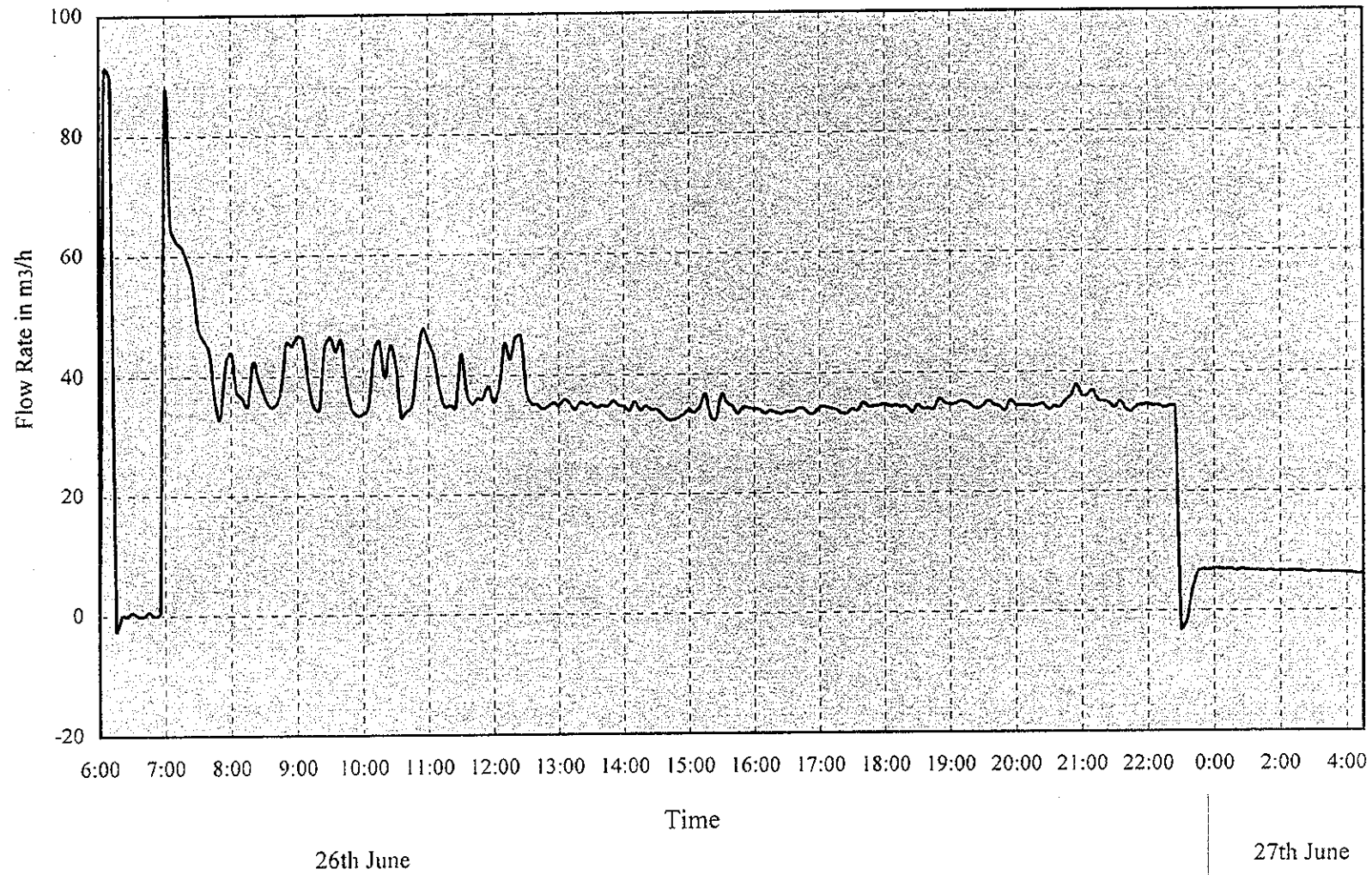


DATA BOOK
CHAPTER 9 WATER SUPPLY FACILITY

Figure 1 Graphed Result of Flow Rater measurement at the Pumping Station (26 - 27 June, 1997)

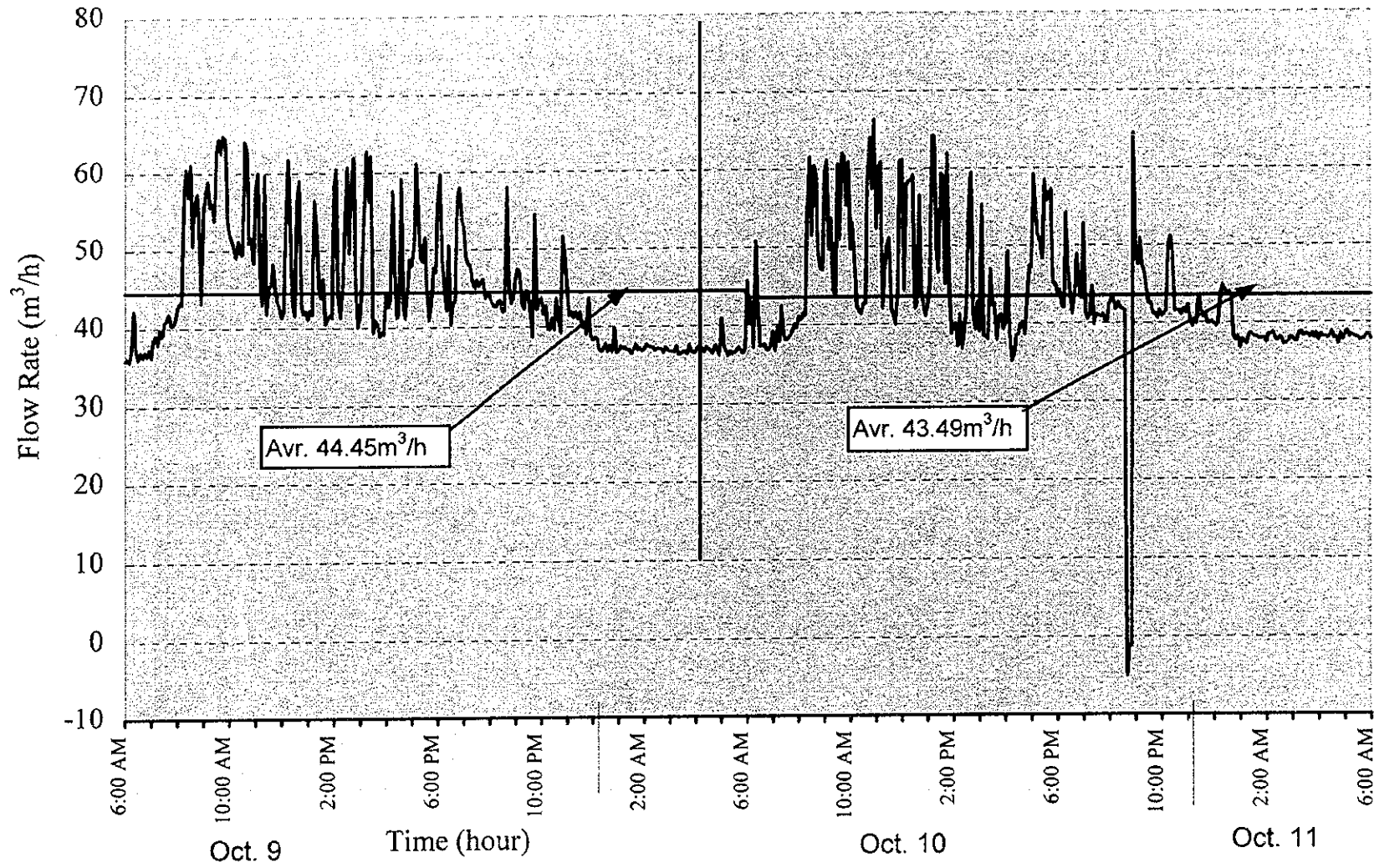


1-6

Annex IX-1

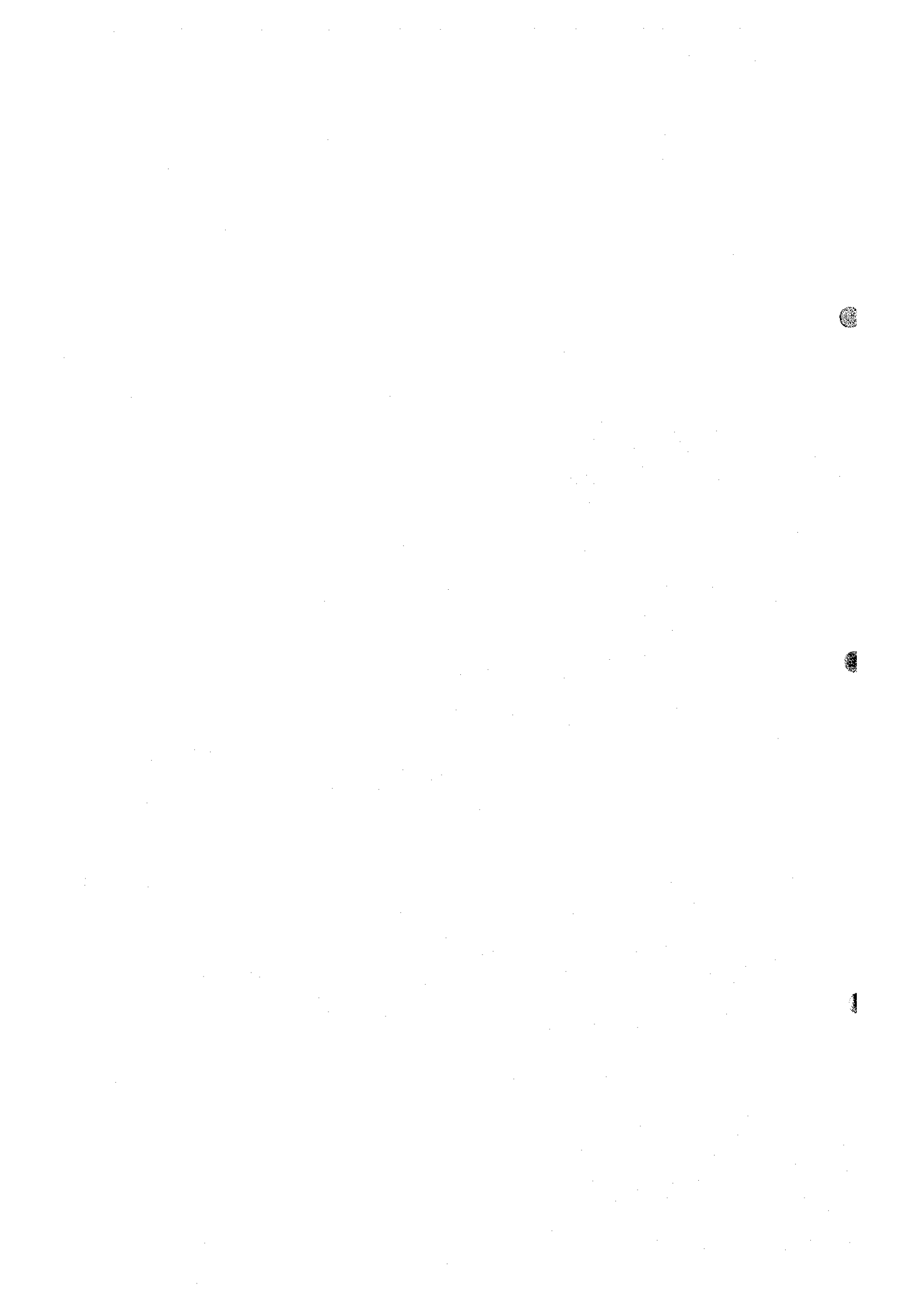
Figure 2 Graphed Result of the Flow Rate Measurement at the Pumping Station (9 - 11 October, 1998)

