UNIVERSITY OF TECHNOLOGY
Building and Construction Engineering Department
Final Exam. 1st attempt, 2014/2015
Subject : Sanitary Engineering
Branch : Building & Construction Management Engineering Branch
Instructor: Ammar A. Al-Sultan
Class: 3rd Year
Time : 3 Hours
Date : May 31st , 2015

Note : Answer of FOUR questions

Q	Description	Score %
1-A	Differentiate (with drawings) between: 1- Sedimentation process & Filtration process in WTP. 2- Loop water network system & Tree water network system. 3- Lining system for Hazardous waste landfill (option -1) & lining system for Non-Hazardous biodegradable waste landfill.	15
1-B	Draw with full details the following items: 1- Typical leachate collection and removal system in landfill site. 2- Diagrammatic section of a rapid sand filter.	10
2-A	The two filters bed system as shown in fig (1), use Kawamura's formula to determine the followings: 1- The particle sizes of anthracite & ilmenite which have velocities equal to that sand 0.5mm in diameter. 2- The filter ratio (%) after increased the length of filter number 2, if the ($Q_{bw1} = 0.03 \times Q_1$), ($Q_{bw2} = 1.3 \times Q_{bw1}$) & ($Q_{bw2} = 0.025 \times Q_2$).	15
2-B	Explain with all definitions of the selected items in the fig (2).	10
3	A WTP contains the flocculation package system as shown in fig (3), this package divided by two basins, each one contain three equal zones & the overall detention time for each basin is 30 min, calculate: 1- The input flowrate in (m^3/d). 2- The concentration of Alum in (mg/ℓ) if the quantity of coagulant is 120 kg/d. 3- The surface area for each basin & overall surface area. Use: $GT = 1 \times 10^5$, basin depth = 3.5 m, $\mu = 1.3 \times 10^{-3}$ kg/m.s	25
4	The sewer network including construction of the sewer pipe as shown in the fig (4), the trench of this pipe must be filling back by damp clay soil & it's intersect by 1.0 m inclined water channel that carry out loading of 1500 kg/m. Suggest a construction method at the intersection region according to ASTM specifications, use the following data in the fig (4).	25
5	Calculate the number of population in the residential area which receiving the portable water by pipeline AB, use the Monogram chart method and check the velocity in the pipeline AB as shown in the fig (5).	25

With my best wishes for success

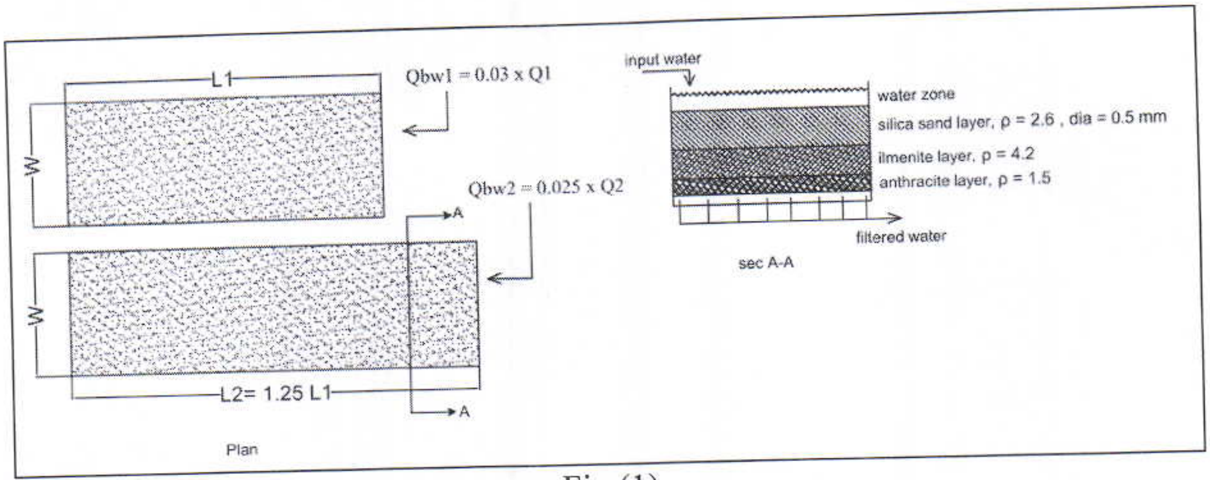

Fig (1)

