ATTACHMENT 4

WATER HAMMER CALCULATION OF AQUEDUCT PIPELINE

**************CALCULATION FORMULA OF HYDRAULIC LOSSES ******************

1. Friction loss of straight pipe : H1

H1 is given by the following formula as per WILLIAM HAZEN's formula.

$$H1 = f \times \frac{L}{D} \times \frac{V**2}{2g}$$

Where
- H1 = Friction loss (m)
- L = Pipe length (m)
- D = Pipe diameter (m)
- V = Flow velocity (m/sec)
- g = Gravity acceleration (m/sec**2)

$$f = \frac{134}{C**1.85} \times \frac{1}{D**(1/6) \times V**0.15}$$

- C = Coefficient indicating pipe inner roughness

2. Taper pipe loss in case of convergent flow : H2

H2 is given by the following formula:

$$H2 = f \times \frac{V2 \times V2 - V1 \times V1}{2g}$$

Where
- H2 = Taper pipe loss (m)
- V1 = Inlet flow velocity (m/sec)
- V2 = Outlet flow velocity (m/sec)
- θ = Convergent angle (deg)

$$f = \frac{0.025}{8 \times \sin(\theta/2)}$$

3. Taper pipe loss in case of divergent flow : H3

H3 is given by the following formula:

$$H3 = f \times \frac{(V1 - V2)**2}{2g}$$

Where
- H3 = Taper pipe loss (m)
- V1 = Inlet flow velocity (m/sec)
- V2 = Outlet flow velocity (m/sec)
- θ = Divergent angle (deg)

f is given by the following table:

θ (deg)	8	12	16
f	0.15	0.215	0.307

4. Bend pipe loss : H4

H4 is given by the following formula as per WEISBACH's formula:

$$H4 - f \times \frac{V \times V}{2g}$$

Where

H4 - Bend pipe loss (m)
V - Flow velocity (m/sec)
D - Bend pipe diameter (mm)
θ - Bend angle (deg)
R - Radius of bend pipe center (mm)

$$f - \left(0.131 + 1.847 \times \left(\frac{D}{2R}\right)**3.5 \right) \times \left(\frac{\theta}{90}\right)**0.5$$

5. Butterfly valve loss : H5

H5 is given by the following formula:

$$H5 - f \times \frac{V \times V}{2g}$$

Where

H5 - Butterfly valve loss (m)
V - Flow velocity (m/sec)
f - 0.18 (Dia. is not less than 1200mm)
f - 0.20 (Dia. is less than 1200mm)

6. Sluice valve loss : H6

H6 is given by the following formula:

$$H6 - f \times \frac{V \times V}{2g}$$

Where

H6 - Sluice valve loss (m)
V - Flow velocity (m/sec)
f - 0.05 (In case of full open)

7. Non-return valve loss : H7

H7 is given by the following formula:

$$H7 - f \times \frac{V \times V}{2g}$$

Where

H7 - Non-return valve loss (m)
V - Flow velocity (m/sec)
f - 0.5

8. Inlet loss for bellmouth : H8

H8 is given by the following formula:

$$H8 - f \times \frac{V \times V}{2g}$$

Where

H8 - Inlet loss for bellmouth (m)
V - Flow velocity (m/sec)
f - 0.2 (Made from casting)
f - 0.4 (Made from steel)

9. Loss of branch and confluence flow : H9

H9 is given by the following formula as per CARDEL's formula:

In case of confluence flow

$$H\beta - H\alpha = f\beta \times \frac{V\gamma \times V\gamma}{2 \times g}$$

$$H\gamma - H\alpha = f\gamma \times \frac{V\gamma \times V\gamma}{2 \times g}$$

$$H\gamma - H\beta = (f\gamma - f\beta) \times \frac{V\gamma \times V\gamma}{2 \times g}$$

$$f\beta = -0.95(1 + q\beta)**2 + q\beta \times q\beta \times (1 + 0.42(\frac{\cos\theta}{\phi} - 1) - 0.8(1 - \frac{1}{\phi \times \phi}) + (1 - \phi)(\frac{\cos\theta}{\phi} - 0.38))$$

$$f\gamma = q\beta**2 \times (2.59 + (1.62 - \rho**0.5)(\frac{\cos\theta}{\phi} - 1) - 0.62\phi) + q\beta(1.94 - \phi) - 0.03$$

Where $H\alpha$ - Pressure head at the upstream of main pipe (m)
$H\beta$ - Pressure head at the upstream of branch pipe (m)
$H\gamma$ - Pressure head at the downstream of main pipe (m)
Each abbreviation α, β, γ indicate a location described in the above.
$f\alpha$ - Loss coefficient at α
$f\beta$ - Loss coefficient at β
$f\gamma$ - Loss coefficient at γ
$V\gamma$ - Flow velocity at γ (m/sec)
θ - Angle between main and branch pipe (deg)
ϕ - Area ratio of main and branch pipe
ρ - Ratio of radius at branch and main diameter
$q\beta$ - $Q\beta / Q\gamma$ (shall be negative value)
$Q\gamma$ - Main outlet flow at γ
$Q\beta$ - Branch inlet flow at β
$Q\alpha$ - $Q\gamma - Q\beta$

LOSS CALCULATION TABLE

Service :

Item No.	Description of losses	Flow (m3/sec)	Dia. (mm)	Velocity (m/sec)	f	Loss (m)
0	Screen loss	0.00000	0	0.000	0.0000	0.300
1	Bellmouth	0.30000	400	2.387	0.2000	0.058
2	45 deg Bend	0.30000	400	2.387	0.0994	0.029
3	Straight pipe(William Hazen) Length= 8.00(m) C=110	0.30000	400	2.387	0.0229	0.133
4	Sluice valve	0.30000	400	2.387	0.0500	0.015
5	Taper pipe(Divergent)	0.30000	D1= 300 D2= 400	V1= 4.244 V2= 2.387	0.1717	0.030
6	Butterfly valve	0.30000	400	2.387	0.2000	0.058
7	Non-return valve	0.30000	400	2.387	0.5000	0.145
8	Confluence flow at T	0.30000	D1= 400 D2=1100	V1= 2.387 V2= 0.316	46.0531	0.234
9	Straight pipe(William Hazen) Length= 4.00(m) C=110	0.30000	1100	0.316	0.0262	0.000
10	Confluence flow at T	0.60000	D1= 400 D2=1100	V1= 2.387 V2= 0.631	0.6869	0.014
11	Straight pipe(William Hazen) Length= 4.00(m) C=110	0.60000	1100	0.631	0.0236	0.002
12	Confluence flow at T	0.90000	D1= 400 D2=1100	V1= 2.387 V2= 0.947	0.5228	0.024
13	Straight pipe(William Hazen) Length= 4.00(m) C=110	0.90000	1100	0.947	0.0222	0.004
14	Confluence flow at T	1.20000	D1= 400 D2=1100	V1= 2.387 V2= 1.263	0.4202	0.034
15	Straight pipe(William Hazen) Length= 15.00(m) C=110	1.20000	1100	1.263	0.0213	0.024
16	Ventury flow meter	0.00000	0	0.000	0.0000	0.200
17	Straight pipe(William Hazen) Length=19450.00(m) C=110	1.20000	1100	1.263	0.0213	30.642
18	Ventury flow meter	0.00000	0	0.000	0.0000	0.200
19	Other loss	0.00000	0	0.000	0.0000	0.800
20	Velocity head	1.20000	1100	1.263	1.0000	0.081
	Sum of Hydraulic losses in meter					33.028
	Static head					85.300
	Total Head					(118.328) 120.0

Calculation of Water Hammer by Electronic Computor

We are conducting the calculation of the water hammering phenomenon by use of the electronic computor. This calculation is based on the formulae prepared from the graphic calculation method developed by R.W. Angus, L. Bergeron, Therefore, the explanation of the graphic calculation method makes also clear the electronic computor calculation system for the water hammer.

The most fundamental concept of the graphic calculation method is to assume the water and Pipe as the elastic materials. When the pressure rises, water is compressed and the pipe expands. On the contrary, if the pressure is lowered, the water expands and the pipe is contracted. This phenomenon is relayed from one end of the pipe conduit to the another end of the pipe conduit. This is the propagation of the pressure wave.

According to Newton's motion law and continuation formula, the following formula is obtained.

$$\frac{dv}{dt} = g \frac{dH}{dx} \qquad \frac{dv}{dx} = \frac{g}{a^2} \cdot \frac{dH}{dt}$$

When this differential equation is solved, the general equation of the propagation of pressure wave is obtained as to the respective points of the pipe conduit.

$$H_{At} - H_{Bt} = - a/g\ (V_{At} - V_{At1})$$

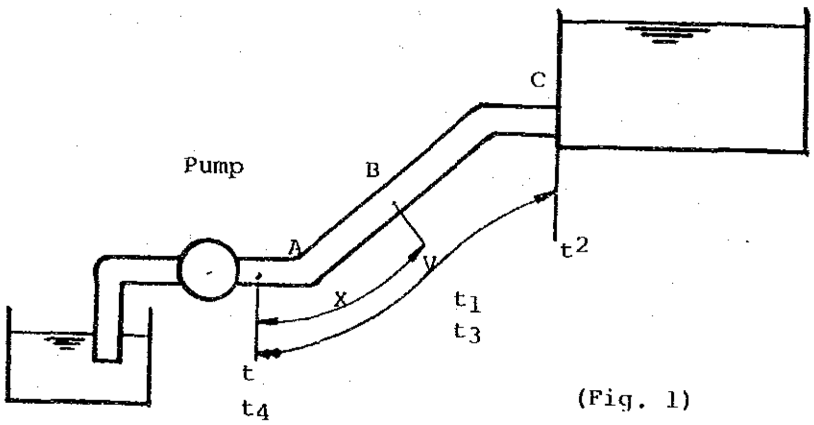
$$H_{Bt1} - H_{Ct2} = - a/g\ (V_{Bt1} - V_{Ct2})$$

$$H_{Ct2} - H_{Bt3} = + a/g\ (V_{Ot2} - V_{Bt3})$$

$$H_{Bt3} - H_{Bt4} = + a/g\ (V_{Bt3} - V_{At4})$$

These formulae form the basis of the graphic calculation system.

The meaning of the respective signs are shown in the drawing at the below. As the pressure wave is propagated, the distance from the pump and the time are changed.



(Fig. 1)

These formulae represent such straight lines as have the gradient of $\pm\ a/g$. The graph at the Fig. 2 shows this relation.

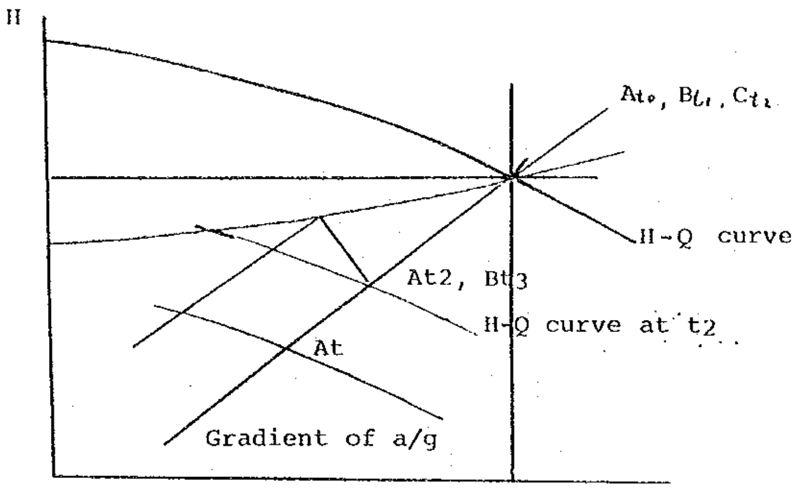


Fig. 2

The change of pressure at A point results in the decline along a/g gradient line. This is assumed that the pressure wave under the constant condition at C point reaches A point at the time t_2.

On the other hand, A·point at t_2 time shows the condition after the input is shut off. The revolution number, therefore, is reduced and H-Q curve is lowered considerably. The crossing point between this straight line and H-Q curve is obtained as At_2 point.

The propagation of the pressure wave : A → B → C

The propagation of the reflective wave: C → B → A

The above propagation is pursued by a/g straight line and the pressure changes at A, B and C points are to be obtained successively.

Since this work is so much complicated and is time-consuming, the numerical formulae are prepared and the calculation is made by the electonic computor.

On opening position of Delivery Valve

When the pump outlet conditions are to be obtained, it must be taken into consideration that the delivery valve is throttled down and the resistance loss occurs. The resistance value at the respective opening positions is calculation as follows:

$$H = \zeta \frac{V^2}{2g}$$

The resistance coefficient ζ is

$$\zeta = F_1 (0) \qquad \theta : \text{valve opening position}$$

$$\theta = F_2 (t)$$

This is a function of the time. After all, the resistance loss is expressed as:

$$H_L = F(t) \frac{V^2}{2g}$$

This is also a function of the time.

In this case, V value is changes as the time passed by and is to be obtained during the process of the successive calculation.

In the whole calculation, the resistance loss is subtracted from H-Q curve toward H direciton and the resultant curve of the pump and valve is prepared.

On Surge Tank

when the calculation on the surge tank is to be made, such a concept has to be introduced as covers the branched pipe, Where the pipe conduit merging pipe.

The conditions which are established at the branching point of the pipe conduit are as follows.

$$Ha = Hc = Hd$$

$$Qa + Qd = Qc$$

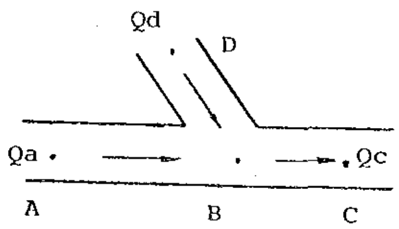


Fig. 3

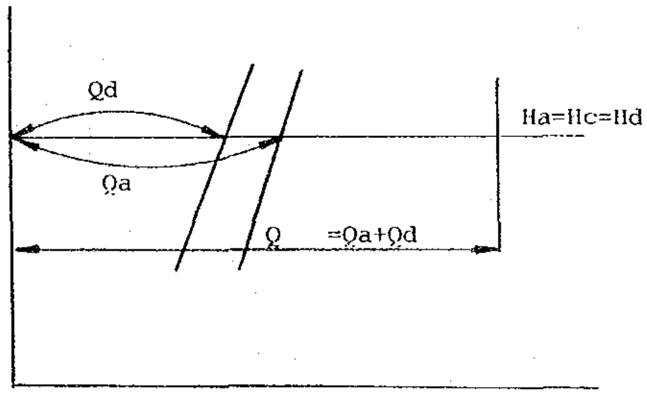


Fig. 4

(In case of the merging flow)

When these conditions are shown in the graph, together with the general formula, the graph at the above is obtained. The calculation frequency of the pipe conduits A, C and D is arranged to be combined at B point, and such a value of this merging point is to be obtained as satisfies the above relations.

The lowered liquid face of the surge tank is expressed by the following formula.

$$\frac{Qt + Q(t - \Delta t)}{2} \cdot \Delta t/s = \Delta H$$

At : Calculation time

Qt : Delivery amount

ΔH : Reduced amount

S : Surge tank sectional area

Together with ΔH, the pressure by the surge tank water level is changed, and Qt and $Q(t - \Delta t)$ are changed incessantly. Therefore, they are combined in the process of the successive calculation.

On Dimensionless Form

In order to facilitate the above calculations and to provide the universality in application, the dimensions are made dimensionless in the calculation so that no unit may be involved.