9-2



Annex IX -1

**DATA BOOK
II MASTER PLAN**



Caluculation of Pipeline Network (Case 1)

[Caluculation Condition]

1. Formula for Caluculation

Hazen-Williams Formula

$$h = I \times L$$

$$I = 10.666 \times C^{-1.85} \times D^{-4.97} \times Q^{1.85}$$

(Herein)

h : Friction loss (m)

L : Pipe length

I : hydraulic gradient (‰)

C : Coefficient of flow rate condition (-)

(C=90 : Supposed the pipe condition in 25 years after installation)

D : Pipe diameter (mm)

Q : Flow rate (L/sec)

2. Allowable range of In-put data and Out-put data

| | | |
|---------------------------|---------|---------|
| Minimum effective head | (m) | 5.00 |
| Maximum static head | (m) | 75.00 |
| Nominal diameter | (mm) | 75~1000 |
| Flow velocity | (m/sec) | 0.0~5.0 |
| Total Number of Nodes | | 38 |
| Total Number of Pipelines | | 47 |

3. Result of Caluculation

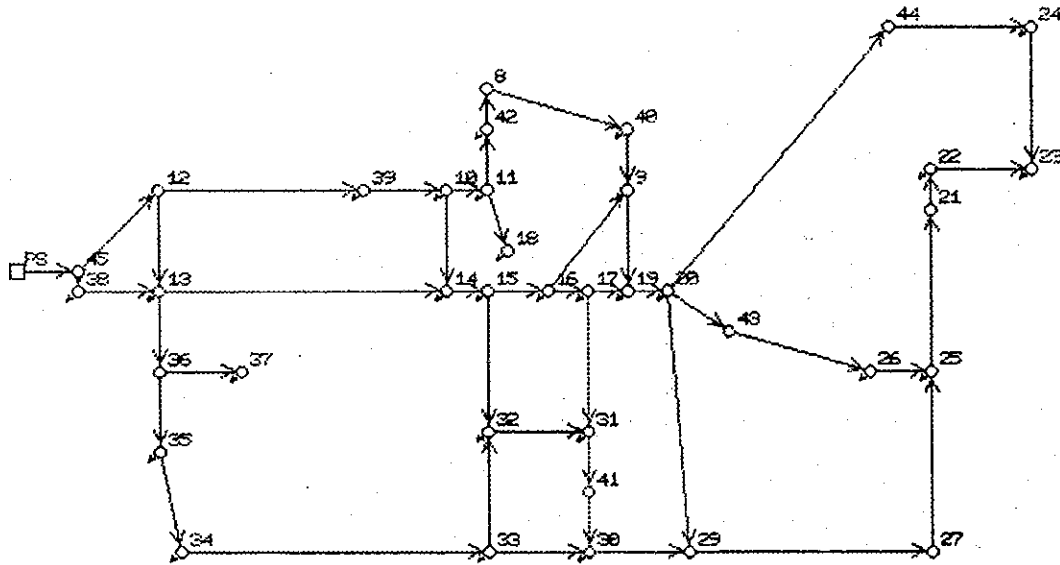
The results of calculation are shown in next 4 pages for Case 1.

(Herein)

| | | |
|-------|-----------------------------|---------|
| Point | : Name of node | (-) |
| H | : Hydrodynamic head | (m) |
| G | : Ground Level | (m) |
| E | : Effective head | (m) |
| S | : Static head | (m) |
| T | : Total distribution amount | (L/sec) |
| Line | : No. of Pipeline | (-) |
| B | : Start point | (-) |
| F | : End point | (-) |
| N | : Nominal diameter of pipe | (mm) |
| V | : Flow velocity | (m/sec) |

A. Calculation of pipe network (case 1-1 : For Low G·L Area)

(1) Figure of pipe network



(2) Point data (PS: appointed the pumping station)

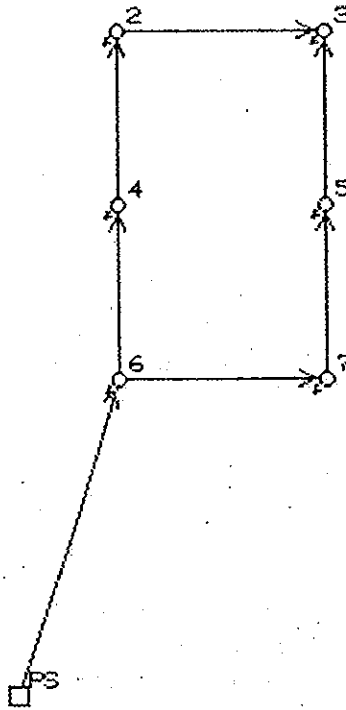
| Point | H (m) | G (m) | E (m) | S (m) | T (L/SEC) |
|-------|----------|----------|----------|----------|--------------|
| 38 | 2195.46 | 2165.00 | 30.46 | 33.50 | 1.150 |
| 13 | 2194.47 | 2165.00 | 29.47 | 33.50 | 0.680 |
| 12 | 2194.67 | 2170.00 | 24.67 | 28.50 | 1.670 |
| 36 | 2193.50 | 2160.00 | 33.50 | 38.50 | 0.000 |
| 37 | 2193.44 | 2160.00 | 33.44 | 38.50 | 2.020 |
| 39 | 2194.25 | 2170.00 | 24.25 | 28.50 | 1.220 |
| 10 | 2192.59 | 2165.00 | 27.59 | 33.50 | 0.980 |
| 42 | 2192.51 | 2165.00 | 27.51 | 33.50 | 0.560 |
| 18 | 2192.54 | 2165.00 | 27.54 | 33.50 | 0.160 |
| 14 | 2192.58 | 2165.00 | 27.58 | 33.50 | 1.320 |
| 15 | 2192.33 | 2165.00 | 27.33 | 33.50 | 2.060 |
| 32 | 2192.08 | 2145.00 | 47.08 | 53.50 | 2.560 |
| 11 | 2192.54 | 2165.00 | 27.54 | 33.50 | 0.490 |
| 16 | 2192.10 | 2165.00 | 27.10 | 33.50 | 4.890 |
| 17 | 2192.06 | 2165.00 | 27.06 | 33.50 | 1.930 |
| 9 | 2192.10 | 2165.00 | 27.10 | 33.50 | 0.800 |
| 40 | 2192.12 | 2170.00 | 22.12 | 28.50 | 0.120 |
| 31 | 2192.05 | 2145.00 | 47.05 | 53.50 | 2.480 |
| 19 | 2192.06 | 2165.00 | 27.06 | 33.50 | 0.460 |
| 20 | 2191.99 | 2165.00 | 26.99 | 33.50 | 0.420 |
| 43 | 2191.98 | 2165.00 | 26.98 | 33.50 | 0.000 |
| 33 | 2192.09 | 2140.00 | 52.09 | 58.50 | 0.600 |
| 41 | 2192.03 | 2140.00 | 52.03 | 58.50 | 0.000 |
| 30 | 2192.01 | 2140.00 | 52.01 | 58.50 | 2.100 |
| 29 | 2191.99 | 2150.00 | 46.99 | 48.50 | 0.000 |
| 34 | 2192.27 | 2140.00 | 52.27 | 58.50 | 2.020 |
| 35 | 2192.83 | 2150.00 | 42.83 | 48.50 | 2.020 |
| 27 | 2191.85 | 2145.00 | 46.85 | 53.50 | 0.000 |
| 26 | 2191.82 | 2160.00 | 31.82 | 38.50 | 0.060 |
| 25 | 2191.76 | 2160.00 | 31.76 | 38.50 | 1.810 |
| 21 | 2191.53 | 2170.00 | 21.53 | 28.50 | 0.000 |
| 22 | 2191.48 | 2170.00 | 21.48 | 28.50 | 1.810 |
| 23 | 2191.45 | 2170.00 | 21.45 | 28.50 | 1.810 |
| 24 | 2191.46 | 2175.00 | 16.46 | 23.50 | 1.810 |
| 45 | 2195.61 | 2165.00 | 30.61 | 33.50 | 0.000 |
| PS | 2198.50 | 2165.00 | 33.50 | 33.50 | -40.010 |
| 8 | 2192.45 | 2170.00 | 22.45 | 28.50 | 0.000 |
| 44 | 2191.52 | 2175.00 | 16.52 | 23.50 | 0.000 |

