Table V-50 Hydraulic Calculation of Unlined Canal

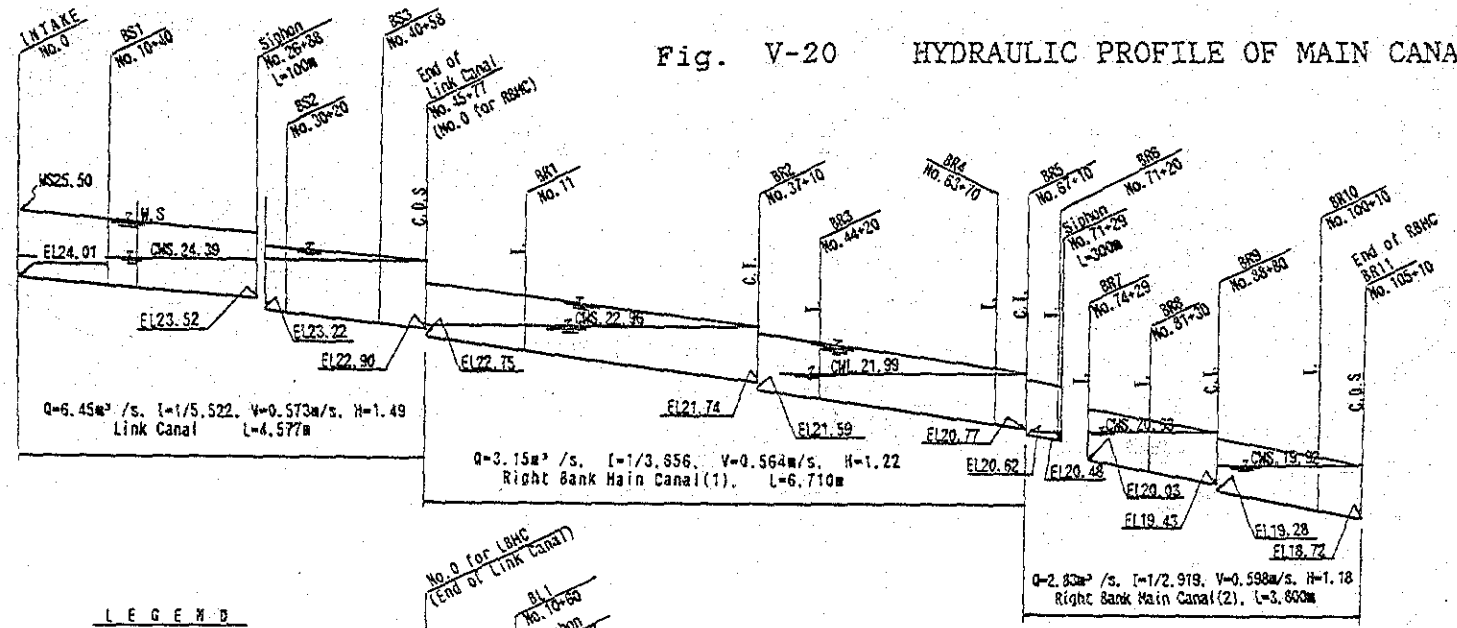
Haring huizen formula 0.277

Water depth h=0.887 x Q

Table Calculation of canal slope

| TYPE | Q | h | B/h | Bl | m | k | Fb | h+Fb | A | V | P | R | R4/3 | 1/K | I | 1/I |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | m3/s | m | | m | | | m | m | m2 | m/s | m | m | | | | |
| L-1 | 6.45 | 1.49 | 3.1 | 4.60 | 2.00 | 42.5 | 0.76 | 2.25 | 11.258 | 0.573 | 11.248 | 1.001 | 1.001 | 0.0235 | 0.000181 | 5522 |
| M-0 | 4.42 | 1.34 | 2.6 | 3.50 | 1.50 | 40.0 | 0.61 | 1.95 | 7.374 | 0.599 | 8.327 | 0.886 | 0.850 | 0.0250 | 0.000264 | 3787 |
| M-1 | 4.20 | 1.32 | 2.5 | 3.30 | 1.50 | 40.0 | 0.63 | 1.95 | 6.969 | 0.603 | 8.059 | 0.865 | 0.824 | 0.0250 | 0.000275 | 3630 |
| M-2 | 3.20 | 1.22 | 2.3 | 2.80 | 1.50 | 40.0 | 0.63 | 1.85 | 5.676 | 0.564 | 7.214 | 0.787 | 0.726 | 0.0250 | 0.000274 | 3656 |
| M-3 | 3.00 | 1.20 | 2.2 | 2.60 | 1.50 | 40.0 | 0.60 | 1.80 | 5.296 | 0.567 | 6.936 | 0.764 | 0.698 | 0.0250 | 0.000287 | 3479 |
| M-4 | 2.80 | 1.18 | 1.9 | 2.20 | 1.50 | 40.0 | 0.62 | 1.80 | 4.683 | 0.598 | 6.454 | 0.726 | 0.652 | 0.0250 | 0.000343 | 2919 |
| M-5 | 2.60 | 1.16 | 1.8 | 2.10 | 1.50 | 40.0 | 0.64 | 1.80 | 4.431 | 0.587 | 6.267 | 0.707 | 0.630 | 0.0250 | 0.000342 | 2927 |
| M-6 | 2.40 | 1.13 | 1.9 | 2.10 | 1.50 | 40.0 | 0.62 | 1.75 | 4.291 | 0.559 | 6.176 | 0.695 | 0.615 | 0.0250 | 0.000318 | 3147 |
| M-7 | 2.20 | 1.10 | 1.8 | 2.00 | 1.50 | 40.0 | 0.60 | 1.70 | 4.034 | 0.545 | 5.979 | 0.675 | 0.592 | 0.0250 | 0.000314 | 3183 |
| M-8 | 2.00 | 1.07 | 1.9 | 2.00 | 1.50 | 40.0 | 0.63 | 1.70 | 3.882 | 0.515 | 5.875 | 0.661 | 0.576 | 0.0250 | 0.000288 | 3470 |
| S-1 | 1.80 | 1.04 | 1.8 | 1.90 | 1.50 | 40.0 | 0.61 | 1.65 | 3.618 | 0.498 | 5.664 | 0.639 | 0.550 | 0.0250 | 0.000281 | 3555 |
| S-2 | 1.60 | 1.01 | 1.8 | 1.80 | 1.50 | 40.0 | 0.64 | 1.65 | 3.350 | 0.478 | 5.443 | 0.615 | 0.524 | 0.0250 | 0.000272 | 3671 |
| S-3 | 1.40 | 0.97 | 1.5 | 1.50 | 1.50 | 40.0 | 0.53 | 1.50 | 2.882 | 0.486 | 5.011 | 0.575 | 0.478 | 0.0250 | 0.000308 | 3245 |
| S-4 | 1.20 | 0.93 | 1.5 | 1.40 | 1.50 | 40.0 | 0.52 | 1.45 | 2.612 | 0.459 | 4.764 | 0.548 | 0.449 | 0.0250 | 0.000294 | 3401 |
| S-5 | 1.00 | 0.89 | 1.4 | 1.20 | 1.50 | 35.0 | 0.51 | 1.40 | 2.245 | 0.446 | 4.398 | 0.510 | 0.408 | 0.0286 | 0.000398 | 2512 |
| S-6 | 0.80 | 0.83 | 1.3 | 1.10 | 1.50 | 35.0 | 0.52 | 1.35 | 1.960 | 0.408 | 4.106 | 0.477 | 0.373 | 0.0286 | 0.000365 | 2738 |
| S-7 | 0.60 | 0.77 | 1.2 | 0.90 | 1.50 | 35.0 | 0.53 | 1.30 | 1.582 | 0.379 | 3.676 | 0.430 | 0.325 | 0.0286 | 0.000362 | 2763 |
| S-8 | 0.40 | 0.69 | 1.0 | 0.70 | 1.50 | 35.0 | 0.41 | 1.10 | 1.192 | 0.336 | 3.181 | 0.375 | 0.270 | 0.0286 | 0.000341 | 2934 |
| S-9 | 0.20 | 0.57 | 1.1 | 0.60 | 1.00 | 35.0 | 0.43 | 1.00 | 0.663 | 0.302 | 2.206 | 0.301 | 0.201 | 0.0286 | 0.000369 | 2709 |

Fig. V-20 HYDRAULIC PROFILE OF MAIN CANAL




L E G E N D

| | | |
|---|---|---|
| W.S | : | Water Surface |
| CWS. | : | Check Water Surface |
| C | : | Check Gate |
| D | : | Diversion Structure |
| S | : | Spillway |
| T | : | Turnout |
| DR | : | Drop |

HYDRAULIC PROFILE OF LEFT BANK MAIN CANAL

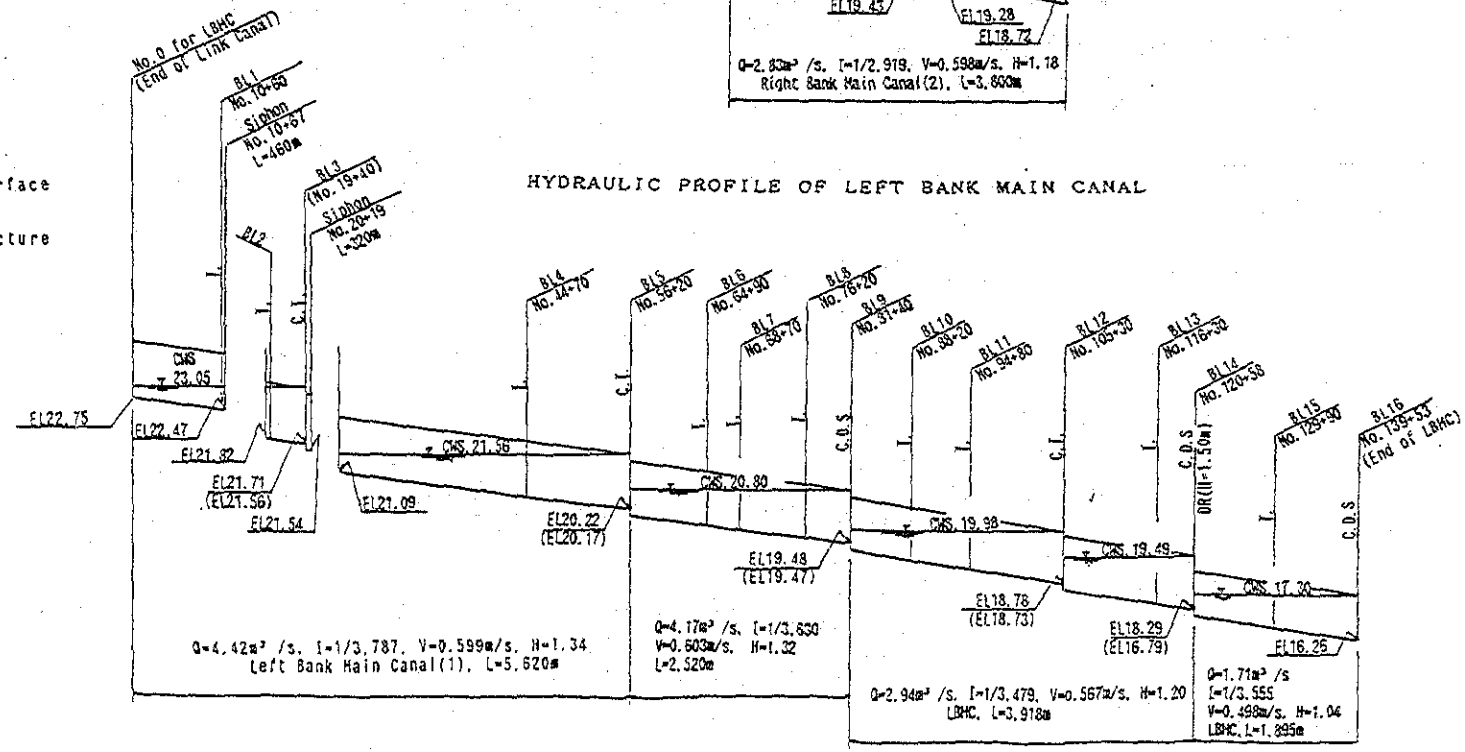


Fig. V-21 STANDARD SECTION OF EARTH CANAL

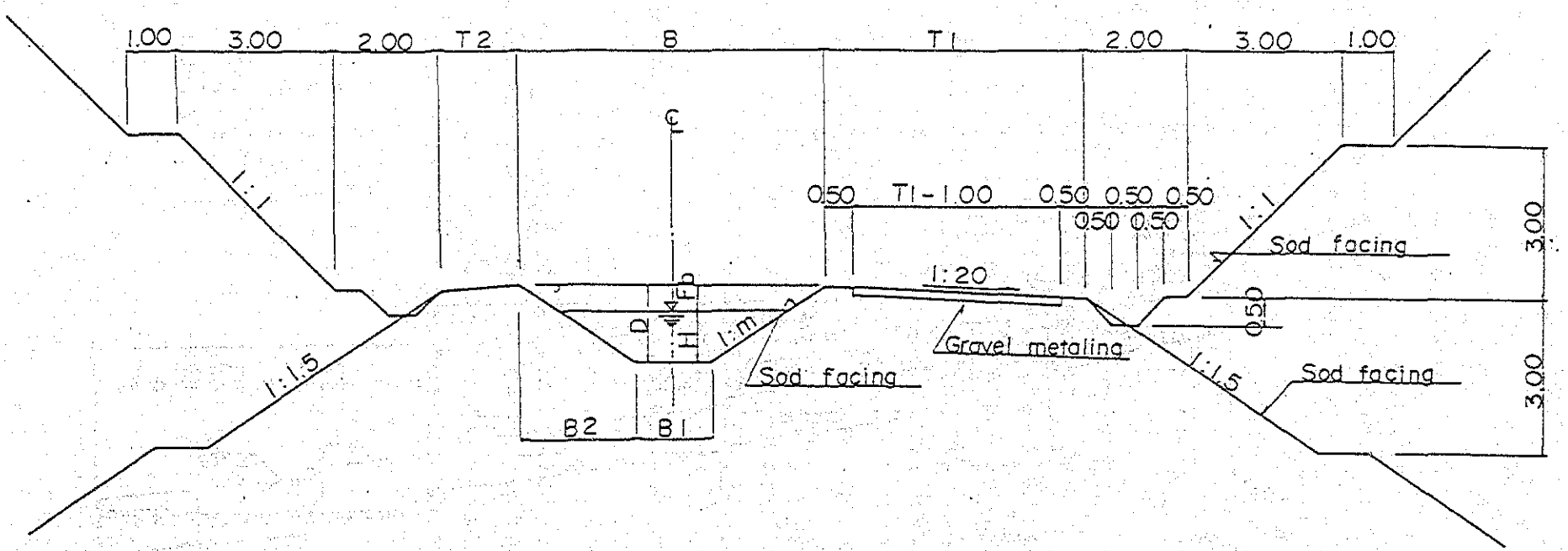


Table V-51 DIMENSION OF EARTH CANAL

| TYPE | Q | H | Fb | D | B1 | m | B2 | B | T1 | T2 | 1/I |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | m3/s | m | m | m | m | | m | m | m | m | |
| L-1 | 6.45 | 1.49 | 0.76 | 2.25 | 4.60 | 2.00 | 4.50 | 13.60 | 5.00 | 3.00 | 5522 |
| M-0 | 4.42 | 1.34 | 0.61 | 1.95 | 3.50 | 1.50 | 2.92 | 9.35 | 5.00 | 2.00 | 3787 |
| M-1 | 4.20 | 1.32 | 0.63 | 1.95 | 3.30 | 1.50 | 2.92 | 9.15 | 5.00 | 2.00 | 3630 |
| M-2 | 3.20 | 1.22 | 0.63 | 1.85 | 2.80 | 1.50 | 2.78 | 8.35 | 5.00 | 2.00 | 3656 |
| M-3 | 3.00 | 1.20 | 0.60 | 1.80 | 2.60 | 1.50 | 2.70 | 8.00 | 5.00 | 2.00 | 3479 |
| M-4 | 2.80 | 1.18 | 0.62 | 1.80 | 2.20 | 1.50 | 2.70 | 7.60 | 5.00 | 2.00 | 2919 |
| M-5 | 2.60 | 1.16 | 0.64 | 1.80 | 2.10 | 1.50 | 2.70 | 7.50 | 5.00 | 2.00 | 2927 |
| M-6 | 2.40 | 1.13 | 0.62 | 1.75 | 2.10 | 1.50 | 2.63 | 7.35 | 5.00 | 2.00 | 3147 |
| M-7 | 2.20 | 1.10 | 0.60 | 1.70 | 2.00 | 1.50 | 2.55 | 7.10 | 5.00 | 2.00 | 3183 |
| M-8 | 2.00 | 1.07 | 0.63 | 1.70 | 2.00 | 1.50 | 2.55 | 7.10 | 5.00 | 2.00 | 3470 |
| S-1 | 1.80 | 1.04 | 0.61 | 1.65 | 1.90 | 1.50 | 2.48 | 6.85 | 5.00 | 2.00 | 3555 |
| S-2 | 1.60 | 1.01 | 0.64 | 1.65 | 1.80 | 1.50 | 2.48 | 6.75 | 5.00 | 2.00 | 3671 |
| S-3 | 1.40 | 0.97 | 0.53 | 1.50 | 1.50 | 1.50 | 2.25 | 6.00 | 5.00 | 2.00 | 3245 |
| S-4 | 1.20 | 0.93 | 0.52 | 1.45 | 1.40 | 1.50 | 2.18 | 5.75 | 5.00 | 2.00 | 3401 |
| S-5 | 1.00 | 0.89 | 0.51 | 1.40 | 1.20 | 1.50 | 2.10 | 5.40 | 3.50 | 2.00 | 2512 |
| S-6 | 0.80 | 0.83 | 0.52 | 1.35 | 1.10 | 1.50 | 2.03 | 5.15 | 3.50 | 2.00 | 2738 |
| S-7 | 0.60 | 0.77 | 0.53 | 1.30 | 0.90 | 1.50 | 1.95 | 4.80 | 3.50 | 2.00 | 2763 |
| S-8 | 0.40 | 0.69 | 0.41 | 1.10 | 0.70 | 1.50 | 1.65 | 4.00 | 3.50 | 2.00 | 2934 |
| S-9 | 0.20 | 0.57 | 0.43 | 1.00 | 0.60 | 1.00 | 1.00 | 2.60 | 3.50 | 2.00 | 2709 |

Table V-52.1 CALCULATION OF CANAL LENGTH (1/7)

CALCULATION OF CANAL LENGTH
NAME OF CANAL: LINK CANAL

| IP | X | Y | LENGTH | | Remarks |
|---|---|---|---|---|---|
| | | | LENGTH | ACCUM. | |
| | m | m | m | m | |
| LINK C. 0 | -320 | -6,582 | 0 | 0 | Intake |
| 1 | -418 | -6,772 | 214 | 214 | |
| 2 | -537 | -7,114 | 362 | 576 | |
| 3 | -616 | -7,219 | 131 | 707 | |
| 4 | -724 | -7,068 | 186 | 893 | |
| 5 | -999 | -7,078 | 275 | 1,168 | |
| 6 | -1,076 | -7,040 | 86 | 1,254 | |
| 7 | -1,327 | -7,090 | 256 | 1,510 | |
| 8 | -1,457 | -6,970 | 177 | 1,687 | |
| 9 | -1,618 | -7,028 | 171 | 1,858 | |
| 10 | -2,222 | -7,668 | 880 | 2,738 | |
| 11 | -2,538 | -7,974 | 440 | 3,178 | |
| 12 | -3,000 | -8,018 | 464 | 3,642 | |
| 13 | -3,150 | -7,829 | 241 | 3,883 | |
| 14 | -3,298 | -7,737 | 174 | 4,058 | |
| 15 | -3,604 | -7,727 | 306 | 4,364 | |
| 16 | -3,741 | -7,890 | 213 | 4,577 | Diversion |
| TOTAL | | | 4,577 | | |

