EWCE 432

L01 17/06

Environmental Engineering Design Sessional

Six groups : Dairy farm | Fertilizer | D | F | D | F

Area (acre) : 70 | 80 | 90 | 100 | 110 | 120

→ 44, 18, 15, 50, 36, 93, 26

Industrial park → Residential, Industrial, Commercial, Admin

Organogram :

Layout: Ensure highway connection, river (72' width)

ETP (larger size)

Ensure security checkpost at entrance

parking beside industry

↳ warehouse, storage

raw mats, finished goods

Dairy farm

Industrial: 7-8 steps

Fire station (perhaps at middle)

Future ext

Internal rd 40'

--- see material (P11)

Quiz: Placement of building

Defn organogram, ...

Highway width, where ETP, ...

LO2 24/06

Exp.: Population

Estimation
1st class
2nd class
3rd class
4th class

Administrative separately

Assumptim

After 10 yrs
Reasonable family mem; should less than 6

Donm → 1.5 % sufficient

$P_f = P(1+r)^n$

L03

01/07

Water Demand Calculation

200, 135, 80

BNBC 2020 (P2237) mention 01, 02, ...

mention

Demand = Pop x lpcd x Time Factor

$\rightarrow \frac{24}{X}$ [X → hrs facility remains open; e.g., 8 hrs]

For production / Dairy farm

180,000 L/day

From internet find water per unit pond

Tubewell design

Standard sieves : 4 8 16 30 50 100

FM $\geq$ 1.5

Course sand > 5

Fine " > 70

Fill in the blank → blank pipe

Design of gravel pack:

Find layer w/ medium sand

D_{10}

$\text{Slot} = \frac{D_{10}}{25.4} \times 1000$

$Cu \leq 1.5 \rightarrow 4$

$Cu \geq 2.5 \rightarrow 6$

---

6. Yield of well

Strainer area = $0.15 \times \pi \times D \times$ strainer length

D : 6"

Strainer length = 100'

ff/s → Yield = Strainer area x flow vel. (0.1) (fps) x screen blockage factor (0.4)

$\text{Number of tubewell} = \frac{\text{water demand}}{\text{Yield}}$

Assessment next cls (potential)

Design of water supply system

Primary unit of water dist. sys. — pump

a) Design of pumping device:

Friction head: [max pipe len → from source to building]

b) Pumping demand:

For pumping, what considerations to take (e.g., device, economic, etc)

Supply ≤ 50 → Pump = 1

" $(50, 100]$ → Pump = 2 (1, 2 or 3, 4 ...)

" $(100, 150)$ → " = 3

" > 150 → " = 4

LO6 22/07

Water Distribution Network Design

First para → fill in the gaps

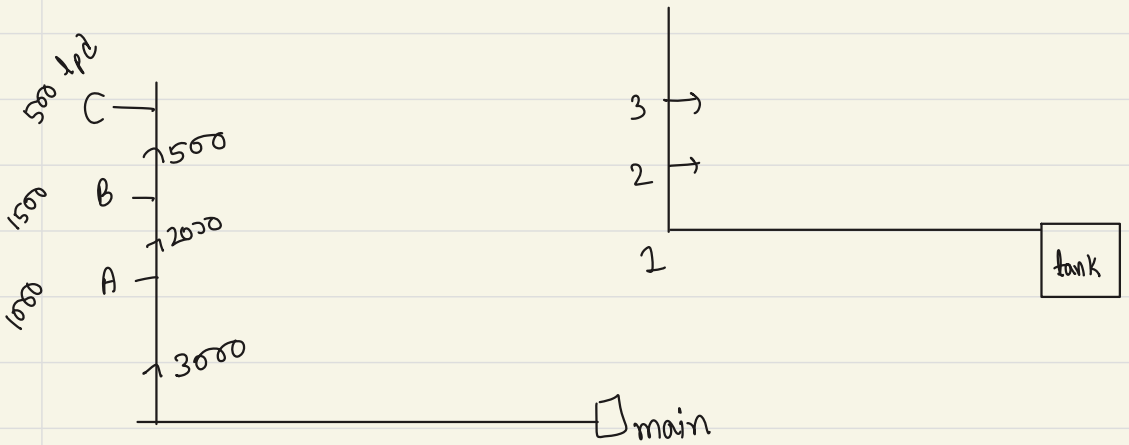
Requirements of good distribution system (mid)

Domestic min pressure → 30 psi
Fire hydrant → 40 psi (min 10 psi)
Max → 100 psi

Pipe below road

Branch network (On final, full math from branch or loop)

Adv. & disadv.



