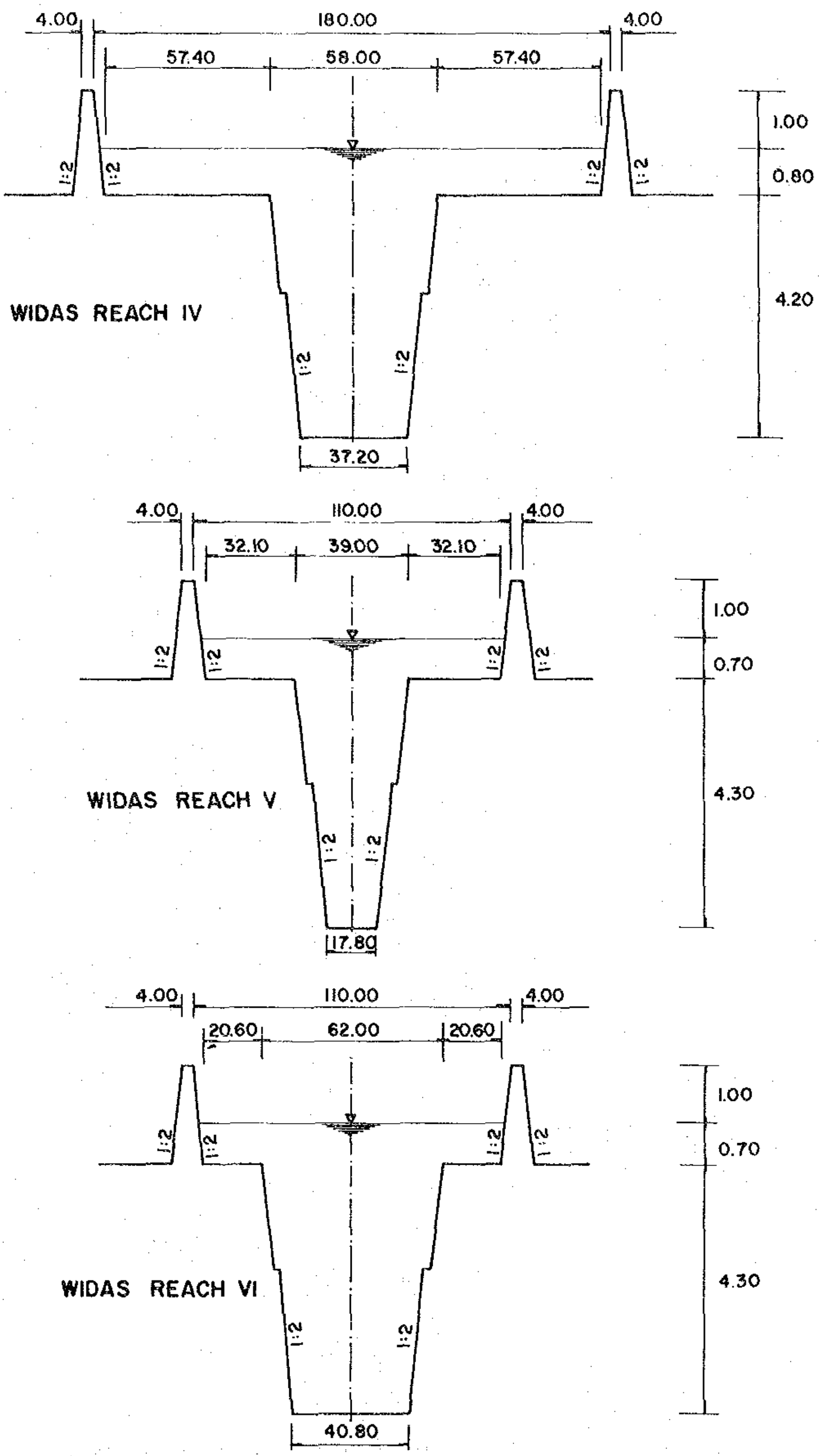
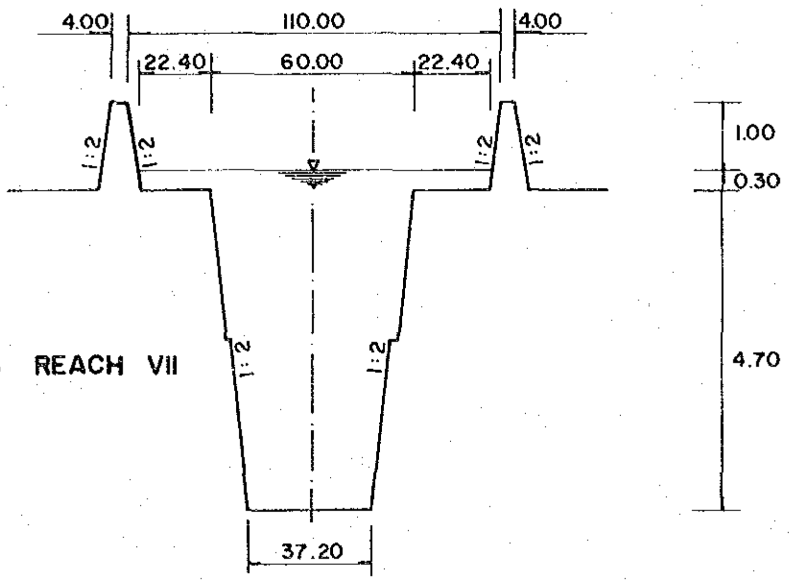
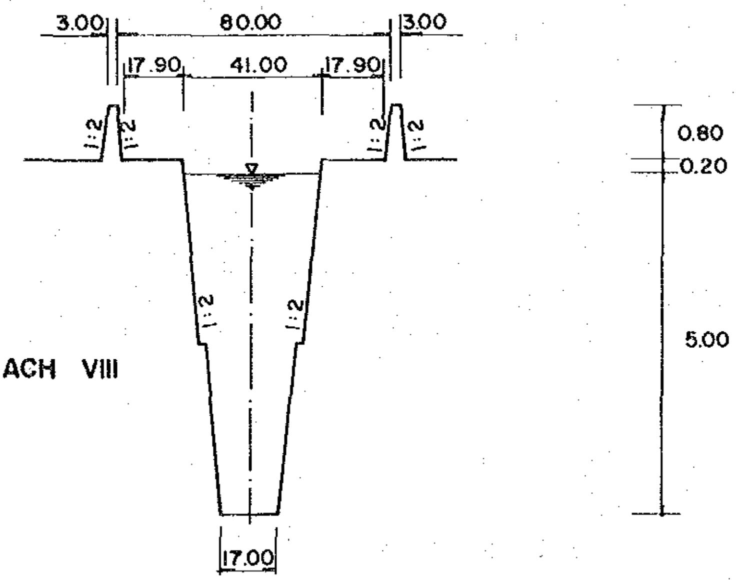


Fig. 4.4.3 TYPICAL RIVER CROSS - SECTIONS FOR FIRST STAGE PLAN (2/6)

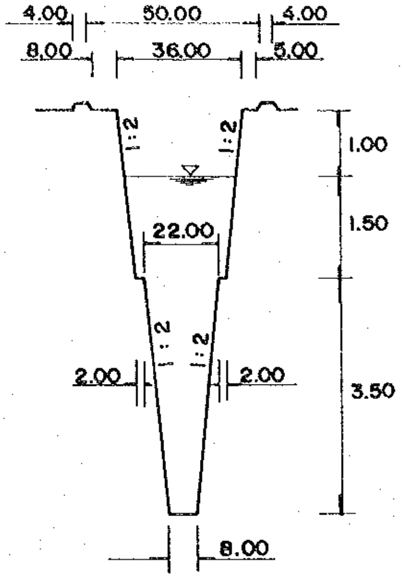


WIDAS REACH VII

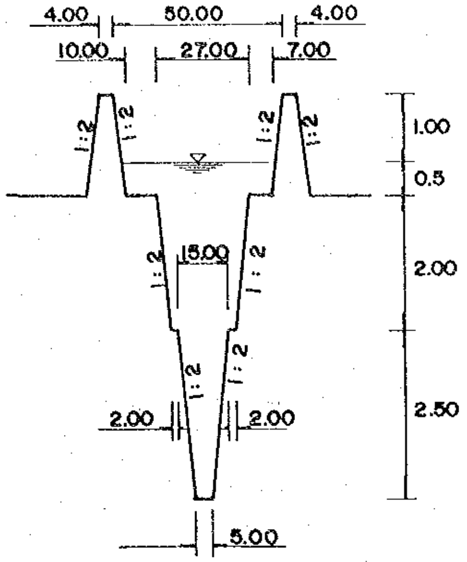


WIDAS REACH VIII

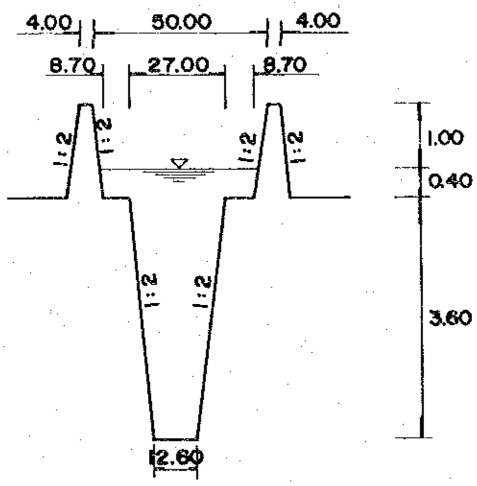
Fig. 4.4.3 TYPICAL RIVER CROSS-SECTIONS FOR FIRST STAGE PLAN (3/6)



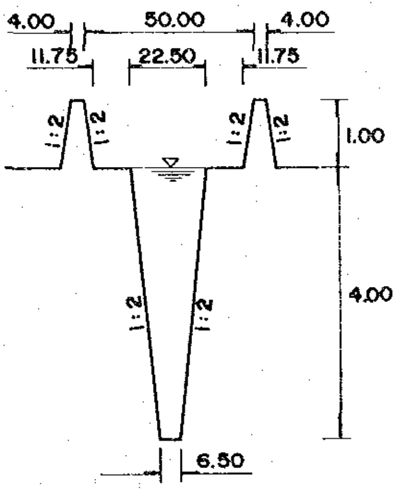
DIVERSION CHANNEL REACH I (lower)



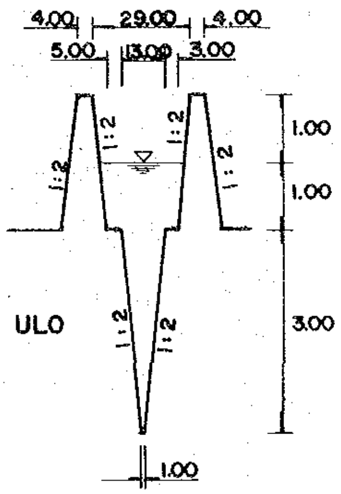
DIVERSION CHANNEL REACH I (upper)



UPPER ULO REACH II



UPPER ULO REACH III



LOWER ULO

Fig. 4.4.3 TYPICAL RIVER CROSS-SECTIONS FOR FIRST STAGE PLAN (4/6)

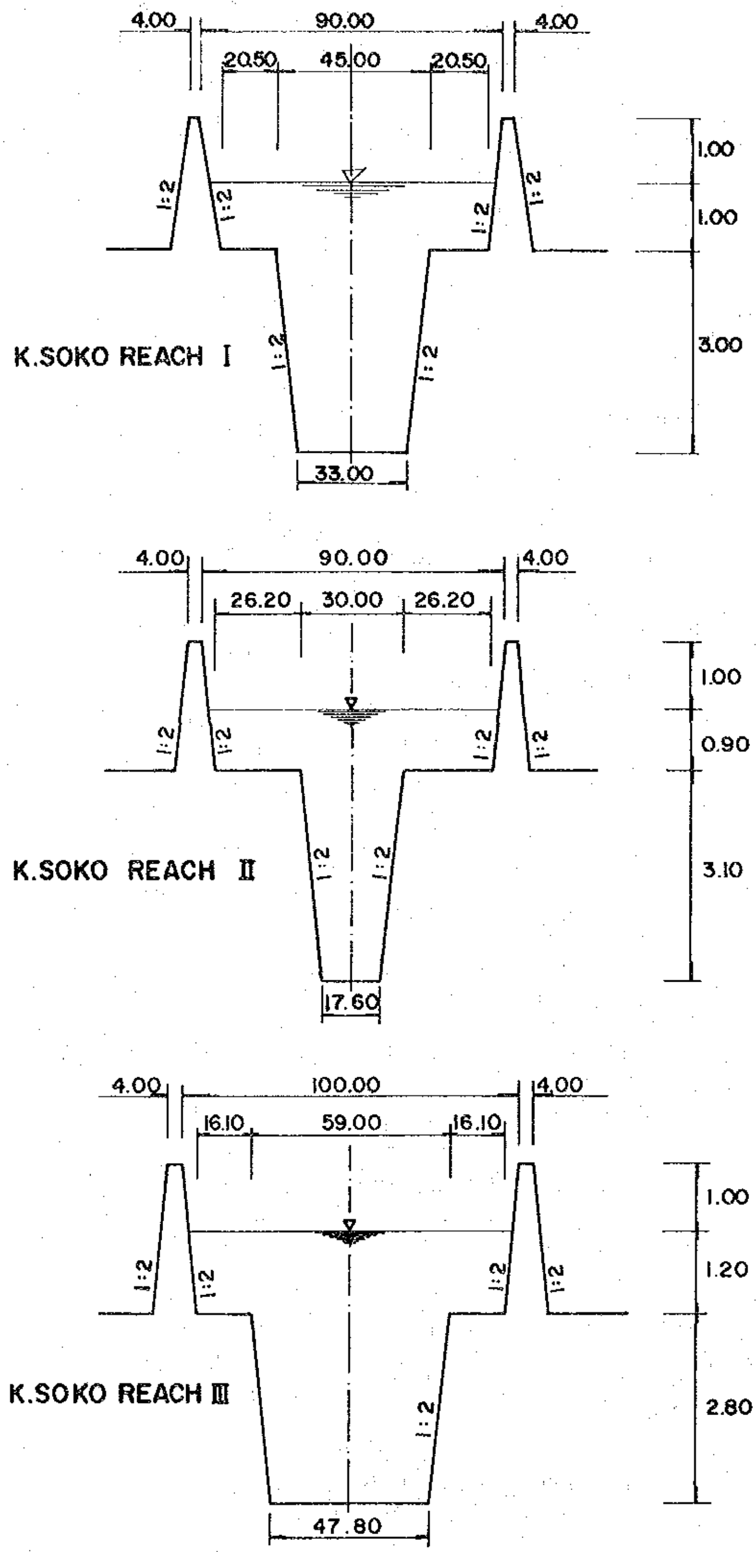


Fig. 4.4.3 TYPICAL RIVER CROSS-SECTIONS FOR FIRST STAGE PLAN (5/6)