The basic numerical values are:

Basis water volume : Qr

Basis head : Hr

The design value is used in general. Following general equations are then obtained.

$$h_{At} - h_{gt_1} = -2\zeta\,(V_{At} - V_{Bt_1})$$

$$h_{bt} - h_{ct_2} = -2\zeta\,(V_{Bt} - V_{ct_2})$$

$$h_{ct_2} - h_{Bt_3} = 2\zeta\,(V_{ct_2} - V_{Bt_3})$$

$$h_{Bt_3} - h_{At_4} = 2\zeta\,(V_{At_4} - V_{At_3})$$

$$= \frac{aV_R}{2gHR} \qquad V_R = \frac{Qr}{A}$$

Formula of Revolution Number Change

The revolution number of the pump is decreased as the inertia (including that of motor) is consumed through the feed work of the water.

The lowered revolution number ΔN is expressed then as follows.

$$\Delta N = K.m.\Delta t$$

$$m\,\frac{Mt + M(t - \Delta t)}{2} \cdot \frac{1}{MR}$$ (Dimensionless form of the torque)

$$K = \frac{91200\ HgQ_R}{IN_R^2}$$ (Coefficient of the inertia force)

$$I = GD^2/4g$$ (Inertia moment)

These values are calculated and indicated in the calculation sheet. The values of ΔN and m are changed as the time passes by and the successive calculation is carried out.

The above is the brief calculation mechanism in the economic computor and the main calculaiton formulae.
The resistance of the pipe conduit and the pump characteristic curve and also set in the formulation and are included in the calculation.

The Symbol of Output Sheets by Computor
(PRO. NO. C911)

1. Page 1.

LEVEL	; Water level in suction well
DT	; Minute time
----KANRO DATA----	;Pipe line data
KYORI	; Distance of pipeline
KANSYU	; Kind of pipe
D	; Diameter of main pipe
T	; Thickness of pipe
E	; Elastic modulus
MOTO-KANRO	; Previous pipeline
PUMP NO	; Pipe number
S-NO	;Surge tank number
V-NO	; Valve number
END	; The end of pipeline
SUIRYO	; Totalcapacity in main pipe
PIPE-LOSS	; Loss head of main pipeline
VALVE-LOSS	; Loss head of valve
2L/A	;Interval of time for pressure wave round trip
ROW	; Pipe coefficient
POINT	; No. of intermediate point for calculation
BUNKATU	; Division for calculation

----PUMP DATA----

DAISU	; Quantity of pump
TOKUSEI	: Type of pump
VALVE	: Type of discharge check valve
V-NO	: Number of cushion check valve
PLOT	: Plotting indicate mark
YOOTEI	: Total pump head
SUIRYO	: Capacity of a set pump
KW	:Output of motor
P	: Pole of motor

GD2	: Inertia of pump and motor
GD2(WHEEL)	: Inertia of fly-wheel
RPM	: Pump speed
K	;Damping coefficient

-----SURGE TANK----

NO	: Surge tank number
SYURUI	: Surge tank type
V-NO	: Valve number
PLOT	: Plotting mark
SUITO	:Initial level of tank
MENSEKI	: Sectional area of surge tank
LOSS	: Loss head of surge tank pipe
KYORI	: Distance from surge tank
KANSYU	: Kind of surge tank pipe
AIR-Q	: Initial air volume
LOSS	:Loss head from surge tank

-----ATURYOKU SENZU DATA-----

; Water hummer pressure curve

----JUDAN DATA----

NO	: Pipe number
KYORI	: Distance from pump
TAKASA	: Level

2. Page 2.

KEISAN INTERVAL : Interval for calculation

SURGE TANK SUII HENKA : Variation of surge tank level

NO	;Surge tank number
MAX. (MIN.)	
YOOTEI	:Maximum (minimum) head in pipe at each place
LEVEL	:Maximum (Minimum) level in pipe at each place
SUII HENKA	:Variation of level
MENSEKI	:Sectional area of surge tank
SUIRYO	:Flow volume of surge tank

KANRO ATURYOKU	:Pressure of pipeline
NO	:Pipeline number (symbol)
KYORI	:Distance from pump
TIME	:Time after power failure
SUIRYO	:Capacity in pipe at each place
YOOTEI	:Head in pipe at each place
LEVEL	:Level in pipe at each place

NO COUNTERMEASURE

W A T E R   H A M M E R   A N A L Y S I S

SUEZ/EGYPT

LEVEL 3.300 M
DT .04944 SEC

--- KANRO DATA ---

NO	KYORI M	KAN SYU	D MM	T MM	E	MOTO-KANRO	PUMP-NO	S-NO	V-NO	END	PLOT	SUIRYO M3/M	PIPE LOSS M	VALVE LOSS M	2L/A SEC	ROW	POINT	BUNKATU	
A	19450.0	FCD3	1100	14.0	1.600		1 0 0	0	0	1	0	72.000	34.700	.000	38.7646	.8984	3	784	.0

--- PUMP DATA ---

NO	DAI SU	TOKU SEI	VAL VE	V-NO	PLOT A	PLOT B	YOOTEI M	SUIRYO M3/M	KW	P	GD2 KG-M2	GD2 (WHEEL) KG-M2	RPM	%	K	START CONDITION YOOTEI M	START CONDITION SUIRYO M3/M	N	M
1	4	1	1	0	0	0	120.000	18.000	500.0	6	100.000	.000	980	83	1.6146	120.000	18.000	1.000	1.000

--- ATURYOKU SENZU DATA ---

A

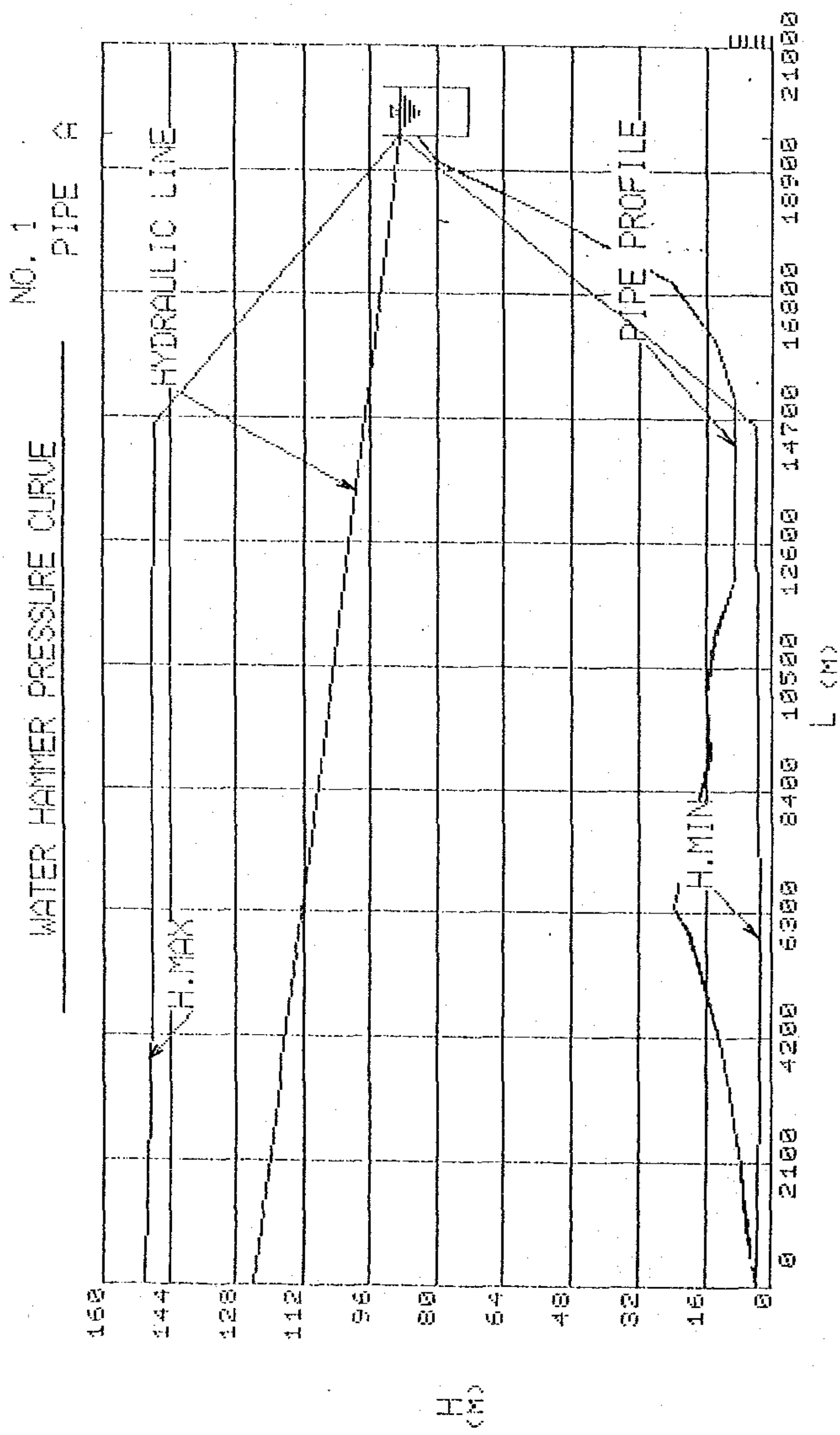
--- JUDAN DATA ---

NO	KYORI M	TAKASA M	KYORI M	TAKASA M	KYORI M	TAKASA M	KYORI M	TAKASA M
A	.0	3.50	1000.0	6.00	2000.0	7.30	4000.0	12.00
	6000.0	20.00	6400.0	23.70	9000.0	15.00	10000.0	16.00
	11000.0	14.00	12000.0	9.00	13800.0	9.00	15000.0	9.00
	16000.0	13.50	17000.0	24.00	18000.0	49.00	19000.0	79.00
	19450.0	85.00						

1. KEISAN INTERVAL 5

3. KANRO ATURYOKU

NO		KYORI M	MAX TIME SEC	MAX SUIRYO M3/M	MAX YOOTEI M	MAX LEVEL M	MIN TIME SEC	MIN SUIRYO M3/M	MIN YOOTEI M	MIN LEVEL M
A	0/ 4	.0	77.580	.000	146.782	150.082	34.018	5.114	-.176	3.124
A	1/ 4	4862.5	72.734	-1.059	144.881	148.181	33.919	5.117	-.213	3.083
A	2/ 4	9725.0	67.888	-1.077	144.852	148.152	29.073	5.148	-.204	3.096
A	3/ 4	14587.5	63.043	-1.274	144.502	147.802	24.228	5.498	.362	3.662

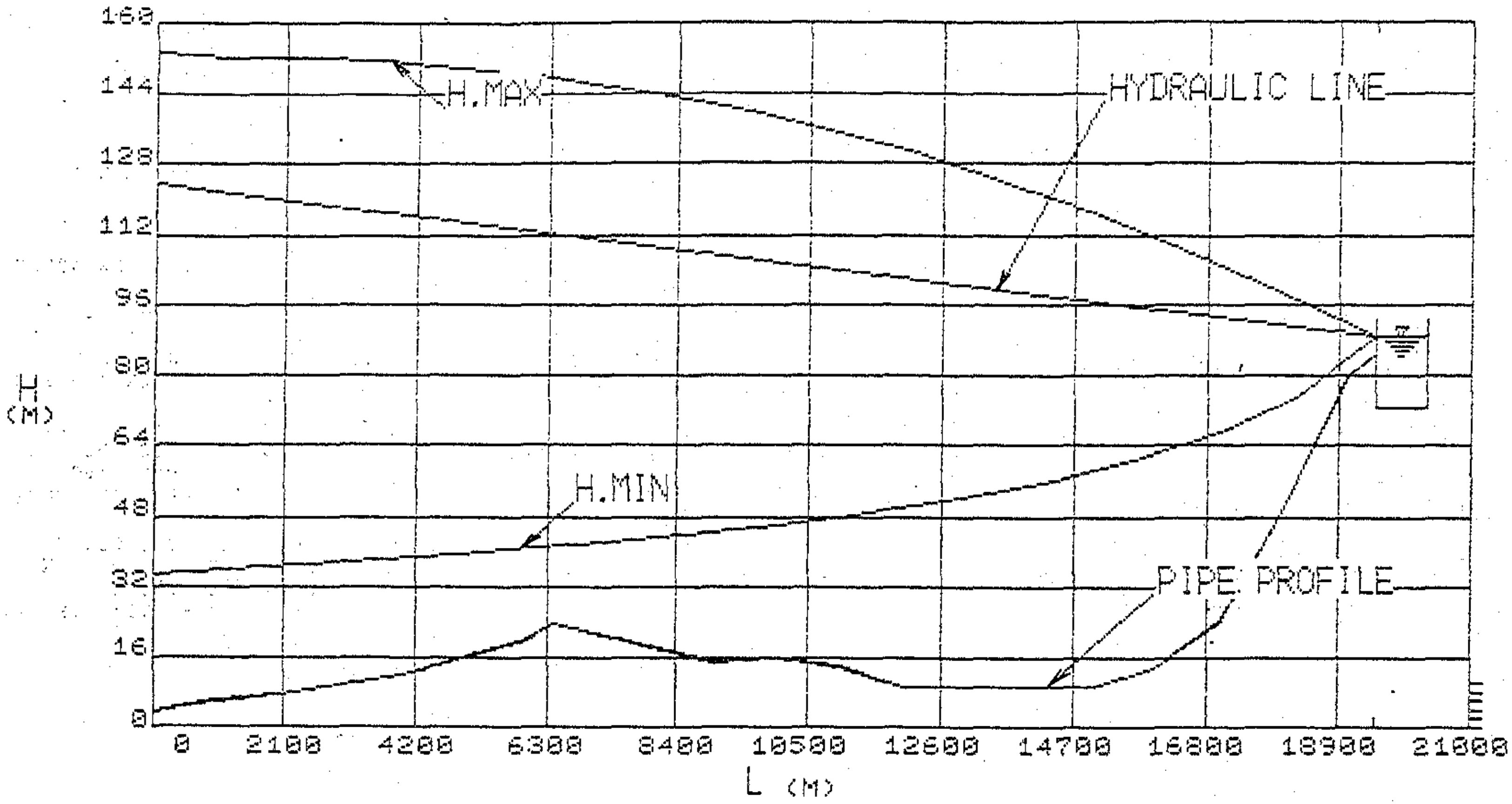

WATER HAMMER PRESSURE CURVE
NO. 1
PIPE A
HYDRAULIC LINE
PIPE PROFILE
H.MAX
H.MIN
0
2100
4200
6300
8400
10500
12600
14700
16800
18900
21000
L (M)
0
16
32
48
64
80
96
112
128
144
160
H (M)