Don't back calc: show 'not okay'.
Always start w/ 40 psi

Rough / midquiz

29/07

Pump capacity & pumping schedules

Two part:

1. Defⁿ pump capacity
2. Pump scheduling

Pump capacity:

$$WHP = \frac{HQ}{3960}$$

(H → total head, Q → gpm)

H = Static head +

$A = 0.2(\pi DL)$

$Q = AV \times B.F$ or $\frac{AV}{S.F}$

x	y
1.18	14.19
0.6	1.38

$y = m \log(x) + C$

$m = \frac{14.19 - 1.38}{\log \frac{1.18}{0.6}} = 43\ 61$

$C = 11.06$

$x = 10^{\frac{y-C}{m}}$

#4 — 4.75

8 — 2.36

16 — 1.18

30 — 0 6

50 — 0.3

100 — 0.15

L07 19/08

Loop network

Grid iron network:

adv. disadv.

Ring

Radial

} for quiz

Hardy cross:

$H = KQ^{x}$ ← 1.85

$v = 3$ fps

loop until 3 zero

for quiz:

Head loss per 1000' pipe = 300'

1 loop may pen provided

Example:

RIVER

Existing Residential Settlement (extends westward)

560'

420'

420'

72'

Future Extension

D34 D33 D32 D31

D24 D23 D22 D21

Courtyard Parking & Vehicle Access (280' x 50')

D14 D13 D12 D11

Future Extension

C34 C33 C32 C31

Courtyard Parking & Vehicle Access (280' x 50')

C24 C23 C22 C21

C14 C13 C12 C11

Future Extension

Overhead Tank, OHT-1 (125' x 85')

Future Extension

Water Pump Station, P-2 (125' x 85')

40' Local Road

B25 B24 B23 B22 B21

B15 B14 B13 B12 B11

Central Park & Sports Field (420' x 190')

Water Pump Station, P-3 (125' x 115')

Primary School (305' x 115')

Supermarket with ATM Kiosk (250' x 170')

Food Court (170' x 170')

Gym (125' x 85')

Telecom Center (125' x 85')

Bank (170' x 85')

Future Extension

Postal Service (125' x 85')

Laundry (85' x 85')

Salon (85' x 85')

Future Extension

Training Academy (130' x 64')

Future Extension

R&D Facility (130' x 64')

IT Center (130' x 64')

QA Office (130' x 64')

Park Op. Center (130' x 64')

Future Extension

Executive Villas (220' x 230')

A22 A21

A12 A11

Central Mosque (200' x 300')

Residential Estate Office (220' x 130')

Community Center (220' x 100')

Dairy Retail Outlet & Cafe (220' x 170')

Insurance Corporate Office (200' x 170')

Veterinary Medicine (85' x 85')

Daycare Center (125' x 85')

Shopping Complex with ATM Kiosk (210' x 85')

Pharmacy (85' x 85')

Hardware Store (125' x 85')

Autoshop & Truck Servicing Center (210' x 85')

Future Extension

Power Plant (130' x 128')

Water Pump Station, P-1 (130' x 128')

Health Clinic (130' x 128')

Fire Station (130' x 128')

Corporate HQ with ATM Kiosk (130' x 128')

Exhibition Center (260' x 128')

Parking Lot (260' x 128')

Future Extension

Veterinary Office (195' x 64')

Logistics & Customs Office (195' x 64')

CMS (130' x 64')

Inspection Bay (130' x 64')

ROAD CANAL

Highway

Checkpoint (10' x 20')

1400'

Cow Barn A (420' x 360')