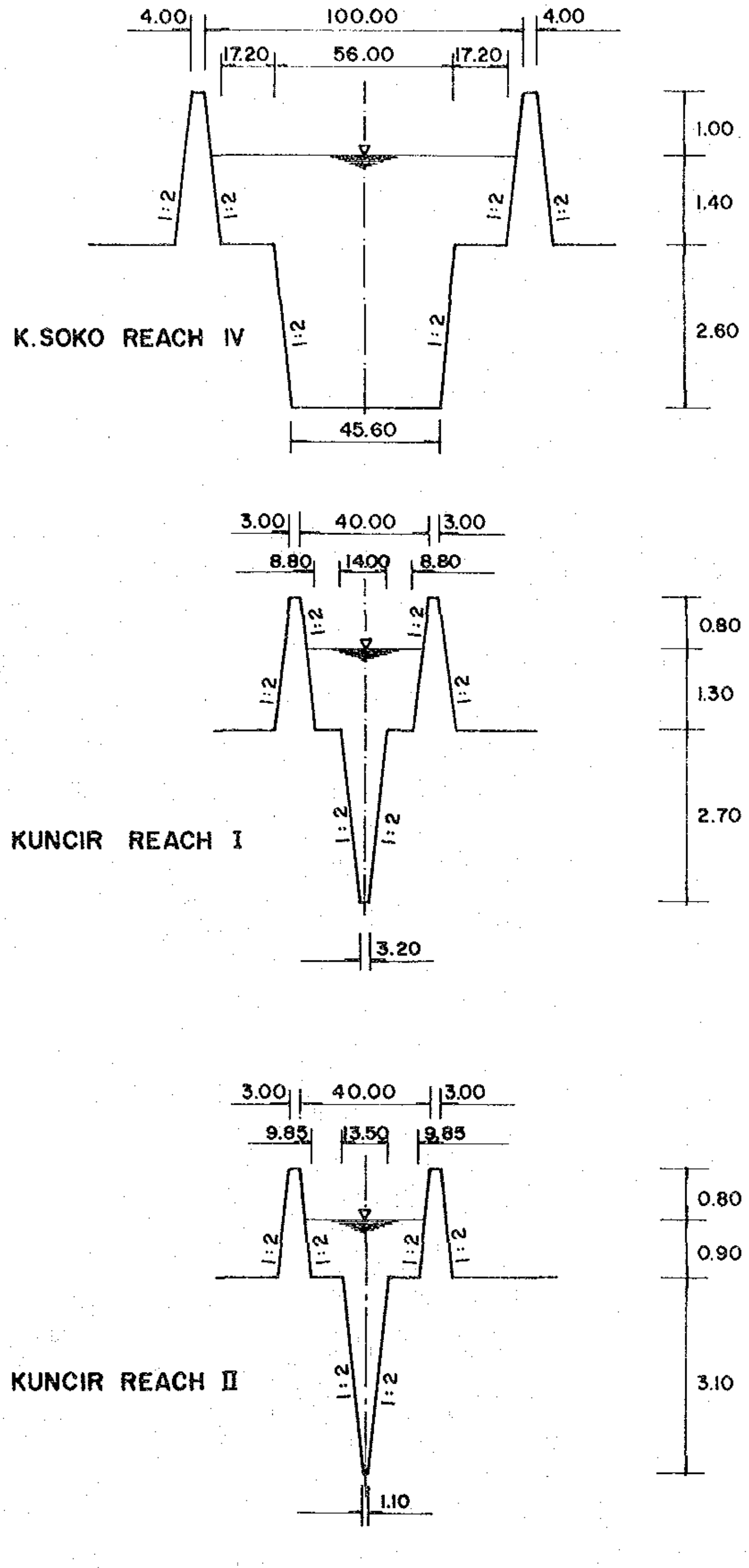
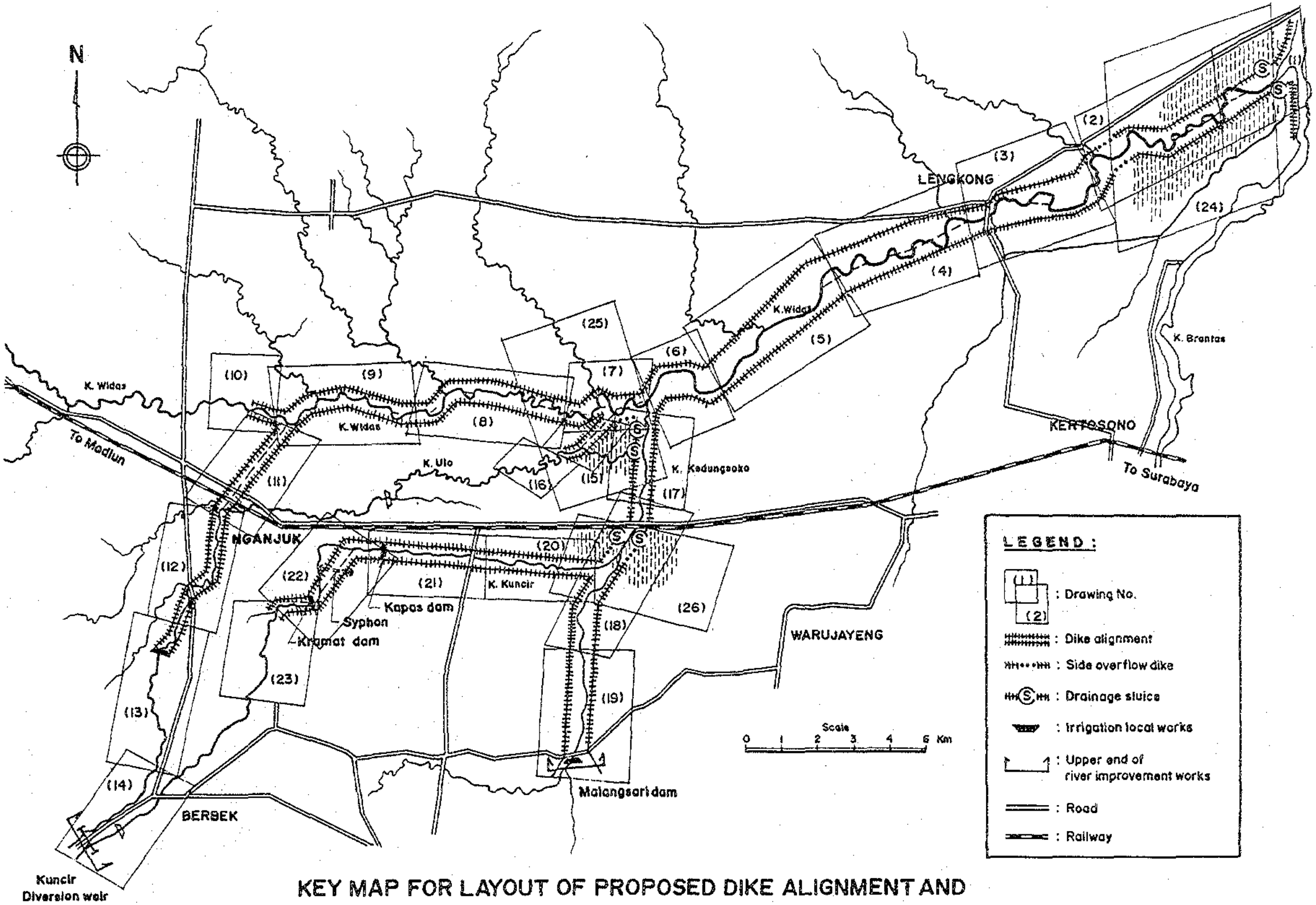
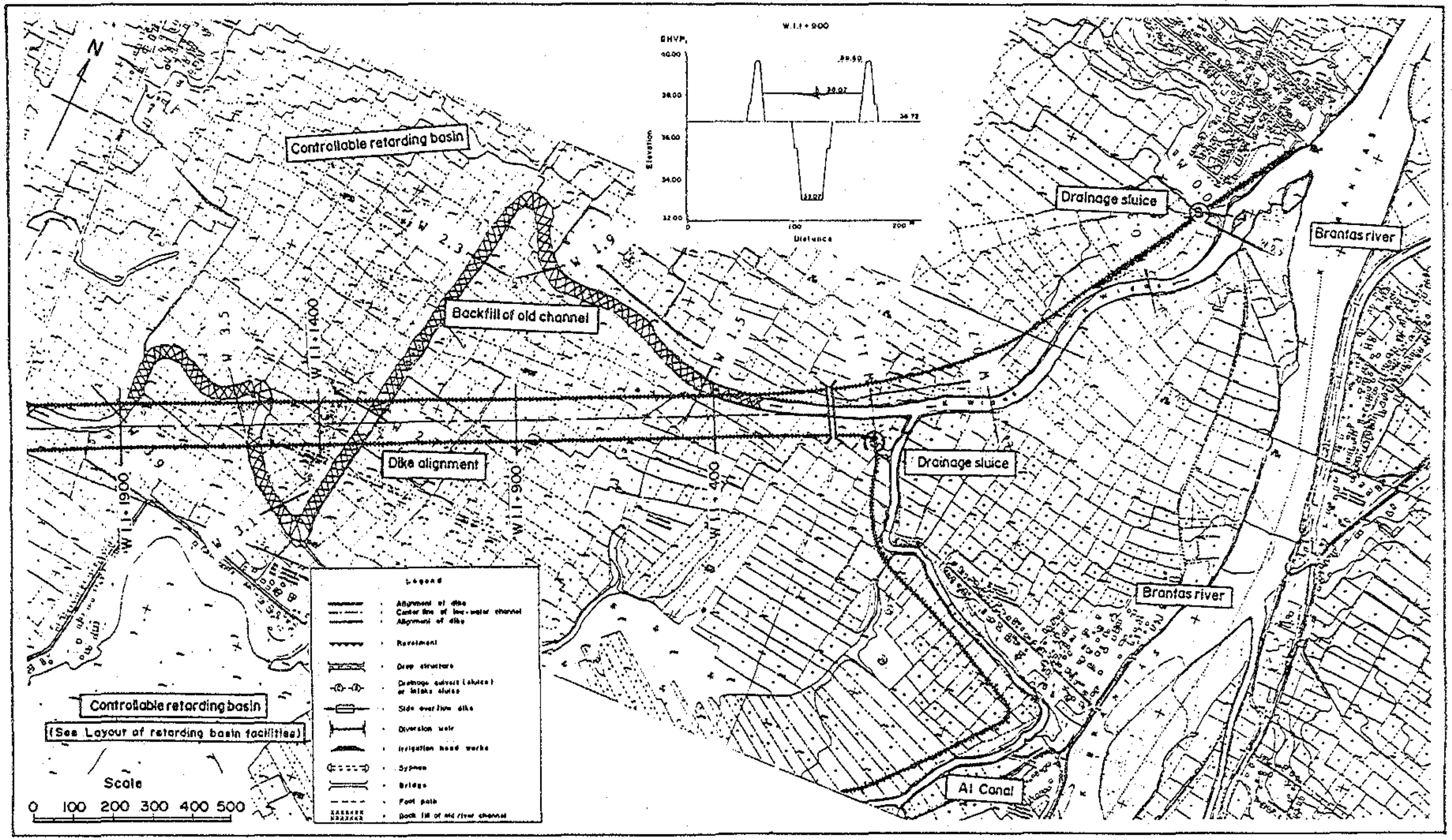


Fig. 4.4.3 TYPICAL RIVER CROSS-SECTIONS FOR FIRST STAGE PLAN (6/6)

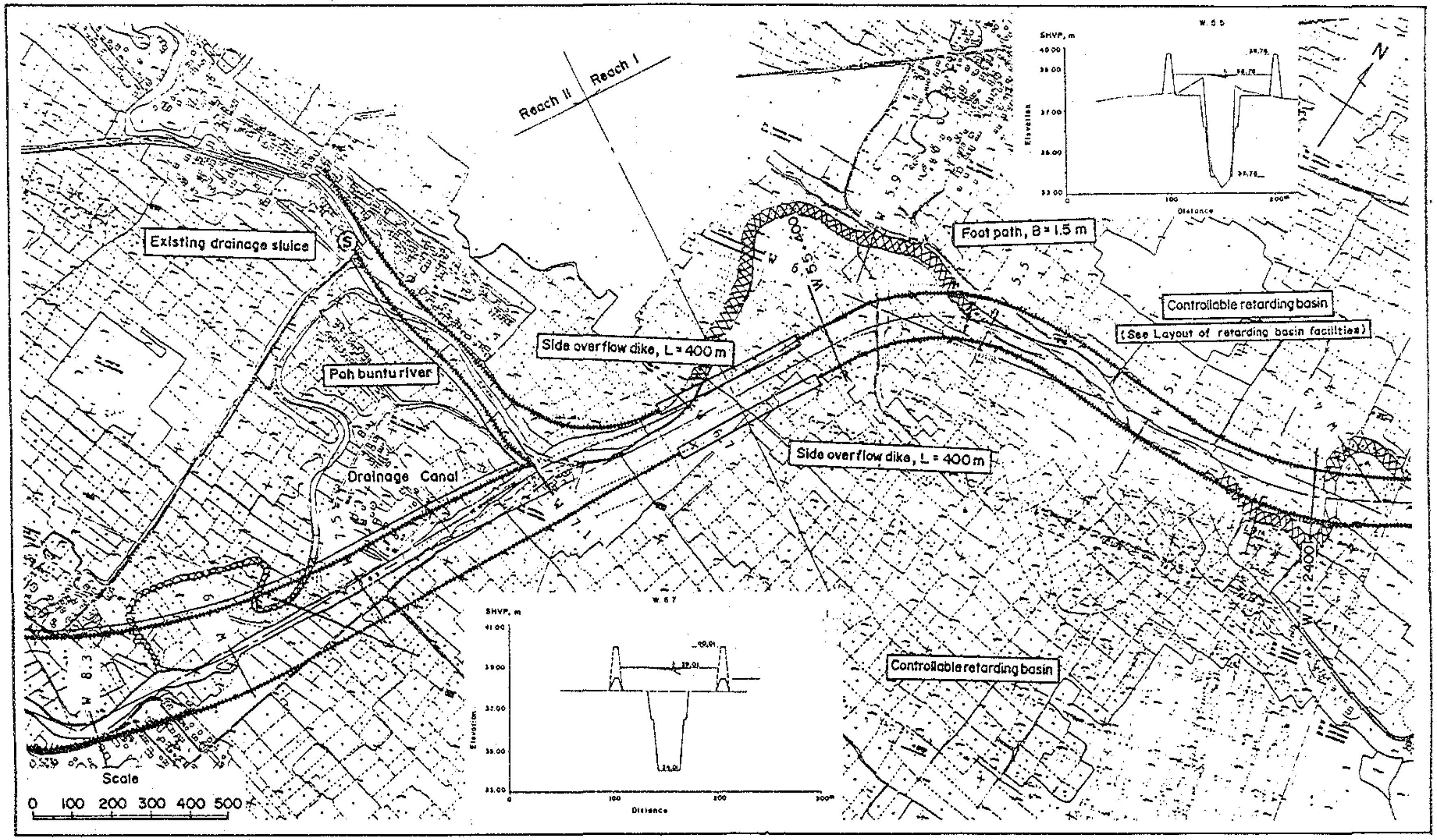


KEY MAP FOR LAYOUT OF PROPOSED DIKE ALIGNMENT AND RELATED RIVER STRUCTURES



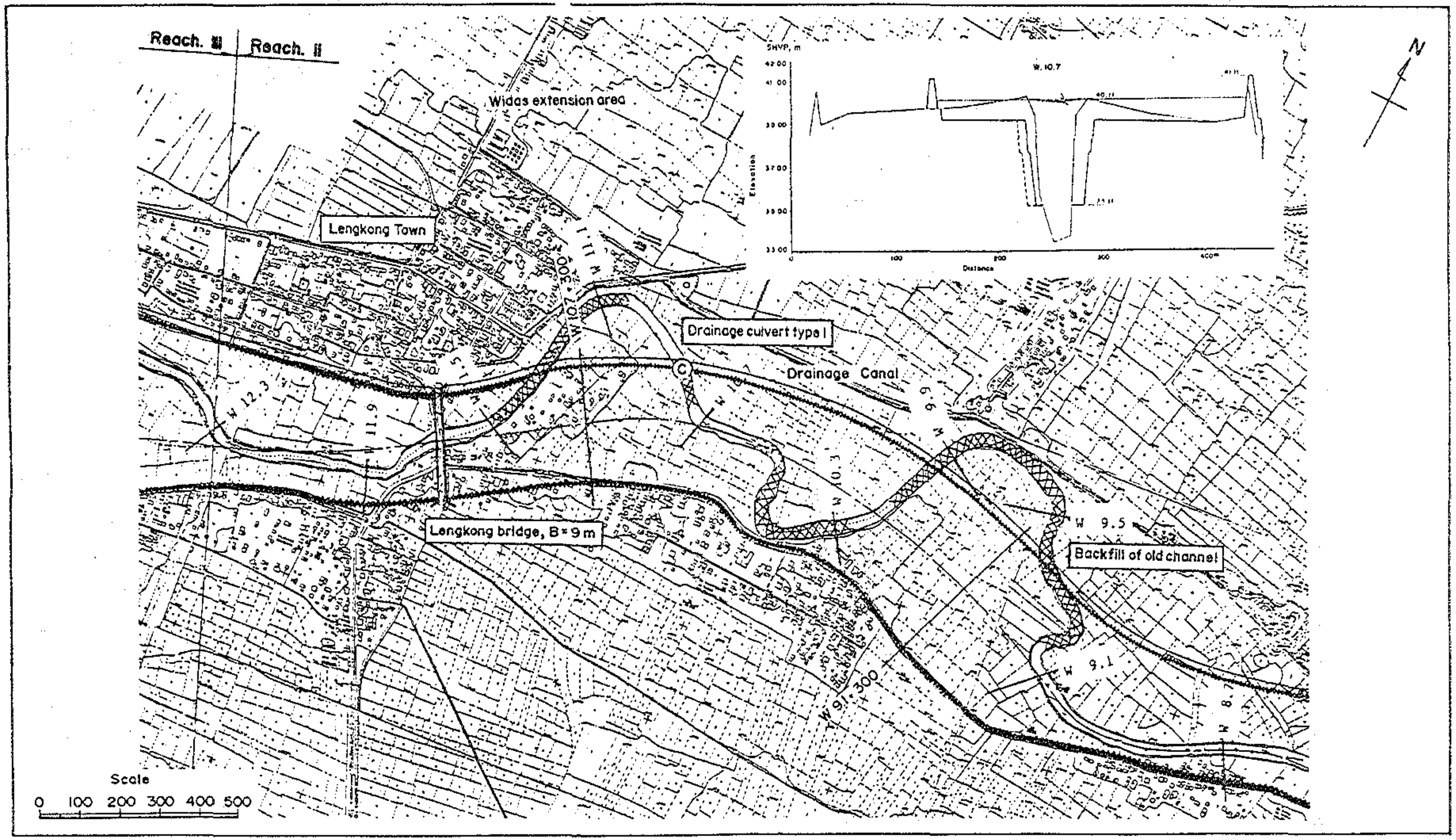
River : LOWER WIDAS

Fig. 4.4.4. LAYOUT OF PROPOSED DIKE ALIGNMENT AND RELATED RIVER STRUCTURES (1/26)



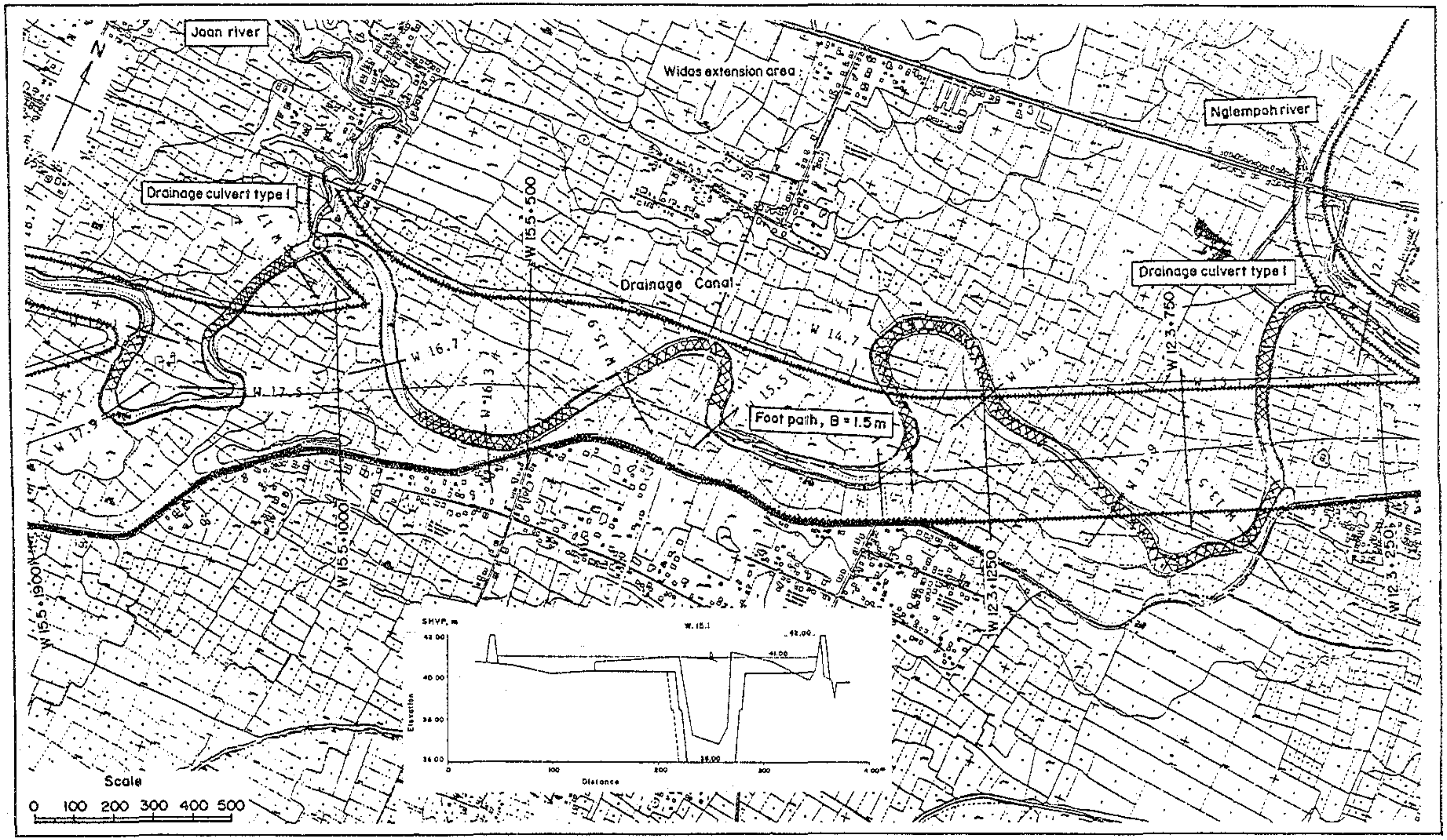
River : LOWER WIDAS

Fig.4.4.4. LAYOUT OF PROPOSED DIKE ALIGNMENT AND RELATED RIVER STRUCTURES (2/26)