WITH AIR VESSEL

```
                    W A T E R   H A M M E R   A N A L Y S I S        NO. 2              PAGE    1

                    SUEZ/EGYPT

                    LEVEL          3.300 M
                    DT            .04944 SEC
                                                                               P
--- KANRO DATA ---                                                           E L      PIPE  VALVE                      PO
     KYORI  KAN    D      T      E                             S- V- N O  SUIRYO   LOSS   LOSS    2L/A              IN  BUN
  NO     M  SYU   MM     MM              MOTO-KANRO  PUMP-NO NO NO D T    M3/M      M      M      SEC       ROW   T KATU
   A 19450.0 FCD3 1100   14.0   1.600                  1  0  0  1  0 1 0  72.000 34.700   .000 38.7646    .8984 15  784       .0

--- PUMP DATA ---                                                      GD2                          - - - START CONDITION - - -
    DAI TOKU VAL V- PLOT  YOOTEI   SUIRYO                  GD2      (WHEEL)                         YOOTEI   SUIRYO
 NO  SU  SEI  VE NO  A B      M     M3/M      KW  P      KG-M2      KG-M2  RPM  %        K            M       M3/M      N      M
  1   4   1   1   0  0 0 120.000   18.000  500.0  6    100.000       .000  980 83   1.6146 120.000   18.000 1.000 1.000

--- SURGE TANK DATA ---
    SYU V- PL   SUITO MENSEKI   LOSS  KYORI KAN     D     T      E     2L/A     ROW  BUN   AIR-Q    LOSS
 NO RUI NO OT       M     M2      M       M  SYU   MM    MM             SEC         KATU     M3       M
  1  3   0  0   3.300    .000  7.347     .0    0    0    .0   .000    .0000    .000   0     10.0   1.000

--- ATURYOKU SENZU DATA ---

   A

--- JUDAN DATA ---
        KYORI    TAKASA       KYORI   TAKASA       KYORI   TAKASA       KYORI   TAKASA
 NO        M        M           M        M            M        M           M        M
  A       .0      3.50      1000.0     6.00      2000.0     7.30      4000.0    12.00
      6000.0     20.00      6400.0    23.70      9000.0    15.00     10000.0    16.00
     11000.0     14.00     12000.0     9.00     13800.0     9.00     15000.0     9.00
     16000.0     13.50     17000.0    24.00     18000.0    49.00     19000.0    79.00
     19450.0     85.00
```

WATER HAMMER PRESSURE CURVE

NO. 2
PIPE A



W A T E R   H A M M E R   A N A L Y S I S   NO. 2   PAGE 2

1. KEISAN INTERVAL 4

2. SURGE TANK SUII HENKA

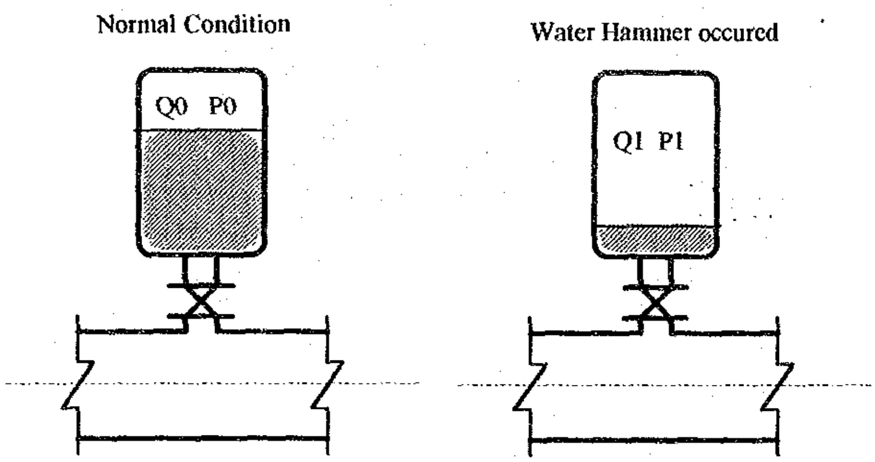
NO	MAX YOOTEI M	MAX LEVEL M	MIN YOOTEI M	MIN LEVEL M	SUII HENKA M	MENSEKI M2	SUIRYO M3
1	150.176	153.476	31.544	34.844	118.633	.0000	.000

3. KANRO ATURYOKU

NO		KYORI M	MAX TIME SEC	MAX SUIRYO M3/M	MAX YOOTEI M	MAX LEVEL M	MIN TIME SEC	MIN SUIRYO M3/M	MIN YOOTEI M	MIN LEVEL M
A	0/16	.0	123.911	-.016	150.176	153.476	44.599	.129	31.544	34.844
A	1/16	1215.6	117.507	-1.902	148.807	152.107	37.553	23.594	32.796	36.096
A	2/16	2431.3	118.719	-2.038	149.054	152.354	36.342	24.297	33.797	37.097
A	3/16	3646.9	119.188	-1.910	148.114	151.414	35.130	25.069	34.889	38.189
A	4/16	4862.5	118.966	-2.063	146.645	149.945	33.919	25.923	36.088	39.388
A	5/16	6078.1	118.842	-2.173	144.718	148.018	32.708	26.874	37.411	40.711
A	6/16	7293.8	118.768	-2.256	142.296	145.596	31.496	27.943	38.881	42.181
A	7/16	8509.4	118.743	-2.296	139.343	142.643	30.285	29.155	40.530	43.830
A	8/16	9725.0	118.719	-2.353	135.821	139.121	29.073	30.546	42.396	45.696
A	9/16	10940.6	118.793	-2.234	131.695	134.995	27.862	32.165	44.532	47.832
A	10/16	12156.3	118.818	-2.201	126.936	130.236	26.651	34.082	47.012	50.312
A	11/16	13371.9	118.843	-2.170	121.526	124.826	25.439	36.400	49.940	53.240
A	12/16	14587.5	118.867	-2.140	115.457	118.757	24.228	39.284	53.471	56.771
A	13/16	15803.1	118.892	-2.112	108.741	112.041	23.017	43.007	57.848	61.148
A	14/16	17018.8	118.917	-2.086	101.422	104.722	21.805	48.076	63.478	66.778
A	15/16	18234.4	118.942	-2.060	93.574	96.874	20.594	55.565	71.096	74.396

CALICURATION OF SERGE VESSEL FOR INTAKE PUMPING SYSTEM

1. Initial Volume of Air in the Vessel (Q0) = 10 m3



P0 : Intial Pressure

Q0 : Intial Volume of Air

P1 : Balanced Pressure at Water Hammer

Q1 : Balanced Air Volume at Water Hammer

2. Required Air Storage at Water Hammer

(P0 + 1) Q0 = (P1 + 1) Q1

where P0 = Maximum Hydraulic Head = 15.0176 kg/cm2

P1 = Minimum Hydraulic Head = 3.1544 kg/cm2

Q0 = 10 m3

then (15.0176 + 1) x 10 = (3.1544 + 1) x Q1

therefore

Q1 = 38.94 m3

Hence, the volume of air vessel is 40 m3.

ATTACHMENT 5

HYDRAULIC CALCULATION OF WATER TREATMENT PLANT

Calculation of Hydraulics of Water Treatment Plant

1. Quantity of Water to be Treated by the Facility

Quantity of water treated by the facility is :

Q_0 = 25,000 m^3/day

= 1041.66 m^3/hr

= 17.36 m^3/min

= 0.289 m^3/sec

2. Water level at individual processes in the water treatment plant

1) Raw water reservoir w_1

Piping from the raw water reservoir to the receiving tank is steel pipe of 700mm diameter and 20.0m length, which corresponds to the flow speed :

$$VR_1 = \frac{Q_0}{\pi/4 \times 0.7^2} = 0.752 \text{ m/sec}$$

a) Pressure loss at straight pipe section n_1

From the William & Hazen's equation,

$n_1 = 10.666 \cdot C^{-1.85} \cdot D^{-4.87} \cdot Q^{1.85} \cdot L$

$= 10.666 \times 100^{-1.85} \times 0.70^{-4.87} \times 0.289^{1.85} \times 20$

$= 0.0243$ m

where C = flow speed coefficient

D = pipe inside diameter (m)

Q = flow rate (m^3/sec)

L = pipe length (m)

b) Pressure loss at bending section h_2

$$h_2 = (f_1 \times 1 + f_2 \times 5 + f_3 \times 1 + f_4 \times 1 + f_5 \times 1) \times \frac{VR^2}{2g}$$

$$= (1.0 + 0.3 \times 5 + 1.0 \times 5 + 1.0 + 0.1 \times 3) \times \frac{0.752^2}{2 \times 9.8}$$

$$= 0.254 \text{ m}$$

where f_1 = pressure loss factor at exit opening: 1.0

f_2 = pressure loss factor at bending section: 0.3

f_3 = pressure loss factor at tee section: 1.0

f_4 = pressure loss factor at inlet opening: 1.0

f_5 = pressure loss factor at butterfly valve: 0.1

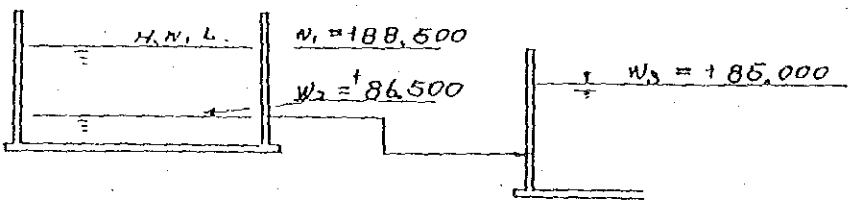
c) Pressure loss at flow meter and valve h_2'

h_2' = 1.0 m as the pressure loss at Venturi flowmeter and control valve

From the above assumptions:

$$n_1 + n_2 + h_2' = 0.0243 \text{ m} + 0.254 \text{ m} + 1.00 \text{ m}$$

$$= 1.2783 \text{ m} = 1.50 \text{ m}$$



Raw water reservoir. Receiving well

w_1(HWL) = 85.00 + 3.50 = 88.50 m

w_2 = 85.00 + 1.50 = 86.50 m

2) Water level in receiving well w_3

w_3 = 85.00 m

3) Water level in mixing well w_4

a) $w_4 = w_3 - h_3$ = 85.00 - 0.30 = 84.70 m

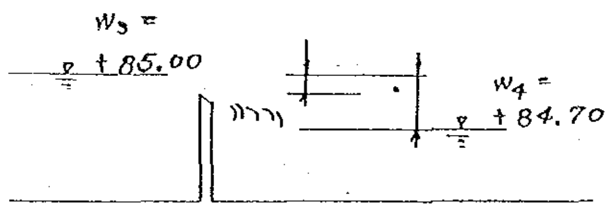
Take $Q = 1.84 \; B \cdot h_{3'}^{3/2}$

Q = flow rate: 0.289 m^3/s

B = weir width: 3.50 m

Then, $h_{3'}$ = 0.1263 m

Put h_3 = 0.30 m to assure overflow



Receiving well   Mixing well

b) Calculation of G value

$$G = \sqrt{\frac{p \cdot h}{\mu \cdot v}}$$

where p = shaft horsepower $kg \cdot m^2/s^3$

h = efficiency of reduction gear 0.8

v = capacity of mixing basin 52.08 m^3

μ = water viscosity 1.0×10^{-3} $kg/m \cdot s$ (at 20°C)

G = 250 (experiential value) 250

$$250 = \sqrt{\frac{p \times 0.8}{52.08 \times 10^{-3}}}$$

Then, $p = 4068.75\ kg \cdot m^2/s^2$

$= 4.07$ kw

Elective motor of 5.5 kw is employed.

4) Water level at upstream of the flocculation basin w_5

a) Condition of calculation

Number of basins $NF_1 = 2$ (stand-by basin = 0)

Number of rows NR = 10

b) Friction loss at the inlet gate to the flocculation basin h_4

Dimensions of gate: 0.5 m width, 0.5 m height

Flow speed at gate:

$VR_2 = 0.289\ m^3/s \div (0.5 \times 0.5) \div 2 = 0.578$ m/s

Pressure loss across gate:

$$h_4 = f_6 \times \frac{VR_2^2}{2g} = 0.60 \times \frac{0.578^2}{2 \times 9.8}$$

$= 0.0102$ m $\fallingdotseq 0.02$ m

Then, the water level at upstream of the flocculation basin becomes to:

$w_5 = 84.70 - 0.02 = 84.68$ m

5) Water level at downstream of the flocculation basin W_6

Head loss caused by baffled-flow of flocculation basin, h_5, is calculated as below.

a) Condition

Number of baffled-flow rows : 10

Total head loss : 1.0 m

Mixing : tapered flocculation

Baffled-flow cross section : 1.0 m width, 3.5 m length

Flow speed at the first baffled-flow : 0.6 m/sec

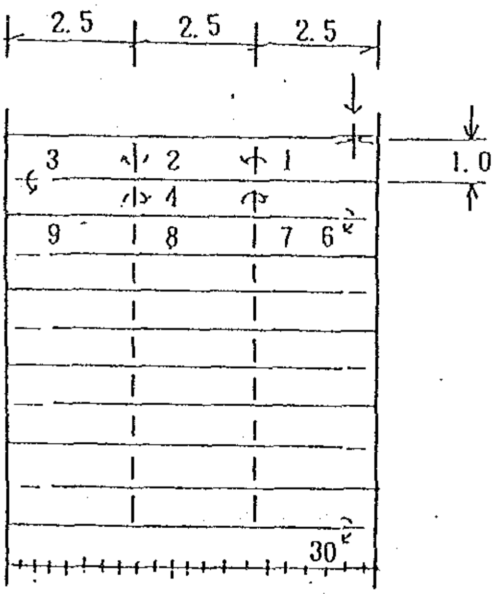
Flow speed at the last baffled-flow : 0.3 m/sec

GT value : ≧ 100000

Baffle plate thickness TU : 0.03 m

Bottom level : +80.70

Initial depth HUO : 3.98 m



Flocculation basin Plan view

b) Main equations

Baffled-flow loss

* At the lower bent section

$hU(n) = fd \times vU(n)^2/2g + HU(n)/C^2 \cdot R \times vUA^2$

where fd : loss coefficient at the lower bent section 2.5 (average 3.5)

vU(n) : average flow speed at the lower bent section (m/sec)

g : gravitational acceleration 9.8 m/sec^2

HU(n) : depth of the portion No. n : odd number for upper position and even number for lower position

C : Chezy's coefficient

$C^2 = 1/n^2 \times R^{1/3}$

n : Manning's roughness factor : 0.014

R : Hydraulic radius (m)

* At the upper bent portion

$hU(n) = vU(n)^2/2g + HU(n)/C^2 \cdot R \times vUA^2$

* Total head loss

$$hU = \sum_{N-1}^{N} hU(n)$$

c) Result of calculation

No.	Average flow speed at baffled-flow section m/sec	Height of opening mm	Upper bending loss mm	Lower bending loss mm	Depth m
					3.98
1	0.60	0.241	0.018		3.97
2	0.59	0.245		0.062	3.90
3	0.58	0.249	0.017		3.89
4	0.57	0.254		0.058	3.83
5	0.56	0.258	0.016		3.81
6	0.55	0.263		0.054	3.76
7	0.54	0.268	0.015		3.74
8	0.53	0.273		0.050	3.69
9	0.52	0.278	0.014		3.68
10	0.51	0.284		0.046	3.63
11	0.50	0.289	0.013		3.62
12	0.49	0.295		0.043	3.58
13	0.48	0.301	0.012		3.56
14	0.47	0.308		0.039	3.53
15	0.46	0.315	0.011		3.51
16	0.45	0.322		0.036	3.48
17	0.44	0.329	0.010		3.47
18	0.43	0.336		0.033	3.44
19	0.42	0.344	0.009		3.43
20	0.41	0.353		0.030	3.40
21	0.40	0.362	0.008		3.39
22	0.39	0.371		0.027	3.36
23	0.38	0.381	0.007		3.35
24	0.37	0.391		0.024	3.33
25	0.36	0.402	0.007		3.32
26	0.35	0.413		0.022	3.30
27	0.34	0.426	0.006		3.30
28	0.33	0.438		0.019	3.28
29	0.32	0.452	0.005		3.27
30	0.31	0.467		0.017	3.25
		Subtotal of head loss	0.168	0.563	

Total head loss $h_5 = 0.731$ m

d) GT value

$GT = (p \cdot g \cdot hF4 \cdot T/\mu)^{0.5}$

where p = water density 1000 kg/m^3

μ = water viscosity factor 1×10^{-3} $kg/m \cdot S$

T = retention time in flocculation basin 1836 sec

$= (1000 \times 9.8 \times 0.731 \times 1836/1 \times 10^{-3})^{0.5}$

$= 114{,}634 \geqq 100000$

$w_6 = W_5 - h_5$

$= 84.68 - 0.731 = 83.95$

with some margin,

$w_6 = 83.80$

6) Water level in sedimentation basin w_7

a) Baffle wall loss at upstream of sedimentation basin h_6

Diameter of baffle hole is 100 mm, number of baffle wall rows is 20, and number of stages is 10.

