

TABLES

Table 2.1 Summary of Laboratory Test on Samples in Oued Hammam

No.	Sample Depth(m)	MC	Gs	Gradation			Atterberg limits			Compaction		k
				gravel	sand	s/cl	LL	PL	Ip	OMC	MDD	
SL1	0.0-2.5	19.8	2.67	0.0	47.0	53.0	28.7	13.0	15.7	12.7	1.86	4.3E-8
SL2	0.7-3.0	23.9	2.66	0.0	70.0	30.0	18.9	NP	NP	10.6	1.86	6.4E-7
SL2	0.3-1.9	22.6	2.68	0.0	47.0	53.0	25.4	13.4	12.0	12.4	1.88	5.6E-7
SL3	0.0-3.0	1.5	2.63	1.0	92.0	7.0	NP	NP	NP	8.0	1.73	5.3E-3
SL4	0.5-2.2	19.7	2.68	1.0	49.0	50.0	26.8	13.6	13.2	11.9	1.92	6.2E-7

Legend

- MC : Moisture content (%)
 Gs : Specific gravity
 s/cl : Silt & clay content (%)
 LL : Liquid limit (%)
 PL : Plastic limit (%)
 OMC : Optimum moisture content (%)
 MDD : Maximum dry density (t/m³)
 k : Permeability coefficient (cm/sec)

Table 3.1 Basic Condition of Rational Formula

1) Rational Formula

$$Q = \frac{1}{3.6} \cdot f \cdot i \cdot A$$

Q : peak discharge (m³/s)
 f : runoff coefficient
 i : rainfall intensity in time T_c (mm/hr)
 A : catchment area (km²)

2) Runoff Coefficient (f)

Land Use Type	Present Condition	Future Condition
ZONE 1 : Urban center areas, Commercial areas, Residential areas	0.6	0.8
ZONE 2 : Industrial areas	0.6	0.6
ZONE 3 : Agricultural lands, Open spaces	0.2	0.2
ZONE 4 : Water surfaces	1.0	1.0

3) Time of Concentration (T_c)

$$T_c = T_i + T_f$$

$$T_i = 0.01947 \left(\frac{L_0}{\sqrt{S}} \right)^{0.77}$$

$$T_f = \frac{1}{60} \sum \frac{L_i}{v_i}$$

T_c : time of concentration (min)
 T_i : inlet time (min)
 T_f : flow time (min)

L₀ : overland flow length (m)
 S : average basin slope

L_i : length in channel (m)
 v_i : average velocity (m/s)

4) IDF curve formula

Station : Monastir (1981-1990)

$$i = \frac{287.4 \times T^{0.34}}{t^{0.74}}$$

i : average rainfall intensity (mm/hr)
 T : return period (year)
 t : rainfall duration (min)

Table 3.2 Runoff Coefficient of the Qued Hammam Basin

Basin Code	Area (sq.km)		Ground El. (mNGT)		Present Land Use Condition				Future Land Use Condition				Weighted γ
	Max.	Min.	Zone 1 f=0.60 (sq.km)	Zone 2 f=0.60 (sq.km)	Zone 3 f=0.20 (sq.km)	Zone 4 f=1.00 (sq.km)	Weighted f	Zone 1 f=0.60 (sq.km)	Zone 2 f=0.60 (sq.km)	Zone 3 f=0.20 (sq.km)	Zone 4 f=1.00 (sq.km)		
												Max.	
1	52.50	150	59	0.00	52.50	0.00	0.20	0.00	0.00	52.50	0.00	0.20	0.20
2	8.60	145	55	0.00	8.60	0.00	0.20	0.00	0.00	8.60	0.00	0.20	0.20
3	38.70	140	35	0.00	38.70	0.00	0.20	0.00	0.00	38.70	0.00	0.20	0.20
4	14.90	140	35	0.00	14.90	0.00	0.20	0.00	0.00	14.90	0.00	0.20	0.20
5	15.80	100	25	0.00	15.80	0.00	0.20	0.00	0.00	15.80	0.00	0.20	0.20
6	5.20	75	17	0.16	5.02	0.00	0.21	0.98	0.00	4.22	0.00	0.31	0.31
7	10.70	140	45	0.00	10.70	0.00	0.20	0.00	0.02	10.68	0.00	0.20	0.20
8	1.70	65	17	0.00	1.70	0.00	0.20	0.08	0.17	1.50	0.00	0.25	0.25
9	7.80	70	12	1.25	6.45	0.00	0.27	2.97	0.12	4.71	0.00	0.43	0.43
10	7.80	80	7	0.00	7.79	0.00	0.20	0.00	0.01	7.79	0.00	0.20	0.20
11	4.60	85	7	0.00	4.60	0.00	0.20	0.00	0.00	4.60	0.00	0.20	0.20
12	6.20	135	50	0.00	6.20	0.00	0.20	0.00	0.00	6.20	0.00	0.20	0.20
13	9.80	90	22	0.62	2.98	0.00	0.27	1.48	0.00	2.12	0.00	0.45	0.45
14	3.20	120	65	0.00	3.20	0.00	0.20	0.00	0.00	3.20	0.00	0.20	0.20
15	9.40	110	22	0.29	9.11	0.00	0.21	1.01	0.00	8.38	0.00	0.28	0.28
16	1.10	55	15	0.86	0.27	0.00	0.50	1.10	0.00	0.00	0.00	0.60	0.60
17	4.40	100	15	1.53	2.87	0.00	0.34	2.10	0.00	2.30	0.00	0.49	0.49
18	0.20	40	12	0.02	0.16	0.00	0.24	0.04	0.00	0.16	0.00	0.32	0.32
19	11.00	106	12	0.04	10.86	0.00	0.20	0.37	0.33	10.30	0.00	0.23	0.23
20	0.90	50	10	0.30	0.60	0.00	0.33	0.42	0.00	0.49	0.00	0.48	0.48
21	0.30	20	7	0.04	0.26	0.00	0.25	0.04	0.00	0.26	0.00	0.28	0.28
22	9.60	70	3	1.89	7.26	0.00	0.30	3.38	1.07	5.15	0.00	0.48	0.48
23	4.10	35	0	1.72	2.20	0.00	0.39	2.28	0.37	1.45	0.00	0.57	0.57
Total	222.30	150	0	8.51	212.83	0.00	0.22	16.20	2.09	204.01	0.00	0.25	0.25

Note) Zone 1 : Urban center, Commercial and Residential areas
 Zone 2 : Industrial areas
 Zone 3 : Agricultural lands and Open spaces
 Zone 4 : Water surfaces

Table 3.3 Calculated Basic Flood Runoff in Oued Hammam Basin

Runoff Calculation by Rational Method

(Present Land Use)

Calc. Point	Sub-basin Combination	Total Area (sq.km)	Runoff Coeff. f	Design tc (min)	Calc. Q(1.05) (cu.m/s)	Calc. Q(2) (cu.m/s)	Calc. Q(5) (cu.m/s)	Calc. Q(10) (cu.m/s)	Calc. Q(25) (cu.m/s)	Calc. Q(50) (cu.m/s)	Calc. Q(100) (cu.m/s)
1	1	52.50	0.20	276	13.3	16.6	22.6	28.7	39.1	49.5	62.7
2	2	8.60	0.20	106	4.4	5.5	7.5	9.5	13.0	16.5	20.9
3	1-2	61.10	0.20	276	15.5	19.3	26.4	33.4	45.6	57.6	73.0
4	1-3	99.80	0.20	352	21.1	26.3	36.0	45.5	62.1	78.6	99.5
5	4	14.90	0.20	98	8.1	10.1	13.8	17.5	23.9	30.2	38.3
6	1-4	114.70	0.20	352	24.3	30.3	41.3	52.3	71.4	90.4	114.4
7	1-5	130.50	0.20	410	24.7	30.8	42.0	53.2	72.6	91.9	116.3
8	1-6	135.70	0.20	434	24.6	30.7	41.9	53.0	72.4	91.6	115.9
9	7	10.70	0.20	116	5.1	6.4	8.8	11.1	15.1	19.2	24.3
10	7-8	12.40	0.20	148	5.0	6.2	8.5	10.7	14.7	18.6	23.5
11	1-8	148.10	0.20	434	26.8	33.5	45.7	57.8	79.0	99.9	126.5
12	1-9	155.90	0.20	458	27.2	33.9	46.2	58.5	79.9	101.1	128.0
13	1-10	163.70	0.20	504	26.6	33.1	45.2	57.2	78.2	99.9	125.2
14	11	4.60	0.20	72	3.2	3.9	5.4	6.8	9.3	11.7	14.8
15	12	6.20	0.20	88	5.0	6.2	8.5	10.7	14.7	18.6	23.5
16	12-13	9.80	0.29	100	6.1	7.5	10.3	13.0	17.8	22.5	28.5
17	14	3.20	0.20	44	3.2	3.9	5.4	6.8	9.3	11.7	14.9
18	14-15	12.60	0.21	102	7.0	8.7	11.9	15.1	20.6	26.1	33.0
19	12-15	22.40	0.22	102	13.0	16.3	22.2	28.1	38.4	48.6	61.5
20	12-16	23.50	0.23	122	12.5	15.6	21.3	27.0	36.9	46.6	59.0
21	17	4.40	0.34	56	6.2	7.7	10.5	13.3	18.2	23.0	29.1
22	12-17	27.90	0.25	122	16.2	20.2	27.5	34.8	47.6	60.2	76.2
23	12-18	28.10	0.25	130	15.5	19.4	26.4	33.5	45.7	57.8	73.2
24	19	11.00	0.20	88	6.5	8.1	11.1	14.0	19.1	24.2	30.6
25	12-19	39.10	0.23	130	19.9	24.8	33.9	42.8	58.5	74.0	93.7
26	12-20	40.00	0.24	144	19.7	24.5	33.5	42.4	57.9	73.3	92.8
27	12-21	40.30	0.24	154	18.9	23.5	32.1	40.7	55.5	70.3	88.9
28	1-21	208.60	0.21	504	35.5	44.3	60.5	76.6	104.6	132.3	167.5
29	1-22	218.20	0.21	530	35.8	44.7	61.0	77.2	105.4	133.4	168.8
30	1-23	222.30	0.22	558	36.8	45.9	62.6	79.3	108.3	137.0	173.4

Runoff Calculation by Rational Method

(Future Land Use Condition)

Calc. Point	Sub-basin Combination	Total Area (sq.km)	Runoff Coeff. f	Design tc (min)	Calc. Q(1.05) (cu.m/s)	Calc. Q(2) (cu.m/s)	Calc. Q(5) (cu.m/s)	Calc. Q(10) (cu.m/s)	Calc. Q(25) (cu.m/s)	Calc. Q(50) (cu.m/s)	Calc. Q(100) (cu.m/s)
1	1	52.50	0.20	276	13.3	16.6	22.6	28.7	39.1	49.5	62.7
2	2	8.60	0.20	106	4.4	5.5	7.5	9.5	13.0	16.5	20.9
3	1-2	61.10	0.20	276	15.5	19.3	26.4	33.4	45.6	57.6	73.0
4	1-3	99.80	0.20	352	21.1	26.3	36.0	45.5	62.1	78.6	99.5
5	4	14.90	0.20	98	8.1	10.1	13.8	17.5	23.9	30.2	38.3
6	1-4	114.70	0.20	352	24.3	30.3	41.3	52.3	71.4	90.4	114.4
7	1-5	130.50	0.20	410	24.7	30.8	42.0	53.2	72.6	91.9	116.3
8	1-6	135.70	0.20	434	24.6	30.7	41.9	53.0	72.4	91.6	115.9
9	7	10.70	0.20	116	5.1	6.4	8.8	11.1	15.1	19.2	24.3
10	7-8	12.40	0.21	148	5.2	6.5	8.9	11.3	15.4	19.5	24.7
11	1-8	148.10	0.20	434	26.8	33.5	45.7	57.8	79.0	99.9	126.5
12	1-9	155.90	0.22	458	28.9	37.2	50.8	64.4	87.9	111.2	140.8
13	1-10	163.70	0.21	504	27.9	34.8	47.5	60.1	82.1	103.8	131.5
14	11	4.60	0.20	72	3.2	3.9	5.4	6.8	9.3	11.7	14.8
15	12	6.20	0.20	88	5.0	6.2	8.5	10.7	14.7	18.6	23.5
16	12-13	9.80	0.29	100	7.6	9.5	13.0	16.4	22.5	28.4	36.0
17	14	3.20	0.20	44	3.2	3.9	5.4	6.8	9.3	11.7	14.9
18	14-15	12.60	0.24	102	8.0	10.0	13.6	17.2	23.5	29.8	37.7
19	12-15	22.40	0.27	102	16.0	20.0	27.2	34.5	47.1	59.6	75.4
20	12-16	23.50	0.29	122	15.8	19.7	26.9	34.0	45.5	58.8	74.5
21	17	4.40	0.49	56	8.9	11.1	15.1	19.2	26.2	33.1	41.9
22	12-17	27.90	0.32	122	20.7	25.8	35.2	44.6	60.9	77.1	97.5
23	12-18	28.10	0.32	130	19.9	24.8	33.9	42.8	58.5	74.0	93.7
24	19	11.00	0.23	88	7.5	9.3	12.7	16.1	22.0	27.8	35.2
25	12-19	39.10	0.30	130	25.9	32.3	44.2	55.9	76.3	96.6	122.3
26	12-20	40.00	0.30	144	24.8	30.7	41.9	53.0	72.4	91.6	116.0
27	12-21	40.30	0.30	154	23.6	29.4	40.2	50.8	69.4	87.8	111.2
28	1-21	208.60	0.23	504	38.9	48.5	66.3	83.9	114.5	144.9	183.5
29	1-22	218.20	0.24	530	40.9	51.0	69.7	88.2	120.4	152.4	192.9
30	1-23	222.30	0.25	558	41.8	52.1	71.2	90.1	123.0	155.7	197.1

Table 4.1 Present Land use Proportion in the Study Area of Regional Sousse

	Hamam Sousse	Akouda	Kalaa Kebira	Kalla Seghira	Regional Area	Total
Urbanized Area	2.5km ²	1.8km ²	4.1km ²	2.2km ²	-	10.6km ²
Agricultural (olive)	-	-	-	-	171.3km ²	171.3km ²
Agricultural (orange)/ Open Space	-	-	-	-	40.4km ²	40.4km ²
Total	2.5km ²	1.8km ²	4.1km ²	2.2km ²	211.7km ²	222.3km ²

Source : Calculated by the study team

Table 4.2 Future Land use Proportion in the Study Area of Regional Sousse

	Hamam Sousse	Akouda	Kalaa Kebira	Kalla Seghira	Regional Area	Total
Urbanized Area	3.7km ²	2.5km ²	5.9km ²	3.8km ²	-	15.9km ²
Industrial	-	-	-	-	2.3km ²	2.3km ²
Urban Green	-	-	-	-	4.3km ²	4.3km ²
Agricultural (high irrigated)	-	-	-	-	114.1km ²	114.1km ²
Agricultural (mid, low irrigated)	-	-	-	-	85.7km ²	85.7km ²
Total	3.7km ²	2.5km ²	5.9km ²	3.8km ²	206.4km ²	222.3km ²

Source : Calculated by the study team

Table 6.1 Environmental Impact Assessment Matrix for Oued Hammam Study Area

Project Component	Natural resources		Natural physical		Natural ecology		Environmental parameters				Socio-economic/quality of life												
	Watershed erosion	Surface water hydrology	Surface water quality	Ground water	Soil erosion	Green area	Freshwater fisheries	Marine fisheries	Land use changes	Roads	Drainage/flooding	Canal/weir maintenance	Employment opportunities	(short term)	Public health	Water supplies	Cultural buildings/sights	Recreation	Environmental aesthetics	Transportation disruption	Air pollution	Noise pollution	
Proposed works (post construction effects)																							
River improvement works by channel widening and deepening	N	1	1	N	1	N	N	N	N	1	2	1	N		2	N	N	2	2	N	N	N	N
Levee construction	N	N	N	N	1	1	N	N	N	1	2	1	N		2	N	N	2	2	N	N	N	N
Bridge construction or renewal	N	1	N	N	1	N	N	N	N	2	2	1	N		2	N	N	1	2	N	N	N	N
Type of works (during construction effects)																							
Dredging	N	N	N	N	(1)	(1)	N	N	N	N	N	(1)	2		(1)	N	N	(1)	(1)	(1)	(1)	(1)	(1)
Excavation and filling	N	N	N	N	(1)	(1)	N	N	N	N	(1)	(1)	2		(1)	N	N	(1)	(1)	(1)	(1)	(1)	(1)
Concreting	N	N	N	N	N	N	N	N	N	N	N	(1)	2		N	N	N	(1)	(1)	(1)	(1)	(1)	(1)