Table V-52.2 CALCULATION OF CANAL LENGTH (2/7)

CALCULATION OF CANAL LENGTH
NAME OF CANAL: RIGHT BANK MAIN CANAL

| IP | | X | Y | LENGTH | | Remarks |
|---|---|---|---|---|---|---|
| | | | | LENGTH | ACCUM. | |
| | | m | m | m | m | |
| RIGHT | BP | -3,741 | -7,890 | 0 | 0 | IP16 |
| | 1 | -4,025 | -7,657 | 367 | 367 | |
| | 2 | -4,050 | -7,477 | 182 | 549 | |
| | 3 | -4,485 | -7,360 | 450 | 1,000 | |
| | 4 | -4,670 | -7,360 | 185 | 1,185 | |
| | 5 | -4,887 | -7,332 | 219 | 1,403 | |
| | 6 | -5,257 | -7,508 | 410 | 1,813 | |
| | 7 | -5,807 | -7,550 | 552 | 2,365 | |
| | 8 | -5,859 | -7,350 | 207 | 2,571 | |
| | 9 | -5,974 | -7,232 | 165 | 2,736 | |
| | 10 | -6,188 | -7,340 | 240 | 2,976 | |
| | 11 | -6,254 | -7,190 | 164 | 3,140 | |
| | 12 | -6,360 | -7,187 | 106 | 3,246 | |
| | 13 | -6,650 | -7,392 | 355 | 3,601 | |
| | 14 | -6,661 | -7,591 | 199 | 3,800 | |
| | 15 | -6,966 | -7,500 | 318 | 4,118 | |
| | 16 | -7,031 | -7,275 | 234 | 4,353 | |
| | 17 | -7,361 | -7,065 | 391 | 4,744 | |
| | 18 | -7,500 | -7,026 | 144 | 4,888 | |
| | 19 | -7,634 | -7,145 | 179 | 5,067 | |
| | 20 | -7,694 | -7,124 | 64 | 5,131 | |
| | 21 | -7,821 | -6,722 | 422 | 5,553 | |
| | 22 | -8,210 | -6,870 | 416 | 5,969 | |
| | 23 | -8,304 | -6,697 | 197 | 6,166 | |
| | 24 | -8,840 | -6,622 | 541 | 6,707 | |
| | 25 | -8,996 | -6,455 | 229 | 6,935 | |
| | 26 | -9,129 | -6,400 | 144 | 7,079 | |
| | 27 | -9,584 | -6,490 | 464 | 7,543 | |
| | 28 | -9,745 | -6,668 | 240 | 7,783 | |
| | 29 | -9,926 | -6,555 | 213 | 7,996 | |
| | 30 | -10,136 | -6,484 | 222 | 8,218 | |
| | 31 | -10,170 | -6,400 | 91 | 8,309 | |
| | 32 | -10,511 | -6,325 | 349 | 8,658 | |
| | 33 | -10,880 | -6,298 | 370 | 9,028 | |
| | 34 | -10,916 | -6,188 | 116 | 9,144 | |
| | 35 | -11,087 | -6,246 | 181 | 9,324 | |
| | 36 | -11,232 | -6,248 | 145 | 9,469 | |
| | 37 | -11,502 | -6,233 | 270 | 9,740 | |
| | 38 | -11,763 | -6,167 | 269 | 10,009 | |
| | 39 | -11,911 | -6,212 | 155 | 10,164 | |
| | 40 | -12,078 | -6,456 | 296 | 10,459 | |
| | EP | -12,129 | -6,455 | 51 | 10,510 | BR11 |
| TOTAL | | | | 10,510 | | |

Table V-52.3 CALCULATION OF CANAL LENGTH (3/7)

CALCULATION OF CANAL LENGTH
NAME OF CANAL: HITAM SECONDARY CANAL

| IP | | X | Y | LENGTH | | Remarks |
|---|---|---|---|---|---|---|
| | | | | LENGTH | ACCUM. | |
| | | m | m | m | m | |
| HITAM | BP | -12,129 | -6,455 | 0 | 0 | BR11 |
| | 1 | -12,579 | -6,427 | 451 | 451 | |
| | 2 | -12,644 | -6,120 | 314 | 765 | |
| | 3 | -12,856 | -5,791 | 391 | 1,156 | |
| | 4 | -13,064 | -5,664 | 244 | 1,400 | |
| | BH1 | -13,230 | -5,665 | 166 | 1,566 | |
| | 5 | -13,232 | -5,863 | 198 | 1,764 | |
| | 6 | -13,329 | -6,093 | 250 | 2,013 | |
| | 7 | -13,323 | -6,246 | 153 | 2,167 | |
| | 8 | -13,587 | -6,570 | 418 | 2,584 | |
| | 9 | -13,936 | -6,851 | 448 | 3,033 | |
| | 10 | -14,015 | -7,305 | 461 | 3,493 | |
| | 11 | -14,410 | -7,403 | 407 | 3,900 | |
| | EP | -14,690 | -7,285 | 304 | 4,204 | BH12 |
| TOTAL | | | | 4,204 | | |

NAME OF CANAL: PONDOK BATU SEC. CANAL

| IP | | X | Y | LENGTH | | Remarks |
|---|---|---|---|---|---|---|
| | | | | LENGTH | ACCUM. | |
| | | m | m | m | m | |
| RIGHT | BR11 | -12,129 | -6,455 | 0 | 0 | |
| PONDOK | 1 | -12,135 | -6,672 | 217 | 217 | |
| BATU | 2 | -12,197 | -6,939 | 274 | 491 | |
| | 3 | -12,403 | -6,950 | 206 | 697 | |
| | 4 | -13,092 | -7,525 | 897 | 1,595 | |
| | 5 | -13,175 | -7,538 | 84 | 1,679 | |
| | 6 | -13,514 | -7,816 | 438 | 2,117 | |
| | 7 | -13,503 | -8,027 | 211 | 2,329 | |
| | 8 | -13,821 | -8,211 | 367 | 2,696 | |
| | 9 | -14,299 | -8,335 | 494 | 3,190 | |
| | 10 | -14,340 | -9,050 | 716 | 3,906 | |
| | 11 | -14,460 | -9,180 | 177 | 4,083 | |
| | 12 | -14,470 | -9,370 | 190 | 4,273 | |
| | 13 | -14,570 | -9,630 | 279 | 4,552 | |
| | 14 | -15,105 | -10,180 | 767 | 5,319 | |
| | 15 | -15,220 | -10,120 | 130 | 5,449 | |
| | 16 | -15,450 | -10,280 | 280 | 5,729 | |
| | EP | -18,500 | -9,910 | 3,072 | 8,801 | BP11 |
| TOTAL | | | | 8,801 | | |

Table V-52.4 CALCULATION OF CANAL LENGTH (4/7)

CALCULATION OF CANAL LENGTH
NAME OF CANAL: TRANSFER CANAL

| IP | | X | Y | LENGTH | | Remarks |
|---|---|---|---|---|---|---|
| | | | | LENGTH | ACCUM. | |
| | | m | m | m | m | |
| RIGHT | BR11 | -13,230 | -5,665 | 0 | 0 | |
| TRANS. | 1 | -13,554 | -5,668 | 324 | 324 | |
| | 2 | -13,664 | -5,581 | 140 | 464 | |
| | 3 | -13,768 | -5,223 | 373 | 837 | |
| | 4 | -13,668 | -4,964 | 278 | 1,115 | |
| | 5 | -13,734 | -4,793 | 183 | 1,298 | |
| | 6 | -13,720 | -4,604 | 190 | 1,488 | |
| | 7 | -13,743 | -4,400 | 205 | 1,693 | |
| | BTR2 | -13,774 | -4,325 | 81 | 1,774 | |
| | 8 | -13,848 | -4,140 | 199 | 1,973 | |
| | 9 | -13,989 | -3,983 | 211 | 2,184 | |
| | 10 | -14,099 | -3,816 | 200 | 2,384 | |
| | 11 | -14,136 | -3,407 | 411 | 2,795 | |
| | 12 | -14,135 | -3,246 | 161 | 2,956 | |
| | 13 | -14,490 | -2,910 | 489 | 3,445 | |
| | 14 | -14,600 | -2,885 | 113 | 3,557 | |
| | 15 | -14,848 | -2,775 | 271 | 3,829 | |
| | 16 | -15,403 | -2,710 | 559 | 4,388 | |
| | BB4 | -15,713 | -2,741 | 312 | 4,699 | IP17 |
| TOTAL | | | | 4,699 | | |

NAME OF CANAL: TRANSFER-2 CANAL

| IP | | X | Y | LENGTH | | Remarks |
|---|---|---|---|---|---|---|
| | | | | LENGTH | ACCUM. | |
| | | m | m | m | m | |
| RIGHT | BTR2 | -13,774 | -4,325 | 0 | 0 | |
| TRANS. | 1 | -13,866 | -4,330 | 92 | 92 | |
| | BB6 | -14,132 | -4,233 | 283 | 375 | EP |
| TOTAL | | | | 375 | | |

Table V-52.5 CALCULATION OF CANAL LENGTH (5/7)

CALCULATION OF CANAL LENGTH
NAME OF CANAL: LEFT BANK MAIN CANAL

| IP | | X | Y | LENGTH | | Remarks |
|---|---|---|---|---|---|---|
| | | | | LENGTH | ACCUM. | |
| | | m | m | m | m | |
| LEFT | BS4 | -3,741 | -7,890 | 0 | 0 | IP16 |
| M.C. | 1 | -3,876 | -7,983 | 164 | 164 | |
| | 2 | -3,774 | -8,243 | 279 | 443 | |
| | 3 | -3,826 | -8,404 | 169 | 612 | |
| | 4 | -3,917 | -8,386 | 93 | 705 | |
| | 5 | -4,000 | -8,738 | 362 | 1,067 | |
| | 6 | -3,754 | -9,127 | 460 | 1,527 | |
| | 7 | -3,835 | -9,531 | 412 | 1,939 | |
| | 8 | -3,865 | -9,983 | 453 | 2,392 | |
| | 9 | -4,132 | -10,093 | 289 | 2,681 | |
| | 10 | -4,854 | -10,164 | 725 | 3,406 | |
| | 11 | -5,073 | -9,927 | 323 | 3,729 | |
| | 12 | -5,219 | -9,950 | 148 | 3,877 | |
| | 13 | -5,824 | -9,703 | 653 | 4,530 | |
| | 14 | -5,921 | -9,926 | 243 | 4,774 | |
| | 15 | -6,108 | -9,854 | 200 | 4,974 | |
| | 16 | -6,300 | -10,060 | 282 | 5,256 | |
| | 17 | -6,492 | -9,817 | 310 | 5,565 | |
| | 18 | -7,197 | -9,663 | 722 | 6,287 | |
| | 19 | -7,268 | -9,410 | 263 | 6,550 | |
| | 20 | -7,476 | -9,232 | 274 | 6,823 | |
| | 21 | -8,104 | -9,220 | 628 | 7,451 | |
| | 22 | -8,536 | -9,312 | 442 | 7,893 | |
| | 23 | -8,656 | -9,495 | 219 | 8,112 | |
| | BL9 | -8,644 | -9,520 | 28 | 8,140 | S.S.BL9Ka |
| | 24 | -8,566 | -9,670 | 169 | 8,309 | |
| | 25 | -8,784 | -9,819 | 264 | 8,573 | |
| | 26 | -8,910 | -10,236 | 436 | 9,008 | |
| | 27 | -8,630 | -10,396 | 322 | 9,331 | |
| | 28 | -8,682 | -10,726 | 334 | 9,665 | |
| | 29 | -9,448 | -10,774 | 768 | 10,433 | |
| | 30 | -9,499 | -11,668 | 895 | 11,328 | |
| | 31 | -9,890 | -11,822 | 420 | 11,748 | |
| | BL14 | -10,150 | -11,990 | 310 | 12,058 | S.S.BL14Ka |
| | 32 | -10,806 | -12,422 | 785 | 12,843 | |
| | 33 | -11,071 | -12,340 | 277 | 13,121 | |
| | 34 | -11,152 | -12,182 | 178 | 13,298 | |
| | 35 | -11,528 | -12,048 | 399 | 13,697 | |
| | 36 | -11,652 | -12,047 | 124 | 13,821 | |
| | EP | -11,697 | -11,923 | 132 | 13,953 | S.S.MUKOMU |
| TOTAL | | | | 13,953 | | |

Table V-52.6 CALCULATION OF CANAL LENGTH (6/7)

CALCULATION OF CANAL LENGTH
NAME OF CANAL: BL9Ka SECONDARY CANAL

| | IP | X | Y | LENGTH | | Remarks |
|---|---|---|---|---|---|---|
| | | | | LENGTH | ACCUM. | |
| | | m | m | m | m | |
| LEFT | BL9 | -8,644 | -9,520 | 0 | 0 | |
| | 1 | -8,890 | -9,605 | 260 | 260 | |
| | BK2 | -9,047 | -9,480 | 201 | 461 | S.S.BK2Ka |
| | 3 | -9,137 | -9,408 | 115 | 576 | |
| | 4 | -9,788 | -9,042 | 747 | 1,323 | |
| | 5 | -9,936 | -8,699 | 374 | 1,697 | |
| | 6 | -10,674 | -8,202 | 890 | 2,586 | |
| | 7 | -11,510 | -8,208 | 836 | 3,422 | |
| | 8 | -12,000 | -8,500 | 570 | 3,993 | |
| | BK6 | -12,161 | -8,677 | 239 | 4,232 | |
| TOTAL | | | | 4,232 | | |

NAME OF CANAL: BK2Ka SECONDARY CANAL

| | IP | X | Y | LENGTH | | Remarks |
|---|---|---|---|---|---|---|
| | | | | LENGTH | ACCUM. | |
| | | m | m | m | m | |
| LEFT | BK2 | -9,047 | -9,480 | 0 | 0 | |
| | 1 | -8,975 | -9,391 | 114 | 114 | |
| | 2 | -9,064 | -8,800 | 598 | 712 | |
| | BBK2 | -9,092 | -8,180 | 621 | 1,333 | |
| TOTAL | | | | 1,333 | | |

NAME OF CANAL: BL14Ka SECONDARY CANAL

| | IP | X | Y | LENGTH | | Remarks |
|---|---|---|---|---|---|---|
| | | | | LENGTH | ACCUM. | |
| | | m | m | m | m | |
| LEFT | BL14 | -10,150 | -11,990 | 0 | 0 | |
| | 1 | -10,899 | -11,745 | 788 | 788 | |
| | 2 | -10,863 | -11,073 | 673 | 1,461 | |
| | 3 | -11,281 | -10,835 | 481 | 1,942 | |
| | 4 | -11,606 | -10,725 | 343 | 2,285 | |
| | 5 | -11,988 | -10,722 | 382 | 2,667 | |
| | BLK4 | -13,285 | -10,413 | 1,333 | 4,000 | |
| TOTAL | | | | 4,000 | | |

Table V-52.7 CALCULATION OF CANAL LENGTH (7/7)

CALCULATION OF CANAL LENGTH
NAME OF CANAL: MUKOMUKO SEC. CANAL

| IP | | X | Y | LENGTH | | Remarks |
|---|---|---|---|---|---|---|
| | | | | LENGTH | ACCUM. | |
| | | m | m | m | m | |
| LEFT BL16 | | -11,697 | -11,923 | 0 | 0 | |
| MUKO2 | 1 | -12,735 | -11,913 | 1,038 | 1,038 | |
| | 2 | -13,399 | -11,683 | 703 | 1,741 | |
| | 3 | -14,509 | -11,819 | 1,118 | 2,859 | |
| | 4 | -16,239 | -11,755 | 1,731 | 4,590 | |
| | 5 | -16,500 | -11,936 | 318 | 4,908 | |
| | 6 | -17,320 | -12,000 | 822 | 5,730 | |
| | BM4 | -18,074 | -12,420 | 863 | 6,593 | S.S.TANAHREKAH |
| | 8 | -18,500 | -12,668 | 493 | 7,086 | |
| | 9 | -19,284 | -12,553 | 792 | 7,879 | |
| | 10 | -19,378 | -12,313 | 258 | 8,137 | |
| | 11 | -20,194 | -10,927 | 1,608 | 9,745 | |
| | 12 | -20,187 | -10,395 | 532 | 10,277 | |
| | BM7 | -20,229 | -9,950 | 447 | 10,724 | |
| TOTAL | | | | 10,724 | | |

NAME OF CANAL: TANAH REKAH SEC. CANAL

| IP | | X | Y | LENGTH | | Remarks |
|---|---|---|---|---|---|---|
| | | | | LENGTH | ACCUM. | |
| | | m | m | m | m | |
| LEFT | BM4 | -18,074 | -12,420 | 0 | 0 | |
| TANAH | 1 | -18,720 | -11,764 | 921 | 921 | |
| REKAH | 2 | -18,929 | -11,807 | 213 | 1,134 | |
| | BT2 | -19,140 | -11,600 | 296 | 1,430 | |
| TOTAL | | | | 1,430 | | |

## 4.4 Basic Plan of Drainage System

### (1) Drainage System

Provision of a suitable drainage facility is one of the important factor to improve agricultural productivity in the low-lying land of the project.

Most natural streams which are located in the study area will become main drainage canal, while smaller drainage canal, that is, secondary drain will be provided according to land and soil conditions. However some of secondary drain will be constructed along the line of old river.

### (2) Design Discharge

Design discharge analysis will be divided into two methods namely drainage requirement for rice fields and non-rice fields.

Design capacity for rice fields is calculated using the following conditions.

a. Return period of design discharge : 5 years
b. 3 day consecutive rain fall : 286 mm (Pondok Panjang)
c. Design discharge;

$$Q\ 1 = 1.62\ Dm \times A^{0.92} \quad (A \geq 400\ ha)$$
$$Q\ 1 = Dm \times A \quad (A > 400\ ha)$$

where Q 1 is design discharge (l/s)
Dm is drainage modules (l/s/ha)
A is drainage area (ha)

The drainage modules is taken 8.64 l/s/ha. If the drainage area is less than 400 ha, the drainage discharge per unit area is taken as constant.

As to the drainage requirement at non-rice fields such as villages, roads and non-agric land, Mc-Math empirical formula (by Prosida/Harza) will be applied as follows:

$$Q\ 2 = 0.023 \times c \times i \times A^{4/5} \times S^{1/5}$$

where Q2 is design discharge ($m^3$/sec)
c is run off coefficient 0.80
i is rainfall intensity (cm/hr)
R24 (1/5) = 174 mm/day = 0.725 cm/hr
R24 (1/25) = 222 mm = 0.925 cm/hr
A is drainage area. Max. area 10,000 ha
S is average ground slope of drainage area

The design drainage discharge combines those of rice fields and non-rice fields. Then total drainage discharges will be Qd equals to 1.15 x (Q1 + Q2).