Flow speed across the baffle wall:

$$VR_3 = \frac{0.289 \ m^3/S}{\pi/4 \times 0.1^2 \times 20 \times 10 \times 2 \text{ basins}} = 0.094 \text{ m/s}$$

$$h_6 = 1/C_0^2 \times \frac{VR_3}{2g}$$

where c_0 = loss factor of baffle hole : 0.6

$$h_6 = \frac{1}{0.6^2} \times \frac{0.094^2}{2 \times 9.8} = 0.0013 \text{ m} \fallingdotseq 0 \text{ m}$$

b) Baffle wall loss at downstream of sedimentation basin n_7

Diameter of baffle hole is 100 mm, number of baffle wall rows is 20, and number of stages is 10.

$n_7 = 0.0013 \text{ m} \fallingdotseq 0 \text{ m}$

Then, the Water level in the sedimentation basin becomes:

$w_7 = w_6 - 0 = 83.80 - 0 = 83.80 \text{ m}$

7) Water level in the sedimentation treated water conduit w_8

Multi-hole trough is employed as the water efluent troughs, which has the dimensions of 350 mm width, 350 mm depth, and 4,000 mm length. The number of troughs is 6 for every basin.

$w_8 = w_7 - HT1 + HT2 - HT3$

where HT1 = trough depth 0.35 m

HT2 = distance between the top of trough and the center of collection hole 0.05 m

HT3 = margin 0.15 m

Then, the water level in the sedimentation treated water conduit becomes:

$w_8 = 83.80 - 0.35 + 0.05 - 0.15 = 83.35 \text{ m}$

8) Water level in the intake conduit to the filter basin w_9

Piping from the sedimentation treated water conduit to the intake conduit of the filter basin is steel pipe of 700 mm diameter x 20.0 m length.

Flow speed in the filter basin :

$$VR_4 = \frac{Q_0}{\pi/4 \times 0.7^2} = 0.752 \text{ m/s}$$

a) Pressure loss at straight pipe section n_8

From the William & Hazen's equation,

$$n_8 = 10.666 \times 100^{-1.85} \times 0.70^{-4.87} \times 0.289^{1.85} \times 20$$

$$= 0.0244 \text{ m}$$

b) Pressure loss at bending section n_9

$$n_9 = (f_1 \times 1 + f_2 \times 5 + f_4 \times 1) \times \frac{VR_4}{2g}$$

$$= (1 + 0.3 \times 5 + 1) \times \frac{0.752^2}{2 \times 9.8} = 0.101 \text{ m}$$

Then, $n_8 + n_9 = 0.0244 + 0.101 = 0.1254 \text{ m} \fallingdotseq 0.200 \text{ m}$

$w_9 = w_8 - 0.200 \text{ m} = 83.350 - 0.200 = 83.15 \text{ m}$

9) Water level in the filter basin w_{10}

Number of basins NR_2 = 6 basins (stand-by basin = 1)

Design filtration to be treated per basin : 5000 m^3/day

= 208.33 m^3/hr

= 3.472 m^3/min

= 0.0579 m^3/sec

a) Pressure loss at straight pipe section n_{10}

With the piping of 350 mm diameter and 5000 mm length, the flow speed in the pipe :

$VR_5 = 0.0579 - (\pi/4 \times 0.35^2) = 0.602$ m/sec

From the William & Hazen's equation,

$n_{10} = 10.888 \times 100^{-1.85} \times 0.35^{-4.87} \times 0.0579^{1.85} \times 5$

$= 0.009$ m

b) Pressure loss at bending section n_{11}

$$n_{11} = (f_1 \times 1 + f_2 \times 3 + f_4 \times 1 + f_5 \times 1) \times \frac{VR_5{}^2}{2g}$$

$$= (1 + 0.9 + 1 + 0.1) \times \frac{0.602^2}{2 \times 9.8} = 0.0555 \text{ m}$$

Then, $n_{10} + n_{11} = 0.009 + 0.0555 = 0.0645$ m ≒ 0.10 m

$w_{10} = w_9 - 0.10$ m $= 83.15 - 0.10 = 83.05$

10) Height of top of the treated water channel w_{11}

Head loss of sedimentation basin is taken as n_{12} = 3.65 m.

$w_{11} = w_{10} - 3.50 = 83.050 - 3.65 = 79.4$ m

11) Head loss during backwashing HG

Filtration area AF = 42.00 m^2

Backwashing rate qB = 0.800 $m^3/min \cdot m^2$

Quantity of backwashing water

QB = AF x qB = 42.00 x 0.800

= 33.6 m^3/min

$= 0.56\ m^3/sec$

a) Head loss of silica sand hG1: From the theory of fluidization,

$hG1 = LO/pF(1-\varepsilon O)(pS-pF)$

where L0 = thickness of silica sand bed before fluidization: 0.800 m

$\varepsilon 0$ = void fraction of silica sand bed before fluidization : 0.470 at 0.6 mm or less of effective diameter and at 1.5 or less of uniformity factor

pS = true specific weight of silica sand

$pS = 2630\ kg/m^3$

pF = relative weight of backwashing water

$pF = 1000\ kg/m^3$

$= (0.800/1000) \times (1-0.470) \times (2630-1000)$

$\doteq 0.691\ m$

b) Head loss of gravel bed hG2: From the theory of stagnant layer,

$$hG2 = 200 \times LG \times \frac{VG \cdot \mu}{pF \cdot g \cdot \phi G^2 \cdot DG^2} \cdot \frac{(1-\varepsilon G)^2}{\varepsilon G^3}$$

where LG = thickness of gravel bed 0.050 m/gravel dia.

VG = backwashing rate $0.8\ m/min \cdot m^2 = 0.013\ m/sec \cdot m^2$

μ = viscosity factor of backwash water

10^{-3} kg/m sec as stagnant water

ϕG = shape factor of gravel: 0.800 for round gravel

DG = gravel dia.

2 - 4 mm	DG 1	= 2.5×10^{-3}
4 - 6 mm	DG 2	= 4.5×10^{-3}
6 - 13 mm	DG 3	= 8.5×10^{-3}
13 - 20 mm	DG 4	= 15.0×10^{-3}

εG = void of gravel bed: 0.380 for round gravel

$$= 200 \times 0.05 \times \frac{0.013 \times 10^{-3}}{1000 \times 9.8 \times 0.80^2 \times DG^2} \times \frac{(1-0.380)^3}{0.380^3} = \frac{8.99 \times 10^{-8}}{DG^2}$$

Thus,

$\therefore$ hG21 = 0.0144 m

hG22 = 0.0044 m

hG23 = 0.0012 m

hG24 = 0.0004 m

and

hG2 = hG21 + hG22 + hG23 + hG24

= 0.0204 m

c) Head loss of collection block hB: From the experimental data,

$hB = 0.400$ m for 0.8 $m^3/min \cdot m^2$ of backwashing rate.

d) Head loss of piping system h

Piping from the head tank to the filter basin is 700 mm of diameter and 400 m of length.

Flow speed inside the pipe $VR_6 = 0.56 m^3/sec \div (\pi/4 \times 0.75^2)$

$= 1.267$ m/sec

i) Pressure loss at straight piping section h_{13}

From William Hazen's equation:

$h_{13} = 10.666 \times 100^{-1.85} \times 0.70^{-4.87} \times 0.56^{1.85} \times 400$

$= 1.659$ m

ii) Pressure loss at bent section and valve section h_{14}

$$h_{14} = (f_1 x1 + f_2 x15 + f_3 x8 + f_4 x1 + f_5 x4) \times \frac{VR_6^{\ 2}}{.2g}$$

h9

$$= (1+0.3x15+8+1+0.1x4) \times \frac{1.267^2}{2 \times 9.8}$$

$= 1.220$ m

h_{15} (flow meter) = 1.0 m

Then, $h_{12} + h_{14} + h_{15} = 1.659 + 1.220 + 1.0 = 3.880$ m

Consequently, $HG = hG1 + hG2+ + hB + hj$

$= 0.691 + 0.0204 + 0.400 + 3.880$

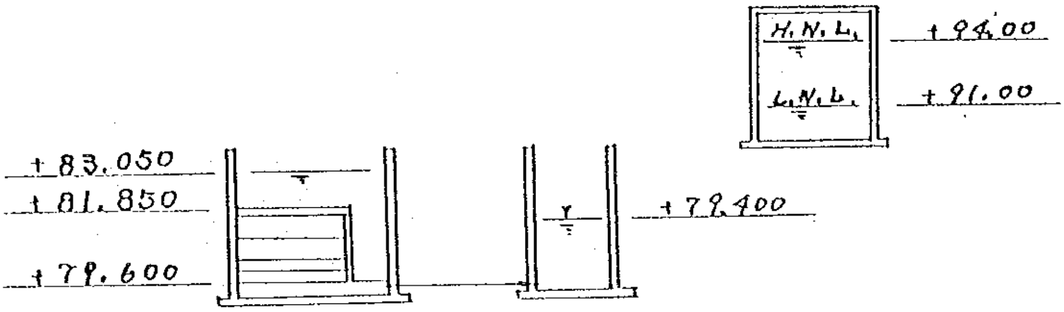
$= 4.992$ m

L.W.L. = 81.850 + 4.992 x 1.5 (margin hight)

$= 89.338$

$\fallingdotseq 91.00$

H.W.L. = 91.00 m + 3.0 m (depth of water) = 94.00 m



Filter basin Treated water channel Filter washing water basin

Required tank capacity = 336 m^3/cycle x 2 basins x 1.5 (margin) $\fallingdotseq$ 1008 m^3

Net capacity = 20.0 m x 19.5 m x 3.0 m = 1170 m^3

Net retention cycle = 1170 m^3 ÷ 336 m^3/day = 3.48 cycle

12) Height of top of the treated water basin w_{12}

Piping from the treated water channel to the treated water basin is 700 mm of diameter and 20 m of length.

Flow speed inside the pipe

$$VR_7 = Q_o \div (\pi/4 \times 0.7^2) = 0.752 \text{ m/s}$$

a) Pressure loss at straight piping section h_{16}

From William Hazen's equation:

$$h_{16} = 10.666 \times 100^{-4.85} \times 0.70^{-1.87} \times 0.289^{1.85} \times 20 = 0.0243 \text{ m}$$

b) Pressure loss at bent section and valve section h_{17}

$$h_{17} = (f_1 x 1 + f_2 x 5 + f_3 x 1 + f_4 x 1 + f_5 x 1) \times \frac{VR_7^2}{2g}$$

$$= (1 + 0.3 x 5 + 1 + 1 + 0.1) \times \frac{0.752^2}{2 \times 9.8} = 0.1327 \text{ m}$$

Then, $n_{16} + n_{17} = 0.0243 \text{ m} + 0.1327 \text{ m} = 0.157 \text{ m}$

$0.157 \text{ m} + 0.20$ (margin height) $= 0.357 \text{ m}$

$\fallingdotseq 0.400$

$w_{12} = w_{11} - 0.300 = 79.400 - 0.400 = 79.00$

ATTACHMENT 6

CAPACITY CALCULATION OF WATER TREATMENT PLANT

Capacity Calculation of Waterworks Facility

1. Quantity of water to be treated by the facility Q_0

$Q_0 = 25{,}000\ m^3/d \times 4$ lines $= 100{,}000\ m^3/d$

One line treats $25{,}000\ m^3/d$, then

$25{,}000\ m^3/d = 1041.66\ m^3/hn = 17.36\ m^3/m = 0.289\ m^3/s$

2. Capacity of individual unit in the process

1) Raw water reservoir

Number of reservoirs NR = 4 (including no spare)

Design retention time DR = 4 hr or longer

Design capacity of reservoir VR = $100{,}000\ m^3 \times 4/24 = 16{,}667\ m^3$

Design capacity of single reservoir = $16{,}667\ m^3 \div 4 = 4{,}167\ m^3$

Dimensions = 27.0 m width x 62.0 m length x 2.5 m depth x 4 reservoirs = $16{,}740\ m^3$

Retention time = $16{,}740 \div 100{,}000 \times 24 = 4.02$ hr > 4.0 hr

2) Receiving well

Number of wells NA = 4 (including no spare)

Design retention time DA = 1.5 min or longer

Design capacity of basin VA = $100{,}000\ m^3 \times \frac{1.5}{24 \times 60}$

$= 104.2\ m^3$

Design capacity of single well $= 104.2 \div 4 = 26.04\ m^3$

Dimensions = 3.5 m width x 3.5 m length x 4.3 m depth

x 4 wells $= 210.7\ m^3$

Retention time $= 210.7 \div 100{,}000 \times 24 \times 60 = 3.03$ min

3) Mixing well

Number of basins NM = 4 (including no spare)

Design retention time DM = 1 - 5 min

Design capacity of the basin VM $= 100{,}000\ m^3 \times$

$$\frac{3}{24 \times 60} = 208.33\ m^3$$

Design capacity of single well $= 208.33\ m^3 \div 4$ basins

$= 52.08\ m^3$

Dimensions = 3.5 m width x 5.0 m length x 4.0 m depth

x 4 basins $= 280.0\ m^3$

Retention time $= 280.0\ m^3 \div 100{,}000 \times 24 \times 60 =$

4.03 min

4) Flocculation basin

Number of basins NF = 8 basins (including spare basin)

Number of rows NR = 10 rows/basin

Design retention time DF = 20 - 40 min

Design capacity of basin VF $= 100{,}000\ m^3 \times \frac{30}{24 \times 60}$

$= 2083.3\ m^3$

Design capacity of single basin $= 2083.3\ m^3 \div 8$ basins

$= 260.4\ m^3$

Dimension = 1.0 m width x 7.5 m length x 3.54 m depth x 10 rows x 8 basins = $2,124\ m^3$

Retention time = 2,124 ÷ 100,000 x 24 x 60 = 30.59 min

5) Sedimentation basin

Number of basins NS = 8 (including no spare)

Design retention time DS = 120 min

$$\text{Design capacity of basin VS} = 100,000\ m^3 \times \frac{120}{24 \times 60}$$

$= 8333.3\ m^3$

Design capacity of single basin $= 8333.3\ m^3 \div 4$ basins

$= 2083.3\ m^3$

Dimension = 7.5 m width x 40.0 m length x 3.5 m depth x 8 basins = $8,400\ m^3$

Retention time = 8,400 ÷ 100,000 x 24 x 60 = 120.96 min

Number of efluent troughs : Overflow load is taken as 260 m^3/hr and the effective length of trough is taken as 4.0 m. Then, the necessary number of efluent troughs is

100,000 m^3/d - (260 x 4 x 8 basins x 2) = 6.01

6/basin

$$\text{Overflow load} = \frac{100{,}000\ m3/d}{2 \times 6 \times 8\ \text{basins} \times 4\ m}$$

$$= 260.4\ m^3/m \cdot d$$

6) Filter basin

Number of basins NK = 6 basins per line (including 1 spare basin)

24 basins per 4 lines (including 4 spare basins)

Design filtration rate VK = 120 - 150$m^3/m^3 \cdot d$

Water quantity to be treated per basin QK =

100,000 m^3/d ÷ (24 basins - 4 basins) =

5,000 $m^3/d \cdot$basin

Required filtration area per basin AK =

5,000 $m^3/d \cdot$basin ÷ 120 $m^3/m^3 \cdot d$ = 41.7 m^2

Dimension of single basin = 6.0 m width x 7.0 m length

Filtration area = 6.0 m x 7.0 m x (24 basins - 4 basins) = 840 m^2

Filtration rate = 100,000 m^3/d - 840 m^2 = 119.0 m/d

7) Treated water reservoir

Number of reservoirs NN = 4 (including no spare)

Design retention time DW = 4 hr or longer

Design capacity VW = 100,000 m^3 x 4/24 = 16,667 m^3

Capacity of single reservoir = 16,667 m^3 ÷ 4 =
4,167 m^3

Dimension = 23.0 m width x 46.0 m length x 4.0 m depth

Net capacity = 23.0 m x 46.0 m x 4.0 m x 4 basins =
16,928 m^3

Net retention time = 16,928 m^3 ÷ 100,000 m^3/d x 24 =
4.06 hr

8) Filter washing water basin

Number of basin NT = 1

Washing rate VT = 0.80 $m^3/m^2 \cdot min$

Washing water quantity QT = 42 m^2 x 0.8 $m^3/m^2 \cdot min$ x 10 min = 336 m^3/batch·basin; the quantity is specified to enable 2 basins simultaneous washing.