Notes: Levels of effects
 N = No significant effect. 1 = Slight effect 2 = Significant effect 3 = Major effect
 Parentheses indicate negative or adverse effect

Table 7.1 Flood Inundation Area and Duration of Oued Hammam (1/2)

Zone-A (from river mouth to GP-1 Road)

Return Period (year)	Present Land Use Condition					Future Land Use Condition (2020)				
	Flood Area (ha)				Duration (hours)	Flood Area (ha)				Duration (hours)
	Urban	Agricul.	Open	Total		Urban	Agricul.	Open	Total	
1.05	0	0	12	12	12	0	0	12	12	13
2	0	1	12	13	14	1	2	12	15	16
5	5	12	13	30	16	20	16	14	50	18
10	20	29	14	63	19	40	28	14	82	22
25	23	72	15	110	25	50	60	15	125	28
50	27	93	15	135	29	60	70	15	145	33
100	30	107	16	153	36	70	74	16	160	39

Zone-B (from GP-1 Road to Bypass Road of GP-1)

Return Period (year)	Present Land Use Condition					Future Land Use Condition (2020)				
	Flood Area (ha)				Duration (hours)	Flood Area (ha)				Duration (hours)
	Urban	Agricul.	Open	Total		Urban	Agricul.	Open	Total	
1.05	0	1	4	5	12	0	1	4	5	13
2	0	2	4	6	13	1	3	4	8	14
5	2	6	5	13	15	4	7	5	16	16
10	5	9	5	19	17	7	10	5	22	20
25	6	15	6	27	24	11	14	6	31	26
50	8	19	6	33	27	13	17	6	36	30
100	10	23	6	39	33	16	20	6	42	37

Zone-C (from Bypass Road of GP-1 to junction with Oued Kebir)

Return Period (year)	Present Land Use Condition					Future Land Use Condition (2020)				
	Flood Area (ha)				Duration (hours)	Flood Area (ha)				Duration (hours)
	Urban	Agricul.	Open	Total		Urban	Agricul.	Open	Total	
1.05	0	1	8	9	11	0	1	8	9	12
2	0	2	8	10	12	0	3	8	11	13
5	0	3	9	12	13	0	4	9	13	14
10	0	5	9	14	15	0	6	9	15	17
25	1	10	9	20	22	2	14	9	25	24
50	2	16	10	28	25	3	21	10	34	27
100	3	25	10	38	30	6	25	10	41	33

Zone-D (from junction with Oued Kebir to upstream)

Return Period (year)	Present Land Use Condition					Future Land Use Condition (2020)				
	Flood Area (ha)				Duration (hours)	Flood Area (ha)				Duration (hours)
	Urban	Agricul.	Open	Total		Urban	Agricul.	Open	Total	
1.05	0	0	4	4	3	0	0	4	4	3
2	0	0	5	5	6	0	0	5	5	7
5	0	1	5	6	9	0	1	5	6	9
10	0	2	5	7	11	0	3	5	8	11
25	0	5	5	10	13	0	7	5	12	13
50	0	8	6	14	15	0	11	6	17	16
100	0	13	6	19	18	0	15	6	21	19

Table 7.1 Flood Inundation Area and Duration of Oued Hammam (2/2)

Zone-E (from junction with Oued Laia to MC-48 Road)

Return Period (year)	Present Land Use Condition					Future Land Use Condition (2020)				
	Flood Area (ha)				Duration (hours)	Flood Area (ha)				Duration (hours)
	Urban	Agricul.	Open	Total		Urban	Agricul.	Open	Total	
1.05	0	1	4	5	2	0	1	4	5	3
2	0	1	4	5	3	0	2	4	6	4
5	0	2	4	6	4	0	3	4	7	5
10	0	3	4	7	5	0	4	4	8	6
25	0	4	4	8	6	1	5	4	10	7
50	1	4	4	9	7	2	5	5	12	8
100	1	5	5	11	8	3	7	5	15	10

Zone-F (from MC-48 Road to Railway)

Return Period (year)	Present Land Use Condition					Future Land Use Condition (2020)				
	Flood Area (ha)				Duration (hours)	Flood Area (ha)				Duration (hours)
	Urban	Agricul.	Open	Total		Urban	Agricul.	Open	Total	
1.05	0	3	3	6	2	0	4	3	7	3
2	0	4	3	7	3	0	5	3	8	4
5	0	5	3	8	4	0	7	3	10	5
10	0	7	3	10	5	0	10	3	13	6
25	0	10	3	13	6	1	11	3	15	7
50	0	11	3	14	7	1	12	3	16	8
100	1	12	3	16	8	1	13	3	17	9

Zone-G (from Railway to upstream)

Return Period (year)	Present Land Use Condition					Future Land Use Condition (2020)				
	Flood Area (ha)				Duration (hours)	Flood Area (ha)				Duration (hours)
	Urban	Agricul.	Open	Total		Urban	Agricul.	Open	Total	
1.05	0	0	5	5	2	0	0	5	5	3
2	0	0	6	6	3	0	0	6	6	3
5	0	1	6	7	3	0	2	6	8	4
10	1	2	6	9	4	1	2	6	9	5
25	1	3	6	10	4	1	4	6	11	5
50	1	4	6	11	5	2	4	6	12	6
100	1	5	6	12	6	2	5	6	13	8

Total

Return Period (year)	Present Land Use Condition					Future Land Use Condition (2020)				
	Flood Area (ha)				Duration (hours)	Flood Area (ha)				Duration (hours)
	Urban	Agricul.	Open	Total		Urban	Agricul.	Open	Total	
1.05	0	6	40	46	2~12	0	7	40	47	3~13
2	0	10	42	52	3~14	2	15	42	59	3~16
5	7	30	45	82	3~16	24	40	46	110	4~18
10	26	57	46	129	4~19	48	63	46	157	5~22
25	31	119	48	198	4~25	66	115	48	229	5~28
50	39	155	50	244	5~29	81	140	51	272	6~33
100	46	190	52	288	6~36	98	159	52	309	8~39

Table 10.1 Estimates of Traffic Flows on the GP-1 and the GP-1 By-Pass - Traffic Census 1992

CATEGORY	BY-PASS OF GP-1			GP-1		
	March	April	Average	March	April	Average
	A+B : 2 WHEELS	350	320	335	2879	2119
C: TAXIS AND PRIVATE CARS	4487	5469	4978	11727	9817	10772
D+E : LIGHT TRUCKS	3474	5053	4263	4531	3985	4258
F : HEAVY VEHICLES	1720	2642	2181	502	709	605
AUTOBUS	111	120	115	470	497	483
TOTAL	10142	13604	11873	20109	17127	18618

Table 10.2 Estimated Flows of Traffic on the GP-1 and GP-1 By Pass - 1993

CATEGORY	BY-PASS OF GP-1			GP-1		
	March	April	Average	March	April	Average
	A+B : 2 WHEELS	175	160	167,5	1439,5	1059,5
C: TAXIS AND PRIVATE CARS	2243,5	2734,5	2489	5863,5	4908,5	5386
D+E : LIGHT TRUCKS	1737	2526,5	2131,5	2265,5	1992,5	2129
F : HEAVY VEHICLES	860	1321	1090,5	251	354,5	302,5
AUTOBUS	55,5	60	57,5	235	248,5	241,5
TOTAL	5071	6802	5936,5	10054,5	8563,5	9309

Table 10.3 Results of the Traffic Census on the MC 48 and the RVE 835 - 1992

CATEGORY	MC 48			RVE 845		
	March	April	Average	March	April	Average
A+B : 2 WHEELS	2806	2265	2535	1750	1656	1703
C: TAXIS AND PRIVATE CARS	6568	4583	5575	7569	9611	8634
D+E : LIGHT TRUCKS	3316	2577	2946	2772	2068	2420
F : HEAVY VEHICLES	938	802	870	392	177	284
AUTOBUS	354	242	298	188	368	278
TOTAL	13982	10469	12225	12671	13968	13319

Table 10.4 Estimate of Present and Future Traffic Flows on the GP-1 Bypass, 1993 and 2020

CATEGORY	BYPASS OF GP-1					
	1993			2020		
	OCCUP.	Veh/day	Pass.	Veh/day	Pass.	
A+B : 2 WHEELS	1,2	167,5	201	910	1092	
C: TAXIS AND PRIVATE CARS	3,8	2489	9458,2	13500	51300	
D+E : LIGHT TRUCKS	2	2131,5	4263	11600	23200	
F : HEAVY VEHICLES	2	1090,5	2181	6000	12000	
AUTOBUS	45	57,5	2587,5	300	13500	
TOTAL		5936,5	18690,7	32310	101092	

Table 10.5 Estimates of Present and Future Traffic Flows on the GP-1, 1993 and 2020

CATEGORY	1993						2020	
	Occup.	Veh/Day		Pass.	Veh.	Pass.		
A+B : 2 WHEELS	1,2	1250	1499	3400	4080			
C: TAXIS AND PRIVATE CARS	3,8	5386	20467	14600	55480			
D+E : LIGHT TRUCKS	2	2129	4258	5200	10400			
F : HEAVY VEHICLES	2	303	605	800	1600			
AUTOBUS	45	242	10868	650	29250			
TOTAL		9309	37697	24650	100810			

Table 10.6 Estimates of Present and Future Traffic Flows on the MC 48, 1993 and 2020

CATEGORY	1993		2020	
	Occup.	Veh/Day	Pass.	Veh/Day
A+B : 2 WHEELS	1,2	2535	3042	6800
C: TAXIS AND PRIVATE CARS	3,8	5575	21185	15200
D+E : LIGHT TRUCKS	2	2946	5892	8050
F : HEAVY VEHICLES	2	870	1740	2300
AUTOBUS	45	298	13410	820
TOTAL		12224	45269	33170
				123520

Table 10.7 Estimates of Present and Future Traffic Flows on the RVE 835, 1993 and 2020

CATEGORY	1993		2020	
	OCCUPA	Veh/Day	Pass	Veh./Day
A+B : 2 WHEELS	1,2	1703	2044	4600
C: TAXIS AND PRIVATE CARS	3,8	8634	32809	23500
D+E : LIGHT TRUCKS	2	2420	4840	6600
F : HEAVY VEHICLES	2	284	568	800
AUTOBUS	45	278	12510	750
TOTAL		13319	52771	36250
				143370

Table 10.8 Population And Employment Data For Selected Delegations In The Sousse Area

DELEGATION	POPULATION	POPULATION EMPLOYED	UNEMPLOYMENT RATE (%)
Hammam Sousse	20037	6490	9.9
Akouda	11501	3840	13.7
Kalaa Kebira	31406	8840	11.5
Kalaa Seghira	12476	4260	4.3
TOTAL	75420	24430	

Table 10.9 Difference In Vehicle Operating Costs In Flooded And Non Flooded Cases (TD per 1000 vehicle/km).

VEHICLE TYPE	NON-FLOODED CASE	FLOODED CASE	DIFFERENCE
Private Car / Taxi	114.51	143.3	28.79
Bus	459.57	511.17	51.60
Light/Medium Goods	247.59	333.70	86.11
Heavy goods	663.81	900.54	236.73

Table 10.10 Employment in the Industrial Sector in Hammam Sousse

CATEGORY	NO OF ENTERPRISES	TOTAL EMPLOYEES
Agro-Industries	3	25
Construction Materials	2	28
Electrical and Mechanical	11	117
Chemical	1	10
Textiles and Leather	11	675
Miscellaneous	12	298
TOTAL	40	1153

Source :Industrial Promotion Agency

Table 10.11 Zone A Estimated loss of income by Category of passenger, under Present and Future Land use Conditions

CATEGORY	MOVEMENTS		VALUE OF TIME (TD)	LAND USE	
	Present	Future		PRESENT (3 DAYS)	FUTURE (4 DAYS)
Tourists	12 000	20 000	4.0	144 000	320 000
Skilled Labour	20 800	69 300	2.1	131 000	582 000
Unskilled Labour	19 950	54 070	0.7	42 000	151 000
TOTAL	52 750	143 370		317 000	1 053 000

Table 10.12 Additional Vehicle Operating Costs Per Day RVE 835; 1993 and 2020

VEHICLE TYPE	DIFFERENCE (TD per 1000 vehicle/km)	DAILY TRAFFIC		COSTS (TD) (30 DAYS)	
		Present Traffic (v.p.d)	Add. VOCs (TD)	Future Traffic (v.p.d)	Add. VOCs (TD)
Private Car / Taxi	28.79	8634	7 500	23500	20 300
Bus	51.60	278	450	750	1 200
Light/Medium Goods	86.11	2420	6 250	6600	17 000
Heavy goods	236.73	284	2 000	800	5 700
TOTAL			16 200		44 200

Table 10.13 Additional Diversion Vehicle Operating Costs Per Day, RVE 835 -1993 and 2020

VEHICLE TYPE	DIFFERENCE (TD per 1000 vehicle/km)	DAILY TRAFFIC		COSTS (TD) (30 DAYS)	
		Present Traffic (v.p.d)	Add. VOCs (TD)	Future Traffic (v.p.d)	Add. VOCs (TD)
Private Car / Taxi	114.51	8624	4000	23 500	13 500
Bus	459.57	278	650	750	1 750
Light/Medium Goods	247.59	2420	3000	6 600	9 800
Heavy goods	663.81	284	750	800	2 700
TOTAL			8 400		27 750

Table 10.14 Industries Located In Akouda And Kalaa Kebira

Category	Akouda		Kalaa Kebira	
	Number	Employment	Number	Employment
Agro-Industries	5	40	11	41
Construction Materials	5	91	1	10
Mechanical/Electrical	23	493	8	201
Chemical etc.	1	16	1	n.a.
Textile/Leather	25	1491	19	1065
Miscellaneous	26	1972	8	71
TOTAL	85	4103	48	1388

Source : Industrial Promotion Agency (Agence de Promotion de l'Industrie)

Table 10.15 Additional Vehicle Operating Costs Over Damaged Road Surfaces on the MC 48 1993 and 2020

VEHICLE TYPE	DIFFERENCE (TD per 1000 vehicle/km)	DAILY TRAFFIC		COSTS (TD) (30 DAYS)	
		Present	Add.	Future	Add.
		Traffic (v.p.d)	VOCs (TD)	Traffic (v.p.d)	VOCs (TD)
Private Car / Taxi	28.79	5575	2 500	15 200	6 500
Bus	51.60	298	250	820	650
Light/Medium Goods	86.11	2946	3 800	8050	10 400
Heavy goods	236.73	870	3 000	2300	8 200
TOTAL			9 550		25 750

Table 10.16 Additional Diversion Vehicle Operating Costs on the MC 48 : Present And Future Land Use Conditions

VEHICLE TYPE	DIFFERENCE (TD per 1000 vehicle/km)	DAILY TRAFFIC		COSTS (TD) (30 DAYS)	
		Present	Add.	Future	Add.
		Traffic (v.p.d)	VOCs (TD)	Traffic (v.p.d)	VOCs (TD)
Private Car / Taxi	114.51	5575	9 500	15200	26 100
Bus	459.57	298	2 100	820	5 700
Light/Medium Goods	247.59	2946	11 000	8050	30 000
Heavy goods	663.81	870	8 700	2300	23 000
TOTAL			31 300		84 800

Table 11.1 Summary of Project Cost, Hammam 1st Stage

(US\$1.0 = DT1.0)

Cost Items	F.C (1,000 US\$)	L.C (1,000 DT)	Total (1,000 DT)
1. Direct construction cost <1	3,643	2,680	6,323
2. Land acquisition and compensation costs	0	362	362
3. Government's administration expenses <2	0	316	316
4. Engineering services expenses <3	759	190	948
Sub-total	4,402	3,548	7,950
5. Price contingency <4	356	872	1,228
6. Physical contingency <5	600	635	1,235
Total	5,358	5,055	10,413

- Notes
- <1 : including TVA
 - <2 : 5 % of direct construction cost
 - <3 : 15 % of direct construction cost for detailed design and const. supervision including price and physical contingencies, 80 % of F.C
 - <4 : 2.3 % F.C and 6.2 % L.C p.a.
 - <5 : 15 % of total 1+2+3+5

Table 11.2 Summary of Project Cost, Hammam 2nd Stage

Cost Items	(US\$1.0 = DT1.0)		
	F.C (1,000 US\$)	L.C (1,000 DT)	Total (1,000 DT)
1. Direct construction cost <1	364	292	656
2. Land acquisition and compensation costs	0	0	0
3. Government's administration expenses <2	0	33	33
4. Engineering services expenses <3	79	20	98
Total	443	344	787

Notes

- <1 : including TVA
- <2 : 5 % of direct construction cost
- <3 : 15 % of direct construction cost for detailed design and const. supervision excluding price and physical contingencies, due to unknown factor, 80 % of F.C

Table 11.3 Annual Disbursement Schedule, Hammam 1st Stage

Cost Items	unit (F.C: 1,000 US\$, L.C & Total: 1,000 DT)													
	1994		1995		1996		1997		1998		1999		2000	
	F.C (US\$)	L.C (DT)	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C
1. Direct construction cost <1	3,643	2,680	6,323	0	0	0	0	729	536	1,822	1,340	1,093	804	
2. Land acquisition and compensation costs	0	362	362	0	0	362	0	0	0	0	0	0	0	0
3. Government's administration expenses <2	0	316	316	0	16	0	63	0	95	0	63	0	79	
4. Engineering services expenses <3	759	190	948	0	0	228	57	152	38	190	47	190	47	
Sub total *	4,402	3,548	7,950	0	16	0	425	729	631	1,822	1,403	1,093	883	
5. Price contingency <4	356	872	1,228	0	1	0	54	52	125	173	382	131	310	
6. Physical contingency <5	600	635	1,234											
Total	5,358	5,054	10,412											

Notes <1 : including TVA

<2 : 5 % of direct construction cost

<3 : 15 % of direct construction cost for detailed design and const. supervision including price and physical contingencies, 80 % F.C

<4 : 2.3 % F.C & 6.2 % L.C p.a., period for 1994-1998

<5 : 15 % of total 1+2+3+5, period for 1994-1998

* : Sub total in each year (1994-1998) excludes E/S cost (item 4).