Cow Barn B (420' x 360')

Milking Rotary (Left: 180' x 300' Right: 240' x 180')

Milking Center Utilities (240' x 120')

Cold Storage Warehouse (420' x 210')

Truck Staging Yard (200' x 130')

Shipping Docks (220' x 130')

Sewage Treatment Plant (480' x 170')

Effluent Treatment Plant (460' x 170')

Water Pump Station, P-4 (150' x 150')

Bottle Inventory (270' x 150')

Packaging Station (420' x 150')

Processing Core (420' x 300')

Water Pump Station, P-8 (120' x 150')

Raw Milk Silos (300' x 150')

Chilling & Filtration Block (420' x 150')

Future Extension

Water Pump Station, P-7 (140' x 130')

Future Extension

Solid Waste Dump (420' x 130')

Overhead Tank, OHT-2 (120' x 120')

Water Pump Station, P-5 (120' x 140')

Future Extension

Water Pump Station, P-6 (120' x 140')

Highway

1400'

1400'

Agricultural Land (extends eastward)

1400'

DRAWING COMPONENT

DAIRY FARM INDUSTRIAL PARK

DATE

2026-08-08

SCALE

1:2500

PARAMETERS

DEPARTMENT: ENVIRONMENTAL, WATER RESOURCES, AND COASTAL ENGINEERING

COURSE: ENVIRONMENTAL ENGINEERING DESIGN SESSIONAL (EWCE 432)

GROUP NO.: 03

PARK TYPE: DAIRY FARM

TOTAL FOOTPRINT: 90 ACRES

LEGENDS

- Administrative Wing
- Commercial Wing
- Residential Wing
- Industrial Wing
- River / Lake / Road Canals
- Road

RESIDENTIAL SCHEDULE

Villa	Residence of Senior Executives (220' x 230')
A	Division Head Quarters (100' x 115')
B	Department Manager & Doctor Quarters (84' x 57.5')
C	Technical Staff & Supervisor Quarters (70' x 60')
D	Operator, Clerk, and Laborer Quarters (70' x 60')

RIVER

Existing Residential Settlement (extends westward)

Agricultural Land (extends eastward)

560'

420'

420'

72'

1400'

1400'

1400'

Future Extension

D34 D33 D32 D31

D24 D23 D22 D21

Courtyard Parking & Vehicle Access (280' x 50')

D14 D13 D12 D11

B25 B24 B23 B22 B21

B15 B14 B13 B12 B11

Executive Villas (220' x 230')

A22 A21

A12 A11

Central Park & Sports Field (420' x 190')

Future Extension

C34 C33 C32 C31

Courtyard Parking & Vehicle Access (280' x 50')

C24 C23 C22 C21

C14 C13 C12 C11

Water Pump Station, P-3 (120' x 115')

Primary School (305' x 115')

Central Mosque (200' x 230')

Residential Estate Office (220' x 130')

Community Center (220' x 100')

Future Extension

Overhead Tank, OHT-1 (125' x 85')

Supermarket with ATM Kiosk (250' x 170')

Food Court (170' x 170')

Dairy Retail Outlet & Cafe (220' x 170')

Insurance Corporate Office (200' x 170')

Future Extension

Water Pump Station, P-2 (125' x 85')

Gym (125' x 85')

Telecom Center (125' x 85')

Bank (170' x 85')

Future Extension

Postal Service (125' x 85')

Laundry (85' x 85')

Salon (85' x 85')

Veterinary Medicine (85' x 85')

Daycare Center (125' x 85')

Shopping Complex with ATM Kiosk (210' x 85')

Pharmacy (85' x 85')

Traditional Spice (125' x 85')

Autoshop & Truck Servicing Center (210' x 85')

40' Local Road

Future Extension

Training Academy (150' x 64')

Future Extension

Power Plant (130' x 128')

Water Pump Station, P-1 (130' x 128')

Health Clinic (130' x 128')

Fire Station (130' x 128')

Future Extension

R&D Facility (130' x 64')

IT Center (130' x 64')

QA Office (130' x 64')