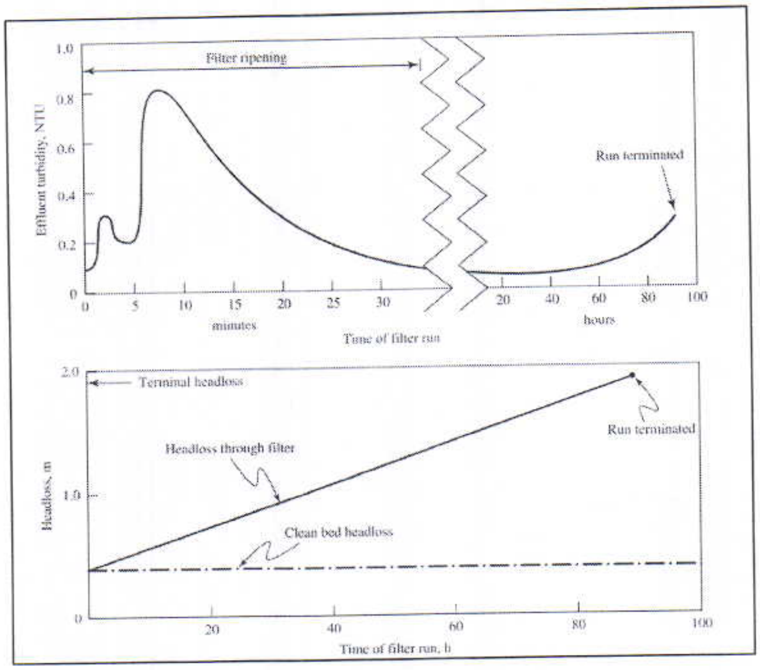

Fig (2)

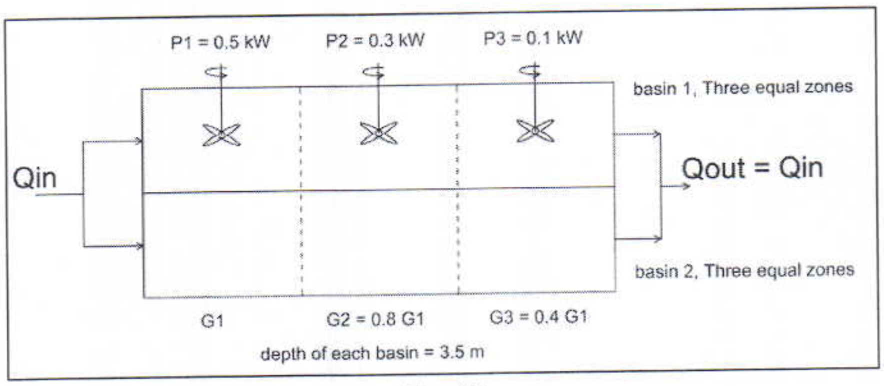

Fig (3)

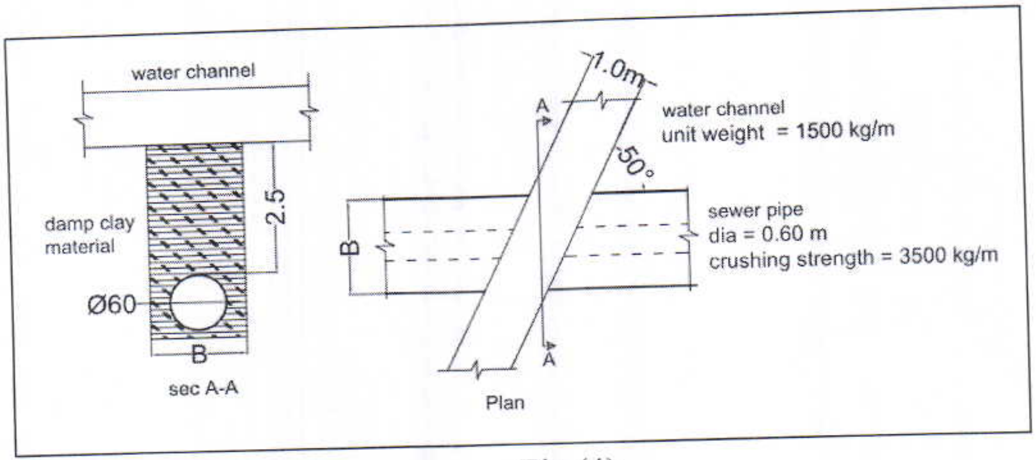

Fig (4)

Materials	Unit wt (kg/m3)
Dry sand	1600
Ordinary sand	1840
Wet sand	1920
damp clay	1920
Saturated clay	2080
Saturated top soil	1840
Sand & damp top soil	1600

Soil type	Max value of (kμ)
Cohesion less granular material	0.192
Sand & gravel	0.165
Sat. top soil	0.15
Clay	0.13
Sat. clay (wet clay)	0.11

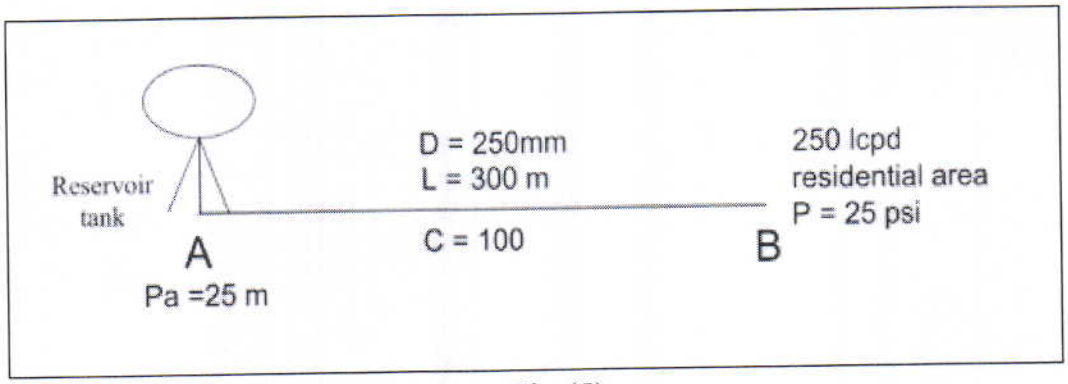

Fig (5)