Table 13.1 Cost Benefit Streams for Oued Hammam Flood Control Project

EIRR = 17.4%		(Unit : 1,000 DT)				
No.	Year	Cost			Benefit	Net Benefit
		Construction	O&M	Total		
1	1994	18	0	18	0	-18
2	1995	774	0	774	0	-774
3	1996	1,627	23	1,650	317	-1,333
4	1997	3,629	80	3,709	634	-3,075
5	1998	2,320	114	2,434	951	-1,483
6	1999		114	114	1,268	1,154
7	2000		114	114	1,318	1,204
8	2001		114	114	1,369	1,255
9	2002		114	114	1,419	1,305
10	2003		114	114	1,470	1,356
11	2004		114	114	1,520	1,406
12	2005		114	114	1,571	1,457
13	2006		114	114	1,621	1,507
14	2007		114	114	1,672	1,558
15	2008		114	114	1,722	1,608
16	2009		114	114	1,773	1,659
17	2010		114	114	1,823	1,709
18	2011		114	114	1,874	1,760
19	2012		114	114	1,924	1,810
20	2013		114	114	1,975	1,861
21	2014		114	114	2,025	1,911
22	2015		114	114	2,076	1,962
23	2016		114	114	2,126	2,012
24	2017		114	114	2,177	2,063
25	2018		114	114	2,227	2,113
26	2019		114	114	2,278	2,164
27	2020		114	114	2,328	2,214
28	2021		114	114	2,328	2,214
29	2022		114	114	2,328	2,214
30	2023		114	114	2,328	2,214
31	2024		114	114	2,328	2,214
32	2025		114	114	2,328	2,214
33	2026		114	114	2,328	2,214
34	2027		114	114	2,328	2,214
35	2028		114	114	2,328	2,214
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.
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50	2043		114	114	2,328	2,214

FIGURES

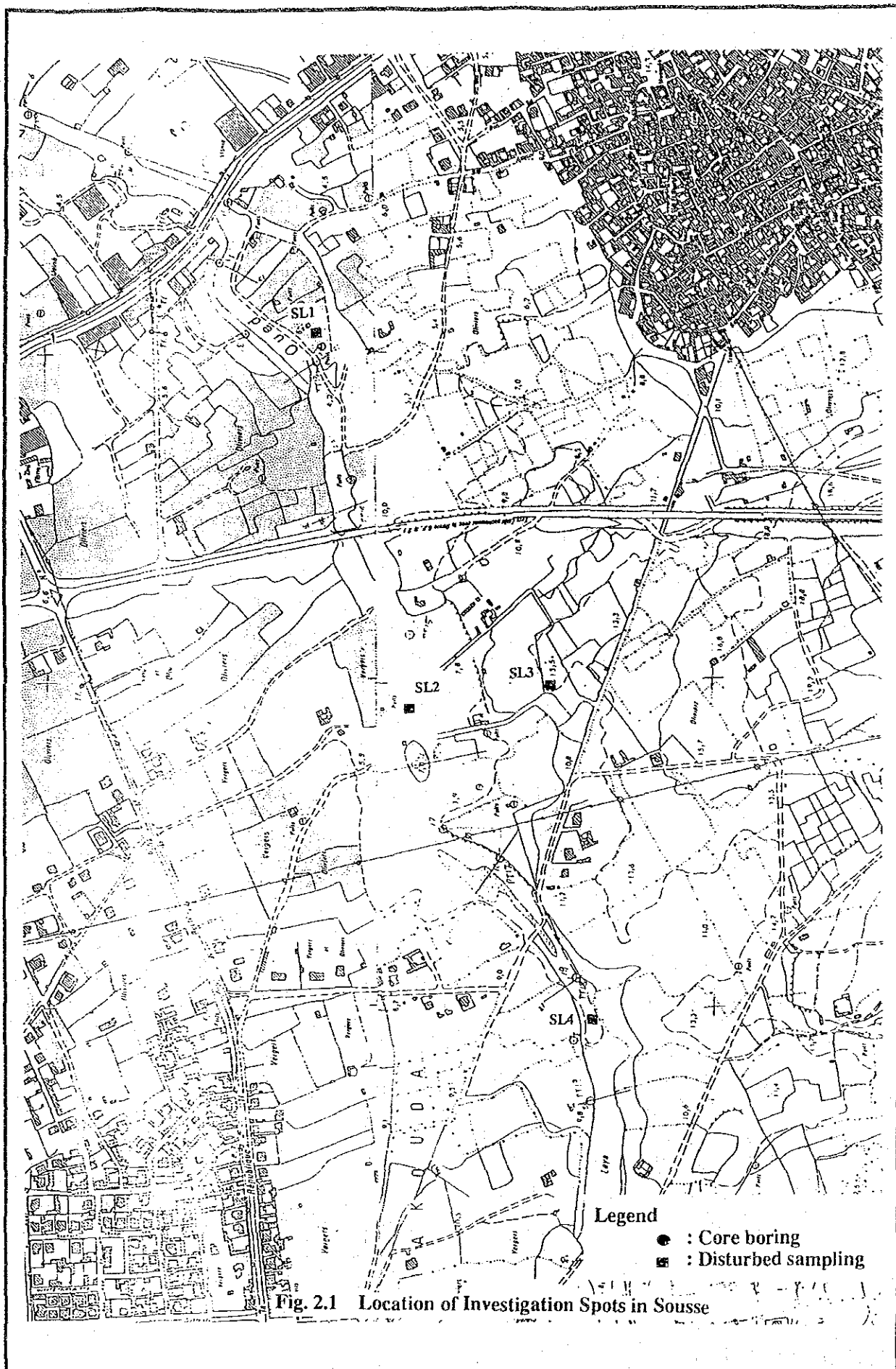


Fig. 2.1 Location of Investigation Spots in Sousse

SL1

Depth (m)	Sym-bol	Soil description
0		Top soil with organic matters
		Medium sand with some gravel
		Red
1		Sandy clay; Brown
2		
3		

SL2

Depth (m)	Sym-bol	Soil description
0		Medium sand; Yellow
1		Silty sand; Gray
2		Clayey fine sand; Brown
3		

SL3

Depth (m)	Sym-bol	Soil description
0		Top soil with organic matters
		Fine sand; Yellow
1		
2		
3		

Fig.2.2 Log of Sampling Spots for Levee Embankment Materials (1/2)

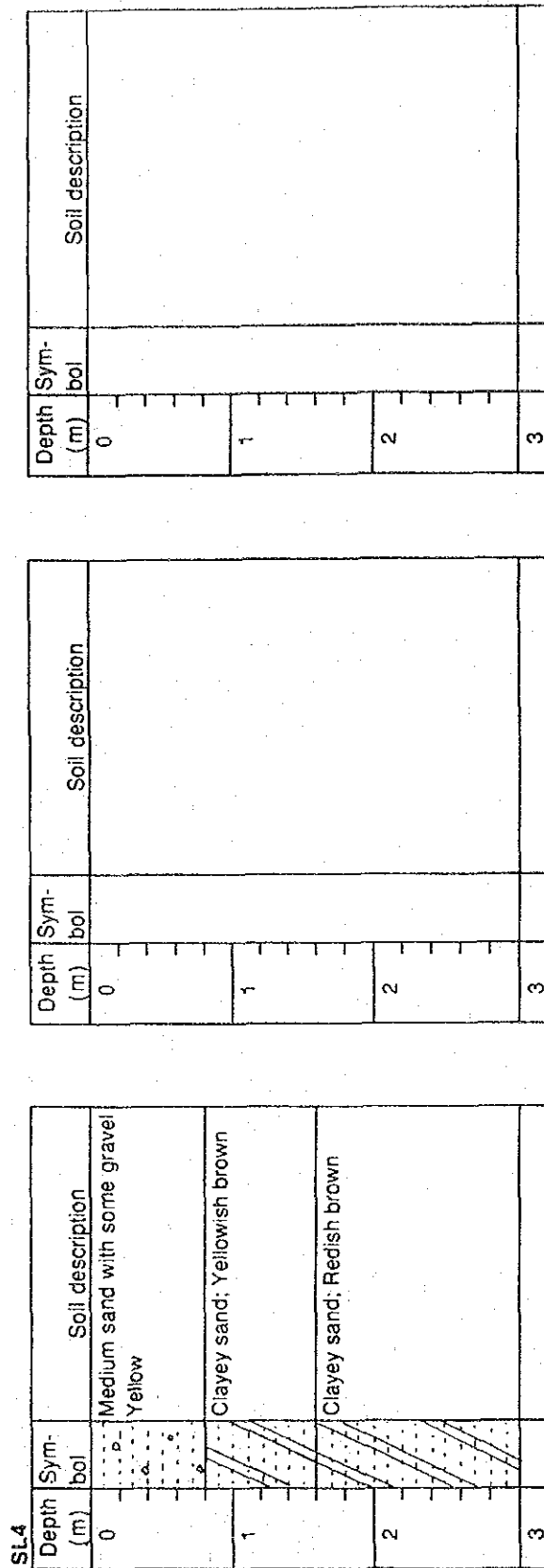


Fig.2.2 Log of Sampling Spots for Levee Embankment Materials (2/2)

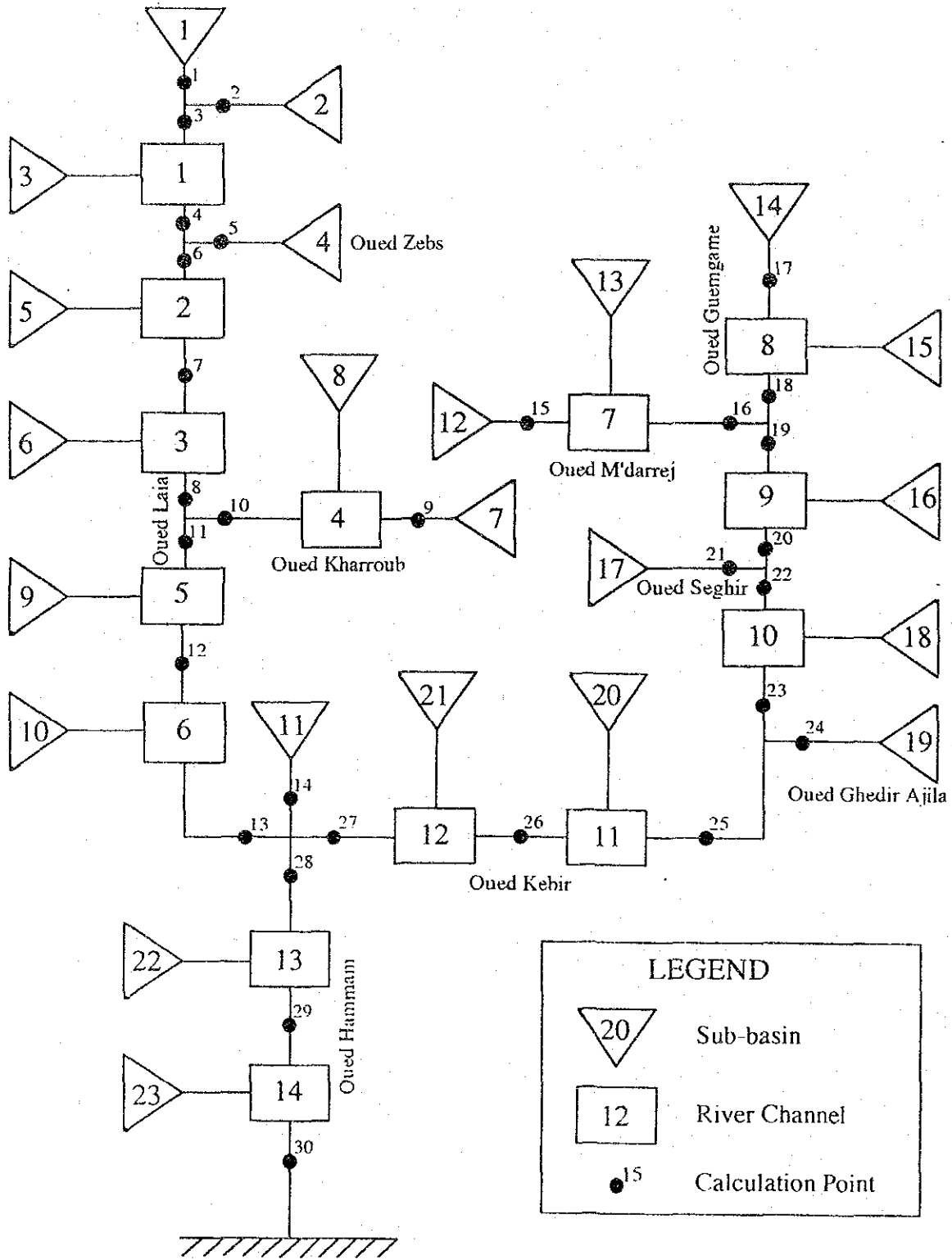


Fig. 3.1 River System Model of Oued Hammam

Fig. 3.2 Runoff Hydrograph in Oued Hammam Basin (1/4)