(3) Pipeline data

| Line | B | F | N (mm) | D (mm) | C | L (m) | Q (L/SEC) | V (m/s) | I (1/1000) | h (m) |
|------|----|----|-----------|-----------|----|----------|--------------|------------|---------------|----------|
| K1 | PS | 45 | 200 | 200 | 90 | 170.00 | 40.010 | 1.274 | 16.999 | 2.891 |
| K2 | 12 | 39 | 200 | 200 | 90 | 390.00 | 9.085 | 0.289 | 1.077 | 0.427 |
| K3 | 13 | 36 | 150 | 150 | 90 | 220.00 | 9.064 | 0.513 | 4.409 | 0.974 |
| K4 | 36 | 37 | 150 | 150 | 90 | 200.00 | 2.020 | 0.114 | 0.300 | 0.055 |
| K5 | 12 | 13 | 200 | 200 | 90 | 200.00 | 8.645 | 0.275 | 1.000 | 0.200 |
| K6 | 13 | 14 | 200 | 200 | 90 | 470.00 | 18.362 | 0.584 | 4.021 | 1.892 |
| K7 | 14 | 15 | 200 | 200 | 90 | 60.00 | 18.645 | 0.593 | 4.167 | 0.249 |
| K8 | 15 | 32 | 200 | 200 | 90 | 560.00 | 5.569 | 0.177 | 0.446 | 0.248 |
| K9 | 10 | 14 | 200 | 200 | 90 | 230.00 | 1.603 | 0.051 | 0.044 | 0.010 |
| K10 | 39 | 10 | 125 | 125 | 90 | 200.00 | 7.865 | 0.641 | 8.300 | 1.655 |
| K11 | 10 | 11 | 200 | 200 | 90 | 130.00 | 5.281 | 0.168 | 0.385 | 0.052 |
| K12 | 11 | 42 | 200 | 200 | 90 | 90.00 | 4.631 | 0.147 | 0.334 | 0.028 |
| K13 | 11 | 18 | 200 | 200 | 90 | 190.00 | 0.160 | 0.005 | 0.000 | 0.000 |
| K14 | 40 | 9 | 200 | 200 | 90 | 90.00 | 3.951 | 0.126 | 0.222 | 0.021 |
| K15 | 9 | 19 | 200 | 200 | 90 | 210.00 | 3.529 | 0.112 | 0.191 | 0.040 |
| K16 | 15 | 16 | 200 | 200 | 90 | 150.00 | 11.016 | 0.351 | 1.533 | 0.235 |
| K17 | 16 | 9 | 200 | 200 | 90 | 340.00 | 0.378 | 0.012 | 0.000 | 0.001 |
| K18 | 16 | 17 | 200 | 200 | 90 | 70.00 | 5.748 | 0.183 | 0.572 | 0.033 |
| K19 | 17 | 19 | 200 | 200 | 90 | 70.00 | 2.708 | 0.086 | 0.000 | 0.008 |
| K20 | 17 | 31 | 200 | 200 | 90 | 530.00 | 1.110 | 0.035 | 0.019 | 0.012 |
| K21 | 32 | 31 | 200 | 200 | 90 | 160.00 | 3.588 | 0.114 | 0.188 | 0.031 |
| K22 | 19 | 20 | 200 | 200 | 90 | 140.00 | 5.777 | 0.184 | 0.500 | 0.066 |
| K23 | 20 | 43 | 200 | 200 | 90 | 120.00 | 2.799 | 0.089 | 0.083 | 0.015 |
| K24 | 36 | 35 | 150 | 150 | 90 | 240.00 | 7.044 | 0.399 | 2.791 | 0.666 |
| K25 | 35 | 34 | 150 | 150 | 90 | 380.00 | 5.024 | 0.284 | 1.474 | 0.565 |
| K26 | 34 | 33 | 150 | 150 | 90 | 310.00 | 3.004 | 0.170 | 0.580 | 0.178 |
| K27 | 33 | 32 | 150 | 150 | 90 | 210.00 | 0.579 | 0.033 | 0.048 | 0.006 |
| K28 | 33 | 30 | 150 | 150 | 90 | 330.00 | 1.825 | 0.103 | 0.243 | 0.075 |
| K29 | 41 | 30 | 150 | 150 | 90 | 60.00 | 2.218 | 0.125 | 0.334 | 0.020 |
| K30 | 31 | 41 | 200 | 200 | 90 | 230.00 | 2.218 | 0.071 | 0.087 | 0.019 |
| K31 | 30 | 29 | 150 | 150 | 90 | 100.00 | 1.943 | 0.110 | 0.200 | 0.026 |
| K32 | 45 | 12 | 200 | 200 | 90 | 210.00 | 19.400 | 0.618 | 4.477 | 0.936 |
| K33 | 20 | 29 | 150 | 150 | 90 | 770.00 | 0.124 | 0.007 | 0.000 | 0.001 |
| K34 | 20 | 44 | 150 | 150 | 90 | 1200.00 | 2.435 | 0.138 | 0.392 | 0.467 |
| K35 | 27 | 25 | 150 | 150 | 90 | 310.00 | 2.067 | 0.117 | 0.291 | 0.089 |
| K36 | 43 | 26 | 150 | 150 | 90 | 310.00 | 2.799 | 0.158 | 0.516 | 0.156 |
| K37 | 29 | 27 | 150 | 150 | 90 | 500.00 | 2.067 | 0.117 | 0.280 | 0.144 |
| K38 | 26 | 25 | 150 | 150 | 90 | 130.00 | 2.739 | 0.155 | 0.462 | 0.063 |
| K39 | 44 | 24 | 150 | 150 | 90 | 150.00 | 2.435 | 0.138 | 0.400 | 0.058 |
| K40 | 25 | 21 | 150 | 150 | 90 | 400.00 | 2.995 | 0.169 | 0.575 | 0.228 |
| K41 | 24 | 23 | 150 | 150 | 90 | 380.00 | 0.625 | 0.035 | 0.026 | 0.012 |
| K42 | 22 | 23 | 150 | 150 | 90 | 230.00 | 1.185 | 0.067 | 0.131 | 0.024 |
| K43 | 21 | 22 | 150 | 150 | 90 | 90.00 | 2.995 | 0.169 | 0.556 | 0.051 |
| K44 | 45 | 38 | 200 | 200 | 90 | 30.00 | 20.611 | 0.656 | 5.005 | 0.150 |
| K45 | 38 | 13 | 200 | 200 | 90 | 220.00 | 19.461 | 0.619 | 4.500 | 0.986 |
| K46 | 42 | 8 | 150 | 150 | 90 | 60.00 | 4.071 | 0.230 | 1.001 | 0.060 |
| K47 | 8 | 40 | 150 | 150 | 90 | 330.00 | 4.071 | 0.230 | 0.999 | 0.332 |

B. Calculation of pipe network (case 1-2 : For High G·L Area)

(1) Figure of pipe network



(2) Point data (PS: appointed the pumping station)

| Point | H (m) | G (m) | E (m) | S (m) | T (L/SEC) |
|-------|----------|----------|----------|----------|--------------|
| PS | 2218.50 | 2165.00 | 53.50 | 53.50 | -14.670 |
| 6 | 2210.95 | 2180.00 | 30.95 | 38.50 | 2.350 |
| 7 | 2210.16 | 2180.00 | 30.16 | 38.50 | 2.540 |
| 4 | 2210.11 | 2190.00 | 20.11 | 28.50 | 2.350 |
| 5 | 2209.83 | 2190.00 | 19.83 | 28.50 | 2.540 |
| 2 | 2209.85 | 2200.00 | 9.85 | 18.50 | 2.350 |
| 3 | 2209.80 | 2200.00 | 9.80 | 18.50 | 2.540 |

(3) Pipeline data

| Line | B | F | N (mm) | D (mm) | C | L (m) | Q (L/SEC) | V (m/s) | I (1/1000) | h (m) |
|------|----|---|-----------|-----------|----|----------|--------------|------------|---------------|----------|
| K1 | PS | 6 | 150 | 150 | 90 | 700.00 | 14.670 | 0.830 | 10.786 | 7.552 |
| K2 | 6 | 7 | 150 | 150 | 90 | 360.00 | 6.203 | 0.351 | 2.195 | 0.790 |
| K3 | 7 | 5 | 150 | 150 | 90 | 400.00 | 3.663 | 0.207 | 0.825 | 0.331 |
| K4 | 5 | 3 | 150 | 150 | 90 | 290.00 | 1.123 | 0.064 | 0.104 | 0.027 |
| K5 | 2 | 3 | 150 | 150 | 90 | 370.00 | 1.417 | 0.080 | 0.135 | 0.053 |
| K6 | 4 | 2 | 150 | 150 | 90 | 300.00 | 3.767 | 0.213 | 0.867 | 0.262 |
| K7 | 6 | 4 | 150 | 150 | 90 | 390.00 | 6.117 | 0.346 | 2.153 | 0.834 |

Calculation of Pipeline Network (Case 2)

[Calculation Condition]

1. Formula for Calculation

Hazen-Williams Formula

$$h = I \times L$$

$$I = 10.666 \times C^{-1.85} \times D^{-4.87} \times Q^{1.85}$$

(Herein)

h : Friction loss (m)

L : Pipe length

I : hydraulic gradient (‰)

C : Coefficient of flow rate condition (-)

(C=90 : Supposed the pipe condition in 25 years after installation)

D : Pipe diameter (mm)

Q : Flow rate (L/sec)

2. Allowable range of In-put data and Out-put data

| | | |
|---------------------------|---------|---------|
| Minimum effective head | (m) | 5.00 |
| Maximum static head | (m) | 75.00 |
| Nominal diameter | (mm) | 75~1000 |
| Flow velocity | (m/sec) | 0.0~5.0 |
| Total Number of Nodes | | 38 |
| Total Number of Pipelines | | 47 |

3. Result of Calculation

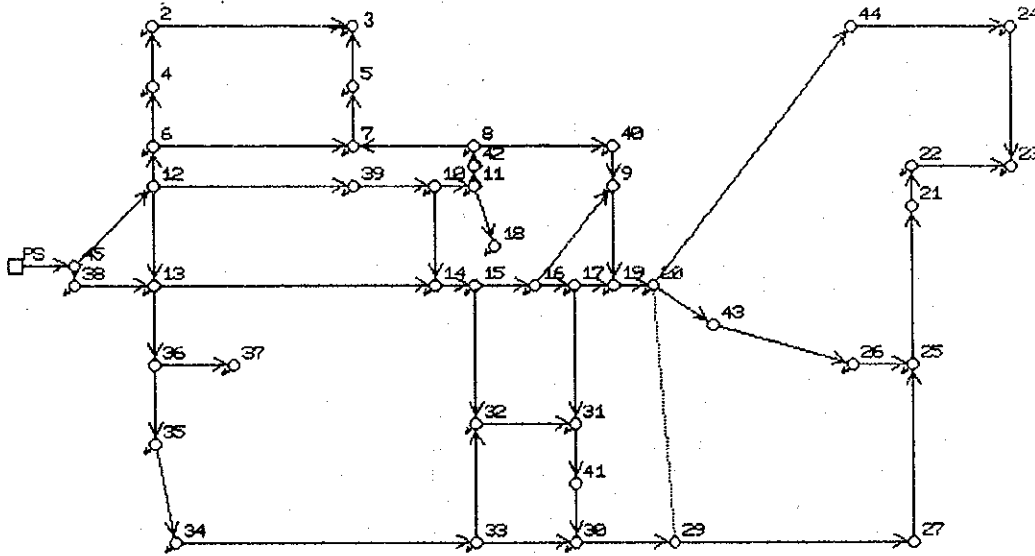
The results of calculation are shown in next 3 pages for Case 2.