Table V-53 YEARLY MAXIMUM THREE DAY CONSECUTIVE RAINFALL

| | Pondok Kopi | | Jelinjing | | Lg.Luas | | Ujung Padan | | Penarik | | Pondok Panjang | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HB | HO | HB | HO | HB | HO | HB | HO | HB | HO | HB | HO |
| 1980 | | | | | | 122.5 | 174.2 | 187.5 | 222.3 | | | |
| 81 | 78.8 | 113.4 | | | 157.3 | 410.5 | 204.6 | 206.0 | 223.2 | 129.9 | | |
| 82 | 128.6 | 169.5 | 131.5 | | 126.8 | 150.2 | 136.1 | 145.7 | 115.1 | - | 161.0 | 207.5 |
| 83 | 201.4 | 211.4 | 69.9 | 86.9 | 183.2 | 192.1 | 220.4 | 193.3 | 101.8 | 141.0 | 303.6 | 224.5 |
| 84 | 204.4 | 204.3 | 141.7 | | 183.3 | 182.5 | - | | 132.0 | 158.5 | 198.5 | 173.4 |
| 85 | 204.9 | 72.5 | 344.5 | | 116.6 | 115.4 | 147.1 | | 176.5 | 90.2 | 183.2 | 97.7 |
| 86 | 210.9 | | 85.5 | | 174.3 | 70.4 | 194.7 | | 301.2 | | 311.1 | 317.4 |
| 87 | 219.0 | | 220.0 | | 196.7 | | 154.2 | | | | 197.8 | |
| 88 | 303.6 | | 155.1 | | | | 332.8 | | | | 285.7 | |

H . B : Rainfall Gauge
H . O : Automatic Rainfall Recorder

YEARLY MAXIMUM THREE DAY CONSECUTIVE RAINFALL
WITH NON-EXCEEDANCE PROBABILITY

Iwai Method

| Probability | Jelinjing | Lg.Luas | Penarik | Pk.Kopi | Pk.Panjang | Ug.Padang |
|---|---|---|---|---|---|---|
| 1/10 | 295 | 205 | 278 | 275 | 321 | 280 |
| 1/5 | 223 | 188 | 240 | 249 | 286 | 234 |
| 1/2 | 140 | 159 | 181 | 202 | 233 | 181 |

Gumbel Chow Method

| Probability | Jelinjing | Lg.Luas | Penarik | Pk.Kopi | Pk.Panjang | Ug.Padang |
|---|---|---|---|---|---|---|
| 1/10 | 276 | 199 | 267 | 269 | 311 | 273 |
| 1/5 | 227 | 182 | 233 | 240 | 280 | 240 |
| 1/2 | 153 | 157 | 182 | 197 | 233 | 189 |

(3) Dimension of Drainage Canal

- For the drainage canal, earthen type will be adopted taking the construction cost into consideration.
- The maximum design water level is equal to ground level.

- Maximum velocity of 1.5 times the maximum velocity of conveyance canal will be adopted.

- Free board is taken from irrigation design standard KP-03 "CANALS" as follows.

| | |
|---|---|
| Qd < 0.1 $m^3/s$ | Fb = 0.40 m |
| 0.1 ≦ Qd < 0.5 | 0.45 |
| 0.5 ≦ Qd < 0.5 | 0.50 |
| 1.0 ≦ Qd < 1.5 | 0.55 |
| 1.5 ≦ Qd < 2.5 | 0.60 |
| 2.5 ≦ Qd < 3.0 | 0.65 |
| 3.0 ≦ Qd < 4.5 | 0.70 |
| 4.5 ≦ Qd < 6.0 | 0.75 |
| 6.0 ≦ Qd < 9.0 | 0.80 |
| 9.0 ≦ Qd < 15.0 | 0.85 |
| 15.0 ≦ Qd | 1.00 |

- Side slope : every excavation depth D

| | |
|---|---|
| D < 1.0 m | 1 : 1 |
| 1.0 ≦ D < 1.5 | 1 : 1.5 |
| 1.5 ≦ D | 1 : 2.0 |

- Width-depth ratio : b/h = 1 to 3

- Strikler's roughness coefficients

h ≧ 1.5 m ; K = 30
h < 1.5 m ; K = 25

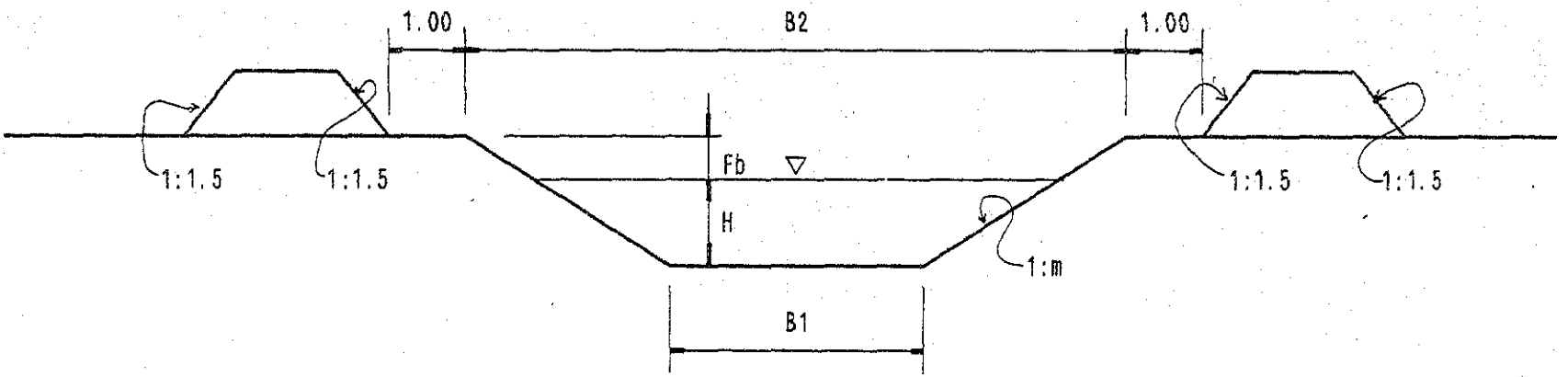
(4) Length of Drainage Canal

| Place | Nos. | Length |
|---|---|---|
| Right bank | 23 | 66.90 Km |
| Left bank | 18 | 32.70 |

Table V-54 List of drainage Canal

| Left Bank | | | | | | Right Bank | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Division | Canal name | Length(km) | Excavation volume($10^3$) | Structure | | Division | Canal name | Length(km) | Excavation volume($10^3$) | Structure | |
| | | | | Bridge | Culuvert | | | | | Bridge | Culuvert |
| Ⅲ | C - 14 | 5.25 | 110.9 | | | Ⅱ | B - 10 | 1.00 | 3.4 | | |
| 〃 | C - 16 | 1.90 | 7.3 | | | 〃 | B - 11 | 0.70 | 1.8 | | |
| 〃 | C - 17 | 1.90 | 14.4 | | | 〃 | B - 9 | 1.10 | 10.1 | | |
| 〃 | C - 18 | 0.90 | 4.9 | | | 〃 | A - 11 | 1.15 | 4.3 | | 1 |
| Ⅴ | C - 1 | 2.60 | 23.9 | | | 〃 | A - 12 | 2.80 | 8.4 | | 1 |
| 〃 | C - 2 | 2.35 | 21.6 | | | Ⅳ | A - 1 | 3.40 | 18.5 | 1 | |
| 〃 | C - 3 | 1.60 | 7.8 | 1 | | 〃 | A - 2 | 8.65 | 131.3 | 2 | |
| 〃 | C - 4 | 0.80 | 3.1 | | | 〃 | A - 3 | 3.70 | 24.6 | 1 | |
| 〃 | C - 5 | 1.40 | 6.8 | | | 〃 | A - 4 | 7.40 | 112.3 | 2 | |
| 〃 | C - 6 | 0.95 | 4.6 | | | 〃 | A - 5 | 5.65 | 85.8 | 2 | |
| 〃 | C - 7 | 1.00 | 5.2 | | | 〃 | A - 6 | 4.30 | 215.0 | 1 | |
| 〃 | C - 8 | 1.10 | 7.2 | | | 〃 | A - 7 | 1.75 | 9.9 | 1 | |
| 〃 | C - 9 | 0.75 | 2.3 | | | 〃 | A - 8 | 0.35 | 0.8 | | |
| 〃 | C - 10 | 2.30 | 21.1 | | | 〃 | A - 9 | 1.50 | 17.1 | 1 | |
| 〃 | C - 11 | 5.60 | 97.8 | 1 | 1 | 〃 | A - 10 | 1.80 | 4.5 | | 1 |
| 〃 | C - 12 | 0.80 | 2.3 | | | 〃 | B - 1 | 3.05 | 28.0 | 1 | |
| 〃 | C - 13 | 0.50 | 1.3 | | | 〃 | B - 2 | 5.10 | 63.1 | 1 | |
| 〃 | C - 15 | 1.30 | 3.8 | | | 〃 | B - 3 | 1.10 | 3.3 | | |
| Sub Total | | | | | | 〃 | B - 4 | 2.40 | 16.9 | | |
| Ⅲ | | 9.95 | 137.5 | - | - | 〃 | B - 5 | 2.20 | 9.5 | | 1 |
| Ⅴ | | 22.75 | 208.8 | 2 | 1 | 〃 | B - 6 | 2.75 | 19.8 | 1 | 1 |
| | | | | | | 〃 | B - 7 | 2.20 | 12.4 | 1 | 1 |
| | | | | | | 〃 | B - 8 | 2.85 | 27.4 | | 3 |
| | | | | | | Sub Total | | | | | |
| | | | | | | Ⅱ | | 6.75 | 28.0 | | 2 |
| | | | | | | Ⅳ | | 60.15 | 800.2 | 15 | 7 |
| Grand Total | | 32.70 | 346.3 | 2 | 1 | Grand Total | | 66.90 | 828.2 | 15 | 9 |

Fig. V-22 STANDARD SECTION OF DRAINAGE CANAL




DEMENSION OF DRAINAGE CANAL

| Type | Q (m3/s) | B1 (m) | B2 (m) | H (m) | Fb (m) | m 1.0 |
|---|---|---|---|---|---|---|
| D1 | 0.5 | 1.00 | 4.00 | 1.00 | 0.50 | 1.5 |
| D2 | 1.0 | 1.00 | 5.50 | 1.00 | 0.50 | 1.5 |
| D3 | 2.0 | 1.00 | 5.80 | 1.00 | 0.60 | 1.5 |
| D4 | 3.0 | 1.20 | 6.60 | 1.20 | 0.60 | 2.0 |
| D5 | 4.0 | 2.00 | 11.00 | 1.50 | 0.75 | 2.0 |
| D6 | 5.0 | 2.00 | 11.20 | 1.50 | 0.80 | 2.0 |
| D7 | 10.0 | 4.00 | 13.20 | 1.50 | 0.80 | 2.0 |
| D8 | 21.0 | 15.00 | 25.00 | 1.50 | 1.00 | 2.0 |

## 4.5 Related Structures of Main & Secondary System

As for the related structures, the following facilities are required.

a. Intake structure
b. Diversion structures
c. Turnouts
d. Check gates
e. Parshall flume and other measuring devices
f. Syphon and aqueduct if necessary
g. Culvert
h. Waste way
i. Drops
j. Drainage culverts
k. Bridges
l. Inspection roads
m. Access roads
n. Others if necessary

Number of structures are summarized in Table V-55.

The scale of syphon is estimated as below.

| No. | Place | Canal Name | Design Discharge | Length | Section |
|---|---|---|---|---|---|
| No.1 | Right Side | L.C. | 6.45$m^3/s$ | 100 m | 2.4 x 2.4 m |
| No.2 | Rengas River | R.M.C. | 2.83 | 300 | 1.6 x 1.6 |
| No.3 | Selagan River | L.M.C. | 4.42 | 460 | 1.9 x 1.9 |
| No.4 | Betong River | L.M.C. | 4.42 | 320 | 1.9 x 1.9 |
| No.5 | Hitam River | S.C. | 0.98 | 500 | 1.2 x 1.0 |

Table V-55 STRUCTURE LIST

| CANAL NAME | DIVI-SION | LENGTH [km] | DIVER-SION [nos] | TURN OUT [nos] | CHECK GATE [nos] | STOP-LOG [nos] | SPILL WAY [nos] | SIPHON L(m) | SIPHON [nos] | DRAINAGE CULVERT [nos] | BRIDGE [nos] | DROPP [nos] | TERTIARY NETWORKS [HA] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LINK CANAL | I | 4.577 | 1 | 3 | 1 | | 1 | 100 | 1 | 6 | 3 | | 69 |
| ToTAL | | 4.577 | 1 | 3 | 1 | 0 | 1 | 100 | 1 | 6 | 3 | | 69 |
| RIGHT BANK M.C | II | 10.510 | 1 | 12 | 4 | | 1 | 300 | 1 | 12 | 7 | | 265 |
| S.S PONDOK | II | 3.190 | | 8 | 3 | | 1 | | | 3 | 2 | 7 | 273 |
| S.S HITAM | II | 4.204 | 1 | 6 | 1 | 2 | 1 | 500 | 1 | 3 | 3 | | 181 |
| TRANSFER-1 | II | 4.699 | 1 | 9 | 1 | | 1 | | | 3 | 3 | | 575 |
| TRANSFER-2 | II | 0.375 | | 1 | | | | | | 1 | | | 183 |
| ToTAL | | 22.978 | 3 | 36 | 9 | 2 | 4 | 800 | 2 | 22 | 15 | 7 | 1,477 |
| LEFT BANK M.C | III | 12.058 | 2 | 19 | 5 | | 2 | 780 | 2 | 9 | 8 | | 213 |
| S.S BL9KA | III | 4.232 | 1 | 8 | 3 | | 1 | | | 2 | 3 | 8 | 470 |
| S.S BK2KA | III | 1.333 | | 2 | | | | | | 1 | 1 | | 139 |
| ToTAL | | 17.623 | 3 | 29 | 8 | 0 | 3 | 780 | 2 | 12 | 12 | 8 | 822 |
| S.S PONDOK | IV | 5.611 | | 7 | 3 | | 1 | | | 4 | 4 | | 245 |
| ToTAL | | 5.611 | 0 | 7 | 3 | 0 | 1 | | | 4 | 4 | | 245 |
| LEFT BANK M.C | V | 1.895 | | 5 | 1 | | 1 | | | 1 | 1 | | 108 |
| S.S BL14KA | V | 4.000 | | 8 | 2 | | 1 | | | 1 | 3 | 1 | 443 |
| S.S MUKOMUKO | V | 10.724 | 1 | 9 | 6 | | 3 | | | 1 | 7 | 5 | 820 |
| S.S TANAH.R | V | 1.430 | | 3 | | | | | | | 1 | | 216 |
| ToTAL | | 18.049 | 1 | 25 | 9 | 0 | 5 | | | 3 | 12 | 6 | 1,587 |
| GRAND TOTAL | | 68.838 | 8 | 100 | 30 | 2 | 14 | 1,680 | 5 | 47 | 46 | 21 | 4,200 |

## 4.6 Tertiary Canal and On-Farm Facilities

### (1) Command Area

As the general criteria for tertiary unit development, the following standards will be accepted being based on Design Criteria, Tertiary Units, KP-05.

| | | |
|---|---|---|
| Size of tertiary unit | : | 50 - 150 ha |
| Size of quaternary unit | : | 8 - 15 ha |
| Length of tertiary canal | : | < 1500 m |
| Length of quaternary canal | : | < 500 m |
| Distance between quaternary canal and drainage canal | : | < 300 m |

### (2) Design criteria for unlined irrigation canals

The following criteria will be applied for unlined irrigation canals. (from design standards, KP-05)

| Design Characteristics | Unit | Tertiary Canal | Quaternary Canal |
|---|---|---|---|
| Max. velocity | m/s | following design graphs | |
| Min. velocity | m/s | 0.20 | 0.20 |
| K. Values | - | 35 | 30 |
| Min. bottom width | m | 0.30 | 0.30 |
| Side slopes | - | 1 : 1 | 1 : 1 |
| Min. embankment width | m | 0.50 | 0.40 |
| Min. free board | m | 0.30 | 0.20 |

Note - The bottom width will be equal to the water depth (b/h = 1).

### (3) Required Water Surface

The Required Water Head (P) for the canal water supplying from secondary canal to paddy field is mainly influenced by the concerned tertiary canal length.

The required paddy field elevation (maximum field elevation in each block) to be planned is obtained from the calculation, that is, the check water surface of secondary canal minus(-) the required water head consisting of the following factors.

| | |
|---|---|
| Ponding depth on ground surface | : a = 0.10 m |
| Conveyance loss on quarterly canal | : b = 0.05 |
| Diversion loss on quarterly canal | : c = 0.05 |
| Conveyance loss on tertiary canal | : d = L x 0.0004 |
| Diversion loss on tertiary canal | : e = 0.10 |
| Siphon loss | : f = 0.05 |
| Diversion loss on secondary canal | : g = 0.15 |
| Other loss | : h = 0.05 |
| Total | : P = 0.55 + d |

| Tertiary Canal Length (m) | 100 | 200 | 300 | 400 | 500 | 750 | 1,000 |
|---|---|---|---|---|---|---|---|
| Required Water Head (P) (m) | 0.59 | 0.63 | 0.67 | 0.71 | 0.75 | 0.85 | 0.95 |

(4) Scale of Facilities

| Facility | Unit | Left Bank | Right Bank | Total |
|---|---|---|---|---|
| Irrigation Area | ha | 2,400 | 1,800 | 4,200 |
| Tertiary Irrigation Canal | Km | 40 | 30 | 70 |
| Tertiary Drainage Canal | " | 39 | 29 | 68 |
| Quarterly Irrigation Canal | " | 120 | 90 | 210 |
| Quarterly Drainage Canal | " | 24 | 18 | 42 |
| Farm Road | " | 48 | 36 | 84 |

(5) Development Plan of Tertiary System

| | 1995/96 | 1996/97 | 1997/98 | Total |
|---|---|---|---|---|
| Transmigration | 1,163 ha | 1,801 ha | 186 ha | 3,150 ha |
| Local people | 416 | 366 | 268 | 1,050 |
| Total | 1,579 | 2,167 | 454 | 4,200 |

| Construction Division | I | II | III | IV | V | Total |
|---|---|---|---|---|---|---|
| Tertiary System (ha) | 69 | 1,477 | 1,038 | 245 | 1,371 | 4,200 |

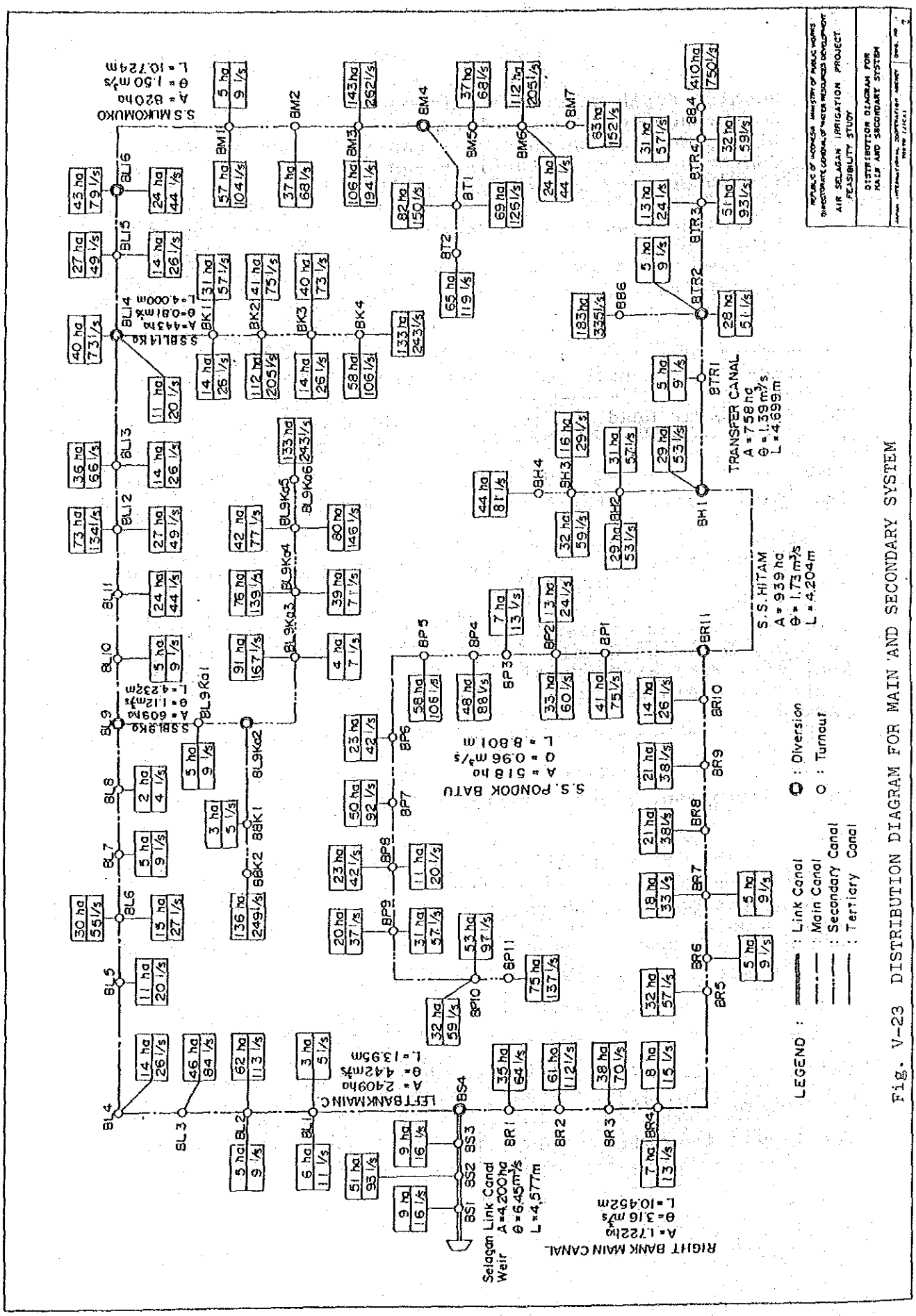



Fig. V-23 DISTRIBUTION DIAGRAM FOR MAIN AND SECONDARY SYSTEM

# CHAPTER 5 OTHER WORKS

## 5.1 Study of Small-scale Hydro-power Generation

### 5.1.1 Outline

Small-scale hydro-power generation is to utilize the energy of elevation head which a weir holds in it being a structure of water resources.