Calculation Point No.13

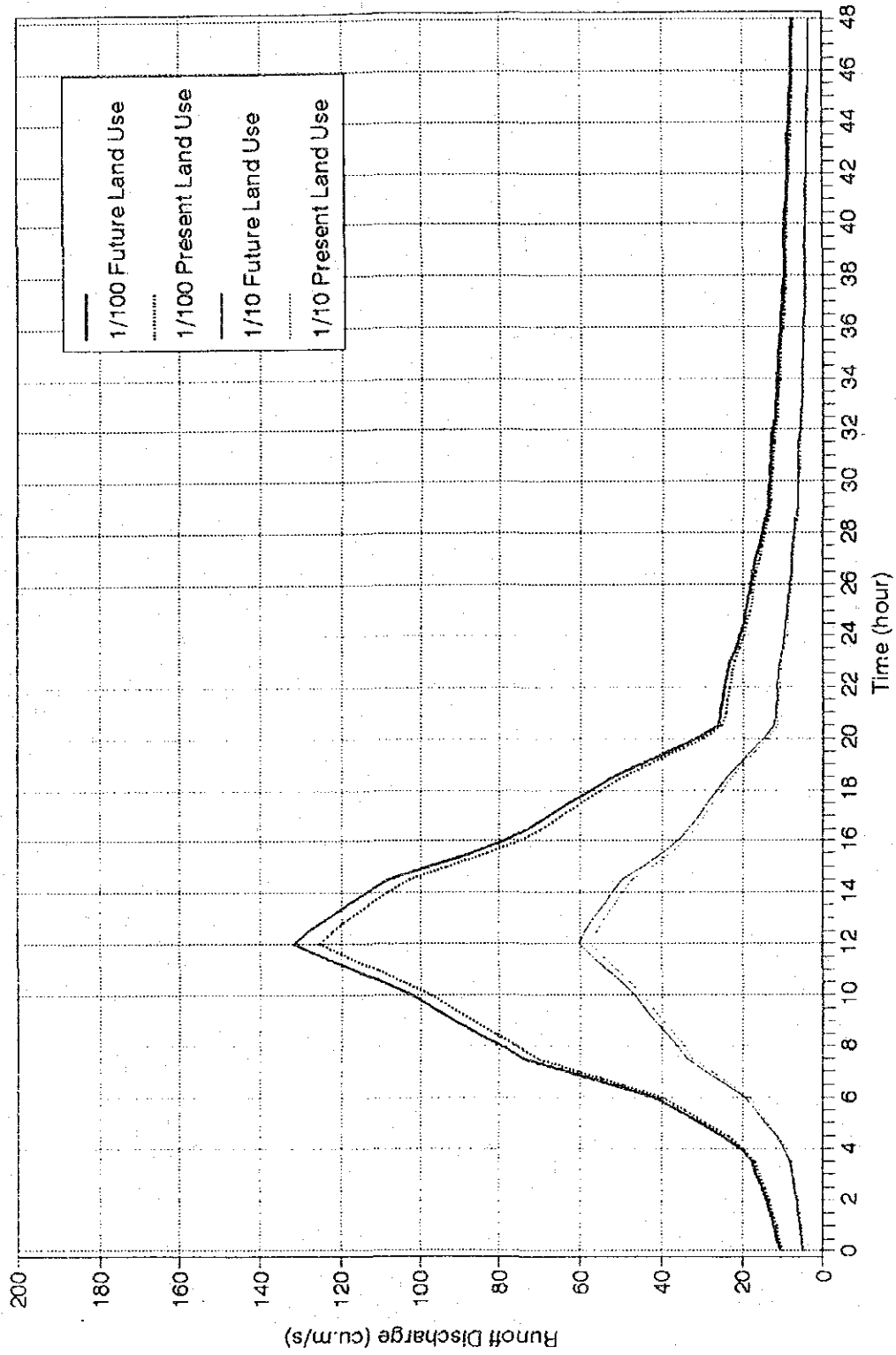


Fig. 3.2 Runoff Hydrograph in Oued Hammam Basin (2/4)
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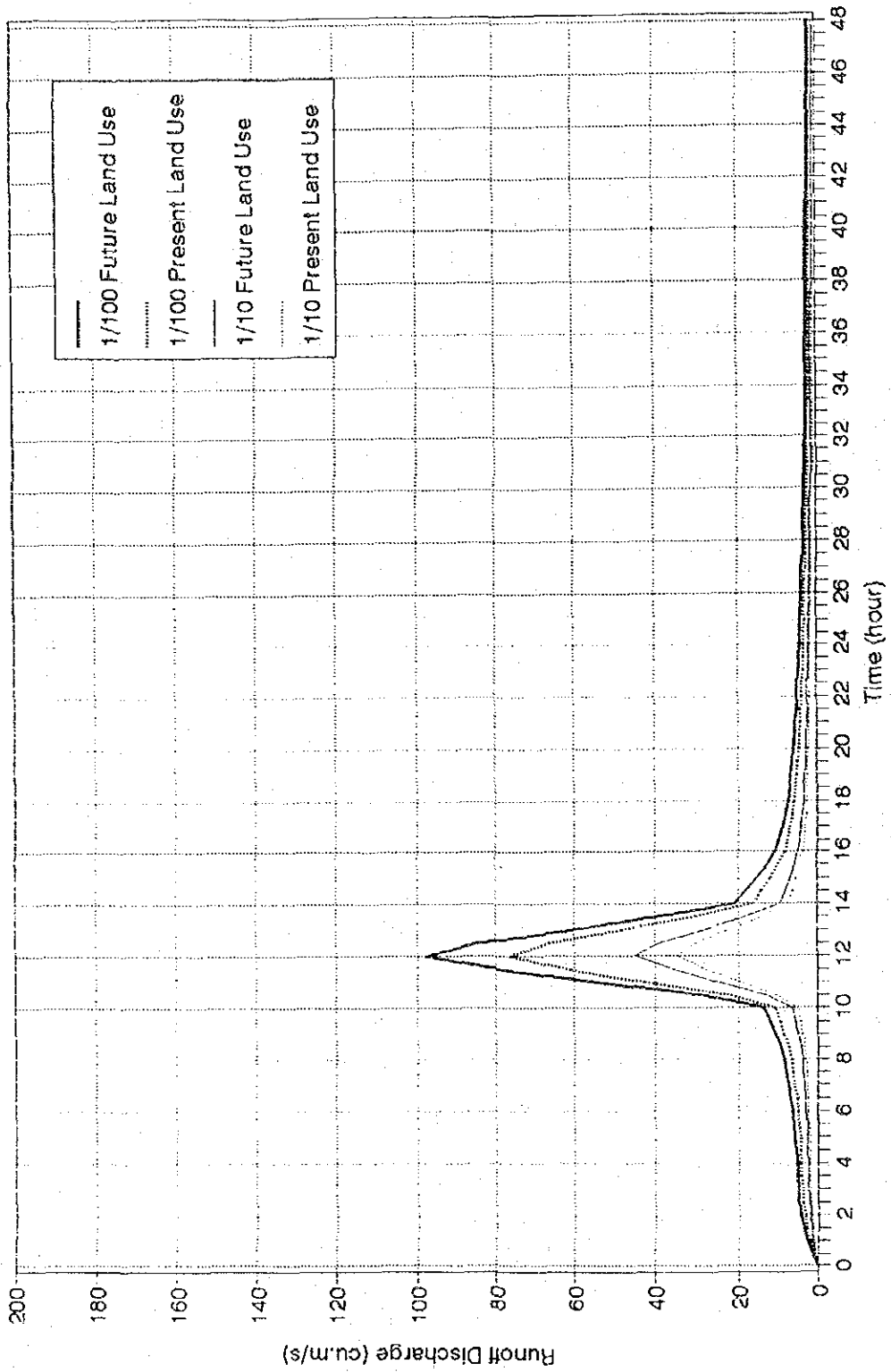


Fig. 3.2 Runoff Hydrograph in Oued Hammam Basin (3/4)
 Calculation Point No.27

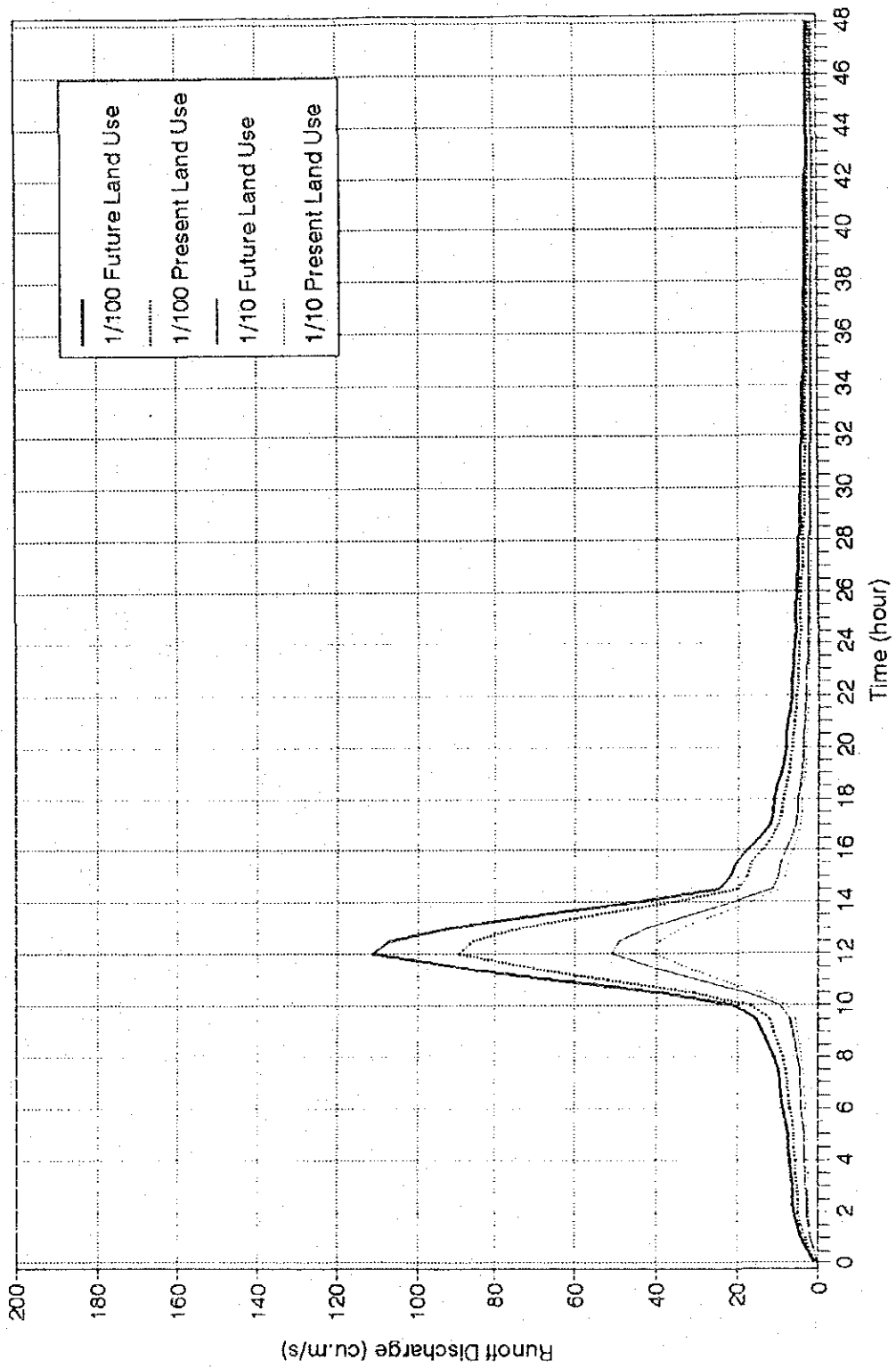
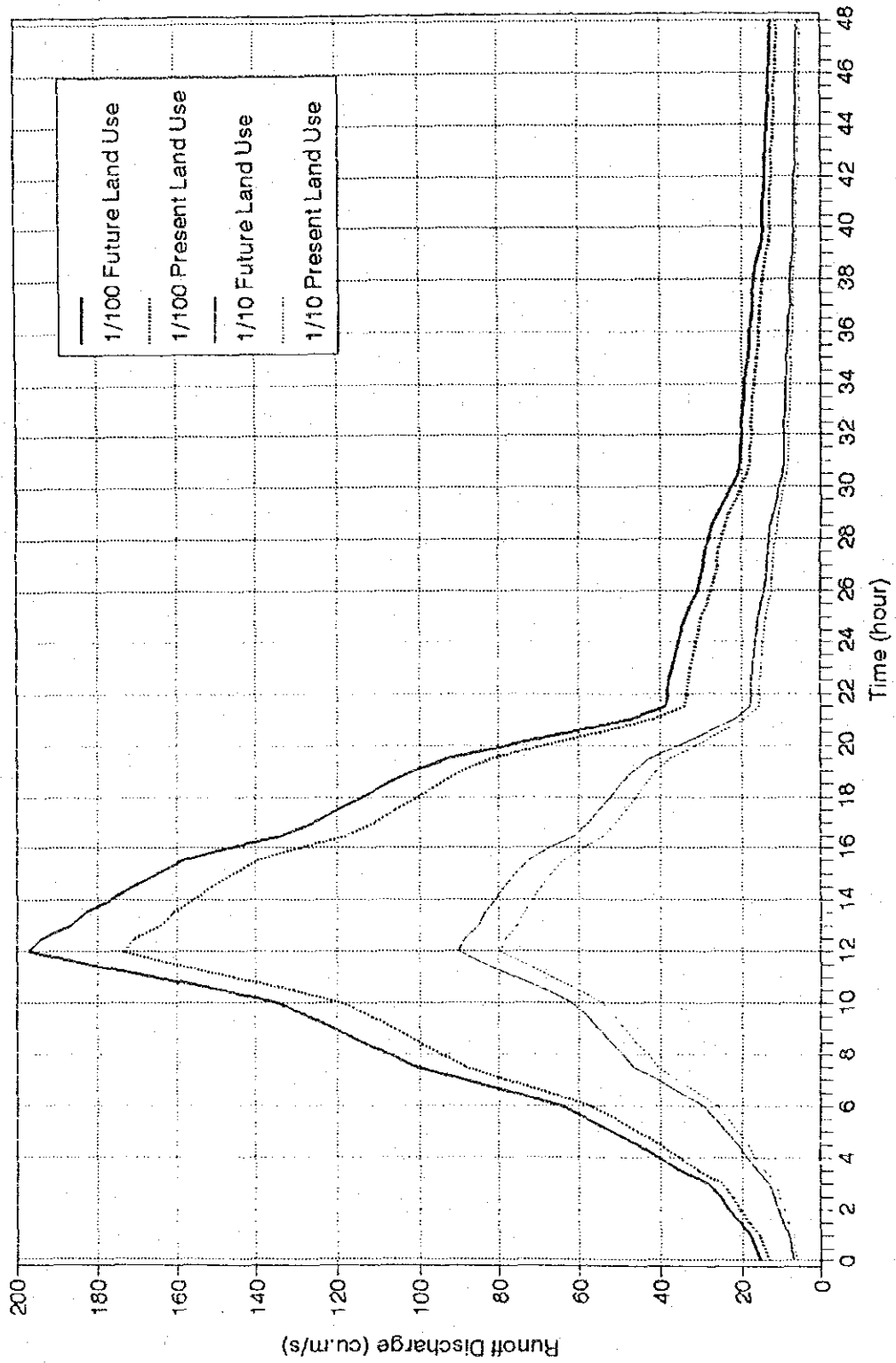


Fig. 3.2 Runoff Hydrograph in Oued Hammam Basin (4/4)

Calculation Point No.30



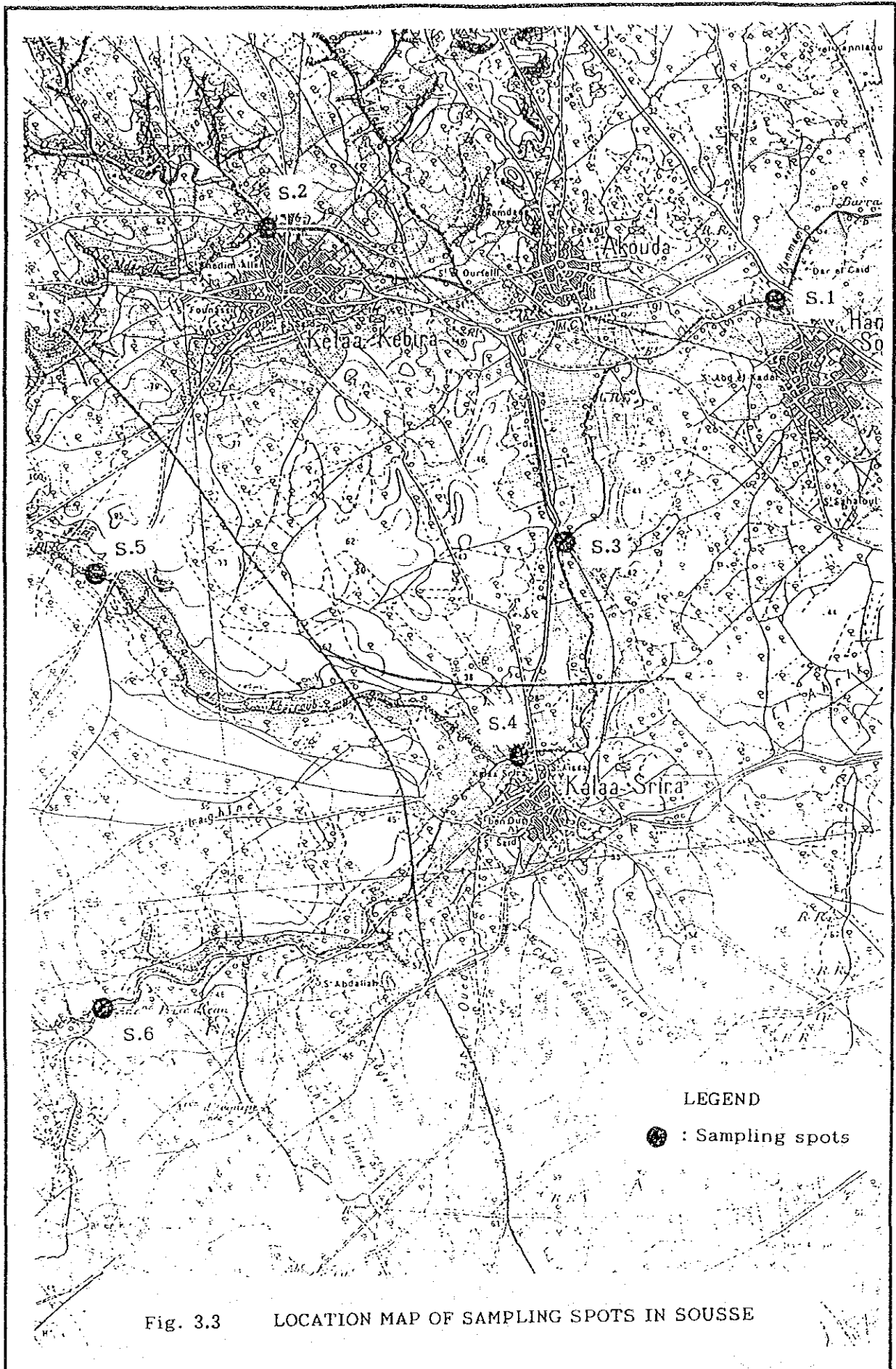
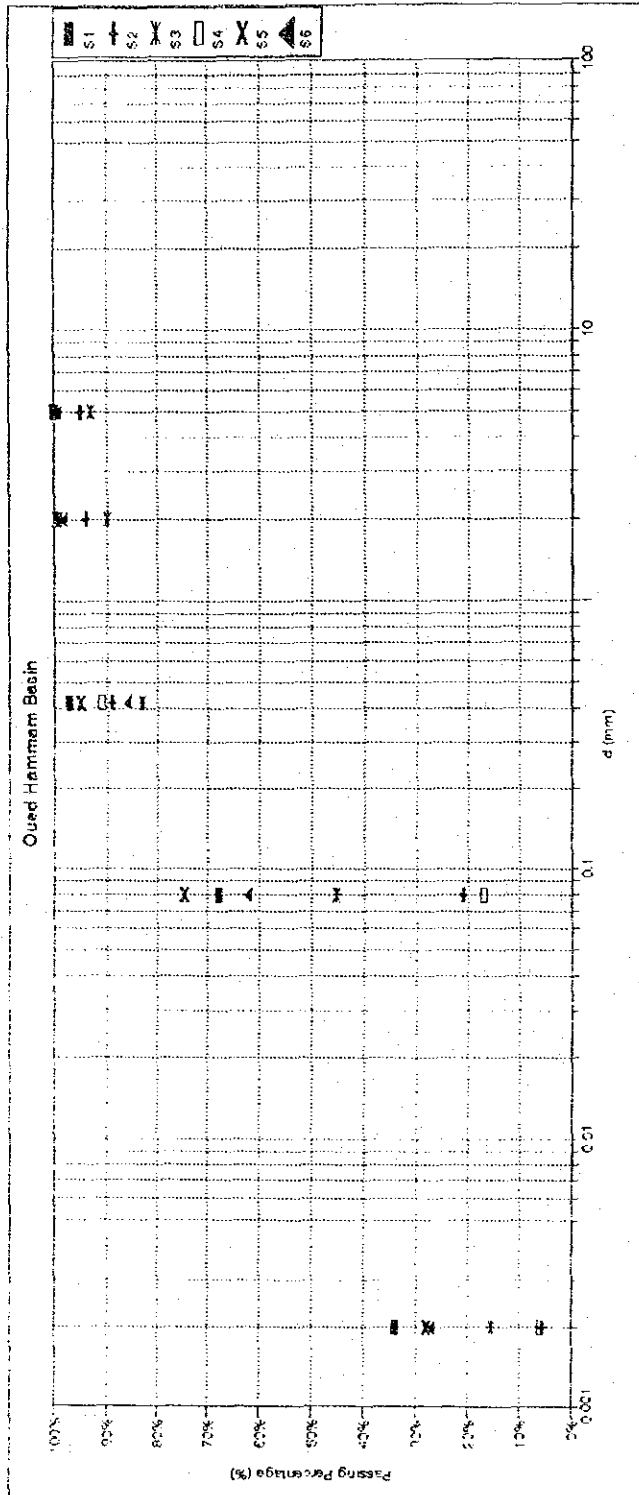