Park Op. Center (130' x 64')

Corporate HQ with ATM Kiosk (130' x 128')

Exhibition Center (130' x 128')

Parking Lot (260' x 128')

Future Extension

Veterinary Office (195' x 64')

Logistics & Customs Office (130' x 64')

CMS (130' x 64')

Inspection Bay (130' x 64')

ROAD CANAL

Checkpoint (10' x 20')

Cow Barn A (420' x 360')

Cow Barn B (420' x 360')

Milking Rotary (Left: 180' x 300' Right: 240' x 180')

Milking Center Utilities (240' x 120')

Cold Storage Warehouse (420' x 210')

Truck Staging Yard (200' x 130')

Shipping Docks (220' x 130')

Sewage Treatment Plant (480' x 170')

Effluent Treatment Plant (460' x 170')

Water Pump Station, P-4 (150' x 150')

Bottle Inventory (270' x 150')

Packaging Station (420' x 150')

Processing Core (420' x 300')

Water Pump Station, P-8 (120' x 150')

Raw Milk Silos (300' x 150')

Chilling & Filtration Block (420' x 150')

Future Extension

Water Pump Station, P-7 (140' x 130')

Future Extension

Solid Waste Dump (420' x 130')

Overhead Tank, OHT-2 (120' x 120')

Water Pump Station, P-5 (120' x 140')

Future Extension

Water Pump Station, P-6 (120' x 140')

Highway

Highway

DRAWING COMPONENT

DAIRY FARM INDUSTRIAL PARK

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A	Division Head Quarters (100' x 115')
B	Department Manager & Doctor Quarters (84' x 57.5')
C	Technical Staff & Supervisor Quarters (70' x 60')
D	Operator, Clerk, and Laborer Quarters (70' x 60')

RIVER

Existing Residential Settlement (extends westward)

Agricultural Land (extends eastward)

560'

420'

420'

1400'

72'

Future Extension

Building Type - D (135.2 klpd = 13.8 klpd/house)

D34 D33 D32 D31 D24 D23 D22 D21 D14 D13 D12 D11

Building Type - B (83.7 klpd = 8.4 klpd/house)

B25 B24 B23 B22 B21 B15 B14 B13 B12 B11

Executive Villas (49.4 klpd)

Building Type - A (67.5 klpd = 16.9 klpd/house)

A22 A21 A12 A11

Central Park & Sports Field (15.0 klpd)

Future Extension

Building Type - C (141.9 klpd = 11.8 klpd/house)

C34 C33 C32 C31 C24 C23 C22 C21 C14 C13 C12 C11

Central Mosque (194.4 klpd)

Residential Estate Office (7.1 klpd)

Community Center (16.1 klpd)

Water Pump Station, P-3 (0.1 klpd)

Primary School (231.9 klpd)

Future Extension

Overhead Tank, OHT-1 (125' x 85')

Supermarket with ATM Kiosk (13.0 klpd)

Food Court (21.7 klpd)

Dairy Retail Outlet & Cafe (15.1 klpd)

Insurance Corporate Office (1.9 klpd)

Future Extension

Water Pump Station, P-2 (0.1 klpd)

Gym (18.9 klpd)

Telecom Center (2.7 klpd)

Bank (23.2 klpd)

Future Extension

Postal Service (2.7 klpd)

Laundry (1.0 klpd)

Salon (1.0 klpd)

Veterinary Medicine (7.1 klpd)

Daycare Center (11.0 klpd)

Shopping Complex with ATM Kiosk (12.0 klpd)

Pharmacy (1.0 klpd)

Hardware Store (0.9 klpd)

Autoshop & Truck Servicing Center (1.5 klpd)

40' Local Road

Future Extension

Training Academy (48.6 klpd)

Future Extension

Power Plant (0.8 klpd)

Water Pump Station, P-1 (0.1 klpd)

Health Clinic (102.5 klpd)

Fire Station (3.1 klpd)

Future Extension

R&D Facility (4.6 klpd)

IT Center (0.7 klpd)

QA Office (2.7 klpd)

Park Op. Center (0.6 klpd)