(Herein)

| | | |
|-------|-------------------------------|---------|
| Point | : Name of node | (-) |
| H | : Hydrodynamic head | (m) |
| G | : Ground Level | (m) |
| E | : Hydrodynamic effective head | (m) |
| S | : Static head | (m) |
| T | : Total distribution amount | (L/sec) |
| Line | : No. of Pipeline | (-) |
| B | : Start point | (-) |
| F | : End point | (-) |
| N | : Nominal diameter of pipe | (mm) |
| V | : Flow velocity | (m/sec) |

A. Calculation of pipe netwo (case 2)

(1) Figure of pipe network



(2) Point data (PS: appointed the pumping station)

| Point | H (m) | G (m) | E (m) | S (m) | T (L/SEC) |
|-------|----------|----------|----------|----------|--------------|
| 38 | 2213.10 | 2165.00 | 48.10 | 53.50 | 1.150 |
| 13 | 2211.46 | 2165.00 | 46.46 | 53.50 | 0.680 |
| 12 | 2211.52 | 2170.00 | 41.52 | 48.50 | 1.670 |
| 36 | 2210.39 | 2160.00 | 50.39 | 58.50 | 0.000 |
| 37 | 2210.34 | 2160.00 | 50.34 | 58.50 | 2.020 |
| 39 | 2211.06 | 2170.00 | 41.06 | 48.50 | 1.220 |
| 10 | 2209.24 | 2165.00 | 44.24 | 53.50 | 0.980 |
| 7 | 2208.76 | 2175.00 | 33.76 | 43.50 | 2.540 |
| 18 | 2209.15 | 2165.00 | 44.15 | 53.50 | 0.160 |
| 14 | 2209.24 | 2165.00 | 44.24 | 53.50 | 1.320 |
| 15 | 2208.98 | 2165.00 | 46.98 | 53.50 | 2.060 |
| 32 | 2208.73 | 2145.00 | 63.73 | 73.50 | 2.560 |
| 11 | 2209.15 | 2165.00 | 44.15 | 53.50 | 0.490 |
| 16 | 2208.73 | 2165.00 | 43.73 | 53.50 | 4.890 |
| 17 | 2208.70 | 2165.00 | 43.70 | 53.50 | 1.930 |
| 9 | 2208.73 | 2165.00 | 43.73 | 53.50 | 0.800 |
| 6 | 2209.16 | 2180.00 | 29.16 | 38.50 | 2.350 |
| 31 | 2208.70 | 2145.00 | 63.70 | 73.50 | 2.480 |
| 19 | 2208.69 | 2165.00 | 43.69 | 53.50 | 0.460 |
| 20 | 2208.63 | 2165.00 | 43.63 | 53.50 | 0.420 |
| 43 | 2208.61 | 2165.00 | 43.61 | 53.50 | 0.000 |
| 33 | 2208.75 | 2140.00 | 68.75 | 78.50 | 0.600 |
| 41 | 2208.68 | 2140.00 | 68.68 | 78.50 | 0.000 |
| 30 | 2208.66 | 2140.00 | 68.66 | 78.50 | 2.100 |
| 29 | 2208.63 | 2145.00 | 63.63 | 73.50 | 0.000 |
| 34 | 2208.98 | 2140.00 | 68.98 | 78.50 | 2.020 |
| 35 | 2209.64 | 2150.00 | 59.64 | 68.50 | 2.020 |
| 27 | 2208.49 | 2145.00 | 63.49 | 73.50 | 0.000 |
| 44 | 2208.16 | 2175.00 | 33.16 | 43.50 | 0.000 |
| 26 | 2208.46 | 2160.00 | 48.46 | 58.50 | 0.060 |
| 25 | 2208.40 | 2160.00 | 48.40 | 58.50 | 1.810 |
| 21 | 2208.17 | 2170.00 | 38.17 | 48.50 | 0.000 |
| 22 | 2208.12 | 2170.00 | 38.12 | 48.50 | 1.810 |
| 23 | 2208.09 | 2170.00 | 38.09 | 48.50 | 1.810 |
| 24 | 2208.11 | 2175.00 | 33.11 | 43.50 | 1.810 |
| 45 | 2213.35 | 2165.00 | 48.35 | 53.50 | 0.000 |
| PS | 2218.50 | 2165.00 | 53.50 | 53.50 | -54.680 |
| 40 | 2208.74 | 2170.00 | 38.74 | 48.50 | 0.120 |
| 42 | 2209.1 | 2170.00 | 39.10 | 48.50 | 0.000 |
| 8 | 2208.96 | 2170.00 | 38.96 | 48.50 | 0.560 |
| 4 | 2208.47 | 2190.00 | 18.47 | 28.50 | 2.350 |
| 2 | 2208.28 | 2200.00 | 8.28 | 18.50 | 2.350 |
| 3 | 2208.26 | 2200.00 | 8.26 | 18.50 | 2.540 |
| 5 | 2208.32 | 2190.00 | 18.32 | 28.50 | 2.540 |

(3) Pipeline data

| Line | B | F | N (mm) | D (mm) | C | L (m) | Q (L/SEC) | V (m/s) | I (1/1000) | h (m) |
|------|----|----|-----------|-----------|----|----------|--------------|------------|---------------|----------|
| K1 | PS | 45 | 200 | 200 | 90 | 170.00 | 54.68 | 1.741 | 30.294 | 5.153 |
| K2 | 12 | 39 | 200 | 200 | 90 | 390.00 | 9.49 | 0.302 | 1.179 | 0.463 |
| K3 | 13 | 36 | 150 | 150 | 90 | 220.00 | 9.52 | 0.539 | 4.864 | 1.067 |
| K4 | 36 | 37 | 150 | 150 | 90 | 200.00 | 2.02 | 0.114 | 0.249 | 0.055 |
| K5 | 12 | 13 | 200 | 200 | 90 | 200.00 | 4.55 | 0.145 | 0.300 | 0.061 |
| K6 | 13 | 14 | 200 | 200 | 90 | 470.00 | 20.01 | 0.637 | 4.723 | 2.219 |
| K7 | 14 | 15 | 200 | 200 | 90 | 60.00 | 18.99 | 0.604 | 4.334 | 0.257 |
| K8 | 15 | 32 | 200 | 200 | 90 | 560.00 | 5.57 | 0.177 | 0.446 | 0.248 |
| K9 | 10 | 14 | 200 | 200 | 90 | 230.00 | 0.30 | 0.009 | 0.000 | 0.000 |
| K10 | 39 | 10 | 125 | 125 | 90 | 200.00 | 8.27 | 0.674 | 9.100 | 1.816 |
| K11 | 10 | 11 | 200 | 200 | 90 | 130.00 | 6.99 | 0.223 | 0.693 | 0.088 |
| K12 | 42 | 8 | 150 | 150 | 90 | 60.00 | 6.34 | 0.359 | 2.336 | 0.137 |
| K13 | 11 | 18 | 200 | 200 | 90 | 190.00 | 0.16 | 0.005 | 0.000 | 0.000 |
| K14 | 11 | 42 | 200 | 200 | 90 | 90.00 | 6.34 | 0.202 | 0.553 | 0.051 |
| K15 | 9 | 19 | 200 | 200 | 90 | 210.00 | 3.26 | 0.104 | 0.191 | 0.035 |
| K16 | 15 | 16 | 200 | 200 | 90 | 150.00 | 11.36 | 0.361 | 1.667 | 0.248 |
| K17 | 16 | 9 | 200 | 200 | 90 | 340.00 | 0.91 | 0.029 | 0.000 | 0.005 |
| K18 | 16 | 17 | 200 | 200 | 90 | 70.00 | 5.55 | 0.177 | 0.429 | 0.031 |
| K19 | 17 | 19 | 200 | 200 | 90 | 70.00 | 2.85 | 0.091 | 0.143 | 0.009 |
| K20 | 17 | 31 | 200 | 200 | 90 | 530.00 | 0.78 | 0.025 | 0.000 | 0.006 |
| K21 | 32 | 31 | 200 | 200 | 90 | 160.00 | 3.90 | 0.124 | 0.188 | 0.037 |
| K22 | 19 | 20 | 200 | 200 | 90 | 140.00 | 5.65 | 0.180 | 0.429 | 0.064 |
| K23 | 20 | 43 | 200 | 200 | 90 | 120.00 | 2.80 | 0.089 | 0.165 | 0.015 |
| K24 | 36 | 35 | 150 | 150 | 90 | 240.00 | 7.50 | 0.425 | 3.125 | 0.749 |
| K25 | 35 | 34 | 150 | 150 | 90 | 380.00 | 5.48 | 0.310 | 1.737 | 0.664 |
| K26 | 34 | 33 | 150 | 150 | 90 | 310.00 | 3.46 | 0.196 | 0.742 | 0.231 |
| K27 | 33 | 32 | 150 | 150 | 90 | 210.00 | 0.89 | 0.050 | 0.095 | 0.013 |
| K28 | 33 | 30 | 150 | 150 | 90 | 330.00 | 1.97 | 0.112 | 0.273 | 0.087 |
| K29 | 41 | 30 | 150 | 150 | 90 | 60.00 | 2.20 | 0.124 | 0.334 | 0.019 |
| K30 | 31 | 41 | 200 | 200 | 90 | 230.00 | 2.20 | 0.070 | 0.087 | 0.018 |
| K31 | 27 | 25 | 150 | 150 | 90 | 310.00 | 2.07 | 0.117 | 0.291 | 0.089 |
| K32 | 45 | 12 | 200 | 200 | 90 | 210.00 | 27.86 | 0.887 | 8.715 | 1.829 |
| K33 | 29 | 27 | 150 | 150 | 90 | 500.00 | 2.07 | 0.000 | 0.28 | 0.144 |
| K34 | 30 | 29 | 150 | 150 | 90 | 100.00 | 2.07 | 0.117 | 0.3 | 0.029 |
| K35 | 29 | 20 | 150 | 150 | 90 | 770.00 | 0.00 | 0.117 | 0.000 | 0 |
| K36 | 43 | 26 | 150 | 150 | 90 | 310.00 | 2.80 | 0.000 | 0.484 | 0.156 |
| K37 | 20 | 44 | 150 | 150 | 90 | 1200.00 | 2.43 | 0.158 | 0.138 | 0.467 |
| K38 | 26 | 25 | 150 | 150 | 90 | 130.00 | 2.74 | 0.138 | 0.155 | 0.063 |
| K39 | 44 | 24 | 150 | 150 | 90 | 150.00 | 2.43 | 0.170 | 0.138 | 0.058 |
| K40 | 25 | 21 | 150 | 150 | 90 | 400.00 | 3.00 | 0.035 | 0.17 | 0.228 |
| K41 | 24 | 23 | 150 | 150 | 90 | 380.00 | 0.62 | 0.067 | 0.035 | 0.012 |
| K42 | 22 | 23 | 150 | 150 | 90 | 230.00 | 1.19 | 0.170 | 0.067 | 0.024 |
| K43 | 21 | 22 | 150 | 150 | 90 | 90.00 | 3.00 | 0.854 | 0.17 | 0.051 |
| K44 | 45 | 38 | 200 | 200 | 90 | 30.00 | 26.82 | 0.817 | 0.854 | 0.243 |
| K45 | 38 | 13 | 200 | 200 | 90 | 220.00 | 25.67 | 0.185 | 0.817 | 1.646 |
| K46 | 8 | 40 | 150 | 150 | 90 | 330.00 | 3.27 | 0.100 | 0.185 | 0.221 |
| K47 | 40 | 9 | 150 | 150 | 90 | 90.00 | 3.15 | 0.046 | 0.1 | 0.014 |
| K48 | 2 | 3 | 150 | 150 | 90 | 370 | 0.82 | 0.098 | 0.046 | 0.019 |
| K49 | 5 | 3 | 150 | 150 | 90 | 290 | 1.72 | 0.241 | 0.098 | 0.06 |
| K50 | 7 | 5 | 150 | 150 | 90 | 400 | 4.26 | 0.236 | 0.241 | 0.439 |
| K51 | 8 | 7 | 150 | 150 | 90 | 500 | 2.52 | 0.119 | 0.400 | 0.206 |
| K52 | 6 | 7 | 150 | 150 | 90 | 360 | 4.29 | 0.261 | 1.111 | 0.399 |
| K53 | 4 | 2 | 150 | 150 | 90 | 300 | 3.17 | 0.184 | 0.633 | 0.190 |
| K54 | 6 | 4 | 150 | 150 | 90 | 390 | 5.52 | 0.317 | 1.769 | 0.689 |
| K55 | 12 | 6 | 150 | 150 | 90 | 310 | 12.16 | 0.711 | 7.613 | 2.362 |