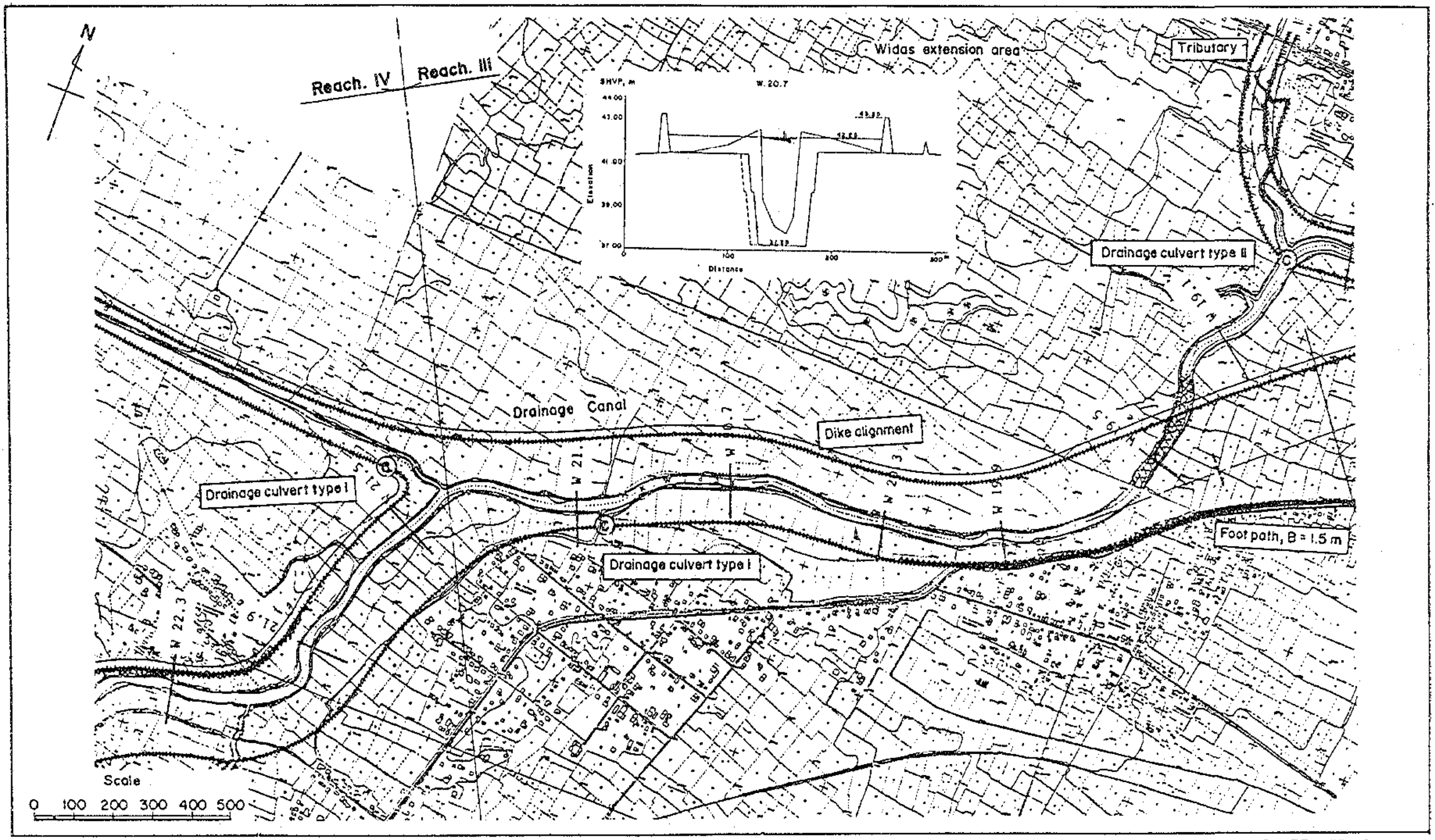
River : LOWER WIDAS

Fig. 4.4.4. LAYOUT OF PROPOSED DIKE ALIGNMENT AND RELATED RIVER STRUCTURES (3/26)



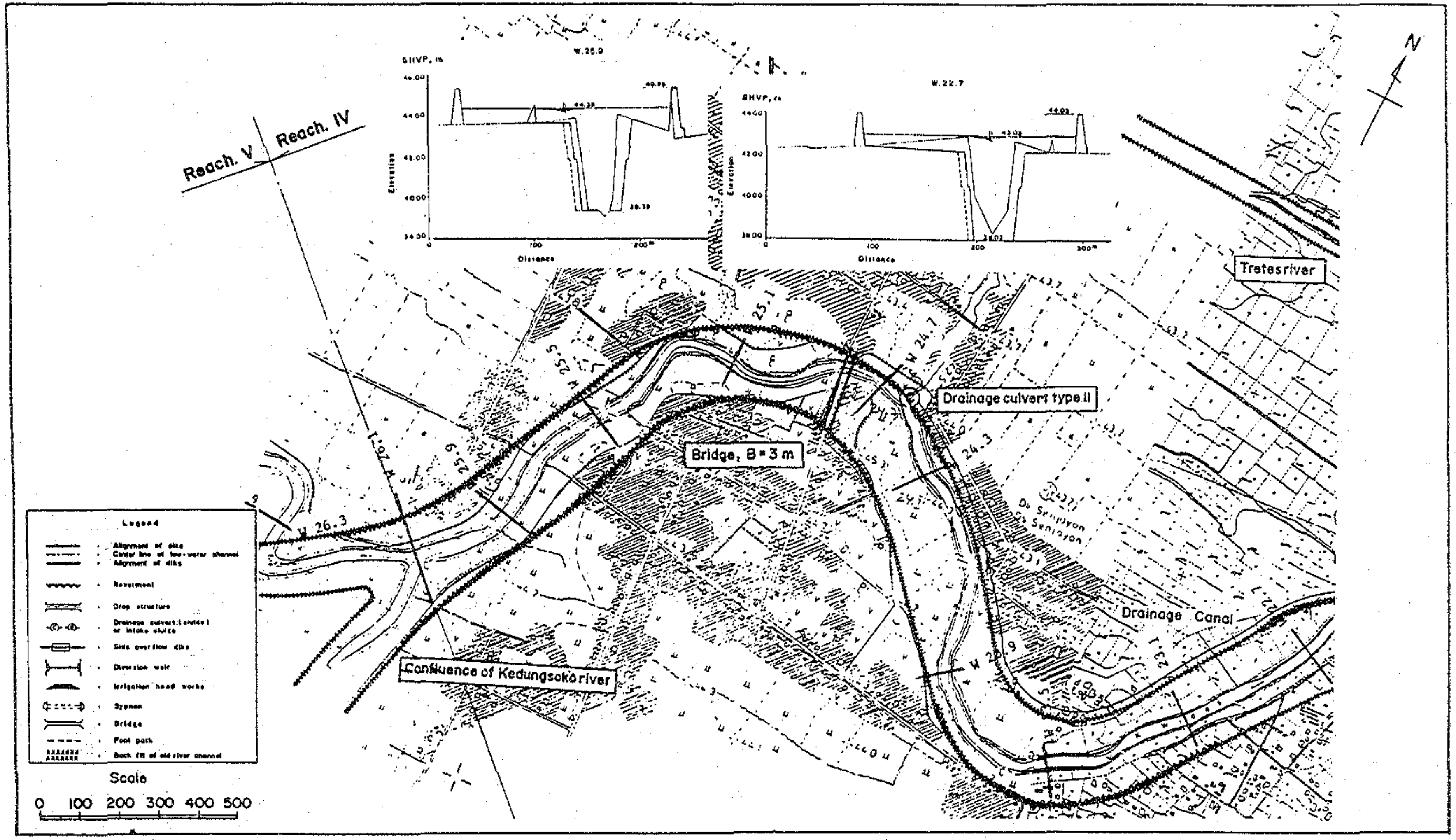
River : LOWER WIDAS

Fig.4.4.4. LAYOUT OF PROPOSED DIKE ALIGNMENT AND RELATED RIVER STRUCTURES (4/26)



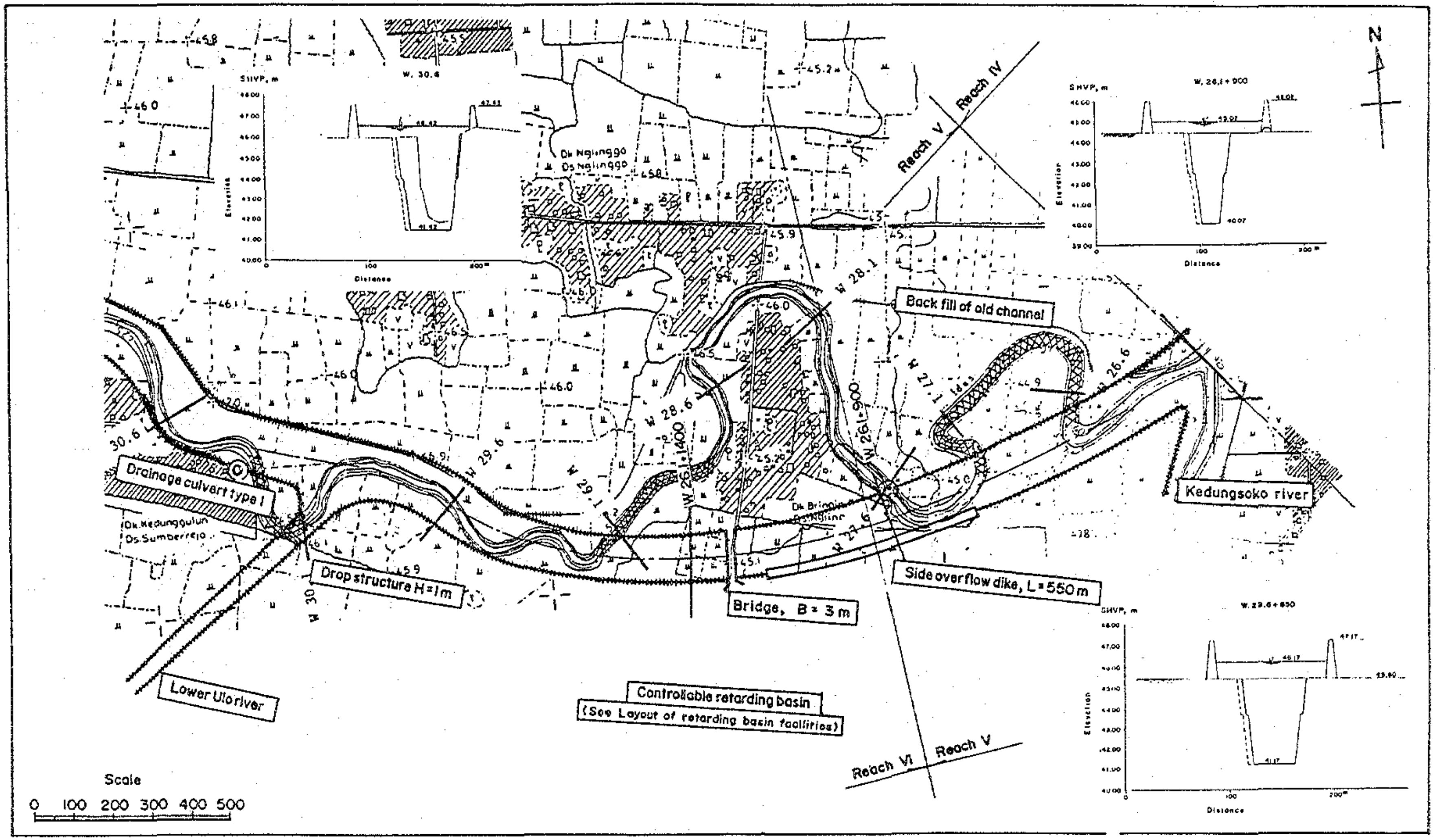
River : LOWER WIDAS

Fig.4.4.4. LAYOUT OF PROPOSED DIKE ALIGNMENT AND RELATED RIVER STRUCTURES (5/26)



River : LOWER WIDAS

Fig.4.4.4. LAYOUT OF PROPOSED DIKE ALIGNMENT AND RELATED RIVER STRUCTURES (6/26)

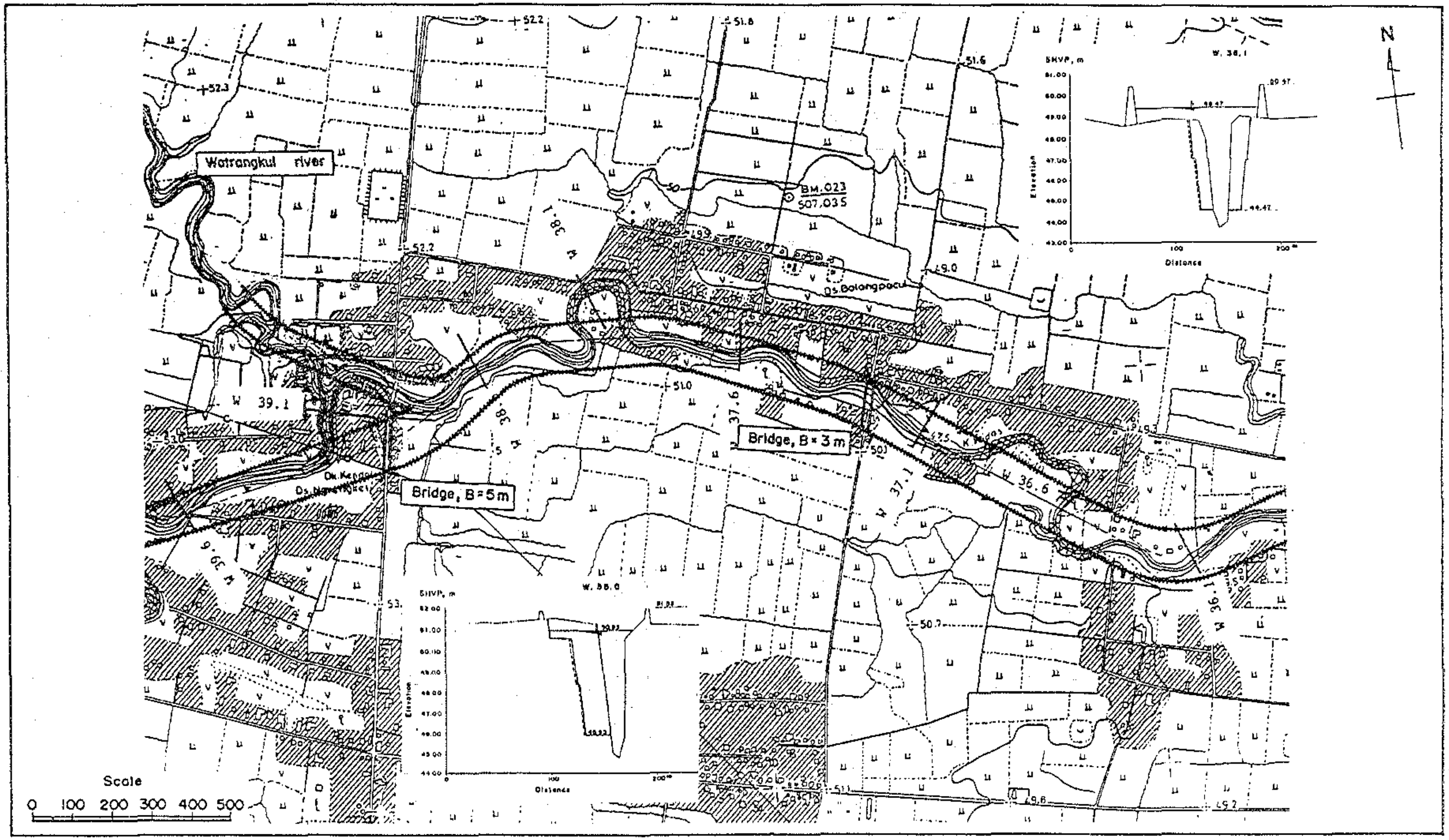


River : UPPER WIDAS

Fig.4.4.4. LAYOUT OF PROPOSED DIKE ALIGNMENT AND RELATED RIVER STRUCTURES (7/26)

River : UPPER WIDAS

Fig. 4.4.4. LAYOUT OF PROPOSED DIKE ALIGNMENT AND RELATED RIVER STRUCTURES (8/26)



River : UPPER WIDAS

Fig.4.4.4. LAYOUT OF PROPOSED DIKE ALIGNMENT AND RELATED RIVER STRUCTURES (9/26)