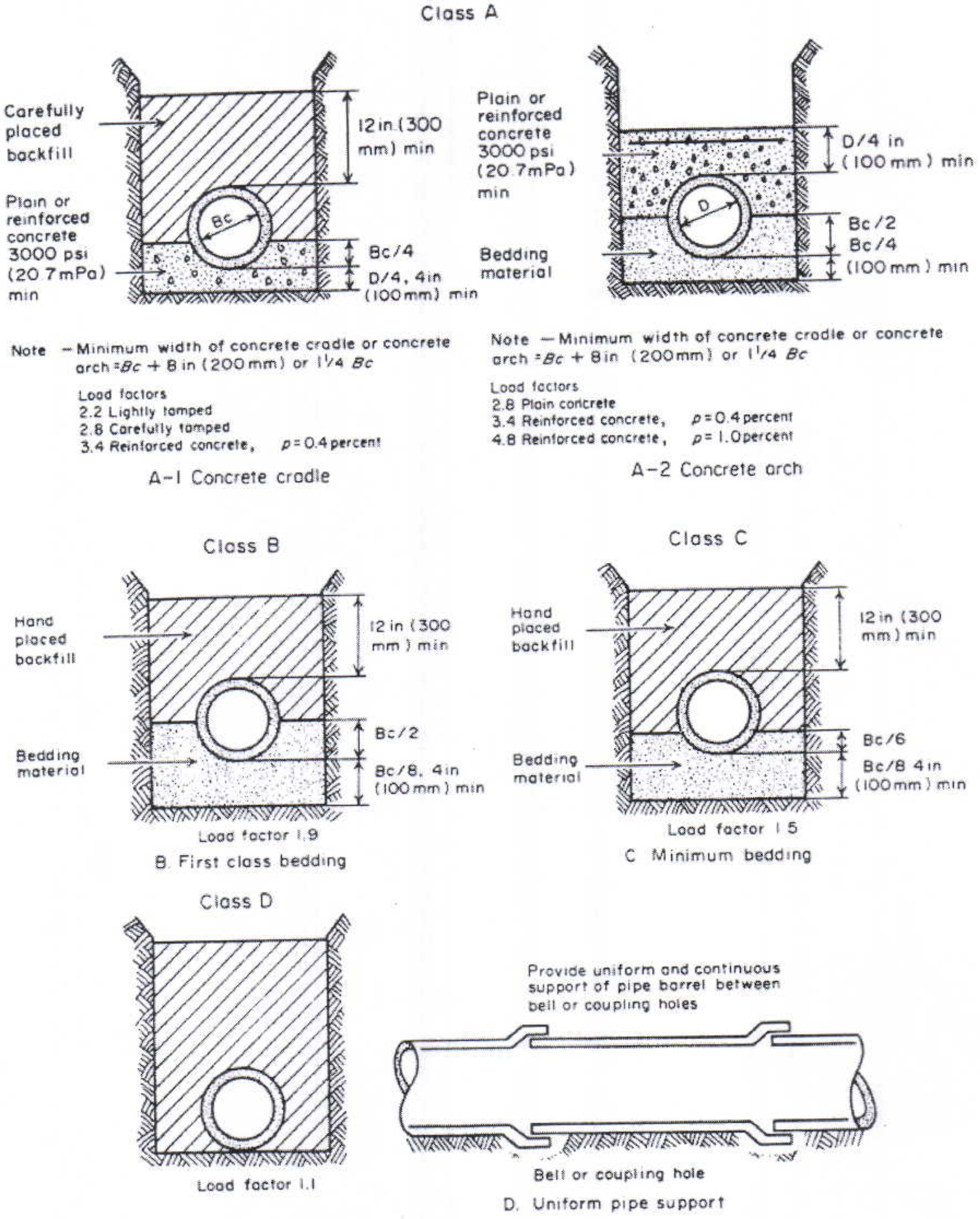

Figure 14-2 Methods of bedding clay pipe and load factors applicable to strength.[4] (*Reprinted by Permission of the American Society for Testing and Materials, Copyright 1977.*)