Calculation of Pipeline Network (Case 3)

[Calculation Condition]

1. Formula for Calculation

Hazen-Williams Formula

$$h = I \times L$$

$$I = 10.666 \times C^{-1.85} \times D^{-4.87} \times Q^{1.85}$$

(Herein)

h : Friction loss (m)

L : Pipe length

I : hydraulic gradient (‰)

C : Coefficient of flow rate condition (-)

(C=90 : Supposed the pipe condition in 25 years after installation)

D : Pipe diameter (mm)

Q : Flow rate (L/sec)

2. Allowable range of In-put data and Out-put data

| | | |
|---------------------------|---------|---------|
| Minimum effective head | (m) | 5.00 |
| Maximum static head | (m) | 75.00 |
| Nominal diameter | (mm) | 75~1000 |
| Flow velocity | (m/sec) | 0.0~5.0 |
| Total Number of Nodes | | 37 |
| Total Number of Pipelines | | 45 |

3. Result of Calculation

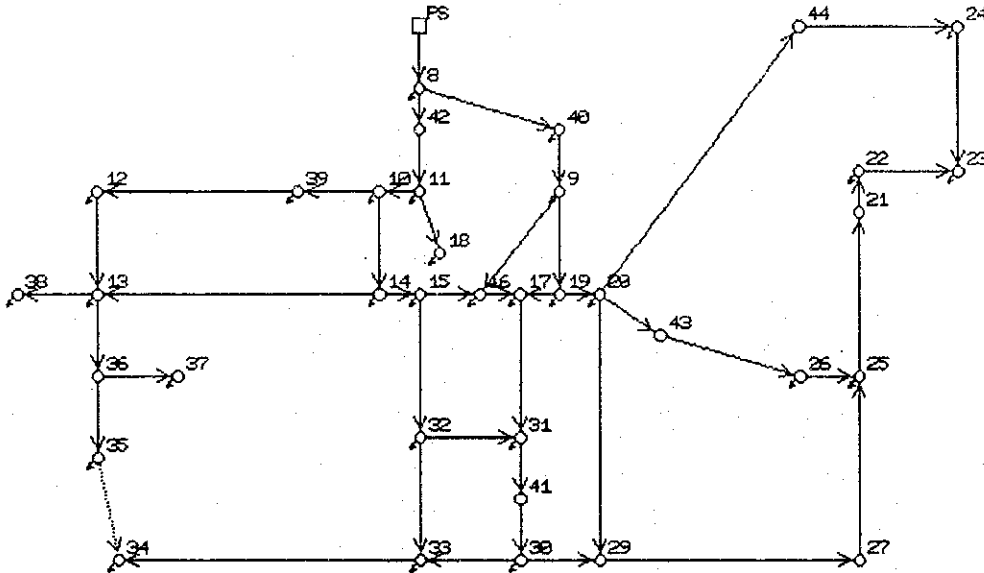
The results of calculation are shown in next 5 pages for Case 3.

(Herein)

| | | |
|-------|-------------------------------|---------|
| Point | : Name of node | (-) |
| H | : Hydrodynamic head | (m) |
| G | : Ground Level | (m) |
| E | : Hydrodynamic effective head | (m) |
| S | : Static head | (m) |
| T | : Total distribution amount | (L/sec) |
| Line | : No. of Pipeline | (-) |
| B | : Start point | (-) |
| F | : End point | (-) |
| N | : Nominal diameter of pipe | (mm) |
| V | : Flow velocity | (m/sec) |

A. Calculation of pipe netwo (case 3-1 : For Low G•L Area)

(1) Figure of pipe network



(2) Point data (PS:appointed the pumping station)

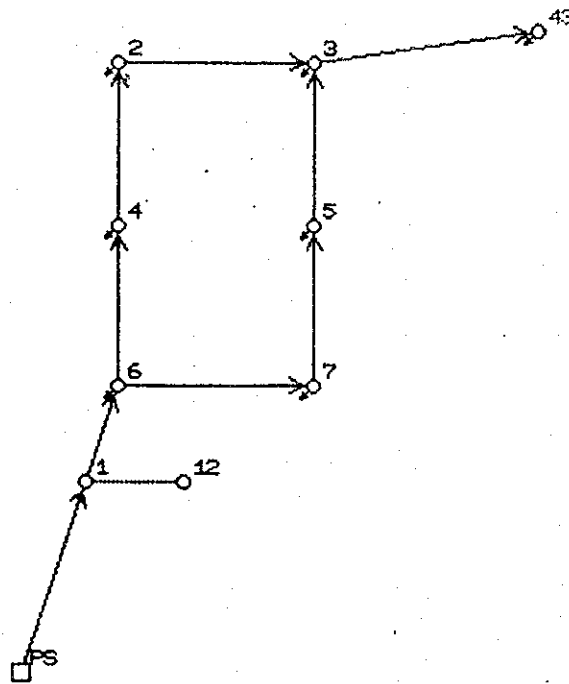
| Point | H (m) | G (m) | E (m) | S (m) | T (L/SEC) |
|-------|----------|----------|----------|----------|--------------|
| 38 | 2191.83 | 2165.00 | 26.83 | 33.50 | 1.150 |
| 13 | 2191.83 | 2165.00 | 26.83 | 33.50 | 0.680 |
| 12 | 2191.84 | 2170.00 | 21.84 | 28.50 | 1.670 |
| 36 | 2191.61 | 2160.00 | 31.61 | 38.50 | 0.000 |
| 37 | 2191.55 | 2160.00 | 31.55 | 38.50 | 2.020 |
| 39 | 2191.92 | 2170.00 | 21.92 | 28.50 | 1.220 |
| 10 | 2192.54 | 2165.00 | 27.54 | 33.50 | 0.980 |
| 42 | 2193.61 | 2165.00 | 28.61 | 33.50 | 0.000 |
| 18 | 2193.16 | 2165.00 | 28.16 | 33.50 | 0.160 |
| 14 | 2191.95 | 2165.00 | 26.95 | 33.50 | 1.320 |
| 15 | 2191.89 | 2165.00 | 26.89 | 33.50 | 2.060 |
| 32 | 2191.68 | 2145.00 | 46.68 | 53.50 | 2.560 |
| 11 | 2193.16 | 2165.00 | 28.16 | 33.50 | 0.490 |
| 16 | 2191.88 | 2165.00 | 26.88 | 33.50 | 4.890 |
| 17 | 2191.86 | 2165.00 | 26.86 | 33.50 | 1.930 |
| 9 | 2192.15 | 2165.00 | 27.15 | 33.50 | 0.800 |
| 40 | 2192.53 | 2170.00 | 22.53 | 28.50 | 0.120 |
| 31 | 2191.68 | 2145.00 | 46.68 | 53.50 | 2.480 |
| 19 | 2191.87 | 2165.00 | 26.87 | 33.50 | 0.460 |
| 20 | 2191.76 | 2165.00 | 26.76 | 33.50 | 0.420 |
| 43 | 2191.74 | 2165.00 | 26.74 | 33.50 | 0.000 |
| 33 | 2191.62 | 2140.00 | 51.62 | 58.50 | 0.600 |
| 41 | 2191.66 | 2140.00 | 51.66 | 58.50 | 0.000 |
| 30 | 2191.63 | 2140.00 | 51.63 | 58.50 | 2.100 |
| 44 | 2191.26 | 2175.00 | 16.26 | 48.50 | 0.000 |
| 34 | 2191.54 | 2140.00 | 51.54 | 58.50 | 2.020 |
| 35 | 2191.54 | 2150.00 | 41.54 | 48.50 | 2.020 |
| 29 | 2191.63 | 2145.00 | 46.63 | 53.50 | 0.000 |
| 27 | 2191.53 | 2145.00 | 46.53 | 53.50 | 0.000 |
| 26 | 2191.55 | 2160.00 | 31.55 | 38.50 | 0.060 |
| 25 | 2191.47 | 2160.00 | 31.47 | 38.50 | 1.810 |
| 21 | 2191.25 | 2170.00 | 21.25 | 28.50 | 0.000 |
| 22 | 2191.21 | 2170.00 | 21.21 | 28.50 | 1.810 |
| 23 | 2191.18 | 2170.00 | 21.18 | 28.50 | 1.810 |
| 24 | 2191.20 | 2175.00 | 16.20 | 23.50 | 1.810 |
| 8 | 2193.91 | 2170.00 | 23.91 | 28.50 | 0.560 |
| PS | 2198.50 | 2208.50 | -10.00 | -10.00 | -40.010 |