In this study, economic valuation is taken place by rough estimation of generated output, generated energy, construction cost etc, based on the design scale of weir in this project.

### 5.1.2 Rough estimation of generated output

a) Rough determination of headwater and tailwater level.

In case of weir, overflow depth in upstream and depth of river in downstream are changed by amount of discharge in the river. However, the changes of water level in up & down streams are treated to be the similar changes.

- o Headwater level is the elevation of crest
  EL 26.00 = WL 26.00
- o Tailwater level is the elevation of river bed
  EL 22.20 = WL 22.20

b) Rough estimation of effective head

Effective head is the one which is subtracted total loss head from total head. In this study about 8% of total head is considered as rough loss head.

- Total head Ho = WL26.00 - WL22.20 = 3.30m
- Effective head H = 3.80 - (3.80 x 0.08) ≒ 3.50m

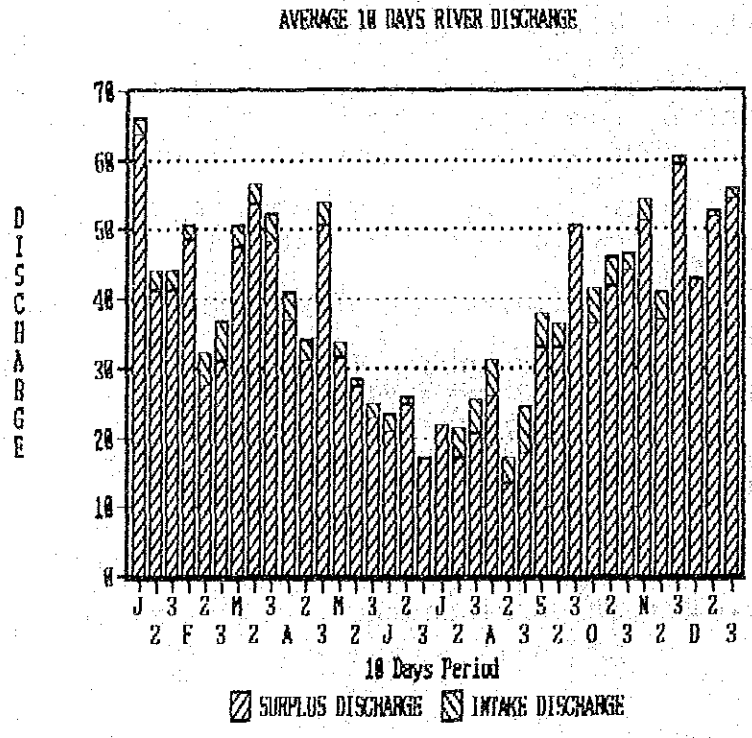
c) Rough estimation of effective discharge

Maximum discharge is given by the minimum 10 days discharge, 17.33 $m^3/s$ (second 10 days in August) based on each 10 days discharge of river (average discharge from 1981 to 1988) and irrigation requirement, 3.93 $m^3/s$ at the spot of weir.

- o Maximum discharge Q = 17.33 - 3.93 = 13.40 $m^3/s$
- o Effective discharge Q = Qmax x 0.80 = 10.72 $m^3/s$

Table V-56 AVERAGE 10 DAYS RIVER DISCHARGE(SELAGAN RIVER)

| Period | 10 Days River Discharge | Intake Discharge | Surplus Discharge | Remarks | Period | 10 Days River Discharge | Intake Discharge | Surplus Discharge | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | m3/s | m3/s | m3/s | | | m3/s | m3/s | m3/s | |
| Jan.1 | 66.24 | 2.33 | 63.91 | | Jul.1 | 21.86 | 0.02 | 21.84 | |
| 2 | 43.99 | 2.75 | 41.24 | | 2 | 21.67 | 4.51 | 17.16 | |
| 3 | 44.35 | 2.96 | 41.39 | | 3 | 25.64 | 4.93 | 20.71 | |
| Feb.1 | 50.70 | 2.04 | 48.66 | | Aug.1 | 31.34 | 5.19 | 26.15 | |
| 2 | 32.22 | 4.64 | 27.58 | | 2 | 17.33 | 3.93 | 13.40 | Min.dis. |
| 3 | 36.78 | 5.73 | 31.05 | | 3 | 24.15 | 6.45 | 17.70 | |
| Mar.1 | 50.70 | 3.09 | 47.61 | | Sep.1 | 38.14 | 4.98 | 33.16 | |
| 2 | 56.49 | 2.75 | 53.74 | | 2 | 36.48 | 3.46 | 33.02 | |
| 3 | 52.11 | 3.84 | 48.27 | | 3 | 50.71 | 0.02 | 50.69 | |
| Apr.1 | 40.76 | 3.93 | 36.83 | | Oct.1 | 41.50 | 5.14 | 36.36 | |
| 2 | 34.10 | 2.96 | 31.14 | | 2 | 46.04 | 4.18 | 41.86 | |
| 3 | 53.95 | 3.34 | 50.61 | | 3 | 46.59 | 2.41 | 44.18 | |
| May 1 | 33.72 | 2.29 | 31.43 | | Nov.1 | 54.42 | 3.09 | 51.33 | |
| 2 | 28.47 | 1.11 | 27.36 | | 2 | 40.76 | 3.76 | 37.00 | |
| 3 | 24.89 | 1.99 | 22.90 | | 3 | 60.65 | 1.15 | 59.50 | |
| Jun.1 | 23.21 | 2.20 | 21.01 | | Dec.1 | 43.15 | 0.36 | 42.79 | |
| 2 | 25.83 | 1.11 | 24.72 | | 2 | 52.87 | 0.86 | 52.01 | |
| 3 | 17.15 | 0.02 | 17.13 | | 3 | 55.78 | 1.28 | 54.50 | |



5.1.3 Rough estimation of generated energy

a) Calculation of generated output

When effective head H (m) and discharge Q ($m^3/s$) are given generated output (KM) can be calculated by the following formula.

P = 9.8 x Q x H x n (KW)
Here n: Total efficiency (supposed to be 80%)
H: Effective head = 3.50 m
Q: Discharge = 10.72 $m^3/s$

o Maximum generated output (P)

P = 9.8 x 10.72 x 3.50 x 0.80
= 294 KW ≒ 290 KW

b) Generated energy

o Annual possible power generation ( P)

P = 290 KW x 365 days x 24 hr/day
= 2,540,400 KWh

c) Estimation of family numbers for electric supply

o Annual consumption of electricity per family

W = 100 W/h x 24 h x 365 days = 876 KWh/year
(electric supply per one family is supposed to be 100 W/h)

o Family numbers of electric supply in relation with electric supply ratio ( )

Family numbers of electric supply =
Annual possible power generation/Electric supply ratio/Annual consumption of electricity

The objective ratio of PLN in Bengkulu province in 1989 is = 32.26%.

* Family numbers = 2,540,400/0.3226/876 ≒ 8,980 Nos.

5.1.4 Economic Evaluation

In this study, comparative study is taken between hydro-power and diesel generations, and the economic valuation is done for unit construction cost per generated energy (Kwh) which is calculated by construction unit cost method.

There are still some more valuation factors beside the economic such as the necessity of electricity, and extension

effect etc.

Comparative conditions are given as follows:

* Capacity of maximum generated output of diesel generation is the same with the case of small-scale hydro-power generation. P = 290 KW ; 290/0.80 = 362 KVA

* Annual possible generated energy
  P = 290 Kw x 24 hr x 365 days = 2,540,400 Kwh

* Fuel expense of the diesel is calculated in 20 years which are the standard durable period of water turbine and generator.

* Fuel expense of diesel generation in 20 years.
  (The plan of small-scale hydro-power generation):
  125 KVA x 3 Nos = 375 KVA > 362 KVA
  lit. per year = (40 1/h x 8760 hr/y x 3 Nos)
  = 1,051,200 lit.
  lit. per 20 years = 1,051,200 lit. x 20 = 21,024,000 lit.

* Exchange rate
  US$ 1.0 = ¥153 = Rp.1,845 Yen = 12.06 Rp.

* Rough construction cost (See the following table)

Table V-57 COMPARISON OF APPROXIMATE CONSTRUCTION COST FOR HYDRO-POWER GENERATION

| Item | Comparative Plan | | Small-scale Hydro-power Generation | | | Diesel Generation Plan | |
|---|---|---|---|---|---|---|---|
| Maximum generated output | | | 290 Kw | | | 290 Kw | |
| Annual possible generated | | | 2,540,400 Kwh | | | 2,540,400 Kwh | |
| Numbers of generator | | | 362 KVA x 1 No. | | | 125 KVA x 3 Nos. | |
| Fuel (lit./20 years) | | | - | | | 21,024,000 Lit. | |
| Approximate construction cost | Numbers | Unit | Cost | Numbers | Unit | Cost | |
| (1) Electric equipment | | Rp.10x6 | Rp.10x6 | | Rp.10x6 | Rp.10x6 | |
| Water turbine | 1 | set | 1,150 | - | - | - | |
| Generator | 1 | " | 580 | 3 | 133 | 400 | |
| Accessory | 1 | " | 1,810 | 1 | set | 1,360 | |
| Transmission line | 50 km | 18.2 | 910 | 50 km | 18.2 | 910 | |
| Distribution line | 300 km | 1.8 | 540 | 300 km | 1.8 | 540 | |
| Installation cost | 1 | set | 720 | 1 | set | 240 | |
| Transportation cost etc. | 1 | " | 670 | 1 | " | 380 | |
| Sub-total: | | | 6,380 | | | 3,830 | |
| (2) Civil works | | | | | | | |
| Power station (Civil) | 1 | set | 430 | 1 | set | 20 | |
| " (Building) | 15.0x12.5 | 1.2 | 220 | 12.5x12.5 | 1.2 | 190 | |
| Pipeline etc. | 30.0m | 6 | 180 | - | - | - | |
| Sub-total: | | | 830 | | | 210 | |
| (3) Total: | | | 7,210 | | | 4,040 | |

Table V-58 ECONOMIC COMPARISON FOR HYDRO-POWER & DIESEL ELECTRIC POWER

| | Small-scale Hydro-power Generation Plan | | Diesel Generation Plan | |
|---|---|---|---|---|
| (1) Annual possible generated energy | 2,540,400 KWH | | 2,540,400 KWH | |
| | (Unit: Million Rp.) | | | |
| (2) Approximate construction cost | 7,210 | | 4,040 | |
| (3) Fuel cost for 20 years | - | | 5,046 | |
| (4) Total (2) + (3) | 7,210 | | 9,086 | |
| (5) Construction cost per KWH | 10x6 Yen | 10x6 Rp. | 10x6 Yen | 10x6 Rp. |
| Initial (2)/(1) | ¥235 | Rp.2,838 | ¥132 | Rp.1,590 |
| Running (4)/(1) | ¥235 | Rp.2,838 | ¥297 | Rp.3,577 |
| Ratio | 1.00 | | 1.26 | |

o Unit cost of fuel 240 Rp/lit. = 19.9 Yen/lit.

As seen above, the initial cost of diesel generation is lower than that of small-scale hydro-power generation, but the former is about 26% higher in running cost compared with the later. Therefore, the small-scale hydro-power generation is more economic.

# APPENDIX VI

# IMPLEMENTATION SCHEDULE AND COST ESTIMATE

# CHAPTER 1 IMPLEMENTATION SCHEDULE

## 1.1 General

The plan of construction period is five (5) years from 1992 to 1997. Two (2) years from 1991 are necessary period for survey and detailed design concerning weir, irrigation and drainage facilities and tertiary system.

The construction stage is divided into five (5) work divisions consisting of weir, link canal, main and secondary irrigation canals, drainage canals, tertiary system, etc. In the above works, the construction of drainage canals proposed in the plantation area shall be completed at the earliest possible date, taking into consideration that plantation will be commenced after the completion of the construction works.

The construction period including preparatory works is five (5) years from 1992 to 1997 overlapping with the period of the detailed design period.

The main works in each division are shown in Table VI-1.

Table VI-1 WORK DIVISION & QUANTITY (1/3)

| Work Division | Main Works | | Construction Work |
|---|---|---|---|
| WD-I | Selagan Diversion Weir | (H=3.8m, W=74m) | 1993 - 1996 |
| | Link Canal | (L=4.58km) | |
| | Tertiary Development | (69ha) | |
| | Canal Related Facilities | | |
| | Diversion structure | : 1 nos. | |
| | Turnout | : 3 nos. | |
| | Siphon | : 1 nos. | |
| | Check gate | : 1 nos. | |
| | Spillway | : 1 nos. | |
| | Bridge | : 1 nos. | |
| | Drainage culvert | : 6 nos. | |
| WD-II | Right Bank Main Canal | (10.51km) | 1993 - 1997 |
| | Secondary Canals | (12.47km) | |
| | Tertiary Development | (1,477ha) | |
| | Drainage Canal | ( 6.75km) | |
| | Canal Related Facilities | | |
| | Diversion structure | : 3 nos. | |
| | Turnout | : 35 nos. | |
| | Siphon | : 2 nos. | |
| | Check gate | : 9 nos. | |
| | Spillway | : 4 nos. | |
| | Stop log | : 2 nos. | |
| | Drop | : 7 nos. | |
| | Bridge | : 16 nos. | |
| | Drainage culvert | : 22 nos. | |

Table VI-1 WORK DIVISION & QUANTITY (2/3)

| Work Division | Main Works | | Construction Work |
|---|---|---|---|
| WD-III | Left Bank Main Canal | (12.06km) | 1994 - 1997 |
| | Secondary Canals | ( 5.57km) | |
| | Tertiary Development | (1,038ha) | |
| | Drainage Canal | ( 9.95km) | |
| | Canal Related Facilities | | |
| | Diversion structure | : 3 nos. | |
| | Turnout | : 29 nos. | |
| | Siphon | : 2 nos. | |
| | Check gate | : 8 nos. | |
| | Spillway | : 3 nos. | |
| | Drop | : 8 nos. | |
| | Bridge | : 12 nos. | |
| | Drainage culvert | : 12 nos. | |
| WD-IV | Secondary Canals | ( 5.61km) | 1994 - 1997 |
| | Tertiary Development | ( 245ha) | |
| | Drainage Canal | (31.60km) | |
| | Drainage Canals for Plantation | (28.6km) | |
| | Canal Related Facilities | | |
| | Turnout | : 7 nos. | |
| | Check gate | : 8 nos. | |
| | Spillway | : 1 nos. | |
| | Bridge | : 20 nos. | |
| | Drainage culvert | : 4 nos. | |

Table VI-1 WORK DIVISION & QUANTITY (3/3)

| Work Division | Main Works | | Construction Work |
|---|---|---|---|
| | Left Bank Main Canal | ( 1.90km) | |
| | Secondary Canals | (16.15km) | 1994 - 1997 |
| | Tertiary Development | (1,371ha) | |
| | Drainage Canal | (22.75km) | |
| WD-V | Canal Related Facilities | | |
| | Diversion structure | : 2 nos. | |
| | Turnout | : 24 nos. | |
| | Check gate | : 9 nos. | |
| | Spillway | : 5 nos. | |
| | Drop | : 6 nos. | |
| | Bridge | : 12 nos. | |
| | Drainage culvert | : 3 nos. | |