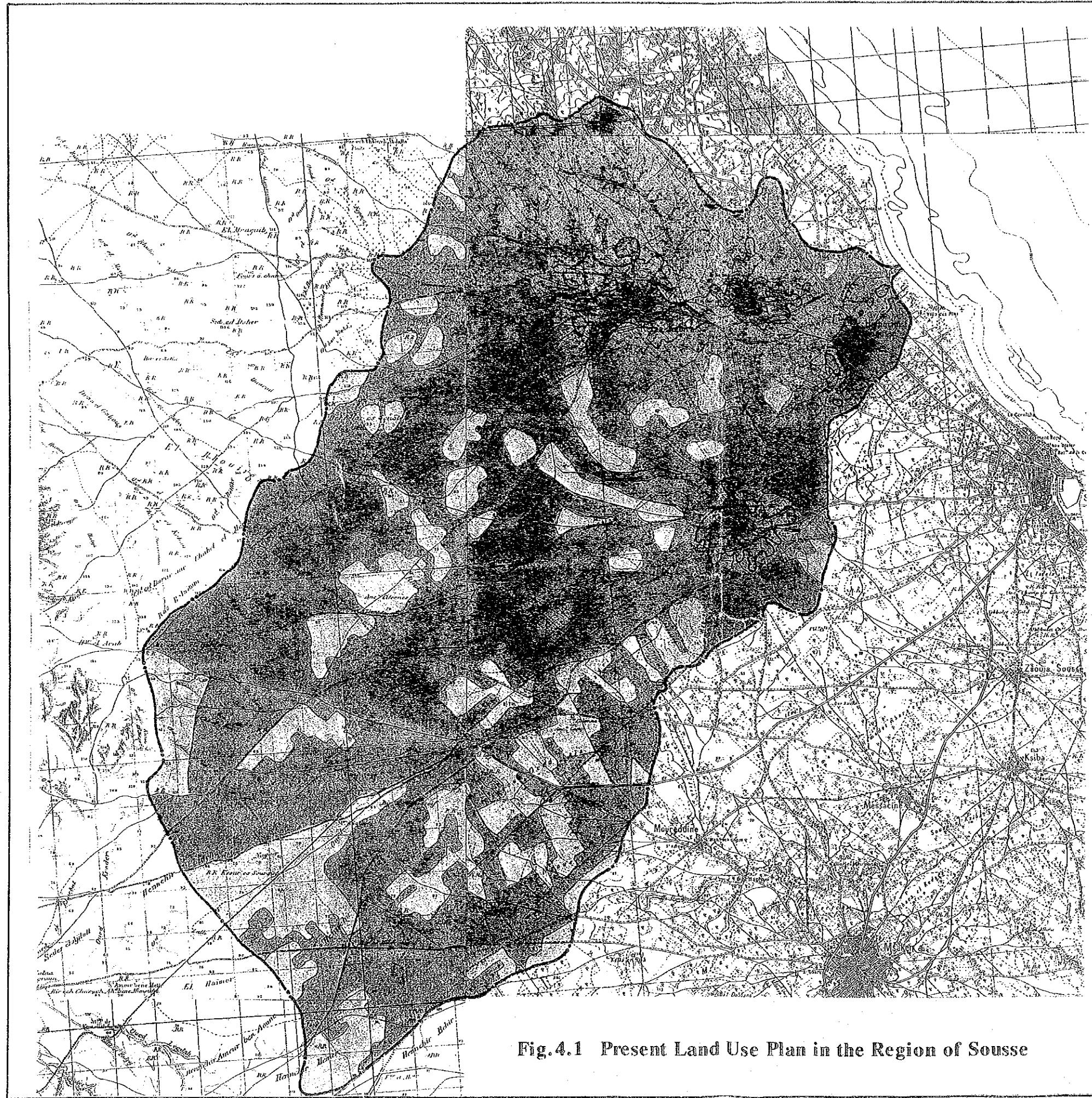
Fig. 3.3

LOCATION MAP OF SAMPLING SPOTS IN SOUSSE





Fig. 3.4 Result of Gradation Test of Qued Hammam Basin



Sampling Point	Specific Gravity	Gradation Test (Passing Percentage)						d50 (mm)
		< 0.002mm	< 0.08mm	< 0.42mm	< 2mm	< 5mm	< 0.075	
S1 (+ 2.0 km)	2.66	34.0%	68.0%	97.0%	99.0%	100.0%	0.0350	
S2 (+ 7.5 km)	2.61	5.5%	21.0%	89.0%	94.0%	95.0%	0.1200	
S3 (+ 5.8 km)	2.66	15.5%	45.0%	83.0%	90.0%	93.0%	0.1000	
S4 (+ 8.3 km)	2.63	5.0%	17.0%	91.0%	99.5%	100.0%	0.2100	
S5 (+ 13.0 km)	2.68	28.0%	74.5%	95.0%	99.5%	100.0%	0.0270	
S6 (+ 14.5 km)	2.67	27.0%	62.0%	86.0%	98.0%	99.0%	0.0360	



LEGEND

-  Urbanized Area
-  Agricultural (olive trees)
-  Agricultural Pomegranate, Orange trees / Open Space
-  Catchment Area

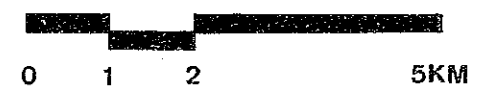
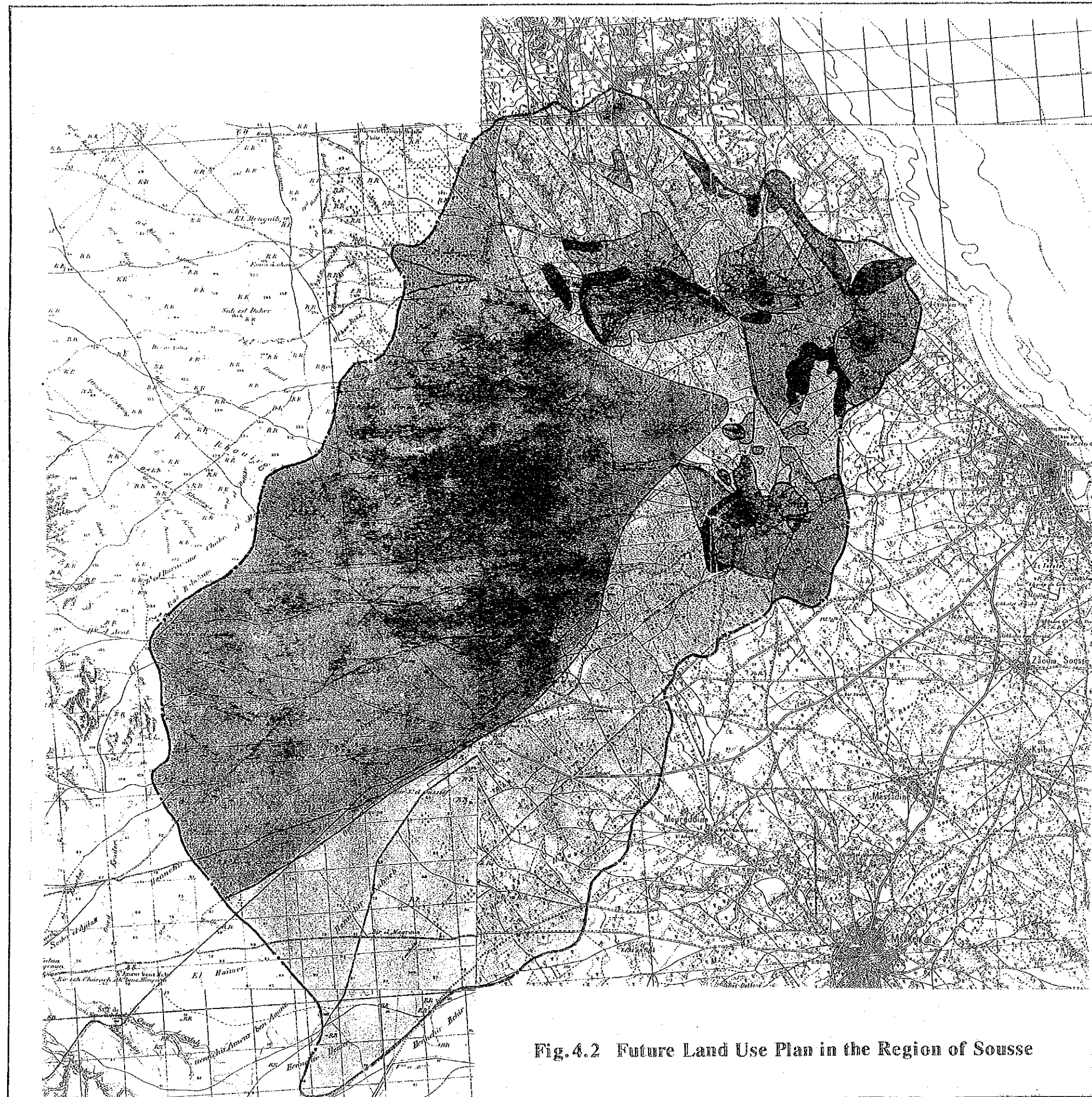




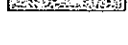
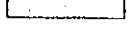


Fig.4.1 Present Land Use Plan in the Region of Sousse



LEGEND

-  Urbanized Area
-  Industrial
-  Urban Green
-  Agricultural (high-irrigated)
-  Agricultural (mid-irrigated, low-irrigated, non-irrigated)
-  Catchment Area