(1) Calculation of sludge generation in sedimentation basin

Water to be treated in basins = 25,000 m^3/d x 4 lines = 100,000 m^3/d

Water quality : 18 BTU ≑ 20 mg/l

Solid aluminum feeding rate

Quantity of generated solid matter per line is calculated by: 40 mg/l (15% - Al_2O_3)

$$25{,}000 \times (20 + 40 \times 0.15 \times \frac{2 \times 78 \text{ (Molecular weight of } Al(OH)_3)}{102 \text{(Molecular weight of } Al_2O_3)})$$

$\times 10^{-3}$ = 729.4 kg/d

The removal rate of turbidity in sedimentation basin is taken as 90%, and the sludge concentration is taken as 0.3%. Then, the discharged sludge from the sedimentation basin is calculated by:

$$729.4 \text{ kg/d} \times 0.9 \times 100/0.3 \times 10^{-3} = 218.8 \text{ m}^3\text{/d}$$

$$\fallingdotseq 220 \text{ m}^3\text{/d}$$

(2) Calculation of sludge generated from filtration basin

Number of basins = 6 (including 1 spare)

Filtration area = 7.0 m width x 6.0 m length = 42 m^2/basin

Washing water quantity = 42.0 x 0.8 x 10 = 336 m^3/basin·batch

Number of washing cycles = 1 cycle/36 hr (1.5 day)

Quantity of washing water per 1 line =

$$(336 + 42 \times 1.5) \times \frac{1}{1.5} \times 5 \text{ basins} = 1{,}330 \text{ m}^3\text{/d}$$

Sludge concentration of washing water = 729.4 kg/d x 0.1 ÷ 1330 x 10^{-3} ≑ 54.8 mg/l

(3) Capacity of sludge discharge basin

Number of sludge discharge basins = 2 basins/line x 4 lines = 8 basins

Capacity of sludge discharge basin = 10 x 13.5 x 3.0 = 405 m^3; Quantity of one cycle of washing water; the basin shall have the sludge retention part at the bottom.

Dimension = 10.0 m width x 13.5 m length x 3.0 m depth

2) Sludge drying bed

(1) Calculation of sludge quantity generated from 1 line

Sludge discharged from sedimentation basin and from filtration basin is sedimented to separate in the sludge discharge basin. The sludge concentration is taken as 2.0%. The overflow from the sludge discharge basin contains approximately 50 mg/l of sludge.

	Water quantity	Concentration	Sludge quantity
Feed from sludge discharge basin to sludge drying bed	32.68 m^3	2.0 %	653.5 kg/d
Overflow from sludge discharge basin	1517.32 m^3	50 mg/l	75.9 kg/d
Total	1550 m^3/d (220 m^3 + 1330 m^3)		729.4 kg/d

(2) Required area per 1 line

Assuming the water removal rate per day of 8.0 mm/day, to give 60 % of water content at 0.60 m of water depth, needs:

$$60\%\ \text{sludge height} = \frac{0.02 \times 0.6}{1 - 0.6} = 0.030\ \text{m}$$

$$\text{Drying days} = \frac{0.6\ \text{m} - 0.030\ \text{m}}{0.008} = 71.25\ \text{day}$$

Capacity of drying bed = 32.68 m^3 x 71.25 d = 2328.45 m^3

Dimension of drying bed = 20 m width x 40.0 m length x 0.6 m water depth x 6 beds

Net drying bed capacity = 20 x 40 x 0.6 x 5

= 2400 m^3 > 2328.45 m^3

ATTACHMENT 7

CHEMICAL DOSING CALCULATION OF WATER TREATMENT PLANT

A. Chlorine dosing unit

1. Design specification

1) Water quantity to be treated   Maximum   25,000 m^3/day

2) Chlorine dosing rate

Pre-chlorine dosing	Maximum	10.0 mg/l
	Average	4.0 mg/l
Post-chlorine dosing	Maximum	3.0 mg/l
	Average	2.0 mg/l

3) Point of chlorine dosing

Pre-chlorine dosing	Receiving well
Post-chlorine dosing	Treated water basin

4) Control method of chlorine dosing

Control with manual control valve

5) Method to stop operation

Manual

2. Calculation of chlorine dose

Chlorine dose is calculated by the equation:

$$q = Q \times 1/24 \times s \times 1/1000$$

where q = quantity of chlorine dose (kg/h)

Q = water quantity to be treated (m^3/day)

s = chlorine dosing rate (mg/l)

Calculated result is given below.

1) Pre-chlorine dosing

Water quantity to be treated \ Dosing rate	Maximum	Average
	10.0 mg/l	4.0 mg/l
25,000 m^3/day	10.4 kg/h	4.2 kg/h
100,000 m^3/day	41.6 kg/h	16.8 kg/h

2) Post-chlorine dosing

Treating water quantity \ Dosing rate	Maximum	Average
	3.0 mg/l	2.0 mg/l
25,000 m^3/day	3.1 kg/hr	2.1 kg/hr
100,000 m^3/day	12.4 kg/hr	8.4 kg/hr

3. Capacity of chlorine dosing unit

Based on the chlorine dosing rate calculated in preceding section, the capacity of chlorine dosing unit is defined as below.

1) Pre-chlorine dosing unit

The required chlorine dosing rate is 10.4 kg/hr at the maximum. With a slight margin, the capacity of pre-chlorine dose is defined as 15.0 kg/hr. When the control range of the chlorine dosing unit is selected as 10 : 1, the control range of chlorine dose is 1.5 - 15 kg/hr.

2) Post-chlorine dosing unit

The required chlorine dosing rate is 3.1 kg/hr at the maximum. With a slight margin, the capacity of pre-chlorine dose is defined as 5.0 kg/hr. When the control range of the chlorine dosing unit is selected as 10 : 1, the control range of chlorine dose is 0.5 - 5.0 kg/hr.

3) Type of chlorine dosing unit

Type : Vacuum wet type dosing unit

Capacity : Pre-chlorine dosing unit 15.0 kg/n

Post-chlorine dosing unit 5.0 kg/n

Quantity : Pre-chlorine dosing unit : 5 (including 1 spares)

Post-chlorine dosing unit : 5 (including 1 spares)

Power source : 1^{ϕ} 220^{V}

4. Confirmation of consumption of chlorine

Calculated maximum consumption of chlorine per day is:

Pre-chlorine dose	41.6 kg/day x 24 =	998.4 kg/day
Post-chlorine dose	12.4 kg/day x 24 =	297.6 kg/day
Total		1296.0 kg/day

Maximum quantity of natural evaporation of chlorine from a single cylinder is approximately 7.0 kg/hr. Accordingly, 8 cylinders in parallel are sufficient for chlorine supply without using evaporator. Since the charged quantity of chlorine in an 1 ton cylinder is 1,000 kg, the total capacity of 8 cylinders to supply chlorine is calculated as:

$$\frac{1000 \text{ kg} \times 8}{1296.0 \text{ kg/day}} = 6.17 \text{ days}$$

So the duration of one charge batch is approximately 6 days.

For an ordinary chlorine dosing is estimated as:

Pre-chlorine dose	16.8 kg/day x 24 =	403.2 kg/day
Post-chlorine dose	8.4 kg/day x 24 =	201.6 kg/day
Total		604.8 kg/day

Eight of 1 ton cylinder supply the gas for:

1000 kg/cylinder x 8 cylinders / 604.8 kg/day = 13.23 days

Thus, the exchange of cylinders is done every 13 days.

5. Chlorine gas storage

Chlorine gas for minimum 30 days of operation should be stored. The required number of chlorine gas cylinders is:

604.8 kg/day x 30 days = 18,144 kg

. Calculated number of cylinders is 19 (as 1 ton cylinder).

By adding some margin to possible variation of operating condition, total quantity of 1 ton cylinder is 22 including 8 under operation.

6. Pump capacity of pressured supply water for chlorine dose

The water supply capacity requested to the chlorine dosing unit is:

	Quantity of water	Pressure of water
Pre-chlorine dosing unit	208 l/min·unit	4.8 kg/cm^2
Post-chlorine dosing unit	72 l/min·unit	4.9 kg/cm^2
Total	280 l/min	4.9 kg/cm^2

Necessary quantity of water supply per 1 line is taken as the capacity of full operation of each one unit of pre-chlorine dosing unit and post-chlorine dosing unit at a time. Then, the specification of pressured water supply pump is defined as:

Type : Centrifugal volute pump

Discharge capacity : 280 l/min + 70 l/min (elevated tank)

= 350 l/min

Discharge head : 60 m

Quantity : 8 (including 4 spares)

Motor : 3^{ϕ}, 380^{V}, 50^{HZ}, 7.5^{kw}, 50^{HZ}

B. Chlorine gas neutralization unit

Capacity of chlorine gas neutralization unit is specified as 500 kg/hr. The specification of the unit is:

Type : Packed column gas-liquid contact (2 column system)

Chemical: 15% NaOH soln.

Storage tank : 16 m^3 x 1 tank

NaOH circulation pump : 450 l/min x 15 m x 2 units

3 ϕ, 380 V, 50 Hz, 3.7 kW

Exhaust blower for neutralization : 45 m^3/min x 175 mmAq x 2 units

3 ϕ, 380 V, 50 Hz, 3.7 kW

Chlorine gas leak detector : Type : Diffusion semiconductor type

Power source : 1ϕ, 100 V

Quantity : 6 sets for chlorine cylinder room

4 sets for chlorine dosing room

c. Aluminum sulfate feeding unit

1. Design specification

1) Water quantity to be treated

Maximum quantity 25,000 m^3/day x 4 lines

= 100,000 m^3/day

2) Aluminum sulfate feeding rate (13.0% Al_2O_3 solid aluminum sulfate)

Maximum 60 mg/l

Average 40 mg/l

3) Feeding point of aluminum sulfate

Mixing basin

4) Control method of feeding rate

Manual control

2. Determination of aluminum sulfate feed rate

Solid aluminum sulfate contains 13.0 % of alumina. The feed of aluminum sulfate is carried by preparing 18% solution of the solid aluminum sulfate.

$$q = Q \times S \times \frac{100}{c} \times \frac{1}{r} \times \frac{1}{1000} \times \frac{c_2}{c_1}$$

where q = feeding rate of 18% solid aluminum sulfate solution (l/day)

Q = water quantity to be treated (m^3/day)

S = feeding ratio of 18% aluminum sulfate solution

r = density of 18% aluminum sulfate solution

c = concentration of solution (%)

c_1 = net content of Al_2O_3 : 13.0%

c_2 = standard content of Al_2O_3 : 15.0%

Feeding rate / Water quantity to be treated	Maximum	Average
	60 mg/l	40 mg/l
25,000 m^3/day	8.8 m^3/day	5.9 m^3/day
100,000 m^3/day	35.2 m^3/day	23.6 m^3/day

3. Capacity of individual equipment

1) Storage of solid aluminum sulfate

The total storage capacity is selected to 30 days.

$$100,000 \text{ m}^3\text{/day} \times 60 \text{ mg/l} \times 30 \text{ days} \times 10^{-6} \times \frac{15.0}{13.0}$$

$= 207.7$ t

Adding a margin to fluctuating water quality,

207.7 t x 1.2 = 249.2 = 250 t

the storage quantity is selected to 250 tons.

2) Dissolving and dilution tank

Capacity of dissolving and dilution tank is selected as

2 days.

Capacity of tank* : 17.6 m^3/tank x 2 tanks x 2 days

= 70.4 m^3

Number of tanks: 17.6 m^3/tank x 2 tanks are under operation

17.6 m^3/tank x 2 tanks are for next day operation

17.6 m^3/tank x 2 tanks are under dissolving operation

17.6 m^3/tank x 2 tanks are for spare

Then, the total necessary number of tanks is 8 of 17.6 m^3/tank.

* : with a slight margin, the capacity is selected to 18 m^3/tank.

Dimension of tank: 3.6 m width, 3.0 m length, and 2.2 m height (effective water level is 1.7 m)

4. Aluminum sulfate feeding pump

Required discharge capacity of aluminum sulfate feeding pump is 8.8 m^3/day.