Fig.VI-1 CONSTRUCTION DIVISION

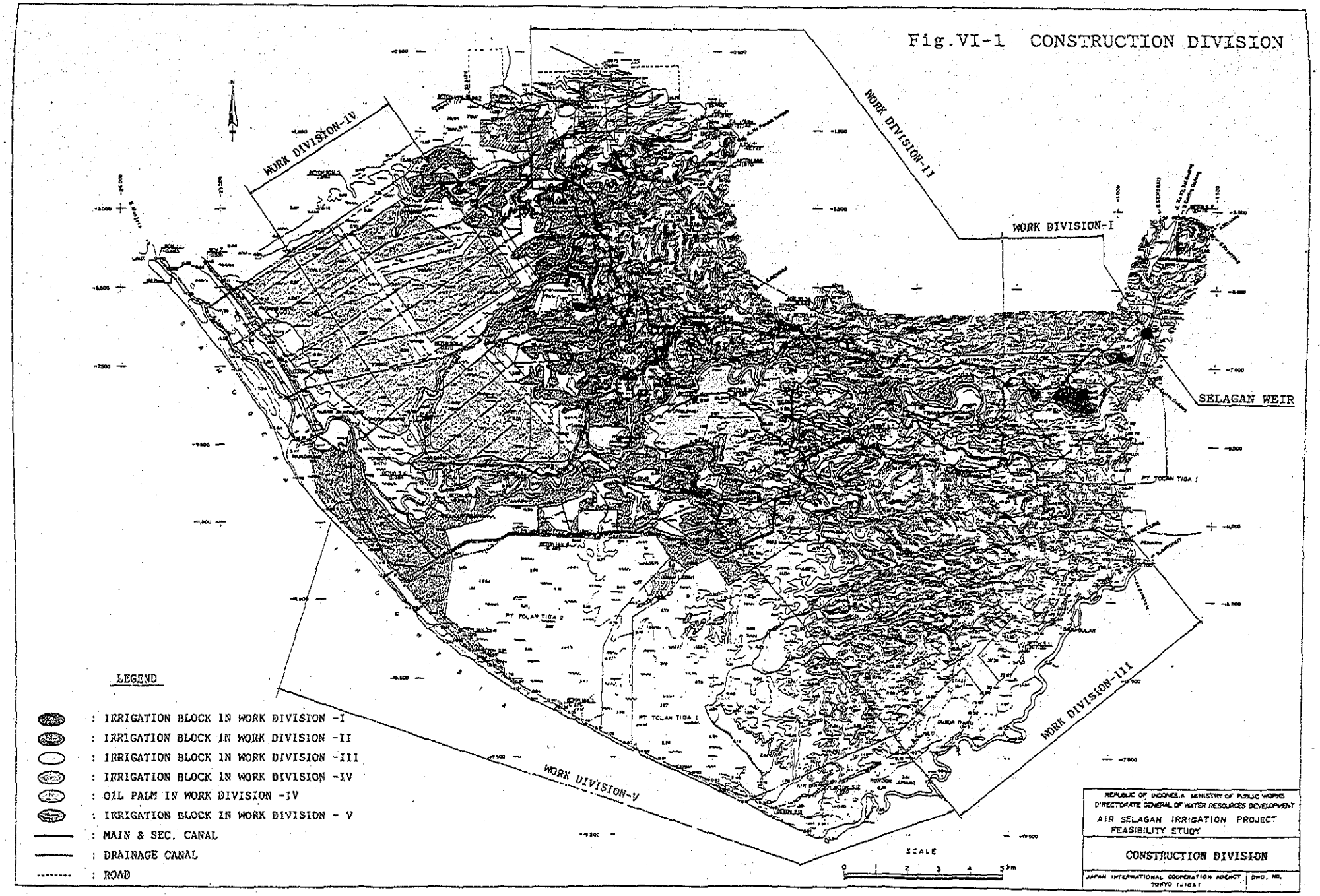


Fig. VI-2 PROJECT IMPLEMENTATION SCHEDULE

| W O R K | ITEM(Quantity) | 1991/92 | 1992/93 | 1993/94 | 1994/95 | 1995/96 | 1996/97 | 1997/98 |
|---|---|---|---|---|---|---|---|---|
| | | AMJJASONDJFMAMJJASONDJFMAMJJASONDJFMAMJJASONDJFMAMJJASONDJFMAMJJASONDJFMAMJJASONDJFM | | | | | | |
| Ⅰ. LOAN AGREEMENT | | GA △ LA △ | | | | | | |
| I-1 Loan Agreement | | | | | | | | |
| I-2 Selection of Consultant | | | | | | | | |
| I-3 Detailed Design | | | | | | | | |
| I-4 Aero-photo Survey(14,800 ha) | | | | | | | | |
| I-5 Construction Supervision | | | | | | | | |
| Ⅱ. PREPARATORY WORK | | | | | | | | |
| II-1 Tendering | | | | | | | | |
| II-2 Office and quarters | | | | | | | | |
| II-3 Land Aquisition | | | | | | | | |
| II-4 Access Road | | | | | | | | |
| Ⅲ. IRRIGATION & DRAINAGE CONSTRUCTION | | | | | | | | |
| Ⅲ-1 Work Division -I (Right Bank) | 1. Head work (H=3.8m, W=74m)<br>2. Link canal (4.58km)<br>3. Tertiary canal (69 ha) | | | | | | | |
| Ⅲ-2 Work Division -Ⅱ (Right Bank) | 1. Right main canal (10.51km)<br>2. Secondary canal (12.47km)<br>3. Tertiary canal (1,477ha)<br>4. Drainage canal (6.75km) | | | | | | | |
| Ⅲ-3 Work Division -Ⅲ (Left Bank) | 1. Left main canal (12.06km)<br>2. Secondary canal (5.57km)<br>3. Tertiary canal (1,038ha)<br>4. Drainage canal (9.95km) | | | | | | | |
| Ⅲ-4 Work Division -Ⅳ (Right Bank) | 1. Secondary canal (5.61km)<br>2. Tertiary canal (245ha)<br>3. Drainage canal (60.15km) | | | | | | | |
| Ⅲ-5 Work Division -Ⅴ (Left Bank) | 1. Left main canal (1.90km)<br>2. Secondary canal (16.15km)<br>3. Tertiary canal (1,371ha)<br>4. Drainage canal (22.75km) | | | | | | | |
| Ⅳ. SMALL-SCALE HYDRO-POWER STATION | | | | | | | | |
| Ⅳ-1 Civil Works | | | | | | | | |
| Ⅳ-2 Electric Equipment | 290 kw | | | | | | | |

1.2 Basic Assumption

a) Conversion Rate of Earth Volume

Earth volumes are changeable according to the natural conditions as they are. Naturally placed earth materials would increase the volume after excavation and decrease after compaction.

These changes of volume should be considered for estimation of produced volumes by construction machinery or earth moving plan. The conversion rates of earth volumes are assumed as follows:

| Abbreviation | Class of earth | Apparent Unit Weight | Conversion Rate | | |
|---|---|---|---|---|---|
| | | | In Place | In Loose | In Compaction |
| S | Sand | 1.7 | 1.00 | 1.20 | 0.95 |
| N/S | Normal Soil | 1.6 | 1.00 | 1.25 | 0.90 |
| C/S | Clayer Soil | 1.8 | 1.00 | 1.35 | 0.90 |
| G & W/R | Gravel & Weathered Rock | 1.9 | 1.00 | 1.20 | 1.00 |
| R | Excavated Rock | 2.5 | 1.00 | 1.50 | 1.20 |

b) Workable Days

Earth works are mostly affected by rainfall. Since embankment of impervious materials are controlled by moisture density. Special attention must be paid to execute the construction works for rain days.

Suspension days of these earth works caused by rainfall are assumed as following criteria according to the daily rainfall intensity.

| Daily Rainfall Intensity (mm/day) | Suspension of Work (day) |
|---|---|
| 0 - 10 | 0 |
| 10 - 30 | 1 |
| 30 - 50 | 2 |
| 50 - 100 | 3 |
| more than 100 | 4 |

Annual mean workable days were estimated on the basis of the above criteria and the rainfall records in PONDOK KOPI observatory, the nearest station to the project, for recent 7 years.

| Year | Jan. | Feb. | Mar. | Apr. | May | June. | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1982 | 22 | 12 | 21 | NA | 24 | 22 | 24 | 23 | 19 | 22 | 20 | 18 |
| 1983 | 20 | 13 | 18 | 17 | 18 | 19 | 17 | 19 | 19 | 12 | 10 | 18 |
| 1984 | 17 | 24 | 14 | 18 | 16 | 26 | 24 | 29 | 19 | 29 | 13 | 15 |
| 1985 | 21 | 19 | 17 | 22 | 24 | 20 | 23 | 24 | 12 | 22 | NA | 16 |
| 1986 | 19 | 20 | 10 | 21 | 20 | 24 | 21 | 23 | 18 | 10 | 22 | 13 |
| 1987 | 12 | 18 | 13 | 9 | 25 | 23 | 20 | 21 | 19 | 15 | 19 | 18 |
| 1988 | 12 | 16 | 15 | 15 | 22 | 26 | 20 | 18 | 11 | 17 | 8 | 20 |
| Total | 123 | 122 | 108 | 102 | 149 | 160 | 149 | 157 | 117 | 127 | 92 | 118 |
| Mean | 17.6 | 17.4 | 15.4 | 17.0 | 21.3 | 22.9 | 21.3 | 22.4 | 16.7 | 18.1 | 15.3 | 16.9 |

Note:

Mean of Wet Season: Jan - Apr, Oct - Dec $\frac{17.6+17.4+15.4+17.0+18.1+15.3+16.9}{7} = 16.8 = 17$

Mean of Dry Season: May - Sep $\frac{21.3+22.9+21.3+22.4+16.7}{5} = 20.9 = 21$

Therefore, workable days for impervious materials are decided to be 17 days in the Wet season and 21 days in the Dry season, and total 224 days in a year.

c) Construction materials

The explanation of construction materials are shown in Appendix II, Geology and Soil Mechanics.

The technical points in addition to them are shown as follows.

i) Concrete materials

- Cement : Padan or Bengkulu
- Iron bar : - ditto -
- Aggregate : The river side area of Air Selagan or Air Manjuto
- Big stone : - ditto -

Note:
The river side areas of Air Selagan and Air Manjuto produce enough quality and volume of aggregate and big stones.

ii) Embankment materials

- Impervious materials:
  The embankment materials for the sub-dike of the Selagan Weir is planned to be collected from the hillside in the right bank side of the Selagan river. This material can be utilized for the embankment of the upstream of the Link Canal.

- Semi-pervious materials:

  The semi-pervious material will be used for the embankment of both the main and secondary canals. The material can be taken from a lot of terrace which exist in the project site.

## 1.3 Implementation Schedule

### 1.3.1 Preparatory Works

The time required for the preparatory works such as survey and investigation, construction of access road and project office and quarters, and land acquisition is estimated to be 4 years as shown in Fig. VI-2.

The survey and investigation work will be completed before start of the detailed design.

The construction of access road including to widen the existing roads, project office and quarters will be completed prior to the major construction work.

The construction of new bridge crossing Selagan river at Lubuk Sahung shall be completed by BINA MARGA before commencement of the construction of the diversion weir.

The land acquisition for the construction of project facilities will be completed one year ahead of the construction work.

### 1.3.2 Diversion Weir

The construction of the diversion weir would be executed using temporary diversion channel taking the river condition into account.

The construction of the diversion weir can be divided into 3 works.

The first work : Excavating temporary diversion channel.

The second work : Construction of weir and intake (Earth works and concrete works).

The third work : Embankment works and Relative works.

- The first work

The construction of detour road of about 700m in length and of 5.0m in width, shifting the existing road would be carried out.

The construction of temporary diversion channel will be excavated by bulldozer and backhoe together with dump tracks. The length of the channel is estimated at about 800m and the capacity of the channel shall be more than 840$m^3$/s which is 25 year probable flood discharge at the proposed weir site.

The excavated soil will be disposed to a spoil area and be partly deposited and used for backfilling of the channel after completion of the weir.

- The second work

The construction of the weir including flood way, under sluice and intake is desired to execute in dry condition. Therefore, proper temporary pumping system will be required.

The excavation of weir will be carried out by backhoe together with wheel loader and dump tracks. The excavated material will be deposited and be partly used for backfilling of weir.

The concrete works of about 15,700 $m^3$ will be executed

using concrete plant erected at the proposed weir site.

After completion of weir, the temporary diversion channel will be partly backfilled for sub-dike and intake with sand trap and the river direction will be changed to the constructed weir.

- The third work

The construction of sub-dike embankment, then, will be carried out by bulldozer together with vibrating roller using the impervious material taken from a borrow pit.

At the time of the completion of the embankment, the relative works such as installation of gates, sodding, gravel metalling on the detour road etc. will be completed.

### 1.3.3 Main & Secondary System

The construction of the Main & Secondary System consists of main canals, secondary canals, drainage canals and their related structures.

The construction of main and secondary canals will be carried out from upside to downside.

The drainage canals which located mostly in the downside of the project area will be constructed at earlier stage. Especially, the construction of drainage canals concerning the plantation area will be executed at the earliest possible date.

The construction of the access road will be carried out at earlier stage so as to be convenience for the construction of the main and secondary system and tertiary system.

### 1.3.4 Tertiary System

The construction of tertiary systems will be commenced from April 1995 and be completed by the end of March 1997.

According to the progress of the Work Division I to V, tertiary development follows in order.

Paddy cultivation is expected to commence from July 1996 and to increase year by year.

### 1.3.5 Proposed Tentative Resettlement Schedule

One or two years before the construction of tertiary system, the resettlement in the project area should be carried out by the Government under the Ministry of Transmigration including land

clearing and land leveling works.

From the view of both irrigation and transmigration projects a tentative resettlement schedule is proposed taking the construction schedule of tertiary development into consideration as shown in Table VI-2.

## 1.4 Construction Machinery

The major civil works of the project would principally be carried out be heavy construction machinery.

The type and number of construction machinery to be required for the major civil works are estimated based on the work quantity, construction time schedule and the natural condition in the project area.

Table VI-2 PROPOSED TENTATIVE RESETTLEMENT SCHEDULE

| Item | Village | Number of Household | 1991/92 | 1992/93 | 1993/94 | 1994/95 | 1995/96 | 1996/97 | 1997/98 |
|---|---|---|---|---|---|---|---|---|---|
| Tertiary Development | | kk | | | | | ← Right 1,800ha | | → |
| 1. Right Bank | Existing SP-II | 50 | | | | | 75ha | | |
| | 〃 SP-III | 290 | | | | | 435ha | | |
| | 〃 SP-VI | 120 | | | | | | 180ha | |
| | 〃 Local | 300 | | | | | | 450ha | |
| | Planned | 440 | | | | | 660ha | | |
| | | | | | | | | | |
| 2. Left Bank | Existing SP-IV | 250 | | | | | 375ha | | |
| | 〃 Spontanecus | 40 | | | | | 60ha | | |
| | 〃 Local | 400 | | | | | | 600ha | |
| | Planned | 910 | | | | | | 1,365ha | |
| | | | | | | | ← Left 2,400ha | | → |
| Resettlement | | | PREPARATORY 2,110kk(New & Perambah) | | | | | | |
| 1. Right Bank | Planned SP-II | 130 | 130kk | | | | | | |
| | 〃 SP-III | 10 | 10kk | | | | | | |
| | New | 300 | | 150kk | 150kk | | | | |
| | | | | | | | | | |
| 2. Left Bank | Planned SP-IV | 200 | 200kk | | | | | | |
| | New | 710 | | 150kk | 150kk | 200kk | 210kk | | |
| | | | | | | | | | |
| 3. Right Bank | New | 550 | | | | | | 250kk | 300kk |
| ( Plantation ) | Perambah | 550 | | | | | | 300kk | 250kk |
| | | | | | | | | | |
| | | | | | | ← drainage work | | → | |
| | | | | | | | | | |

# CHAPTER 2 COST ESTIMATE

## 2.1 Construction Cost

### 2.1.1 Conditions

The construction cost is estimated based on the following conditions.

(1) The exchange rate used in the estimate is:

US$1 = Rp.1,845
= ¥153

(2) Civil engineering works are to be carried out on the contract basis using contractor's own heavy construction machinery and equipment.

(3) Taxes on the construction materials, machinery and equipment to be imported from abroad are exempted from the estimate of construction cost.

(4) The construction cost comprises foreign and local currency portions. The local currency portion is estimated based on the current prices in Bengkulu Province in September 1989 and the data collected from the on-going projects in the province. The foreign currency portion is estimated based on the CIF prices at Bengkulu referring to the FOB prices of materials, machinery and equipment in Japan in December 1989. The classification of local and foreign currency portions is defined as follows:

Local currency portion

- Labor force,
- sand, gravel and wooden materials,
- raw cost for fuel, oil etc. and cement,
- inland transportation costs,
- contractors' general expenses and profit,
- expenses of engineering services for local consultant, and
- minor works.

Foreign currency portion

- reinforcement bar and other structural steel,
- cement excluding raw cost,
- fuel, oil etc. excluding raw cost,
- steel gates, diesel generators, motor and other metal works,
- depreciation costs for heavy construction machinery and equipment,
- vehicles to be required for the construction supervision and O & M equipment for the project

operation,
- contractors' general expenses and profit, and
- expense and fee of engineering services by foreign consultant.

(5) The physical contingency related to the construction quantities, around 5% of the direct cost, is included in the construction cost in view of the preliminary nature of the estimate. The price contingency; 3.7-4.9% per annum for the foreign currency portion and 9.9% per annum for the local currency portion, is also included in the project cost.

(6) The associated costs to be financed by the Government such as the costs for strengthening the extension services, facilities of the water users' association, and improvement of the social infrastructures are not included in the estimate.

### 2.1.2 Estimate of Construction Cost

The total construction costs of the project are estimated at US$ 37.3 million, which comprise US$ 9.8 million equivalent of local currency and US$ 27.5 million of foreign currency. The summary and breakdown of the cost estimate are shown in Table VI-3 through Table VI-9.

The prices of local materials and labour used in the estimate and the unit rates for major works are as shown in Table VI-10 and VI-11, respectively.

### 2.1.3 Annual Disbursement Schedule

The annual disbursement schedule is worked out based on the construction time schedule. The details are stated in Table VIII-14 in Appendix VIII, Project Evaluation.

Annual Disbursement Schedule

| Year | Foreign Portion ($10^3$US$) | Local Portion ($10^3$US$) | Total ($10^3$US$) |
|---|---|---|---|
| 1991/92 | 337 | 138 | 475 |
| 1992/93 | 1,307 | 394 | 1,701 |
| 1993/94 | 1,673 | 795 | 2,468 |
| 1994/95 | 6,583 | 2,588 | 9,171 |
| 1995/96 | 11,347 | 3,937 | 15,284 |
| 1996/97 | 6,236 | 1,990 | 8,226 |
| Total: | 27,483 | 9,842 | 37,325 |

## 2.2 Annual Operation and Maintenance Costs

The annual operation and maintenance costs include the salaries of project administrative and water control staffs, the materials and labor costs for repair and maintenance of project facilities, the costs for operation, repair and maintenance of O & M equipment, and the running costs of project facilities including diesel generators.

The annual operation and maintenance costs are counted to be Rp.25,500 per ha. for irrigation and drainage system and Rp.8,600 per ha. for plantation.

## 2.3 Replacement Costs

Some of the facilities, especially mechanical and electrical works have shorter useful life than the civil works and are require replacement at a certain time within the project useful life.

The replacement cost and the useful lives of these facilities re listed in Table VI-12.