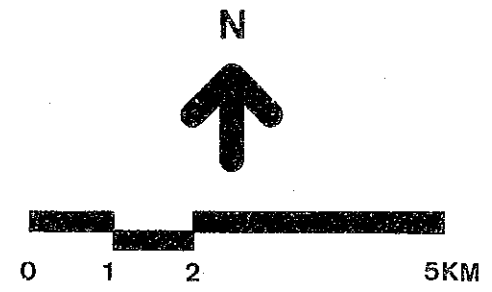


Fig.4.2 Future Land Use Plan in the Region of Sousse

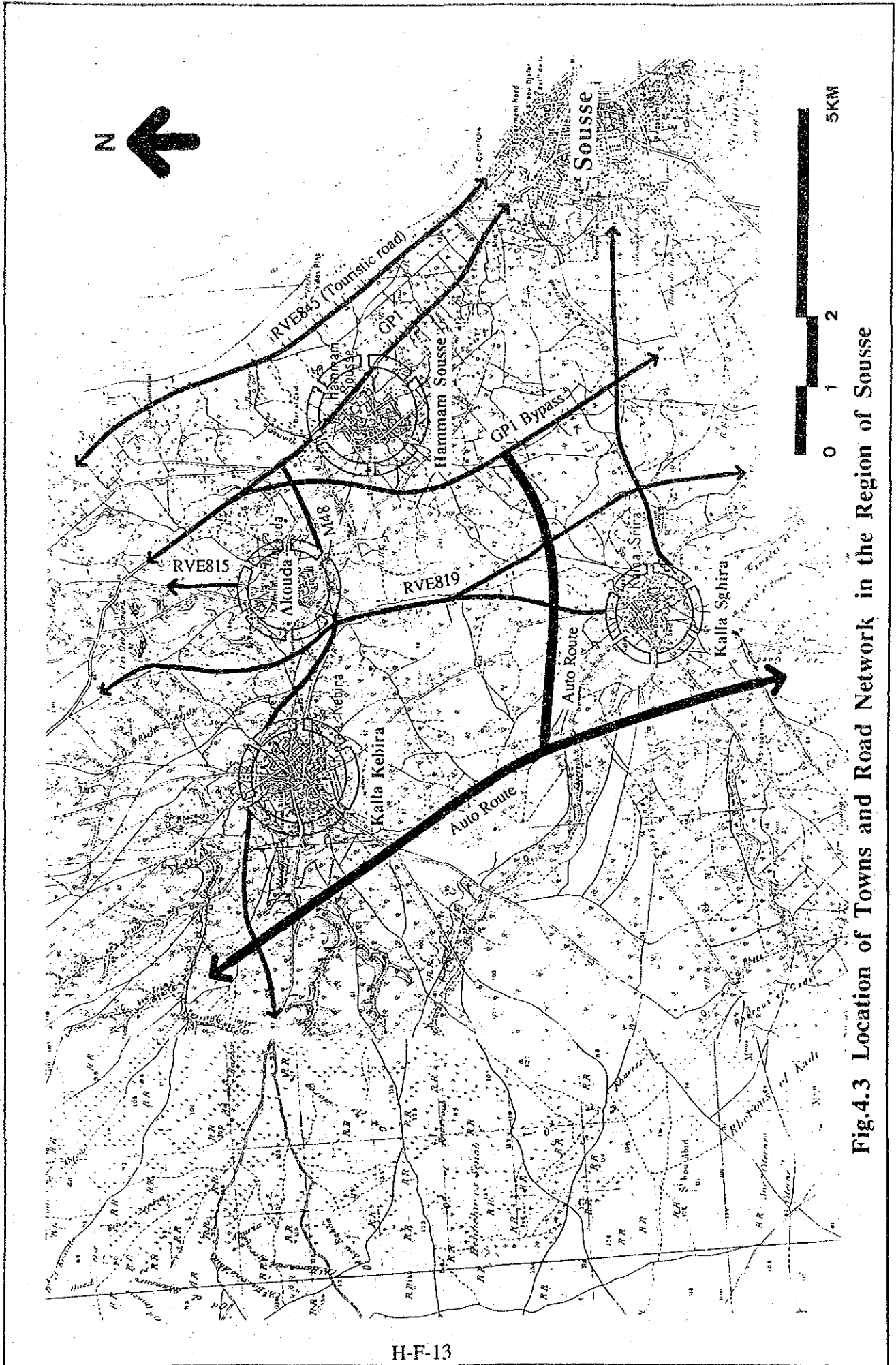
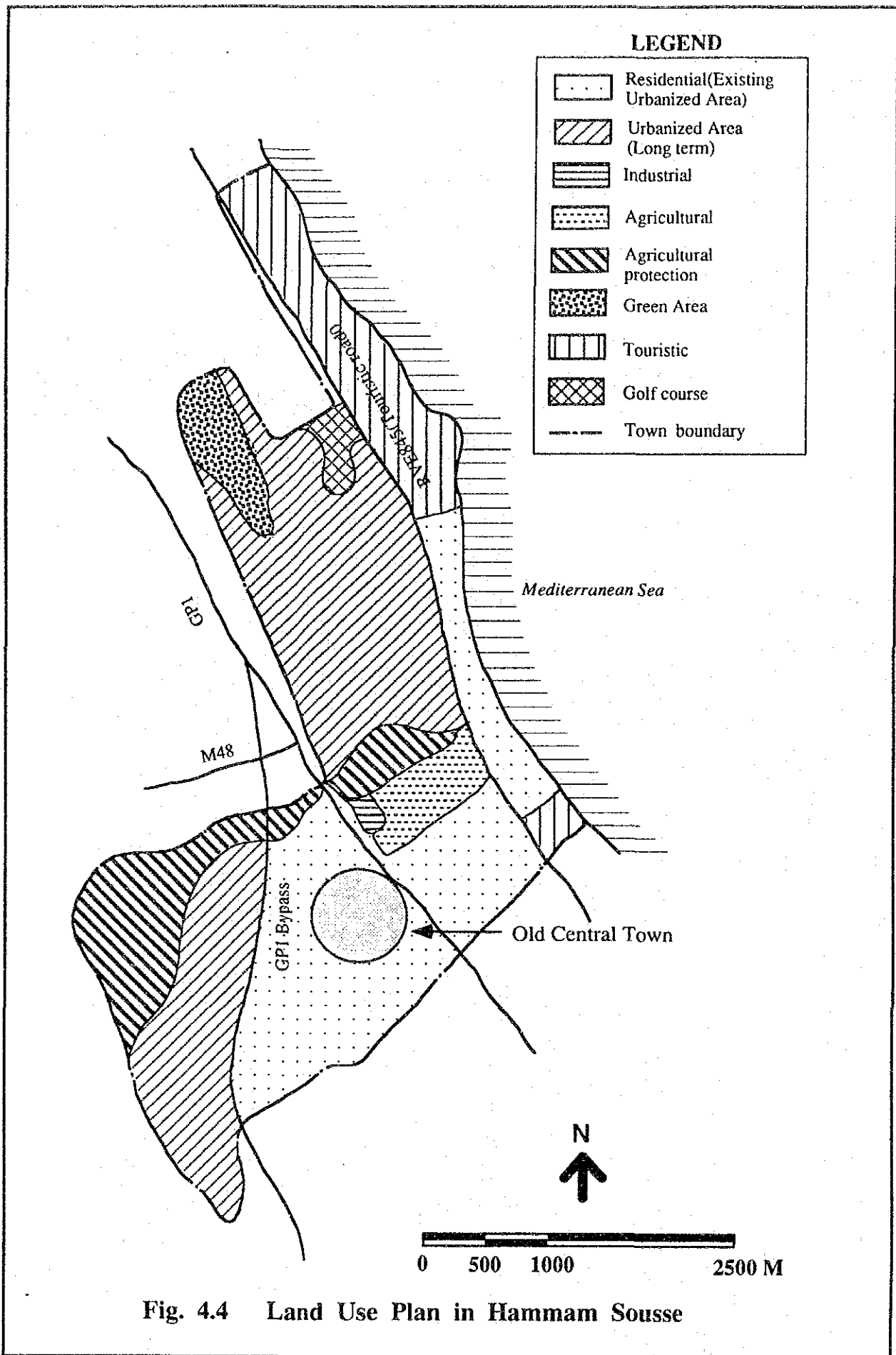


Fig.4.3 Location of Towns and Road Network in the Region of Sousse



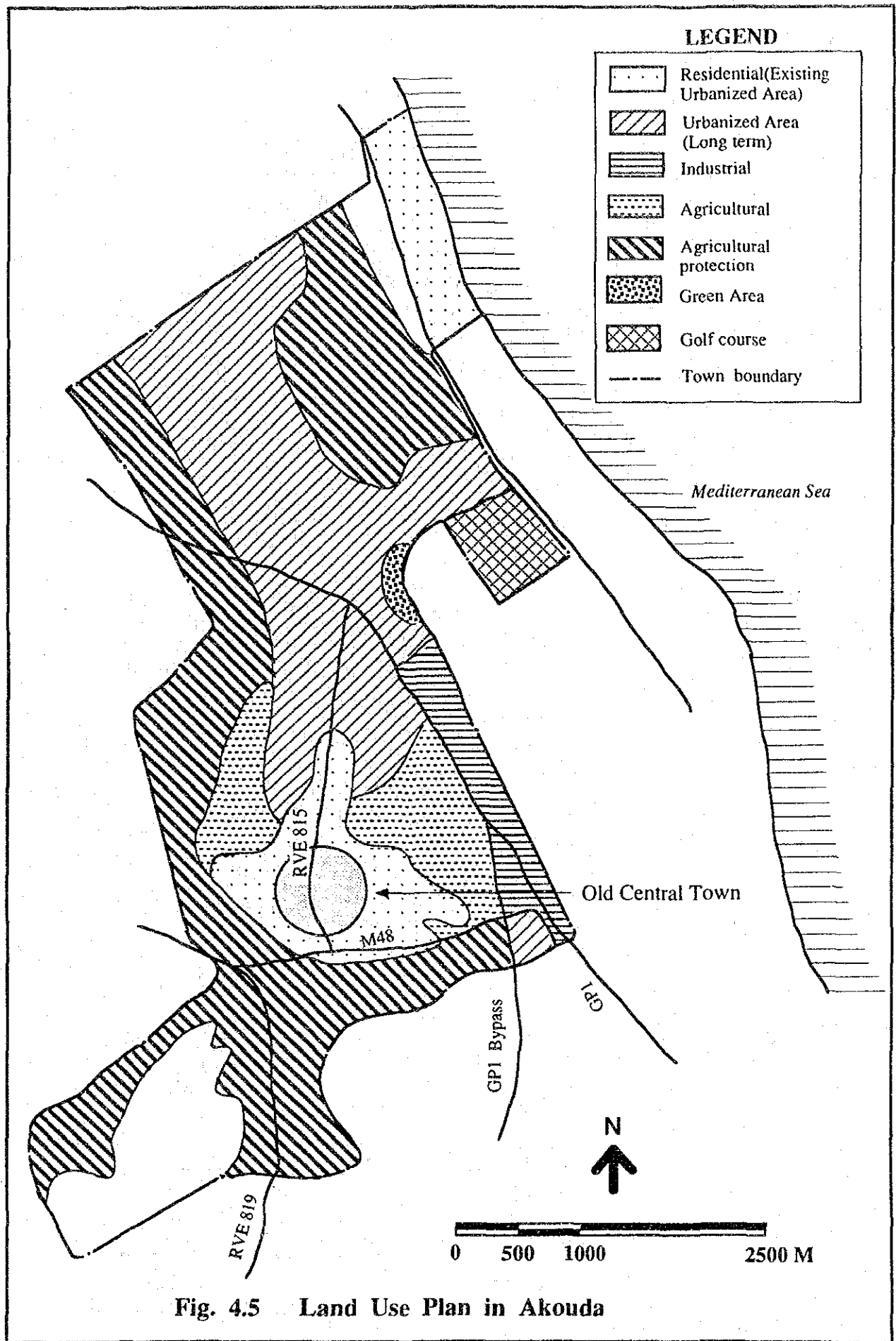


Fig. 4.5 Land Use Plan in Akouda

The Study on Flood Protection Program for Greater Tunis and Sousse in the Republic of Tunisia

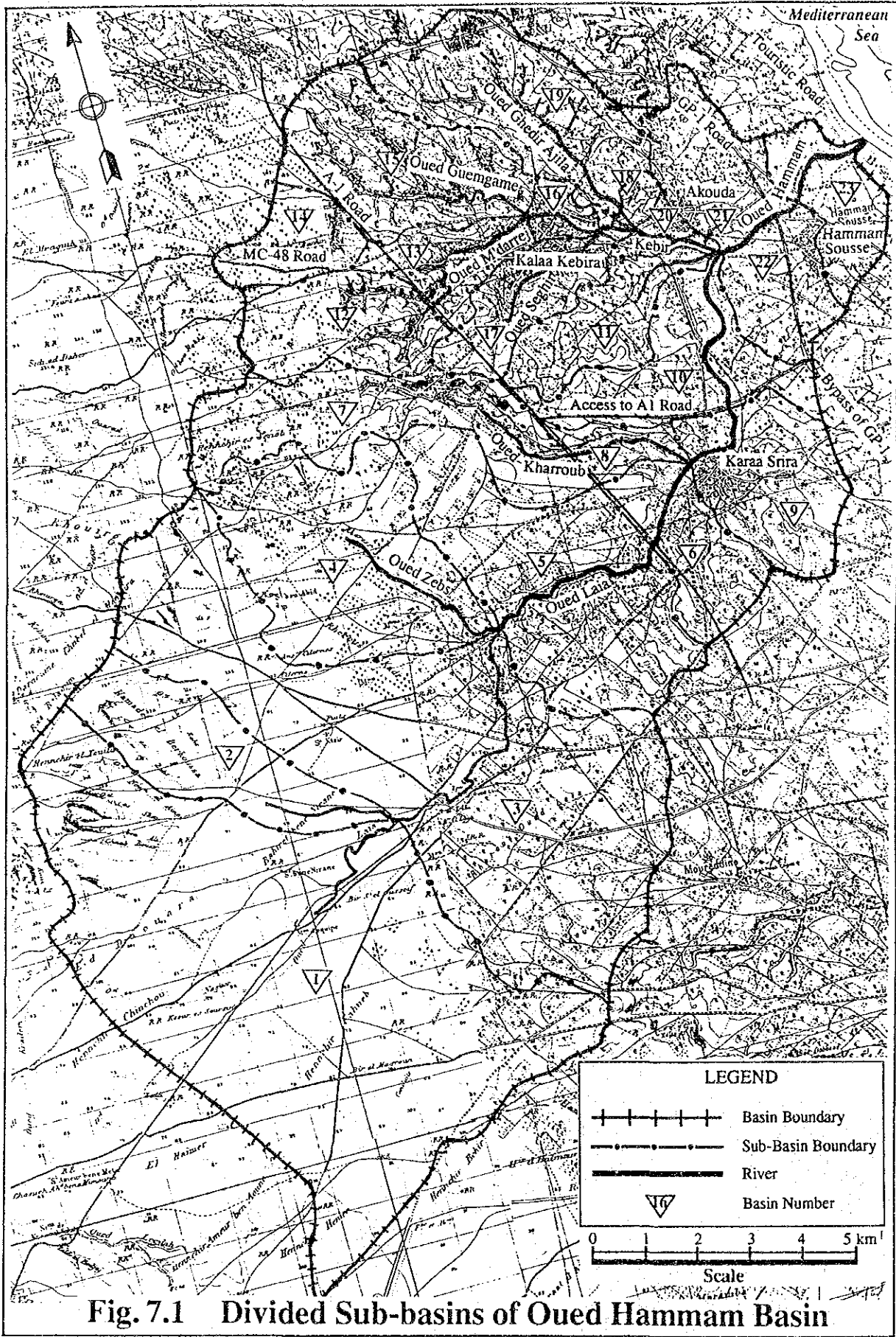


Fig. 7.1 Divided Sub-basins of Oued Hammam Basin

The Study on Flood Protection Program for Greater Tunis and Sousse in the Republic of Tunisia