Type : Diaphragm metering pump

Discharge capacity : 6.12 l/min

Motor : 0.4^{kw}, 3 ϕ, 380^{V}, 50^{Hz}

Quantity : 6 (including 2 spares)

ATTACHMENT 8

ELECTRIC MOTOR LIST

Electrical Equipment List (1/4)

No.	Name of load	Rating/ Unit(kW)	Quantity (spare)	Volt-age(v)	Eff. (η)	Pf. (pf)	Is (A)	Total P0(kW)	Input P1(kW)	Input P2(kVA)	Input P3(kVar)	Demand Factor(β)	Input PA(kW)	Input PB(kVA)	Input PC(kVar)	Load for E.G	Remarks
1	Flash Mixer	5.50	4	380	0.88	0.85		22.00	25.00		15.49	0.9	22.50		13.94	○	
2	Sludge Scraper	1.50	8	380	0.81	0.82		12.00	14.81		10.34	0.9	13.33		9.31		
3	Floor Drain Pump of Coaguration and Sedimentation Basin	0.75	4(4)	380	0.78	0.75		3.00	3.85		3.40	0.5	1.93		1.70		
4	Washing Blower	45.00	4(4)	380	0.91	0.89		180.00	197.80		101.34	0.5	98.90		50.67		
5	Air Valve	0.40	20(4)	380	0.77	0.74		8.00	10.39		9.44	0.5	5.20		4.72		
6	Inlet Valve	0.40	20(4)	380	0.77	0.74		8.00	10.39		9.44	0.5	5.20		4.72		
7	Wash Outlet Gate	0.75	20(4)	380	0.78	0.75		15.00	19.23		16.96	0.5	9.62		8.48		
8	Washing Valve	0.75	20(4)	380	0.78	0.75		15.00	19.23		16.96	0.5	9.62		8.48		
9	Automatic Flow Control Valve	0.40	20(4)	380	0.77	0.74		8.00	10.39		9.44	0.5	5.20		4.72		
10	Drain Valve	0.40	20(4)	380	0.77	0.74		8.00	10.39		9.44	0.5	5.20		4.72		
11	Outlet Valve	0.40	20(4)	380	0.77	0.74		8.00	10.39		9.44	0.5	5.20		4.72		
12	Floor Drain Pump of Filter Basin	0.75	4(4)	380	0.78	0.75		3.00	3.85		3.40	0.5	1.93		1.70		
13																	
14																	

Is:Starting Current

$PA=P1\times\beta$
$PB=P2\times\beta$
$PC=P3\times\beta$

Electrical Equipment List (2/4)

No.	Name of load	Rating/ Unit(kW)	Quantity (spare)	Volt- age(v)	Eff. (η)	Pf. (pf)	Is (A)	Total P0(kW)	Input P1(kW)	Input P2(kVA)	Input P3(kVar)	Demand Factor(β)	Input PA(kW)	Input PB(kVA)	Input PC(kVar)	Load for E.G	Remarks
1	Lifting Pump	18.50	8(4)	380	0.91	0.87		148.00	162.64		92.17	0.9	146.38		82.95		
2	Water Pressure Booster Pump	7.50	4(4)	380	0.88	0.88		30.00	34.09		18.40	0.9	30.68		16.56	○	
3	Floor Drain Pump of Treated Water Reservoir	0.75	4(4)	380	0.78	0.75		3.00	3.85		3.40	0.5	1.93		1.70		
4	Sludge Disposal Pump	3.70	4(4)	380	0.86	0.85		14.80	17.21		10.60	0.5	8.61		5.30		
5	Floor Drain Pump of Draw-off Water Reservoir	0.75	4(4)	380	0.78	0.75		3.00	3.85		3.40	0.5	1.93		1.70		
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	

Is:Starting Current

$PA=P1\times\beta$
$PB=P2\times\beta$
$PC=P3\times\beta$

Electrical Equipment List (3/4)

No.	Name of load	Rating/ Unit(kW)	Quantity (spare)	Volt-age(v)	Eff. (η)	Pf. (pf)	Is (A)	Total P0(kW)	Input P1(kW)	Input P2(kVA)	Input P3(kVar)	Demand Factor(β)	Input PA(kW)	Input PB(kVA)	Input PC(kVar)	Load for E.G	Remarks
1	Chlorinator(pre)	3.00	4(1)	380	0.85	0.80		12.00	14.12		9.00	0.9	12.71		8.10		
2	Chlorinator(post)	3.00	4(1)	380	0.85	0.80		12.00	14.12		9.00	0.9	12.71		8.10		
3	Chain Hoist	3.00 0.75	1 1	380 380	0.85 0.78	0.80 0.75		3.00 0.75	3.53 0.96		2.65 0.85	0.5 0.5	1.77 0.48		1.33 0.43		
4	Coastic Soda Solution Recirculation Pump	3.70	1(1)	380	0.86	0.85		3.70	4.30		2.66	0.9	3.87		2.39	○	
5	Chlorin Exhaust Fan	3.70	1(1)	380	0.86	0.85		3.70	4.30		2.66	0.9	3.87		2.39	○	
6	Chemical Drain Pump	0.75	1(1)	380	0.78	0.75		0.75	0.96		0.85	0.5	0.48		0.43		
7	Automatic Dumper	0.20	2	380	0.63	0.67		0.40	0.63		0.70	0.9	0.57		0.63	○	
8	Alum Sulfate Solution Doseing Pump	0.40	4(2)	380	0.77	0.74		1.60	2.08		1.89	0.9	1.87		1.70	○	
9	Alum Sulfate Solution Agitator	3.70	4(4)	380	0.86	0.85		14.80	17.21		10.67	0.9	15.49		9.60		
10																	
11																	
12																	
13																	
14																	

Is:Starting Current

$PA=P1\times\beta$
$PB=P2\times\beta$
$PC=P3\times\beta$

Electrical Equipment List (4/4)

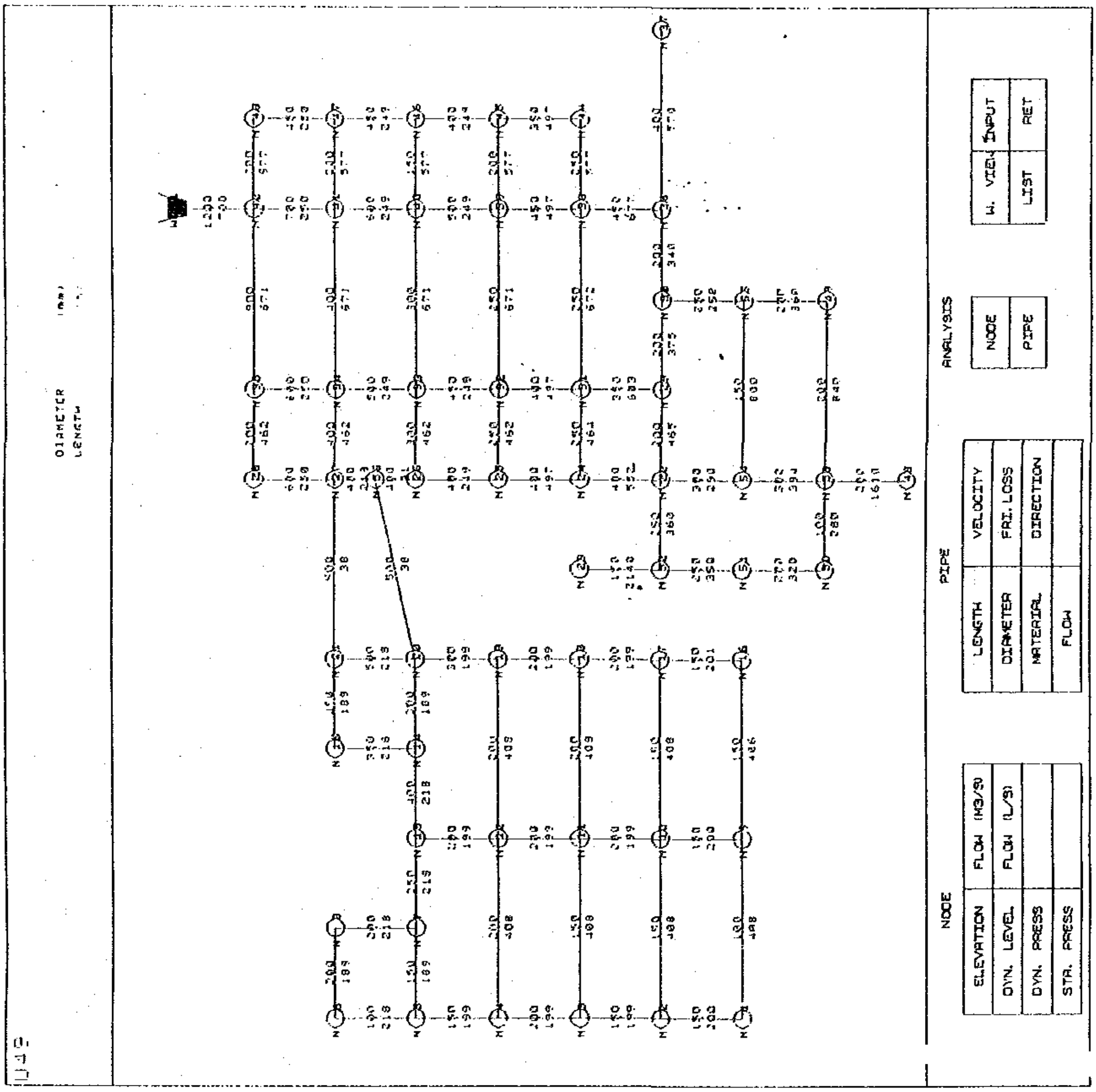
No.	Name of load	Rating/ Unit(kW)	Quantity (spare)	Volt-age(v)	Eff. (η)	Pf. (pf)	Is (A)	Total P0(kW)	Input P1(kW)	Input P2(kVA)	Input P3(kVar)	Demand Factor(β)	Input PA(kW)	Input PB(kVA)	Input PC(kVar)	Load for E.G	Remarks
1	Liting/Ventilation Capacity of Administration Building D/Box	32.50	1		0.85	0.80		32.50	38.24		28.68	0.9	34.42		25.31	○	
2	Outer Lighting/Receptale Capacity of Administration Building D/Box	23.00	1		0.85	0.80		23.00	27.06		20.30	0.5	18.53		10.15		
3	Ventilation Capacity of Work Shop D/Box	6.00	1		0.85	0.80		6.00	7.06		5.30	0.9	6.35		4.77	○	
4	Lighting/Receptacle Capacity of Work Shop D/Box	11.00	1		0.85	0.80		11.00	12.94		9.71	0.5	6.47		4.86		
5	Lighting/Ventilation Capacity of Chemical Building D/Box	33.00	1		0.85	0.80		33.00	38.82		29.12	0.9	34.94		26.21	○	
6	Receptacle Capacity of Chemical Building D/Box	9.00	1		0.85	0.80		9.00	10.59		7.94	0.5	5.25		3.97		
7	Ventilation Capacity of D/Box around Raw Water Reservoir	15.00	1		0.85	0.80		15.00	17.65		13.24	0.9	15.89		11.92	○	
8	Lighting/Outer Lighting/receptacle Capa of D/Box around Raw Water Reservoir	42.00	1		0.85	0.80		42.00	49.41		37.06	0.5	24.71		18.53		
9	Ventilation Capacity of D/Box around Filer Basin	15.00	1		0.85	0.80		15.00	17.65		13.24	0.9	15.89		11.92	○	
10	Lighting/Outer Lighting/receptacle Capa of D/Box around Filer Basin	44.00	1		0.85	0.80		44.00	51.76		38.82	0.5	25.88		19.41		
11	Ventilation Capacity of D/Box around Treated Water Reservoir	9.00	1		0.85	0.80		9.00	10.59		7.94	0.9	9.53		7.15	○	
12	Lighting/Outer Lighting/receptacle Capa of D/Box around Treated Water Reservoir	51.00	1		0.85	0.80		51.00	60.00		45.00	0.5	30.00		22.50		
13	Lighting/receptacle Capacity of D/Box around Sludge Drying Bed	11.00	1		0.85	0.80		11.00	12.94		9.71	0.5	6.47		4.86		
14																	

Is:Starting Current

PA=P1×β
PB=P2×β
PC=P3×β

ATTACHMENT 9

HYDRAULIC CALCULATION OF TREATED WATER DISTRIBUTION NETWORK


DIAMETER (mm)
LENGTH
ANALYSIS
NODE
PIPE
W. VIEW
INPUT
LIST
RET
PIPE
LENGTH
VELOCITY
DIAMETER
FRI. LOSS
MATERIAL
DIRECTION
FLOW
NODE
ELEVATION
FLOW (M3/S)
DYN. LEVEL
FLOW (L/S)
DYN. PRESS
STR. PRESS

IRRIGATION

U49

PIPE LIST

	KIND	DIA. (mm)	LENGTH (m)	QUANTITY (m3/sec)	VELOCITY (m/sec)	FRICTION LOSS (m)	C VALUE
W 1 - N 42	DCI T 5	1200	700.0	1.3374	1.18	0.86	110.00
N 2 - N 1	VP RR	150	200.0	0.0117	0.69	0.90	120.00
N 3 - N 2	VP RR	150	199.0	0.0165	0.97	1.70	120.00
N 4 - N 3	VP RR	200	199.0	0.0240	0.80	0.85	120.00
N 5 - N 4	VP RR	150	199.0	0.0170	1.00	1.78	120.00
N 6 - N 5	VP RR	100	218.0	0.0063	0.78	1.95	120.00
N 7 - N 5	VP RR	150	189.0	0.0190	1.12	2.09	120.00
N 7 - N 8	VP RR	200	218.0	0.0063	0.21	0.08	120.00
N 8 - N 6	VP RR	200	189.0	0.0063	0.21	0.07	120.00
N 9 - N 1	VP RR	100	408.0	0.0045	0.56	1.94	120.00
N 10 - N 2	VP RR	150	408.0	0.0113	0.66	1.72	120.00
N 10 - N 9	VP RR	150	200.0	0.0100	0.59	0.68	120.00
N 11 - N 3	VP RR	150	408.0	0.0087	0.51	1.06	120.00
N 11 - N 10	VP RR	200	199.0	0.0267	0.89	1.04	120.00
N 12 - N 4	VP RR	200	408.0	0.0230	0.77	1.62	120.00
N 12 - N 11	VP RR	200	199.0	0.0316	1.05	1.42	120.00
N 13 - N 7	DCI T 3	250	218.0	0.0253	0.51	0.35	110.00
N 13 - N 12	VP RR	200	199.0	0.0439	1.46	2.60	120.00
N 14 - N 13	DCI T 3	400	218.0	0.0775	0.62	0.29	110.00
N 15 - N 14	DCI T 3	350	218.0	0.0529	0.55	0.28	110.00

AGE 1 5

U49

PIPE LIST

	KIND	DIA. (mm)	LENGTH (m)	QUANTITY (m3/sec)	VELOCITY (m/sec)	FRICTION LOSS (m)	C VALUE
N 16 - N 9	VP RR	150	406.0	0.0106	0.62	1.51	120.00
N 17 - N 10	VP RR	150	408.0	0.0108	0.64	1.58	120.00
N 17 - N 16	VP RR	150	201.0	0.0106	0.62	0.75	120.00
N 18 - N 11	VP RR	200	408.0	0.0199	0.66	1.23	120.00
N 18 - N 17	VP RR	200	199.0	0.0214	0.71	0.69	120.00
N 19 - N 12	VP RR	200	406.0	0.0268	0.89	2.14	120.00
N 19 - N 18	VP RR	200	199.0	0.0413	1.38	2.32	120.00
N 20 - N 14	DCI T 3	300	189.0	0.0246	0.35	0.13	110.00
N 20 - N 19	DCI T 3	300	199.0	0.0680	0.98	0.89	110.00
N 20 - N 56	DCI T 3	500	38.0	0.0716	0.36	0.01	110.00
N 21 - N 15	DCI T 3	350	189.0	0.0529	0.55	0.24	110.00
N 21 - N 20	DCI T 3	500	218.0	0.1642	0.84	0.40	110.00
N 22 - N 52	DCI T 3	250	360.0	0.0602	1.21	2.90	110.00
N 22 - N 54	DCI T 3	300	290.0	0.0993	1.43	2.60	110.00
N 24 - N 22	DCI T 3	400	552.0	0.1857	1.48	3.76	110.00
N 25 - N 24	DCI T 3	400	497.0	0.1849	1.48	3.36	110.00
N 26 - N 25	DCI T 3	400	249.0	0.1819	1.45	1.64	110.00
N 27 - N 21	DCI T 3	500	38.0	0.2171	1.11	0.12	110.00
N 27 - N 56	DCI T 3	400	218.0	0.1062	0.85	0.53	110.00
N 28 - N 27	DCI T 3	600	250.0	0.2769	0.98	0.49	110.00