Table VI-3 SUMMARY OF PROJECT COST

(Unit:Million Rp.)

| Item | Project Cost | | |
|---|---|---|---|
| | Foreign Portion | Local Portion | Total |
| 1. Preparatory Works | 1,451 | 622 | 2,073 |
| 2. Irrigation and Drainage Construction(4,200ha) | 25,879 | 7,909 | 33,788 |
| 2.1 Work Division-I | 4,324 | 1,662 | 5,986 |
| Head Works | 2,754 | 1,219 | 3,973 |
| Main & Sec. System | 1,530 | 431 | 1,961 |
| Tertiary System | 40 | 12 | 52 |
| 2.2 Work Division-II | 7,102 | 2,172 | 9,274 |
| Main & Sec. System | 6,242 | 1,924 | 8,166 |
| Tertiary System | 860 | 248 | 1,108 |
| 2.3 Work Division-III | 6,533 | 1,847 | 8,380 |
| Main & Sec. System | 5,928 | 1,673 | 7,601 |
| Tertiary System | 605 | 174 | 779 |
| 2.4 Work Division-IV | 2,323 | 602 | 2,925 |
| Seccondary System | 2,181 | 561 | 2,742 |
| Tertiary System | 142 | 41 | 183 |
| 2.5 Work Division-V | 5,597 | 1,626 | 7,223 |
| Main & Sec. System | 4,798 | 1,397 | 6,195 |
| Tertiary System | 799 | 229 | 1,028 |
| 3. Small-scale Hydro-power Generation(290KW) | 6,323 | 887 | 7,210 |
| 3.1 Electric Equipment | 5,742 | 638 | 6,380 |
| 3.2 Civil Works | 581 | 249 | 830 |
| 4. O & M Facilities Cost | 735 | 245 | 980 |
| 5. Land Acquisition Cost | - | 237 | 237 |
| 6. Administration Cost | - | 880 | 880 |
| 7. Engineering Services | 4,342 | 482 | 4,824 |
| 7.1 Detailed Design | 1,737 | 193 | 1,930 |
| 7.2 Construction S/V | 2,605 | 289 | 2,894 |
| Sub-total(1 to 7) | 38,730 | 11,262 | 49,992 |
| 8. Physical Contingency | 1,937 | 563 | 2,500 |
| Sub-total(1 to 8) | 40,667 | 11,825 | 52,492 |
| 9. Price Contingency | 10,038 | 6,334 | 16,372 |
| Total | 50,705 | 18,159 | 68,864 |

Table VI-4 BREAKDOWN OF DIRECT CONSTRUCTION COST FOR PREPARATORY EXPENSE

| Works | Unit | Quantity | Unit Price | Cost |
|---|---|---|---|---|
| | | | Rp. | 10x3Rp |
| 1. Project office & quarters | | | | 348,000 |
| 1.1 Main office | m2 | 1,000 | 120,000 | 120,000 |
| 1.2 Repair shop | m2 | 200 | 120,000 | 24,000 |
| 1.3 Store house | m2 | 200 | 120,000 | 24,000 |
| 1.4 Quarters | m2 | 1,500 | 120,000 | 180,000 |
| 2. Widening of existing road | m | 4,600 | 11,000 | 50,600 |
| 3. Access road | m | 7,400 | 50,000 | 370,000 |
| 4. Clearing | ha | 470 | 1,200,000 | 564,000 |
| 5. Survey and investigation | ha | 14,800 | 50,000 | 740,000 |
| Total | | | | 2,072,600 |

Table.VI-5 BREAKDOWN OF DIRECT CONSTRUCTION COST
FOR DIVISION I (Head Works & Link Canal)
unit; 1,000 Rp

| WORK DESCRIPTION | UNIT | Q'TY | FOREIGN PORTION | LOCAL PORTION |
|---|---|---|---|---|
| I IRRIGATION AND DRAINAGE CONSTRUCTION | | | | |
| 1.HEAD WORK | | | | |
| 1.1 EARTH WORKS | | | | |
| 1.1.1 CLEARING | m2 | 99,000 | 7,920 | 1,287 |
| 1.1.2 EXCAVATION | m3 | 129,336 | 212,806 | 35,639 |
| 1.1.3 EARTHFILL | m3 | 14,613 | 62,134 | 12,260 |
| 1.1.4 BACKFILL | m3 | 5,017 | 12,547 | 9,115 |
| 1.2 CONCRETE WORKS | | | | |
| 1.2.1 REINFORCEMENT CONCRETE | m3 | 2,044 | 104,331 | 36,368 |
| 1.2.2 CONCRETE | m3 | 13,614 | 675,308 | 237,618 |
| 1.2.3 REINFORCEMENT WORKS | t | 306 | 342,986 | 7,090 |
| 1.2.4 FORM WORKS | L.S | 1 | 112,096 | 535,902 |
| 1.3 MASONRY WORKS | m3 | 2,126 | 82,794 | 49,301 |
| 1.4 GATE WORKS | t | 33 | 495,000 | 4,950 |
| 1.5 ROAD WORKS | m | 700 | 10,327 | 4,967 |
| 1.6 MISCELLANEOUS & OTHERS | L.S | 1 | 635474 | 284,572 |
| Sub-Total | | | 2,753,723 | 1,219,069 |
| 2.LINK CANAL | | | | |
| 1.1 EARTH WORKS | m | 4,577 | 1,137,641 | 309,333 |
| 1.2 SIPHON WORKS | nos | 1 | 229,663 | 54,802 |
| 1.3 RELATION STRUCTURES | | | | |
| 1.3.1 DIVERSION | nos | 1 | 14,000 | 6,000 |
| 1.3.2 TURNOUT | nos | 3 | 21,000 | 9,000 |
| 1.3.3 CHECK GATE | nos | 1 | 9,000 | 1,000 |
| 1.3.4 STOP LOG | nos | | | |
| 1.3.5 SPILLWAY | nos | 1 | 14,000 | 6,000 |
| 1.3.6 DROP | nos | | | |
| 1.3.7 DRAINAGE CULVERT | nos | 6 | 63,000 | 27,000 |
| 1.3.8 BRIDGE | nos | 3 | 42,000 | 18,000 |
| Sub-Total | | | 1,530,304 | 431,135 |
| 3.TERTIARY NETWORKS | ha | 69 | 40,194 | 11,555 |
| TOTAL | | | 4,324,221 | 1,661,759 |
| GRAND TOTAL [F.C+L.C] | | | | 5,985,980 |

Table.VI-6 BREAKDOWN OF DIRECT CONSTRUCTION COST FOR DIVISION II (Right Bank)

unit; 1,000 Rp

| WORK DESCRIPTION | UNIT | Q'TY | FOREIGN PORTION | LOCAL PORTION |
|---|---|---|---|---|
| I.IRRIGATION AND DRAINAGE CONSTRUCTION | | | | |
| 1.MEIN CANAL | | | | |
| 1.1 EARTH WORKS | m | 10,510 | 2,690,375 | 799,332 |
| 1.2 SIPHON WORKS | nos | 1 | 400,830 | 102,905 |
| 1.3 RELATION STRUCTURES | | | | |
| 1.3.1 DIVERSION | nos | 1 | 14,000 | 6,000 |
| 1.3.2 TURNOUT | nos | 12 | 84,000 | 36,000 |
| 1.3.3 CHECK GATE | nos | 4 | 36,000 | 4,000 |
| 1.3.4 STOP LOG | nos | | | |
| 1.3.5 SPILLWAY | nos | 1 | 14,000 | 6,000 |
| 1.3.6 DROP | nos | | | |
| 1.3.7 DRAINAGE CULVERT | nos | 12 | 126,000 | 54,000 |
| 1.3.8 BRIDGE | nos | 7 | 98,000 | 42,000 |
| Sub-Total | | | 3,463,205 | 1,050,237 |
| 2.SECONDARY CANAL | | | | |
| 2.1 EARTH WORKS | m | 12,470 | 1,930,881 | 587,627 |
| 2.2 SIPHON WORKS | nos | 1 | 422,543 | 121,666 |
| 2.3 RELATION STRUCTURES | | | | |
| 2.3.1 DIVERSION | nos | 2 | 21,000 | 9,000 |
| 2.3.2 TURNOUT | nos | 24 | 126,000 | 54,000 |
| 2.3.3 CHECK GATE | nos | 5 | 22,500 | 2,500 |
| 2.3.4 STOP LOG | nos | 2 | 2,000 | 1,000 |
| 2.3.5 SPILLWAY | nos | 3 | 31,500 | 13,500 |
| 2.3.6 DROP | nos | 7 | 24,500 | 10,500 |
| 2.3.7 DRAINAGE CULVERT | nos | 10 | 70,000 | 30,000 |
| 2.3.8 BRIDGE | nos | 8 | 67,200 | 28,800 |
| Sub-Total | | | 2,718,124 | 858,593 |
| 3.DRAINAGE CANAL | m | 6,750 | 60,340 | 15,524 |
| 4.TERTIARY NETWORKS | ha | 1,477 | 860,389 | 247,360 |
| TOTAL | | | 7,102,058 | 2,171,714 |
| GRAND TOTAL [F.C+L.C] | | | | 9,273,772 |

Table.VI-7 BREAKDOWN OF DIRECT CONSTRUCTION COST FOR DIVISION III (Left Bank)

unit; 1,000 Rp

| WORK DESCRIPTION | UNIT | Q'TY | FOREIGN PORTION | LOCAL PORTION |
|---|---|---|---|---|
| I.IRRIGATION AND DRAINAGE CONSTRUCTION | | | | |
| 1.MAIN CANAL | | | | |
| 1.1 EARTH WORKS | m | 12,060 | 3,055,072 | 831,913 |
| 1.2 SIPHON WORKS | nos | 2 | 1,333,368 | 332,630 |
| 1.3 RELATION STRUCTURES | | | | |
| 1.3.1 DIVERSION | nos | 2 | 28,000 | 12,000 |
| 1.3.2 TURNOUT | nos | 19 | 133,000 | 57,000 |
| 1.3.3 CHECK GATE | nos | 5 | 45,000 | 5,000 |
| 1.3.4 STOP LOG | nos | | | |
| 1.3.5 SPILLWAY | nos | 2 | 28,000 | 12,000 |
| 1.3.6 DROP | nos | | | |
| 1.3.7 DRAINAGE CULVERT | nos | 9 | 94,500 | 40,500 |
| 1.3.8 BRIDGE | nos | 8 | 112,000 | 48,000 |
| Sub-Total | | | 4,828,940 | 1,339,043 |
| 2.SECONDARY CANAL | | | | |
| 2.1 EARTH WORKS | m | 5,565 | 736,917 | 233,136 |
| 2.2 SIPHON WORKS | nos | | | |
| 2.3 RELATION STRUCTURES | | | | |
| 2.3.1 DIVERSION | nos | 1 | 10,500 | 4,500 |
| 2.3.2 TURNOUT | nos | 10 | 52,500 | 22,500 |
| 2.3.3 CHECK GATE | nos | 3 | 13,500 | 1,500 |
| 2.3.4 STOP LOG | nos | | | |
| 2.3.5 SPILLWAY | nos | 1 | 10,500 | 4,500 |
| 2.3.6 DROP | nos | 8 | 28,000 | 12,000 |
| 2.3.7 DRAINAGE CULVERT | nos | 3 | 21,000 | 9,000 |
| 2.3.8 BRIDGE | nos | 4 | 33,600 | 14,400 |
| Sub-Total | | | 906,517 | 301,536 |
| 3.DRAINAGE CANAL | m | 9,950 | 193,188 | 32,038 |
| 4.TERTIARY NETWORKS | ha | 1,038 | 604,660 | 173,839 |
| TOTAL | | | 6,533,305 | 1,846,456 |
| GRAND TOTAL [F.C+L.C] | | | | 8,379,761 |

Table.VI-8 BREAKDOWN OF DIRECT CONSTRUCTION COST FOR DIVISION IV (Right Bank)

unit; 1,000 Rp

| WORK DESCRIPTION | UNIT | Q'TY | FOREIGN PORTION | LOCAL PORTION |
|---|---|---|---|---|
| I.IRRIGATION AND DRAINAGE CONSTRUCTION | | | | |
| 1.MAIN CANAL | | | | |
| 1.1 EARTH WORKS | m | | | |
| 1.2 SIPHON WORKS | nos | | | |
| 1.3 RELATION STRUCTURES | | | | |
| 1.3.1 DIVERSION | nos | | | |
| 1.3.2 TURNOUT | nos | | | |
| 1.3.3 CHECK GATE | nos | | | |
| 1.3.4 STOP LOG | nos | | | |
| 1.3.5 SPILLWAY | nos | | | |
| 1.3.6 DROP | nos | | | |
| 1.3.7 DRAINAGE CULVERT | nos | | | |
| 1.3.8 BRIDGE | nos | | | |
| Sub-Total | | | 0 | 0 |
| 2.SECONDARY CANAL | | | | |
| 2.1 EARTH WORKS | m | 5,611 | 701,040 | 226,366 |
| 2.2 SIPHON WORKS | nos | | | |
| 2.3 RELATION STRUCTURES | | | | |
| 2.3.1 DIVERSION | nos | | | |
| 2.3.2 TURNOUT | nos | 7 | 36,750 | 15,750 |
| 2.3.3 CHECK GATE | nos | 3 | 13,500 | 1,500 |
| 2.3.4 STOP LOG | nos | | | |
| 2.3.5 SPILLWAY | nos | 1 | 10,500 | 4,500 |
| 2.3.6 DROP | nos | | | |
| 2.3.7 DRAINAGE CULVERT | nos | 4 | 28,000 | 12,000 |
| 2.3.8 BRIDGE | nos | 4 | 33,600 | 14,400 |
| Sub-Total | | | 823,390 | 274,516 |
| 3.DRAINAGE CANAL | m | 60,150 | 1,357,382 | 286,347 |
| 4.TERTIARY NETWORKS | ha | 245 | 142,718 | 41,031 |
| TOTAL | | | 2,323,490 | 601,894 |
| GRAND TOTAL [F.C+L.C] | | | | 2,925,384 |

Table.VI-9 BREAKDOWN OF DIRECT CONSTRUCTION COST
FOR DIVISION V (Left Bank)

unit; 1,000 Rp

| WORK DESCRIPTION | UNIT | Q'TY | FOREIGN PORTION | LOCAL PORTION |
|---|---|---|---|---|
| I.IRRIGATION AND CONSTRUCTION | | | | |
| 1.MEIN CANAL | | | | |
| 1.1 EARTH WORKS | m | 1,895 | 530,010 | 148,067 |
| 1.2 SIPHON WORKS | nos | | | |
| 1.3 RELATION STRUCTURES | | | | |
| 1.3.1 DIVERSION | nos | | | |
| 1.3.2 TURNOUT | nos | 5 | 35,000 | 15,000 |
| 1.3.3 CHECK GATE | nos | 1 | 9,000 | 1,000 |
| 1.3.4 STOP LOG | nos | | | |
| 1.3.5 SPILLWAY | nos | 1 | 14,000 | 6,000 |
| 1.3.6 DROP | nos | | | |
| 1.3.7 DRAINAGE CULVERT | nos | 1 | 10,500 | 4,500 |
| 1.3.8 BRIDGE | nos | 1 | 14,000 | 6,000 |
| Sub-Total | | | 612,510 | 180,567 |
| 2.SECONDARY CANAL | | | | |
| 2.1 EARTH WORKS | m | 16,154 | 3,476,452 | 1,001,904 |
| 2.2 SIPHON WORKS | nos | | | |
| 2.3 RELATION STRUCTURES | | | | |
| 2.3.1 DIVERSION | nos | 1 | 10,500 | 4,500 |
| 2.3.2 TURNOUT | nos | 25 | 131,250 | 56,250 |
| 2.3.3 CHECK GATE | nos | 9 | 40,500 | 4,500 |
| 2.3.4 STOP LOG | nos | | | |
| 2.3.5 SPILLWAY | nos | 5 | 52,500 | 22,500 |
| 2.3.6 DROP | nos | 6 | 21,000 | 9,000 |
| 2.3.7 DRAINAGE CULVERT | nos | 3 | 21,000 | 9,000 |
| 2.3.8 BRIDGE | nos | 12 | 100,800 | 43,200 |
| Sub-Total | | | 3,854,002 | 1,150,854 |
| 3.DRAINAGE CANAL | m | 22,750 | 331,864 | 65,150 |
| 4.TERTIARY NETWORKS | ha | 1,371 | 798,641 | 229,608 |
| TOTAL | | | 5,597,017 | 1,626,179 |
| GRAND TOTAL [F.C+L.C] | | | | 7,223,196 |

Table.VI-10 BASIC MATERIAL PRICE & LABOURS COST

| ITEM | UNIT | UNIT PRICE(Rp) | COMPONENT F(%) | COMPONENT L(%) | UNIT PRICE(Rp) F/P | UNIT PRICE(Rp) L/P | |
|---|---|---|---|---|---|---|---|
| 1.LABOUR | | | | | | | |
| Labour | m.day | 3,000 | | 100 | 0 | 3,000 | |
| Foreman | m.day | 4,000 | | 100 | 0 | 4,000 | |
| Carpenter | m.day | 3,250 | | 100 | 0 | 3,250 | |
| Head of Carpenter | m.day | 4,000 | | 100 | 0 | 4,000 | |
| Worker(Excavation) | m.day | 3,500 | | 100 | 0 | 3,500 | |
| Brick Layer | m.day | 3,250 | | 100 | 0 | 3,250 | |
| Steel Worker | m.day | 3,500 | | 100 | 0 | 3,500 | |
| Head of Steel worker | m.day | 4,000 | | 100 | 0 | 4,000 | |
| Painter | m.day | 3,500 | | 100 | 0 | 3,500 | |
| Head of Painter | m.day | 4,000 | | 100 | 0 | 4,000 | |
| Operator(Heavy Equ.) | m.day | 4,500 | | 100 | 0 | 4,500 | |
| Assistant | m.day | 3,000 | | 100 | 0 | 3,000 | |
| Driver | m.day | 4,000 | | 100 | 0 | 4,000 | |
| Mechanical | m.day | 4,500 | | 100 | 0 | 4,500 | |
| Head of Mechanical | m.day | 5,000 | | 100 | 0 | 5,000 | |
| Electric Worker | m.day | 3,500 | | 100 | 0 | 3,500 | |
| Watchman | m.day | 3,000 | | 100 | 0 | 3,000 | |
| 2.MATERIAL | | | | | | | |
| Portland Cement | zac | 6,250 | 80 | 20 | 5,000 | 1,250 | |
| Sand for Concrete | m3 | 8,250 | 80 | 20 | 6,600 | 1,650 | * |
| Gravrl for Concrete | m3 | 8,750 | 90 | 10 | 7,875 | 875 | * |
| Gravel for Masonry | m3 | 8,250 | 80 | 20 | 6,600 | 1,650 | * |
| Brick | nos | 26 | | 100 | 0 | 26 | |
| Asphalt | kg | 500 | 50 | 50 | 250 | 250 | |
| Reinforcement Bar | t | 939,000 | 100 | 0 | 939,000 | 0 | |
| Binding Wire | kg | 1,500 | 100 | 0 | 1,500 | 0 | |
| Nail | kg | 1,200 | 100 | 0 | 1,200 | 0 | |
| Timber II | m3 | 140,000 | 0 | 100 | 0 | 140,000 | |
| Light Oil | l | 290 | 34 | 66 | 99 | 191 | ** |
| Gasoline | l | 490 | 60 | 40 | 294 | 196 | ** |
| Heavy Oil | l | 250 | 34 | 66 | 85 | 165 | ** |
| Engine Oil | l | 4,700 | 96 | 4 | 4,512 | 188 | ** |
| Gear Oil | l | 5,100 | 96 | 4 | 4,896 | 204 | ** |
| Steel Gate | kg | 3,000 | 90 | 10 | 2,700 | 300 | |
| 3.EQUIPMENT | | | | | | | |
| Track (6 t) | hr | 18,000 | 90 | 10 | 16,200 | 1,800 | |
| Bulldozer t-16 | hr | 47,300 | 90 | 10 | 42,570 | 4,730 | |
| Excavator 0.7 m3 | hr | 43,000 | 90 | 10 | 38,700 | 4,300 | |
| Compactor 9-12 ton | hr | 34,000 | 90 | 10 | 30,600 | 3,400 | |
| Vibro roller 0.6 t | hr | 3,000 | 90 | 10 | 2,700 | 300 | |
| Tamping Rammer 80 kg | hr | 2,550 | 90 | 10 | 2,295 | 255 | |
| Diesel Engine 5 ps | hr | 230 | 90 | 10 | 207 | 23 | |
| Concrete Mixer 0.22m3 | hr | 1,530 | 90 | 10 | 1,377 | 153 | |

Sorce; DAFTAR HARGA SATUAN BAHAN
BANGUNAN/PEKERJA PROPINSI BENGKULU
Bulan Augustus-September 1989-1990

Note; *) Transportation cost by track is including
**) Forign costs were estimated
without crude oil price in INDONESIA