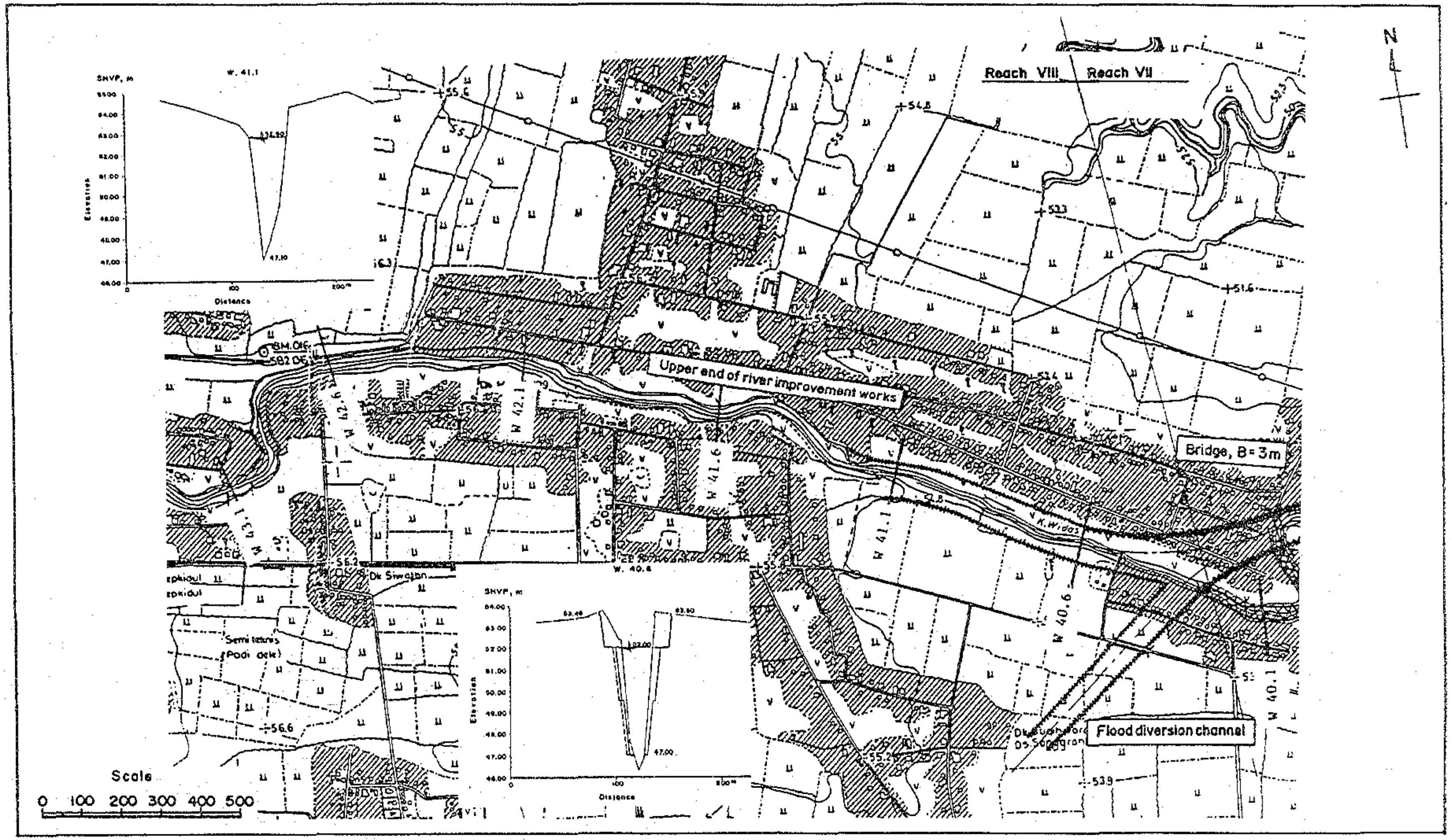
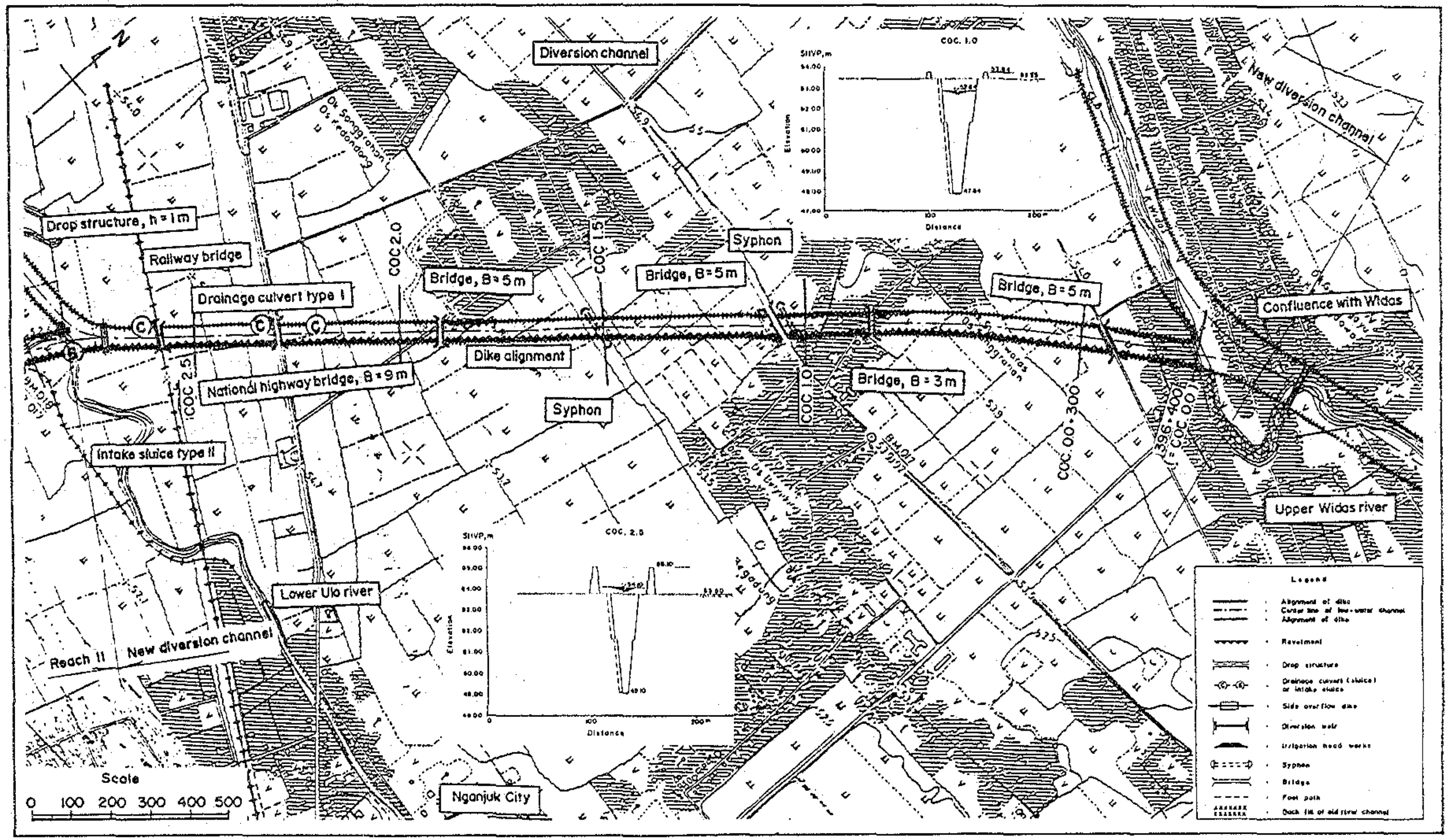
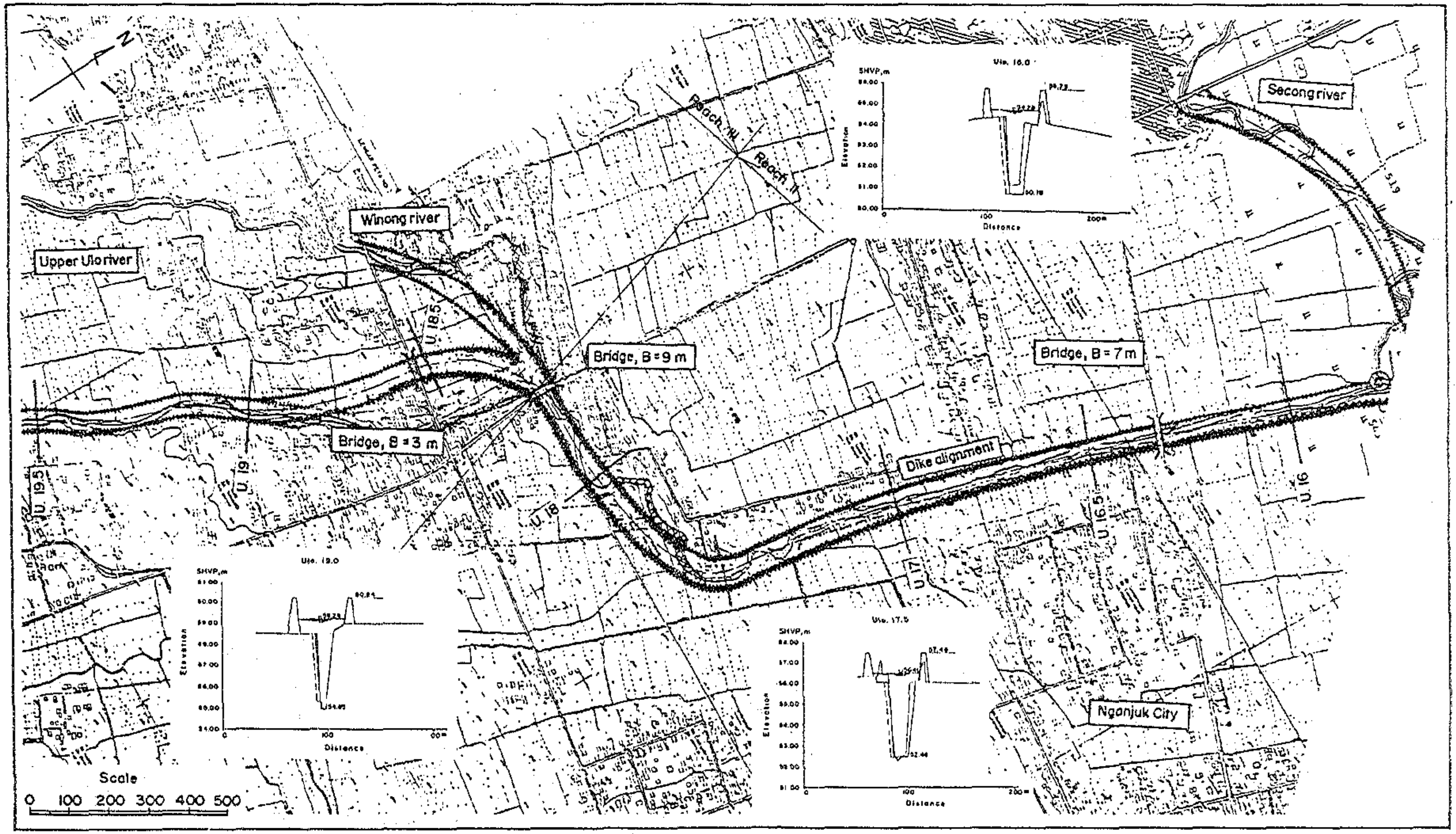


Fig. 4.4.4. LAYOUT OF PROPOSED DIKE ALIGNMENT AND RELATED RIVER STRUCTURES (10/26)



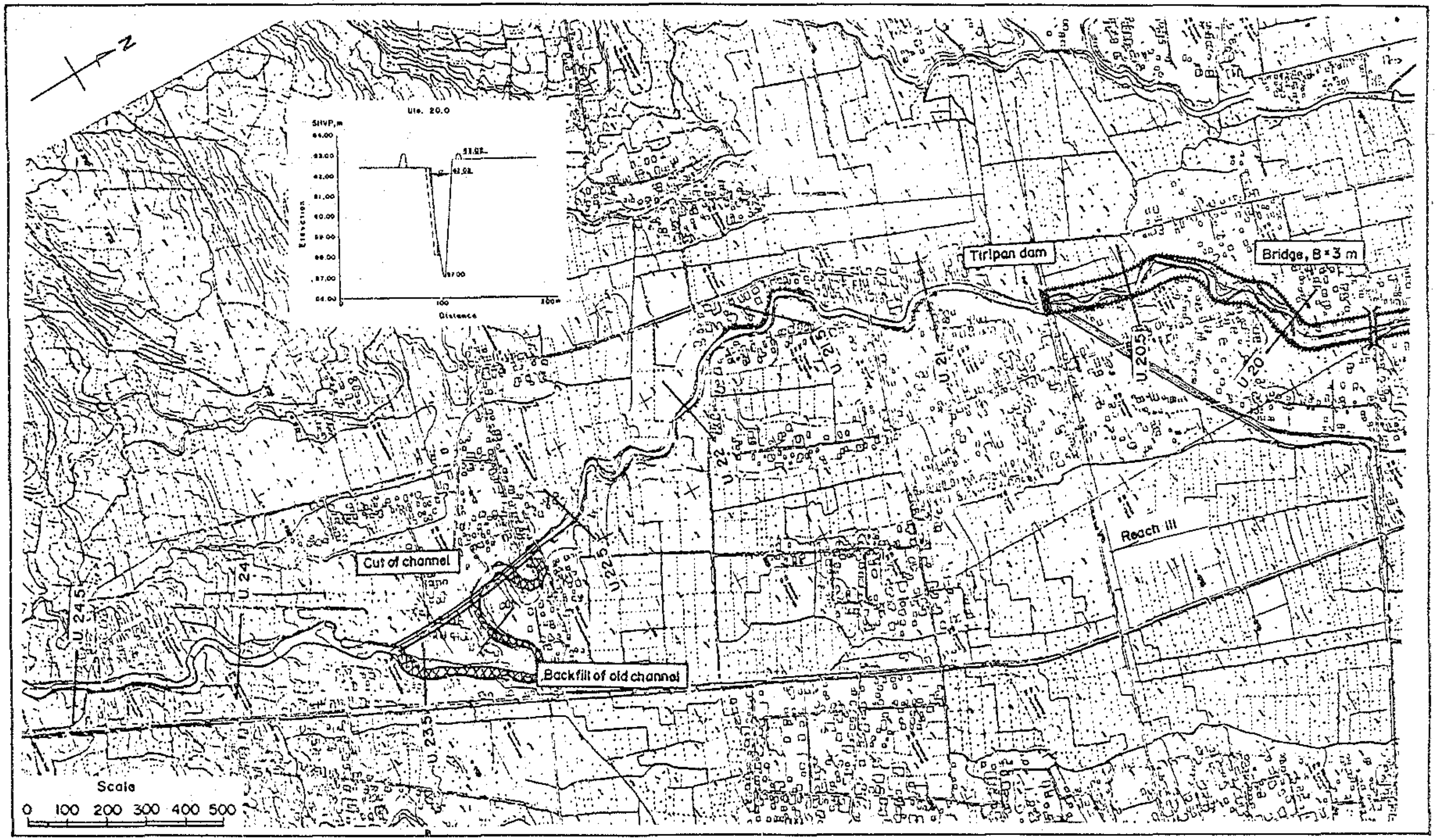
River : DIVERSION CHANNEL

Fig.4.4.4. LAYOUT OF PROPOSED DIKE ALIGNMENT AND RELATED RIVER STRUCTURES (II/26)



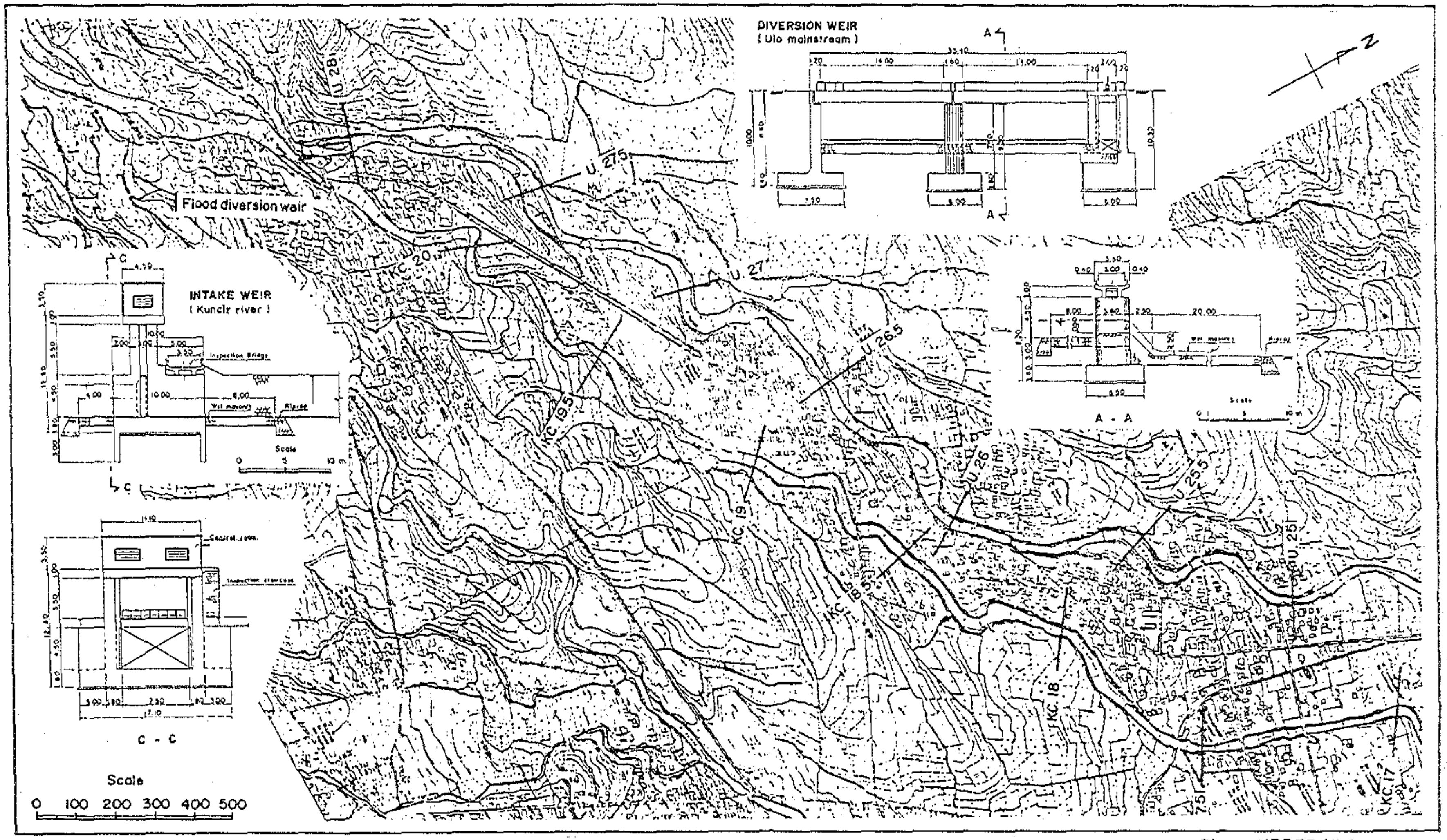
River : UPPER ULO

Fig.4.4.4. LAYOUT OF PROPOSED DIKE ALIGNMENT AND RELATED RIVER STRUCTURES (12/26)



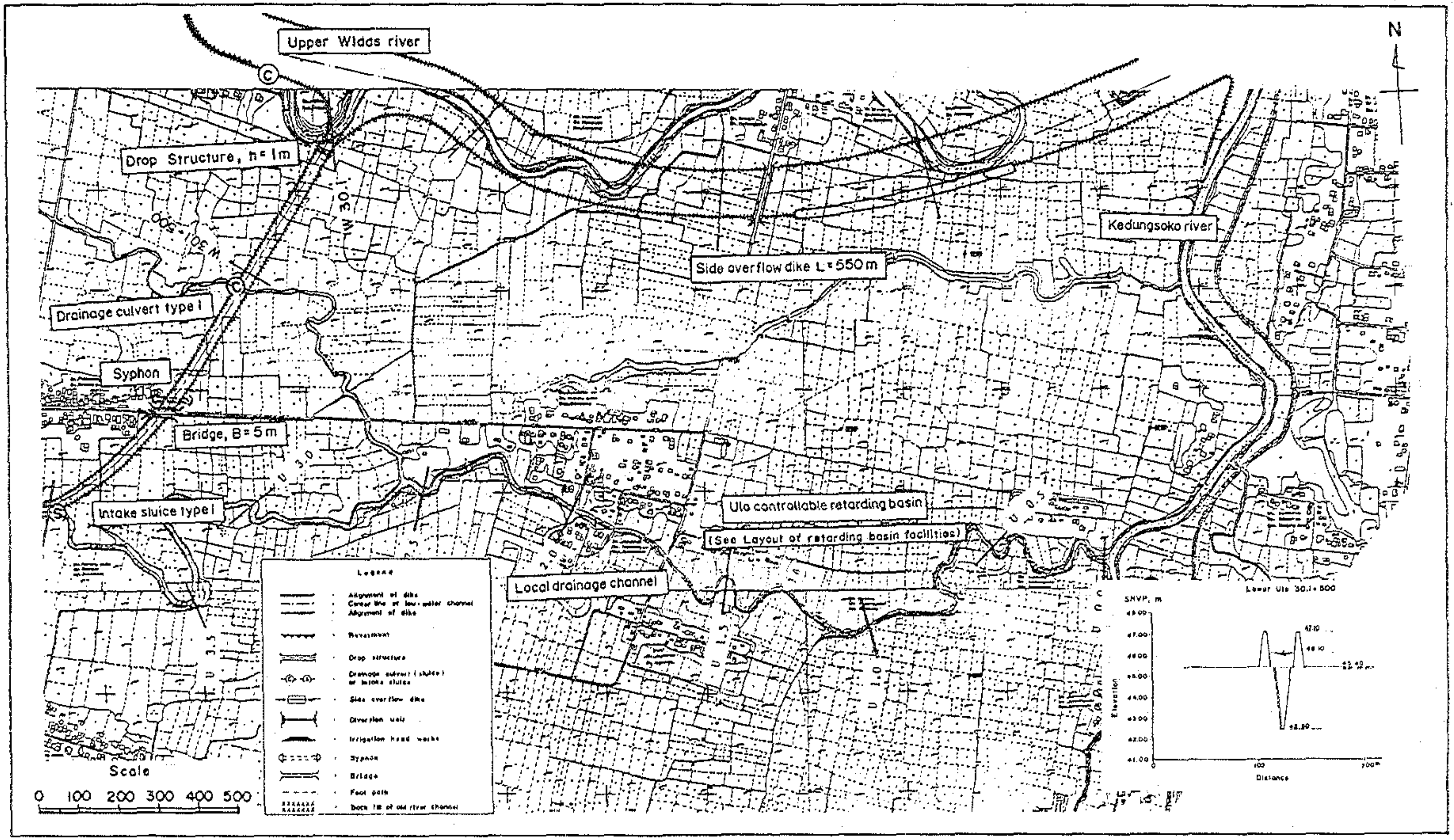
River : UPPER ULO

Fig. 4.4.4. LAYOUT OF PROPOSED DIKE ALIGNMENT AND RELATED RIVER STRUCTURES (13/26)