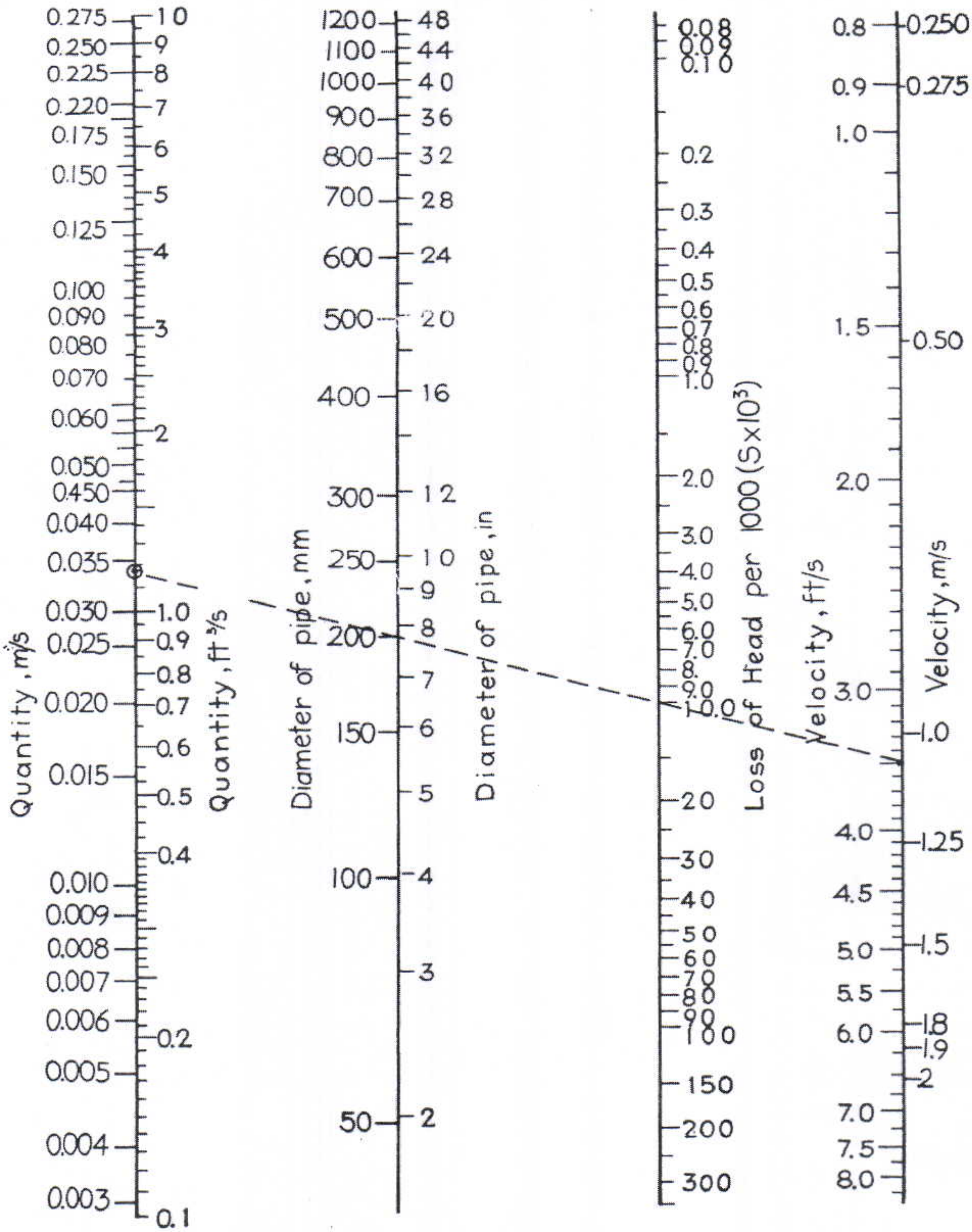

Figure 6-8 Flow in old cast-iron pipes. (Hazen-Williams $C = 100$.)

Table 14-5 Proportion of "long" superficial loads reaching pipe in trenches

Ratio of depth to width	Sand and damp topsoil	Saturated topsoil	Damp yellow clay	Saturated yellow clay
0.0	1.00	1.00	1.00	1.00
0.5	0.85	0.86	0.88	0.89
1.0	0.72	0.75	0.77	0.80
1.5	0.61	0.64	0.67	0.72
2.0	0.52	0.55	0.59	0.64
2.5	0.44	0.48	0.52	0.57
3.0	0.37	0.41	0.45	0.51
4.0	0.27	0.31	0.35	0.41
5.0	0.19	0.23	0.27	0.33
6.0	0.14	0.17	0.20	0.26
8.0	0.07	0.09	0.12	0.17
10.0	0.04	0.05	0.07	0.11

Table 14-6 Proportion of "short" superficial loads reaching pipe in trenches

Ratio of depth to width	Sand and damp topsoil		Saturated topsoil		Damp clay		Saturated clay	
	Max	Min	Max	Min	Max	Min	Max	Min
0.0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
0.5	0.77	0.12	0.78	0.13	0.79	0.13	0.81	0.13
1.0	0.59	0.02	0.61	0.02	0.63	0.02	0.66	0.02
1.5	0.46	.....	0.48	.....	0.51	.....	0.54	
2.0	0.35	.....	0.38	.....	0.40	.....	0.44	
2.5	0.27	.....	0.29	.....	0.32	.....	0.35	
3.0	0.21	.....	0.23	.....	0.25	.....	0.29	
4.0	0.12	.....	0.14	.....	0.16	.....	0.19	
5.0	0.07	.....	0.09	.....	0.10	.....	0.13	
6.0	0.04	.....	0.05	.....	0.06	.....	0.08	
8.0	0.02	.....	0.02	.....	0.03	.....	0.04	
10.0	0.01	.....	0.01	.....	0.01	.....	0.02	