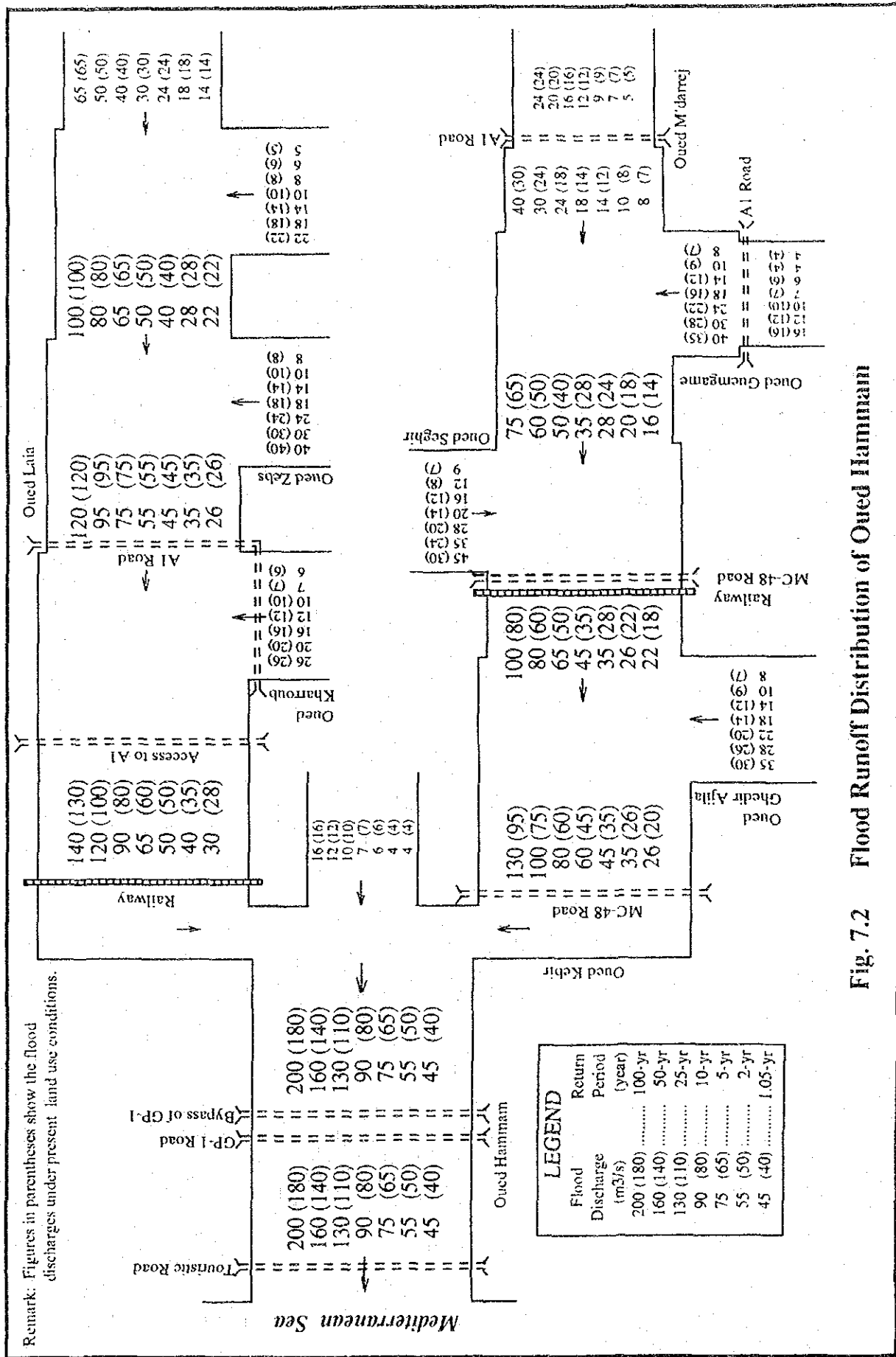


Fig. 7.2 Flood Runoff Distribution of Oued Hammam

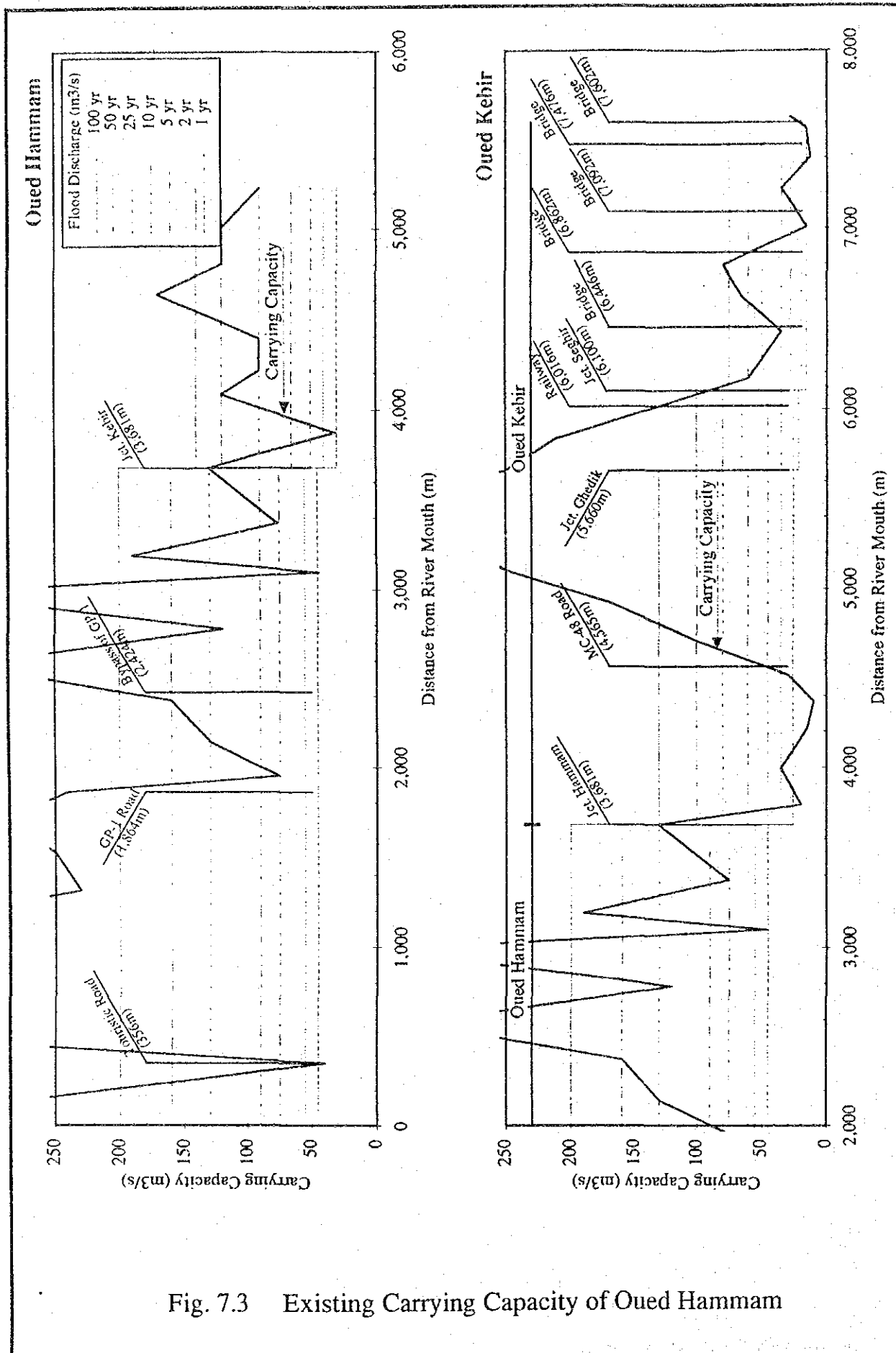


Fig. 7.3 Existing Carrying Capacity of Oued Hammam

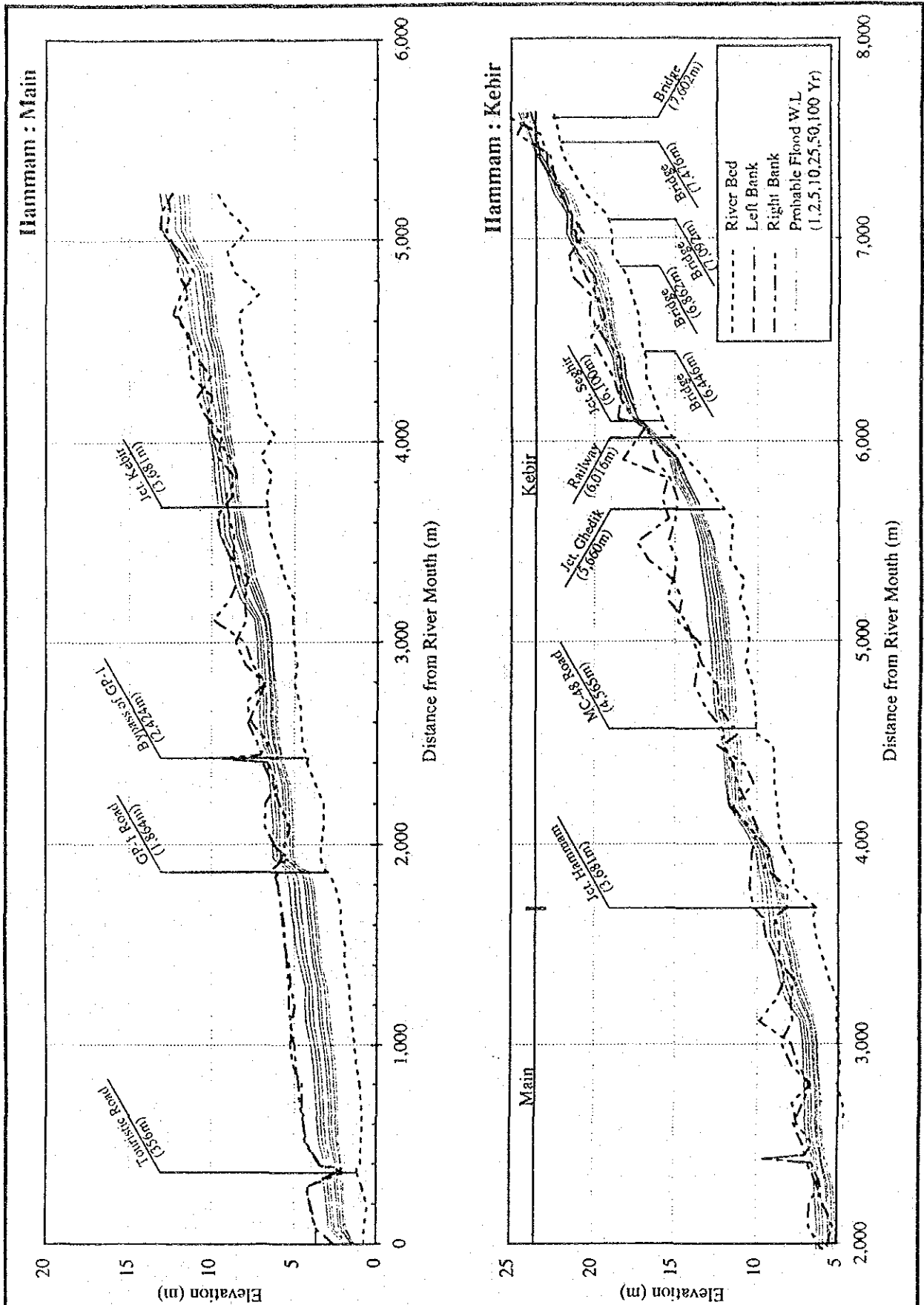


Fig. 7.4 Flood Water Level of Oued Hammam under Existing River Facilities

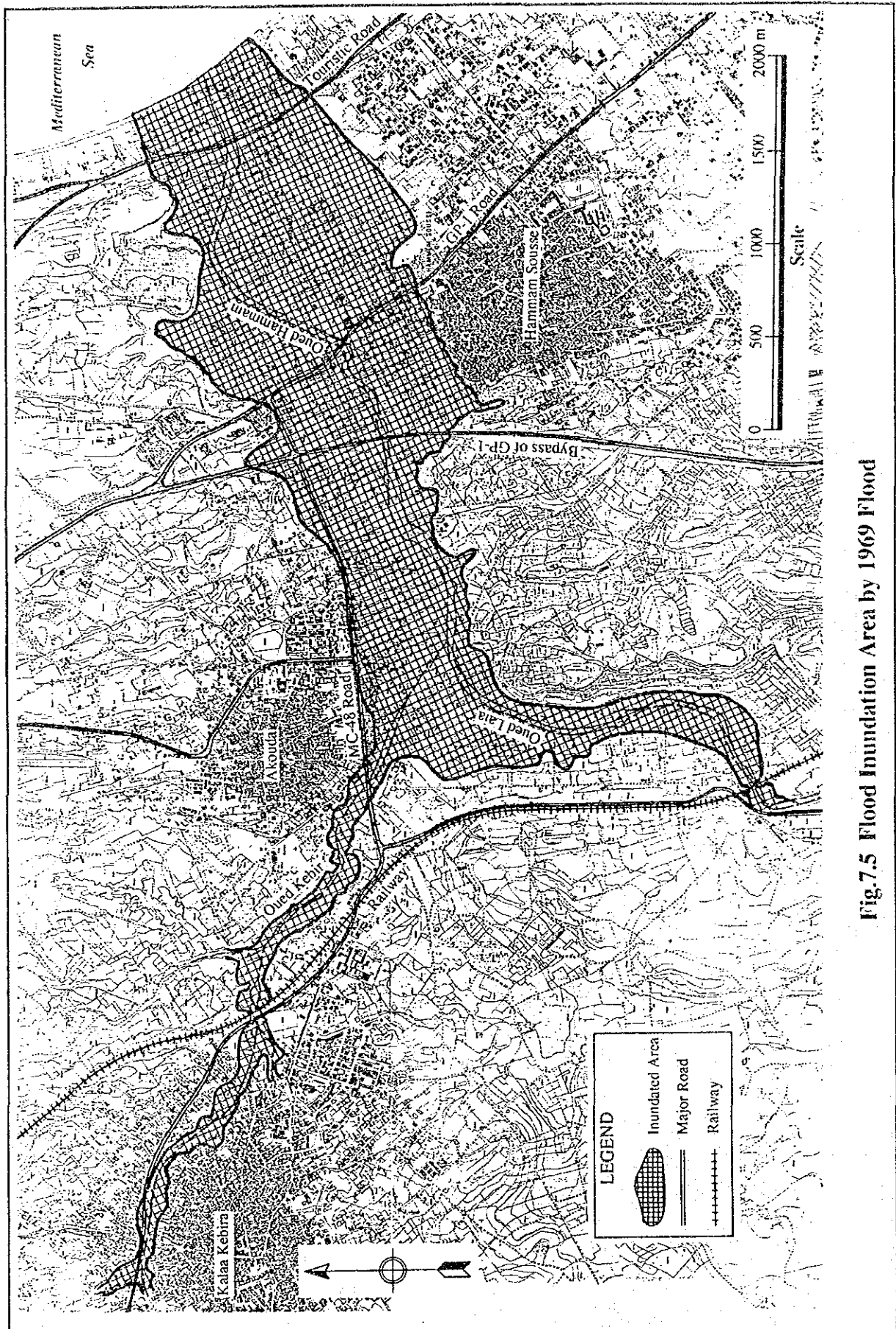


Fig.7.5 Flood Inundation Area by 1969 Flood

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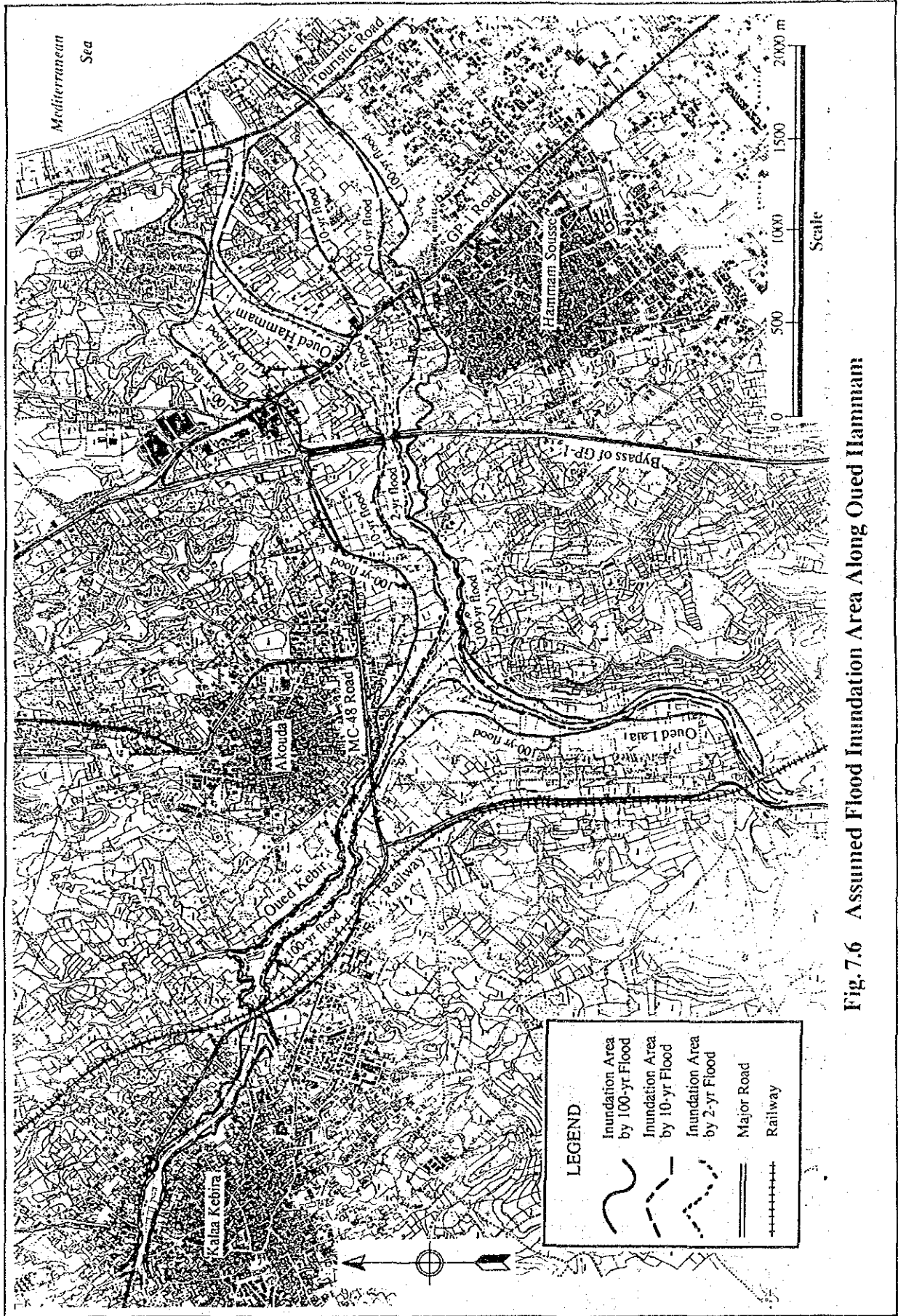


Fig. 7.6 Assumed Flood Inundation Area Along Oued Hammam

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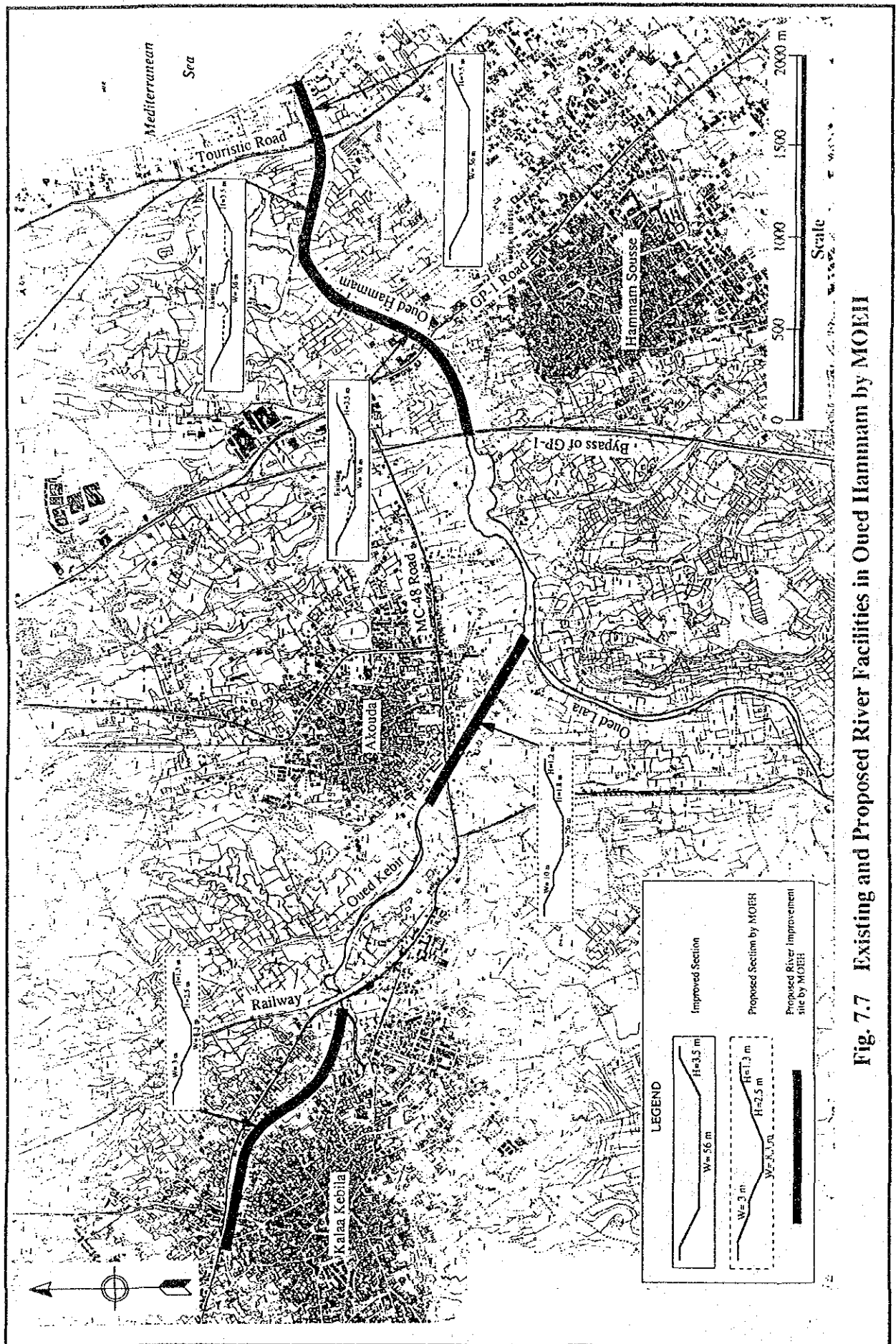