(3) Pipeline data

| Line | B | F | N (mm) | D (mm) | C | L (m) | Q (L/SEC) | V (m/s) | I (1/1000) | h (m) |
|------|----|----|-----------|-----------|----|----------|--------------|------------|---------------|----------|
| K1 | PS | 8 | 250 | 250 | 90 | 800.00 | 40.010 | 0.815 | 5.738 | 4.590 |
| K2 | 39 | 12 | 200 | 200 | 90 | 390.00 | 3.441 | 0.110 | 0.205 | 0.071 |
| K3 | 13 | 36 | 150 | 150 | 90 | 220.00 | 4.091 | 0.231 | 1.000 | 0.224 |
| K4 | 36 | 37 | 150 | 150 | 90 | 200.00 | 2.020 | 0.114 | 0.300 | 0.055 |
| K5 | 12 | 13 | 200 | 200 | 90 | 200.00 | 1.771 | 0.056 | 0.050 | 0.011 |
| K6 | 14 | 13 | 200 | 200 | 90 | 470.00 | 4.150 | 0.132 | 0.255 | 0.121 |
| K7 | 14 | 15 | 200 | 200 | 90 | 60.00 | 8.914 | 0.284 | 1.001 | 0.063 |
| K8 | 15 | 32 | 200 | 200 | 90 | 560.00 | 5.048 | 0.161 | 0.375 | 0.207 |
| K9 | 10 | 14 | 200 | 200 | 90 | 230.00 | 14.384 | 0.458 | 2.566 | 0.589 |
| K10 | 10 | 39 | 125 | 125 | 90 | 200.00 | 4.661 | 0.380 | 3.101 | 0.629 |
| K11 | 11 | 10 | 200 | 200 | 90 | 130.00 | 20.025 | 0.637 | 4.768 | 0.614 |
| K12 | 42 | 11 | 200 | 200 | 90 | 90.00 | 20.675 | 0.658 | 5.002 | 0.451 |
| K13 | 11 | 18 | 200 | 200 | 90 | 190.00 | 0.160 | 0.005 | 0.000 | 0.000 |
| K14 | 40 | 9 | 200 | 200 | 90 | 90.00 | 18.656 | 0.594 | 4.224 | 0.373 |
| K15 | 9 | 19 | 200 | 200 | 90 | 210.00 | 10.220 | 0.325 | 1.332 | 0.286 |
| K16 | 15 | 16 | 200 | 200 | 90 | 150.00 | 1.806 | 0.057 | 0.067 | 0.008 |
| K17 | 9 | 16 | 200 | 200 | 90 | 340.00 | 7.636 | 0.243 | 0.794 | 0.270 |
| K18 | 16 | 17 | 200 | 200 | 90 | 70.00 | 4.552 | 0.145 | 0.283 | 0.021 |
| K19 | 19 | 17 | 200 | 200 | 90 | 70.00 | 2.169 | 0.069 | 0.143 | 0.005 |
| K20 | 17 | 31 | 200 | 200 | 90 | 530.00 | 4.791 | 0.153 | 0.340 | 0.178 |
| K21 | 32 | 31 | 200 | 200 | 90 | 160.00 | 0.393 | 0.013 | 0.000 | 0.001 |
| K22 | 19 | 20 | 200 | 200 | 90 | 140.00 | 7.590 | 0.242 | 0.786 | 0.110 |
| K23 | 20 | 43 | 200 | 200 | 90 | 120.00 | 3.115 | 0.099 | 0.167 | 0.018 |
| K24 | 36 | 35 | 150 | 150 | 90 | 240.00 | 2.071 | 0.117 | 0.292 | 0.069 |
| K25 | 35 | 34 | 150 | 150 | 90 | 380.00 | 0.051 | 0.003 | 0.000 | 0.000 |
| K26 | 33 | 34 | 150 | 150 | 90 | 310.00 | 1.969 | 0.111 | 0.258 | 0.081 |
| K27 | 32 | 33 | 150 | 150 | 90 | 210.00 | 2.095 | 0.119 | 0.285 | 0.062 |
| K28 | 30 | 33 | 150 | 150 | 90 | 330.00 | 0.474 | 0.027 | 0.030 | 0.006 |
| K29 | 41 | 30 | 150 | 150 | 90 | 60.00 | 2.704 | 0.153 | 0.500 | 0.028 |
| K30 | 31 | 41 | 200 | 200 | 90 | 230.00 | 2.704 | 0.086 | 0.087 | 0.027 |
| K31 | 20 | 44 | 150 | 150 | 90 | 1200.00 | 2.514 | 0.142 | 0.417 | 0.495 |
| K32 | 8 | 42 | 200 | 200 | 90 | 60.00 | 20.675 | 0.658 | 4.997 | 0.301 |
| K33 | 44 | 24 | 150 | 150 | 90 | 150.00 | 2.514 | 0.142 | 0.400 | 0.062 |
| K34 | 30 | 29 | 150 | 150 | 90 | 100.00 | 0.130 | 0.007 | 0.000 | 0.000 |
| K35 | 20 | 29 | 150 | 150 | 90 | 770.00 | 1.541 | 0.087 | 0.169 | 0.128 |
| K36 | 43 | 26 | 150 | 150 | 90 | 310.00 | 3.115 | 0.176 | 0.613 | 0.190 |
| K37 | 29 | 27 | 150 | 150 | 90 | 500.00 | 1.670 | 0.095 | 0.200 | 0.097 |
| K38 | 26 | 25 | 150 | 150 | 90 | 130.00 | 3.055 | 0.173 | 0.616 | 0.077 |
| K39 | 27 | 25 | 150 | 150 | 90 | 310.00 | 1.670 | 0.095 | 0.194 | 0.060 |
| K40 | 25 | 21 | 150 | 150 | 90 | 400.00 | 2.916 | 0.165 | 0.550 | 0.217 |
| K41 | 24 | 23 | 150 | 150 | 90 | 380.00 | 0.704 | 0.040 | 0.053 | 0.015 |
| K42 | 22 | 23 | 150 | 150 | 90 | 230.00 | 1.106 | 0.063 | 0.131 | 0.021 |
| K43 | 21 | 22 | 150 | 150 | 90 | 90.00 | 2.916 | 0.165 | 0.445 | 0.049 |
| K44 | 8 | 40 | 200 | 200 | 90 | 330.00 | 18.776 | 0.598 | 4.181 | 1.384 |
| K45 | 13 | 38 | 200 | 200 | 90 | 220.00 | 1.150 | 0.037 | 0.000 | 0.005 |

B. Calculation of pipe network (case 3-2 : For High G·L Area)

(1) Figure of pipe network



(2) Point data (PS: appointed the pumping station)

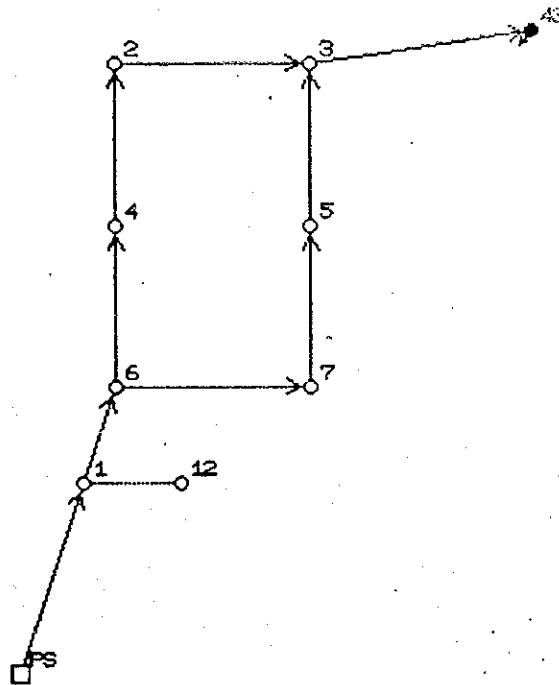
| Point | H (m) | G (m) | E (m) | S (m) | T (L/SEC) |
|-------|----------|----------|----------|----------|--------------|
| PS | 2228.50 | 2163.50 | 65.00 | 65.00 | -24.770 |
| 6 | 2223.74 | 2180.00 | 43.74 | 48.50 | 2.350 |
| 7 | 2222.50 | 2180.00 | 42.5 | 48.50 | 2.540 |
| 4 | 2222.72 | 2190.00 | 32.72 | 38.50 | 2.350 |
| 5 | 2221.83 | 2190.00 | 32.83 | 38.50 | 2.540 |
| 2 | 2222.15 | 2200.00 | 22.15 | 28.50 | 2.350 |
| 3 | 2221.69 | 2200.00 | 21.69 | 28.50 | 2.540 |
| 43 | 2220.63 | 2212.00 | 8.63 | 16.50 | 10.100 |
| 1 | 2225.56 | 2170.00 | 55.56 | 58.50 | 0.000 |
| 12 | 2225.56 | 2170.00 | 55.56 | 58.50 | 0.000 |

