

Irrigation Water Demand in 2010

| River Basin | Irrigation Area (ha) | | Water Demand (MCM/yr) | |
|--------------|----------------------|----------------|-----------------------|----------------|
| | 1990 | 2010 | 1990 | 2010 |
| Belawan | 8,242 | 14,942 | 35.3 | 149.5 |
| Deli | 4,940 | 4,940 | 44.1 | 63.9 |
| Percut | 5,356 | 6,451 | 30.0 | 59.4 |
| Serdang | 14,879 | 15,755 | 84.2 | 161.2 |
| Ular | 24,296 | 24,296 | 349.8 | 355.0 |
| Belutu | 11,398 | 16,368 | 79.9 | 180.5 |
| Padang | 9,255 | 17,655 | 31.8 | 195.7 |
| Total | 78,366 | 100,407 | 655.1 | 1,165.2 |

River Maintenance Flow

As discussed in Section 3.1, the river maintenance flow is proposed at the maximum specific discharge of $0.01 \text{ m}^3/\text{s}/\text{km}^2$, or a low flow discharge in the drought year of a 10-year return period under the present condition of water use. The river maintenance flow of each river at its lowest point is determined as follows:

Proposed River Maintenance Flow

| River | Catchment Area (km^2) | Maintenance Flow | | Remarks |
|---------|----------------------------------|-------------------------------------|--|---------------------|
| | | Discharge (m^3/s) | Specific Discharge ($\text{m}^3/\text{s}/\text{km}^2$) | |
| Belawan | 647 | 5.2 | 0.0081 | 10-yr return period |
| Deli | 358 | 2.9 | 0.0081 | 10-yr return period |
| Percut | 186 | 1.5 | 0.0081 | 10-yr return period |
| Serdang | 671 | 4.9 | 0.0073 | 10-yr return period |
| Ular | 1,081 | 10.8 | 0.0100 | Specific Discharge |
| Belutu | 500 | 4.9 | 0.0098 | 10-yr return period |
| Padang | 919 | 9.2 | 0.0100 | Specific Discharge |

4.2 Water Resource Structures

Other than the reservoirs proposed in the upstream of the respective rivers, a transbasin water diversion is also considered as a promising source of municipal water for Medan Area. Through the water balance study, Serdang, Ular and Padang rivers have surplus water, while other rivers are in shortage even only to fulfill the present water demand. Therefore, transbasin diversion is possible from the three rivers.

The surplus water of Serdang, Ular and Padang rivers is estimated at $5.7 \text{ m}^3/\text{s}$, $11.2 \text{ m}^3/\text{s}$ and $18.0 \text{ m}^3/\text{s}$, respectively, at the lowest point of each river in the second driest year for 20 years from

1969 to 1988. Since Padang River is located farthest from Medan City, transbasin water diversion from the Padang River to Medan City is less economical compared with Ular and Serdang.

Two (2) routes of transbasin water diversion by aqueduct are planned as shown in Fig. 4-1 on account of the following (3) conditions. One route is 9.0 km from Sincambah on the Belumai River and the other is 30.5 km from Pulau Tagor on the Ular River.

- (a) Receiving structure is assumed to be located at Percut River.
- (b) Water diversion is by gravity flow; the longitudinal profile of aqueduct is shown in Fig. 4-2.
- (c) Length of the aqueduct is to be made as short as possible.

As for the reservoirs, only three (3) dams; namely, Tembengan on the Belawan River, Namobatang on the Deli River and Lausimeme on the Percut River are potential sources to supply water to Medan Area because of their locations and effective storage capacities, as discussed in Section 3.2.

Applying the same simulation model, the maximum reservoir yield is estimated at 3,700 l/s and 2,000 l/s for Lausimeme Dam and Namobatang Dam, respectively. The simulation results for both dams are presented in Fig. 4-3. Tembengan Dam will have a reservoir yield of 2,500 l/s.

Summarizing the water resources facilities such as aqueducts and reservoirs, the following are technically and economically viable to ensure municipal water supply for Medan Area:

Viable Municipal Water Supply Facilities for Medan Area

| Water Resources Facility | Dimension | Supply Capacity (m ³ /s) |
|--------------------------|---|-------------------------------------|
| Tembengan Dam | Storage Capacity = 21.0 MCM | 2.50 (216,600)* |
| Namobatang Dam | Storage Capacity = 11.0 MCM | 1.65 (142,500)* |
| Lausimeme Dam | Storage Capacity = 29.5 MCM | 3.70 (319,680) |
| Belumai Aqueduct | Length = 5.5 km Diameter = 1,500 mm | 2.60 (224,640) |
| Ular Aqueduct | Length = 27.0 km Diameter = 2,000 mm | 6.10 (527,040) |

Note: Figures in parentheses are in m³/d.

*: These are estimated as new supplying capacities.

4.3 Optimum Water Supply Plan

Project Scale and Target Area

(1) Project Scale

The project scale of a water supply plan is defined by the recurrence probability of drought. Compared to irrigation water supply, the allowable limit of water shortage for domestic water supply is more strict. To simplify the water balance analysis, the design drought of a 10-year return period is adopted for both domestic and irrigation water supply.

(2) Target Area

As mentioned before, the target area for the water supply plan is limited to only Medan Area and Tebing Tinggi City. Kecamatan where the demand for domestic water is small were excluded from the target area of the water supply plan since groundwater utilization by means of deep well is more economical and easier than river surface flow.

Optimum Combination of Structures

The municipal water demand of 21,300 m³/d in Tebing Tinggi City in the target year 2010 will be fully supplied by the surface flow of the Padang River. That in Medan City of approx. 770,000 m³/s will be assured mostly by the new water sources such as reservoirs and aqueduct/transbasin diversion. Since about 60,000 m³/d will be supplied from groundwater by means of springs and deep wells, 710,000 m³/d has to come from the new water sources.

To select the appropriate facilities among the alternative water sources, cost efficiency of the facilities was examined, as follows:

Cost Efficiency of Alternative Water Source Facilities

| Water Resources Facility | New Developed Supply Capacity (MCM/yr) | Construction Cost (mil. Rp) | Cost Efficiency (Rp/m ³ /yr) |
|--------------------------|--|-----------------------------|---|
| Tembengan Dam | 79 | 90,000 | 1,139 |
| Namobatang Dam | 52 | 46,000 | 885 |
| Lausimeme Dam | 117 | 124,700 | 1,066 |
| Belumai Aqueduct | 82 | 39,200 | 478 |
| Ular Aqueduct | 192 | 207,100 | 1,079 |

Belumai Aqueduct is the most economical from cost efficiency, although the aqueduct alone could not fully meet the municipal water demand. From the estimated cost efficiency of the facilities, the following three (3) facilities are proposed to fill the municipal water demand in Medan Area:

- (a) Lausimeme Dam
- (b) Namobatang Dam
- (c) Belumai Aqueduct

With the said three (3) facilities, the future demand for municipal water in Medan Area in the target year 2010 (see Table 4-2) will be fully met. The water supply program is proposed, as shown in Fig. 4-4, taking the following conditions into consideration:

- (a) Period and volume of water shortage are to be minimized.
- (b) Surplus in supplying capacity is also to be minimized.
- (c) Irrigation water requirements shall be assured as early as possible, since the present municipal water supply consumes the irrigation demand in the downstream.

TABLES

Table 2-1 CURRENT WATER SUPPLY SYSTEM IN NORTH SUMATRA

| No. | Name of Kotamadya/Kecamatan | Population | Supply Source | System Operation | | Construction Status Up To 87/88 | | | Construction Plan Up to 88/89 | | Remarks |
|-----------------|-----------------------------|------------|---------------|------------------|------------------|---------------------------------|---------------------|--------------------|-------------------------------|-------------|---------------------------------|
| | | | | Status | Operation (hour) | Capacity (l/s) | No. of House (unit) | Public Tap. (unit) | No. of House | Public Tap. | |
| 1. | MEAN TIMUR | 1,807,000 | MA/PL/SB | PDAM | 24 | 1,400.0 | 96,900 | 185 | 0 | 0 | *)Proyek penanggulangan Darurat |
| 2. | TANJUNG BALAI | 62,000 | --/PL/-- | BPAM | 20 | 60.0 | 2,600 | 30 | 0 | 0 | |
| 3. | PEMATANG SIANTAR | 170,630 | MA/--/SB | PDAM | 24 | 324.0 | 555 | 20 | 0 | 0 | |
| 4. | BINJAI | 87,000 | SB | PDAM | 24 | 40.0 | 950 | 22 | 0 | 0 | |
| 5. | TEBING TINGGI | 103,000 | PL | PDAM | 24 | 60.0 | 2,890 | 65 | 0 | 0 | |
| 6. | KABANJAHE | 59,970 | MAG | BPAM | 24 | 40.0 | 1,041 | 25 | 100 | 0 | |
| 7. | TARUTUNG | 24,350 | MAG | PDAM | 24 | 17.0 | 716 | 27 | 0 | 0 | |
| 8. | SIDIKALANG | 31,890 | MAP | PDAM | 24 | 38.0 | 350 | 40 | 0 | 0 | |
| 9. | GUNUNG SITOLI | 22,000 | MAP | PDAM | 24 | 20.0 | 850 | 50 | 0 | 0 | |
| 10. | P. SIDEMPUAN | 75,000 | MAG | PDAM | 24 | 60.0 | 3,600 | 30 | 0 | 0 | |
| 11. | RANTAU PRAPAT | 60,620 | PL | PDAM | 24 | 40.0 | 1,263 | 28 | 100 | 0 | |
| 12. | TANJUNG PURA | 14,350 | PL | PDAM | 24 | 10.0 | 490 | 28 | 100 | 0 | |
| 13. | TANJUNG MORAWA | 10,500 | PL | PDAM | 13 | 10.0 | 515 | 28 | 0 | 0 | |
| 14. | PANGKALAN BRANDAN | 44,160 | PL | PDAM | 24 | 40.0 | 1,415 | 33 | 150 | 0 | |
| 15. | KISARAN | 81,720 | PL | PDAM | 24 | 40.0 | 3,015 | 38 | 0 | 0 | |
| 16. | SUNGAI RAMPAH | 14,500 | PL | PDAM | 12 | 20.0 | 915 | 33 | 0 | 0 | |
| 17. | PARAPAT | 10,500 | PL | PDAM | 0 | 20.0 | 270 | 15 | 0 | 0 | |
| 18. | SIBOLGA | 61,000 | PL | PDAM | 24 | 90.0 | 1,330 | 18 | 0 | 0 | |
| 19. | LUBUK PAKAM | 155,000 | SB | PDAM | 24 | 15.0 | 0 | 0 | 0 | 0 | |
| 20. | BALIGE | 40,000 | MAG | PDAM | 24 | 17.0 | 0 | 0 | 0 | 0 | |
| 21. | PERDAGANGAN | 23,700 | PL | PDAM | 0 | 20.0 | 0 | 0 | 0 | 0 | |
| 22. | LAGUBOTI | 19,270 | PL | PDAM | 0 | 10.0 | 0 | 0 | 0 | 0 | |
| 23. | STABAT | 17,000 | SB | PDAM | 0 | 5.0 | 360 | 18 | 0 | 0 | |
| 24. | BARUSJAHE | 12,300 | MAG | BPAM | 24 | 5.0 | 378 | 13 | 0 | 0 | |
| 25. | TIGA PANAH | 8,150 | MAG | BPAM | 24 | 5.0 | 190 | 2 | 0 | 0 | |
| 26. | LAUBALANG | 8,310 | MAG | BPAM | 24 | 5.0 | 170 | 0 | 0 | 0 | |
| 27. | BP. MANDOE | 8,580 | SB | BPAM | 12 | 5.0 | 274 | 9 | 0 | 0 | |
| 28. | SEI LATH ULU | 6,072 | SB | BPAM | 14 | 2.5 | 226 | 9 | 0 | 0 | |
| 29. | SEI SILAU TIMUR | 5,190 | SB | BPAM | 12 | 2.5 | 119 | 9 | 0 | 0 | |
| 30. | IDRAPURA | 10,890 | SB | BPAM | 0 | 5.0 | 215 | 18 | 0 | 0 | |
| 31. | AIR JOHOR | 6,440 | SB | BPAM | 12 | 2.5 | 90 | 9 | 0 | 0 | |
| 32. | PANGKALAN DODEK | 10,075 | SB | BPAM | 0 | 5.0 | 165 | 6 | 0 | 0 | |
| 33. | LIWA PULUH | 0 | SB | BPAM | 24 | 2.5 | 241 | 3 | 0 | 0 | |
| 34. | SEI KEPAYANG | 0 | SB | BPAM | 0 | 2.5 | 0 | 0 | 0 | 0 | |
| 35. | TELUK NIBUNG | 0 | SB | BPAM | 0 | 2.5 | 0 | 0 | 0 | 0 | |
| 36. | HERANTAU | 58,000 | SB | BPAM | 0 | 5.0 | 0 | 0 | 0 | 0 | |
| 37. | LABUHAN RUKU | 0 | SB | BPAM | 22 | 5.0 | 360 | 18 | 0 | 0 | |
| 38. | BAGAN ASAHAN | 7,430 | SB | BPAM | 0 | 5.0 | 0 | 0 | 0 | 0 | |
| 39. | PEMATANG RAYA | 12,000 | MAP | PDAM | 12 | 5.0 | 90 | 13 | 0 | 0 | |
| 40. | SINAKSAK | 7,980 | MAP | PDAM | 24 | 5.0 | 360 | 2 | 0 | 0 | |
| 41. | TANAH JANA | 11,370 | MAP | PDAM | 12 | 5.0 | 360 | 18 | 0 | 0 | |
| 42. | TIGA BALATA | 15,445 | MAG | PDAM | 12 | 5.0 | 0 | 0 | 0 | 0 | |
| 43. | SERIBU DOLCK | 8,780 | MAP | PDAM | 12 | 5.0 | 100 | 11 | 0 | 0 | |
| 44. | PASAR BARU | 0 | SB | PDAM | 12 | 2.5 | 180 | 9 | 0 | 0 | |
| 45. | PORSEA | 15,900 | PL | PDAM | 12 | 5.0 | 335 | 13 | 0 | 0 | |
| 46. | SIBORONG BORONG | 9,450 | PL | PDAM | 12 | 5.0 | 224 | 18 | 0 | 0 | |
| 47. | PANGURURAN | 10,320 | MAP | PDAM | 24 | 5.0 | 246 | 2 | 200 | 0 | |
| 48. | BATANGKUIS | 7,965 | SB | PDAM | 12 | 5.0 | 330 | 9 | 0 | 0 | |
| 49. | PERBAUNGAN | 11,870 | SB | PDAM | 12 | 5.0 | 213 | 18 | 0 | 0 | |
| 50. | DOLCK HASIHUL | 4,970 | SB | PDAM | 0 | 2.5 | 180 | 9 | 0 | 0 | |
| 51. | HAMPARAN PERAK | 7,375 | SB | PDAM | 12 | 2.5 | 180 | 9 | 0 | 0 | |
| 52. | TEMBUNG | 11,260 | SB | PDAM | 0 | 5.0 | 200 | 18 | 0 | 0 | |
| 53. | BANDAR KHALIFAH | 8,540 | SB | PDAM | 0 | 5.0 | 282 | 2 | 0 | 0 | |
| 54. | DOLCK HERAMAN | 6,030 | SB | PDAM | 12 | 2.5 | 180 | 9 | 0 | 0 | |
| 55. | PANTAI CERMIN | 4,460 | SB | PDAM | 12 | 2.5 | 191 | 9 | 0 | 0 | |
| 56. | GALANG | 6,850 | SB | PDAM | 0 | 5.0 | 0 | 18 | 0 | 0 | |
| 57. | TANJUNG SELAMAT | 11,350 | SB | PDAM | 12 | 5.0 | 100 | 18 | 0 | 0 | |
| 58. | GEBANG | 9,630 | SB | PDAM | 12 | 5.0 | 210 | 18 | 0 | 0 | |
| 59. | TANJUNG LANGKAT | 0 | SB | PDAM | 24 | 2.5 | 180 | 9 | 0 | 0 | |
| 60. | SECANGGANG | 7,140 | SB | PDAM | 12 | 2.5 | 180 | 9 | 50 | 0 | |
| 61. | BESITANG | 4,850 | PL | PDAM | 12 | 2.5 | 231 | 9 | 0 | 0 | |
| 62. | PANGKALAN SUSU | 11,830 | SB | PDAM | 12 | 5.0 | 360 | 18 | 0 | 0 | |
| 63. | SELESAT | 7,450 | SB | PDAM | 12 | 5.0 | 238 | 13 | 0 | 0 | |
| 64. | TANJUNG BERINGIN | 13,190 | SB | PDAM | 12 | 10.0 | 720 | 36 | 0 | 0 | |
| 65. | LAHENA | 7,730 | MAP | PDAM | 12 | 5.0 | 305 | 2 | 0 | 0 | |
| 66. | TELUK DALAM | 16,740 | MAP | PDAM | 16 | 5.0 | 360 | 18 | 0 | 0 | |
| 67. | KOTA PINANG | 10,270 | SB | PDAM | 0 | 5.0 | 340 | 19 | 150 | 0 | |
| 68. | PAHOAN | 9,430 | MAG | - | 0 | 5.0 | 190 | 8 | 0 | 0 | |
| 69. | BARUS | 5,800 | MAG | - | 0 | 5.0 | 110 | 7 | 164 | 0 | |
| 70. | SORKAM | 10,890 | MAG | - | 0 | 10.0 | 404 | 10 | 150 | 0 | |
| 71. | GUNUNG TUA | 11,820 | PL | PDAM | 0 | 5.0 | 170 | 18 | 0 | 0 | |
| 72. | PENYABUNGAN | 16,360 | PL | PDAM | 0 | 10.0 | 0 | 9 | 340 | 0 | |
| 73. | SALAK | 2,600 | MAP | PDAM | 12 | 5.0 | 327 | 13 | 0 | 0 | |
| 74. | BANGUN PURBA | 2,451 | MAP | PDAM | 12 | 7.0 | 0 | 0 | 0 | 0 | |
| 75. | TIGA JUHAR | 1,140 | SB | PDAM | 24 | 5.0 | 0 | 0 | 0 | 0 | |
| Total BNA & IKK | | 3,457,833 | - | - | 973 | 2,638 | 130,529 | 1,250 | 1,504 | 0 | - |

LEGEND PDAM : Perusahaan Daerah Air Minum.
BPAM : Badan Pengolahan air minum.
PL : River Water With Treatment Plant.
SB : Deep Well
MAG : Gravitation Spring (without pump).
MAP : Pumping Spring (with pump).

Table 2-2 CURRENT WATER SUPPLY SYSTEM IN THE STUDY AREA

| Kotamadya/ Kabupaten | Name of Kecamatan | Population | Supply Source | Administration Status | Capacity (l/s) |
|-------------------------|----------------------|------------|------------------|--------------------------|-------------------|
| Medan | - | 1,807,000 | MA/PL/SB | PDAM | 1,400.0 |
| Tebing Tinggi | - | 103,000 | PL | PDAM | 60.0 |
| Deli Serdang | Tj. Morawa | 10,500 | PL | PDAM | 10.0 |
| Deli Serdang | S. Rampah | 14,500 | PL | PDAM | 20.0 |
| Deli Serdang | Lubuk Pakam | 155,000 | SB | PDAM | 15.0 |
| Deli Serdang | Batang Kuis | 7,965 | SB | PDAM | 5.0 |
| Deli Serdang | Perbaungan | 11,870 | SB | PDAM | 5.0 |
| Deli Serdang | Dolok Masihul | 4,970 | SB | PDAM | 2.5 |
| Deli Serdang | Hampanan Perak | 7,375 | SB | PDAM | 2.5 |
| Deli Serdang | Tembung | 11,260 | SB | PDAM | 5.0 |
| Deli Serdang | Bdr. Khalipah | 8,540 | SB | PDAM | 5.0 |
| Deli Serdang | Dolok Merawan | 6,030 | SB | PDAM | 2.5 |
| Deli Serdang | Pantai Cermin | 4,460 | SB | PDAM | 2.5 |
| Deli Serdang | Galang | 6,850 | SB | PDAM | 5.0 |
| Deli Serdang | Bangun Purba | 2,450 | MA | PDAM | 7.0 |
| Deli Serdang | Tiga Juhar | 1,140 | SB | PDAM | 5.0 |
| Total | | 2,162,910 | - | - | 1,552.0 |

NOTE PDAM : Perusahaan Daerah Air Minum
 PL : River Water
 SB : Deep Well Water
 MA : Spring Water

Table 2-3 PRESENT STATUS OF DEEP WELL IN THE STUDY AREA

| Kotamadya/Kabupaten No. Location/Name | Designed Well Depth (m) | Present Well Depth (m) | Capacity (l/s) | | Water Depth** | | Operation Starting Year | Remarks | |
|--|-------------------------------|------------------------------|----------------|---------|---------------|----------|-------------------------------|---------|--------------|
| | | | Designed | Present | Designed | Present* | | | |
| KODYA. MEDAN | | | | | | | | | |
| 1. Rumah Susun | 175.00 | 152.00 | 22.00 | 21.00 | 23.10 | 23.3 | 1987 | | |
| 2. Jalan Kenari | 171.00 | 170.00 | 25.00 | 19.00 | 19.75 | 20.2 | 1987 | | |
| 3. Jalan Sakura | 170.00 | 155.00 | 15.00 | 13.31 | 14.30 | 15.3 | 1984 | | |
| 4. Jalan Merak | 175.00 | 170.00 | 23.00 | 22.00 | 20.75 | 25.2 | 1987 | | |
| 5. Simalingkar Pompa I | 145.50 | 138.00 | 20.00 | 19.69 | 10.59 | 11.2 | 1987 | | |
| 6. Simalingkar Pompa II | 179.00 | 150.75 | 23.00 | 16.28 | 12.95 | 13.1 | 1987 | | |
| 7. Labuhan Deli | 170.00 | 153.00 | 24.00 | 14.00 | 7.60 | 8.5 | 1984 | | |
| 8. Pompa IV Belawan | 150.00 | 140.00 | 26.00 | 15.00 | 8.75 | 10.2 | 1984 | | |
| 9. Pompa XI Belawan | 106.00 | 89.00 | 11.60 | 3.00 | 10.10 | 11.1 | 1971 | Close | |
| 10. Jalan Gereja | 170.58 | 133.50 | 30.00 | 19.83 | 15.10 | 16.0 | 1985 | | |
| 11. Simalingkar Pompa III | 130.00 | 118.00 | 24.00 | 19.77 | 11.60 | 11.8 | 1987 | | |
| 12. Pompa V Belawan | 181.00 | - | 25.00 | 20.00 | 10.05 | 10.8 | 1987 | | |
| 13. Jalan Seksama | 178.00 | 169.00 | 23.00 | 20.53 | 17.00 | 20.6 | 1987 | | |
| 14. Pompa XII Belawan | 110.00 | 86.00 | 12.40 | 12.00 | 8.50 | 10.5 | 1971 | | |
| 15. Jalan Sisingamangaraja | 198.00 | - | 8.20 | 5.50 | 23.90 | 24.2 | 1984 | Close | |
| 16. Jalan Bilal | 180.00 | 167.80 | 25.00 | 10.08 | 13.20 | 16.0 | 1985 | | |
| 17. Pompa VIII Belawan | 136.00 | 127.00 | 25.00 | 23.00 | 9.80 | 10.0 | 1987 | | |
| 18. Taman Setia Budi Indah | 146.00 | - | - | 14.14 | 8.70 | 9.8 | 1986 | | |
| 19. Jalan Garuda | 189.50 | - | 21.00 | 15.00 | 16.70 | 17.2 | 1981 | | |
| 20. Jalan Gaperta | 160.00 | 138.00 | 24.00 | 22.14 | 11.00 | 11.5 | 1985 | | |
| 21. Industrial Estate Habar | 173.00 | 153.00 | 24.20 | 15.87 | 12.70 | 13.2 | 1983 | Close | |
| BELAWAN PORT AREA | | | | | | | | | |
| 1. Jl. Anggada Ujung Baru | 150 | - | 9.72 | - | 9.40 | 12.10 | 1980 | | |
| 2. Jl. Suar Ujung Baru | 160 | - | 9.72 | - | 8.03 | 13.35 | 1980 | | |
| 3. Jl. Selat Baru | 122 | - | 9.72 | - | 6.30 | 9.40 | 1978 | | |
| 4. Jl. Bagan Deli | 124 | - | 5.00 | - | 9.70 | 12.30 | 1978 | | |
| 5. Jl. Gablon | 204 | - | 9.72 | - | 6.50 | - | 1978 | | |
| 6. Jl. Proyek Pertamina | 203 | - | 11.11 | - | 8.36 | 22.85 | 1978 | | |
| 7. Jl. Proyek Pertamina | 200 | - | 11.11 | - | 9.95 | 33.69 | 1981 | | |
| 8. Jl. Bagan Deli | 200 | - | 16.66 | - | 6.60 | 13.63 | 1977 | | |
| 9. Jl. Bagan Deli | 206 | - | 16.66 | - | 7.15 | 11.90 | 1977 | | |
| 10. Dept. Gudang 008 | 205 | - | 11.11 | - | 10.39 | 15.10 | 1979 | | |
| 11. Jl. Medan Belawan | 200 | - | 11.11 | - | 6.55 | 15.26 | 1978 | | |
| 12. Jl. Dosomuko | - | - | - | - | - | - | - | | |
| 13. Jl. Pelabuhan Road X | - | - | 16.66 | - | - | - | 1980 | | |
| 14. Jl. Pelabuhan Road X | - | - | 9.72 | - | - | - | 1980 | | |
| KODYA. T. TINGGI | | | | | | | | | |
| 1. Sumur Bor I | 152 | - | 3.60 | - | - | - | - | 50.0*** | |
| 2. Sumur Bor II | 152 | - | 4.40 | - | - | - | - | 48.0 | |
| 3. Sumur Bor III | 175 | - | 4.40 | - | - | - | - | - | |
| 4. Sumur Bor IV | 167 | - | 2.50 | - | - | - | - | - | |
| 5. Sumur Bor V | 210 | - | 6.20 | - | - | - | - | 48.0 | |
| 6. Sumur Bor VI | - | - | 6.00 | - | - | - | - | 48.0 | |
| 7. Sumur Bor VII | - | - | 2.70 | - | - | - | - | 48.5 | |
| 8. Sumur Bor VIII | 261 | - | 5.50 | - | - | - | - | 48.0 | |
| KAB. DELI SERDANG | | | | | | | | | |
| 1. Lubuk Pakam | - | - | 21.1 | - | - | - | - | - | |
| 2. Tanjung Morawa | - | - | - | - | - | - | - | 1982 | |
| 3. Sei Rampah | - | - | - | - | - | - | - | 1983 | |
| 4. Bangun Purba | - | - | - | - | - | - | - | 1983 | |
| 5. Perbaungan | - | - | 7.00 | - | - | - | - | 1958 | |
| 6. Pantai Cermin | - | - | 5.00 | - | - | - | - | 1988 | |
| 7. Dolok Merawan | - | - | 2.50 | - | - | - | - | 1982 | |
| 8. Batang Kuis | - | - | 5.00 | - | - | - | - | 1982 | |
| 9. Hampan Perak | - | - | 2.50 | - | - | - | - | 1987 | |
| 10. Tiga Juhar | - | - | 5.00 | - | - | - | - | 1987 | |
| 11. Tembun g | - | - | 5.00 | - | - | - | - | 1988 | Not Function |
| 12. Dolok Masihul | - | - | 2.50 | - | - | - | - | 1988 | Not Function |
| 13. Bandar Khalipah | - | - | 5.00 | - | - | - | - | 1990 | |
| 14. Galang | - | - | 5.00 | - | - | - | - | - | Not Function |