Table.VI-11 UNIT-PRICE LIST OF MAJOR WORKS

| ITEM NO. | WORK ITEM | UNIT PRICE(Rp) F/P | L/P | REMARKS |
|---|---|---|---|---|
| U-1 | EARTH FILL I | 2,579 | 442 | L<50m |
| U-2 | EARTH FILL II | 4,252 | 839 | L=200m |
| U-3 | EARTH FILL III | 5,543 | 1,146 | L=1000m |
| U-4 | EARTH FILL IV | 2,501 | 1,817 | Manpower |
| U-5 | TRIMMING WORK | 0 | 257 | |
| U-6 | EXCAVATION I | 1,405 | 233 | |
| U-7 | GRAVEL METALING | 2,012 | 833 | |
| U-8 | CLEARING (MANPOWER) | 0 | 75 | |
| U-9 | STRIPPING | 808 | 144 | |
| U-10 | CIEARING II | 80 | 13 | |
| U-11 | RIPPING BY DOZER | 723 | 128 | |
| U-12 | SODDING | 0 | 1,083 | |
| U-S1 | CONCRETE TYPE I | 51,043 | 17,793 | R.Con, |
| U-S2 | CONCRETE TYTPE II | 62,505 | 20,656 | R.Con, |
| U-S3 | CONCRETE TYPE III | 49,604 | 17,454 | |
| U-S4 | CONCRETE TYPE IV | 36,934 | 14,257 | |
| U-S5 | REINFORCEMENT WORK | 1,120,870 | 23,172 | |
| U-S6 | WOODEN FORM | 1,984 | 9,485 | |
| U-S7 | MASONRY WORK | 38,944 | 23,190 | |

Table VI-12 REPLACEMENT COST AND USEFUL LIFE

| Item | Useful Life | Replacement Cost |
|---|---|---|
| | (Years) | (Rp. Million) |
| 1. O&M Equipment | 10 | 980 |
| 2. Project Facilities | | |
| Gate of head works | 30 | 500 |
| Gate of irrigation facilities | 30 | 621 |
| Total | | 2,101 |

Table VI-13 ANNUAL DISBURSEMENT SCHEDULE OF FINANCIAL CONSTRUCTION COST (Unit : Million Rp.)

| Item | Total Cost F.C | Total Cost L.C | Total Cost Total | 1991/92 F.C | 1991/92 L.C | 1992/93 F.C | 1992/93 L.C | 1993/94 F.C | 1993/94 L.C | 1994/95 F.C | 1994/95 L.C | 1995/96 F.C | 1995/96 L.C | 1996/97 F.C | 1996/97 L.C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Preparatory Works | 1,451 | 622 | 2,073 | 218 | 93 | 435 | 187 | 290 | 124 | 290 | 124 | 218 | 94 | | |
| 2. Irrigation & Drainage Construction | 25,879 | 7,909 | 33,788 | | | | | 1,735 | 623 | 8,458 | 2,636 | 11,648 | 3,481 | 4,037 | 1,170 |
| 2.1 Work Division-I | 4,324 | 1,662 | 5,986 | | | | | 1,167 | 449 | 1,859 | 715 | 1,254 | 482 | 43 | 17 |
| 2.2 Work Division-II | 7,102 | 2,172 | 9,274 | | | | | 568 | 174 | 2,486 | 760 | 2,912 | 891 | 1,136 | 347 |
| 2.3 Work Division-III | 6,533 | 1,847 | 8,380 | | | | | | | 2,156 | 610 | 3,397 | 960 | 980 | 277 |
| 2.4 Work Division-IV | 2,323 | 602 | 2,925 | | | | | | | 558 | 144 | 1,231 | 319 | 534 | 139 |
| 2.5 Work Division-V | 5,597 | 1,626 | 7,223 | | | | | | | 1,399 | 407 | 2,854 | 829 | 1,344 | 390 |
| 3. Small-scale Hydro-power Generation | 6,323 | 887 | 7,210 | | | | | | | 145 | 62 | 3,162 | 444 | 3,016 | 381 |
| 3.1 Electric Equipment | 5,742 | 638 | 6,380 | | | | | | | | | 2,871 | 319 | 2,871 | 319 |
| 3.2 Civil Works | 581 | 249 | 830 | | | | | | | 145 | 62 | 291 | 125 | 145 | 62 |
| 4. O & M Facility | 735 | 245 | 980 | | | | | | | | | | | 735 | 245 |
| 5. Land Acquisition | 0 | 237 | 237 | | | | 71 | | 71 | | 47 | | 48 | | |
| 6. Administration | 0 | 880 | 880 | | 88 | | 132 | | 176 | | 176 | | 176 | | 132 |
| 7. Engineering Services | 4,342 | 482 | 4,824 | 347 | 39 | 1,651 | 183 | 521 | 58 | 651 | 72 | 651 | 72 | 521 | 58 |
| 7.1 D/D | 1,737 | 193 | 1,930 | 347 | 39 | 1,390 | 154 | | | | | | | | |
| 7.2 S/V | 2,605 | 289 | 2,894 | | | 261 | 29 | 521 | 58 | 651 | 72 | 651 | 72 | 521 | 58 |
| Sub-total | 38,730 | 11,262 | 49,992 | 565 | 220 | 2,086 | 573 | 2,546 | 1,052 | 9,544 | 3,117 | 15,679 | 4,315 | 8,309 | 1,986 |
| 8. Physical Contingency | 1,937 | 563 | 2,500 | 28 | 11 | 104 | 29 | 127 | 53 | 477 | 156 | 784 | 216 | 417 | 98 |
| Sub-total | 40,667 | 11,825 | 52,492 | 593 | 231 | 2,190 | 602 | 2,673 | 1,105 | 10,021 | 3,273 | 16,463 | 4,531 | 8,726 | 2,084 |
| | | | | | 824 | | 2,792 | | 3,778 | | 13,294 | | 20,994 | | 10,810 |
| 9. Price Contingency | 10,039 | 6,333 | 16,372 | 29 | 23 | 221 | 125 | 414 | 362 | 2,124 | 1,502 | 4,472 | 2,733 | 2,779 | 1,588 |
| Total | 50,706 | 18,158 | 68,864 | 622 | 254 | 2,411 | 727 | 3,087 | 1,467 | 12,145 | 4,775 | 20,935 | 7,264 | 11,505 | 3,672 |
| | | | | | 876 | | 3,138 | | 4,554 | | 16,920 | | 28,199 | | 15,177 |
| Price Index (1990/91=100) | | | | 104.9 | 109.9 | 110.1 | 120.8 | 115.5 | 132.7 | 121.2 | 145.9 | 127.2 | 160.3 | 131.8 | 176.2 |

Remarks: 1US$ = Rp1,845 = ¥153

# APPENDIX VII

# ORGANIZATION AND MANAGEMENT

# CHAPTER 1. ORGANIZATION FOR PROJECT EXECUTION

The Directorate General of Water Resources Development (DGWRD) in the Ministry of Public Works would be the executing agency for implementation of the Air Selagan Irrigation Project. DGWRD would be responsible for both the engineering works and the construction works of the project. It would coordinate all activities of the relevant government agencies and regional administrative organizations in connection with the project implementation.

Actually, the Directorate of Irrigation-II under the said DGWRD would direct responsibility for the project implementation. Public Works Bengkulu Province would directly coordinate the construction of the Project at the provincial level on behalf of Ministry of Public Works.

In order to attain the project successfully, it is proposed to organize the project executing office under the superintendent of the Directorate of Irrigation-II. The main tasks of the project office would be as listed below.

a) Financial arrangements needed for the engineering and construction works of the project.

b) Design, preparatory work and construction supervision of all the implementation activities.

c) Technical assistance and guidance of the on-farm development to be executed by the farmers.

d) Coordination along the government authorities concerned with implementation of the project; the transmigration office (Kantor Transmigrasi), namely agricultural office (Dinas Pertanian), Estate Office, KUD and regional governments.

e) Personnel arrangements for staffs to be required during the construction and O&M stage.

f) Accounting and management of the engineering services and the construction works.

The project office during the construction stage will be organized in the project area. The organizational structure is proposed as presented in Fig. VII-1. The proposed organization comprises four sections, i.e. construction, engineering, operation/ maintenance and administrative sections. A project manager would manage all field works of the project, assisted by these sections. Necessary staff will be supplied from the Directorate of Irrigation-II and the Public Works, Bengkulu Province.

## CHAPTER 2. OPERATION AND MAINTENANCE OF THE PROJECT

### 2.1 Organization and Staffing

After completion of the construction works, the project executing office will be reorganized into the O&M office which will be responsible for the operation and maintenance of all facilities, covering the irrigation facilities up to tertiary blocks. The operation and maintenance between the tertiary blocks and terminal facilities will be entrusted to the farmers' water user group (KP2A) and farmers themselves.

The proposed organizational structure of the O&M office will have four sections, namely operation section, repair and maintenance section, assistance section and administrative section (see Fig. VII-2). The main tasks of these sections are summarized below.

a) Operation Section

- Planning of irrigation schedule
- Arrangement of water distribution
- Hydrological measurement
- Data collection and processing

b) Repair and Maintenance Section

- Repair and maintenance of facilities and equipments
- Management and inspection of facilities and equipments

c) Assistance Section

- Guidance and training to water users' association
- Monitoring and evaluation

d) Administrative Section

- Personnel services
- Accounting and cashiering
- General affair services

The O&M Office will be set up at the project site. Considering the need for smooth and effective water supply and the project location which is divided into two irrigated areas by the Air Selagan, it is proposed that the service area for water management be divided into two areas, the left bank area and the right bank area of Air Selagan. It is proposed that one office be established in these areas in order to execute the smooth and effective water management, otherwise the project area are divided into two areas and water delivery made separately within these areas.

The irrigation supervisor, who are in the operation section, would be responsible for operation and management of the irrigation system through the above mentioned sections. The staff

necessary for the O&M office were estimated at 87 persons including water management engineering, hydrologist, mechanics, driver/operators, accountant, etc. The details are presented in Tables VII-1 and VII-2.

## 2.2 Management Plan for Operation and Maintenance

Major management works of the O&M office will consist of planning of the irrigation schedule, control of irrigation water delivery, maintenance and repair, assistance to water users and administration. Details of the proposed plans are given below.

### 2.2.1 Planning of Irrigation Schedule

Planning of the irrigation schedule will be made in three stages; long-term plan, yearly plan and seasonal plan.

a) Long-term Plan

The long-term plan will be prepared once every 3 to 4 years. This plan will define the targets such as total irrigation area, irrigation efficiency, operation cost and other specific targets for operation and maintenance.

b) Yearly Plan

Before the start of the wet season, the yearly plan will be prepared for the coming wet and dry seasons in accordance with the long-term plan. Several alternatives will be studied in this planning procedure by means of simulation studies made, for example, for combinations of irrigated crop area and irrigation schedules against a drought year, a normal year and a rainy year of appropriate probability.

c) Seasonal Plan

The seasonal plan will be prepared for every crop season in line with the yearly and long-term plans, but some adjustment will be made, depending on the actual hydrological conditions.

The operation section will be responsible for these plans. A hydrologist will be assigned in this section and statistical analyses for previous seasons will be included in the evaluation report which is issued yearly.

### 2.2.2 Control of Irrigation Water Delivery

In order to ensure efficient management of irrigation water delivery, it is recommended that centralized monitoring system be

introduced. The delivery control of irrigation water under this system will be realized by the following work flow:

a) Data Collection and Processing

The data required for delivery control are farming activities and hydrological data such as hourly rainfall, river water level, canal water level and gate opening records. In order to collect the data on farming activities, the field investigation should be done by field personnel. Major survey items consist of 1) kind of crops, 2) crop varieties, 3) planting area, 4) harvesting area and 5) the period of transplanting. These data are compiled by each month.

Due to the preparation of the water management plan, data processing would be done to the following three main items; 1) water balance simulation, 2) hydrological data processing and 3) processing of dimensions such as cropping area and canal discharge to be necessary for the operation. If a micro computer is available, this processing can be done easily and accurately.

b) Water Management and Operation Plan

The water management and operation plan will be prepared for each irrigation block in accordance with the seasonal plan. The plan will consist of the following three items; 1) seasonal management plan, 2) monthly management plan and 3) weekly operation plan.

The seasonal management plan will clarify the proposed irrigation area, irrigation schedule, cropping calendar, etc. After irrigation starts, the seasonal management plan will always be checked and corrected by the daily water balance study.

The monthly management plan will be prepared for the next month. The weekly operation plan will be made for the operation of the following week from the results of water balance study for the previous week, based on the operation monitoring records. This plan will indicate the volume of irrigation water delivery required at each point of the field.

c) Operation and Monitoring

According to the weekly operation plan, the field personnel will set the irrigation facilities to control the water delivery. It should be noted that the minimum operation term is not a day but week. So, the operation of the control facilities will be set up at the beginning of the week and not be changed except in case of an order from the operation section.

The irrigation water distribution and hydrological features will be monitored through the field personnel and field monitoring station, and will be reported periodically to the operation section through the wireless radio system.

### 2.2.3 Operation Rule

The establishment of the operation rule aims at the high irrigation efficiency, equitable distribution of irrigation water and even control between irrigation systems/blocks. In order to ensure the purposes, the following several operation rules will be introduced to the management rule for the O&M office.

a) The control system should be set up, based on the unit operation period of one week. There must be no change of control within the week unless daily rainfall exceeds 30 mm/day.

b) If rainfall of more than 30 mm/day is monitored, the irrigation water supply should be stopped in the appropriate irrigation system from the next day until the end of the week (unit operation period).

c) At the beginning of weekly operation, the daily water balance for the previous week should be reviewed on the basis of the data on farming activities (even cropping area), daily rainfall and the volume of water supplied. At this time, some modifications will be made to the original weekly operation plan, if necessary. After review, the control order should be transmitted from the operation section to the field personnel through the wireless radio system.

d) For the collection of data on farming activities, the field investigation is done by the field personnel. The major items consist of i) kind of crops, ii) crop varieties, iii) planting area, iv) harvesting area and iv) season of transplanting.

e) The condition of flow and water distribution must be monitored by the patrol of field personnel. When the distribution is found not to be done under the schedule, the field personnel must report immediately to the operation section. Then, necessary readjustment should be ordered from this section to the field personnel.

In addition to the above operation rules, it would be necessary to establish the extra-operation rules in case of emergency. The emergency operation will be considered for mismatching between the farming stage and operation period,

troubles at major control points, etc.

In case of a large scale irrigation system, mismatching will often occur, especially at the transplanting stage when much puddling water is required. Owing chiefly to reasons of the farmer's side, transplanting work is delayed beyond the scheduled period. Under the emergency operation rule, the reasons for problems should be cleared through the field investigation, and in parallel with this matter, the prompt readjustment of water scheduling is made by the operation section. Then, the proper time for transplanting is propagated to the water user's associations.

As for the troubles at major control points, detailed operation rules or an instruction manual for countermeasure must be prepared, assuming possible troubles which will occur at each major control points. Moreover, materials and spare parts necessary for repair should be stocked by the repair and maintenance section.

### 2.2.4 Repair and Maintenance

The repair and maintenance section is responsible for repair and maintenance of the facilities managed by the O&M Office. It is recommended that the daily maintenance activities should be intensified with cooperation between the repair and maintenance section and the operation section. Namely, the field personnel under the operation section will be given responsibility for daily maintenance works which always be required as soon as possible. The works of the repair and maintenance section will be concentrated on major irrigation and drainage facilities.

### 2.2.5 Assistance and Administrative Work

As mentioned in Chapter 3, seventeen water user's associations will be set up in the irrigation service area. For active and effective management, these associations will require assistance. The farmer's assistance section will be responsible for this assistance. This section will make periodic and specific plans for guidance and training in scheduling and arrangements, and actual assistance works such as training in water control on field and guidance in repair and maintenance of irrigation facilities will be done through this section with cooperation from the operation section and the repair and maintenance section.

Monitoring and evaluation of the effects of irrigation services will also be conducted by this section through the Project Benefit Monitoring and Evaluation survey (PBME survey). The results of evaluation will be fed back to the management of the O&M Office. At present, the Government envisages collection of an irrigation service fee (water charge) from the beneficiaries. Prior to the introduction of an irrigation service

fee, however, it is necessary first identify the farmers' intentions. Their intentions will be clarified through PBME survey.

Administration work will consist of personnel services, accounting, cashiering and other general affairs services. These will be the responsibility of the administration section. Various data will be collected by the operation section and the farmer's assistance section. Furthermore, all the reports and documents will be completed by the administration section. Through the operation and management, many reports and documents such as monthly and yearly reports for O&M, budgetary reports and texts for guidance and training will be issued by all sections. These data and documents are very important sources for the improvement and up-grading of the management of the O&M Office.

## 2.3 O&M Facilities and Equipment

The O&M equipment that will be required during the O&M stage are bulldozer, motor grader, vehicles, measuring instrument, etc. These are listed in Table VII-3.

For the delivery control of the irrigation water, the introduction of a centralized monitoring system is proposed. This monitoring system is a remote monitoring system but not an automatic remote control system. The monitoring system will comprise a central station and several field stations.

The central station will be established in the operation section. The main functions of the station will consist of collection of water management data from field stations, processing of these data, calculation of water balance and other necessary calculations and storing the water management data as a data base.

The head of the operation section will be responsible for the central station, and overall water control will be carried out promptly by this section, based on the fresh data collected and processed by the central station.

As for the field stations, there are two types. One type includes the intake station, and major head gate stations which will work as field headquarters which will receive control orders from the central station, and transmit these to the field personnel. The other type covers stations equipped with measuring devices such as rainfall and water level gauges. The function of these stations is only to collect and transmit data to the central station. The list of stations may be summarized as follows:

| Location | MI/1 | Rainfall Gauges | Water Level Gauges | Wireless Radio |
|---|---|---|---|---|
| Central Station including SP-IV | 1 | 1 | - | 1 |
| Field Station | | | | |
| Weir Site | - | 2/2 | 1 | 1 |
| SP-II | - | - | 1 | 1 |
| SP-IV/3 | - | - | - | - |
| SP-VI | - | - | - | 1 |

/1 : Meteorological measuring instrument.
/2 : Two gauges are set in the catchment area.
/3 : The field station will be established at same place with the central station.

In order to maintain good liaison between the central station and the field stations, the wireless radio system will be introduced as a communication network. The proposed system will be the VHF simplex wireless radio network. The data and information collected by the field staff will be reported by them through this radio network.

## CHAPTER 3. WATER USERS' GROUP

The O&M of irrigation and drainage facilities in the tertiary block will be done by the farmers' water user group (KP2A). Before completion of construction of the project facilities, this association should be established in each village with guidance from the O&M section of the project executing office during the construction period, O&M office and the agricultural extension office. In particular, the O&M office will provide full technical guidance and advice for water supply management and maintenance of the facilities.

In order to ensure effective water supply and smooth operation and management of irrigation facilities, it is recommended that the water user group be established in the Project area, taking the following items into consideration.

a) Establishment of water user group should be on a village basis and covering several tertiary blocks, and such that every farmer who is either a land proprietor or a share-cropper in the tertiary block must be a member.

b) The management and operation of the water user group should be conducted by a manager with technical assistance under supervision of the Public Works and Agricultural Services at both of Kabupaten and/or Kecamatan levels.

c) Good relationships with the concerned government agencies such as Public Works, Agricultural Service, Rural Extension Center and KUD will promote the successful performance of the activities of these associations.

The proposed organization of a water user group is presented in Fig. VII-3. The association would have a Board, and be staffed by a manager, treasurer, secretary and several Ulu-Ulu (water masters). It is suggested that a unit water user's association be set up in each tertiary block, which will take overall responsibility for distributing irrigation water. One Ulu-ulu would be appointed in each tertiary block in the association to carry out water management including preparation of irrigation calendar, handling of canal structures, diverting of the scheduled amount of water to supply quarternary canals, and supervision of maintenance works. A farmers' leader will be selected in each quarternary block to assist the Ulu-Ulu.

The activities of the Ulu-Ulu and farmers' leaders are important for proper water management both at farm level and at project level. In order to fulfill their missions, it is necessary that they have a through knowledge of water management in the project as well as at farm level. They will, therefore, be

trained by the staff of the O&M Office.