Useful equations

$$A = \frac{Q}{N.q}$$

$$V = 0.849 \times C \times R^{0.63} \times S^{0.54}$$

$$G^2 = \frac{P}{\mu . Vol}$$

$$c = \frac{1 - e^{-k\bar{\xi}(H/B)}}{2k\bar{\xi}}$$

Sanitary Engineering
Final Exam 1st attempt
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الهندسة الصحية
المرحلة الثالثة - اجابة م ح

Q1-A

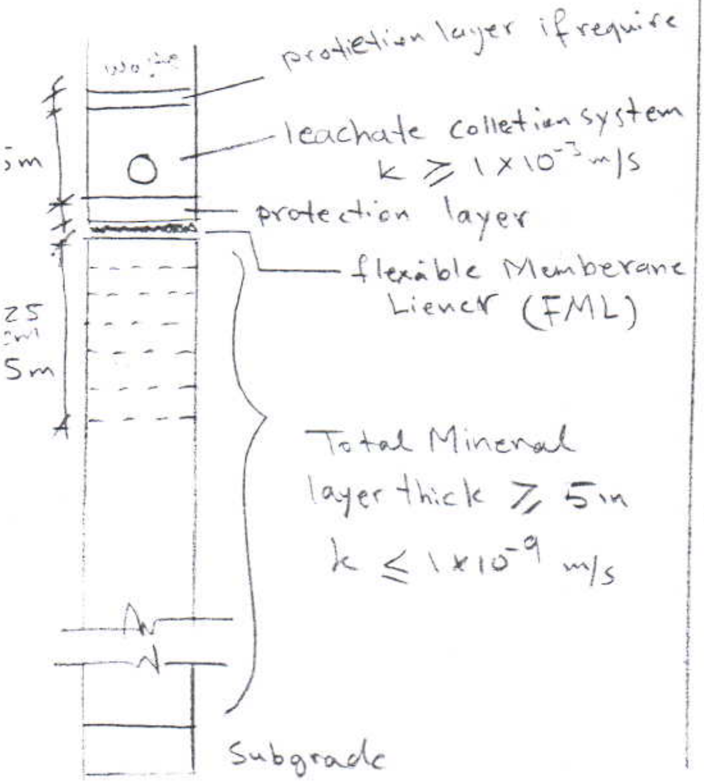
(1)

Sedimentation process	Filtration process
1- The design of tank depended on SOR, d_w, d_p, Re number	1- The design of tank depend on filtration rate, surface area, Q
2- There is no any filter media in the basine	2- There are many types of materiales that use as filter media in the basin
3- The Geometric shape may be designing of rectangular or circular	3- Usually rectangular volumn.
4- Use to clarification the raw water after the coagulation - flocculation process.	4- use to filtering the water after sedimentation process
5- there is no back washing water to cleaning the tanks	5- useing the backwashing water to cleaning the filters.
6- The sedimentation process yield to produt the clarifier water + sludge	6- The filtration procces yield to filterd water.

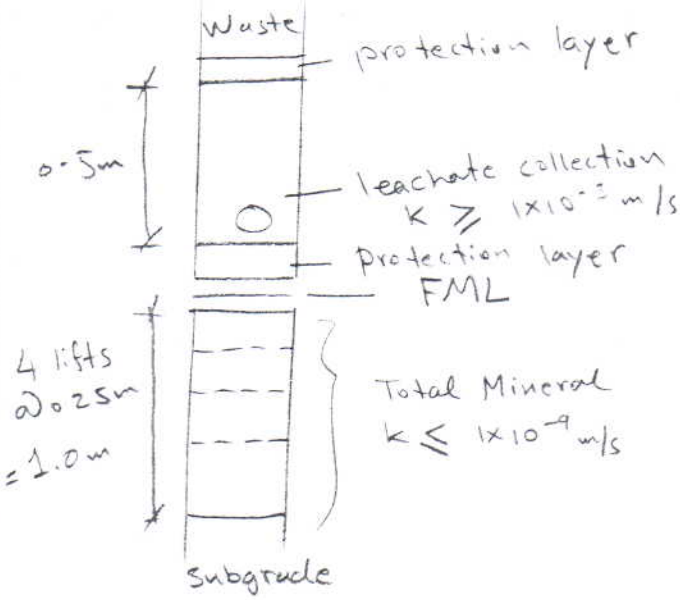
(2)

Loop Network system	Tree Water system
1- Hard work in design & construction	1- More easy in design & construction methodes
2- Homegennose pressure	2- Non-homegenouse pressure.
3- If the one pipe has been crushed the the next regen feed by other pipe	3- If the hammer pheromy happen in one of pipe in the network that may be lead to incapacitate in the next regen.
4- There is no dead end zones in the loop system	4- this network contains the deadend & the material can be sedimentate at the min. velocity
5- More expensive	5- least expensive.