Fig. 7.7 Existing and Proposed River Facilities in Oued Hammam by MOEH

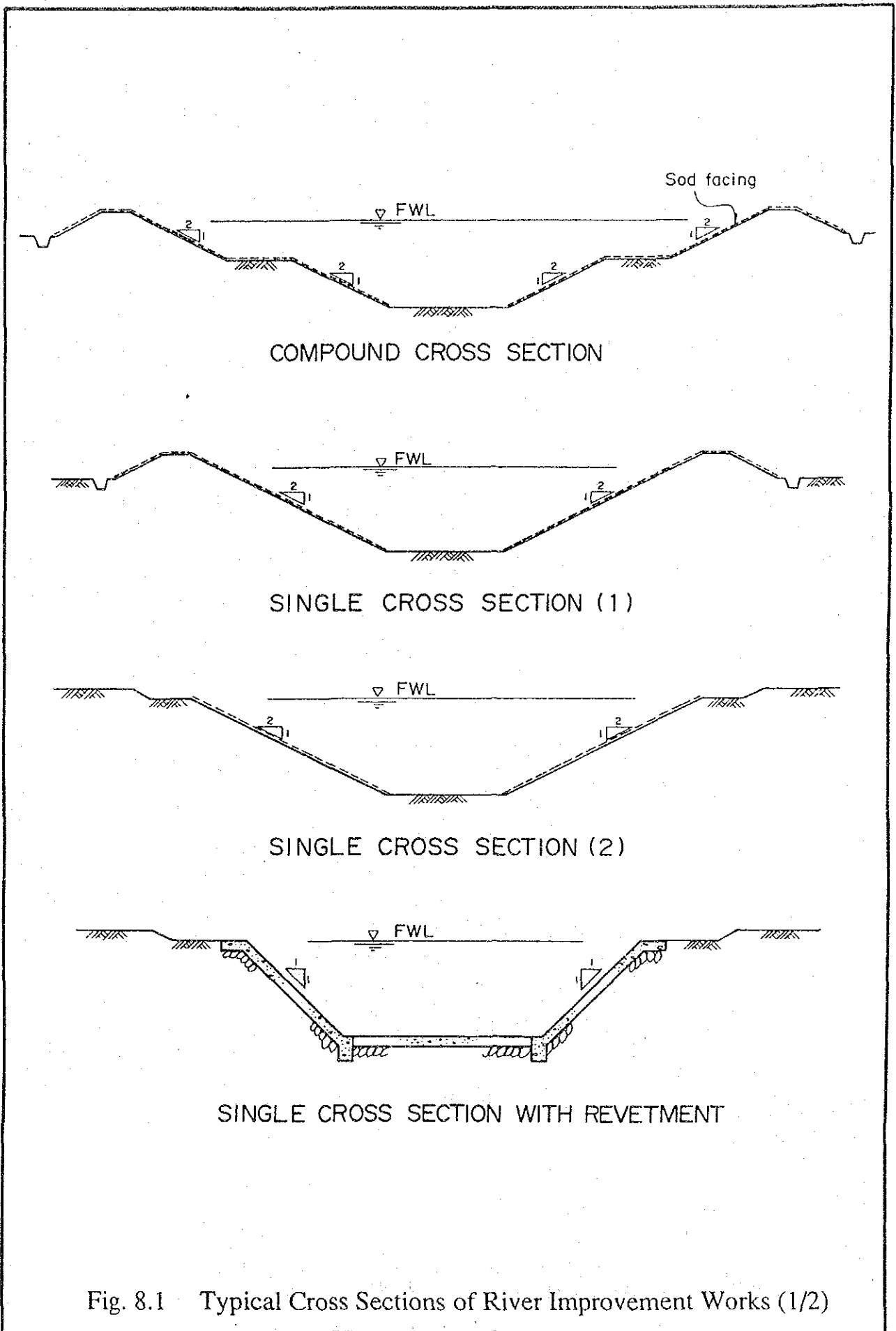
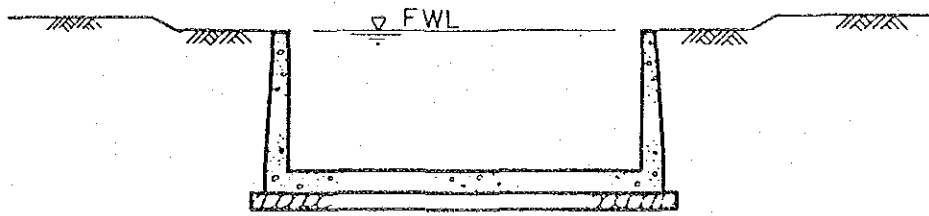
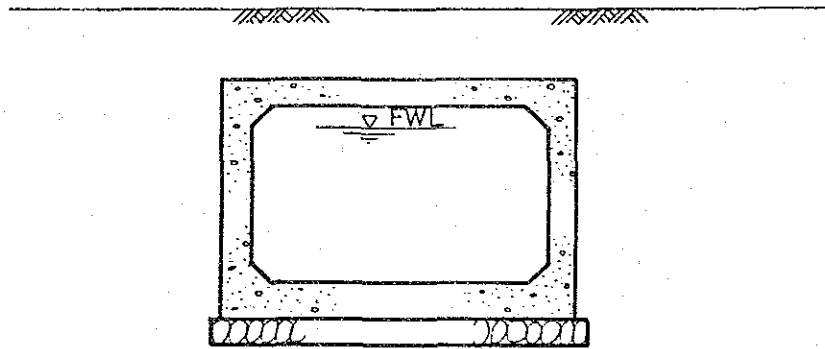


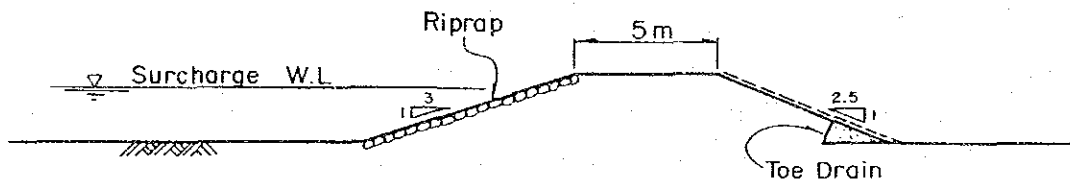
Fig. 8.1 Typical Cross Sections of River Improvement Works (1/2)



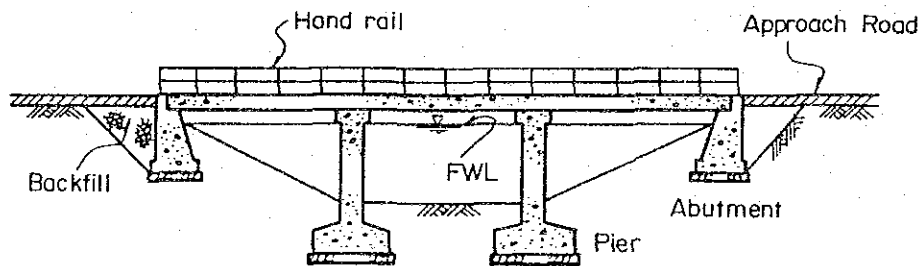
SINGLE CROSS SECTION WITH RETAINING WALL



BOX CULVERT



DAM & RETARDING BASIN



RC SLAB BRIDGE

Fig. 8.1 Typical Cross Sections of River Improvement Works (2/2)

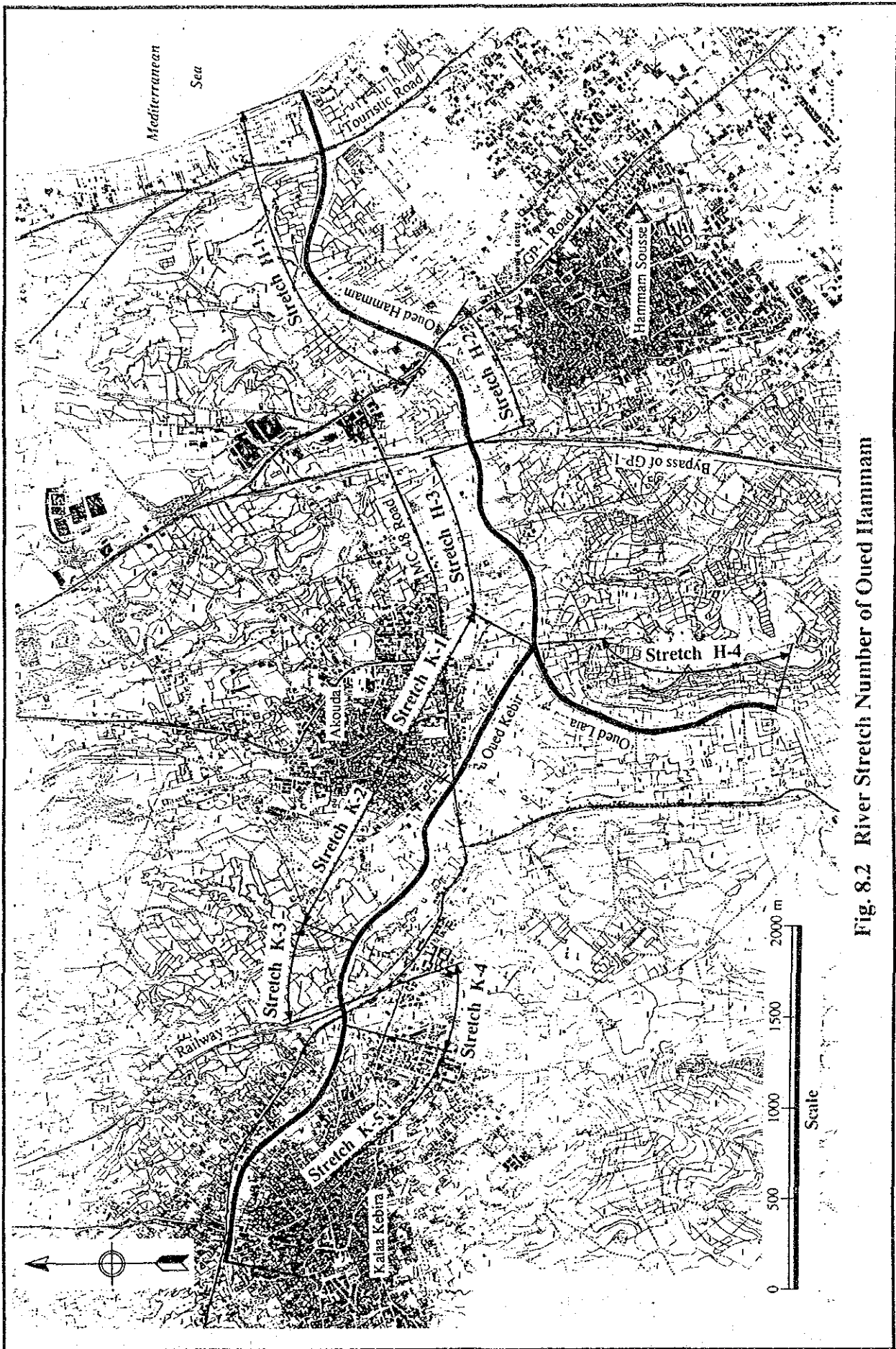


Fig. 8.2 River Stretch Number of Oued Hammam

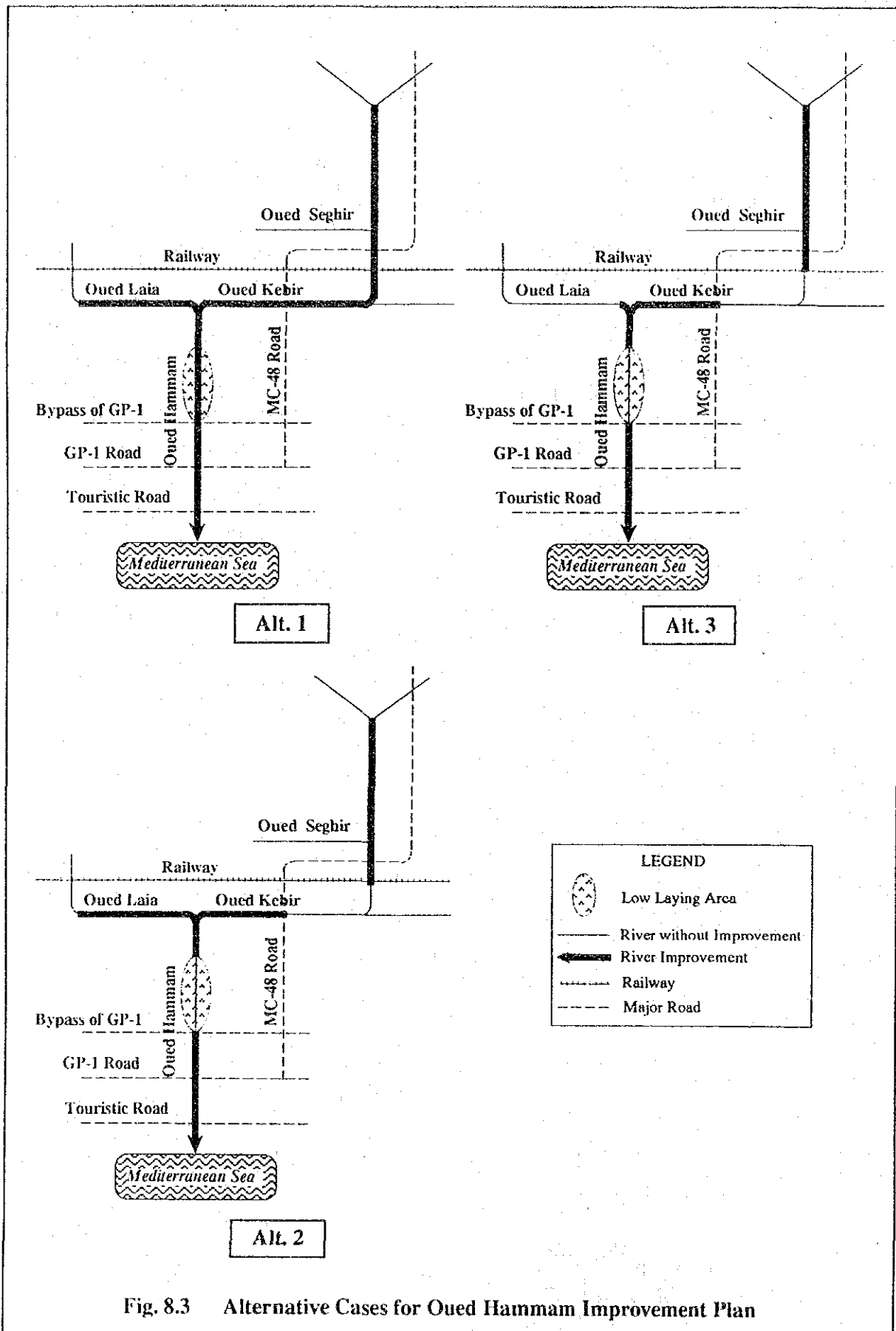


Fig. 8.3 Alternative Cases for Oued Hammam Improvement Plan

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