Note: * Present water depth was measured in 1990.
 ** Static water depth without pump operation.
 *** Water Temperature (C)

Table 2-4 ACTUAL WATER CONSUMPTION IN KODYA. MEDAN
(PDAM MEDAN, AS OF MAY 1990)

| Code | Consumer for Tariff | Number of Consumer | Consumption (m3/month) |
|------|----------------------------|--------------------|------------------------|
| 1. | A. Mosque & Church, Temple | 733 | 99,104 |
| | B. Public Tap | 185 | 24,236 |
| 2. | A. House Connection | 84,431 | 2,922,550 |
| | A1. Consumption 0 - 15 m3 | 18,834 | 1,135,948 |
| | A2. Consumption 16 - 30 m3 | 26,623 | 809,464 |
| | A3. Over 30 m3 | 38,974 | 977,138 |
| | B. Government Office | 888 | 207,296 |
| | B1. Consumption 0 - 15 m3 | 120 | 12,326 |
| | B2. Consumption 16 - 30 m3 | 105 | 10,838 |
| | B3. Consumption 30 - 50 m3 | 117 | 12,190 |
| | B4. Over 50 m3 | 546 | 171,942 |
| 3. | A. Small Commercial | 4,259 | 183,757 |
| | A1. Consumption 0 - 30 m3 | 2,204 | 93,096 |
| | A2. Over 30 m3 | 2,055 | 90,661 |
| | B. Big Commercial | 6,413 | 336,091 |
| | B1. Consumption 0 - 30 m3 | 3,218 | 139,060 |
| | B2. Over 30 m3 | 3,195 | 197,031 |
| 4. | A. Small Industry | 34 | 4,832 |
| | A1. Consumption 0 - 30 m3 | 17 | 763 |
| | A2. Over 30 m3 | 17 | 4,069 |
| | B. Big Industry | 102 | 26,803 |
| | B1. Consumption 0 - 30 m3 | 35 | 2,400 |
| | B2. Over 30 m3 | 67 | 24,403 |
| 5. | Special use | 36 | 5,740 |
| | A. Fire Tap | 3 | 835 |
| | B. Free of charge | 33 | 4,905 |
| | Pipe Clean | 0 | 4,945 |
| | Total of General Use | 193,244 | 7,502,423 |
| | Total of Army Use | 172 | 149,321 |
| | Grand Total | 193,416 | 7,651,744 |

Source : PDAM Medan, May 1990

Table 2-5 ACTUAL WATER CONSUMPTION IN KODYA. T. TINGGI
(PDAM TEBING TINGGI, AS OF FEB 1990)

| Consumer for Tariff | Wilayah I | | Wilayah II | | Wilayah III | | Wilayah IV | | Wilayah V | | Wilayah VI | | Total | |
|---------------------------|-----------|-----|------------|-----|-------------|-----|------------|-----|-----------|-----|------------|-----|-------|--------|
| | (A) | (B) | (A) | (B) | (A) | (B) | (A) | (B) | (A) | (B) | (A) | (B) | (A) | (B) |
| House connection | 315 | - | 160 | - | 210 | - | 153 | - | 231 | - | 36 | - | 1,105 | 28,583 |
| Commercial (Small) | 12 | - | 171 | - | 254 | - | 289 | - | 456 | - | 7 | - | 1,189 | 35,783 |
| Commercial (Big) | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Industry | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Social | 12 | - | 17 | - | 9 | - | 9 | - | 13 | - | 2 | - | 62 | 5,929 |
| Total | 339 | - | 348 | - | 473 | - | 451 | - | 700 | - | 45 | - | 2,356 | 70,295 |

(NOTE) (A) : Number of Supply Unit

(B) : Water Consumption (m³/month)

Institutional consumption is included in house connection

Source : PDAM Tebing Tinggi, Feb. 1990

Table 2-6 WATER SUPPLY SYSTEM IN KAB. DELI SERDANG

| No. | Location | Operation Starting Year | Population Served | Source | Capacity (l/s) | Pumping Power (KVA) | | Production for Utilization (m3/day) | | | | Operation (hour/day) | | Remarks |
|-----|-----------------|-------------------------|-------------------|---------|----------------|---------------------|-------------|-------------------------------------|----|--------|----|----------------------|--------------|----------------|
| | | | | | | PLN | Generator | Designed | | Actual | | PLN/Generator | Distribution | |
| | | | | | | | | SR | HU | SR | HU | | | |
| 1. | Lubuk Pakam | 1980 | 65,642 | ATD | 3.10 | - | - | 1,242 | - | 1,242 | - | 12 | - | |
| | | 1982 | - | ATD | 18.00 | - | - | - | - | - | - | 12 | - | |
| 2. | Tanjung Morawa | 1983 | 19,260 | APS/WTP | 10.00 | - | 27 x 30 | 303 | - | 303 | - | 12 | 10 | |
| 3. | Sei Rampah | 1983 | 20,371 | APS/WTP | 20.00 | - | 2 x 59 | 413 | - | 413 | - | 12 | 10 | |
| 4. | Bangun Purba | 1958 | 2,451 | M. Air | 7.00 | - | 1 x 18 | 234 | - | 231 | - | 12 | 12 | |
| 5. | Perbaungan | 1988 | 10,198 | ATD | 5.00 | - | 2 x 20 | 151 | - | 151 | - | 12 | 12 | |
| 6. | Pantai Cermin | 1982 | 5,281 | ATD | 2.50 | - | 2 x 10 | 224 | - | 157 | - | 12 | 12 | |
| 7. | Dolok Merawan | 1982 | 3,554 | ATD | 2.50 | - | 2 x 10 | 121 | - | 111 | - | 16 | 14 | Already closed |
| 8. | Batang Kuis | 1982 | 2,864 | ATD | 5.00 | - | 2 x 20 | 164 | - | 132 | - | 12 | 12 | |
| 9. | Hampanan Perak | 1987 | 5,811 | ATD | 2.50 | - | 2 x 20 | 104 | - | 100 | - | 12 | 12 | |
| 10. | Tiga Juhar | 1987 | 1,140 | ATD | 5.00 | - | Gravitation | 118 | - | 117 | - | 24 | 24 | |
| 11. | Yambung | 1988 | - | ATD | 5.00 | - | 2 x 25 | - | - | - | - | - | - | No data |
| 12. | Dolok Masihol | 1988 | - | ATD | 2.50 | - | 2 x 10 | 114 | - | 95 | - | 12 | 12 | |
| 13. | Bandar Khalifah | 1990 | - | ATD | 5.00 | - | 2 x 20 | 200 | - | 92 | - | 12 | - | |
| 14. | G a l e n g | - | 6,850 | ATD | 5.00 | - | - | - | - | - | - | - | - | Not function |

Note
 ATD : Deep Well.
 APS : River Water.
 WTP : Water Treatment Plant.
 M. Air : Spring Water.

Table 2-7 ACTUAL WATER CONSUMPTION IN KAB. DELI SERDANG
(PDAM DELI SERDANG, AS OF FEB. 1990)

| No. | Name of Kecamatan | House Connection | | Commercial | | Industrial | | Social | | Institutional | | Public Tap | |
|-------|---------------------|------------------|--------|------------|-------|------------|-----|--------|-----|---------------|-------|------------|-----|
| | | (A) | (B) | (A) | (B) | (A) | (B) | (A) | (B) | (A) | (B) | (A) | (B) |
| 1. | Tanjung Morawa | 287 | 4,927 | 21 | 419 | 1 | 10 | 6 | 80 | 2 | 50 | - | - |
| 2. | Bdr. Khalipah (IKK) | 111 | - | - | - | - | - | - | - | 2 | - | - | - |
| 3. | H. Perak (IKK) | 88 | - | 5 | - | - | - | - | - | 2 | - | - | - |
| 4. | Perbaungan (IKK) | 113 | - | 29 | - | - | - | - | - | - | - | - | - |
| 5. | S. Rampah | 426 | 8,141 | 8 | 0 | - | 0 | 8 | 444 | 9 | 180 | 1 | 92 |
| 6. | DoJok Merawan (IKK) | 110 | - | - | - | - | - | - | - | 1 | - | - | - |
| 7. | Lubuk Pakam | 1,128 | 25,477 | 134 | 3,825 | 5 | 175 | 37 | 364 | 50 | 3,578 | 3 | 201 |
| 8. | P. Cermin (IKK) | 210 | - | 17 | - | 1 | - | 2 | - | 2 | - | - | - |
| 9. | B. Purba | 223 | 3,102 | 13 | 235 | - | - | - | - | 8 | 187 | - | - |
| 10. | Tiga Juhar | 177 | 1,693 | - | - | - | - | - | - | - | - | - | - |
| 11. | Batang Kuis (IKK) | 119 | - | 15 | - | - | - | - | - | - | - | - | - |
| 12. | Tembung * | - | - | - | - | - | - | - | - | - | - | - | - |
| 13. | DoJok Masihul * | - | - | - | - | - | - | - | - | - | - | - | - |
| 14. | Galang * | - | - | - | - | - | - | - | - | - | - | - | - |
| Total | | 2,992 | 43,340 | 242 | 4,479 | 7 | 185 | 53 | 888 | 76 | 3,995 | 4 | 293 |

(Note) (A) : Number of Supply Unit,

(B) : Water Consumption (m³/month),

* : Not Operation

- Data on water supply under IKK is not available.
(Tariff is fixed)

Table 2-8 DOMESTIC AND NON-DOMESTIC WATER DEMAND PARAMETERS

| | "Ultimate" Water Demand | Cipta Karya Variant | | Repelita Variant | | | |
|---------------------------|-------------------------------------|-------------------------------------|---------------|----------------------|------|------|------|
| U R B A N | | | | Average lcd | | | |
| Domestic Water Demand | 80% HC : 150 lcd 20% PT : 50 lcd | 80% HC : 90 lcd 20% PT : 30 lcd | Population | 1985 | 1990 | 2000 | 2010 |
| | | | >1,000,000 | 120 | 120 | 120 | 120 |
| | | | 500-1,000,000 | 100 | 100 | 100 | 100 |
| | | | 100-500,000 | 90 | 90 | 90 | 90 |
| | | | 20-100,000 | 60 | 60 | 60 | 60 |
| | | | 3-20,000 | 45 | 45 | 45 | 45 |
| Non-Domestic Water Demand | % of domestic water demand | | Population | 1985 | 1990 | 2000 | 2010 |
| | >500,000 : 40% | >500,000 : 40% | >1,000,000 | 60 | 60 | 60 | 60 |
| | 100-500,000 : 30% | 100-500,000 : 30% | 500-1,000,000 | 40 | 40 | 40 | 40 |
| | <100,000 : 25% | <100,000 : 25% | 100-500,000 | 30 | 30 | 30 | 30 |
| | | | 20-100,000 | 10 | 10 | 10 | 10 |
| | | | 3-20,000 | 5 | 5 | 5 | 5 |
| Losses | 20% of dom. + non.dom. water demand | 20% of dom. + non.dom. water demand | Population | 1985 | 1990 | 2000 | 2010 |
| | | | >1,000,000 | 25 | 25 | 25 | 25 |
| | | | 500-1,000,000 | 20 | 20 | 20 | 20 |
| | | | 100-500,000 | 20 | 20 | 20 | 20 |
| | | | 20-100,000 | 15 | 15 | 15 | 15 |
| | | | 3-20,000 | 10 | 10 | 10 | 10 |
| Coverage | 100% | 75% | | 55% | 75% | 80% | 85% |
| <hr/> | | | | | | | |
| R U R A L | | | | | | | |
| Domestic Water Demand | 90 lcd | 80% HC : 60 lcd 20% PT : 30 lcd | | Total Average 60 lcd | | | |
| Non-Domestic Water Demand | 10% of dom. + water demand | 10% of dom. + water demand | | | | | |
| Losses | 5% of dom. + non-dom. water demand | 5% of dom. + non-dom. water demand | | | | | |
| Coverage | 100% | 75% | | 1985 | 1990 | 2000 | 2010 |
| | | | | 45% | 60% | 70% | 80% |

(Note) : HC = House Connection
 PT = Public Tap
 lcd = Litre per capita per day

Source : Direktorat Air Bersih,

Table 2-9 NUMBER OF INDUSTRY AND EMPLOYEE IN NORTH SUMATRA

| No. | Kabupaten/Kotamadya | Number of Industry | | | | Number of Employee | | | |
|------------------|---------------------|--------------------|------------|--------------|--------------|--------------------|---------------|---------------|---------------|
| | | Large and Medium | | Small | | Large and Medium | | Small | |
| | | 1974 | 1986 | 1974 | 1986 | 1974 | 1986 | 1974 | 1986 |
| KABUPATEN | | | | | | | | | |
| 1. | Nias | 3 | 4 | 29 | 23 | 73 | 118 | 300 | 142 |
| 2. | Tapanuli Selatan | 21 | 21 | 103 | 110 | 886 | 1,450 | 650 | 781 |
| 3. | Tapanuli Tengah | 3 | 6 | 9 | 35 | 810 | 1,558 | 71 | 324 |
| 4. | Tapanuli Utara | 9 | 13 | 101 | 82 | 161 | 385 | 783 | 563 |
| 5. | Labuhan Batu | 18 | 33 | 131 | 209 | 1,251 | 7,042 | 1,113 | 1,537 |
| 6. | Asahan | 10 | 69 | 129 | 244 | 2,070 | 16,178 | 1,165 | 1,911 |
| 7. | Simalungun | 7 | 50 | 70 | 114 | 1,462 | 7,438 | 516 | 965 |
| 8. | Dairi | 0 | 2 | 4 | 21 | 0 | 291 | 25 | 147 |
| 9. | Karo | 1 | 1 | 17 | 29 | 76 | 85 | 115 | 231 |
| 10. | Deli Serdang | 25 | 162 | 246 | 706 | 5,022 | 20,545 | 1,704 | 5,528 |
| 11. | Langkat | 12 | 37 | 272 | 425 | 792 | 3,886 | 1,935 | 3,114 |
| KOTAMADYA | | | | | | | | | |
| 12. | Sibolangit | 2 | 2 | 16 | 22 | 125 | 48 | 117 | 174 |
| 13. | Tanjung Balai | 0 | 0 | 14 | 14 | 0 | 0 | 110 | 108 |
| 14. | Pematang Siantar | 17 | 39 | 104 | 117 | 2,480 | 5,079 | 872 | 1,079 |
| 15. | Tebing Tinggi | 16 | 24 | 33 | 106 | 928 | 2,287 | 224 | 960 |
| 16. | Medan | 115 | 214 | 662 | 1,353 | 8,885 | 22,129 | 5,735 | 10,817 |
| 17. | Binjai | 7 | 10 | 45 | 137 | 237 | 446 | 315 | 983 |
| Total | | 266 | 687 | 1,985 | 3,747 | 25,258 | 88,965 | 15,750 | 29,364 |

Source : Sumatera Utara Dalam Angka, 1988.

Table 2-10(1/2) EXISTING PADDY FIELD IN THE STUDY AREA

| Name | Total Area (ha) | River | Existing Irrigation | | | | On-Going/Future Scheme | | Category |
|-----------------------------------|-----------------|----------------|---------------------|--------------|--------------|------------|------------------------|--------------------|----------|
| | | | Technical | Semi-Tech | Simple | Rainfed | Rainfed | Not Yet Cultivated | |
| BELAWAN RIVER BASIN | | | | | | | | | |
| 6. Bekala | 200 | Laucikala | 0 | 200 | 0 | 0 | 0 | 0 | A |
| 7. Namo Bintang | 960 | Lau Bertak | 0 | 160 | 0 | 800 | 0 | 0 | A |
| 27. Medan Krio | 3,016 | Tuntungan | 0 | 3,016 | 0 | 0 | 0 | 0 | A |
| 29. Sumber Hulyo Rejo | 550 | Diski | 0 | 0 | 550 | 0 | 0 | 0 | B |
| 30. Paya Bakung | 1,000 | Gelugur | 0 | 0 | 1,000 | 0 | 0 | 0 | B |
| 31. Serba Jadi | 285 | Gelugur | 0 | 0 | 285 | 0 | 0 | 0 | B |
| 46. Tiang Layar | 600 | Tengah | 0 | 0 | 600 | 0 | 0 | 0 | B |
| 47. Namo Riaw | 130 | Tengah | 0 | 0 | 130 | 0 | 0 | 0 | B |
| 66. Sisir Gunting | 3,500 | Belawan | 0 | 0 | 0 | 0 | 1,000 | 2,500 | B |
| 68. Pulau Manan (Hampan Perak) | 3,500 | Belawan | 0 | 0 | 0 | 0 | 0 | 3,500 | C |
| 86. Suka Raya | 201 | Tembengan | 0 | 0 | 201 | 0 | 0 | 0 | B |
| New 1 Bulu Cina | 1,000 | Belawan | 0 | 0 | 0 | 0 | 300 | 700 | A |
| T o t a l | 14,942 | | 0 | 3,376 | 2,766 | 800 | 1,300 | 6,700 | |
| DELI RIVER BASIN | | | | | | | | | |
| 2. Sibolangit | 230 | Lau Betinus | 0 | 230 | 0 | 0 | 0 | 0 | A |
| 3. Kalahan Pinang | 490 | Tembengan | 0 | 490 | 0 | 0 | 0 | 0 | A |
| 4. Namo Rambe | 3,280 | Deli | 0 | 1,460 | 1,820 | 0 | 0 | 0 | A |
| 5. Lau Simeme | 220 | Lau Simeme | 0 | 220 | 0 | 0 | 0 | 0 | A |
| 44. Batu Senggahan | 220 | Seruai | 0 | 0 | 220 | 0 | 0 | 0 | B |
| 45. Belabon | 500 | Betinus | 0 | 0 | 500 | 0 | 0 | 0 | B |
| T o t a l | 4,940 | | 0 | 2,400 | 2,540 | 0 | 0 | 0 | |
| PERCUT RIVER BASIN | | | | | | | | | |
| 1. Bandar Sidoras | 3,457 | Percut | 0 | 1,000 | 2,457 | 0 | 0 | 0 | A |
| 48. Namo Bintang | 40 | Lau Kulumat | 0 | 0 | 40 | 0 | 0 | 0 | B |
| 49. Lantasan | 600 | Seruai | 0 | 0 | 600 | 0 | 0 | 0 | C |
| 50. Suka Rakyat | 40 | Betinus | 0 | 0 | 40 | 0 | 0 | 0 | B |
| 104. Bangun Setia | 209 | - | 0 | 0 | 100 | 109 | 0 | 0 | B |
| New 2 Paluh Merbau | 2,105 | - | 0 | 0 | 0 | 0 | 1,010 | 1,095 | A |
| T o t a l | 6,451 | | 0 | 1,000 | 3,237 | 109 | 1,010 | 1,095 | |
| SERDANG RIVER BASIN | | | | | | | | | |
| 10. Perbarakan | 820 | Batu Ginggaing | 0 | 400 | 420 | 0 | 0 | 0 | A |
| 12. Penara | 421 | Batu Ginggaing | 0 | 421 | 0 | 0 | 0 | 0 | A |
| 14. Monosari | 585 | Batu Ginggaing | 0 | 585 | 0 | 0 | 0 | 0 | A |
| 32. Batang Kuis | 4,750 | Belumei | 0 | 0 | 4,750 | 0 | 0 | 0 | B |
| 34. Bandar Labuhan | 935 | S. Labuhan | 0 | 0 | 935 | 0 | 0 | 0 | B |
| 35. Tanjung Morawa | 1,000 | Barumbu | 0 | 0 | 1,000 | 0 | 0 | 0 | B |
| 38. Serdang | 950 | Barumbu | 0 | 200 | 50 | 0 | 0 | 700 | B |
| 39. Petanggihan | 180 | Barumbu | 0 | 0 | 180 | 0 | 0 | 0 | C |
| 41. Petumbukan | 40 | Barumbu | 0 | 0 | 40 | 0 | 0 | 0 | B |
| 42. Kotasan | 200 | Barumbu | 0 | 0 | 200 | 0 | 0 | 0 | B |
| 43. Pisang Para | 100 | Batu Rata | 0 | 0 | 100 | 0 | 0 | 0 | B |
| 51. Bintang Merah I | 200 | Lau Kaca | 0 | 0 | 200 | 0 | 0 | 0 | B |
| 52. Bintang Merah II | 230 | Lau Kaca | 0 | 0 | 230 | 0 | 0 | 0 | B |
| 53. Tiga Juhar | 600 | Bah Apul | 0 | 600 | 0 | 0 | 0 | 0 | B |
| 55. Teratak | 150 | Kau Muakah | 0 | 0 | 150 | 0 | 0 | 0 | B |
| 36. Jaharum A | 340 | S. Galang | 0 | 0 | 340 | 0 | 0 | 0 | B |
| 37. Paya Itik | 300 | Batu Ginggaing | 0 | 0 | 300 | 0 | 0 | 0 | B |
| 103. Ujung Serdang | 354 | Drainage | 0 | 0 | 114 | 240 | 0 | 0 | B |
| New 3 Sei Tuan | 400 | Barumbu | 0 | 0 | 0 | 0 | 224 | 176 | A |
| New 4 Rantau Panjang | 3,200 | Barumbu | 0 | 0 | 0 | 0 | 3,200 | 0 | A |
| T o t a l | 15,755 | | 0 | 2,206 | 9,009 | 240 | 3,424 | 876 | |

Note A : Public Works Irrigation,
B : Agriculture Irrigation,
C : District Irrigation.