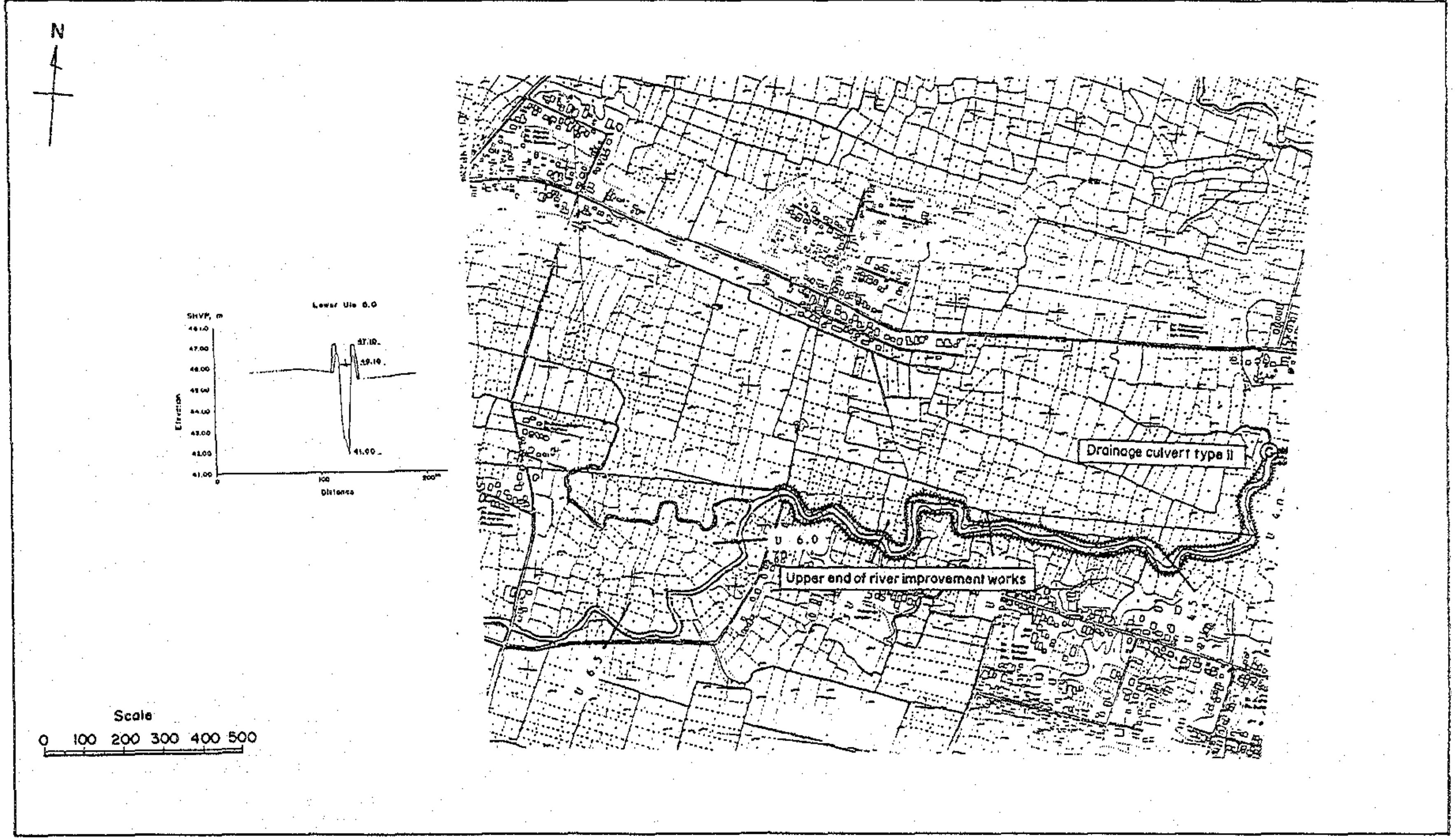
River : UPPER ULO

Fig.4.4.4. LAYOUT OF PROPOSED DIKE ALIGNMENT AND RELATED RIVER STRUCTURES (14/26)



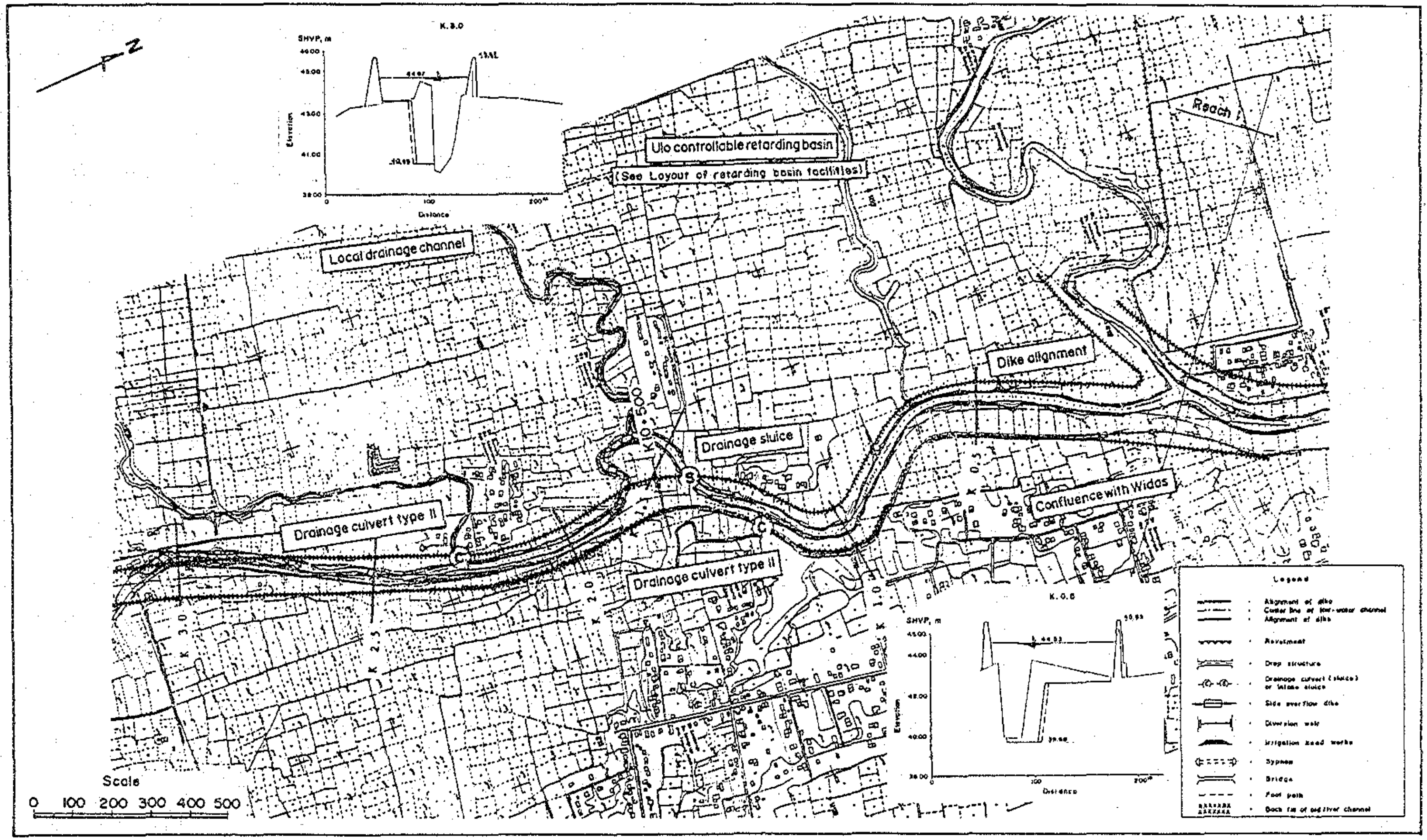
River : LOWER ULO

Fig. 4.4.4. LAYOUT OF PROPOSED DIKE ALIGNMENT AND RELATED RIVER STRUCTURES (15/26)



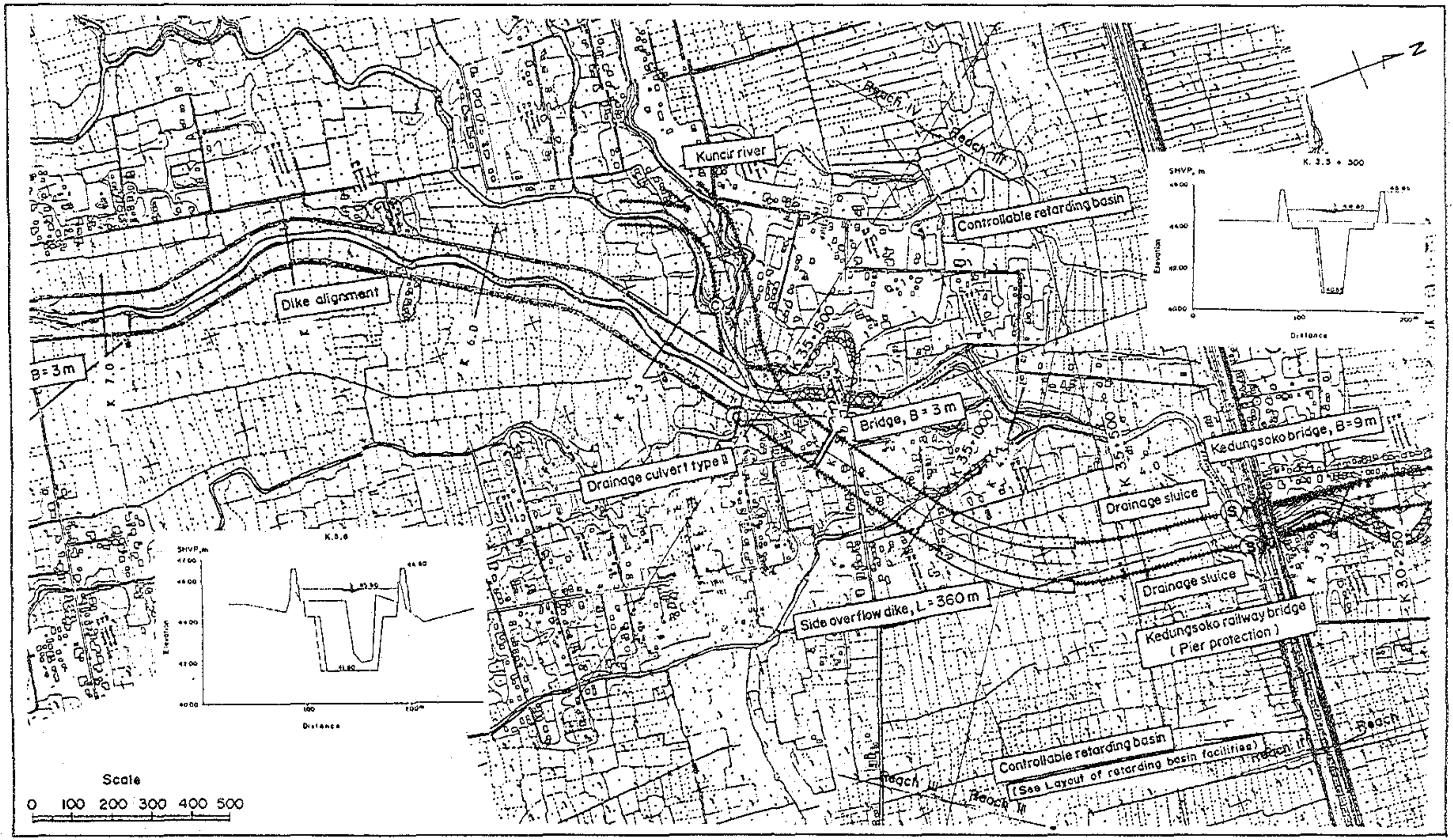
River : LOWER ULO

Fig.4.4.4. LAYOUT OF PROPOSED DIKE ALIGNMENT AND RELATED RIVER STRUCTURES (16/26)



River : KEDUNGSOKO

Fig.4.4.4. LAYOUT OF PROPOSED DIKE ALIGNMENT AND RELATED RIVER STRUCTURES (17/26)



River : KEDUNGSOKO

Fig.4.4.4. LAYOUT OF PROPOSED DIKE ALIGNMENT AND RELATED RIVER STRUCTURES (18/26)

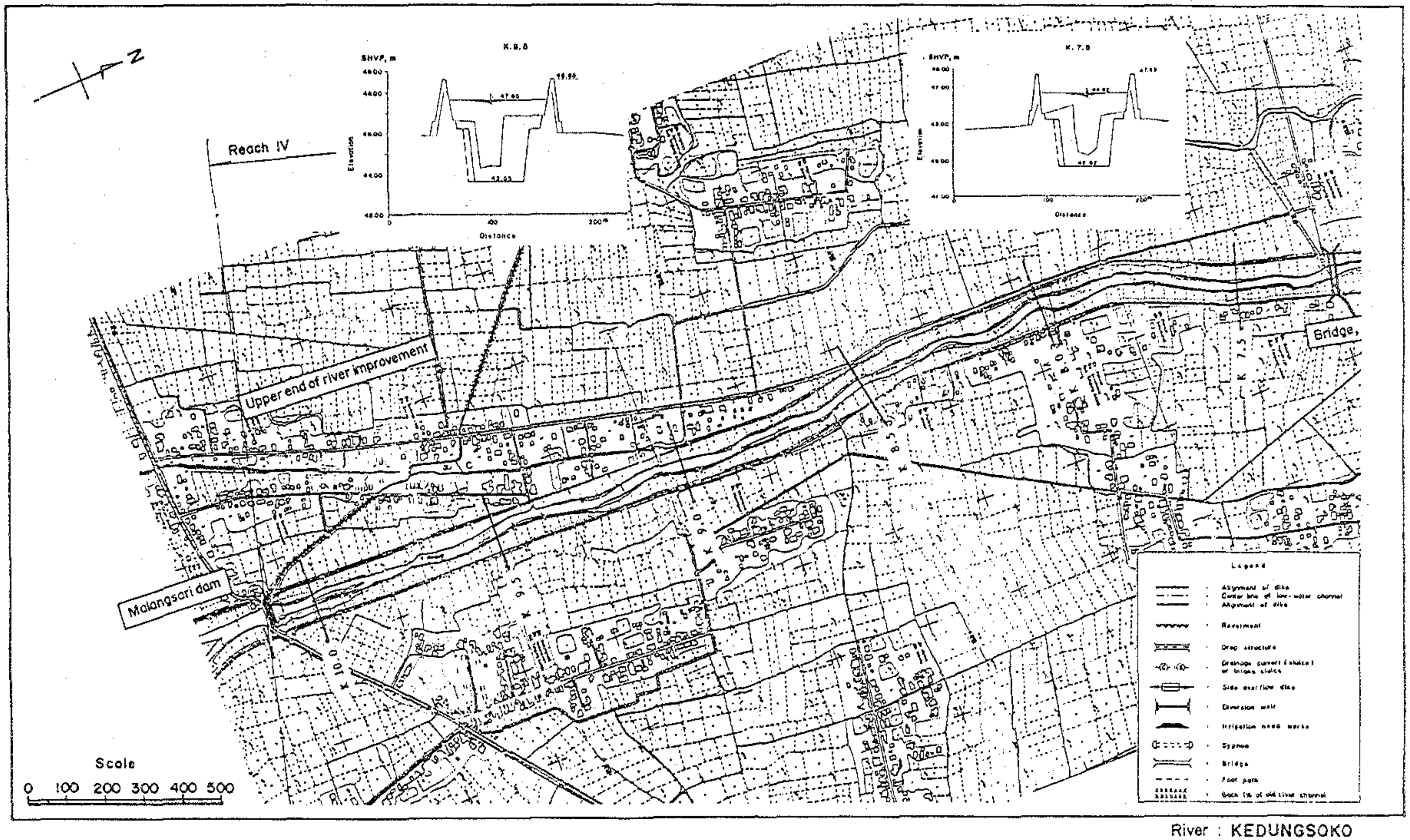
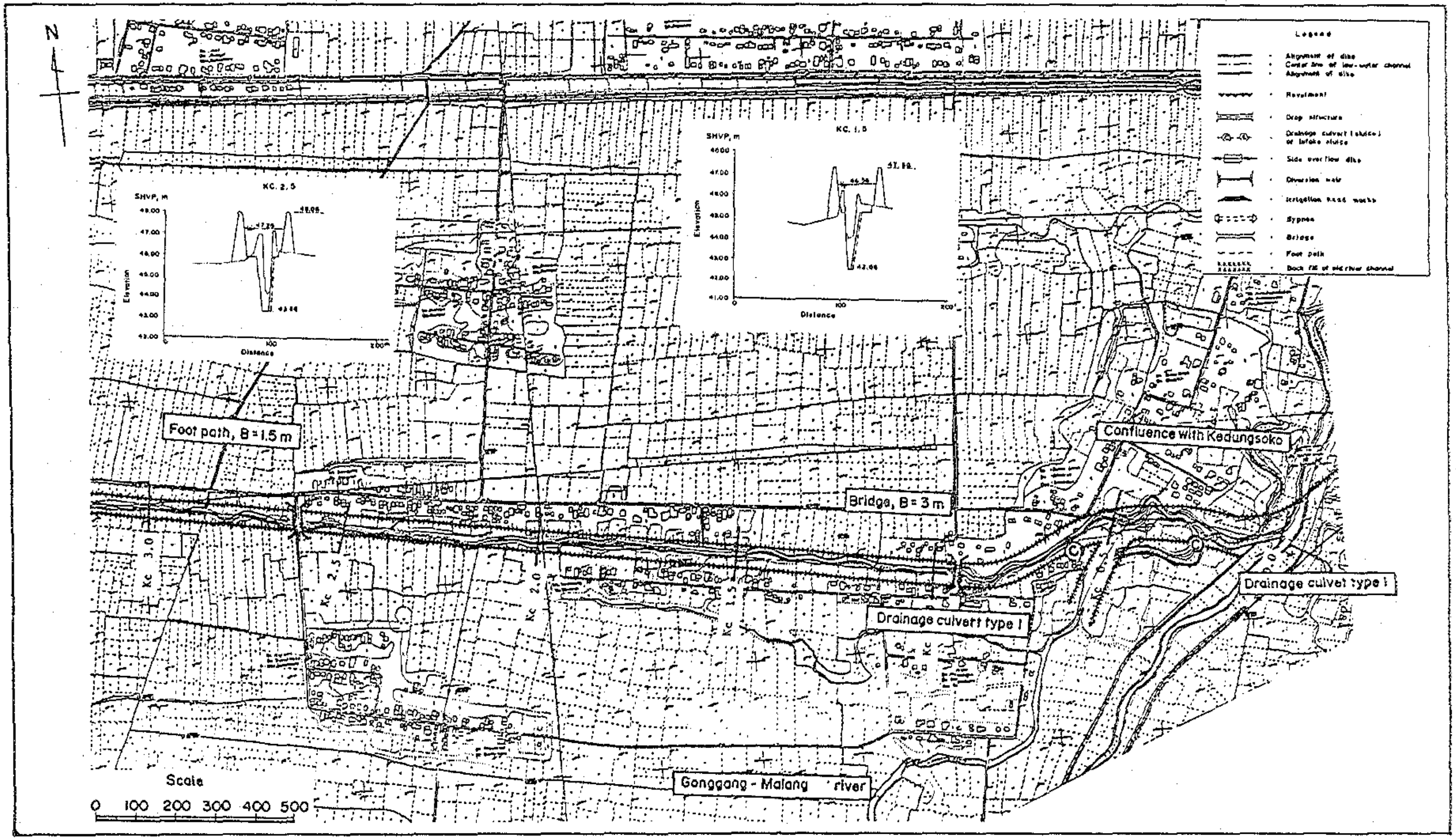