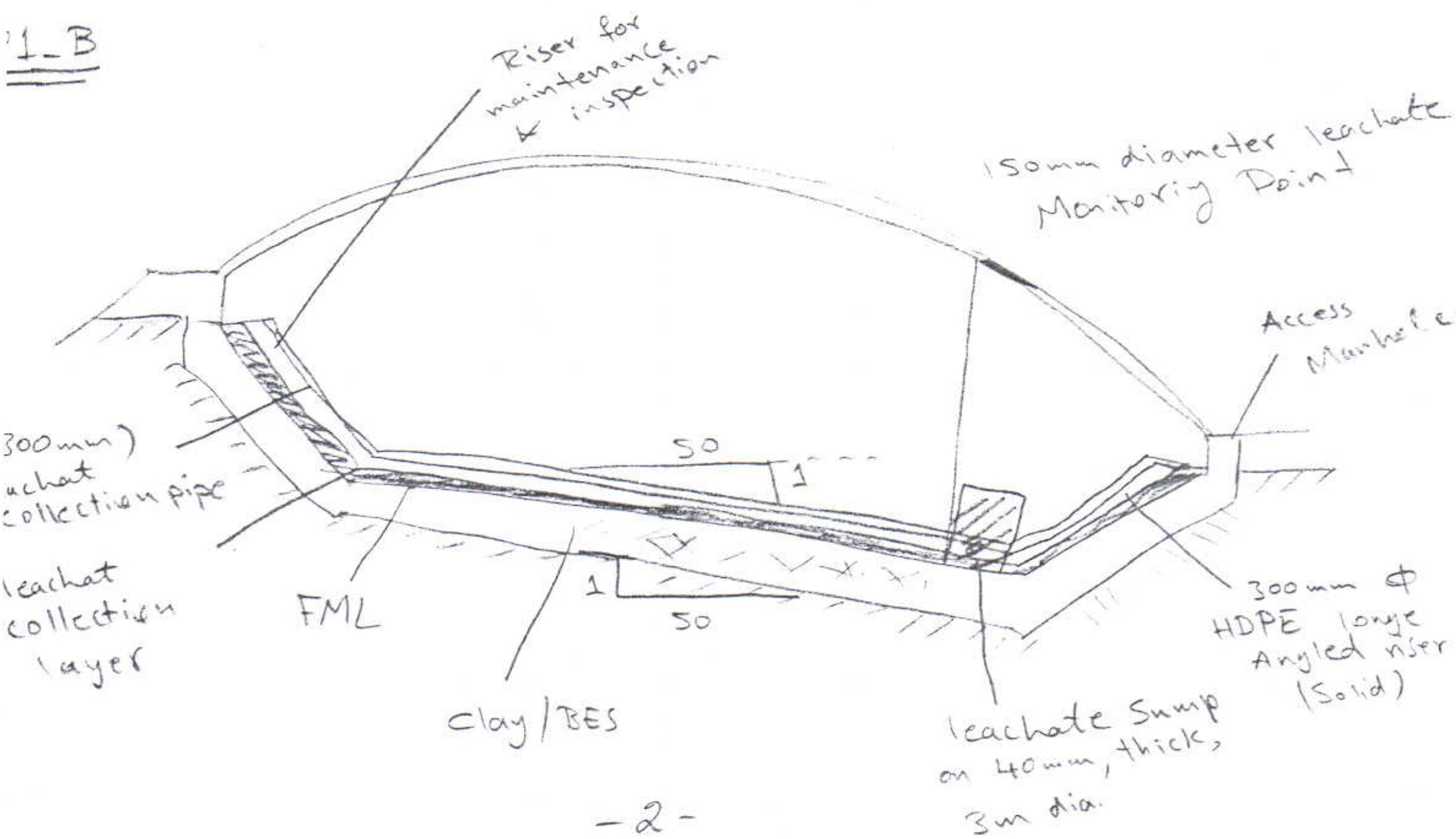
1 Liniy System for Hazardous Wast Land fill (option- 1)



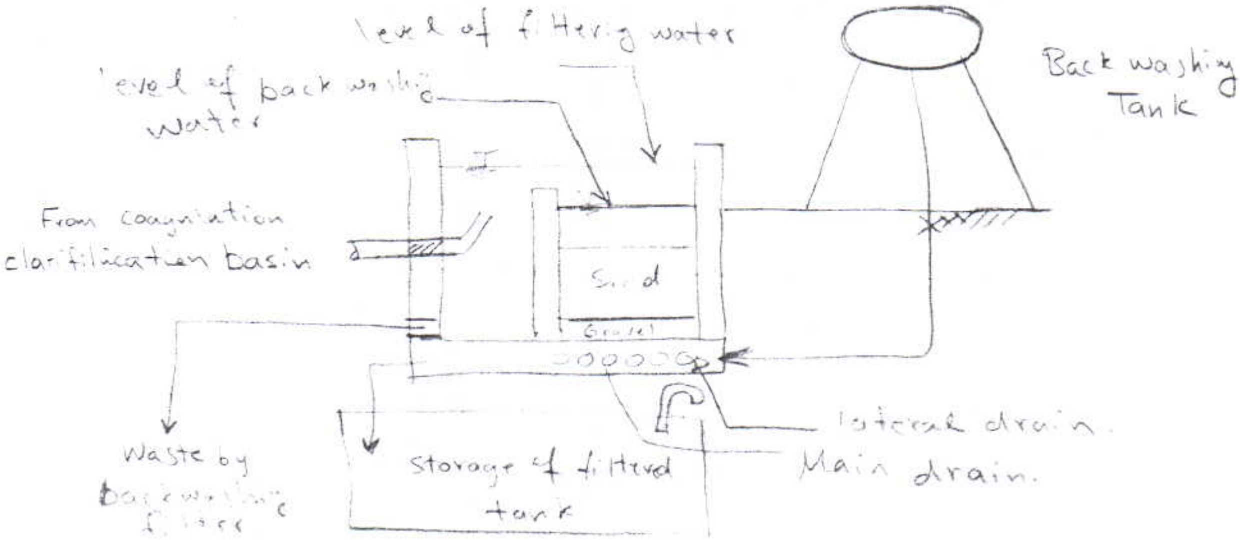
Liniy system for Non- Hazardonse biodegredable waste land fill