Table 2-10(2/2) EXISTING PADDY FIELD IN THE STUDY AREA

| No. | Name | Total Area (ha) | River | Existing Irrigation | | | | On-Going/Future Scheme | | Category |
|--------------------|---------------------------------|-----------------|---------------|---------------------|-----------|--------|---------|------------------------|--------------------|----------|
| | | | | Technical | Semi-Tech | Simple | Rainfed | Rainfed | Not Yet Cultivated | |
| ULAR RIVER BASIN | | | | | | | | | | |
| U-1 | Timbang Dell | 520 | Ular | 520 | 0 | 0 | 0 | 0 | 0 | A |
| U-2 | Sumber Rejo | 2,910 | Ular | 2,910 | 0 | 0 | 0 | 0 | 0 | A |
| U-3 | Ramonta | 1,880 | Ular | 1,880 | 0 | 0 | 0 | 0 | 0 | A |
| U-4 | Pulau Gambar | 990 | Ular | 990 | 0 | 0 | 0 | 0 | 0 | A |
| U-5 | B e n d a n | 1,380 | Ular | 1,380 | 0 | 0 | 0 | 0 | 0 | A |
| U-6 | Singosari | 880 | Ular | 880 | 0 | 0 | 0 | 0 | 0 | A |
| U-7 | Perbaungan | 5,920 | Ular | 5,920 | 0 | 0 | 0 | 0 | 0 | A |
| U-8 | Buluh | 4,020 | Ular | 4,020 | 0 | 0 | 0 | 0 | 0 | A |
| 40. | Desa Manggis | 50 | - | 0 | 0 | 50 | 0 | 0 | 0 | C |
| 54. | Sibaganding | 140 | Buaya | 0 | 0 | 140 | 0 | 0 | 0 | C |
| 58. | Durian Kondot | 120 | Buaya | 0 | 0 | 120 | 0 | 0 | 0 | C |
| 67. | Pagar Manik | 20 | Buaya | 0 | 0 | 20 | 0 | 0 | 0 | B |
| 75. | Nagri Dolok | 420 | Bah Karal | 0 | 0 | 420 | 0 | 0 | 0 | A |
| 76. | Saran Padang | 415 | Bah Pulung | 0 | 0 | 415 | 0 | 0 | 0 | A |
| 77. | S. Herawan | 480 | Situri-turi | 0 | 0 | 480 | 0 | 0 | 0 | A |
| 78. | Bandar Purba | 140 | Situri-turi | 0 | 0 | 140 | 0 | 0 | 0 | A |
| 56. | DT. Buho | 120 | Bah Udon | 0 | 0 | 120 | 0 | 0 | 0 | B |
| 79. | Cherawan | 800 | Nam Pakam | 0 | 0 | 50 | 750 | 0 | 0 | B |
| 80. | Kota Pari | 665 | Drainage | 0 | 0 | 15 | 650 | 0 | 0 | B |
| 81. | T. Mengkudu | 1,550 | Drainage | 0 | 0 | 500 | 1,050 | 0 | 0 | B |
| 82. | B e n d u n g | 177 | Drainage | 0 | 0 | 177 | 0 | 0 | 0 | B |
| 92. | Bah Singkem | 149 | Buaya | 0 | 0 | 49 | 100 | 0 | 0 | B |
| 93. | Sei Dadapan | 135 | Buaya | 0 | 0 | 85 | 50 | 0 | 0 | B |
| 94. | Sei Buaya | 255 | Buaya | 0 | 0 | 105 | 150 | 0 | 0 | B |
| 95. | Sei Singkem | 160 | Buaya | 0 | 0 | 60 | 100 | 0 | 0 | B |
| Total | | 24,296 | | 18,500 | 0 | 2,946 | 2,850 | 0 | 0 | |
| BELUTU RIVER BASIN | | | | | | | | | | |
| 20. | B u l i a n | 300 | Kalibah | 0 | 0 | 300 | 0 | 0 | 0 | A |
| 22. | Sei Belutu | 5,100 | Belutu | 0 | 4,000 | 1,100 | 0 | 0 | 0 | A |
| 25. | Pekan Dolok | 625 | Belutu | 0 | 625 | 0 | 0 | 0 | 0 | A |
| 26. | Cinta Kasih | 360 | Hitau | 0 | 360 | 0 | 0 | 0 | 0 | A |
| 57. | Pekan Kemis | 1,271 | Kerapuh | 0 | 0 | 1,271 | 0 | 0 | 0 | B |
| 59. | Dolok Sagala | 150 | Kerapuh | 0 | 0 | 150 | 0 | 0 | 0 | C |
| 60. | Petambatan | 145 | Belutu | 0 | 0 | 145 | 0 | 0 | 0 | B |
| 65. | Pematang Cermin | 4,600 | Rampah | 0 | 0 | 480 | 0 | 950 | 3,170 | B |
| 85. | Sromerawan | 260 | Belutu | 0 | 0 | 260 | 0 | 0 | 0 | B |
| 87. | Sei Rejo | 522 | Rampah | 0 | 0 | 130 | 392 | 0 | 0 | B |
| 88. | Sei Rampah Pekan | 209 | Rampah | 0 | 0 | 50 | 159 | 0 | 0 | B |
| 89. | Sei Rakyat | 185 | Rampah | 0 | 0 | 40 | 145 | 0 | 0 | B |
| 90. | Sei Parit | 316 | Rampah | 0 | 0 | 150 | 166 | 0 | 0 | B |
| 91. | H a k m u r | 115 | Rampah | 0 | 0 | 75 | 40 | 0 | 0 | B |
| 97. | Wartebing | 210 | - | 0 | 0 | 0 | 210 | 0 | 0 | B |
| New 5 | Belidahan/P. Ganjang | 2,000 | Rampah | 0 | 0 | 0 | 0 | 200 | 1,800 | A |
| Total | | 16,368 | | 0 | 4,985 | 4,151 | 1,112 | 1,150 | 4,970 | |
| PADANG RIVER BASIN | | | | | | | | | | |
| 21. | Raya Lambang | 1,558 | Padang | 0 | 1,558 | 0 | 0 | 0 | 0 | A |
| 23. | Langau | 4,000 | Padang | 0 | 1,150 | 0 | 0 | 750 | 2,100 | A |
| 24. | Bukit Cermin | 800 | Sibaro | 0 | 800 | 0 | 0 | 0 | 0 | A |
| 28. | Bah Tonang | 265 | Bah Tonang | 0 | 265 | 0 | 0 | 0 | 0 | A |
| 62. | Peritokan | 60 | Bentlang | 0 | 0 | 60 | 0 | 0 | 0 | C |
| 63. | Penggalian | 130 | Bah Hilang | 0 | 0 | 130 | 0 | 0 | 0 | C |
| 64. | Bandar Kalipah (1) (Lagunda) | 6,000 | Padang | 0 | 0 | 0 | 0 | 600 | 5,400 | B |
| 69. | Sikaro-Karo | 210 | Bah Hilang | 0 | 210 | 0 | 0 | 0 | 0 | A |
| 70. | Naga Dolok | 324 | Bah Ranggasan | 324 | 0 | 0 | 0 | 0 | 0 | A |
| 71. | Bah Tonang | 480 | Bah Sula | 0 | 480 | 0 | 0 | 0 | 0 | A |
| 72. | Impat Nihirik | 210 | Bah Kalitik | 0 | 210 | 0 | 0 | 0 | 0 | A |
| 73. | Sorba Dolok | 55 | Bah Kamal | 0 | 0 | 55 | 0 | 0 | 0 | A |
| 74. | Samborsa Raya | 293 | Bah Sumbu | 0 | 0 | 293 | 0 | 0 | 0 | A |
| 61. | Penggalangan | 250 | Mentalis | 0 | 250 | 0 | 0 | 0 | 0 | B |
| 83. | Sei Tempurung | 140 | Padang | 0 | 0 | 90 | 50 | 0 | 0 | B |
| 84. | Kayu Besar | 340 | Drainage | 0 | 0 | 0 | 340 | 0 | 0 | B |
| 96. | Mari Janji | 200 | Bah Tumbu | 0 | 0 | 200 | 0 | 0 | 0 | B |
| 98. | A v r o s | 215 | Drainage | 0 | 0 | 200 | 15 | 0 | 0 | B |
| 99. | B i n j e f | 150 | Padang | 0 | 0 | 60 | 90 | 0 | 0 | B |
| 100. | Kota Pinang | 175 | Drainage | 0 | 0 | 15 | 160 | 0 | 0 | B |
| 101. | Paya Mabar | 150 | Drainage | 0 | 0 | 150 | 0 | 0 | 0 | B |
| 105. | Rubuk Baru | 150 | - | 0 | 0 | 50 | 100 | 0 | 0 | B |
| New 6 | Bandar Kalipah (2) | 1,500 | - | 0 | 0 | 0 | 0 | 600 | 900 | A |
| Total | | 17,655 | | 324 | 4,923 | 1,303 | 755 | 1,950 | 8,400 | |

Note A : Public Works Irrigation
B : Agriculture Irrigation
C : District Irrigation

Table 2-11 PRESENT STATUS OF FRESH WATER AQUACULTURE

| Name of Kabupaten | Potential Area (ha) | Existing Area (ha) | | | Total (ha) |
|---------------------|---------------------|--------------------|---------|---------|------------|
| | | Total | Pond | Paddy | |
| 1. N i a s | 400.0 | 39.0 | 39.0 | 0 | 361 |
| 2. Tapanuli Tengah | 1,468.8 | 60.0 | 60.0 | 0 | 1,408.8 |
| 3. Tapanuli Selatan | 11,969.1 | 2,416.0 | 646.0 | 1,770.0 | 9,553.1 |
| 4. Tapanuli Utara | 4,742.7 | 4,555.3 | 435.8 | 4,119.5 | 187.4 |
| 5. Simalungun | 11,820.0 | 3,718.0 | 568.0 | 3,150.0 | 8,102.0 |
| 6. D a i r i | 3,520.7 | 397.0 | 117.0 | 280.0 | 3,123.7 |
| 7. K a r o | 3,652.2 | 183.0 | 163.0 | 20.0 | 3,469.2 |
| 8. Deli Serdang | 9,477.8 | 803.0 | 524.0 | 279.0 | 8,674.8 |
| 9. Langkat | 10,250.9 | 139.0 | 139.0 | 0 | 10,111.9 |
| 10. Asahan | 8,962.5 | 336.0 | 336.0 | 0 | 8,626.5 |
| 11. Labuhan Batu | 18,647.5 | 165.0 | 165.0 | 0 | 18,482.5 |
| T o t a l | 84,912.2 | 12,811.3 | 3,192.8 | 9,618.5 | 72,100.9 |

Source : Laporan Evaluasi Repelita IV, Sub Sektor Perikanan Daerah, Sumatera Utara, 1989

Table 2-12 PRESENT STATUS OF BRACKISH WATER AQUACULTURE
(KAB. DELI SERDANG)

| No. | Name of Tambak | Total Area (ha) | | Production (t/ha/4 months) | Employee |
|-----------|---------------------------|-----------------|-----------|-------------------------------|----------|
| | | Gross | Operation | | |
| 1 | Desa Sei Baharu | 53.0 | 28.7 | 2 - 8 | 5 - 15 |
| 2 | Desa Hampan Perak | 114.1 | 83.8 | 2 - 8 | 2 - 6 |
| 3 | Desa Paluh Kurau | 435.5 | 127.4 | 0.4 - 11 | 1 - 20 |
| 4 | Desa Secanang | 12.0 | 7.5 | 5 | 4 - 15 |
| 5 | (Name is Unknown) | 436.2 | 165.5 | - | - |
| 6 | Kecamatan Percut | 46.8 | 28.7 | 0.2 - 5 | 3 - 10 |
| 7 | Kecamatan Pantai Cermin | 156.0 | 34.5 | 1.6 - 4.6 | 6 - 43 |
| 8 | Kecamatan Pantai Labu | 349.0 | 104.5 | 1.1 - 2.5 | 3 - 23 |
| 9 | Kecamatan Perbaungan | 91.1 | 45.5 | 7 | 5 - 27 |
| 10 | Kecamatan Bandar Khalipah | 135.2 | 50.6 | 5 - 6 | 4 - 11 |
| 11 | Kecamatan Tanjung Beringi | 124.0 | 42.0 | 6 | 13 - 34 |
| 12 | Kecamatan Teluk Mengkudu | 160.2 | 106.8 | 3 - 8 | 2 - 26 |
| T o t a l | | 2,113.1 | 825.5 | - | - |

Source : Laporan Hasil, Lahan Kawasan Usaha Pertambakan dan Hatchery
di Dati II Deli Serdang dan Kota Medan, 1989

Table 3-1 PRESENT MUNICIPAL WATER DEMAND (1990)

(Unit : m³/day)

| Name of River | Name of Kecamatan | Population | Domestic Water | Non-Domestic | Un-Accounted Loss | Total |
|-----------------------|----------------------|---------------------|----------------|--------------|-------------------|---------|
| Belawan River | D-1 Labuhan Deli | 36,773 | 662 | 66 | 38 | 766 |
| | D-2 Hampan perak | 98,153 | 1,767 | 177 | 102 | 2,046 |
| | D-3 Sunggal | 120,681 | 2,172 | 217 | 126 | 2,515 |
| | D-4 Kutalimbaru | 23,362 | 421 | 42 | 24 | 487 |
| | D-5 Pancur Batu | 47,961 | 863 | 86 | 50 | 999 |
| | T o t a l | 326,930 | 5,885 | 588 | 341 | 6,813 |
| Deli River | - Medan | 1,731,000 | 168,773 | 67,509 | 78,761 | 315,042 |
| | D-6 Namorambe | 17,444 | 314 | 31 | 18 | 363 |
| | D-7 Deli Tua | 32,806 | 591 | 59 | 34 | 684 |
| | D10 Sibolangit | 17,971 | 323 | 32 | 19 | 374 |
| | T o t a l | 1,799,221 | 170,000 | 67,632 | 78,832 | 316,463 |
| Percut River | D-8 Patumbak | 34,522 | 621 | 62 | 36 | 719 |
| | D-9 Sibiru-biru | 22,879 | 412 | 41 | 24 | 477 |
| | D-11 Percut Sei Tuan | 197,193 | 3,549 | 355 | 205 | 4,110 |
| | T o t a l | 254,594 | 4,583 | 458 | 265 | 5,306 |
| Serdang River | D-14 Batang Kuis | 30,035 | 541 | 54 | 31 | 626 |
| | D-16 Lubuk Pakam | 65,100 | 1,172 | 117 | 68 | 1,357 |
| | D-18 Tanjung Morawa | 111,349 | 2,004 | 200 | 116 | 2,321 |
| | D-19 Pagar Merbau | 26,491 | 477 | 48 | 28 | 552 |
| | D-21 STM Hilir | 24,282 | 437 | 44 | 25 | 506 |
| | D-22 Bangun Purba | 27,409 | 493 | 49 | 29 | 571 |
| | D-24 STM Hulu | 8,699 | 157 | 16 | 9 | 181 |
| | T o t a l | 293,365 | 5,280 | 528 | 306 | 6,114 |
| Ular River | D-12 Pantai Labu | 32,224 | 580 | 58 | 34 | 672 |
| | D-13 Pantai Cermin | 33,432 | 602 | 60 | 35 | 697 |
| | D-15 Beringin | 39,265 | 707 | 71 | 41 | 818 |
| | D-17 Perbaungan | 105,642 | 1,902 | 190 | 110 | 2,202 |
| | D-20 Galang | 71,869 | 1,294 | 129 | 75 | 1,498 |
| | D-23 Kutarih | 17,321 | 312 | 31 | 18 | 361 |
| | D-25 Gunung Meriah | 3,094 | 56 | 6 | 3 | 64 |
| | S-3 Dolok Silau | 9,746 | 175 | 18 | 10 | 203 |
| | S-5 Raya | 31,705 | 571 | 57 | 33 | 661 |
| | S-6 Purba | 21,036 | 379 | 38 | 22 | 438 |
| | S-7 Silima Kuta | 16,235 | 292 | 29 | 17 | 338 |
| | T o t a l | 381,569 | 6,868 | 686 | 398 | 7,951 |
| | Belutu River | D-26 Teluk Mengkudu | 33,091 | 596 | 60 | 34 |
| D-27 Tanjung Beringin | | 29,953 | 539 | 54 | 31 | 624 |
| D-29 Sei Rampah | | 95,793 | 1,724 | 172 | 100 | 1,996 |
| D-31 Dolok Masihul | | 50,216 | 904 | 90 | 52 | 1,046 |
| S-2 Silau Kahean | | 15,417 | 278 | 28 | 16 | 321 |
| T o t a l | 224,470 | 4,040 | 404 | 234 | 4,678 | |
| Padang River | - Tebing Tinggi | 117,000 | 11,408 | 4,563 | 5,324 | 21,294 |
| | D-28 Bandar Khalipah | 24,137 | 434 | 43 | 25 | 503 |
| | D-30 Tebing Tinggi | 69,620 | 1,253 | 125 | 73 | 1,451 |
| | D-32 Dolok Merawan | 18,379 | 331 | 33 | 19 | 383 |
| | D-33 Sipispis | 35,000 | 630 | 63 | 36 | 729 |
| | S-1 Raya Kahean | 17,292 | 311 | 31 | 18 | 360 |
| | T o t a l | 281,428 | 14,367 | 4,859 | 5,495 | 24,721 |
| GRAND TOTAL | | 3,561,577 | 211,022 | 75,154 | 85,870 | 372,046 |

Table 3-2(1/2) MONTHLY CONSUMPTIVE USE BY CROP AND WATER REQUIREMENT
(WET SEASON)

| ITEM OF WATER REQUIREMENT | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. |
|--|-------------|------|-------------|------|---------|------|
| | Nursery bed | | Paddy field | | Drained | |
| (Kc) Value for First 1/6 area | 1.08 | 1.25 | 1.33 | 1.39 | 1.15 | 1.05 |
| (Kc) Value for Second 1/6 area | 1.08 | 1.17 | 1.25 | 1.33 | 1.24 | 1.15 |
| (Kc) Value for Third 1/6 area | | 1.08 | 1.17 | 1.25 | 1.33 | 1.24 |
| (Kc) Value for 4 th 1/6 area | | 1.08 | 1.17 | 1.25 | 1.33 | 1.24 |
| (Kc) Value for 5 th 1/6 area | | 1.08 | 1.17 | 1.25 | 1.33 | 1.24 |
| (Kc) Value for 6 th 1/6 area | | 1.08 | 1.17 | 1.25 | 1.33 | 1.24 |
| Average for 10 days | 1.08 | 1.17 | 1.21 | 1.24 | 1.31 | 1.19 |
| Evapotranspiration, ET | 2.8 | 3.2 | 3.3 | 3.3 | 4.2 | 3.9 |
| Percolation | 2.0 | 2.0 | 2.0 | 2.0 | 3.0 | 3.0 |
| Effective rainfall | 3.5 | 2.9 | 2.2 | 2.3 | 1.1 | 1.4 |
| Ratio of area | 0.17 | 0.50 | 0.67 | 0.83 | 1.00 | 0.67 |
| Net irrigation requirement(mm/10-days) | 0.22 | 0.49 | 1.15 | 2.49 | 6.10 | 3.69 |
| Water req. for field preparation | 3.30 | 3.30 | 3.30 | 3.30 | 3.30 | 3.30 |
| Effective rainfall | 3.50 | 2.90 | 2.20 | 2.30 | 2.70 | 2.70 |
| Net irrigation requirement | 0.00 | 0.40 | 1.10 | 1.00 | 0.60 | 0.60 |
| Net irr. req. for nur. bed | 0.01 | 0.02 | 0.03 | 0.02 | | |
| Net field irr. req. | 0.01 | 0.02 | 0.24 | 0.52 | 4.60 | 3.69 |
| Field irr. req. (mm/day) | 0.01 | 0.02 | 0.27 | 0.58 | 5.10 | 4.10 |
| Equivalent continuous flow (l/s/ha) | 0.01 | 0.02 | 0.03 | 0.07 | 0.59 | 0.47 |
| Diversion Water Requirement (l/s/ha) | 0.02 | 0.03 | 0.04 | 0.10 | 0.84 | 0.51 |

Table 3-3 PRESENT WATER DEMAND

| Name of City/River Basin | Municipal | | Irrigation | | Total Water Demand (Municipal+Irrigation) |
|--------------------------|---------------------|-----------------------|----------------------|----------------------------------|---|
| | Population (Person) | Water Demand (MCM/yr) | Irrigation Area (ha) | Irrigation Water Demand (MCM/yr) | (MCM/yr) |
| Medan City | 1,731,000 | 115.0 | - | - | 115.0 |
| Tebing Tinggi City | 117,000 | 7.8 | - | - | 7.8 |
| Belawan R.B. | 326,930 | 2.5 | 8,242 | 35.3 | 58.0 |
| Deli R.B. | 68,221 | 0.5 | 4,940 | 44.1 | 44.6 |
| Percut R.B. | 254,594 | 1.9 | 5,356 | 30.0 | 31.9 |
| Serdang R.B. | 293,365 | 2.2 | 14,879 | 84.2 | 86.4 |
| Ular R.B. | 381,569 | 2.9 | 24,296 | 349.8 | 352.7 |
| Belutu R.B. | 224,470 | 1.7 | 11,398 | 79.9 | 81.6 |
| Padang R.B. | 281,428 | 1.3 | 9,255 | 31.8 | 33.1 |
| Total | 3,678,577 | 135.8 | 78,366 | 655.1 | 811.1 |

Table 4-1(1/4) MUNICIPAL WATER DEMAND (1995)

(Unit : m3/day)

| Name of River | Name of Kecamatan | Population (Person) | Domestic Water | Non-Domestic | Un-Accounted Loss | Total |
|-----------------------|----------------------|---------------------|----------------|--------------|-------------------|---------|
| Belawan River | D-1 Labuhan Deli | 41,707 | 949 | 95 | 55 | 1,099 |
| | D-2 Hampanan perak | 111,322 | 2,533 | 253 | 147 | 2,932 |
| | D-3 Sunggal | 136,873 | 3,114 | 311 | 180 | 3,605 |
| | D-4 Kutalinbaru | 26,496 | 603 | 60 | 35 | 698 |
| | D-5 Pancur Batu | 54,396 | 1,238 | 124 | 72 | 1,433 |
| | T o t a l | 370,794 | 8,435 | 843 | 488 | 9,767 |
| - | Medan | 1,935,646 | 202,517 | 81,007 | 87,095 | 370,619 |
| Deli River | D-6 Namorambe | 19,784 | 450 | 45 | 26 | 521 |
| | D-7 Deli Tua | 37,208 | 846 | 85 | 49 | 980 |
| | D10 Sibolangit | 20,382 | 464 | 46 | 27 | 537 |
| | T o t a l | 2,013,021 | 204,277 | 81,183 | 87,197 | 372,657 |
| Percut River | D-8 Patumbak | 39,154 | 891 | 89 | 52 | 1,031 |
| | D-9 Sibiru-biru | 25,949 | 590 | 59 | 34 | 683 |
| | D-11 Percut Sei Tuan | 223,650 | 5,088 | 509 | 295 | 5,891 |
| | T o t a l | 288,753 | 6,569 | 657 | 380 | 7,606 |
| Serdang River | D-14 Batang Kuis | 34,066 | 775 | 77 | 45 | 897 |
| | D-16 Lubuk Pakam | 73,834 | 1,680 | 168 | 97 | 1,945 |
| | D-18 Tanjung Morawa | 126,289 | 2,873 | 287 | 166 | 3,327 |
| | D-19 Pagar Merbau | 30,045 | 684 | 68 | 40 | 791 |
| | D-21 STM Hilir | 27,540 | 627 | 63 | 36 | 725 |
| | D-22 Bangun Purba | 31,086 | 707 | 71 | 41 | 819 |
| | D-24 STM Hulu | 9,866 | 224 | 22 | 13 | 260 |
| | T o t a l | 332,726 | 7,569 | 757 | 438 | 8,764 |
| Ular River | D-12 Pantai Labu | 36,548 | 831 | 83 | 48 | 963 |
| | D-13 Pantai Cermin | 37,918 | 863 | 86 | 50 | 999 |
| | D-15 Beringin | 44,533 | 1,013 | 101 | 59 | 1,173 |
| | D-17 Perbaungan | 119,816 | 2,726 | 273 | 158 | 3,156 |
| | D-20 Galang | 81,512 | 1,854 | 185 | 107 | 2,147 |
| | D-23 Kutarih | 19,645 | 447 | 45 | 26 | 517 |
| | D-25 Gunung Meriah | 3,509 | 80 | 8 | 5 | 92 |
| | S-3 Dolok Silau | 10,208 | 232 | 23 | 13 | 269 |
| | S-5 Raya | 33,207 | 755 | 76 | 44 | 875 |
| | S-6 Purba | 22,033 | 501 | 50 | 29 | 580 |
| | S-7 Silima Kuta | 17,004 | 387 | 39 | 22 | 448 |
| | T o t a l | 425,931 | 9,690 | 968 | 561 | 11,219 |
| | Belutu River | D-26 Teluk Mengkudu | 37,531 | 854 | 85 | 49 |
| D-27 Tanjung Beringin | | 33,972 | 773 | 77 | 45 | 895 |
| D-29 Sei Rampah | | 108,646 | 2,472 | 247 | 143 | 2,862 |
| D-31 Dolok Masihul | | 56,954 | 1,296 | 130 | 75 | 1,500 |
| S-2 Silau Kahean | | 16,147 | 367 | 37 | 21 | 425 |
| T o t a l | | 253,249 | 5,761 | 576 | 334 | 6,670 |
| Padang River | - Tebing Tinggi | 130,385 | 13,642 | 5,457 | 5,867 | 24,965 |
| | D-28 Bandar Khalipah | 27,375 | 623 | 62 | 36 | 721 |
| | D-30 Tebing Tinggi | 78,961 | 1,796 | 180 | 104 | 2,080 |
| | D-32 Dolok Merawan | 20,845 | 474 | 47 | 27 | 549 |
| | D-33 Sipispis | 39,696 | 903 | 90 | 52 | 1,046 |
| | S-1 Raya Kahean | 18,111 | 412 | 41 | 24 | 477 |
| T o t a l | 315,374 | 17,850 | 5,877 | 6,110 | 29,837 | |
| GRAND TOTAL | | 3,999,848 | 260,151 | 90,861 | 95,509 | 446,520 |

Table 4-1(2/4) MUNICIPAL WATER DEMAND (2000)

(Unit : m3/day)

| Name of River | Name of Kecamatan | Population (Person) | Domest Water | Non-Domestic | Un-Accounted Loss | Total | |
|--------------------|-------------------|---------------------|----------------|----------------|-------------------|----------------|---------|
| Belawan River | D-1 | Labuhan Deli | 47,234 | 1,323 | 132 | 77 | 1,531 |
| | D-2 | Hampan perak | 126,074 | 3,530 | 353 | 204 | 4,087 |
| | D-3 | Sunggal | 155,010 | 4,340 | 434 | 251 | 5,025 |
| | D-4 | Kutalimbaru | 30,008 | 840 | 84 | 49 | 973 |
| | D-5 | Pancur Batu | 61,604 | 1,725 | 172 | 100 | 1,997 |
| | T o t a l | 419,929 | 11,758 | 1,176 | 681 | 13,614 | |
| | - | Medan | 2,160,257 | 241,949 | 96,779 | 95,539 | 434,267 |
| Deli River | D-6 | Namorambe | 22,406 | 627 | 63 | 36 | 726 |
| | D-7 | Deli Tua | 42,138 | 1,180 | 118 | 68 | 1,366 |
| | D10 | Sibolangit | 23,083 | 646 | 65 | 37 | 748 |
| | T o t a l | 2,247,884 | 244,402 | 97,025 | 95,681 | 437,107 | |
| Percut River | D-8 | Patumbak | 44,342 | 1,242 | 124 | 72 | 1,437 |
| | D-9 | Sibiru-biru | 29,387 | 823 | 82 | 48 | 953 |
| | D-11 | Percut Sei Tuan | 253,287 | 7,092 | 709 | 411 | 8,212 |
| | T o t a l | 327,016 | 9,156 | 916 | 530 | 10,602 | |
| Serdang River | D-14 | Batang Kuis | 38,579 | 1,080 | 108 | 63 | 1,251 |
| | D-16 | Lubuk Pakam | 83,618 | 2,341 | 234 | 136 | 2,711 |
| | D-18 | Tanjung Morawa | 143,024 | 4,005 | 400 | 232 | 4,637 |
| | D-19 | Pagar Merbau | 34,027 | 953 | 95 | 55 | 1,103 |
| | D-21 | STM Hilir | 31,189 | 873 | 87 | 51 | 1,011 |
| | D-22 | Bangun Purba | 35,206 | 986 | 99 | 57 | 1,141 |
| | D-24 | STM Hulu | 11,174 | 313 | 31 | 18 | 362 |
| | T o t a l | 376,816 | 10,551 | 1,055 | 611 | 12,216 | |
| Ular River | D-12 | Pantai Labu | 41,391 | 1,159 | 116 | 67 | 1,342 |
| | D-13 | Pantai Cermin | 42,942 | 1,202 | 120 | 70 | 1,392 |
| | D-15 | Beringin | 50,434 | 1,412 | 141 | 82 | 1,635 |
| | D-17 | Perbaungan | 135,693 | 3,799 | 380 | 220 | 4,399 |
| | D-20 | Galang | 92,313 | 2,585 | 258 | 150 | 2,993 |
| | D-23 | Kutarah | 22,248 | 623 | 62 | 36 | 721 |
| | D-25 | Gunung Meriah | 3,974 | 111 | 11 | 6 | 129 |
| | S-3 | Dolok Silau | 10,586 | 296 | 30 | 17 | 343 |
| | S-5 | Raya | 34,437 | 964 | 96 | 56 | 1,116 |
| | S-6 | Purba | 22,849 | 640 | 64 | 37 | 741 |
| | S-7 | Silima Kuta | 17,634 | 494 | 49 | 29 | 572 |
| | | T o t a l | 474,501 | 13,286 | 1,328 | 769 | 15,383 |
| | Belutu River | D-26 | Teluk Mengkudu | 42,504 | 1,190 | 119 | 69 |
| D-27 | | Tanjung Beringin | 38,473 | 1,077 | 108 | 62 | 1,247 |
| D-29 | | Sei Rampah | 123,042 | 3,445 | 345 | 199 | 3,989 |
| D-31 | | Dolok Hasihul | 64,501 | 1,806 | 181 | 105 | 2,091 |
| S-2 | | Silau Kahean | 16,745 | 469 | 47 | 27 | 543 |
| | T o t a l | 285,266 | 7,987 | 799 | 462 | 9,248 | |
| Padang River | - | Tebing Tinggi | 144,309 | 16,163 | 6,465 | 6,382 | 29,010 |
| | D-28 | Bandar Khalipah | 31,003 | 868 | 87 | 50 | 1,005 |
| | D-30 | Tebing Tinggi | 89,424 | 2,504 | 250 | 145 | 2,899 |
| | D-32 | Dolok Merawan | 23,607 | 661 | 66 | 38 | 765 |
| | D-33 | Sipispis | 44,956 | 1,259 | 126 | 73 | 1,457 |
| | S-1 | Raya Kahean | 18,782 | 526 | 53 | 30 | 609 |
| | T o t a l | 352,081 | 21,980 | 7,046 | 6,719 | 35,745 | |
| GRAND TOTAL | | 4,483,494 | 319,119 | 109,343 | 105,453 | 533,915 | |