Fig.4.4.4. LAYOUT OF PROPOSED DIKE ALIGNMENT AND RELATED RIVER STRUCTURES (19/26)



River : KUNCIR

Fig.4.4.4. LAYOUT OF PROPOSED DIKE ALIGNMENT AND RELATED RIVER STRUCTURES (20/26)

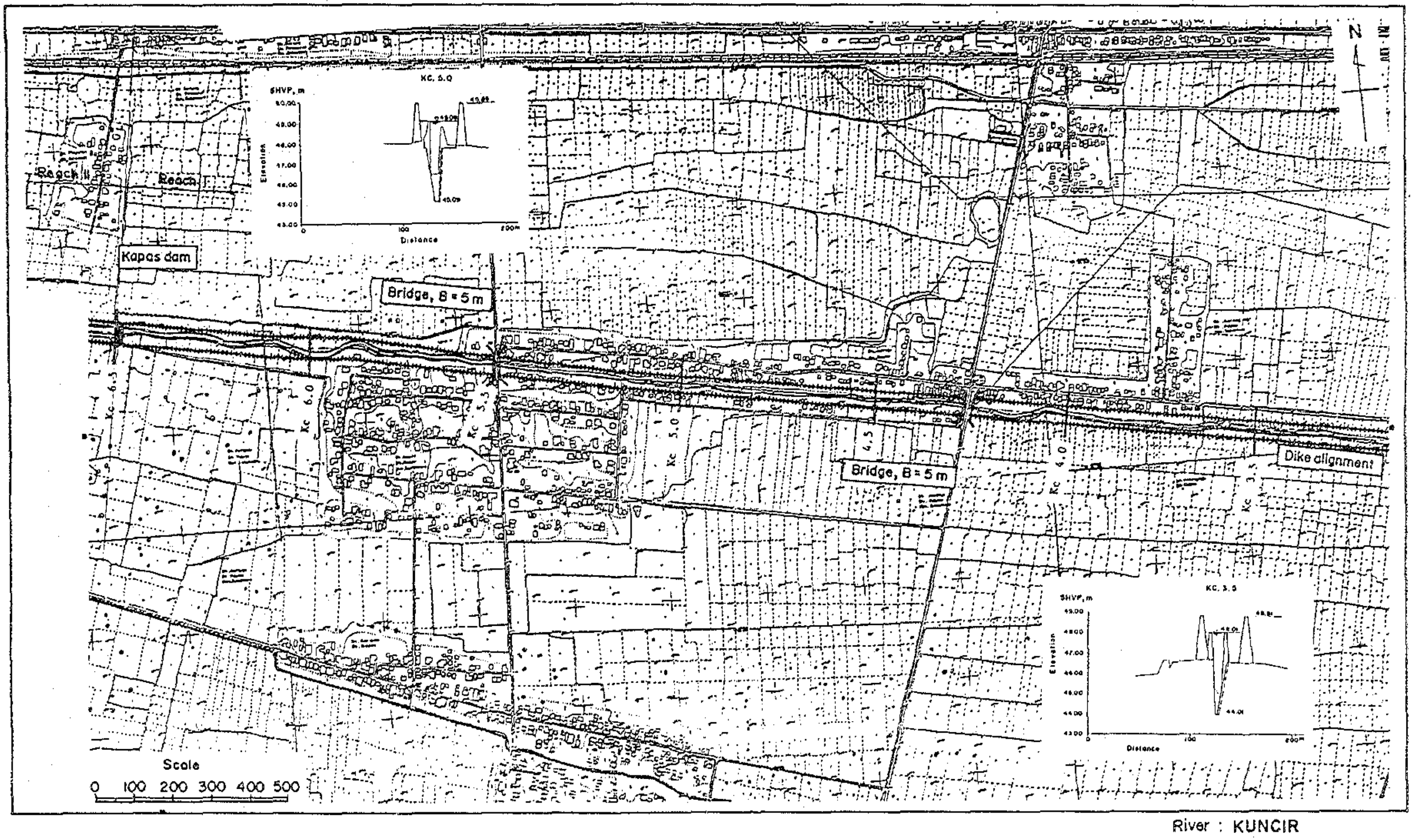
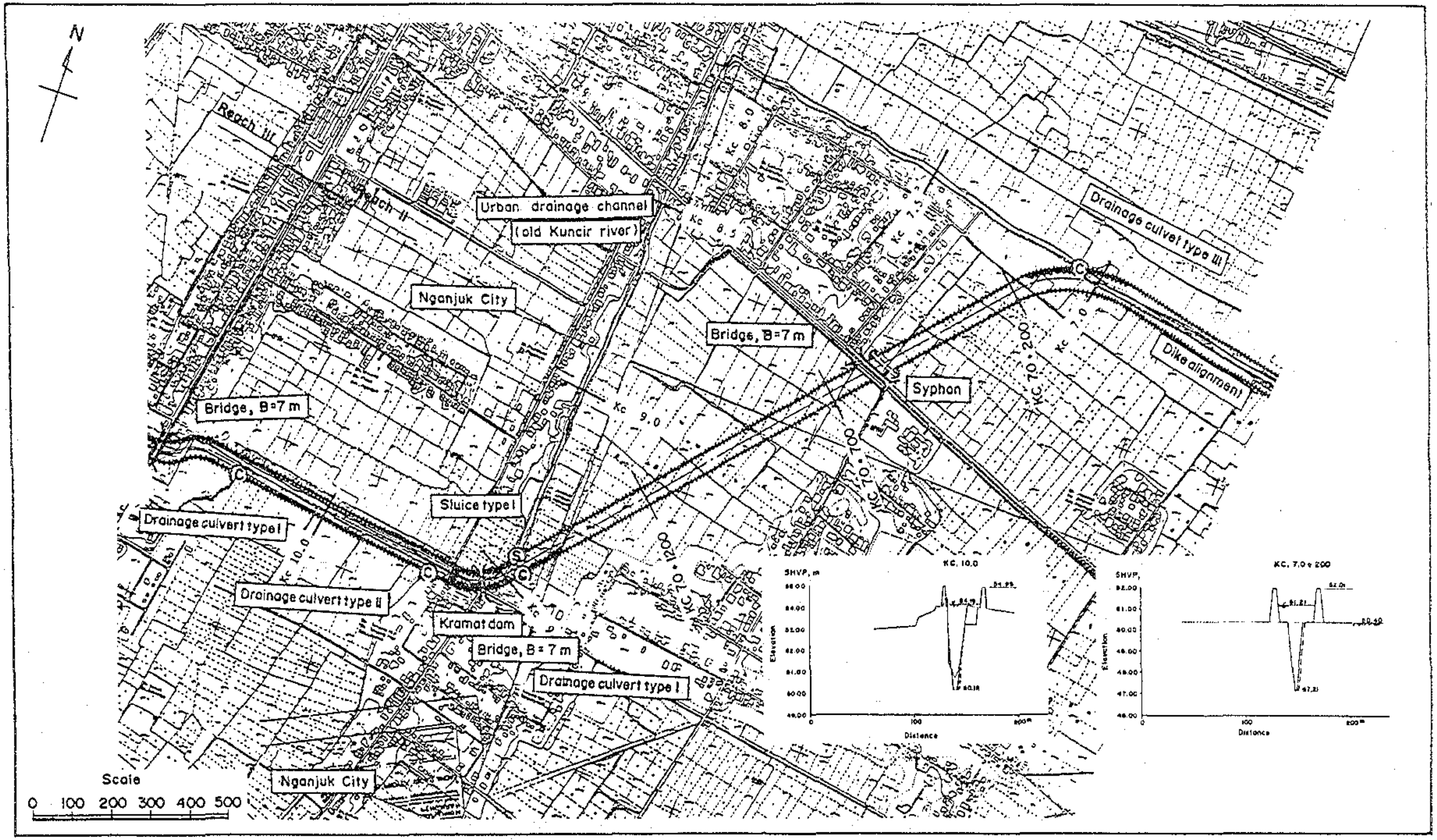
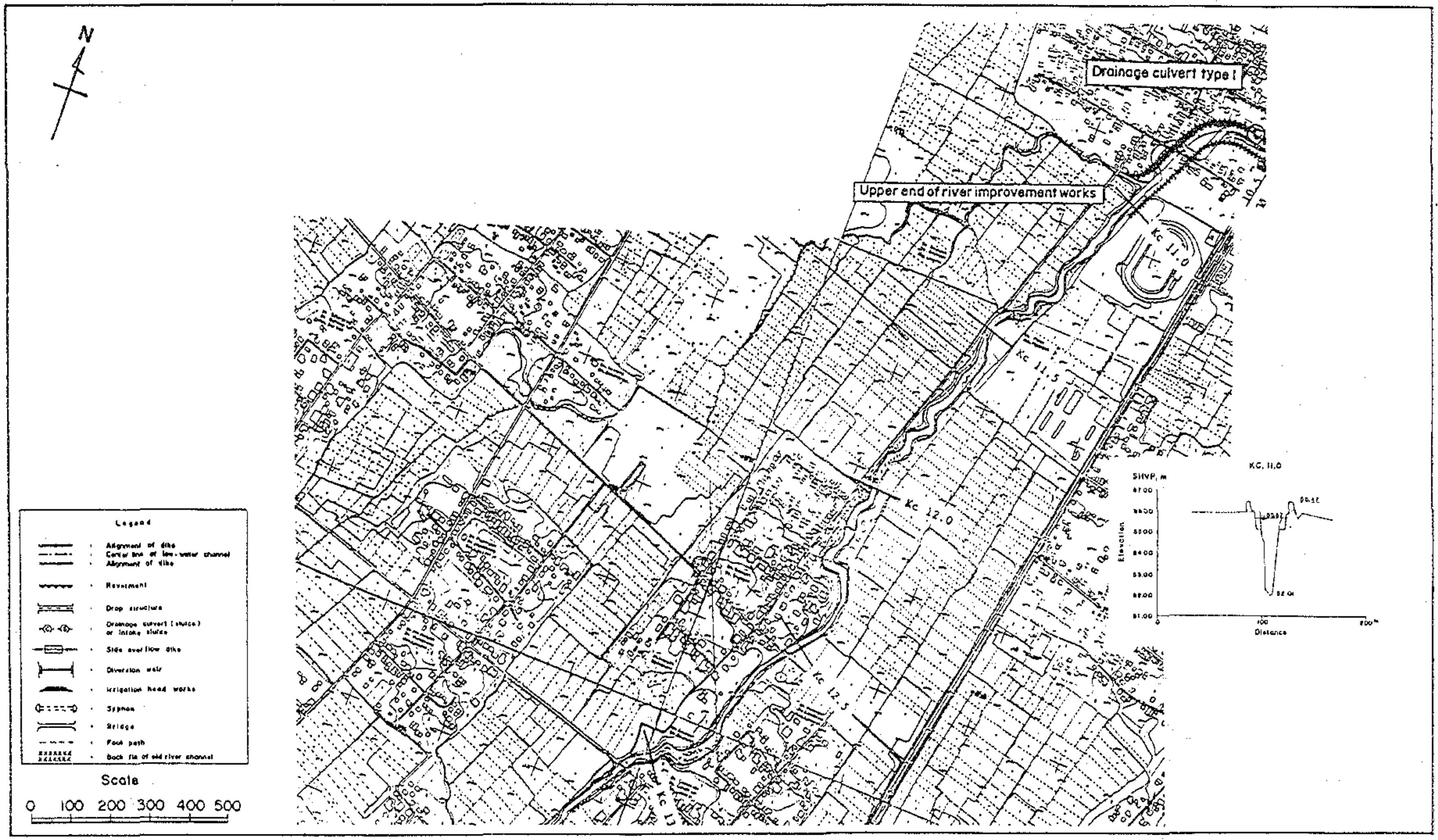


Fig. 4.4.4. LAYOUT OF PROPOSED DIKE ALIGNMENT AND RELATED RIVER STRUCTURES (21/26)



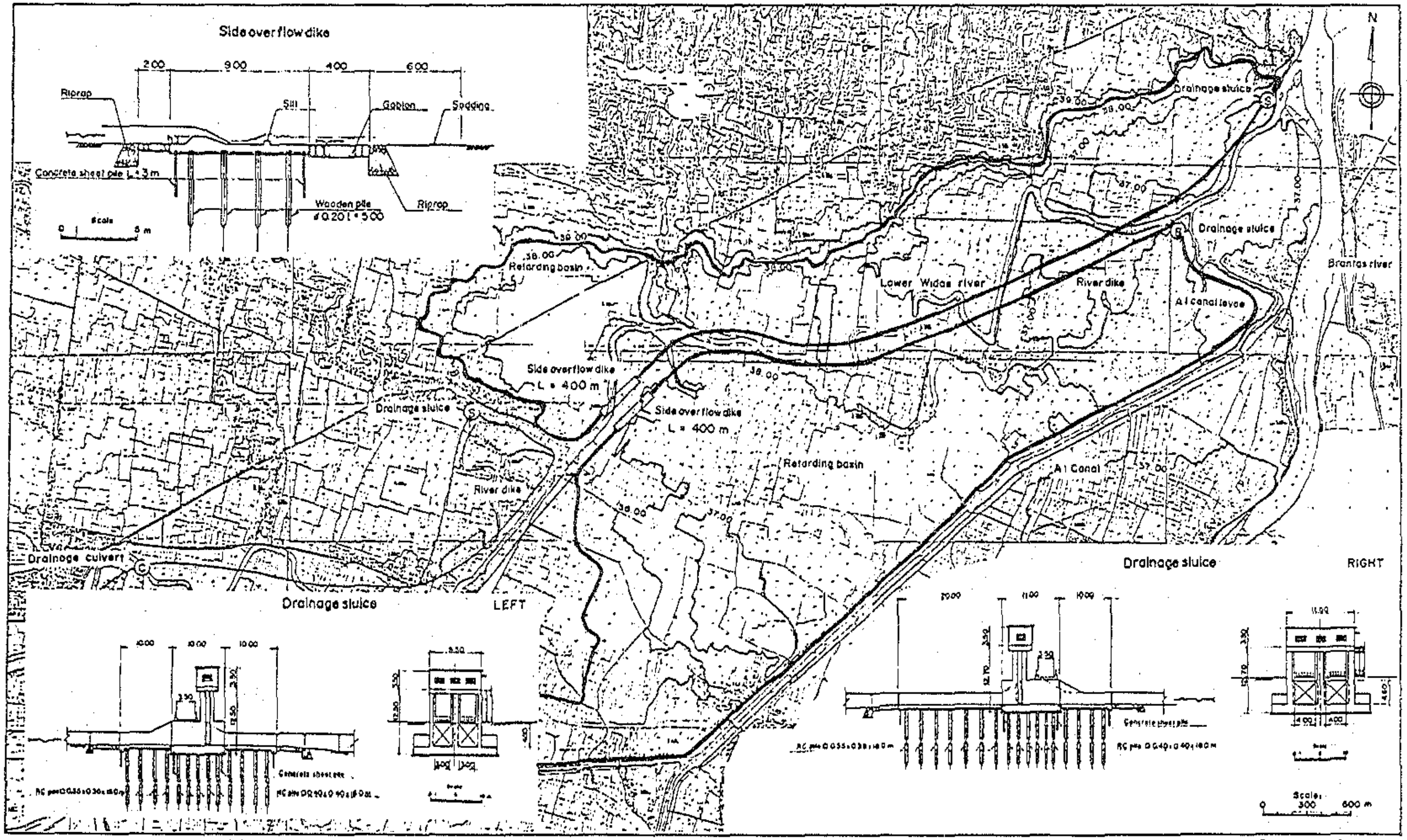
River : KUNCIR

Fig.4.4.4. LAYOUT OF PROPOSED DIKE ALIGNMENT AND RELATED RIVER STRUCTURES (22/26)



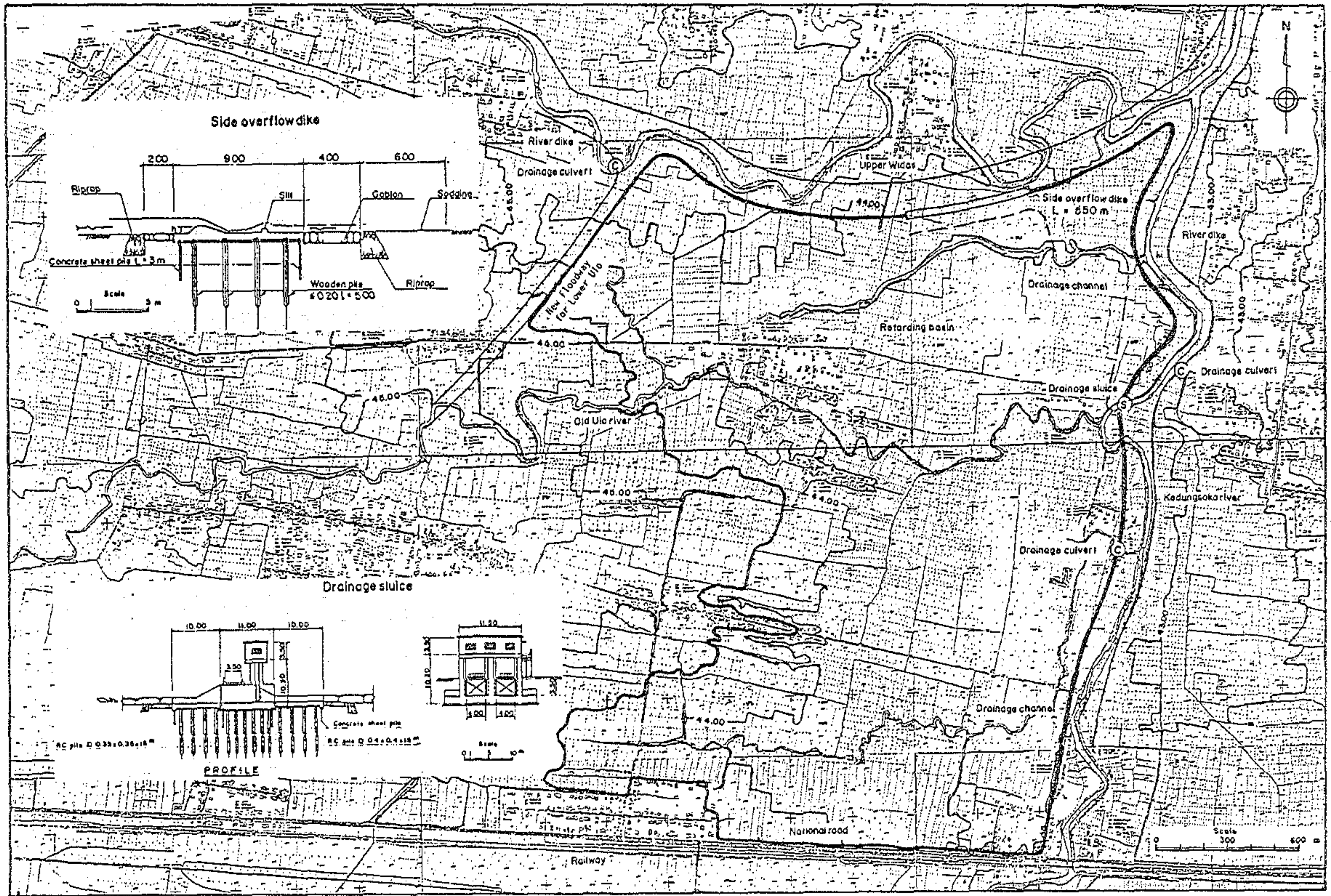
River : KUNCIR

Fig.4.4.4. LAYOUT OF PROPOSED DIKE ALIGNMENT AND RELATED RIVER STRUCTURES (23/26)