(3) Pipeline data

| Line | B | F | N (mm) | D (mm) | C | L (m) | Q (L/SEC) | V (m/s) | I (1/1000) | h (m) |
|------|----|----|-----------|-----------|----|----------|--------------|------------|---------------|----------|
| K1 | 1 | 6 | 200 | 200 | 90 | 260.00 | 24.770 | 0.788 | 7.000 | 1.821 |
| K2 | 6 | 7 | 150 | 150 | 90 | 360.00 | 7.895 | 0.447 | 3.444 | 1.234 |
| K3 | 7 | 5 | 150 | 150 | 90 | 400.00 | 5.355 | 0.303 | 1.675 | 0.669 |
| K4 | 5 | 3 | 150 | 150 | 90 | 290.00 | 2.815 | 0.159 | 0.483 | 0.148 |
| K5 | 2 | 3 | 200 | 200 | 90 | 370.00 | 9.825 | 0.313 | 1.243 | 0.468 |
| K6 | 4 | 2 | 200 | 200 | 90 | 300.00 | 12.175 | 0.388 | 1.900 | 0.565 |
| K7 | 6 | 4 | 200 | 200 | 90 | 390.00 | 14.525 | 0.462 | 2.615 | 1.018 |
| K8 | 3 | 43 | 200 | 200 | 90 | 790.00 | 10.100 | 0.321 | 1.342 | 1.053 |
| K9 | 12 | 1 | 200 | 200 | 90 | 30.00 | 0.000 | 0.000L | 0.000 | 0.000 |
| K10 | PS | 1 | 200 | 200 | 90 | 420.00 | 24.770 | 0.788 | 7.000 | 2.942 |

B. Calculation of pipe netw (case 3-2 night : For High G·L Area)

(1) Figure of pipe network



(2) Point data (PS: appointed the pumping station)

| Point | H (m) | G (m) | E (m) | S (m) | T (L/SEC) |
|-------|----------|----------|----------|----------|--------------|
| PS | 2228.50 | 2163.50 | 65.00 | 65.00 | -24.770 |
| 6 | 2227.59 | 2180.00 | 43.74 | 48.50 | 0.000 |
| 7 | 2227.36 | 2180.00 | 42.49 | 48.50 | 0.000 |
| 4 | 2227.34 | 2190.00 | 32.40 | 38.50 | 0.000 |
| 5 | 2227.09 | 2190.00 | 31.11 | 38.50 | 0.000 |
| 2 | 2227.14 | 2200.00 | 21.37 | 28.50 | 0.000 |
| 3 | 2226.90 | 2200.00 | 20.10 | 28.50 | 0.000 |
| 43 | 2225.85 | 2212.00 | 2.57L | 16.50 | 24.770 |
| 1 | 2227.94 | 2170.00 | 55.56 | 58.50 | 0.000 |
| 12 | 2227.94 | 2170.00 | 55.56 | 58.50 | 0.000 |

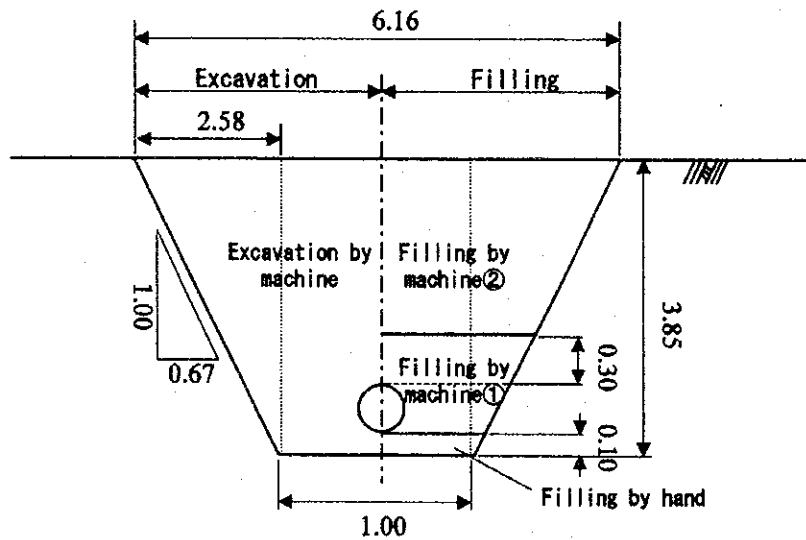
(3) Pipeline data

| Line | B | F | N (mm) | D (mm) | C | L (m) | Q (L/SEC) | V (m/s) | i (1/1000) | h (m) |
|------|----|----|-----------|-----------|----|----------|--------------|------------|---------------|----------|
| K1 | 1 | 6 | 200 | 200 | 90 | 260.00 | 24.770 | 0.788 | 7.000 | 1.821 |
| K2 | 6 | 7 | 150 | 150 | 90 | 360.00 | 7.935 | 0.449 | 3.472 | 1.246 |
| K3 | 7 | 5 | 150 | 150 | 90 | 400.00 | 7.935 | 0.449 | 3.450 | 1.385 |
| K4 | 5 | 3 | 150 | 150 | 90 | 290.00 | 7.935 | 0.449 | 3.483 | 1.004 |
| K5 | 2 | 3 | 200 | 200 | 90 | 370.00 | 16.835 | 0.536 | 3.432 | 1.269 |
| K6 | 4 | 2 | 200 | 200 | 90 | 300.00 | 16.835 | 0.536 | 3.433 | 1.029 |
| K7 | 6 | 4 | 200 | 200 | 90 | 390.00 | 16.835 | 0.536 | 3.436 | 1.337 |
| K8 | 3 | 43 | 200 | 200 | 90 | 790.00 | 24.770 | 0.788 | 7.000 | 5.534 |
| K9 | 12 | 1 | 200 | 200 | 90 | 30.00 | 0.000 | 0.000L | 0.000 | 0.000 |
| K10 | PS | 1 | 200 | 200 | 90 | 420.00 | 24.770 | 0.788 | 7.000 | 2.942 |

Calculation sheet for piping (Dia.150mm)

Unit length 10.00 m

Cross Section

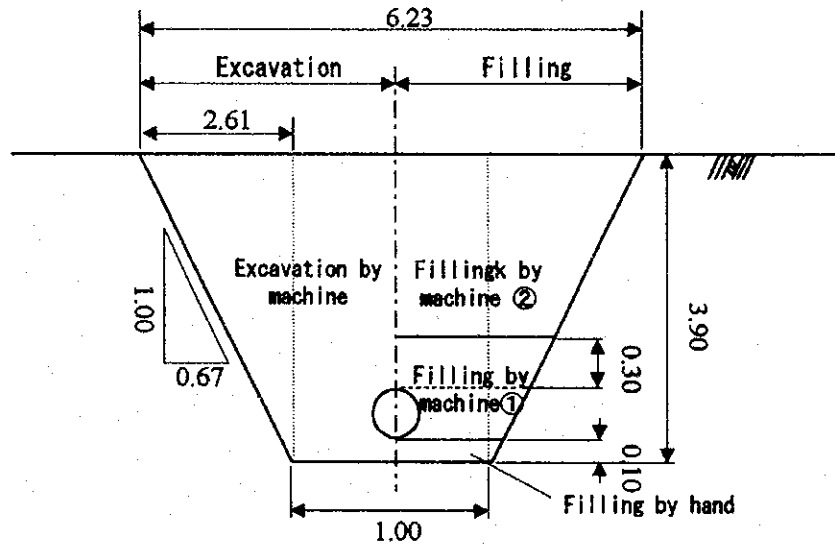


| Category | Calculation | Amount |
|--|--|-------------------------|
| Length | | = 10.00 m |
| Excavation depth | | = 3.85 m |
| Excavation by machine (detritus) | $3.85 \times (6.16 + 1.00) / 2 \times 10.00m$ | = 137.81 m ³ |
| Dia. 150mm (volume of pipe) | $0.165^2 \times \pi / 4 \times 10.00$ | = (0.21) m ³ |
| Filling by hand (sand) | $0.10 \times (1.00 + 1.13) / 2 \times 10.00m$ | = 1.07 m ³ |
| Filling by machine ① (including pipe volume) | $(0.55 - 0.10) \times (1.74 + 1.13) / 2 \times 10.00m$ | = 6.46 m ³ |
| Filling by machine ① (excluding pipe volume) | $(0.55 - 0.10) \times (1.74 + 1.13) / 2 \times 10.00 - 0.21$ | = 6.25 m ³ |
| Filling by machine ② | $137.81 - 6.46 - 1.07$ | = 130.28 m ³ |
| | | |
| | | |
| | | |
| | | |

| Calculation sheet for piping (Dia.150mm×2) | | |
|--|--|-------------------------|
| Unit length | 10.00 m | |
| <u>Cross Section</u> | | |
| | | |
| Category | Calculation | Amount |
| Length | | = 10.00 m |
| Excavation depth | | = 3.85 m |
| Excavation by machine (detritus) | $3.85 \times (6.26 + 1.10) / 2 \times 10.00m$ | = 141.66 m ³ |
| Dia. 150mm×2 (volume of pipe) | $0.165^2 \times \pi / 4 \times 2 \times 10.00$ | = (0.21) m ³ |
| Filling by hand (sand) | $0.10 \times (1.23 + 1.10) / 2 \times 10.00m$ | = 1.17 m ³ |
| Filling by machine ① (including pipe volume) | $(0.55 - 0.10) \times (1.84 + 1.23) / 2 \times 10.00m$ | = 6.91 m ³ |
| Filling by machine ① (excluding pipe volume) | $(0.55 - 0.10) \times (1.84 + 1.23) / 2 \times 10.00 - 0.21$ | = 6.70 m ³ |
| Filling by machine ② | $141.66 - 6.91 - 1.17$ | = 133.58 m ³ |
| | | |
| | | |
| | | |
| | | |

Calculation sheet for piping (Dia.200mm)