Table 4-1(3/4) MUNICIPAL WATER DEMAND (2005)

(Unit : m3/day)

| Name of River | Name of Kecamatan | Population (Person) | Domestic Water | Non-Domestic | Un-Accounted Loss | Total |
|---------------|-----------------------|---------------------|----------------|--------------|-------------------|---------|
| Belawan River | D-1 Labuhan Deli | 53,388 | 1,802 | 180 | 104 | 2,086 |
| | D-2 Hampanan perak | 142,502 | 4,809 | 481 | 278 | 5,569 |
| | D-3 Sunggal | 175,209 | 5,913 | 591 | 342 | 6,847 |
| | D-4 Kuta Limbaru | 33,918 | 1,145 | 114 | 66 | 1,325 |
| | D-5 Pancur Batu | 69,631 | 2,350 | 235 | 136 | 2,721 |
| | T o t a l | 474,648 | 16,019 | 1,602 | 927 | 18,548 |
| - | Medan | 2,407,395 | 287,985 | 115,194 | 107,174 | 510,352 |
| Deli River | D-6 Namorambe | 25,326 | 855 | 85 | 49 | 990 |
| | D-7 Deli Tua | 47,629 | 1,607 | 161 | 93 | 1,861 |
| | D-10 Sibolangit | 26,091 | 881 | 88 | 51 | 1,019 |
| | T o t a l | 2,506,441 | 291,327 | 115,528 | 107,368 | 514,223 |
| Percut River | D-8 Patumbak | 50,120 | 1,692 | 169 | 98 | 1,959 |
| | D-9 Sibiru-biru | 33,217 | 1,121 | 112 | 65 | 1,298 |
| | D-11 Percut Sei Tuan | 286,291 | 9,662 | 966 | 559 | 11,188 |
| | T o t a l | 369,628 | 12,475 | 1,247 | 722 | 14,444 |
| Serdang River | D-14 Batang Kuis | 43,606 | 1,472 | 147 | 85 | 1,704 |
| | D-16 Lubuk Pakam | 94,514 | 3,190 | 319 | 185 | 3,693 |
| | D-18 Tanjung Morawa | 161,660 | 5,456 | 546 | 316 | 6,317 |
| | D-19 Pagar Merbau | 38,461 | 1,298 | 130 | 75 | 1,503 |
| | D-21 STM Hilir | 35,253 | 1,190 | 119 | 69 | 1,378 |
| | D-22 Bangun Purba | 39,793 | 1,343 | 134 | 78 | 1,555 |
| | D-24 STM Hulu | 12,630 | 426 | 43 | 25 | 493 |
| | T o t a l | 425,917 | 14,374 | 1,437 | 832 | 16,644 |
| Ular River | D-12 Pantai Labu | 46,784 | 1,579 | 158 | 91 | 1,828 |
| | D-13 Pantai Cermin | 48,538 | 1,638 | 164 | 95 | 1,897 |
| | D-15 Beringin | 57,006 | 1,924 | 192 | 111 | 2,228 |
| | D-17 Perbaungan | 153,375 | 5,176 | 518 | 300 | 5,994 |
| | D-20 Galang | 104,342 | 3,522 | 352 | 204 | 4,077 |
| | D-23 Kutarih | 25,147 | 849 | 85 | 49 | 983 |
| | D-25 Gunung Meriah | 4,492 | 152 | 15 | 9 | 175 |
| | S-3 Dolok Silau | 10,869 | 367 | 37 | 21 | 425 |
| | S-5 Raya | 35,359 | 1,193 | 119 | 69 | 1,382 |
| | S-6 Purba | 23,460 | 792 | 79 | 46 | 917 |
| | S-7 Silima Kuta | 18,106 | 611 | 61 | 35 | 707 |
| | T o t a l | 527,479 | 17,802 | 1,780 | 1,031 | 20,612 |
| Belutu River | D-26 Teluk Mengkudu | 48,043 | 1,621 | 162 | 94 | 1,877 |
| | D-27 Tanjung Beringin | 43,487 | 1,468 | 147 | 85 | 1,699 |
| | D-29 Sei Rampah | 139,076 | 4,694 | 469 | 272 | 5,435 |
| | D-31 Dolok Masihul | 72,905 | 2,461 | 246 | 142 | 2,849 |
| | S-2 Silau Kahean | 17,194 | 580 | 58 | 34 | 672 |
| | T o t a l | 320,704 | 10,823 | 1,082 | 627 | 12,532 |
| Padang River | - Tebing Tinggi | 158,627 | 18,976 | 7,590 | 7,062 | 33,628 |
| | D-28 Bandar Khalipah | 35,043 | 1,183 | 118 | 68 | 1,369 |
| | D-30 Tebing Tinggi | 101,077 | 3,411 | 341 | 197 | 3,950 |
| | D-32 Dolok Merawan | 26,683 | 901 | 90 | 52 | 1,043 |
| | D-33 Sipispis | 50,814 | 1,715 | 171 | 99 | 1,986 |
| | S-1 Raya Kahean | 19,285 | 651 | 65 | 38 | 753 |
| | T o t a l | 391,529 | 26,836 | 8,376 | 7,517 | 42,729 |
| GRAND TOTAL | | 5,016,346 | 389,657 | 131,052 | 119,023 | 639,732 |

Table 4-1(4/4) MUNICIPAL WATER DEMAND (2010)

(Unit : m3/day)

| Name of River | Name of Kecamatan | Population (Person) | Domestic Water | Non-Domestic | Un-Accounted Loss | Total |
|-----------------------|----------------------|---------------------|----------------|--------------|-------------------|---------|
| Belawan River | D-1 Labuhan Deli | 60,257 | 2,410 | 241 | 140 | 2,791 |
| | D-2 Hampanan perak | 160,835 | 6,433 | 643 | 372 | 7,449 |
| | D-3 Sunggal | 197,750 | 7,910 | 791 | 458 | 9,159 |
| | D-4 Kuta Limbaru | 38,281 | 1,531 | 153 | 89 | 1,773 |
| | D-5 Pancur Batu | 78,590 | 3,144 | 314 | 182 | 3,640 |
| | T o t a l | 535,712 | 21,428 | 2,143 | 1,241 | 24,811 |
| Deli River | - Medan | 2,678,871 | 341,556 | 136,622 | 119,545 | 597,723 |
| | D-6 Namorambe | 28,584 | 1,143 | 114 | 66 | 1,324 |
| | D-7 Deli Tua | 53,756 | 2,150 | 215 | 124 | 2,490 |
| | D10 Sibolangit | 29,448 | 1,178 | 118 | 68 | 1,364 |
| | T o t a l | 2,790,659 | 346,027 | 137,069 | 119,803 | 602,900 |
| Percut River | D-8 Patumbak | 56,568 | 2,263 | 226 | 131 | 2,620 |
| | D-9 Sibiru-biru | 37,490 | 1,500 | 150 | 87 | 1,736 |
| | D-11 Percut Sei Tuan | 323,123 | 12,925 | 1,292 | 748 | 14,966 |
| | T o t a l | 417,181 | 16,687 | 1,669 | 966 | 19,322 |
| Serdang River | D-14 Batang Kuis | 49,216 | 1,969 | 197 | 114 | 2,279 |
| | D-16 Lubuk Pakam | 106,674 | 4,267 | 427 | 247 | 4,941 |
| | D-18 Tanjung Morawa | 182,458 | 7,298 | 730 | 423 | 8,451 |
| | D-19 Pagar Merbau | 43,409 | 1,736 | 174 | 101 | 2,010 |
| | D-21 STM Hilir | 39,789 | 1,592 | 159 | 92 | 1,843 |
| | D-22 Bangun Purba | 44,913 | 1,797 | 180 | 104 | 2,080 |
| | D-24 STM Hulu | 14,254 | 570 | 57 | 33 | 660 |
| | T o t a l | 480,712 | 19,228 | 1,923 | 1,113 | 22,264 |
| Ular River | D-12 Pantai Labu | 52,803 | 2,112 | 211 | 122 | 2,446 |
| | D-13 Pantai Cermin | 54,782 | 2,191 | 219 | 127 | 2,537 |
| | D-15 Beringin | 64,340 | 2,574 | 257 | 149 | 2,980 |
| | D-17 Perbaungan | 173,106 | 6,924 | 692 | 401 | 8,017 |
| | D-20 Galang | 117,766 | 4,711 | 471 | 273 | 5,454 |
| | D-23 Kutarih | 28,382 | 1,135 | 114 | 66 | 1,314 |
| | D-25 Gunung Meriah | 5,070 | 203 | 20 | 12 | 235 |
| | S-3 Dolok Silau | 11,050 | 442 | 44 | 26 | 512 |
| | S-5 Raya | 35,946 | 1,438 | 144 | 83 | 1,665 |
| | S-6 Purba | 23,850 | 954 | 95 | 55 | 1,105 |
| | S-7 Silima Kuta | 18,407 | 736 | 74 | 43 | 852 |
| | T o t a l | 585,503 | 23,420 | 2,342 | 1,356 | 27,117 |
| | Belutu River | D-26 Teluk Mengkudu | 54,223 | 2,169 | 217 | 126 |
| D-27 Tanjung Beringin | | 49,081 | 1,963 | 196 | 114 | 2,273 |
| D-29 Sei Rampah | | 156,968 | 6,279 | 628 | 364 | 7,270 |
| D-31 Dolok Masihul | | 82,285 | 3,291 | 329 | 191 | 3,811 |
| S-2 Silau Kahean | | 17,479 | 699 | 70 | 40 | 809 |
| T o t a l | | 360,037 | 14,401 | 1,440 | 834 | 16,675 |
| Padang River | - Tebing Tinggi | 173,171 | 22,079 | 8,832 | 7,728 | 38,639 |
| | D-28 Bandar Khalipah | 39,551 | 1,582 | 158 | 92 | 1,832 |
| | D-30 Tebing Tinggi | 114,080 | 4,563 | 456 | 264 | 5,284 |
| | D-32 Dolok Merawan | 30,116 | 1,205 | 120 | 70 | 1,395 |
| | D-33 Sipispis | 57,351 | 2,294 | 229 | 133 | 2,656 |
| | S-1 Raya Kahean | 19,605 | 784 | 78 | 45 | 908 |
| T o t a l | 433,876 | 32,507 | 9,874 | 8,331 | 50,713 | |
| GRAND TOTAL | | 5,603,679 | 473,699 | 156,459 | 133,644 | 763,802 |

Table 4-2 MUNICIPAL WATER DEMAND IN MEDAN AREA

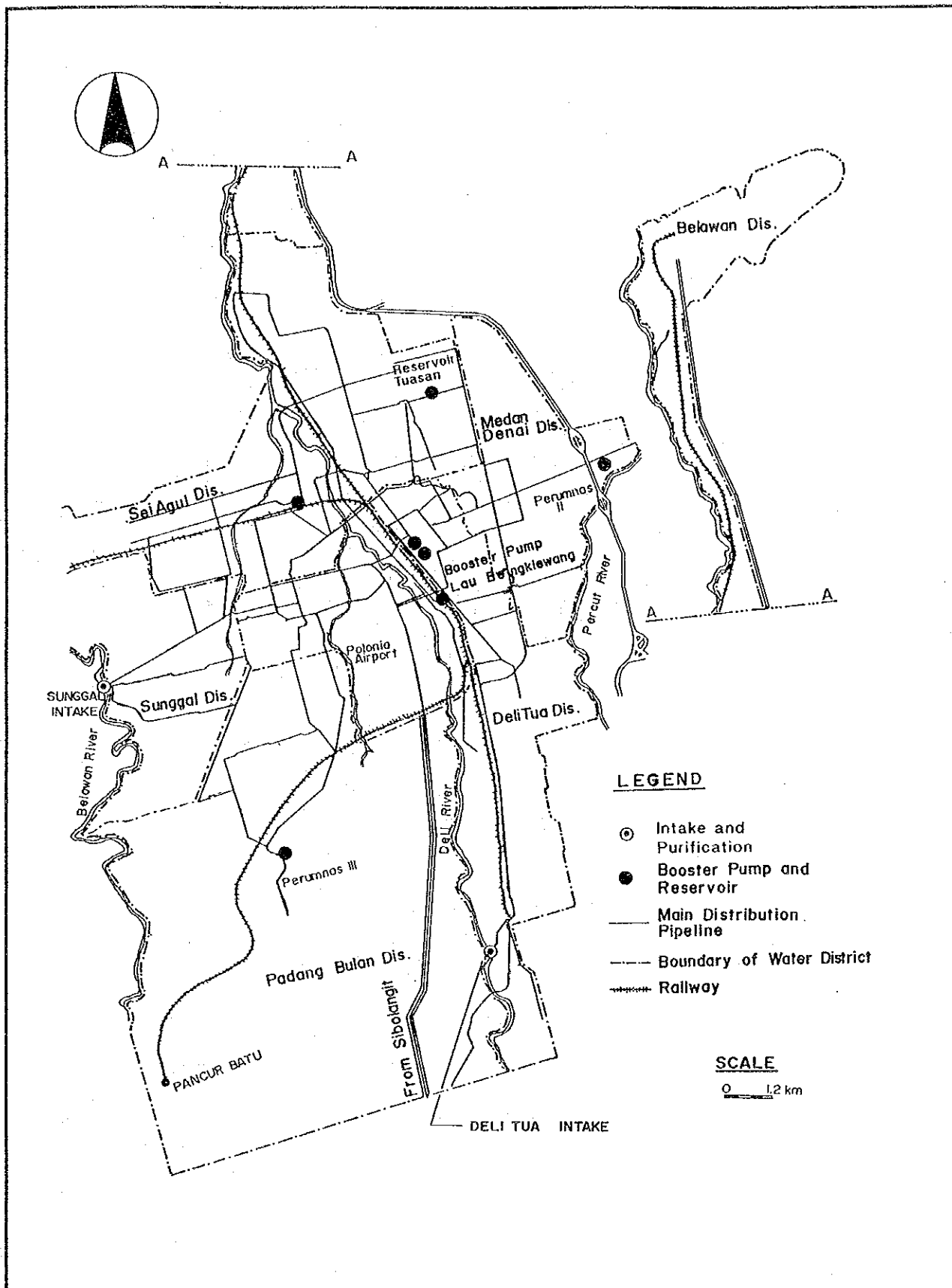
Medan City

| No. | Item | 1990 | 1995 | 2000 | 2005 | 2010 | 2040 |
|-----|-------------------------------------|---------|---------|---------|---------|---------|-----------|
| 1. | Population ('000) | 1,731 | 1,936 | 2,160 | 2,407 | 2,679 | 5,071 |
| 2. | Service Ratio (%) | 75% | 80% | 80% | 80% | 85% | 85% |
| 3. | Served Population ('000) | 1,298 | 1,549 | 1,728 | 1,926 | 2,277 | 4,310 |
| 4. | Per Capita Consumption (l/c/d) | 130 | 135 | 140 | 145 | 150 | 160 |
| 5. | Domestic Water Demand (m3/d) | 168,773 | 209,088 | 241,920 | 279,212 | 341,573 | 689,656 |
| 6. | Non-Domestic Water Demand (m3/d) | 67,509 | 83,635 | 96,768 | 111,685 | 136,629 | 275,862 |
| 7. | Total Water Demand (m3/d) | 236,282 | 292,723 | 338,688 | 390,897 | 478,202 | 965,518 |
| 8. | Unaccounted Loss of Water (%) | 25% | 25% | 25% | 25% | 20% | 20% |
| 9. | Water Production Requirement (m3/d) | 315,042 | 390,298 | 451,584 | 521,196 | 597,752 | 1,206,898 |
| | Water Production Requirement (l/s) | 3,646 | 4,517 | 5,227 | 6,032 | 6,918 | 13,969 |

Six-Kecamatans

| No. | Item | 1990 | 1995 | 2000 | 2005 | 2010 | 2040 |
|-----|-------------------------------------|--------|--------|--------|---------|---------|---------|
| 1. | Population ('000) | 453 | 548 | 644 | 737 | 820 | 1,500 |
| 2. | Service Ratio (%) | 60% | 65% | 70% | 75% | 80% | 85% |
| 3. | Served Population ('000) | 272 | 356 | 451 | 553 | 656 | 1,275 |
| 4. | Per Capita Consumption (l/c/d) | 50 | 75 | 100 | 125 | 150 | 160 |
| 5. | Domestic Water Demand (m3/d) | 13,590 | 26,715 | 45,080 | 69,094 | 98,400 | 204,000 |
| 6. | Non-Domestic Water Demand (m3/d) | 1,359 | 2,672 | 9,016 | 20,728 | 39,360 | 81,600 |
| 7. | Total Water Demand (m3/d) | 14,949 | 29,387 | 54,096 | 89,822 | 137,760 | 285,600 |
| 8. | Unaccounted Loss of Water (%) | 25% | 25% | 25% | 25% | 20% | 20% |
| 9. | Water Production Requirement (m3/d) | 19,932 | 39,182 | 72,128 | 119,763 | 172,200 | 357,000 |
| | Water Production Requirement (l/s) | 231 | 453 | 835 | 1,386 | 1,993 | 4,132 |

FIGURES



LEGEND

- ⊙ Intake and Purification
- Booster Pump and Reservoir
- Main Distribution Pipeline
- - - Boundary of Water District
- ⋯⋯⋯ Railway

SCALE

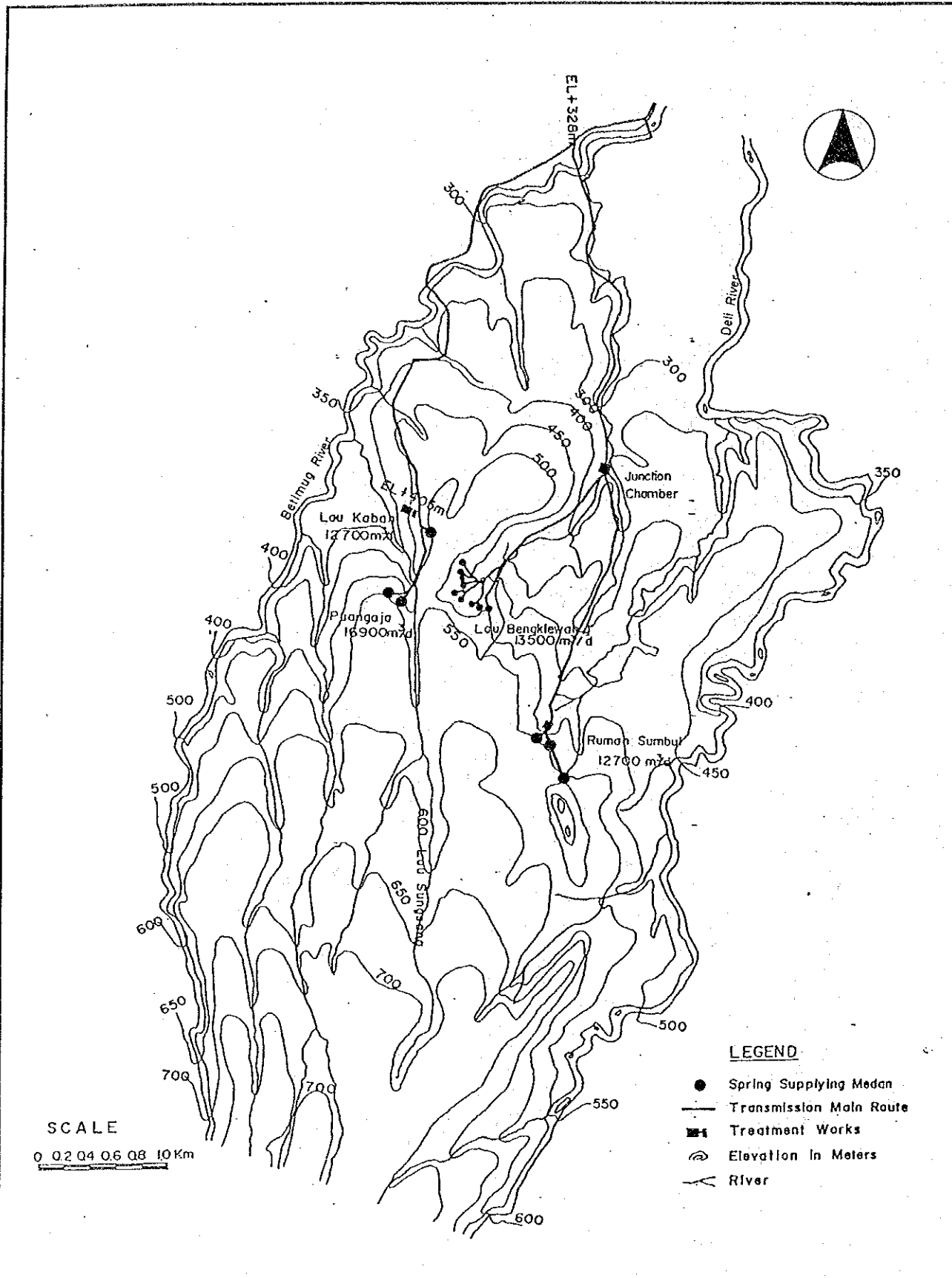
0 — 1.2 km

THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT
IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

EXISTING WATER SUPPLY SYSTEM IN MEDAN

Fig.2-1

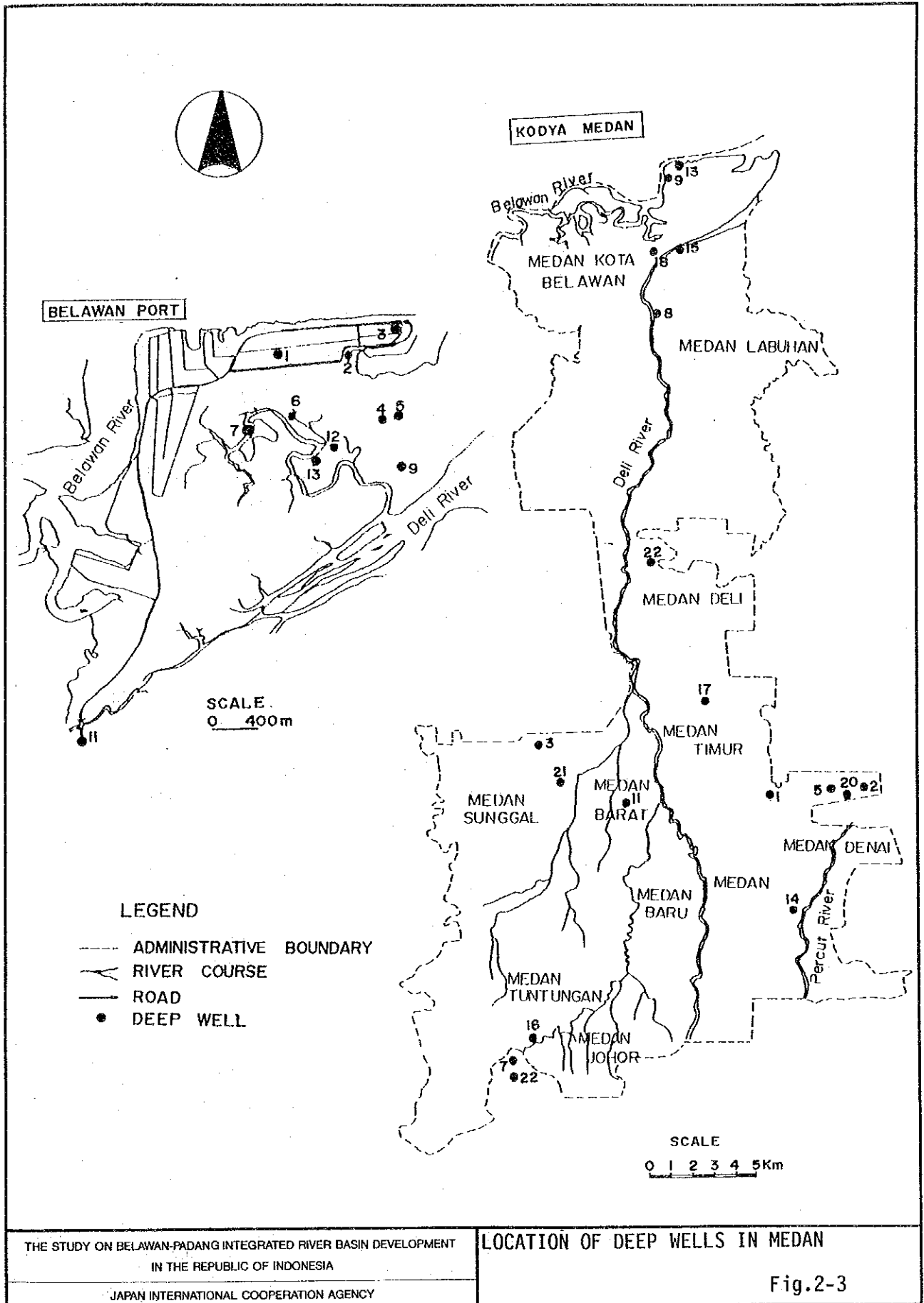


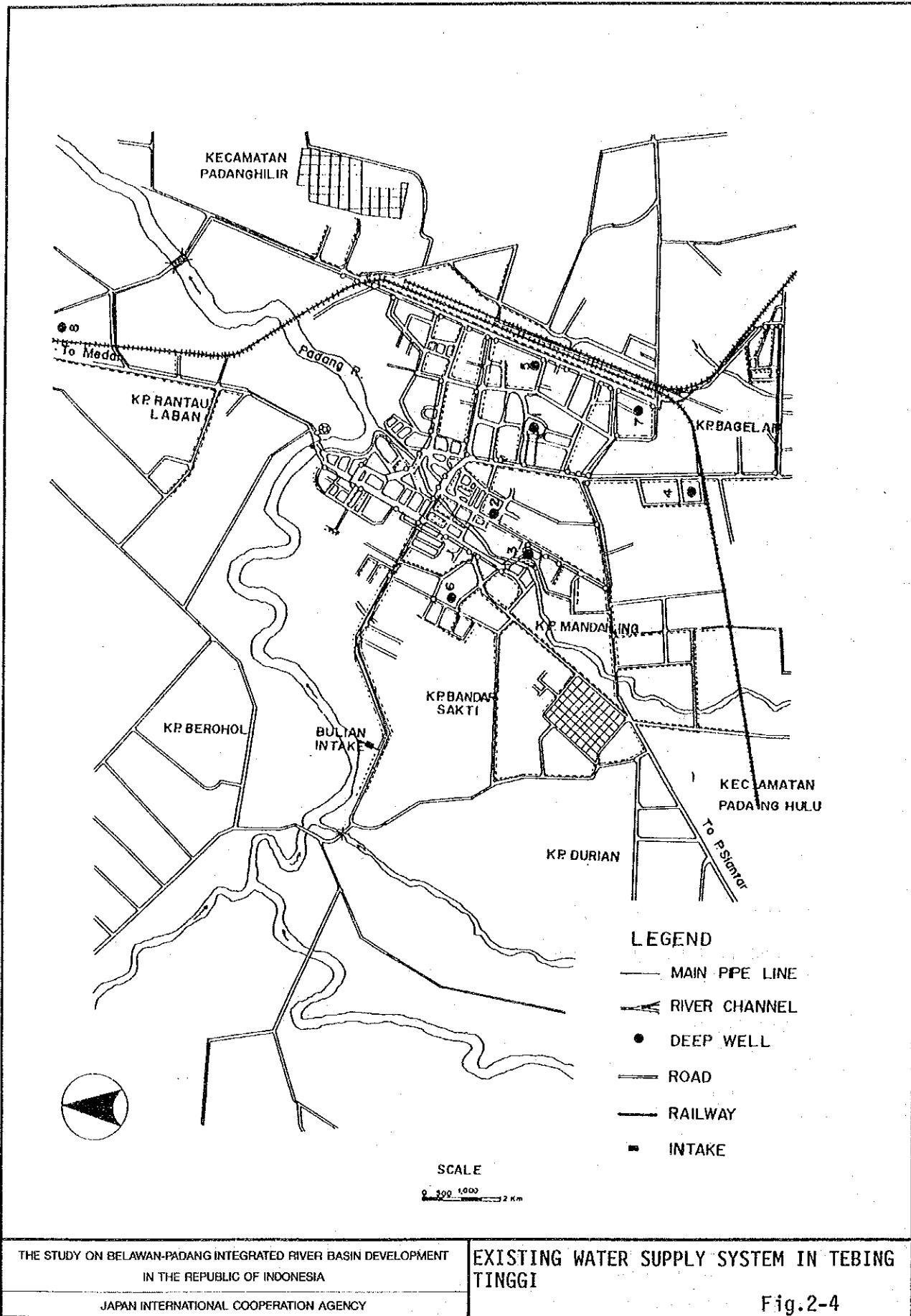
- LEGEND**
- Spring Supplying Medan
 - Transmission Main Route
 - ▨ Treatment Works
 - Elevation in Meters
 - ~ River

THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT
 IN THE REPUBLIC OF INDONESIA
 JAPAN INTERNATIONAL COOPERATION AGENCY

LOCATION OF SPRINGS

Fig.2-2

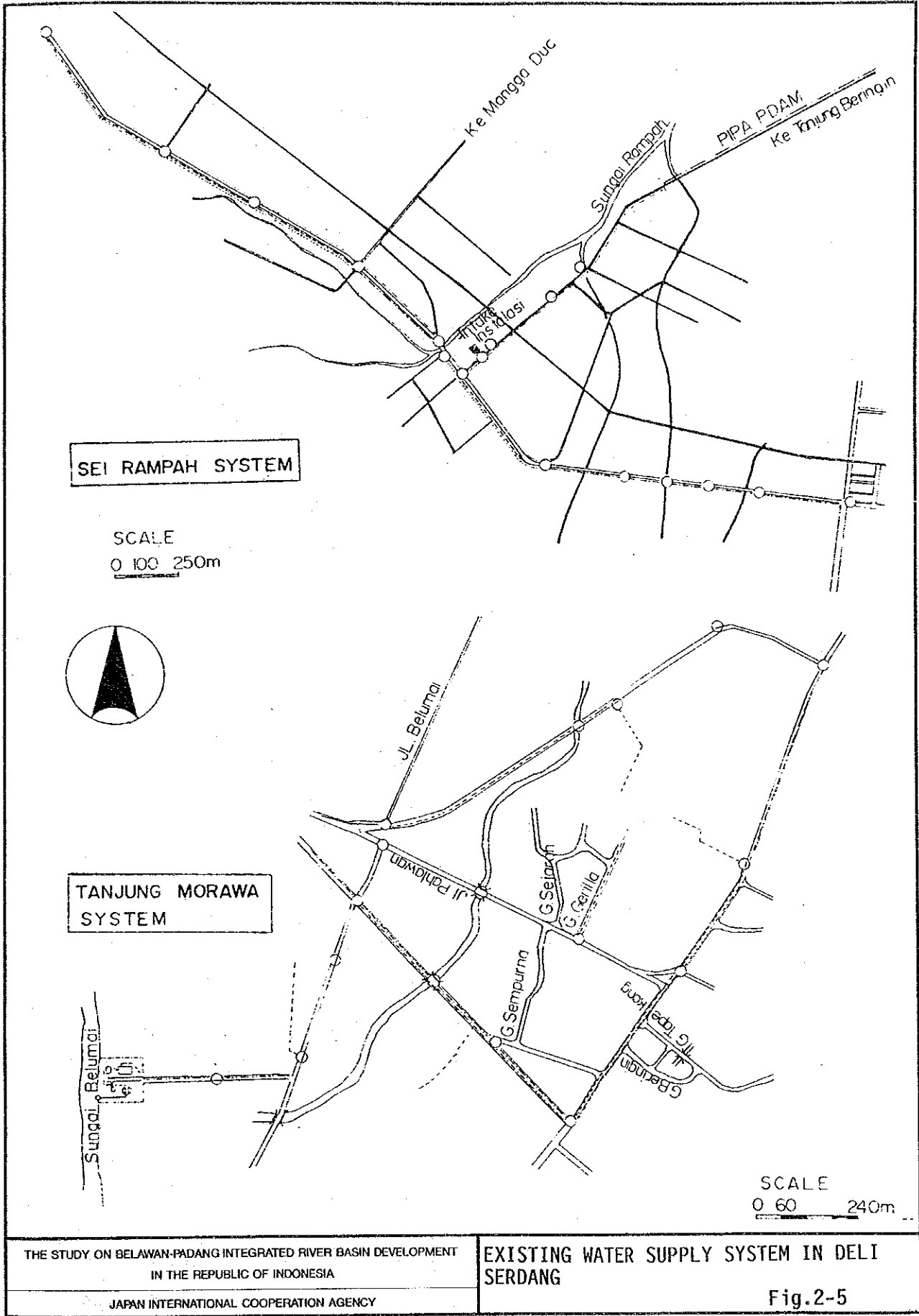




THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT
 IN THE REPUBLIC OF INDONESIA
 JAPAN INTERNATIONAL COOPERATION AGENCY

EXISTING WATER SUPPLY SYSTEM IN TEBING
 TINGGI

Fig.2-4

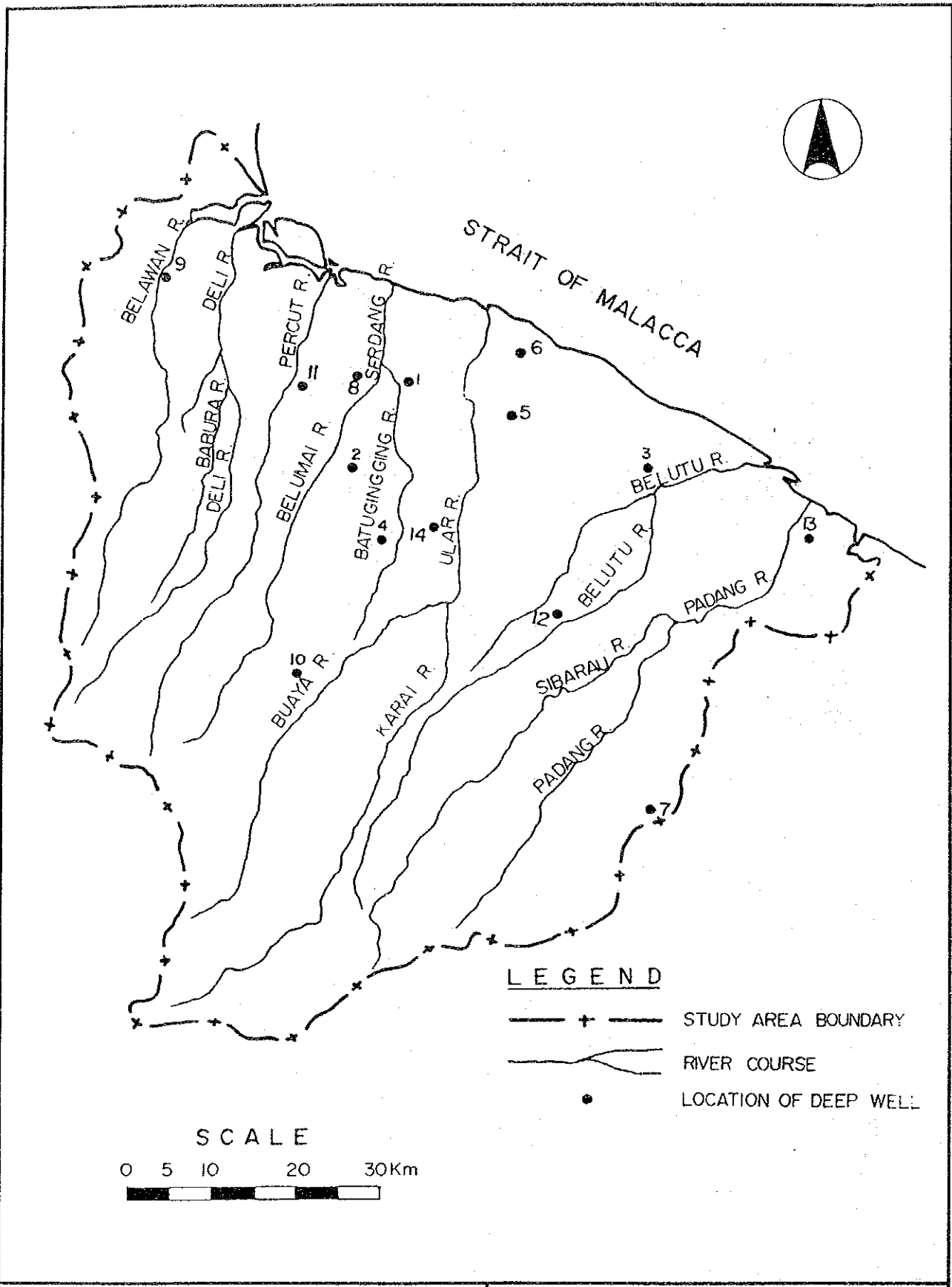


THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT
IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

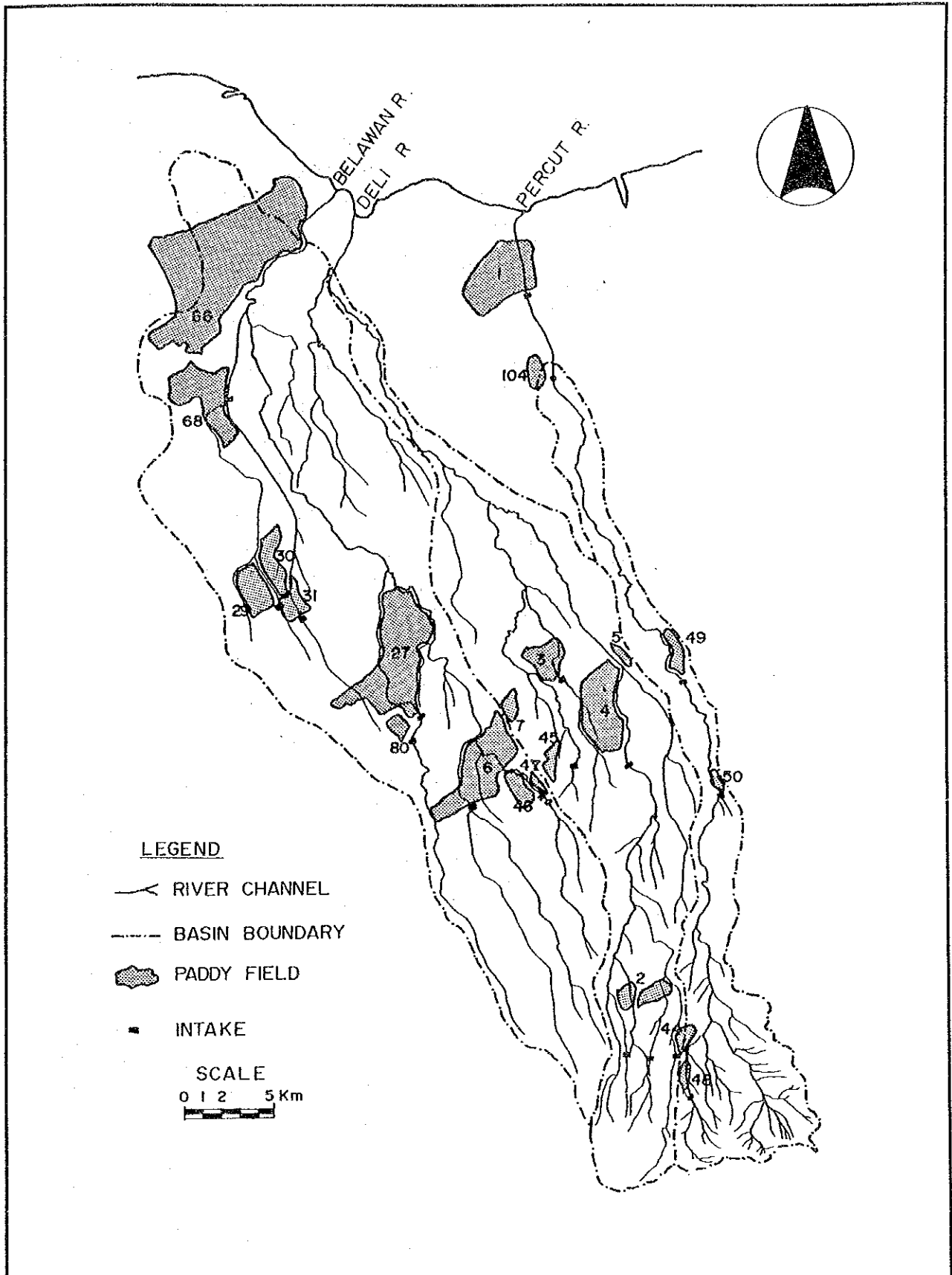
EXISTING WATER SUPPLY SYSTEM IN DELI
SERDANG

Fig.2-5



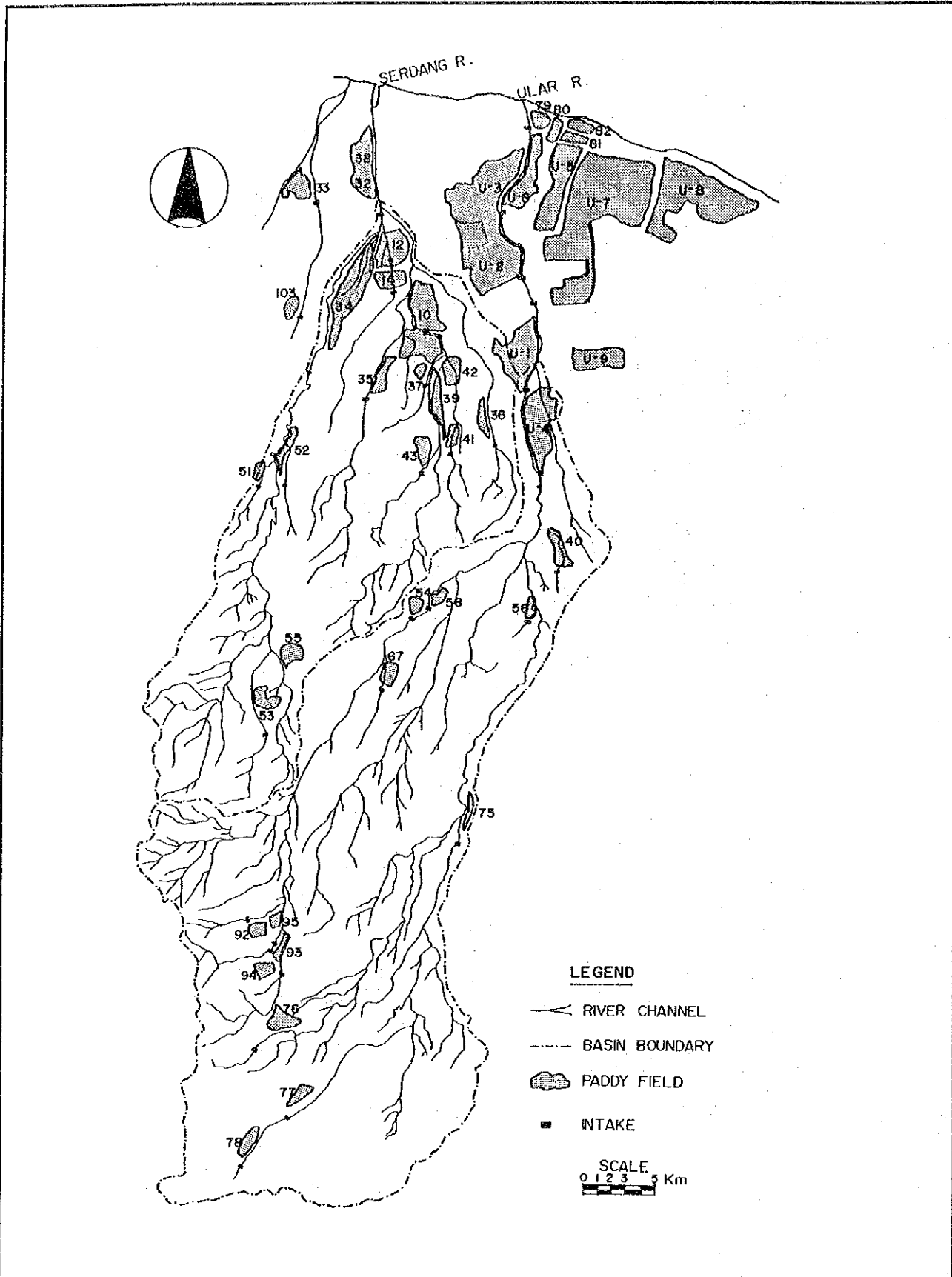
THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT
 IN THE REPUBLIC OF INDONESIA
 JAPAN INTERNATIONAL COOPERATION AGENCY

LOCATION OF DEEP WELLS IN THE STUDY AREA
 Fig.2-6



THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT
IN THE REPUBLIC OF INDONESIA
JAPAN INTERNATIONAL COOPERATION AGENCY

LOCATION OF EXISTING PADDY FIELD
Fig.2-7(1/3)

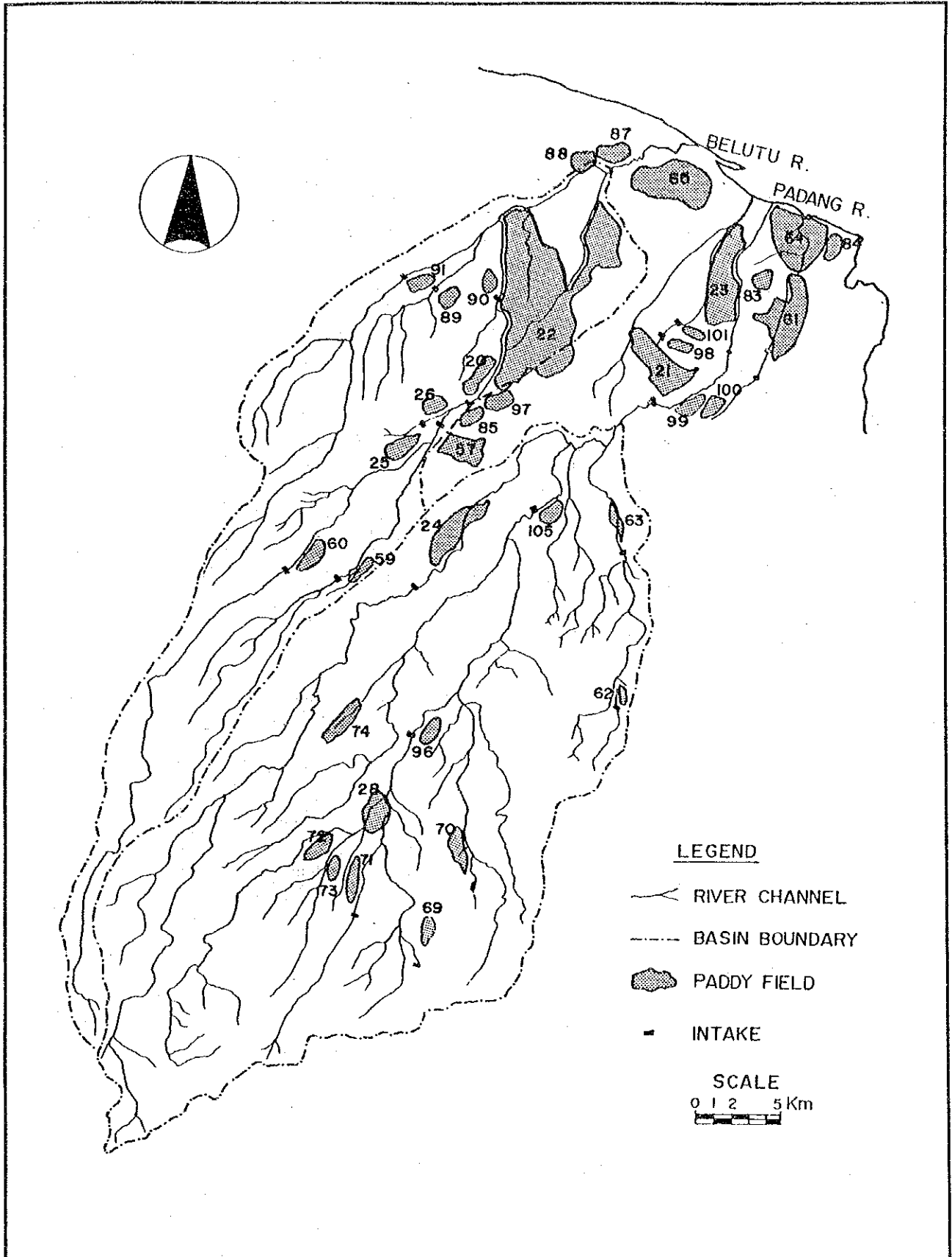


THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT
IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

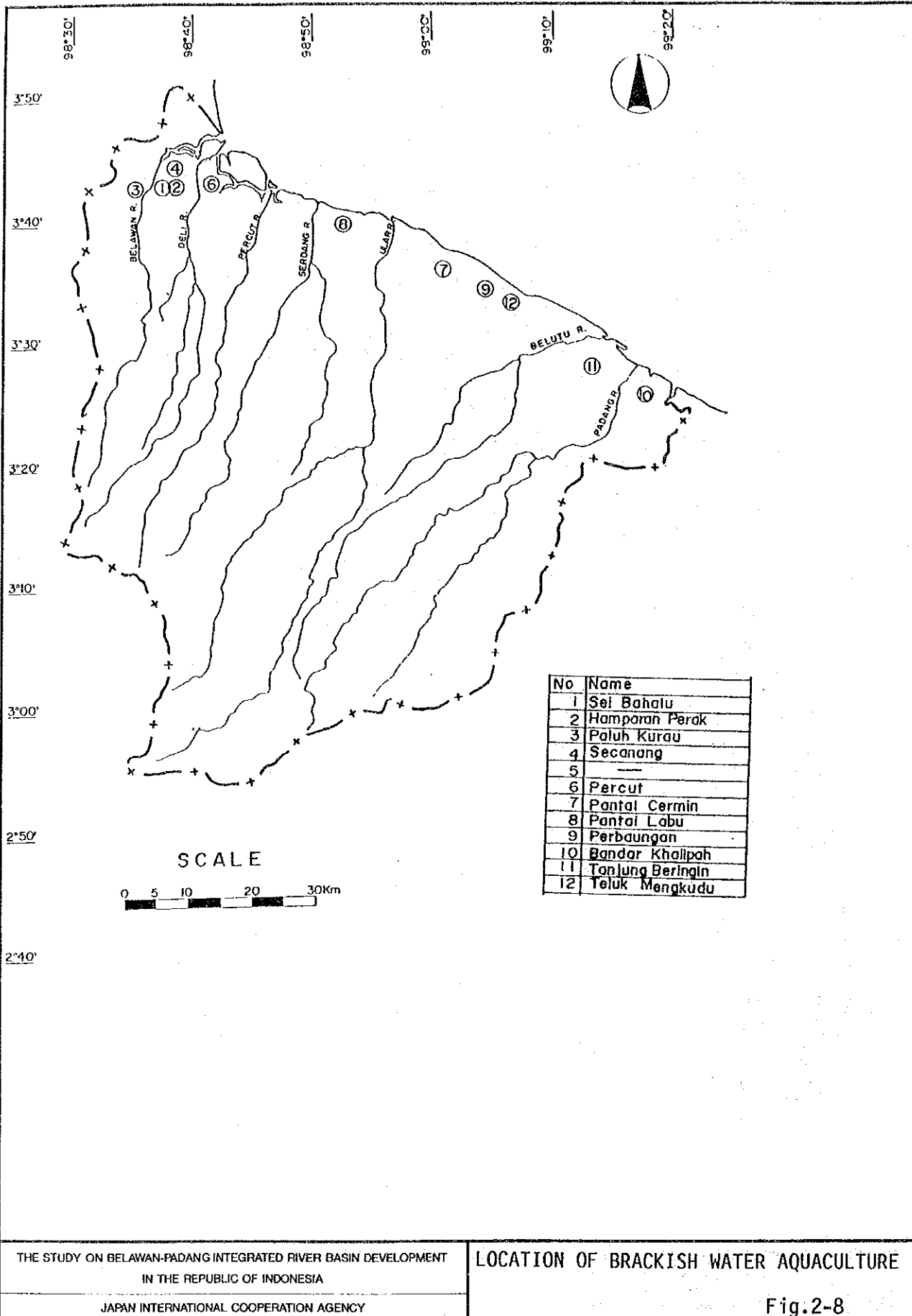
LOCATION OF EXISTING PADDY FIELD

Fig.2-7(2/3)



THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT
 IN THE REPUBLIC OF INDONESIA
 JAPAN INTERNATIONAL COOPERATION AGENCY

LOCATION OF EXISTING PADDY FIELD
 Fig.2-7(3/3)

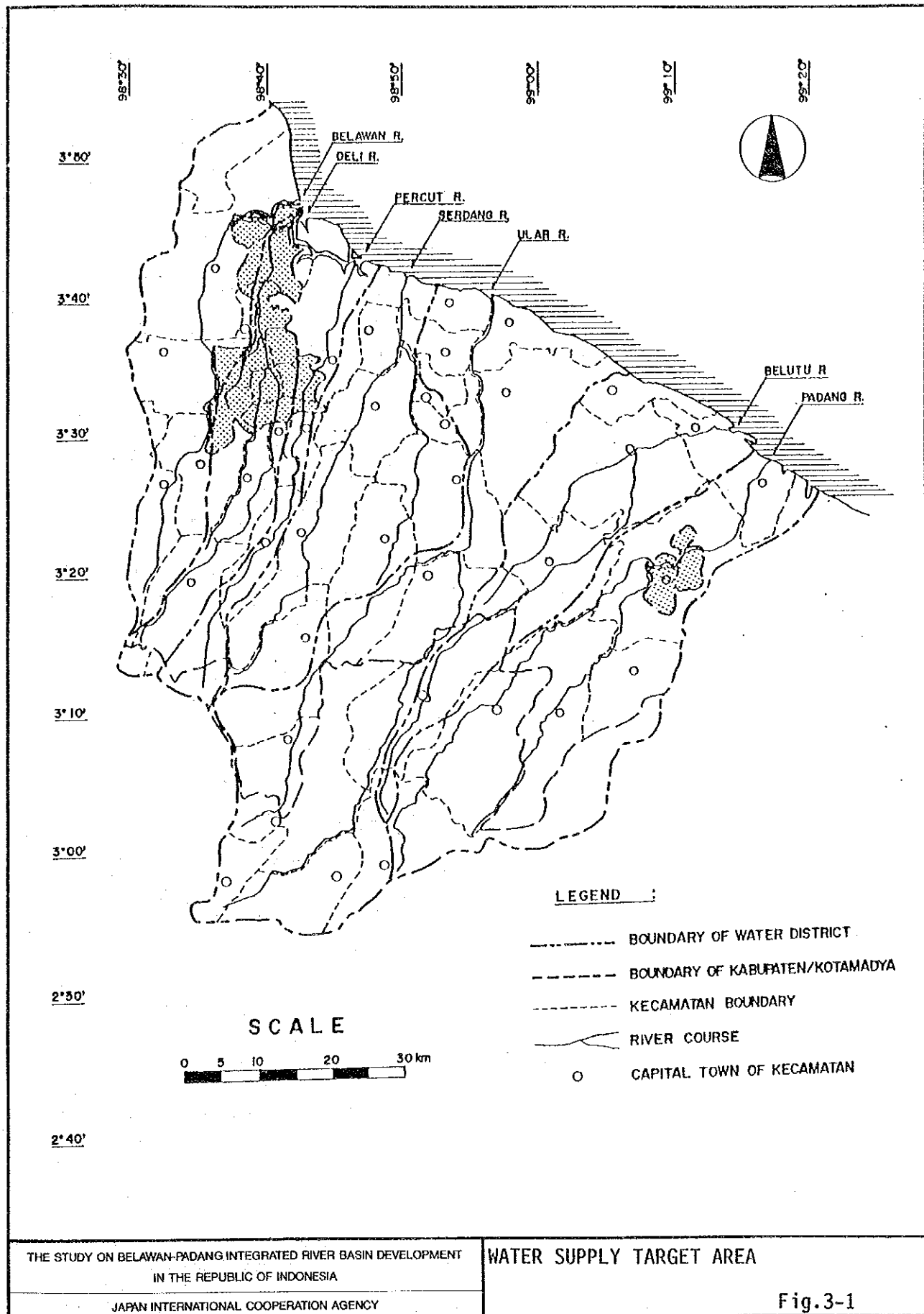


THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT
IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

LOCATION OF BRACKISH WATER AQUACULTURE

Fig.2-8

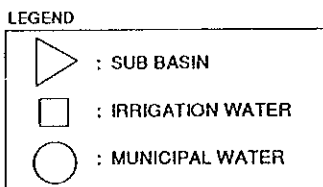
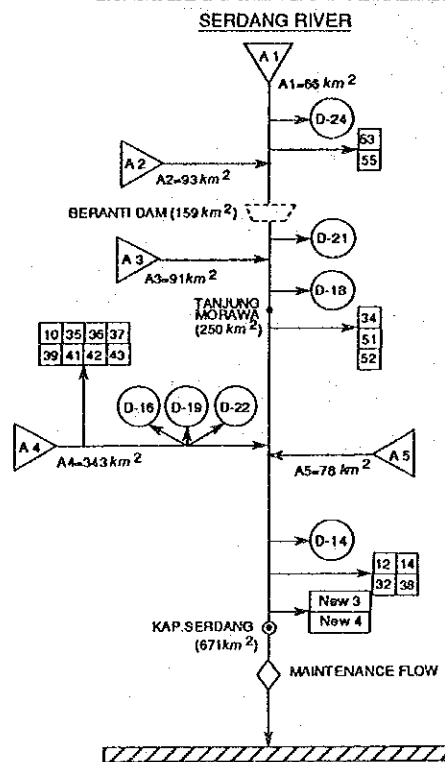
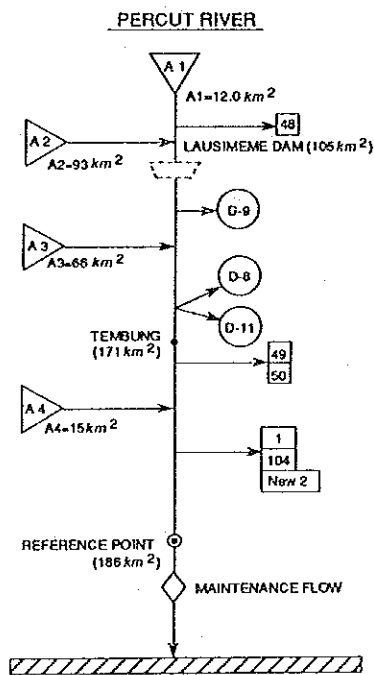
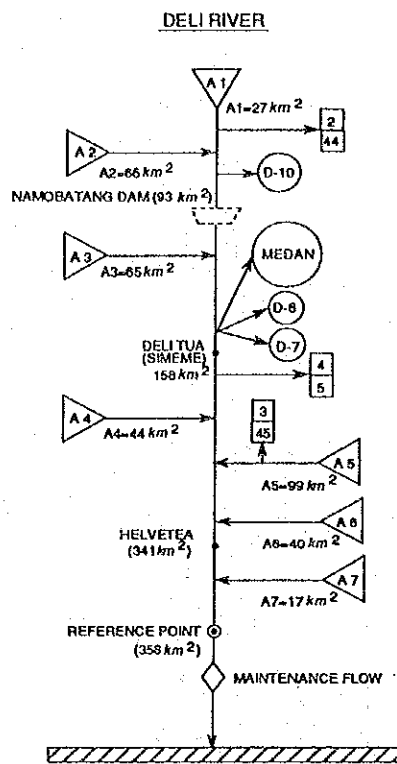
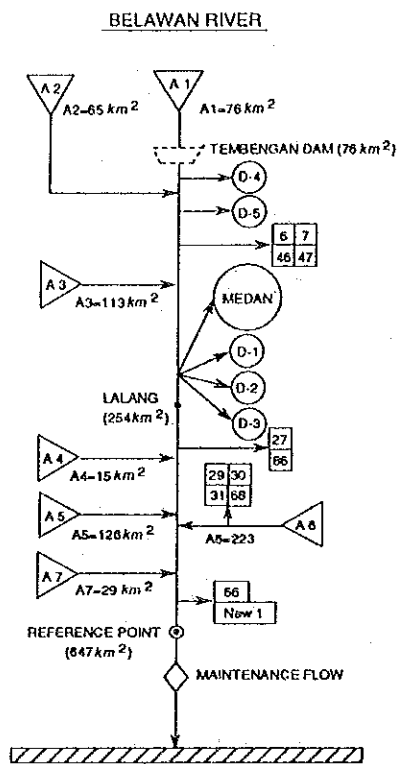


THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT
IN THE REPUBLIC OF INDONESIA

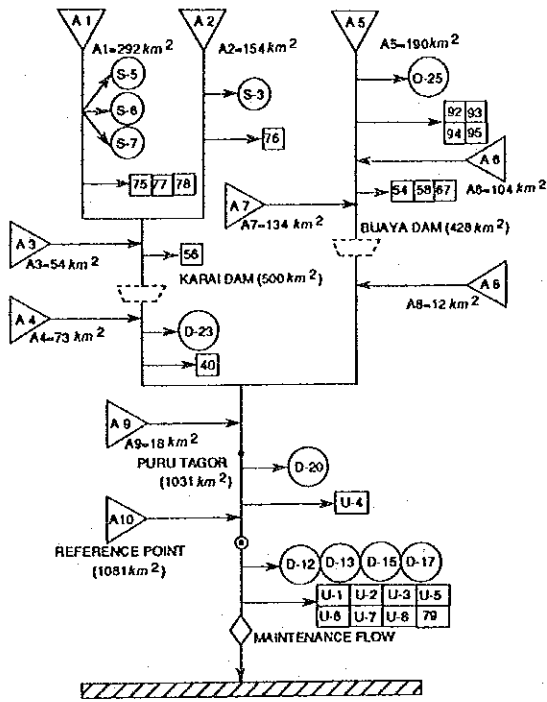
JAPAN INTERNATIONAL COOPERATION AGENCY

WATER SUPPLY TARGET AREA

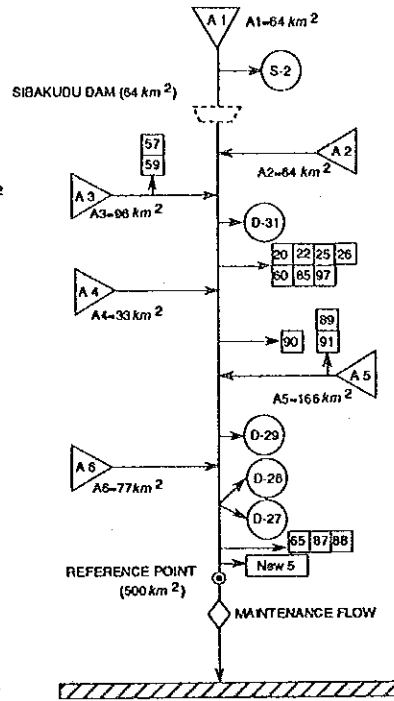
Fig.3-1



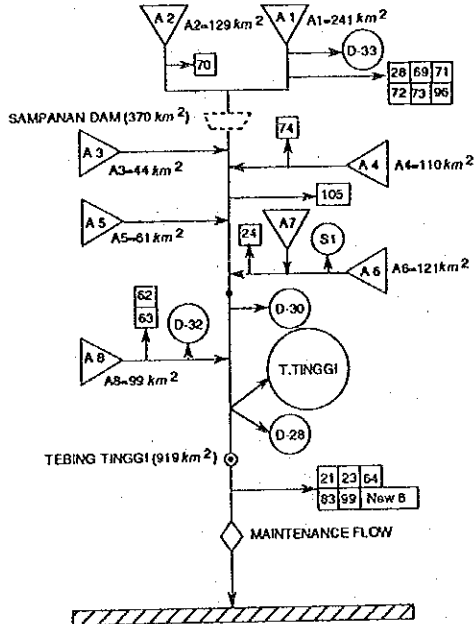
ULAR RIVER



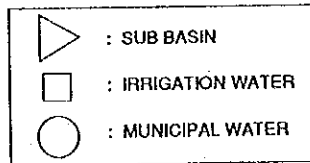
BELUTU RIVER

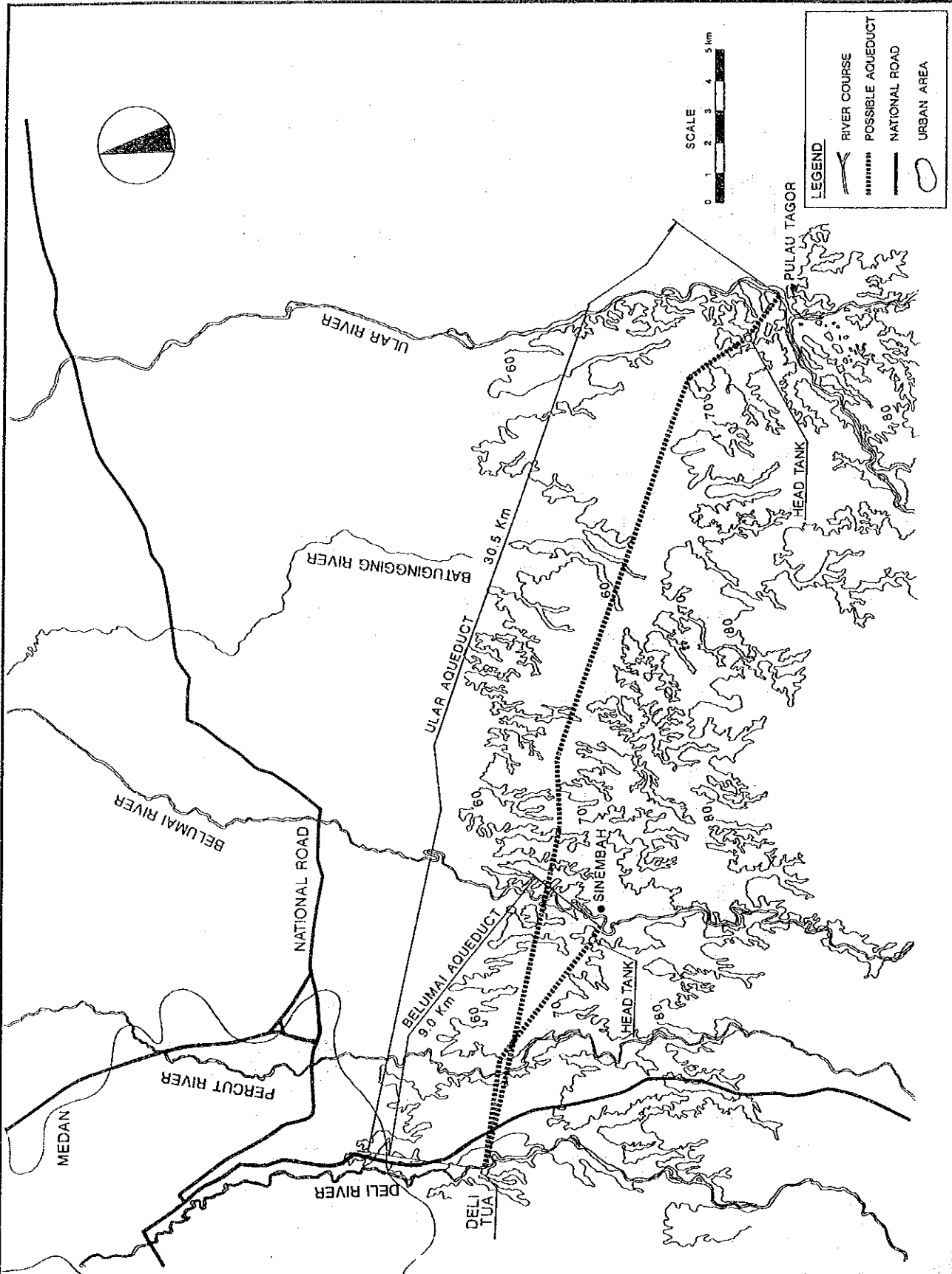


PADANG RIVER



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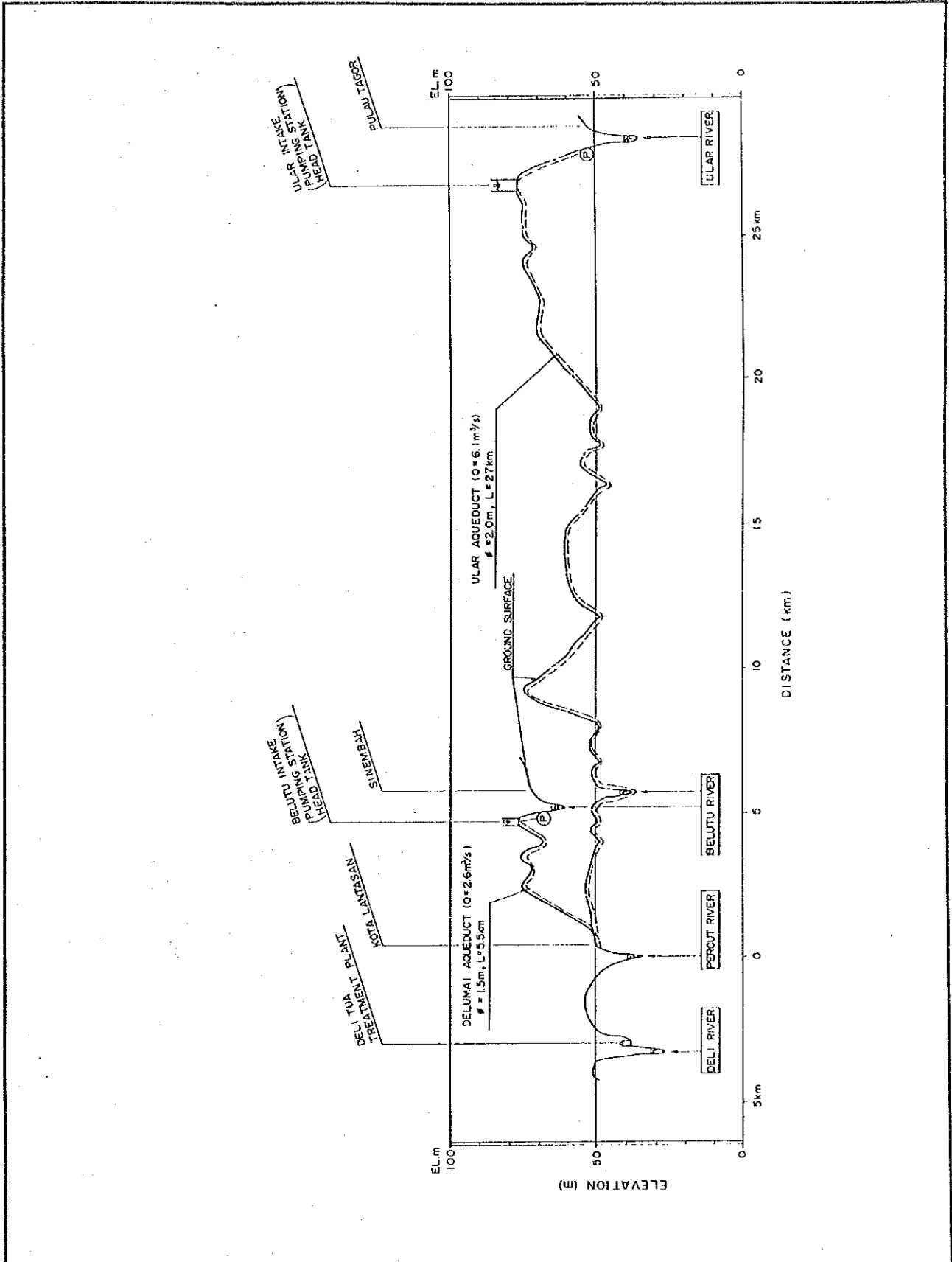


THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT
IN THE REPUBLIC OF INDONESIA

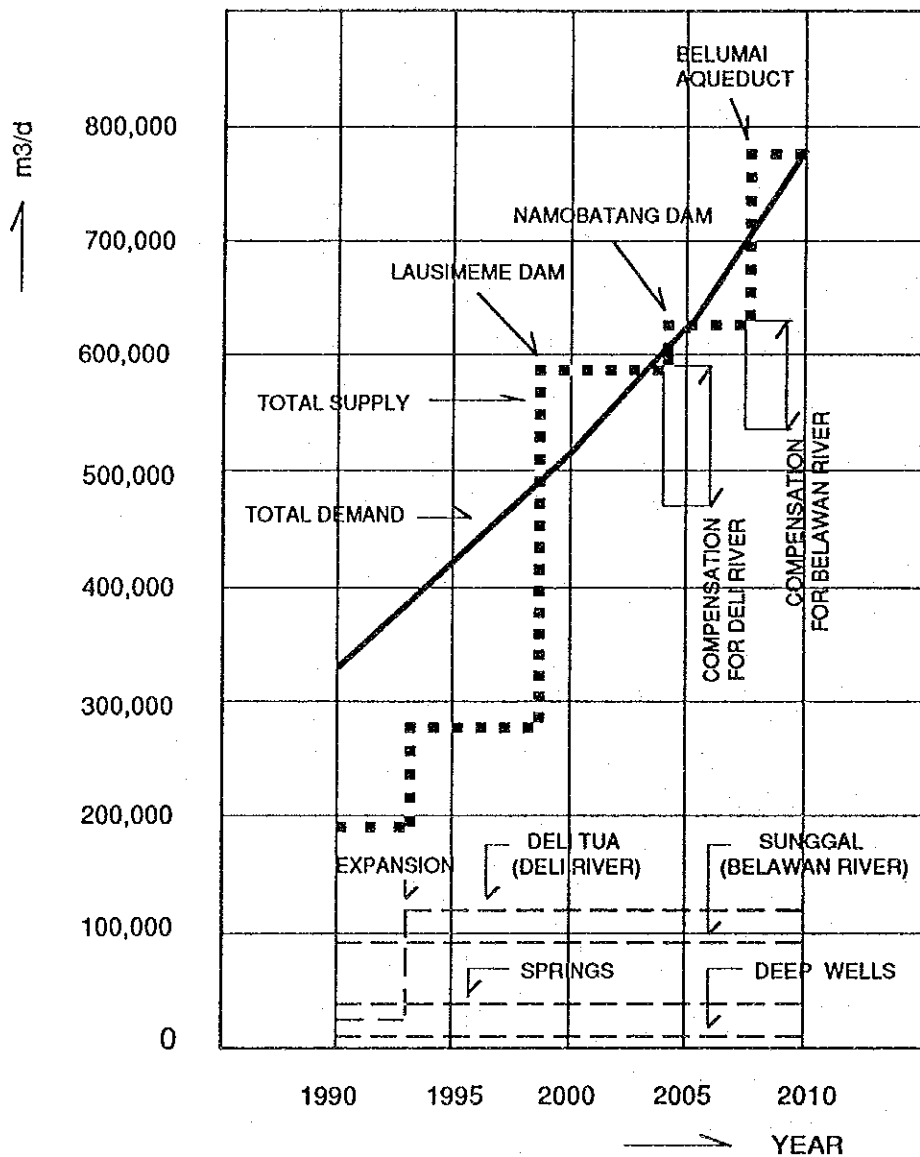
JAPAN INTERNATIONAL COOPERATION AGENCY

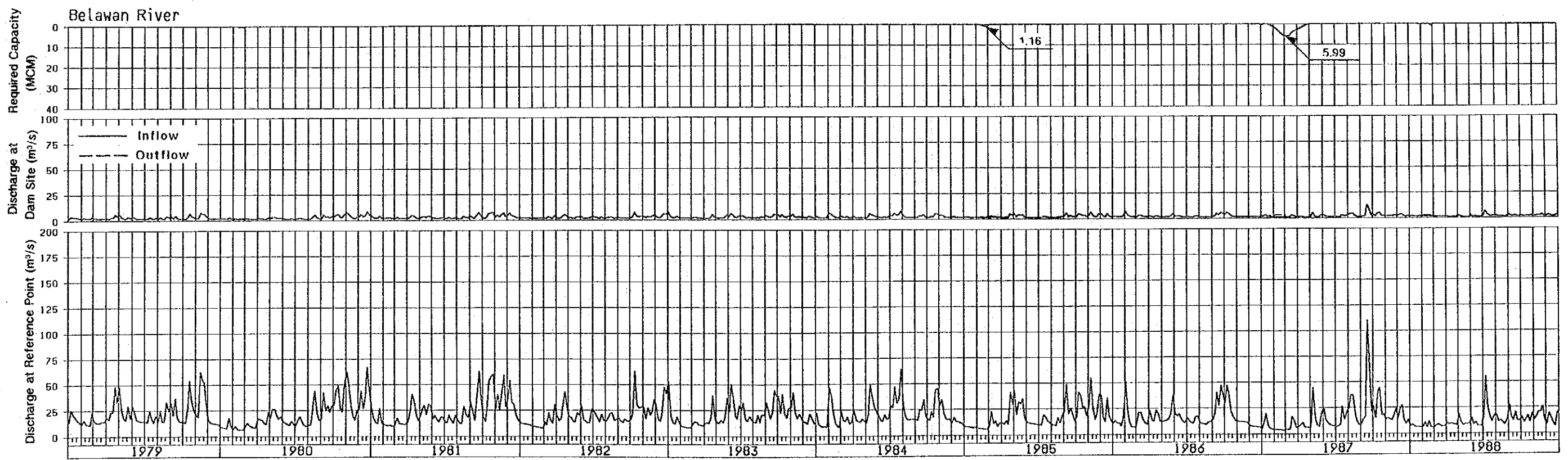
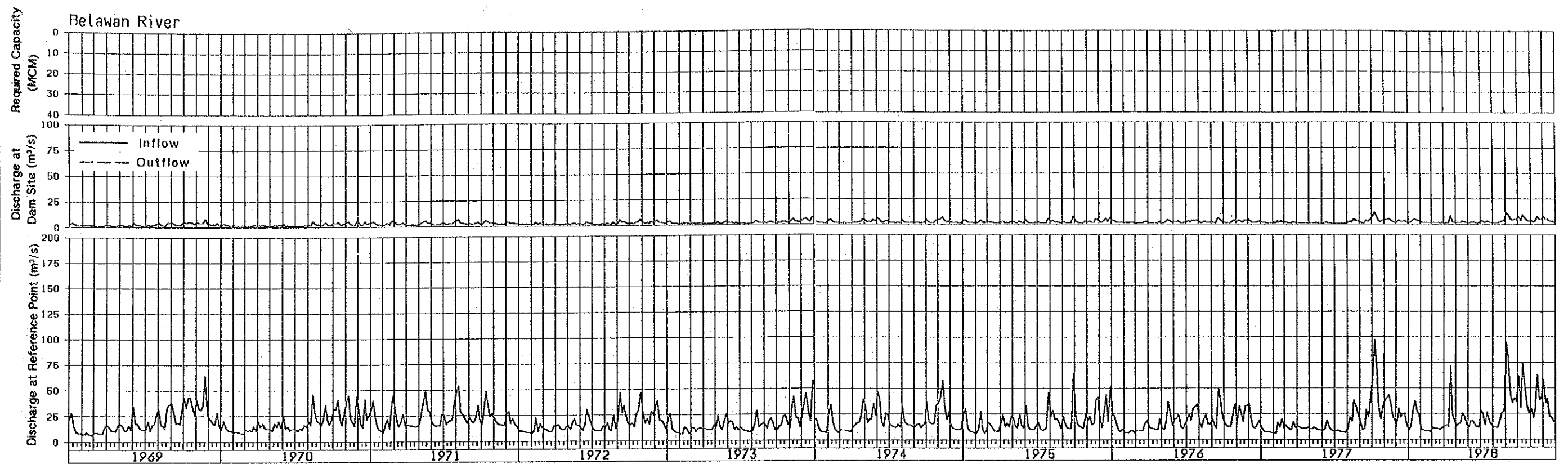
ROUTES OF TRANSBASIN WATER AQUEDUCT