1_B



1B - ②



2-2-A Solution

① $\frac{d_1}{d_2} = \left(\frac{\delta_2 - \delta_w}{\delta_1 - \delta_w}\right)^{2/3}$ ⇒ $d_2 = 0.5$ mm for silica sand.

For the anthacite

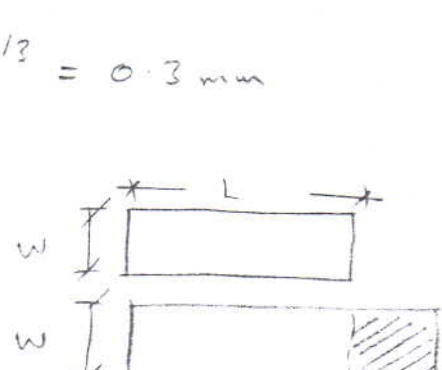
$$d_1 = 0.5 \left(\frac{2.6 - 1}{1.5 - 1}\right)^{2/3} = 1.1 \text{ mm}$$

For the ilmenite

$$d_1 = 0.5 \left(\frac{2.6 - 1}{4.2 - 1}\right)^{2/3} = 0.3 \text{ mm}$$

② $A_1 = W.L$

$A_2 = 1.25\, W.L$



Kawamura's formula

$$A = \frac{Q}{N.q}$$

$$Q_{bw1} = 0.03\, Q_1$$

$$Q_1 = \frac{Q_{bw1}}{0.03} = 33.33\, Q_{bw1} \quad —(1)$$

$$Q_2 = \frac{Q_{bw2}}{0.025} \qquad \text{but } Q_{bw2} = 1.3\, Q_{bw1}$$

$$\therefore Q_2 = \frac{1.3\, Q_{bw1}}{0.025} = 52\, Q_{bw1} \quad —(2)$$

$$A = \frac{Q}{N \cdot q} \Rightarrow q = \frac{Q}{N \cdot A} \qquad N_1 = 1 ,\ N_2 = 1$$

$$q_1 = \frac{Q_1}{N_1 (W \cdot L)} , \quad q_2 = \frac{Q_2}{N_2 (1.25\, W \cdot L)}$$

The filtration rate % After increasing the filter Length

$$\frac{q_2}{q_1} = \frac{\dfrac{Q_2}{N_2\, 1.25\, W \cdot L}}{\dfrac{Q_1}{N_1\, W \cdot L}} = \frac{52\, Q_{bw1} / 1.25\, W \cdot L}{33\, Q_{bw1} / W \cdot L} = \frac{52}{33.33 \times 1.25}$$

$$= 1.248$$

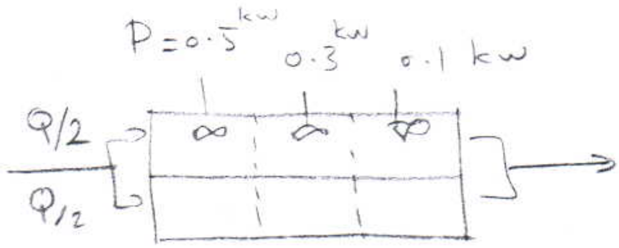
The increasing rate for filtration

$$\Rightarrow \left(\frac{q_2}{q_1} \times 100\%\right) - 100\%$$

$$124.8 - 100 = \boxed{24.8\%}$$

معدل الزيادة في الترشيح اذا زيد طول المرشح بمقدار (1.25)

Q3



$DT = 30\ min = 30 \times 60$
$= 1800\ sec.$

dt for each basine = 10 min = 600 sec.

1- Find the flowrate $(Q/2)$

$\frac{Q}{2} = \frac{Vol}{DT} \quad ∴ \quad G^2 = \frac{P}{\mu . Vol}$

but $GT = G \times DT \Rightarrow G = \frac{GT}{DT} = \frac{1 \times 10^5}{30 \times 60} = 55.56\ sec^{-1}$

$G_{Total} = \frac{G_1 + 0.8 G_1 + 0.4 G_1}{3} \Rightarrow 55.56 = \frac{2.2}{3} G_1$

$∴ G_1 = 75.76\ sec^{-1}$

$\Rightarrow Vol_1 = \frac{P_1}{\mu \times G_1^2} = \frac{0.5 \times 10^3}{1.3 \times 10^{-3} \times (75.76)^2} = \boxed{67.01\ m^3}$

$\Rightarrow G_2 = 0.8 G_1 = 60.61\ s^{-1} \Rightarrow V_2 = \frac{0.3 \times 10^3}{1.3 \times 10^{-3} \times (60.61)^2} = 61.79\ m^3$

$G_3 = 0.4 G_1 = 30.30\ s^{-1} \Rightarrow V_3 = \boxed{83.78\ m^3}$

$\frac{Q}{2} = \frac{V_1 + V_2 + V_3}{DT} \Rightarrow Q = 2 \times \frac{67.01 + 61.79 + 83.78}{30} = \boxed{14.172\ m^3/min}$

overall flowrate $= Q \times 2 = \boxed{20407,68\ m^3/d}$

2- The concentration of Alum.