WIDAS RETARDING BASIN

Fig. 4.4.4 LAYOUT OF PROPOSED DIKE ALIGNMENT AND RELATED RIVER STRUCTURES (24/26)



ULO RETARDING BASIN

Fig. 4.4.4 LAYOUT OF PROPOSED DIKE ALIGNMENT AND RELATED RIVER STRUCTURES (25/26)

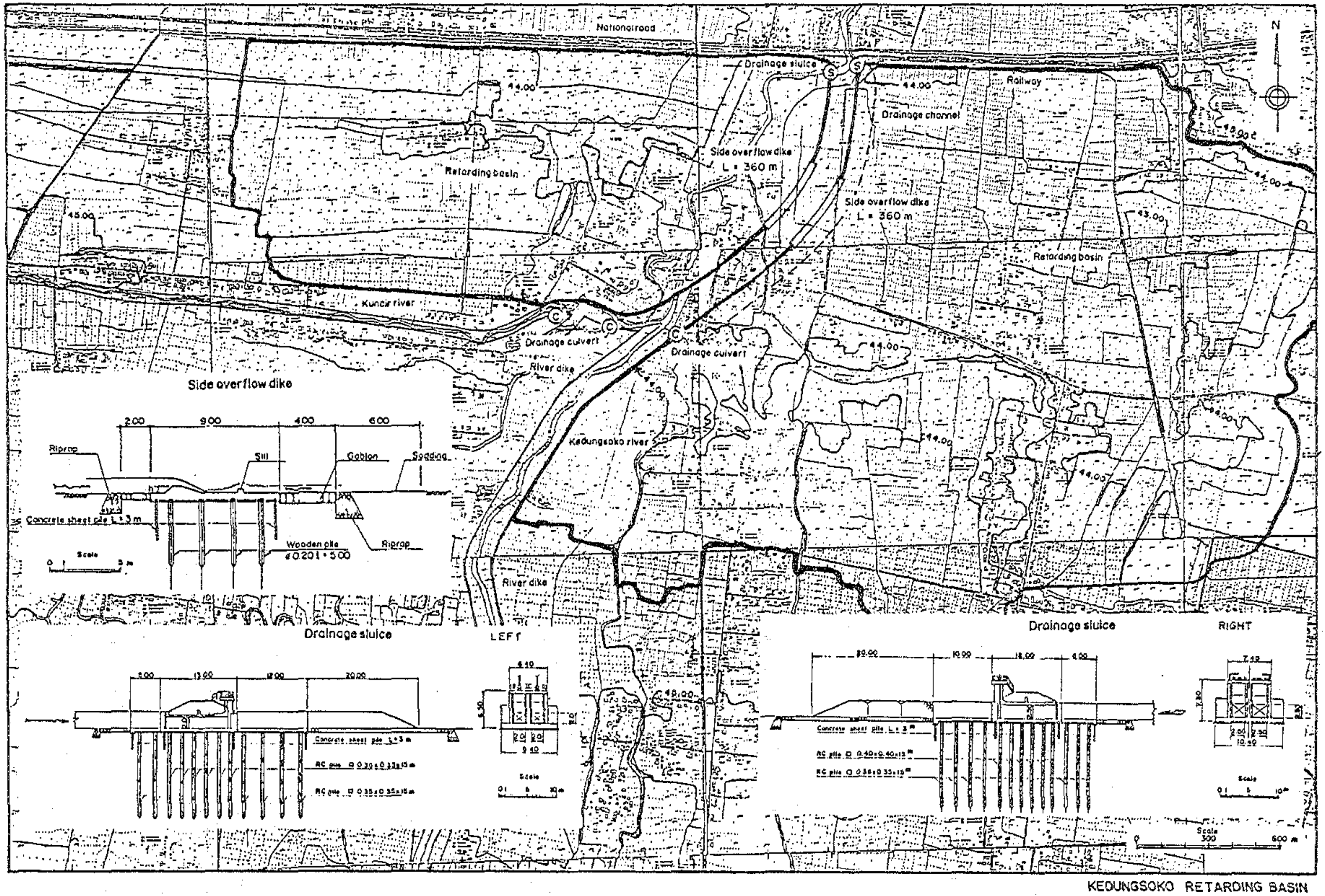


Fig. 4.4.4 LAYOUT OF PROPOSED DIKE ALIGNMENT AND RELATED RIVER STRUCTURES (26/26)

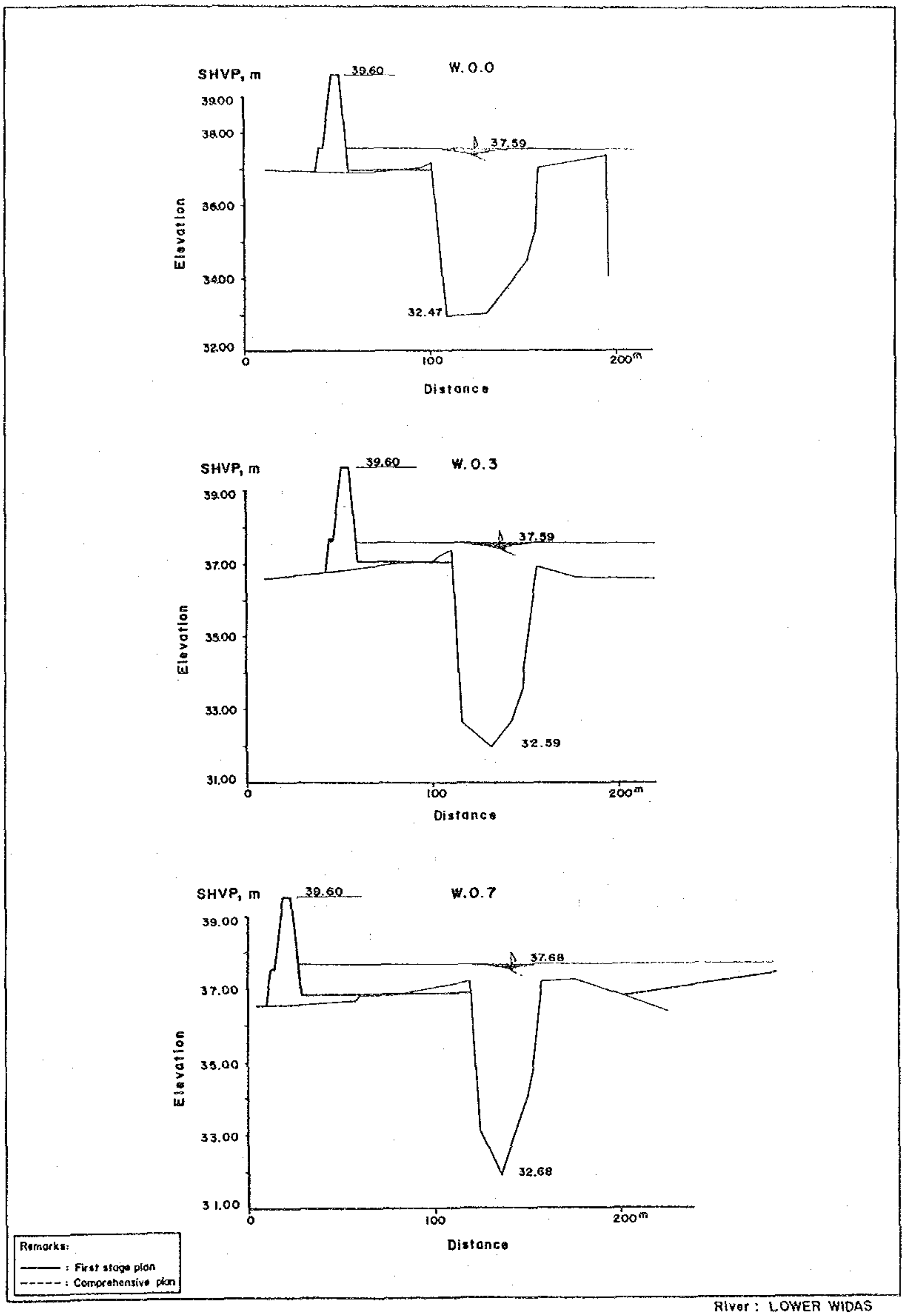


Fig.4.4.5. PROPOSED RIVER CROSS-SECTION (1/26)

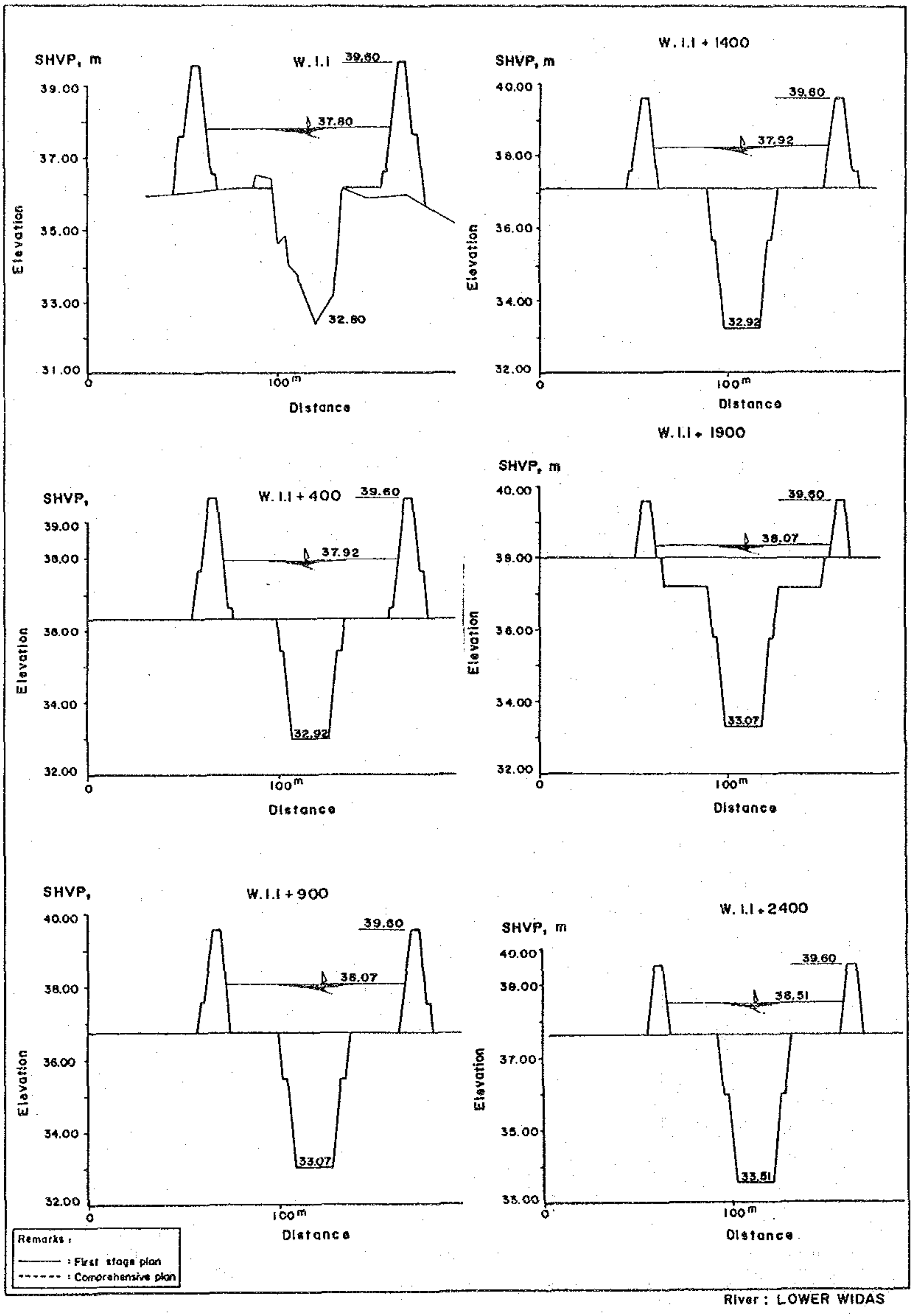


Fig.4.4.5. PROPOSED RIVER CROSS-SECTION (2/26)

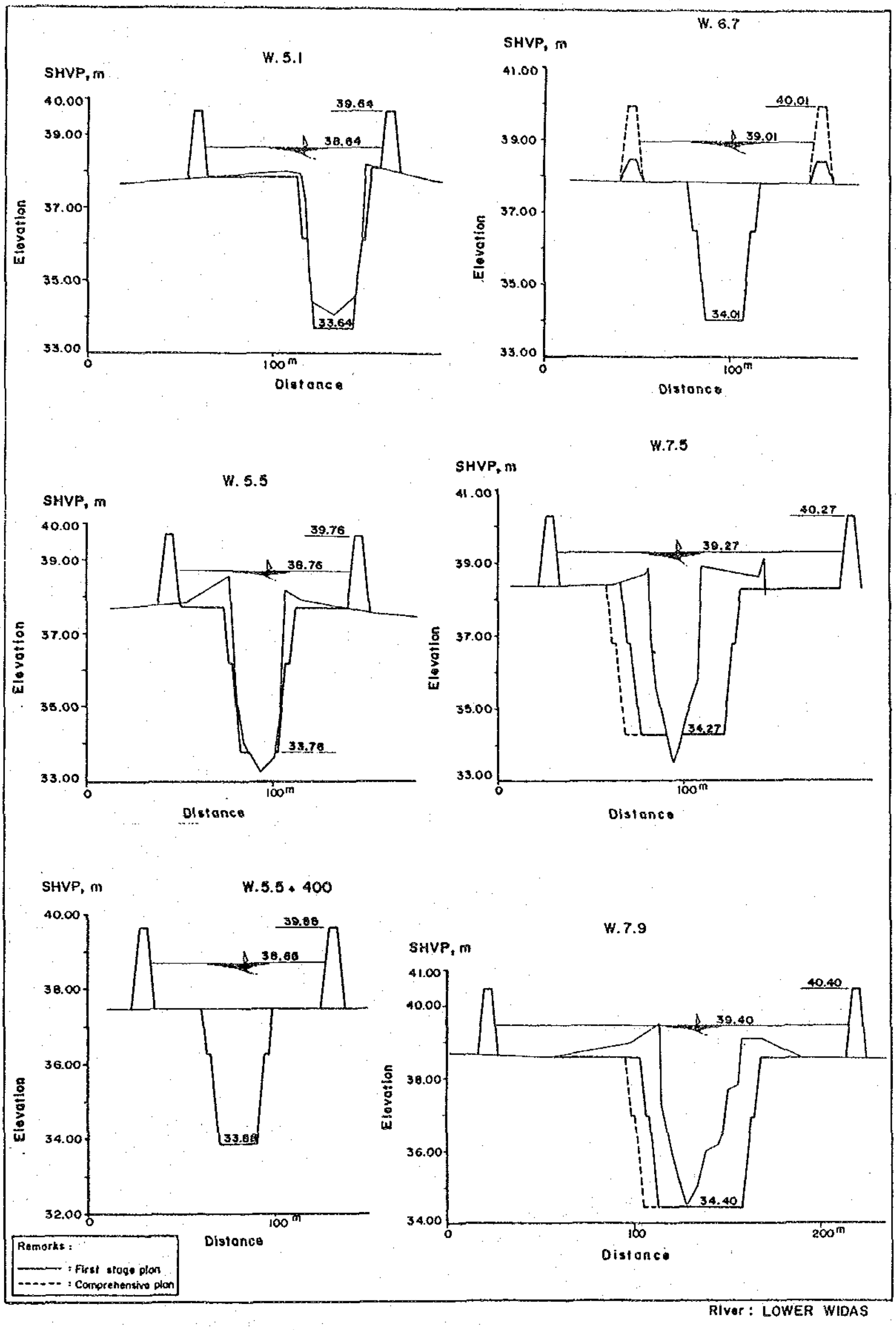
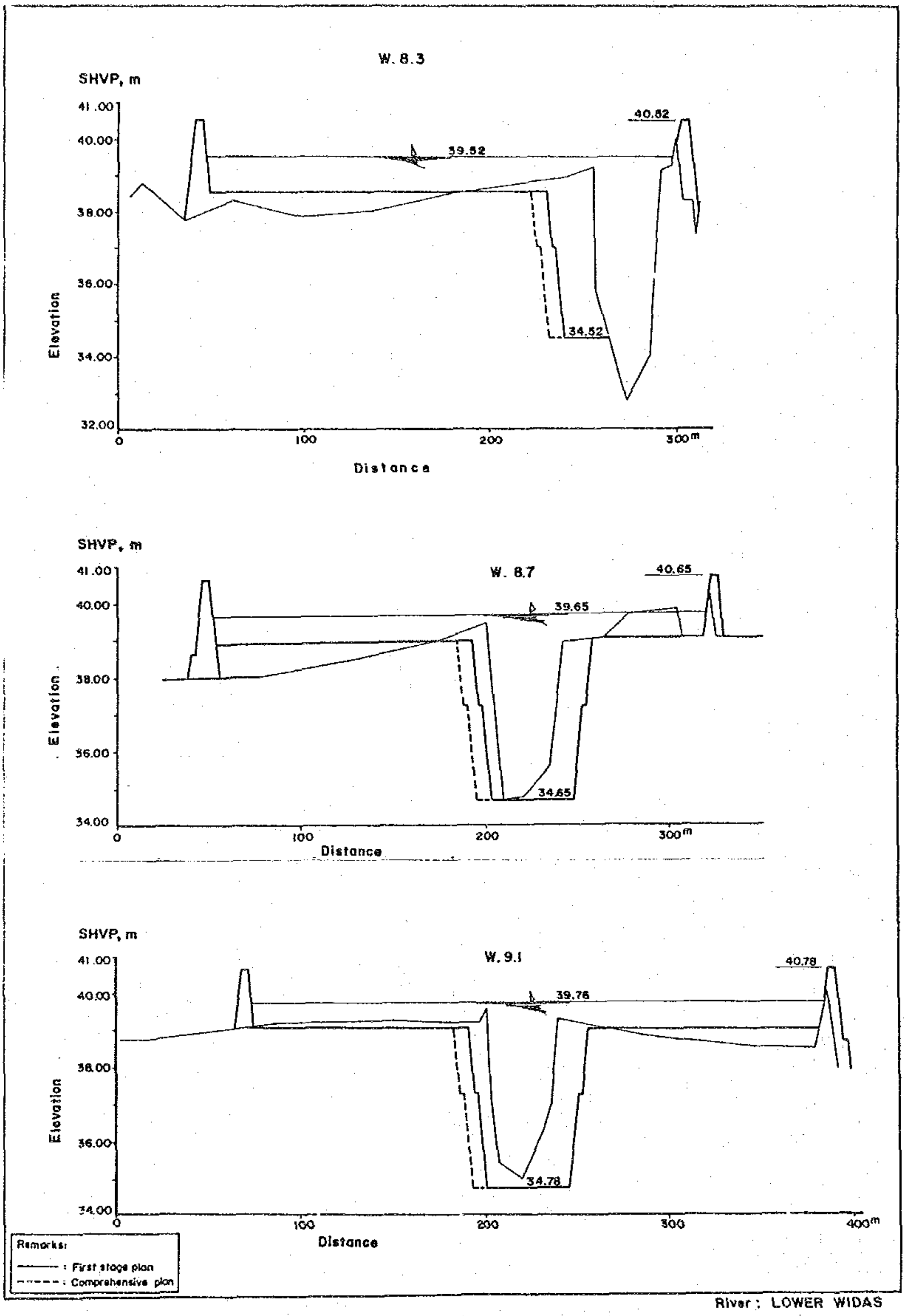