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PIPE LIST

	KIND	DIA. (mm)	LENGTH (m)	QUANTITY (m3/sec)	VELOCITY (m/sec)	FRICTION LOSS (m)	C VALUE
N 29 - N 22	VP RR	200	465.0	0.0219	0.73	1.68	120.00
N 29 - N 30	VP RR	200	375.0	0.0060	0.20	0.12	120.00
N 30 - N 55	DCI T 3	250	258.0	0.0391	0.79	0.94	110.00
N 31 - N 24	DCI T 3	250	464.0	0.0298	0.60	1.02	110.00
N 31 - N 29	DCI T 3	350	603.0	0.1117	1.17	3.10	110.00
N 32 - N 25	DCI T 3	250	462.0	0.0266	0.54	0.82	110.00
N 32 - N 31	DCI T 3	400	497.0	0.1790	1.43	3.17	110.00
N 33 - N 26	DCI T 3	300	462.0	0.0278	0.40	0.39	110.00
N 33 - N 32	DCI T 3	450	249.0	0.2107	1.33	1.21	110.00
N 34 - N 27	DCI T 3	400	462.0	0.0700	0.56	0.52	110.00
N 34 - N 33	DCI T 3	500	249.0	0.2304	1.17	0.85	110.00
N 35 - N 28	DCI T 3	700	462.0	0.2769	0.73	0.45	110.00
N 35 - N 34	DCI T 3	600	250.0	0.2541	0.90	0.42	110.00
N 36 - N 30	VP RR	200	340.0	0.0331	1.10	2.64	120.00
N 36 - N 37	DCI T 3	400	570.0	0.1622	1.29	3.03	110.00
N 38 - N 31	DCI T 3	250	672.0	0.0375	0.76	2.26	110.00
N 38 - N 36	DCI T 3	450	677.0	0.1953	1.23	2.85	110.00
N 39 - N 32	DCI T 3	250	671.0	0.0304	0.61	1.52	110.00
N 39 - N 38	DCI T 3	450	497.0	0.2121	1.34	2.44	110.00
N 39 - N 45	VP RR	200	577.0	0.0070	0.23	0.25	120.00

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PIPE LIST

	KIND	DIA. (mm)	LENGTH (m)	QUANTITY (m3/sec)	VELOCITY (m/sec)	FRICTION LOSS (m)	C VALUE
N 40 - N 33	DCI T 3	300	671.0	0.0435	0.62	1.30	110.00
N 40 - N 39	DCI T 3	500	249.0	0.2494	1.27	0.98	110.00
N 40 - N 46	VP RR	150	577.0	0.0054	0.31	0.61	120.00
N 41 - N 34	DCI T 3	400	671.0	0.0817	0.65	1.00	110.00
N 41 - N 40	DCI T 5	600	249.0	0.2983	1.04	0.55	110.00
N 41 - N 47	VP RR	200	577.0	0.0116	0.39	0.64	120.00
N 42 - N 35	DCI T 5	900	671.0	0.7073	1.10	1.02	110.00
N 42 - N 41	DCI T 5	700	250.0	0.3916	1.02	0.44	110.00
N 42 - N 48	DCI T 3	700	577.0	0.2385	0.63	0.42	110.00
N 44 - N 38	DCI T 3	250	577.0	0.0207	0.42	0.65	110.00
N 45 - N 44	DCI T 3	350	497.0	0.0849	0.89	1.54	110.00
N 46 - N 45	DCI T 3	400	249.0	0.1062	0.86	0.62	110.00
N 47 - N 46	DCI T 3	450	249.0	0.1331	0.84	0.52	110.00
N 48 - N 47	DCI T 3	450	250.0	0.1518	0.96	0.66	110.00
N 49 - N 53	VP RR	200	640.0	0.0281	0.94	4.81	120.00
N 50 - N 53	VP RR	100	280.0	0.0026	0.33	0.50	120.00
N 51 - N 50	VP RR	200	320.0	0.0178	0.59	0.79	120.00
N 52 - N 23	VP RR	150	2140.0	0.0093	0.54	6.24	120.00
N 52 - N 51	DCI T 3	250	350.0	0.0510	1.03	2.07	110.00
N 53 - N 43	VP RR	200	1610.0	0.0366	1.22	15.03	120.00

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PIPE LIST

	KIND	DIA. (mm)	LENGTH (m)	QUANTITY (m3/sec)	VELOCITY (m/sec)	FRICTION LOSS (m)	C VALUE
N 54 - N 53	DCI T 3	300	394.0	0.1012	1.45	3.66	110.00
N 55 - N 49	VP RR	200	360.0	0.0281	0.94	2.06	120.00
N 55 - N 54	VP RR	150	800.0	0.0110	0.65	3.22	120.00
N 56 - N 26	DCI T 3	400	31.0	0.1779	1.42	0.20	110.00

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NODE LIST

	ELEVATION (m)	ESTABLISH LEVEL (m)	DYNAMIC W.PRESSURE (m)	UN-SATISFIED (m)	DYNAMIC W. LEVEL (m)	STATIC W.PRESSURE (m)
W 1	75.0	HWL 75.0 LWL 75.0	0.0		75.0	0.0
N 1	15.1	20.0	48.5	28.5	63.6	59.9
N 2	21.2	20.0	43.2	23.2	64.5	53.8
N 3	27.8	20.0	38.4	18.4	66.2	47.2
N 4	35.4	20.0	31.7	11.7	67.0	39.6
N 5	41.8	20.0	27.0	7.0	68.8	33.2
N 6	50.5	20.0	20.2	0.2	70.7	24.5
N 7	40.9	20.0	30.0	10.0	70.9	34.1
N 8	49.2	20.0	21.6	1.6	70.8	25.8
N 9	14.0	20.0	51.5	31.5	65.5	61.0
N 10	19.7	20.0	46.5	26.5	66.2	55.3
N 11	25.6	20.0	41.6	21.6	67.2	49.4
N 12	32.1	20.0	36.5	16.5	68.6	42.9
N 13	38.9	20.0	32.3	12.3	71.2	36.1
N 14	35.0	20.0	36.5	16.5	71.5	40.0
N 15	41.5	20.0	30.3	10.3	71.8	33.5
N 16	15.8	20.0	51.2	31.2	67.0	59.2
N 17	19.5	20.0	48.3	28.3	67.8	55.5
N 8	23.2	20.0	45.3	25.3	68.5	51.8
N 19	27.1	20.0	43.7	23.7	70.8	47.9

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NODE LIST

	ELEVATION (m)	ESTABLISH LEVEL (m)	DYNAMIC N.PRESSURE (m)	UN-SATISFIED (m)	DYNAMIC N. LEVEL (m)	STATIC N.PRESSURE (m)
N 20	31.2	20.0	40.5	20.5	71.7	43.8
N 21	36.8	20.0	35.3	15.3	72.1	38.2
N 22	6.5	20.0	56.2	36.2	62.7	68.5
N 23	6.5	20.0	47.0	27.0	53.5	68.5
N 24	15.9	20.0	50.6	30.6	66.5	59.1
N 25	25.4	20.0	44.4	24.4	69.8	49.6
N 26	29.7	20.0	41.8	21.8	71.5	45.3
N 27	36.7	20.0	35.5	15.5	72.2	38.3
N 28	42.7	20.0	30.0	10.0	72.7	32.3
N 29	6.3	20.0	58.1	38.1	64.4	68.7
N 30	6.3	20.0	57.9	37.9	64.2	68.7
N 31	17.4	20.0	50.1	30.1	67.5	57.6
N 32	26.0	20.0	44.6	24.6	70.6	49.0
N 33	32.2	20.0	39.6	19.6	71.8	42.8
N 34	37.3	20.0	35.4	15.4	72.7	37.7
N 35	43.3	20.0	29.8	9.8	73.1	31.7
N 36	6.3	20.0	60.6	40.6	66.9	68.7
N 37	6.3	20.0	57.6	37.6	63.9	68.7
N 38	20.6	20.0	49.1	29.1	69.7	54.4
N 39	32.0	20.0	40.2	20.2	72.2	43.0

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NODE LIST

	ELEVATION (m)	ESTABLISH LEVEL (m)	DYNAMIC W.PRESSURE (m)	UN-SATISFIED (m)	DYNAMIC W. LEVEL (m)	STATIC W.PRESSURE (m)
N 40	38.3	20.0	34.9	14.9	73.2	36.7
N 41	44.6	20.0	29.1	9.1	73.7	30.4
N 42	51.7	20.0	22.4	2.4	74.1	23.3
N 43	4.0	20.0	37.4	17.4	41.4	71.0
N 44	21.5	20.0	48.9	28.9	70.4	53.5
N 45	33.2	20.0	38.7	18.7	71.9	41.8
N 46	40.2	20.0	32.3	12.3	72.5	34.8
N 47	46.5	20.0	26.6	6.6	73.1	28.5
N 48	53.3	20.0	20.4	0.4	73.7	21.7
N 49	4.0	20.0	57.2	37.2	61.2	71.0
N 50	4.0	20.0	52.9	32.9	56.9	71.0
N 51	4.0	20.0	53.7	33.7	57.7	71.0
N 52	6.5	20.0	53.3	33.3	59.8	68.5
N 53	4.0	20.0	52.4	32.4	56.4	71.0
N 54	4.0	20.0	56.1	36.1	60.1	71.0
N 55	4.0	20.0	59.3	39.3	63.3	71.0
N 56	30.6	20.0	41.1	21.1	71.7	44.4

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NODE LIST

	ELEVATION (m)	ESTABLISH LEVEL (m)	DYNAMIC W.PRESSURE (m)	UN-SATISFIED (m)	DYNAMIC W. LEVEL (m)	STATIC W.PRESSURE (m)
N 60	5.8	15.0	44.4	29.4	50.3	67.2
N 61	6.1	15.0	33.0	18.0	39.0	66.9
N 62	51.0	15.0	18.2	3.2	69.2	22.0
N 63	51.0	15.0	17.8	2.8	68.8	22.0
N 64	51.0	15.0	17.6	2.6	68.6	22.0
N 65	18.5	15.0	37.6	22.6	56.1	54.5
N 66	23.0	15.0	30.1	15.1	53.1	50.0
N 67	18.5	15.0	35.2	20.2	53.7	54.5
N 68	39.0	15.0	26.5	11.5	65.5	34.0
N 69	38.0	15.0	22.8	7.8	60.8	35.0
N 70	37.5	15.0	26.8	11.8	64.3	35.5
N 71	30.8	15.0	36.8	21.8	67.6	42.2

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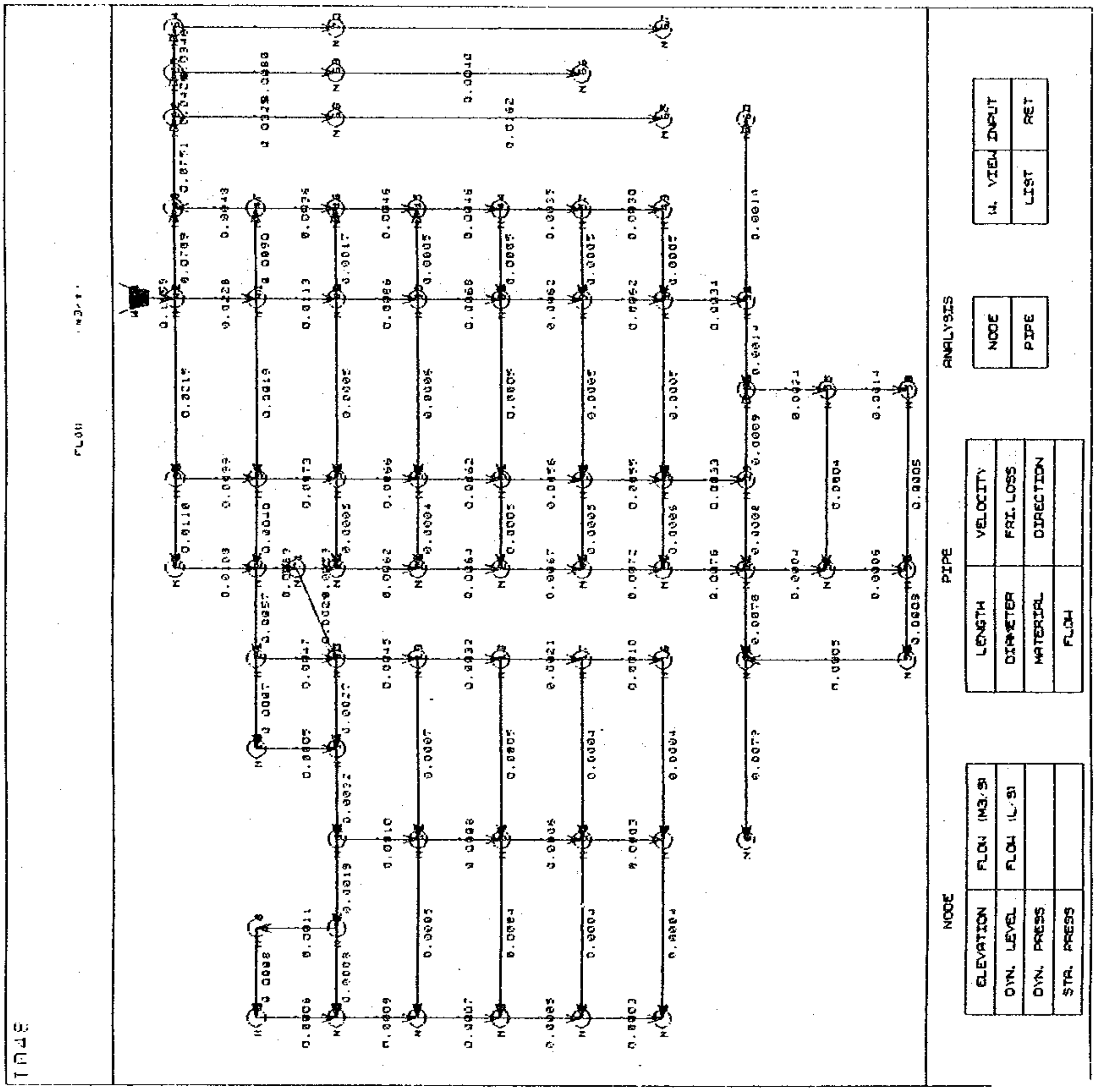
ATTACHMENT 10

HYDRAULIC CALCULATION OF DRAW-OFF WATER DISTRIBUTION NETWORK


FLOW
NODE
ELEVATION
FLOW (M3/S)
DYN. LEVEL
FLOW (L/S)
DYN. PRESS
STA. PRESS
PIPE
LENGTH
VELOCITY
DIAMETER
FRI.LOSS
MATERIAL
DIRECTION
FLOW
ANALYSIS
NODE
PIPE
W. VIEW
INPUT
LIST
RET