The number of water user group to be established in the Project area was estimated as follows:

| Water Users' Group | Canal Name | Diversion/ Turnout | Irrigation Service area (ha) | Name of Village | Farm House hold (KK) |
|---|---|---|---|---|---|
| Right side of Selagan river | | | | | |
| 1 | Link Canal | BS1-BS3 | 69 | Lubuk Sahung | |
| | Left M.C | BL1 | 9 | Lubuk Sahung | |
| | Sub-total | | 78 | | 52 |
| 2 | Right M.C | BR1-BR2 | 96 | Terasterunjam | |
| | | BR3 | 24 | Terasterunjam | |
| | | | 14 | Pondok Kopi | |
| | | BR4-BR7 | 75 | Pondok Kopi | |
| | | BR8 | 16 | Pondok Kopi | |
| | | | 5 | New Settler | |
| | | BR9-BR10 | 35 | SP-III | |
| | Sub-total | | 265 | | 177 |
| 3 | S.S.Hitam | BH1-BH4 | 181 | SP-III | 121 |
| 4 | S.S.Transfer | BTR1 | 5 | SP-III | |
| | | BTR2-BTR3 | 97 | New Settler | |
| | | BTR4 | 23 | New Settler | |
| | | | 40 | SP-III | |
| | Sub-total | | 165 | | 110 |
| 5 | S.S.Transfer | BB4 | 230 | SP-II | |
| | | | 180 | SP-IV | |
| | Sub-total | | 410 | | 273 |
| 6 | S.S.Transfer-2 | BB6 | 183 | SP-III | 122 |
| 7 | S.S.Pondok Batu | BP1 | 11 | SP-III | |
| | | BP2 | 38 | SP-III | |
| | | | 8 | New Settler | |
| | | BP3-BP9 | 271 | New Settler | |
| | Sub-total | | 358 | | 239 |
| 8 | S.S.Pondok Batu | BP10 | 13 | New Settler | |
| | | | 40 | Tanah Rekah | |
| | | | 32 | Pondok Batu | |
| | | BP11 | 70 | Pondok Batu | |
| | | | 5 | Tana Rekah | |
| | Sub-total | | 160 | | 106 |
| | Total | | 1,800 | | 1,200 |

to be continued

| Water Users' Group | Canal Name | Diversion/ Turnout | Irrigation Service area (ha) | Name of Village | Farm House hold (KK) |
|---|---|---|---|---|---|
| Left Side of Selagan river | | | | | |
| 9 | Left M.C | BL2 | 60 | Spontaneous | |
| | | | 7 | Terasterunjam | |
| | | BL3-BL8 | 123 | Terasterunjam | |
| | Sub-total | | 190 | | 127 |
| 10 | Left M.C | BL10-BL16 | 338 | SP-IV | 225 |
| 11 | S.S.BL9Ka | BL9Ka1-6 | 470 | New Settler | 313 |
| 12 | S.S.BK2Ka | BK1 | 3 | New Settler | |
| | | BK2 | 116 | New Settler | |
| | | | 20 | Terasterunjam | |
| | Sub-total | | 139 | | 93 |
| 13 | S.S.BL14Ka | BLK1-BLK3 | 252 | SP-IV | 168 |
| 14 | S.S.BL14Ka | BLK4 | 85 | SP-IV | |
| | | | 106 | New Settler | |
| | Sub-total | | 191 | | 127 |
| 15 | S.S.Mukomuko | BM1-BM3 | 348 | New Settler | 232 |
| 16 | S.S.Mukomuko | BM5-BM7 | 256 | Pasar Mukomuko | 171 |
| 17 | S.S.Tanah R. | BT1 | 22 | New Settler | |
| | | | 129 | Tanah Rekah | |
| | | BT2 | 21 | Tanah Rekah | |
| | | | 44 | Pasar Mukomuko | |
| | Sub-total | | 216 | | 144 |
| | Total | | 2,400 | | 1,600 |
| | Grand total | | 4,200 | | 2,800 |

It is necessary to establish a communication channel (such as a coordination committee) between the O&M Office and the water user group, in order to ensure smooth and effective operation of water supply.

Table VII-1 PERSONNAEL REQUIREMENT OF O&M OFFICE

| Job Type | Number |
|---|---|
| General manager | 1 |
| Operation section | |
| (Central Station)*1 | |
| Irrigation Superviser | 1 |
| Assistant Irrigation Supervisers | 2 |
| Irrigation Inspectors*2 | 1 |
| Hydrologost | 1 |
| Operator for Computor | 1 |
| Measurement Aide*3 | 1 |
| (Field Station) | |
| Irrigation Inspectors*4 | 3 |
| O&M personnel*5 | 47 |
| Measurement Aide*6 | 3 |
| Repair and Maintenance Section | |
| Construction Engineer | 1 |
| Assist. Const. Engineer | 1 |
| Field Supervisor | 2 |
| Mechanic | 1 |
| Mechanic Aide | 2 |
| Driver/Operator | 10 |
| Assistance Section | |
| Agronomist | 1 |
| Monitoring Expert/Assistant Agronomist | 1 |
| Administrative Section | |
| Administrative Officer | 1 |
| Accountant | 1 |
| Clerk | 1 |
| Typist | 1 |
| Storekeeper | 1 |
| Janitor | 2 |
| Total | 87 |

Remarks)
*1 The function of the field station of SP-IV is belong to the central station.
*2 Head of field station of SP-IV
*3 The staff is belong to the field station of SP-IV.
*4 Head of other three field stations except SP-IV
*5 Refer to Table VII-2
*6 Each staff is belong to othe three field station except SP-IV.

Table VII-2 NUMBER OF STAFF NECESSARY FOR O&M

| Items | Unit | Left Bank | Right Bank | No. of Staff Required (person) Left | Right | Total |
|---|---|---|---|---|---|---|
| Net Irrigation Area | (ha) | 2,400 | 1,800 | | | |
| Intake Weir | | | | | | 1 |
| Operation of irrigation water | | | | 4 | 3 | 7 |
| Main Canal | | | | | | |
| Length | (km) | 14.0 | 15.1 | 3 | 4 | 7 |
| Structure | (Nos.) | 48 | 53 | 2 | 2 | 4 |
| Secondary Canal | | | | | | |
| Length | (km) | 21.6 | 18.1 | 4 | 4 | 8 |
| Structure | (Nos.) | 91 | 81 | 2 | 2 | 4 |
| Drainage Canal | (km) | 32.7 | 67.0 | 4 | 7 | 11 |
| Inspection Road | | | | | | |
| Main | (km) | 14.0 | 10.5 | 1 | 1 | 2 |
| Secondary | (km) | 21.6 | 13.0 | 2 | 1 | 3 |
| Total | | | | | | 47 |

Remarks)
Standard coverage of actives for O&M staff is as follows :

| | |
|---|---|
| Intake weir | 1 person |
| Operation of irrigation water | 1 person/700 ha |
| Checking for canal | |
| Main canal | 1 person/5 km |
| Secondary canal | 1 peson/6 km |
| Drainage canal | 10 person/km |
| Check for structure | |
| Main canal | 1 person/40 structures |
| Secondary canal | 1 person/60 box |
| Check for inspection road | |
| Main canal | 1 person/18km |
| Secondary canal | 1 person/15 km |

These standard are based on the density of the O&M personne in the Section Public Works Office in Jawa.

Table VII-3 O&M EQUIPMENT

| No. | Equipment | Type | Nos. |
|---|---|---|---|
| 1 | Backhoe | 0.3 m3 | 1 |
| 2 | Bulldpzer | 6 ton | 1 |
| 3 | Motor Grader | Blade 3m | 1 |
| 4 | Tire Roller | 6-8 ton | 1 |
| 5 | Rammer | 80 kg | 2 |
| 6 | Concrete Mixer | 0.2 m3 | 1 |
| 7 | Concrete Vibrator | Dia 45 mm | 2 |
| 8 | Submersible Pump | 11kW*a50 mm | 2 |
| 9 | Generator | 20 kVA | 1 |
| 10 | Dump Truck | 4 ton | 2 |
| 11 | Truck with Crane | 4 ton | 1 |
| 12 | Jeep (4WD) | | 3 |
| 13 | Motor cycle | 100 cc | 10 |
| 14 | Micro computer with printer and CRT | | 1 set |
| 15 | Current Meter | | 2 |
| 16 | Communication system | | 1 set |
| 17 | Spare parts | | L.S |

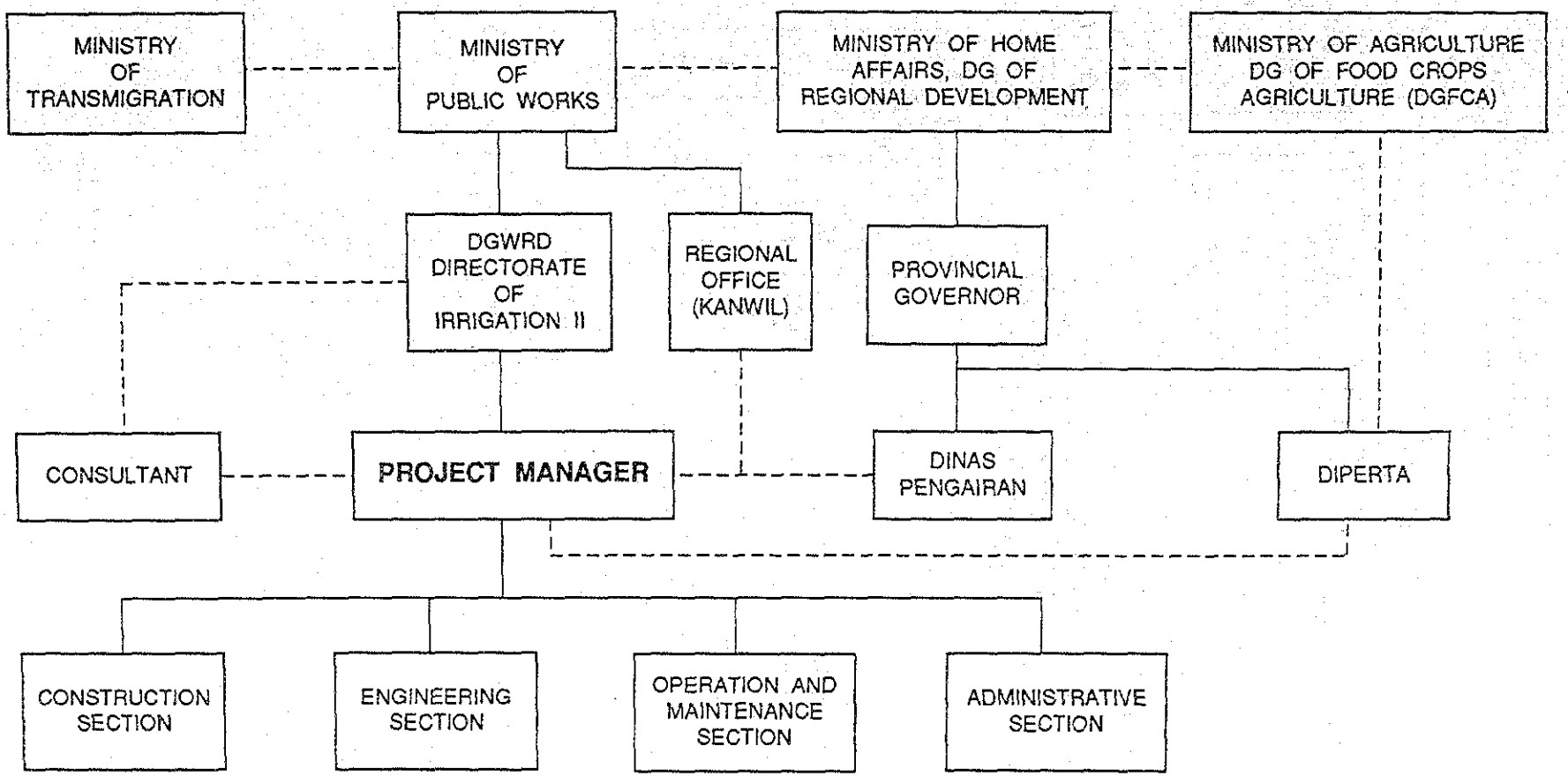



Fig. VII-1 Proposed Organization of Project Executing Office

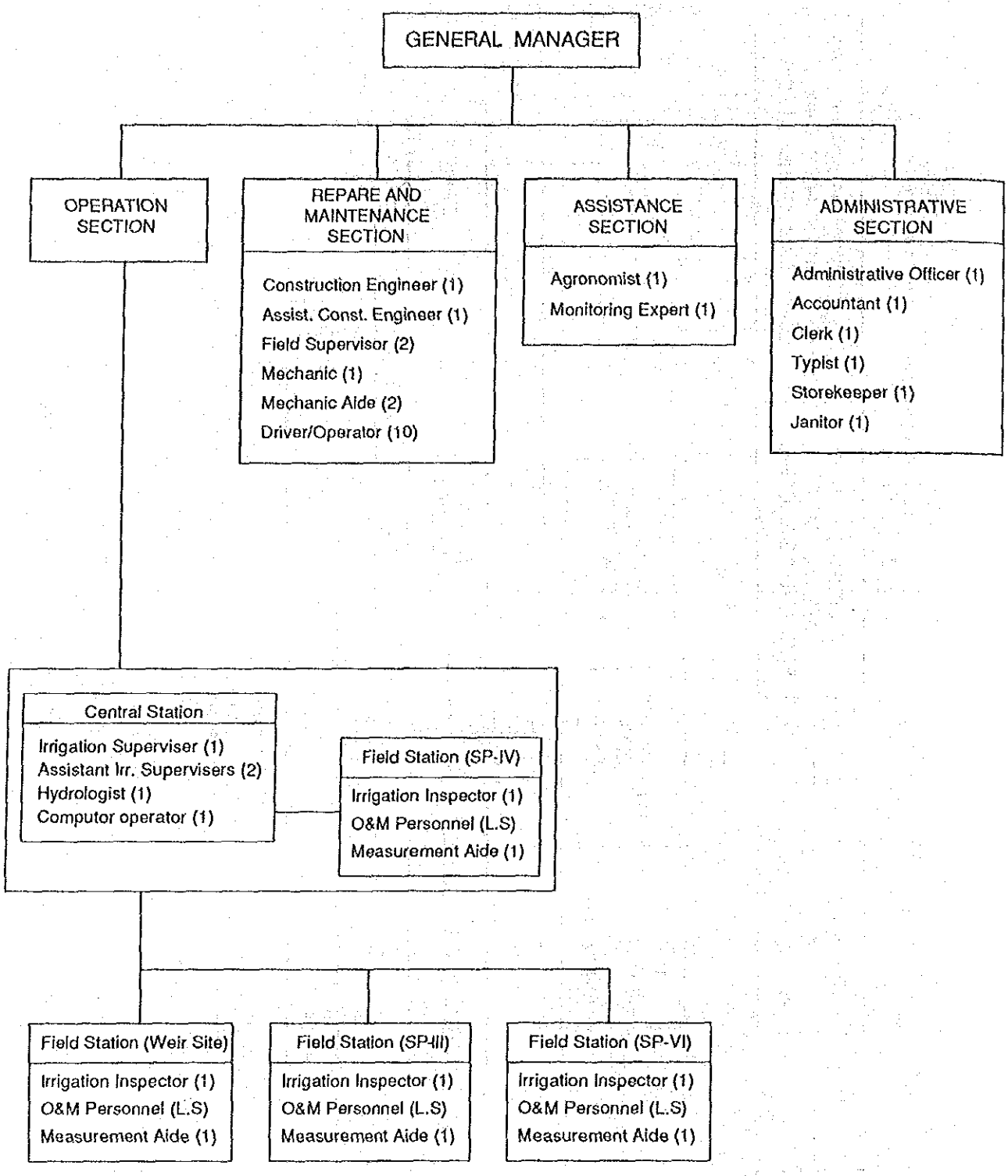
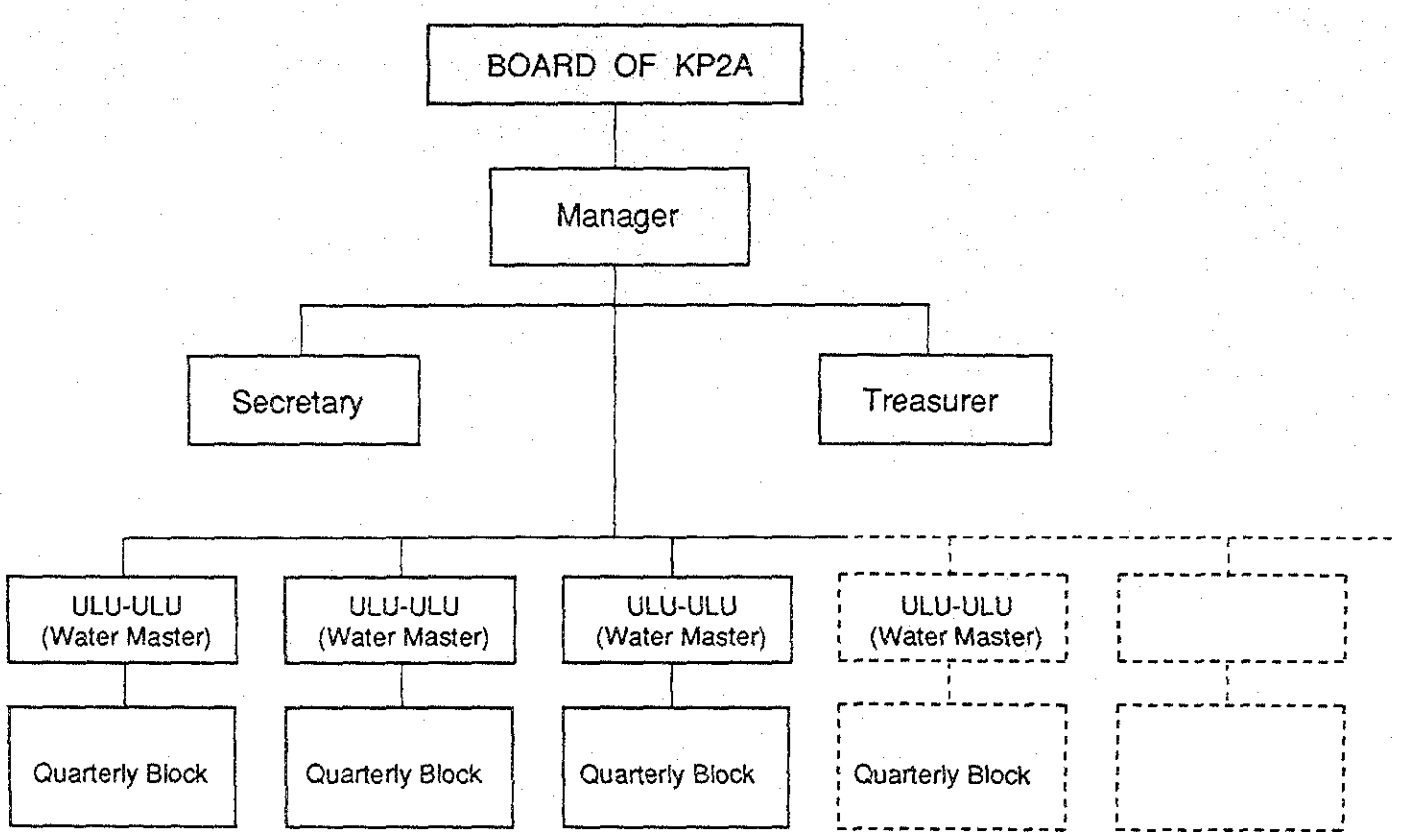



Fig. VII-2 Proposed Organization of O&M Office




Fg. VII-3 Proposed Organization of Water Users' Association