Fig.4-1

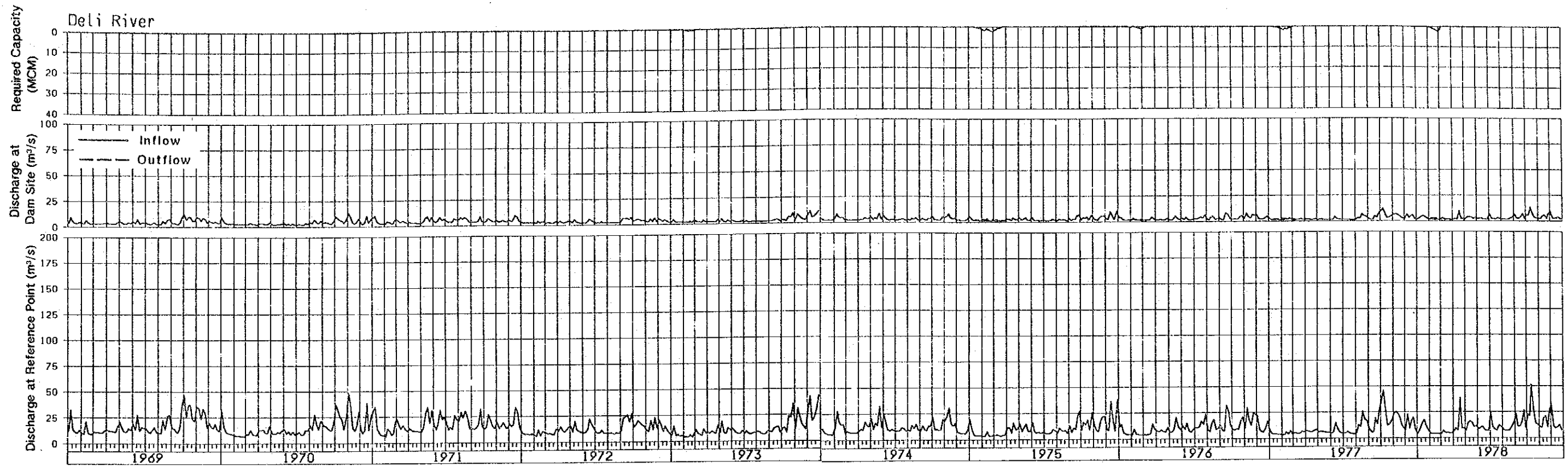


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| <p>THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA</p> <p>JAPAN INTERNATIONAL COOPERATION AGENCY</p> | <p>LONGITUDINAL PROFILE OF TRANSBASIN AQUEDUCT</p> <p>Fig.4-2</p> |
|--|---|

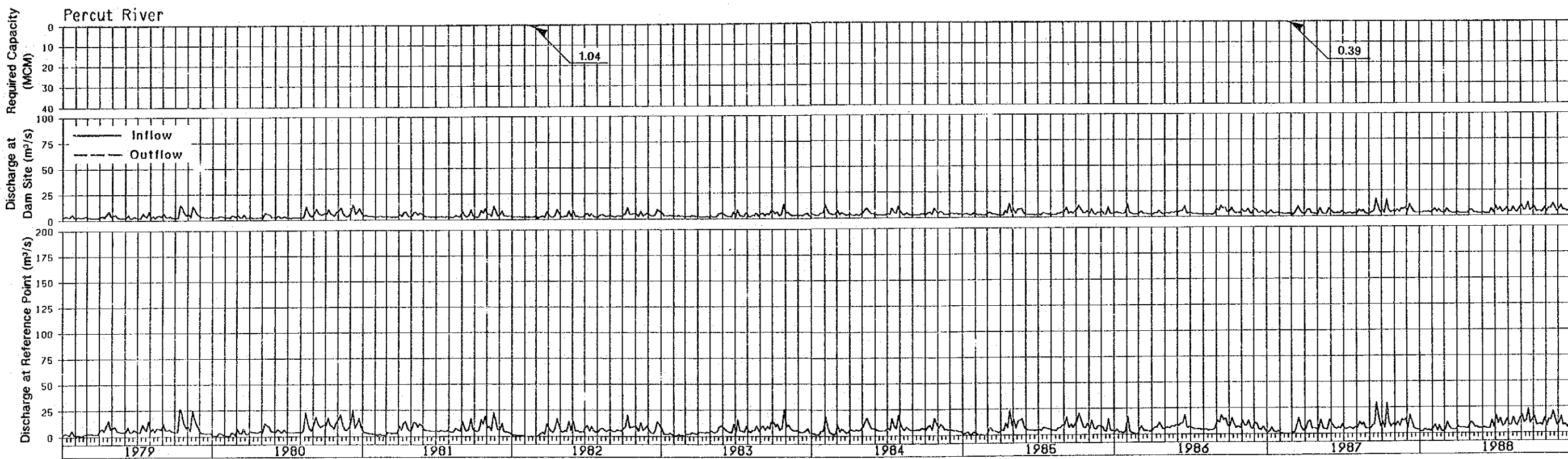




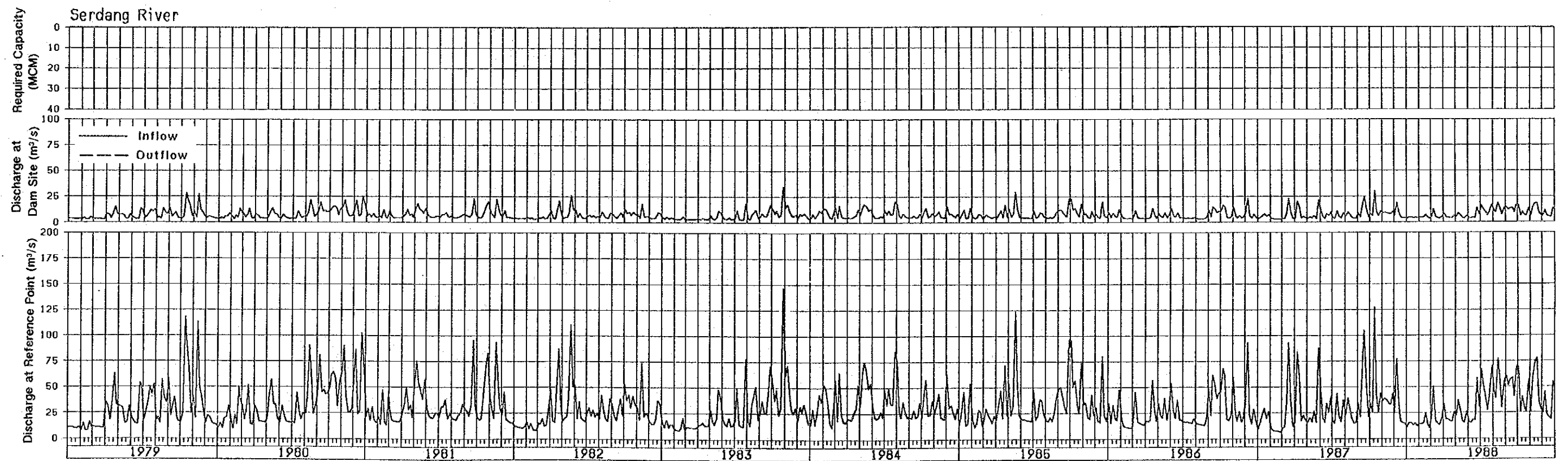
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| THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA | RESULTS OF WATER BALANCE SIMULATION BASED ON ACTUAL WATER DEMAND (BELAWAN RIVER) |
| JAPAN INTERNATIONAL COOPERATION AGENCY | Fig.3-3(1/7) |



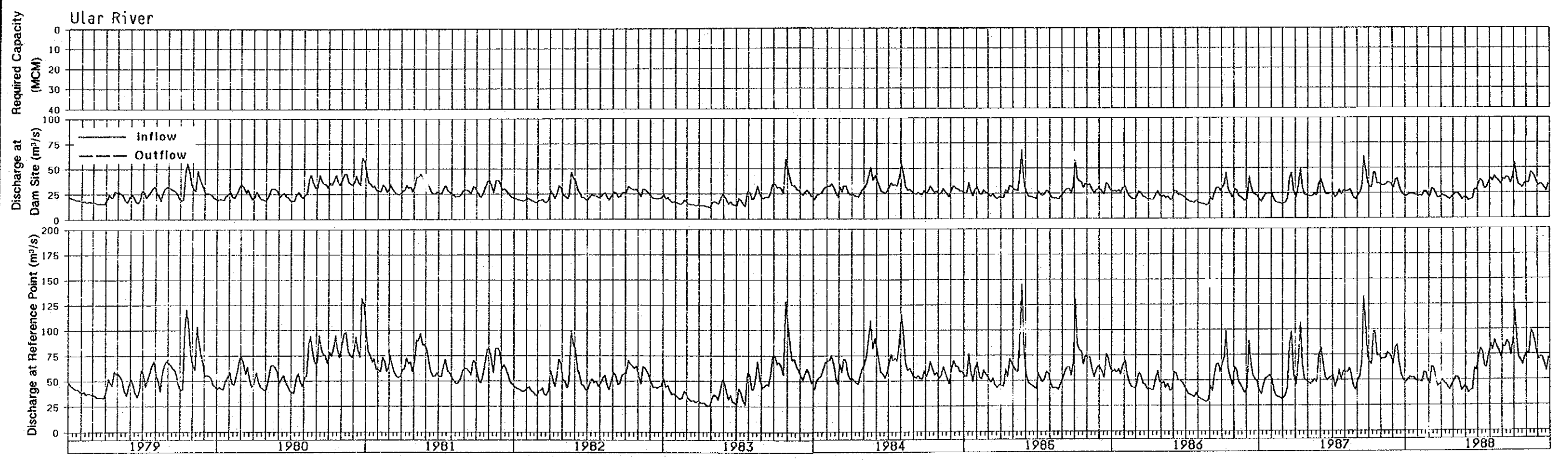
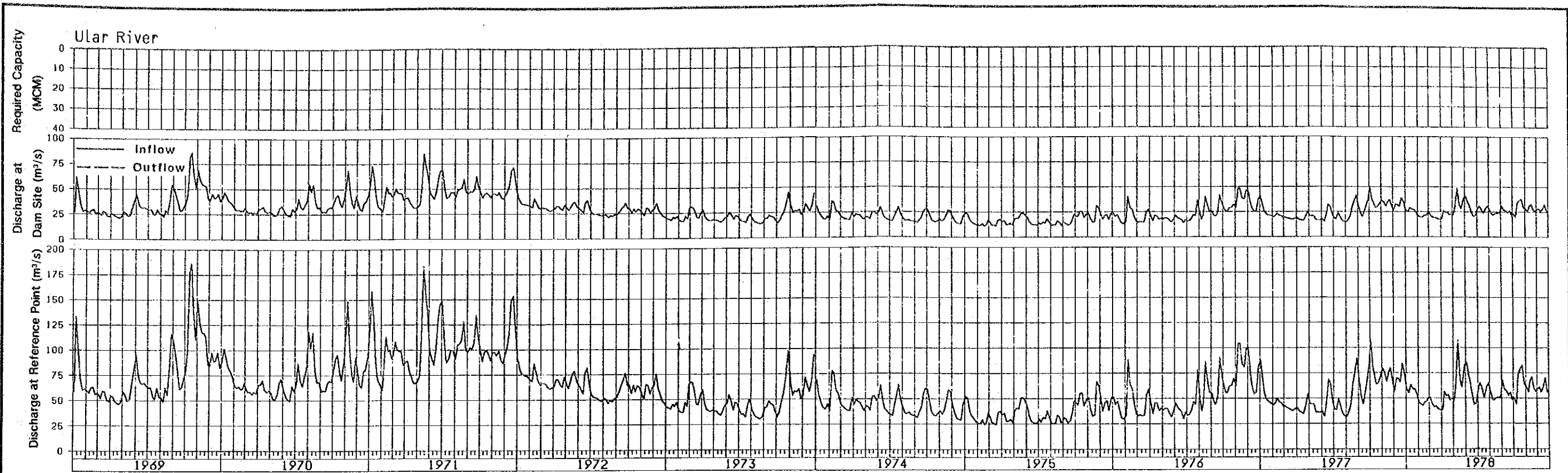
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| THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA | RESULTS OF WATER BALANCE SIMULATION BASED ON ACTUAL WATER DEMAND (DELI RIVER) |
| JAPAN INTERNATIONAL COOPERATION AGENCY | Fig.3-3(2/7) |



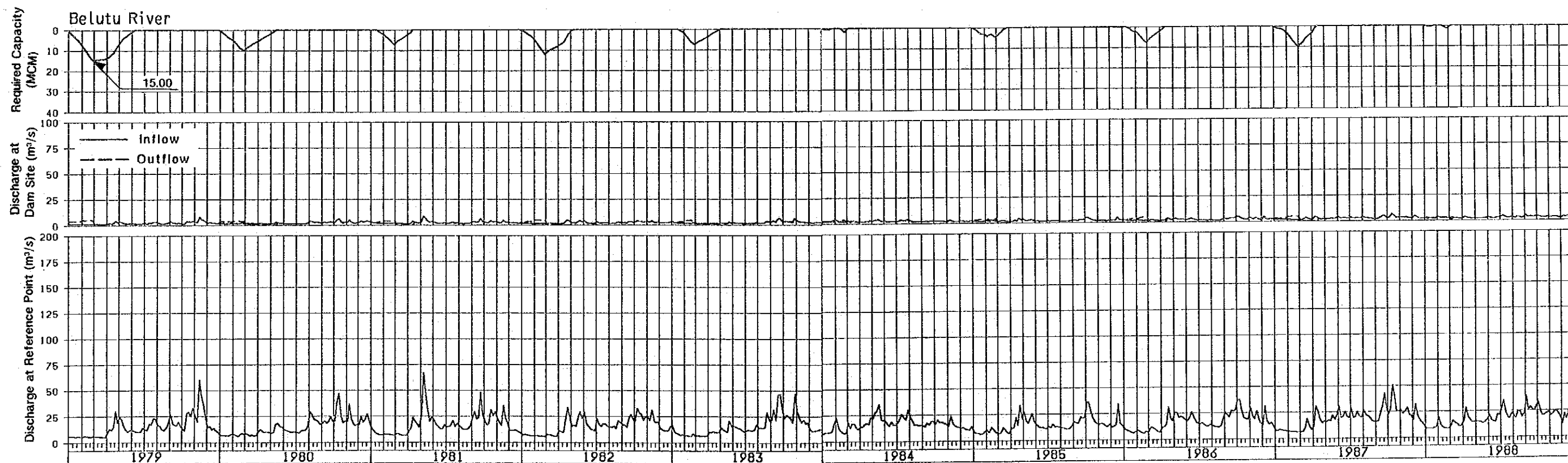
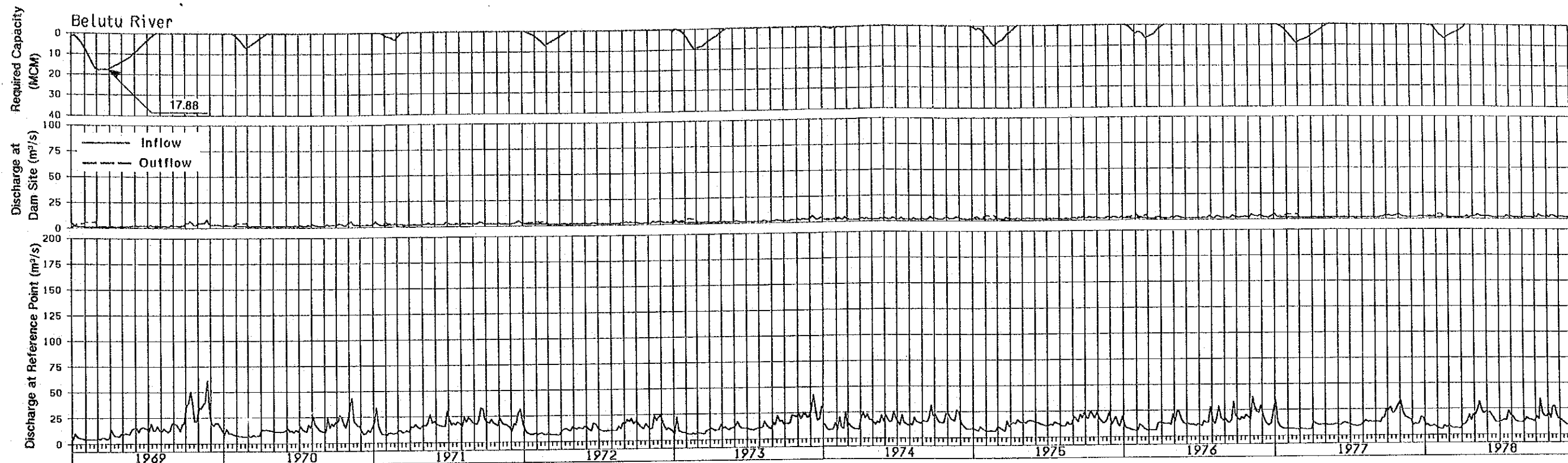
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| THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA | RESULTS OF WATER BALANCE SIMULATION BASED ON ACTUAL WATER DEMAND (PERCUT RIVER) |
| JAPAN INTERNATIONAL COOPERATION AGENCY | Fig.3-3(3/7) |



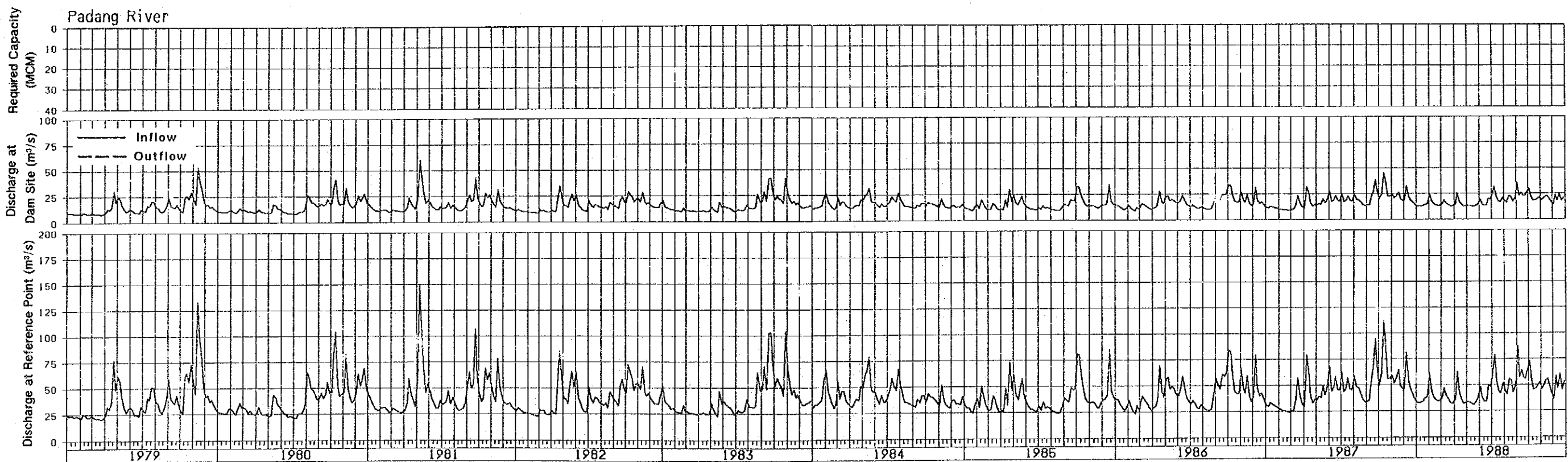
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| THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA | RESULTS OF WATER BALANCE SIMULATION BASED ON ACTUAL WATER DEMAND (SERDANG RIVER) |
| JAPAN INTERNATIONAL COOPERATION AGENCY | Fig.3-3(4/7) |



| | |
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| THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA JAPAN INTERNATIONAL COOPERATION AGENCY | RESULTS OF WATER BALANCE SIMULATION BASED ON ACTUAL WATER DEMAND (ULAR RIVER) Fig.3-3(5/7) |
|--|---|

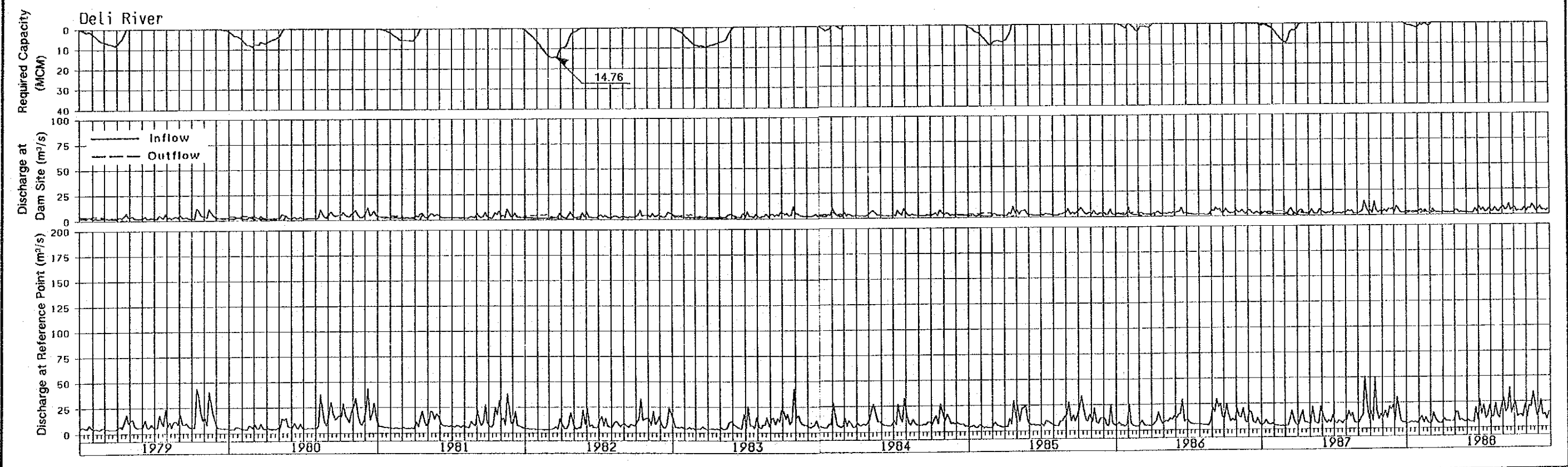
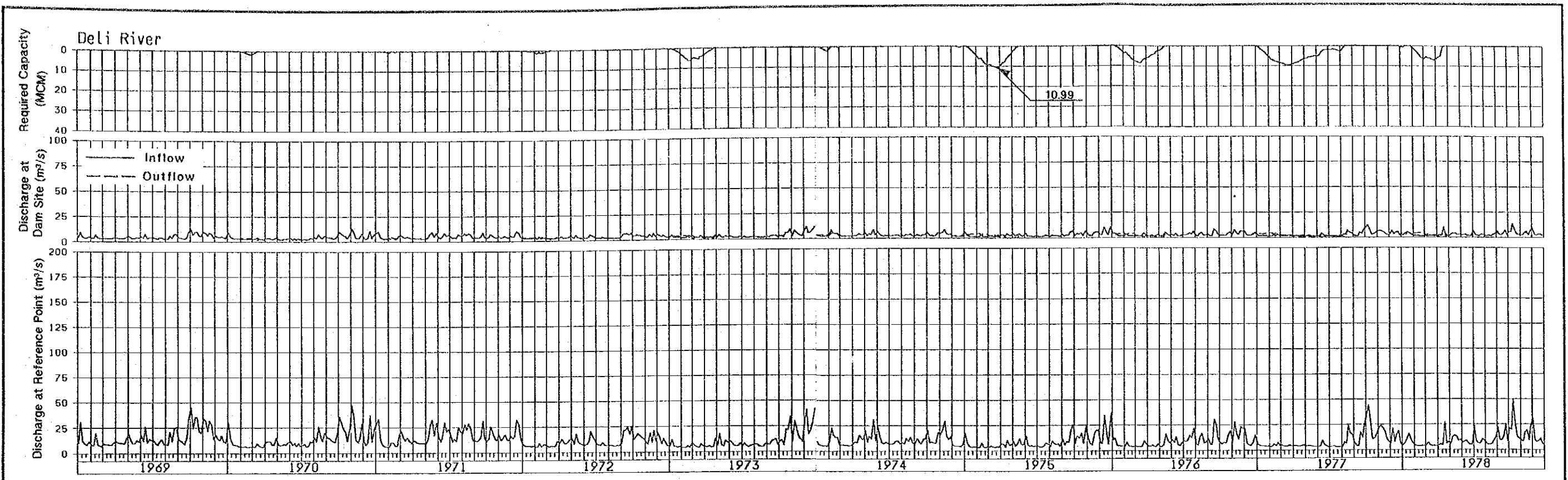