Unit length 10.00 m

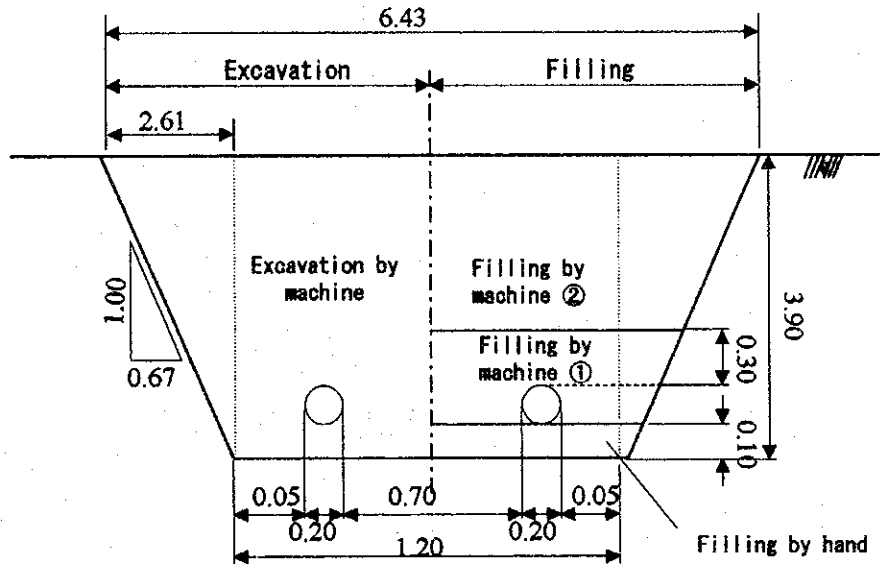
Cross Section

| Category | Calculation | Amount |
|---|---|-------------------------|
| Length | | = 10.00 m |
| Excavation depth | | = 3.90 m |
| Excavation by machine (detritus) | $3.90 \times (6.23 + 1.00) / 2 \times 10.00\text{m}$ | = 140.91 m ³ |
| Dia. 200mm (volume of pipe) | $0.216^2 \times \pi / 4 \times 10.00$ | = (0.37) m ³ |
| Filling by hand (sand) | $1.80 \times (1.00 + 1.13) / 2 \times 10.00\text{m}$ | = 1.07 m ³ |
| Filling by machine ① (including pipe volume) | $(0.60 - 0.10) \times (1.80 + 1.13) / 2 \times 10.00\text{m}$ | = 7.33 m ³ |
| Filling by machine ① (excluding pipe volume) | $(0.60 - 0.10) \times (1.80 + 1.13) / 2 \times 10.00 - 0.37$ | = 6.96 m ³ |
| Filling by machine ② | $140.91 - 7.33 - 1.07$ | = 132.51 m ³ |
| | | |
| | | |
| | | |
| | | |

Calculation sheet for piping (Dia.200mm×2)

Unit length 10.00 m

Cross Section

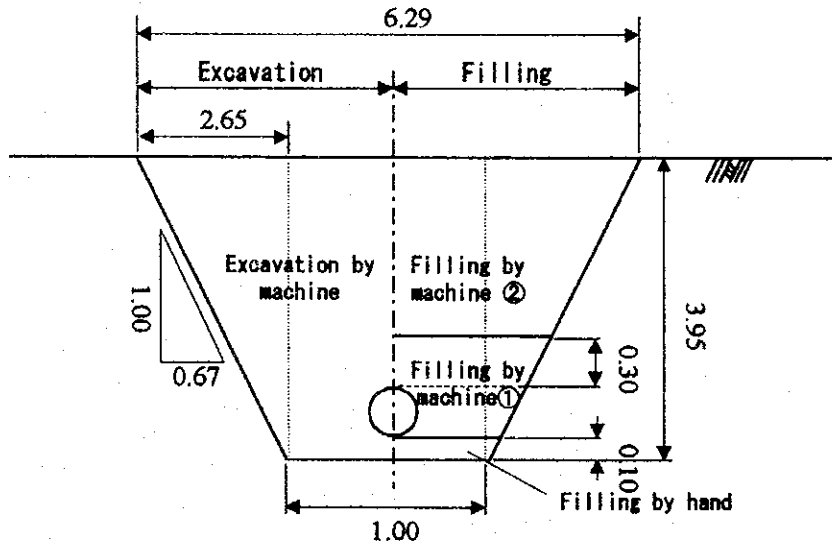


| Category | Calculation | Amount |
|--|--|-------------------------|
| Length | | = 10.00 m |
| Excavation depth | | = 3.90 m |
| Excavation by machine (detritus) | $3.90 \times (6.43 + 1.20) / 2 \times 10.00m$ | = 148.71 m ³ |
| Dia. 200mm×2 (volume of pipe) | $0.216^2 \times \pi / 4 \times 2 \times 10.00$ | = (0.37) m ³ |
| Filling by hand (sand) | $0.10 \times (1.33 + 1.20) / 2 \times 10.00m$ | = 1.27 m ³ |
| Filling by machine ① (including pipe volume) | $(0.60 - 0.10) \times (2.00 + 1.33) / 2 \times 10.00m$ | = 8.33 m ³ |
| Filling by machine ① (excluding pipe volume) | $(0.60 - 0.10) \times (2.00 + 1.33) / 2 \times 10.00 - 0.37$ | = 7.96 m ³ |
| Filling by machine ② | $148.71 - 8.33 - 1.27$ | = 139.11 m ³ |
| | | |
| | | |
| | | |
| | | |

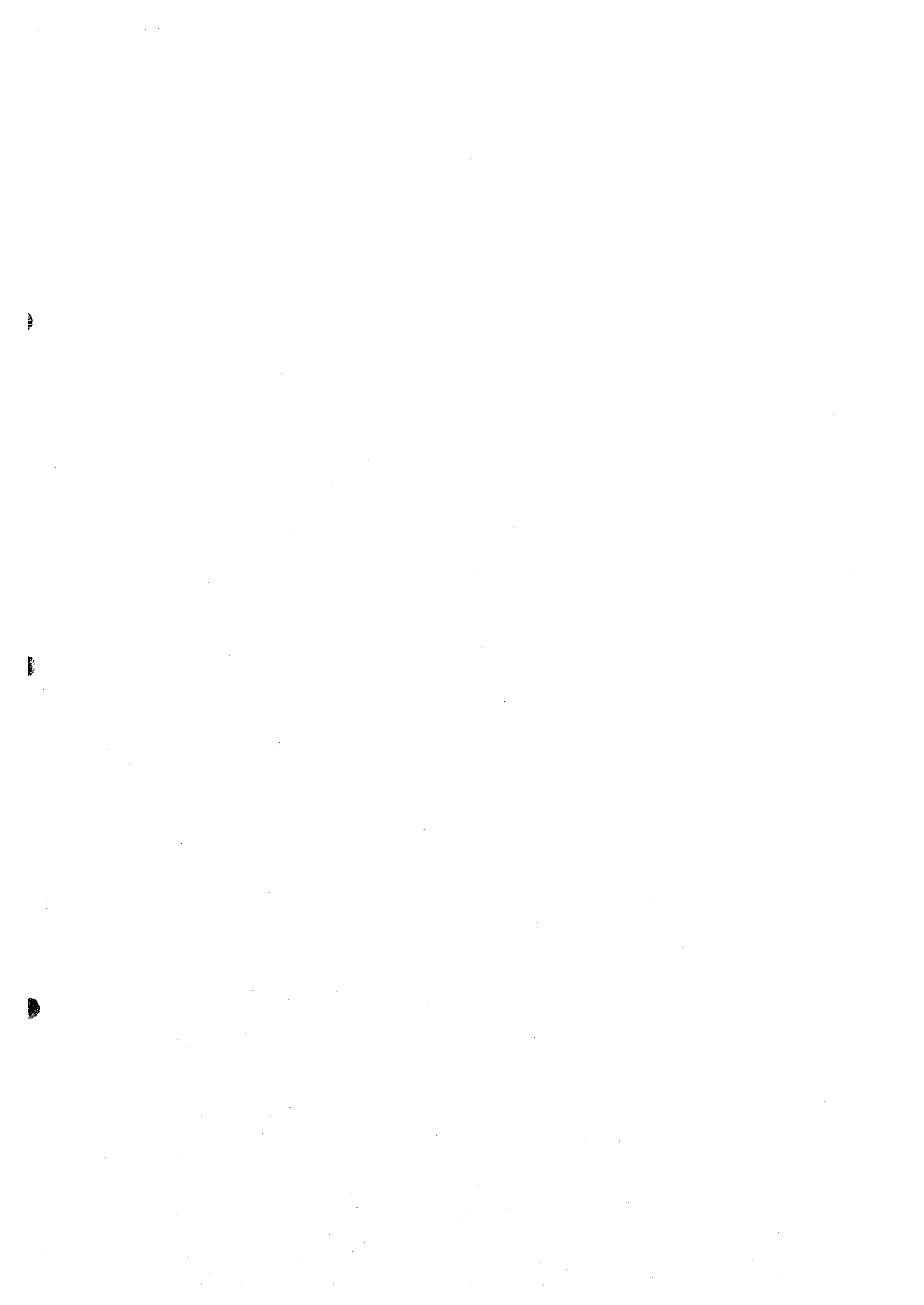
Calculation sheet for piping (Dia.250mm)

Unit length 10.00 m

Cross Section



| Category | Calculation | Amount |
|--|--|-------------------------|
| Length | | = 10.00 m |
| Excavation depth | | = 3.95 m |
| Excavation by machine (detritus) | $3.95 \times (6.29 + 1.00) / 2 \times 10.00m$ | = 144.04 m ³ |
| Dia. 250mm (volume of pipe) | $0.267^2 \times \pi / 4 \times 10.00$ | = (0.56) m ³ |
| Filling by hand (sand) | $1.87 \times (1.00 + 1.13) / 2 \times 10.00m$ | = 1.07 m ³ |
| Filling by machine ① (including pipe volume) | $(0.65 - 0.10) \times (1.87 + 1.13) / 2 \times 10.00m$ | = 8.25 m ³ |
| Filling by machine ① (excluding pipe volume) | $(0.65 - 0.10) \times (1.87 + 1.13) / 2 \times 10.00 - 0.56$ | = 7.69 m ³ |
| Filling by machine ② | $144.04 - 8.25 - 1.07$ | = 134.72 m ³ |
| | | |
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