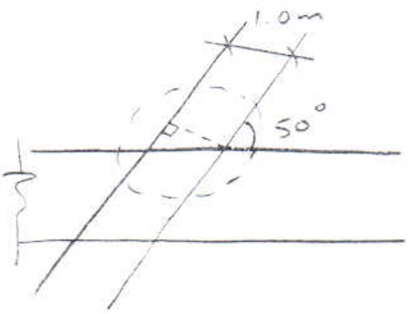
quantity $= Q \times Conc. \Rightarrow Conc. = \frac{quantity}{Q} = \frac{120 \times 10^6\ mg/d}{20407,68\ m^3/d}$

$= 5880.13\ mg/m^3 = \boxed{5.88\ mg/l}$

3- Overall Surface Area $= \frac{2(V_1 + V_2 + V_3)}{3.5} = 121,47$
$\simeq \boxed{130\ m^2}$

Q4 Solution: -

use F.S = 1.5

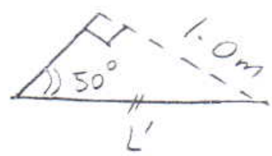


$$L.F = \frac{\text{Total loads}}{\text{crushing strength}} \times F.S$$

F.S ↓ 1.5

1. Static load:

$W = C . \phi . B^2$



$B_{min} = 1.5 \times \phi + 300$ according to ASTM

$= 1.5 \times 600 + 300 = 1,200$ mm

$= 1.20$ m

$L' = \frac{1.0}{\sin 50} = 1.305$ m

$$C = \frac{1 - e^{-2k\mu (H/B)}}{2k\mu}$$

$k\mu$ from table $= 0.11$

$$C = \frac{1 - e^{-2\times 0.11 (2.5/1.2)}}{2 \times 0.11} = 1.671$$

$\Rightarrow W = 1.671 \times 1920 \times (1.2)^2 =$ **4620.5 kg/m.l.**

(1920 ↑ from Table)

2. Non-Static load $B = 1.20m < L' = 1.3$ m

∴ $L' > B \Rightarrow$ ∴ long superficial loading

H/B ratio $= 2.083 \Rightarrow$ superficial load factor $\simeq 0.579$

wieght of water channel $= 1500$ kg/m

$\frac{1500 \times 1.305}{1.20} = 1631,25$ kg/m تحويل القناه احمل باتجاه الانبوب

$\Rightarrow$ Non-Static Load $= 1631,25 \times 0.579 =$ **944.49 kg/m**

$\Rightarrow$ Total load $= 4620.5 + 944.49$

$= 5564.99 \simeq$ **5565 kg/m**

Load factor L.F $= \frac{\text{Total load}}{\text{crushing strength}} \times F.S = \frac{5565}{3500} \times 1.5 =$ **2.385**

nstruct the Class A-1 Concrete cradle, L.F. = 2.8

Q5

A ×——————————————× B

250 lcpd

$P_A = 25\,m$

$P_B = 25\,psi = 17.7\,m$

$$S = \frac{P_A - P_B}{L} = \frac{25 - 17.75}{300} = 0.02416$$

we have 2-points , $S = 0.02416 \times 10^3 = 24.16$

by chart: & $D = 250\,mm = 0.25\,m$

$\Rightarrow V = 1.85\,m/s \Rightarrow V_{Range} = (0.6 - 1.20)\,m/s$ ok

$Q = 0.082\,m^3/s$

$= 7084.8\,m^3/d$

$Q = 7084.8 \times 10^3\,l/d$

$$\Rightarrow \text{number of pop.} = \frac{Q}{q} = \frac{7084.8 \times 10^3}{250}$$

$= \boxed{28339}$ person

check the Velocity by

Hazein William

$V = 0.849\, C\, R^{0.63}\, S^{0.54}$

$= 0.849 \times 100 \times \left(\frac{0.25}{4}\right)^{0.63} \times (0.02416)^{0.54}$

$= 1.98\,m/s$ out of the Range of design $(0.6 - 1.2)\,m/s$

∴ Not ok ⇒ Redesign

For Re-design

Use Av. Velocity $V_{av} = 0.90$ m

But the Q which service the city is equall to

$Q = 0.082\ m^3/s$ & $V = 0.90\ m/s$

∴ New dia of pipe $= \frac{Q}{V} = \frac{0.082\ m^3/s}{0.9\ m/s}$

$\simeq 91\ mm \simeq 9.1\ cm$

use 10 cm @ $V_{av.} = 0.90\ m$

or use $V_{0.6} = 0.6\ m/s \Rightarrow d = 136\ mm$

$V = 1.2\ m/s \Rightarrow d = 68\ mm$