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| THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA | RESULTS OF WATER BALANCE SIMULATION BASED ON ACTUAL WATER DEMAND (BELUTU RIVER) |
| JAPAN INTERNATIONAL COOPERATION AGENCY | Fig.3-3(6/7) |

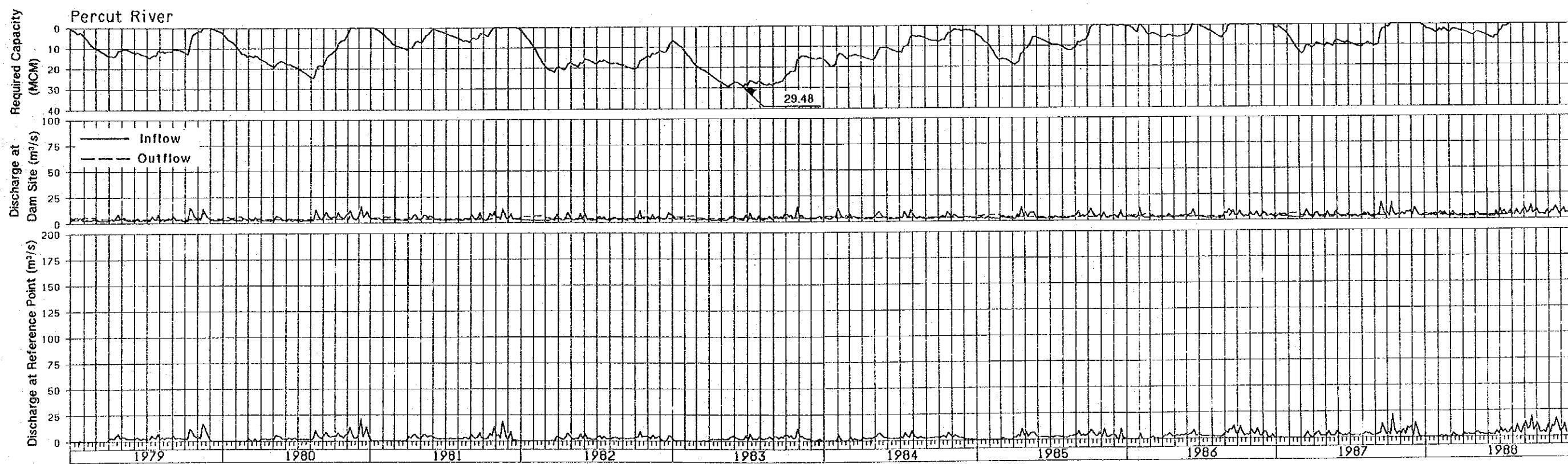
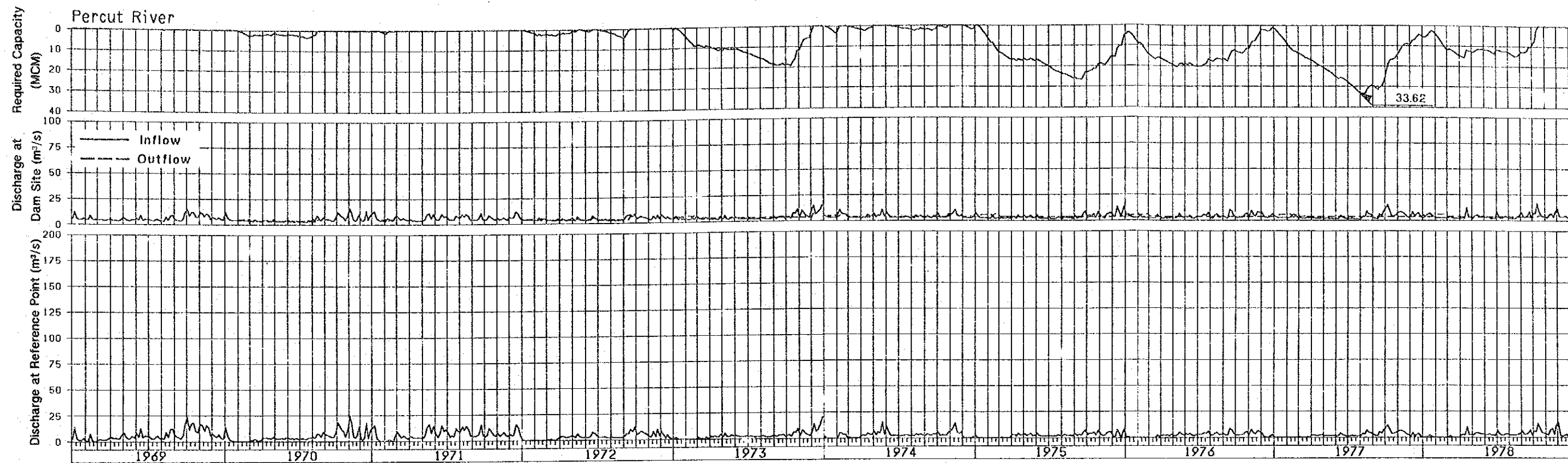


THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT
 IN THE REPUBLIC OF INDONESIA
 JAPAN INTERNATIONAL COOPERATION AGENCY

RESULTS OF WATER BALANCE SIMULATION
 BASED ON ACTUAL WATER DEMAND
 (PADANG RIVER)
 Fig.3-3(7/7)



| | |
|--|---|
| THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA | RESULTS OF WATER BALANCE SIMULATION BASED ON FUTURE WATER DEMAND OF 2010 (DELI RIVER) |
| JAPAN INTERNATIONAL COOPERATION AGENCY | Fig.4-3(1/2) |



| | |
|--|---|
| THE STUDY ON BELAWAN-PADANG INTEGRATED RIVER BASIN DEVELOPMENT IN THE REPUBLIC OF INDONESIA | RESULTS OF WATER BALANCE SIMULATION BASED ON FUTURE WATER DEMAND OF 2010 (PERCUT RIVER) |
| JAPAN INTERNATIONAL COOPERATION AGENCY | Fig.4-3(2/2) |

FC

FLOOD CONTROL PLAN

**STUDY ON BELAWAN-PADANG
INTEGRATED RIVER BASIN DEVELOPMENT**

SUPPORTING REPORT

FLOOD CONTROL PLAN

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SUPPORTING REPORT

FLOOD CONTROL PLAN

1. INTRODUCTION

The main study objectives for the flood control plan are the following:

- (a) To investigate past flood damages through interview survey and collecting flood damage records.
- (b) To identify existing flood control works such as river improvement, dam and retarding basin.
- (c) To estimate flood damage from the damage rate and the value of assets in the inundation areas.
- (d) To propose the optimum flood control master plan.
- (e) To formulate the urgent flood control plan, incorporating the water supply program.

2. FLOOD CONDITION

2.1 Past Flood Damage

Frequent floods have been reported in the study area; however, no record and detail has been compiled into report/documents in the DPUP, except some special study reports such as the Ular River Project and the Medan Urban Development Project (MUDP).

Interview Survey

Interview-survey was first conducted in July and August 1990 at the 55 locations in the flood-prone area shown in Fig. 2-1 and the results are summarized in Table 2-1. It was also carried out in areas east of the Ular River, namely in Belutu and Padang river basins. The three river basins in the west, i.e., Belawan, Deli and Percut, were previously studied under the MUDP. Ular River was excluded from the survey since no flood was experienced upon the completion of the Overall Ular River Improvement Project.

Flood conditions or causes are classified into two, river overbanking and inland drainage. In both cases, high tide worsens the condition such as the increase of flood water depth and longer flood duration.

River overbanking were reported mainly in the downstream areas of all six (6) rivers, while inland drainage problems are observed in urban areas such as Kodya, Medan and Tebing Tinggi and in the coastal low land. The serious river floods were those in the downstream of Deli River in 1988 and 1989. Inundation due to stormwater were simultaneously experienced in Medan.

Aside from Medan, flood damage has also been increasing in Tebing Tinggi. The downstream stretch of Padang River has only a small flow capacity, and the drainage system in Tebing Tinggi has never been improved for a long time.

There is less flooding from the Belawan River, but swampy areas exist in the lowest coastal shore of the basin. As to the basins of Belutu and Serdang rivers, frequent floods have been reported in paddy fields and the oil palm plantation.

The second interview survey was conducted for the flood on November 26, 1990 in Medan City from June to July 1991 at a total of 15 locations along the Deli and Percut rivers in order to identify the flood area. Based on the results of the survey and the flood report prepared by Subdinas Sungai and Rawa, DPUP North Sumatra, the flood area is estimated at about 4,200 ha as shown in Fig. 2-2, together with inundation depths.

Flood Damage Record

Some records on past flood damage in Kodya, Medan and Tebing Tinggi, and in Kab. Deli Serdang have been compiled by the Office of Social Welfare. Due to inadequate personnel and the financial

condition of the office, the flood damage record in Kab. Deli Serdang is only for a short period and inadequate in Kodya. Medan and Tebing Tinggi, as presented in Table 2-2.

In Kab. Deli Serdang where records since 1981 are available, the main cause of flood damage is the overbank flow from the Belutu and Padang rivers. Estimated at approximately Rp. 100 million per annum on average from 1981 to 1988, the damage is considered big because no extraordinary flood has hit the area during the period. However, casualties were few and this is attributed to the topographic condition which does not produce any flash flood.

In Kodya. Medan and Tebing Tinggi, no details are reflected on the records, while it is reported by the River Section of DPUP that Deli River overflowed at around Kecamatan Labuhan Deli in 1988 and 1989. According to some newspapers, the flood started in early Monday, November 26, 1990. It was caused by overflows from the Deli River and Denai (Percut) River. Padang River also overflowed in the upstream of the national road bridge in 1988.

(1) Belawan River

No overbank flow was reported in the last decade, while local inundations have been frequently observed in the downstream area between the Belawan and Deli rivers. Due to the topographic condition of the middle and lower reaches, storm water which flows down along the drainage channels is usually retained in the low-lying area south of the provincial road. This local inundation is also caused by the dikes of Belawan River, since there is neither sluice nor other facilities to drain the storm water into the river.

The area further downstream which is mostly covered with swamps or swampy forests has been flooded by high tide.

(2) Deli River

As described, the river had overbank flows in November 1990. Almost all of Medan City was flooded, including some kecamatans of Kab. Deli Serdang such as Tanjung Morawa, Labuhan Deli and Percut Sei Tuan. Six (6) kecamatans of Medan City, namely Medan Denai, Medan Kota, Medan Baru, Medan Barat, Medan Johor and Medan Deli, were flooded at inundation depths of 0.5 to 1.5 m. Jl. Medan- Tanjung Morawa was flooded at a depth of 1.0 m, and Jl. Selamat Medan and its surroundings were flooded at a depth of 1.5 m. The flood damage has been reported as:

- (a) 8,309 households have evacuated due to serious flooding in their houses;
- (b) 2 children were washed away by the flash flood;
- (c) One bridge on Jl. Amplas at Seksama Ujung, Medan Denai was destroyed by the flash flood;
and
- (d) Hundreds of vehicles, trucks and busses were stranded due to deep inundation at Pulau Brayan on Jl. Raya Medan-Belawan.

The estimated flood damage is approximately Rp. 38 billion for direct damage and Rp. 16 billion for indirect damage. Some 90% of the damage was inflicted on houses and household effects.

On the other hand, the overbank flows in 1988 and 1989 took place at around the confluence with Sikambing River. The flood water has run down northward along the river and spread over the industrial area and trunk roads in Kec. Medan Deli and Medan Timur.

Other than the main stream of Deli River, the Babura, Sikambing, Putih and Kera rivers have repeatedly overflowed with heavy rain. Due to rapid urbanization, infiltration of rainwater to the ground has decreased so much that the runoff discharge has considerably increased year by year. Furthermore, the delay in improving the drainage system in Medan City has worsened the flood condition.

(3) Percut River

As explained for the flood damage of Deli River, Percut River also overflowed in 1990. The flood inundation is caused by the poor drainage capacity of the paddy irrigation system and the river dikes without sluice.

The lowest reaches of the river near the estuary have been suffering from inundation due to high tide.

(4) Serdang River

Although a continuous dike has already been constructed on both sides of the river, the diked section still experienced overbank flows in the 1970's. Through some rehabilitation works by DPUP, no overbank flow was reported in the last decade. However, at around the confluence of two major tributaries, Belumai and Batugingging rivers, overflows have been observed almost in every year. The intake weir constructed across the river may also be affecting the overflow.

Batugingging River has become shallower due to sediment deposition and the flow capacity has been much decreased. From the confluence with Belumai River to the upper stream, floods overflow and spread over the paddy fields.

(5) Ular River

Since the river improvement works was completed in 1988, there has been no flood reported. The scale of improvement works is set at the flood discharge of 800 m³/s which corresponds to a 20-year return period.

On the other hand, there are two bridges across the river, the Serbajadi Bridge and the Ular Bridge, where the effective width of the river is abruptly decreased forming a bottleneck. The flow capacity of the section is roughly estimated at approx. 600 m³/s.

(6) Belutu River

Belutu River has also suffered from sediment deposition and riverbed aggradation. Earth dike was only constructed on the right side with a length of approximately 10 km from the national road. Widespread inundation has frequently taken place in the paddy field between the Rambung River and the main stream. Most of the paddy fields have become swamps due to floodwaters.

In the downstream area, some inundations in a low-lying flat land have been reported. They are caused mostly by high tide and poor drainage of the irrigation system.

(7) Padang River

Padang River has often suffered from overbank floods. Bordering at Tebing Tinggi, the upstream area around the confluence with Sibarau River had a deep inundation that was recorded at 2.5 m in Desa Langau in the year 1970's. The downstream area of Tebing Tinggi also had frequent overflows. Some of the dikes have deteriorated due to poor maintenance works. Floods usually overflowed the broken part of the dike, but the inundation depth is not so big as that in the upstream owing to the flat topography.

The drainage problem in Tebing Tinggi City has worsened with the expansion of the urban area. The drainage channel in the urban area is not adequate in both capacity and length. In the lowest reaches, the riparian area has repeatedly suffered floods caused by high tide.

2.2 Existing Flood Control Works

River Improvement Works

All rivers considerably meander except in the river sections where some improvement works were undertaken. River improvement works were mainly earth dikes with little channel excavation and bank protection.

River improvement works in the study area have been executed mostly by the DPUP. River improvement works including other flood control works for Medan City was started in 1990 by the MUDP II as follows:

(1) River Improvement by DPUP

River improvement works in the study area were undertaken by DPUP from 1980 to 1990, as presented in Table 2-3. Most of the works were rehabilitation of the existing dikes to protect paddy field. Recently, on account of serious flood damage in Medan City, the related budget has been used mainly for the Deli River improvement works.

Some flood control works have been planned by the DPUP as shown in Table 2-4. Among them, only the Deli River improvement project has been carried out with financial assistance from OECF and IBRD.

The scale of improvement works was determined mainly according to the relative importance of individual river basins. Since the work volume was partly affected by financial conditions, the priority of implementation was placed firstly in the low-lying areas where flood damage was serious.

The investigation and design of the Deli River improvement have been executed for a length of 40 km from the river mouth, as a part of the North Sumatra Flood Control Project (PPS.SU) under DPUP from fiscal year 1984 to 1990. The PPS.SU, from fiscal year 1987 to 1990, accomplished the following river improvement works of protection against 10-year return period floods.

River Improvement Works, 1987-90

| Work Item | Improvement Stretch | Improvement Volume (m ³) |
|------------------|---------------------------------|--------------------------------------|
| Excavation | River mouth to 7.5 km upstream* | 498,400 |
| Left Embankment | River mouth to 12 km upstream | 209,136 |
| Right Embankment | Tollway to 7 km upstream** | 93,316 |
| Total | | 800,852 |

* A part of the excavation work with a volume of about 132,000 m³ was not completed due to problems in land acquisition.

** The tollway crosses at a 2.5 km upstream of the river mouth. The right embankment for 440 m long was not completed.

The design and the works were financed by foreign loans such as OECF and IBRD, and also by local funds (APBN). From fiscal year 1987 to 1990, land acquisition along the river from the estuary to the confluence with Sikambing River, an area of 97.11 ha corresponding to 23 km long, was accomplished by PPS.SU.

(2) River Improvement by MUDP II

All flood control works on the rivers flowing through Medan City have been turned over from PPS.SU to MUDP II at the end of 1990. MUDP II is the second phase of a continuing program for enhancement of the quality of life in Medan through the provision of improved housing and essential urban services under ADB loan. The proposed project includes the following components:

- (a) Water Supply
- (b) Sewerage
- (c) Drainage
- (d) Solid Waste Management
- (e) Kampung Improvement Program (KIP) and Market Infrastructure Improvement Program (MIIP)
- (f) Urban Roads and Traffic Management

- (g) Small Towns Infrastructure Improvement
- (h) Flood Control
- (i) Institutional Development and Consulting Services

Implementation of this multi-component project involves agencies at the central, provincial and municipal government levels. The execution agencies for MUDP II are DGCK, Medan City, PDAM Tirtanadi and PERUMNAS. For flood control, however, DGWRD is only appointed as the executing agency. The project area under the flood control sector is situated in Medan City, and the scope of work includes channel improvement, levee bank construction, etc., along the Deli, Sikambing, Putih and Kera rivers.

On the institutional development and consulting services under MUDP II, a flood control advisor was assigned by the Directorate of Rivers (DOR), DGWRD. The main activities of the advisor starting in 30 November 1990 is to review the engineering design which was prepared by PPS.SU, and to assist DOR in the preparation of tender documents, etc.

The quantities of major works involved in the Deli River are 1,846,128 m³ for excavation, 255,454 m³ for embankment and 16,566 m³ for concreting works.

Furthermore, a consultant for the engineering services on flood control has also been employed to carry out the study on flood control and river flows for one (1) year since May 1991, as a part of the institutional development and consulting services under MUDP II.

The project management office of the Medan Flood Control Project under MUDP II was established in January 1991 with financial assistance from ADB. The office will carry out the land acquisition of 5 km long along Deli River, from the confluence with Sikambing River to the point of confluence with Babura River, with funds from APBN. In addition, consulting services for the review of design and supervision of civil works is expected.

Flow Capacity of Existing River Channels

Flow capacity was estimated for the existing river channels of only the Belawan, Deli, Percut, Serdang, Belutu and Padang, because the Ular River has already been improved with the flow capacity of 800 m³/s. Details on flow capacity are presented in the Supporting Report on River Improvement. The relation between flow capacity and flood discharge of a 10-year return period is summarized in the following table.

Relation Between Flow Capacity and Flood Discharge

| River Section | River Length (km) | Flow Capacity (m ³ /s) | Flood Discharge of 10-Yr Return Period (m ³ /s) |
|--|----------------------|--------------------------------------|--|
| 1. Belawan River | | | |
| (a) River Mouth to Confluence with Bras River | 37.5 | 170 | 410 |
| 2. Deli River | | | |
| (a) Crossing with Tollway to Confluence with Sikambang River | 20.4 | 60 | 460 |
| (b) Confluence with Sikambang River to Confluence with Babura River | 5.3 | 110 | 420 |
| (c) Confluence with Babura River to Titi Kuning | 9.2 | 35 | 260 |
| 3. Percut River | | | |
| (a) River Mouth to Titi Kuning | 28.0 | 35 | 230 |
| 4. Serdang River | | | |
| (a) River Mouth to Confluence with Batugingging River | 9.3 | 60 | 680 |
| (b) Belumai River: Confluence with Batugingging River to Crossing with National Road | 14.0 | 70 | 270 |
| (c) Batugingging River: Confluence with Belumai River to Crossing with National Road | 8.9 | 20 | 390 |
| 5. Ular River | | | |
| (a) River Mouth to Pulau Tagor | 31.8 | 800 | 710 |
| 6. Belutu River | | | |
| (a) River Mouth to Confluence with Rambung River | 19.0 | 30 | 260 |
| (b) Confluence with Rambung River to Bakaran Batu | 13.7 | 10 | 160 |
| 7. Padang River | | | |
| (a) River Mouth to Confluence with Sibarau River | 29.5 | 90 | 620 |

Other Related Structures

None of the seven rivers have dams, retarding basins, floodways and any other flood control facilities. Flood control for these rivers, therefore, has been planned relying on only their channels.

3. FLOOD DAMAGE ANALYSIS

3.1 Assets in the Inundation Area

Data on assets, together with the flood damage data especially on houses/buildings were collected through the interview with the inhabitants in the flood prone area. Most of the residential houses in urban and rural areas are built as one-storey single houses made of tile or tile cement. The average floor area of the houses is about 50 m² and the average construction cost of such house is estimated at approximately Rp. 5 million. The results of the assets survey are presented in Table 3-1 and the height of major household effects above floor level are as shown in Table 3-2.

Simultaneously, some statistics on houses such as type, floor area and materials were collected as shown in Tables 3-3 (Source: Kondisi Sosial dan Ekonomi Penduduk, Sumatera Utara 1988). The Directorate General of Cipta Karya, Ministry of Public Works also gave the standard price of government buildings as shown in Table 3-4.

Table 3-5 shows the appraisal of assets on buildings, household effects and agricultural crops. The appraisal of buildings and household effects is given as an average price as of the year 1991 for each of the farmhouses, residences, shops, offices, schools, hospitals, factories, mosques and churches, based on the field survey in the study area. On the other hand, the appraisal of agricultural crops is given as a producer's price in 1991 for each paddy, rubber, coconut, oil palm, cacao, tobacco, maize, cassava, potato, peanut, soybean and green pea plantation.

The area and number of buildings, houses and agricultural crops in the inundation area divided into mesh, are presented in Table 3-6. The inundation area meshed in 1.0 km by 1.0 km is described in the Supporting Report on Hydrology.

3.2 Flood Damage Rate

Flood damage rate was analyzed as follows:

Damage to Buildings and Household Effects

Flood damage to buildings and household effects are considered as a function of inundation depth to buildings. The damage rate to buildings is assumed at 0.5 m of water depth above floor level as shown below, taking the condition of buildings in the study area into consideration based on the rate being used in Japan.

Flood Damage Rate to Buildings (%)

| Water Level Above Flood (m) | Damage Rate |
|-----------------------------|-------------|
| 0.00 - 0.49 | 0.037 |
| 0.50 - 0.99 | 0.064 |
| 1.00 - 1.49 | 0.099 |
| 1.50 - 1.99 | 0.137 |
| 2.00 - 2.49 | 0.179 |

On the other hand, the damage rate to household effects is also assumed at 0.5 m water depth above floor level, taking into account the average distribution of goods above floor level of houses in the study area, based on the damage rate being applied to submerged goods in Japan as shown below.

Flood Damage Rate to Household Effects (%)

| Kind of Building | Water Level Above Flood (m) | | | | | | |
|------------------|-----------------------------|---------|---------|---------|---------|---------|----------|
| | 0.0-0.5 | 0.5-1.0 | 1.0-1.5 | 1.5-2.0 | 2.0-2.5 | 2.5-3.0 | Over 3.0 |
| Farmhouse | 0.448 | 0.621 | 0.656 | 0.676 | 0.690 | 0.690 | 0.690 |
| Residential | 0.407 | 0.600 | 0.642 | 0.622 | 0.683 | 0.690 | 0.690 |
| Shop | 0.251 | 0.448 | 0.543 | 0.561 | 0.579 | 0.597 | 0.597 |
| Office, etc.* | 0.411 | 0.575 | 0.613 | 0.626 | 0.632 | 0.632 | 0.632 |

* Office, school, hospital, factory, mosque, church and kiosk.

Damage to Paddy

Flood damage to paddy is generally related to the height of planted paddy and the depth and duration of submergence. The damage rate is estimated based on the results of experiments by the Ministry of Agriculture, Forestry and Fishery of Japan and the relation between the height and the growth period of planted paddy in Indonesia, as follows:

Flood Damage Rate to Paddy (%)

| Submergence | | Tillering | Booling | Heading | Ripaning |
|---------------------------------------|----------------|--------------------|----------------------|-----------------------|-------------------------|
| Depth | Duration (day) | 0-70th Day (0-54%) | 71-87th Day (55-67%) | 88-100th Day (68-77%) | 101-130th Day (78-100%) |
| Case A (Over Plant Height) | 1 to 2 | 10 | 70 | 30 | 5 |
| | 3 to 4 | 20 | 80 | 80 | 20 |
| | 5 to 6 | 30 | 85 | 90 | 30 |
| | Over 7 | 35 | 95 | 100 | 30 |
| Case B (75% of Plant Height) | 1 to 2 | 6 | 40 | 10 | 4 |
| | 3 to 4 | 9 | 46 | 23 | 15 |
| | 5 to 6 | 14 | 49 | 26 | 23 |
| | Over 7 | 16 | 55 | 30 | 23 |
| Case C (50% of Plant Height) | 1 to 2 | 4 | 37 | 8 | 2 |
| | 3 to 4 | 9 | 42 | 22 | 4 |
| | 5 to 6 | 13 | 45 | 25 | 6 |
| | Over 7 | 15 | 50 | 28 | 6 |

Damage to Oil Palm and Rubber

Recently, drainage facilities of oil palm and rubber plantations have been remarkably improved and so they will scarcely be damaged due to inundation, although their roots are not so strong against water. Nevertheless, the production of palm oil (including kernel) and rubber will decrease due to flood, because of the suspension of production activities during floods and the restoration of production facilities after flood. In estimating these damages, it is assumed that the restoration period is nearly equal to the flood duration and the production is uniformly made all the year round.

Under the above assumption, the decrease in production per day and per hectare of palm oil (incl. kernel) and rubber caused by inundation is respectively estimated as follows, where production costs of these crops are assumed to be 40% of the producer prices in accordance with the plantation statistics in North Sumatra.

(a) Oil Palm (incl. Kernel)

$$\text{Rp. } 665,000 \times (1-0.4) \times 2/365 = \text{Rp. } 2,150/\text{day/ha}$$

(b) Rubber

$$\text{Rp. } 143,000 \times (1-0.4) \times 2/365 = \text{Rp. } 470/\text{day/ha}$$