NODE LIST

	ELEVATION (m)	ESTABLISH LEVEL (m)	DYNAMIC W. PRESSURE (m)	UN-SATISFIED (m)	DYNAMIC W. LEVEL (m)	STATIC W. PRESSURE (m)
N 1	73.0	HWL 73.0 LWL 73.0	0.0		73.0	0.0
N 1	15.1	15.0	48.0	33.0	63.1	57.9
N 2	21.3	15.0	41.9	26.9	63.2	51.7
N 3	27.8	15.0	35.9	20.9	63.7	45.2
N 4	35.4	15.0	29.3	14.3	64.7	37.6
N 5	41.8	15.0	24.2	9.2	66.1	31.2
N 6	50.5	15.0	16.2	1.2	66.7	22.5
N 7	40.9	15.0	26.2	11.2	67.1	32.1
N 8	49.2	15.0	17.7	2.7	66.8	23.8
N 9	14.0	15.0	49.6	34.6	63.6	59.0
N 10	19.7	15.0	44.1	29.1	63.8	53.3
N 11	25.6	15.0	38.8	23.8	64.4	47.4
N 12	32.1	15.0	33.5	18.5	65.6	40.9
N 13	38.9	15.0	28.4	13.4	67.3	34.1
N 14	35.0	15.0	32.9	17.9	67.9	38.0
N 15	41.5	15.0	26.9	11.9	68.4	31.5
N 16	15.8	15.0	48.5	33.5	64.4	57.2
N 17	19.5	15.0	45.1	30.1	64.6	53.5
N 18	23.2	15.0	42.3	27.3	65.4	49.8
N 19	27.1	15.0	40.1	25.1	67.2	45.9

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NODE LIST

	ELEVATION (m)	ESTABLISH LEVEL (m)	DYNAMIC W.PRESSURE (m)	UN-SATISFIED (m)	DYNAMIC W. LEVEL (m)	STATIC W.PRESSURE (m)
N 20	31.2	15.0	37.0	22.0	68.2	41.8
N 21	36.8	15.0	32.6	17.6	69.3	36.3
N 22	6.5	15.0	47.6	32.6	54.1	66.5
N 23	14.0	15.0	45.9	30.9	59.9	59.0
N 24	15.9	15.0	45.2	30.2	61.0	57.1
N 25	25.4	15.0	40.3	25.3	65.7	47.6
N 26	29.6	15.0	38.3	23.3	67.9	43.4
N 27	36.7	15.0	32.7	17.7	69.4	36.3
N 28	42.7	15.0	27.7	12.7	70.4	30.3
N 29	6.3	15.0	50.4	35.4	56.7	66.7
N 30	15.1	15.0	46.5	31.5	61.5	58.0
N 31	17.4	15.0	44.8	29.8	62.3	55.6
N 32	26.0	15.0	40.6	25.6	66.6	47.0
N 33	32.2	15.0	36.9	21.9	69.1	40.8
N 34	37.3	15.0	32.8	17.8	70.0	35.7
N 35	43.3	15.0	27.6	12.6	70.9	29.8
N 36	6.3	15.0	50.8	35.8	57.1	66.7
N 37	18.3	15.0	44.7	29.7	63.0	54.7
N 38	20.6	15.0	43.3	28.3	63.9	52.4
N 39	32.0	15.0	37.1	22.1	69.1	41.0

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NODE LIST

	ELEVATION (m)	ESTABLISH LEVEL (m)	DYNAMIC W.PRESSURE (m)	UN-SATISFIED (m)	DYNAMIC W. LEVEL (m)	STATIC W.PRESSURE (m)
N 40	38.3	15.0	32.2	17.2	70.5	34.8
N 41	44.6	15.0	26.2	11.2	70.7	28.4
N 42	51.7	15.0	20.0	5.0	71.7	21.3
N 43	19.3	15.0	45.2	30.2	64.6	53.7
N 44	21.5	15.0	43.6	28.6	65.1	51.5
N 45	33.2	15.0	34.4	19.4	67.6	39.8
N 46	40.2	15.0	28.7	13.7	68.9	32.8
N 47	46.5	15.0	22.6	7.6	69.1	26.5
N 48	53.3	15.0	15.7	0.7	68.9	19.8
N 49	15.0	15.0	45.6	30.6	60.5	58.0
N 50	16.2	15.0	45.6	30.6	61.9	56.8
N 51	19.5	15.0	44.0	29.0	63.5	53.5
N 52	6.5	15.0	42.9	27.9	49.4	66.5
N 53	4.0	15.0	48.5	33.5	52.5	69.0
N 54	4.0	15.0	49.7	34.7	53.7	69.0
N 55	4.0	15.0	51.1	36.1	55.1	69.0
N 56	6.3	15.0	50.1	35.1	56.4	66.7
N 57	20.4	15.0	44.6	29.6	65.0	52.6
N 58	4.0	15.0	50.4	35.4	54.4	69.0
N 59	4.0	15.0	46.9	31.9	50.9	69.0

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NODE LIST

	ELEVATION (m)	ESTABLISH LEVEL (m)	DYNAMIC W.PRESSURE (m)	UN-SATISFIED (m)	DYNAMIC W. LEVEL (m)	STATIC W.PRESSURE (m)
N 60	5.8	15.0	41.3	26.3	47.2	67.2
N 61	6.1	15.0	33.3	18.3	39.4	66.9
N 62	51.0	15.0	17.5	2.5	68.5	22.0
N 63	51.0	15.0	17.0	2.0	68.0	22.0
N 64	51.0	15.0	16.7	1.7	67.7	22.0
N 65	18.5	15.0	38.9	23.9	57.4	54.5
N 66	23.0	15.0	28.3	13.3	51.3	50.0
N 67	18.5	15.0	36.7	21.7	55.2	54.5
N 68	39.0	15.0	25.0	10.0	64.0	34.0
N 69	38.0	15.0	21.5	6.5	59.5	35.0
N 70	37.5	15.0	25.2	10.2	62.7	35.5
N 71	30.8	15.0	37.4	22.4	68.2	42.2

1048

PIPE LIST

	KIND	DIA. (mm)	LENGTH (m)	QUANTITY (m3/sec)	VELOCITY (m/sec)	FRICTION LOSS (m)	C VALUE
W 1 - N 42	VM RR	450	800.0	0.1159	0.78	1.30	120.00
N 2 - N 1		50	200.0	0.0003	0.13	0.15	120.00
N 3 - N 2		50	199.0	0.0005	0.26	0.50	120.00
N 4 - N 3		50	199.0	0.0007	0.36	0.97	120.00
N 5 - N 4		50	199.0	0.0009	0.44	1.37	120.00
N 6 - N 5		50	208.0	0.0006	0.29	0.67	120.00
N 7 - N 5		50	179.0	0.0008	0.40	1.04	120.00
N 7 - N 8	VP RR	75	208.0	0.0011	0.22	0.25	120.00
N 8 - N 6	VP RR	75	179.0	0.0008	0.17	0.13	120.00
N 9 - N 1		50	408.0	0.0004	0.18	0.56	120.00
N 10 - N 2		50	408.0	0.0004	0.19	0.59	120.00
N 10 - N 9		50	200.0	0.0003	0.14	0.17	120.00
N 11 - N 3		50	408.0	0.0004	0.21	0.69	120.00
N 11 - N 10		50	199.0	0.0006	0.28	0.61	120.00
N 12 - N 4		50	408.0	0.0005	0.24	0.92	120.00
N 12 - N 11		50	199.0	0.0008	0.41	1.20	120.00
N 13 - N 7	VP RR	100	228.0	0.0019	0.23	0.21	120.00
N 13 - N 12		50	199.0	0.0010	0.49	1.70	120.00
N 14 - N 13	VP RR	100	218.0	0.0032	0.40	0.55	120.00
N 15 - N 14		50	208.0	0.0005	0.25	0.51	120.00

I049

PIPE LIST

	KIND	DIA. (mm)	LENGTH (m)	QUANTITY (m3/sec)	VELOCITY (m/sec)	FRICTION LOSS (m)	C VALUE
N 16 - N 9		50	398.0	0.0004	0.22	0.75	120.00
N 17 - N 10		50	398.0	0.0004	0.23	0.80	120.00
N 17 - N 16	VP RR	75	200.0	0.0010	0.22	0.23	120.00
N 18 - N 11		50	398.0	0.0005	0.26	1.02	120.00
N 18 - N 17	VP RR	75	199.0	0.0021	0.44	0.82	120.00
N 19 - N 12		50	398.0	0.0007	0.33	1.53	120.00
N 19 - N 18	VP RR	75	199.0	0.0032	0.67	1.81	120.00
N 20 - N 14	VP RR	100	179.0	0.0027	0.34	0.33	120.00
N 20 - N 19	VP RR	100	199.0	0.0045	0.56	0.96	120.00
N 21 - N 15		50	179.0	0.0007	0.38	0.94	120.00
N 21 - N 20	VP RR	100	208.0	0.0047	0.60	1.11	120.00
N 22 - N 52	VP RR	100	355.0	0.0078	0.98	4.74	120.00
N 22 - N 54		50	295.0	0.0004	0.19	0.42	120.00
N 23 - N 22	VP RR	100	455.0	0.0076	0.95	5.81	120.00
N 24 - N 49	VP RR	100	51.0	0.0067	0.84	0.52	120.00
N 25 - N 24	VP RR	100	497.0	0.0064	0.81	4.67	120.00
N 26 - N 25	VP RR	100	249.0	0.0062	0.78	2.20	120.00
N 27 - N 21	VP RR	125	43.0	0.0057	0.46	0.11	120.00
N 27 - N 71	VP RR	125	208.0	0.0089	0.71	1.19	120.00
N 28 - N 27	VP RR	150	250.0	0.0108	0.64	0.97	120.00

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PIPE LIST

	KIND	DIA. (mm)	LENGTH (m)	QUANTITY (m3/sec)	VELOCITY (m/sec)	FRICTION LOSS (m)	C VALUE
N 29 - N 22		50	470.0	0.0008	0.39	2.63	120.00
N 29 - N 56	VP RR	75	365.0	0.0009	0.19	0.33	120.00
N 30 - N 23		50	520.0	0.0006	0.28	1.60	120.00
N 30 - N 29	VP RR	75	506.0	0.0033	0.69	4.79	120.00
N 31 - N 24		50	469.0	0.0005	0.26	1.22	120.00
N 31 - N 50	VP RR	100	51.0	0.0056	0.70	0.37	120.00
N 32 - N 25		50	467.0	0.0004	0.22	0.90	120.00
N 32 - N 31	VP RR	100	497.0	0.0062	0.78	4.34	120.00
N 33 - N 26		50	467.0	0.0005	0.25	1.16	120.00
N 33 - N 32	VP RR	100	249.0	0.0066	0.83	2.45	120.00
N 34 - N 27	VP RR	125	467.0	0.0040	0.32	0.62	120.00
N 34 - N 33	VP RR	125	249.0	0.0073	0.58	0.98	120.00
N 35 - N 28	VP RR	200	467.0	0.0110	0.37	0.47	120.00
N 35 - N 34	VP RR	150	250.0	0.0099	0.58	0.83	120.00
N 36 - N 56	VP RR	75	350.0	0.0014	0.30	0.72	120.00
N 36 - N 60		50	1140.0	0.0010	0.50	9.96	120.00
N 37 - N 30		50	680.0	0.0005	0.24	1.49	120.00
N 37 - N 36	VP RR	75	580.0	0.0034	0.72	5.89	120.00
N 38 - N 31		50	672.0	0.0005	0.25	1.66	120.00
N 38 - N 51	VP RR	100	51.0	0.0062	0.78	0.44	120.00

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PIPE LIST

	KIND	DIA. (mm)	LENGTH (m)	QUANTITY (m3/sec)	VELOCITY (m/sec)	FRICTION LOSS (m)	C VALUE
N 39 - N 32		50	671.0	0.0006	0.32	2.52	120.00
N 39 - N 38	VP RR	100	497.0	0.0068	0.86	5.21	120.00
N 39 - N 45		50	577.0	0.0005	0.26	1.53	120.00
N 40 - N 33		50	671.0	0.0005	0.23	1.41	120.00
N 40 - N 39	VP RR	125	249.0	0.0086	0.69	1.34	120.00
N 40 - N 46	VP RR	75	577.0	0.0017	0.35	1.59	120.00
N 41 - N 34	VP RR	100	671.0	0.0019	0.24	0.69	120.00
N 41 - N 40	VP RR	200	249.0	0.0113	0.38	0.26	120.00
N 41 - N 47	VP RR	150	577.0	0.0090	0.53	1.59	120.00
N 42 - N 35	VP RR	250	671.0	0.0215	0.47	0.84	120.00
N 42 - N 41	VP RR	200	250.0	0.0228	0.76	0.98	120.00
N 42 - N 48	VP RR	300	577.0	0.0709	1.09	2.78	120.00
N 43 - N 37		50	580.0	0.0005	0.26	1.56	120.00
N 44 - N 38		50	577.0	0.0005	0.23	1.22	120.00
N 44 - N 57	VP RR	100	51.0	0.0035	0.44	0.15	120.00
N 45 - N 44	VP RR	100	497.0	0.0046	0.57	2.46	120.00
N 46 - N 45	VP RR	100	249.0	0.0046	0.58	1.28	120.00
N 47 - N 46	VP RR	125	249.0	0.0036	0.29	0.26	120.00
N 47 - N 48	VP RR	150	250.0	0.0048	0.28	0.22	120.00
N 48 - N 62	VP RR	300	75.0	0.0751	1.16	0.40	120.00

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PIPE LIST

	KIND	DIA. (mm)	LENGTH (m)	QUANTITY (m3/sec)	VELOCITY (m/sec)	FRICTION LOSS (m)	C VALUE
N 49 - N 23	VP RR	100	51.0	0.0072	0.91	0.60	120.00
N 50 - N 30	VP RR	100	51.0	0.0055	0.69	0.36	120.00
N 50 - N 49		50	520.0	0.0005	0.26	1.37	120.00
N 51 - N 37	VP RR	100	51.0	0.0062	0.78	0.45	120.00
N 51 - N 50		50	680.0	0.0005	0.24	1.58	120.00
N 52 - N 61	VP RR	125	2145.0	0.0079	0.64	9.99	120.00
N 53 - N 59		50	280.0	0.0008	0.41	1.67	120.00
N 54 - N 53		50	384.0	0.0006	0.28	1.16	120.00
N 55 - N 54		50	790.0	0.0004	0.21	1.37	120.00
N 55 - N 58	VP RR	75	350.0	0.0014	0.30	0.69	120.00
N 56 - N 55	VP RR	75	263.0	0.0024	0.50	1.35	120.00
N 57 - N 43	VP RR	75	51.0	0.0030	0.62	0.40	120.00
N 57 - N 51		50	580.0	0.0005	0.26	1.51	120.00
N 58 - N 53		50	830.0	0.0005	0.24	1.84	120.00
N 59 - N 52		50	665.0	0.0005	0.24	1.49	120.00
N 62 = N 63	VP RR	250	115.0	0.0426	0.93	0.51	120.00
N 62 = N 68	VP RR	200	600.0	0.0325	1.08	4.49	120.00
N 63 = N 64	VP RR	250	90.0	0.0346	0.75	0.27	120.00
N 63 = N 69	VP RR	100	600.0	0.0080	1.01	8.48	120.00
N 64 = N 70	VP RR	200	600.0	0.0346	1.16	5.66	120.00

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PIPE LIST

	KIND	DIA. (mm)	LENGTH (m)	QUANTITY (m3/sec)	VELOCITY (m/sec)	FRICTION LOSS (m)	C VALUE
N 68 - N 65	VP RR	150	800.0	0.0162	0.95	6.59	120.00
N 69 - N 66	VP RR	75	600.0	0.0040	0.84	8.19	120.00
N 70 - N 67	VP RR	150	800.0	0.0173	1.02	7.43	120.00
N 71 - N 20	VP RR	125	43.0	0.0029	0.23	0.03	120.00
N 71 - N 26	VP RR	100	41.0	0.0059	0.75	0.33	120.00