Fig.4.4.5. PROPOSED RIVER CROSS-SECTION (3/26)



River: LOWER WIDAS

Fig.4.4.5. PROPOSED RIVER CROSS-SECTION (4/26)

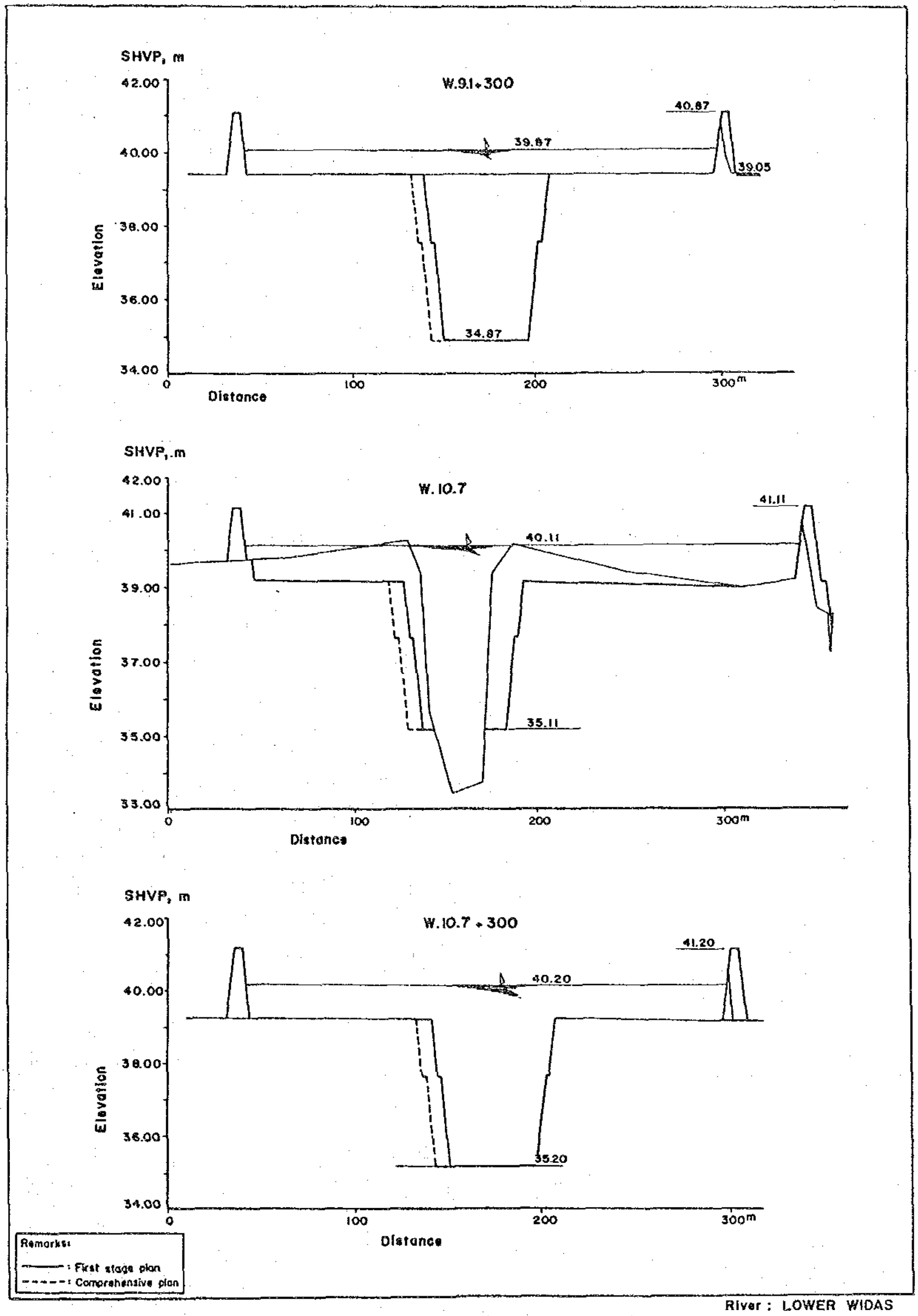


Fig.4.4.5. PROPOSED RIVER CROSS-SECTION (5/26)

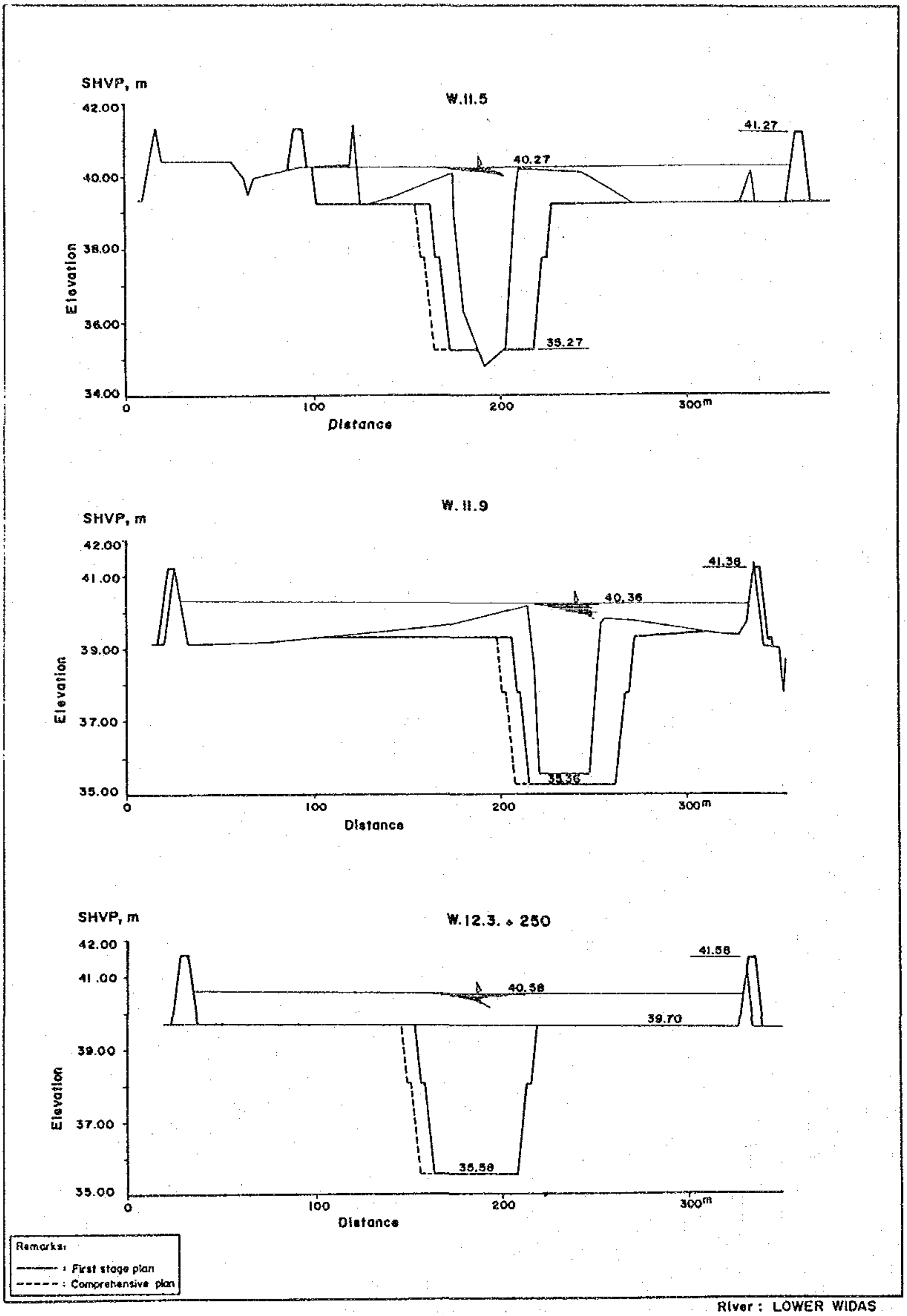
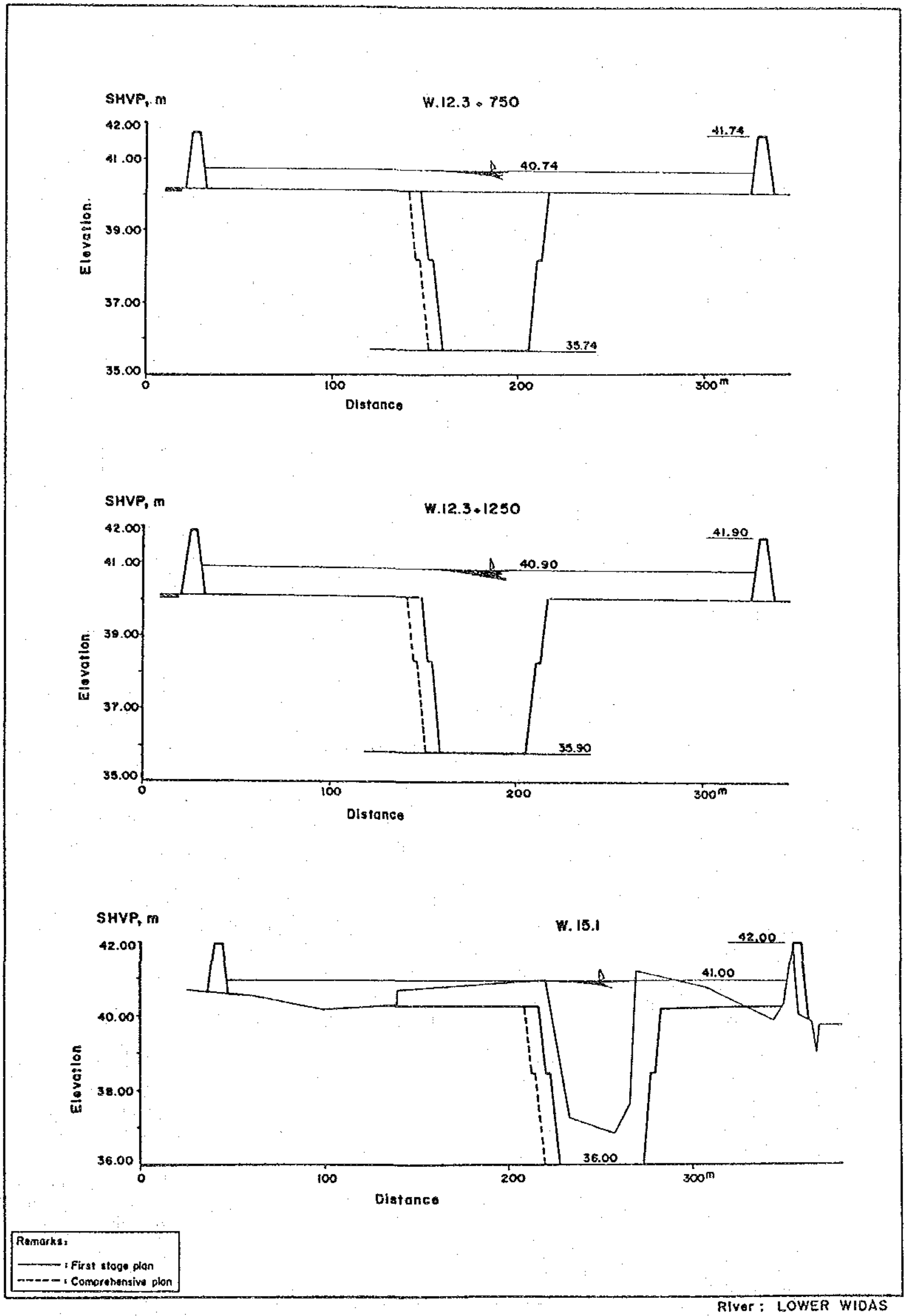


Fig.4.4.5. PROPOSED RIVER CROSS-SECTION (6/26)



River : LOWER WIDAS

Fig. 4.4.5. PROPOSED RIVER CROSS-SECTION (7/26)

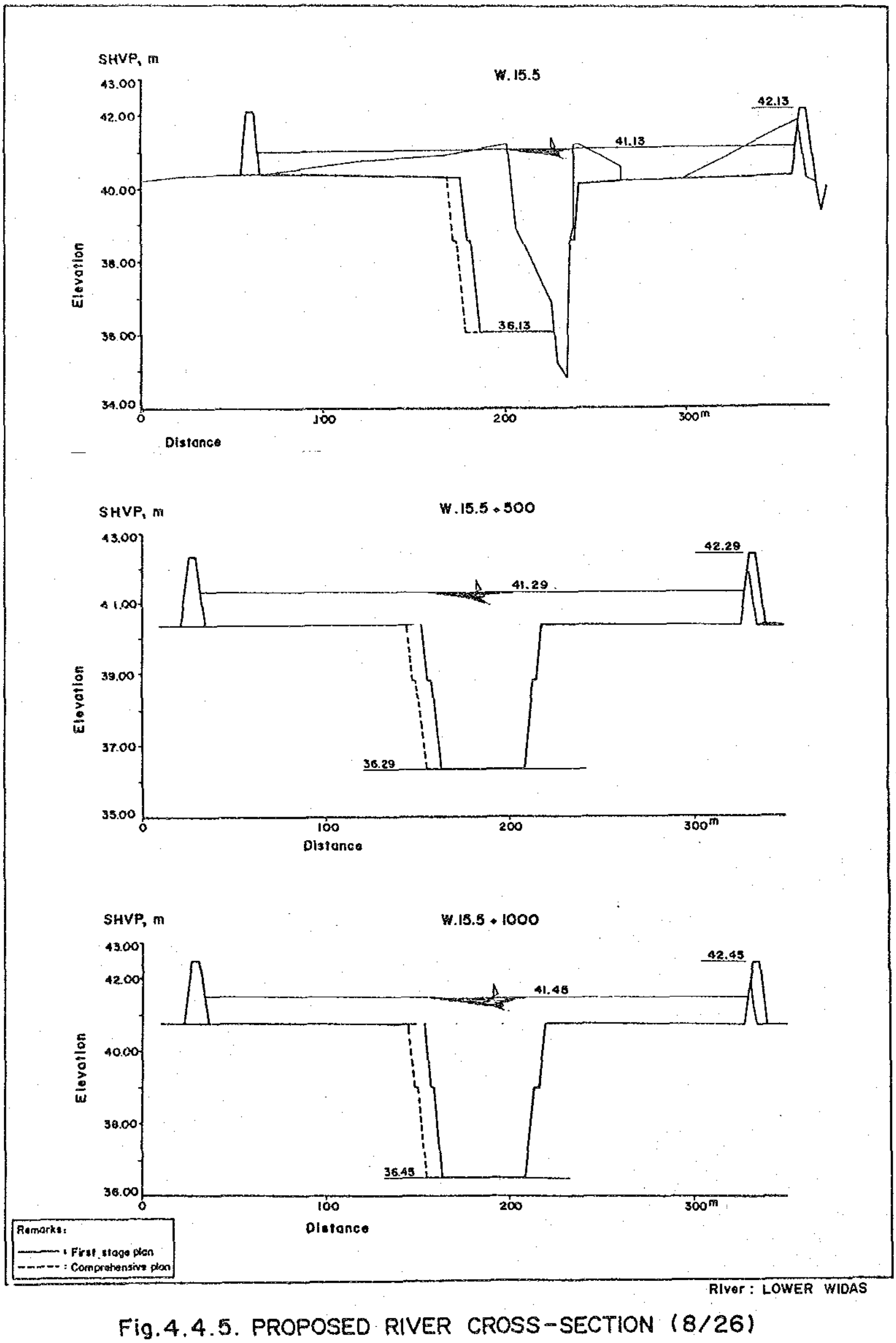


Fig.4.4.5. PROPOSED RIVER CROSS-SECTION (8/26)

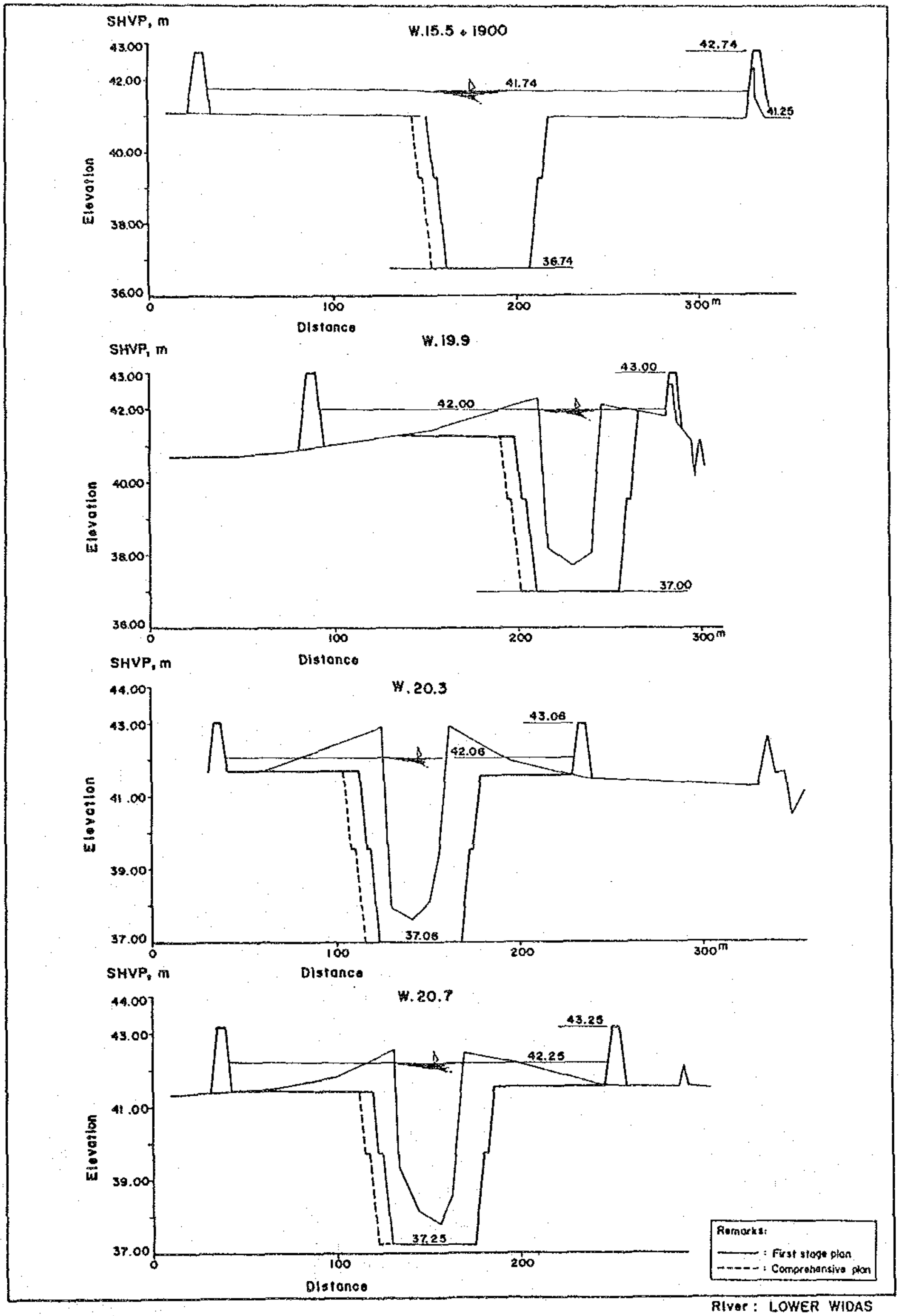


Fig.4.4.5. PROPOSED RIVER CROSS-SECTION (9/26)