Corporate HQ with ATM Kiosk (24.3 klpd)

Exhibition Center (27.4 klpd)

Parking Lot (1.2 klpd)

Future Extension

Veterinary Office (7.1 klpd)

Logistics & Customs Office (5.7 klpd)

CMS (5.1 klpd)

Inspection Bay (0.4 klpd)

ROAD CANAL

Highway

Checkpoint (0.3 klpd)

Highway

1400'

1400'

Cow Barn A (1.8 + 714.4 = 716.2 klpd)

Sewage Treatment Plant (0.2 klpd)

Effluent Treatment Plant (0.4 klpd)

Water Pump Station, P-4 (0.1 klpd)

Bottle Inventory (0.5 + 20.4 = 21.0 klpd)

Solid Waste Dump (1.1 klpd)

Packaging Station (3.9+30.6 = 34.5 klpd)

Overhead Tank, OHT-2 (120' x 120')

Cow Barn B (1.8 + 714.4 = 716.2 klpd)

Water Pump Station, P-5 (0.1 klpd)

Processing Core (5.3 + 102.1 = 107.4 klpd)

Milking Rotary (1.6 + 163.3 = 164.9 klpd)

Future Extension

Milking Center Utilities (0.1 + 81.6 = 81.8 klpd)

Water Pump Station, P-8 (0.1 klpd)

Raw Milk Silos (0.1 + 40.8 = 41.0 klpd)

Cold Storage Warehouse (0.5 klpd)

Chilling & Filtration Block (0.8 + 61.2 = 62.1 klpd)

Truck Staging Yard (0.8 + 10.2 = 11.0 klpd)

Shipping Docks (0.2 klpd)

Future Extension

Water Pump Station, P-7 (0.1 klpd)

Future Extension

Water Pump Station, P-6 (0.1 klpd)

DRAWING COMPONENT

DAIRY FARM INDUSTRIAL PARK

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- Water Supply Pipe

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D	Operator, Clerk, and Laborer Quarters (70' x 60')

Rough/ Loop network 01/09

Handy cross

$H = KQ^x$; $K=1$, $x = 1.85$

Loop → Pipe → Len → Q_0 → H → H/Q_0 → Corr. = $-\frac{\Sigma H}{}$

L08 02/09

Design of wastewater conveyance system: Sanitary sewer design

→ House conn.
→ Network
→ TP
→ Disposal

---

we'll design this ↘

House conn. → branch sewer → main sewer → trunk sewer

Components → domestic
everything excl. industrial prod & storm water

Use avg water supply

Manhole cover always circular
for safety reason
circular can't be swollen inside

$n = 0.013$
Often Q, then find d through trial

→ Q_{full}
→ V_{full}
→ V/a ...

Q = peak wastewater + infil. inflow

↳ D = 175.34 mm

≈ 200 mm

Q_{full}, V_{full}

$Q/Q_{full} \rightarrow V$ (dotted line; const. n)

$V/V_{full} = 0.9$

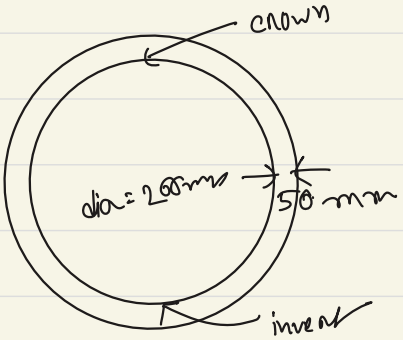
→ check w/ min/max vel

Longitudinal profile:

farthest point 30 m
at STP 25 m
} use diff of 5 mm

gen 4/5 contour lines in btwn

pipe to be atleast 2m below first point of el



Show loc manhole

L09 09/09

Basic Building Plumbing

Direct

Indirect

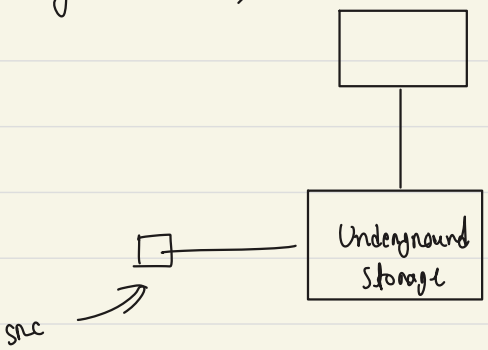
Pipes → PVC, Galvanized

Asbesto cement

imp. towards the end

Good trap qualities

Plumbing defn



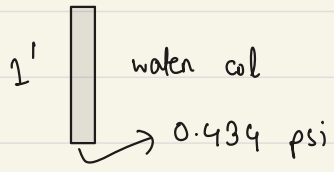
Soil pipe v. waste pipe

L10

16/09

Plumbing design [max mark]

Design from own building (w/ plan available)



Main pressure = 50 psi

Occupancy → public

Always add 5% len

23, 24 dia same

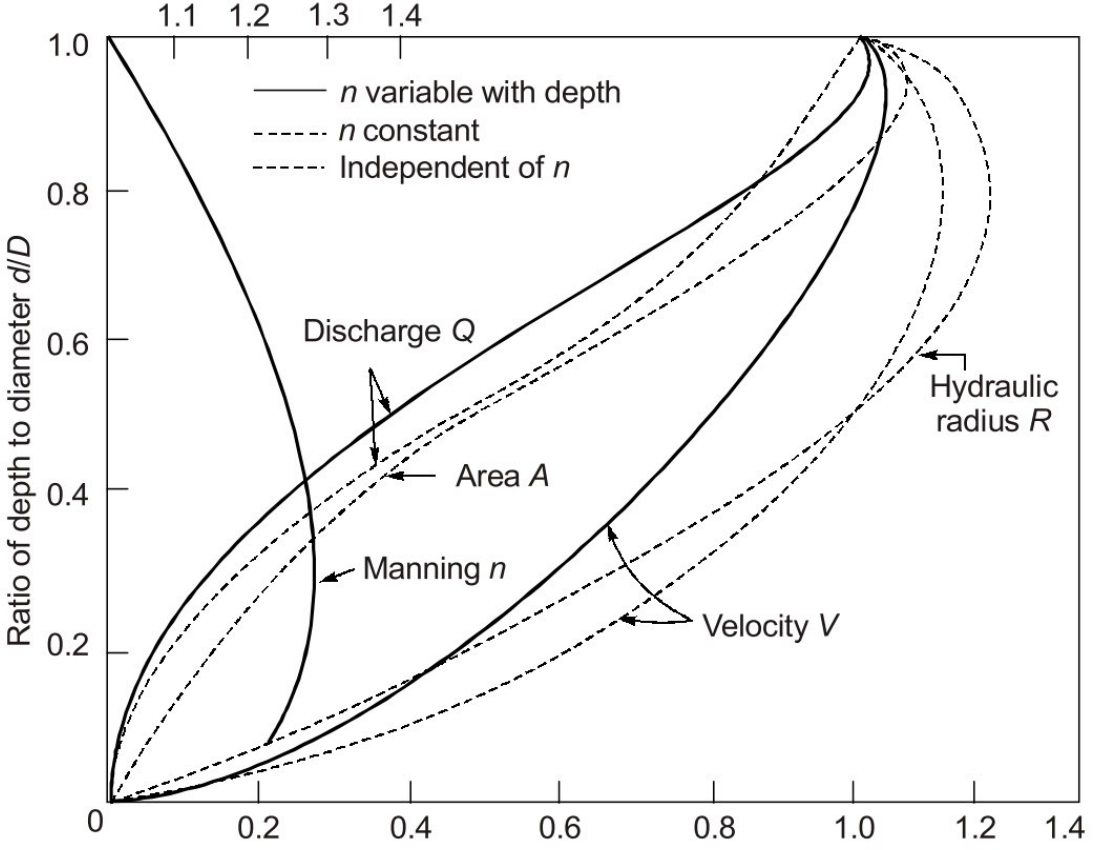
~~Ø Ø Ø~~ zoning (defn upfeed downfeed zone)

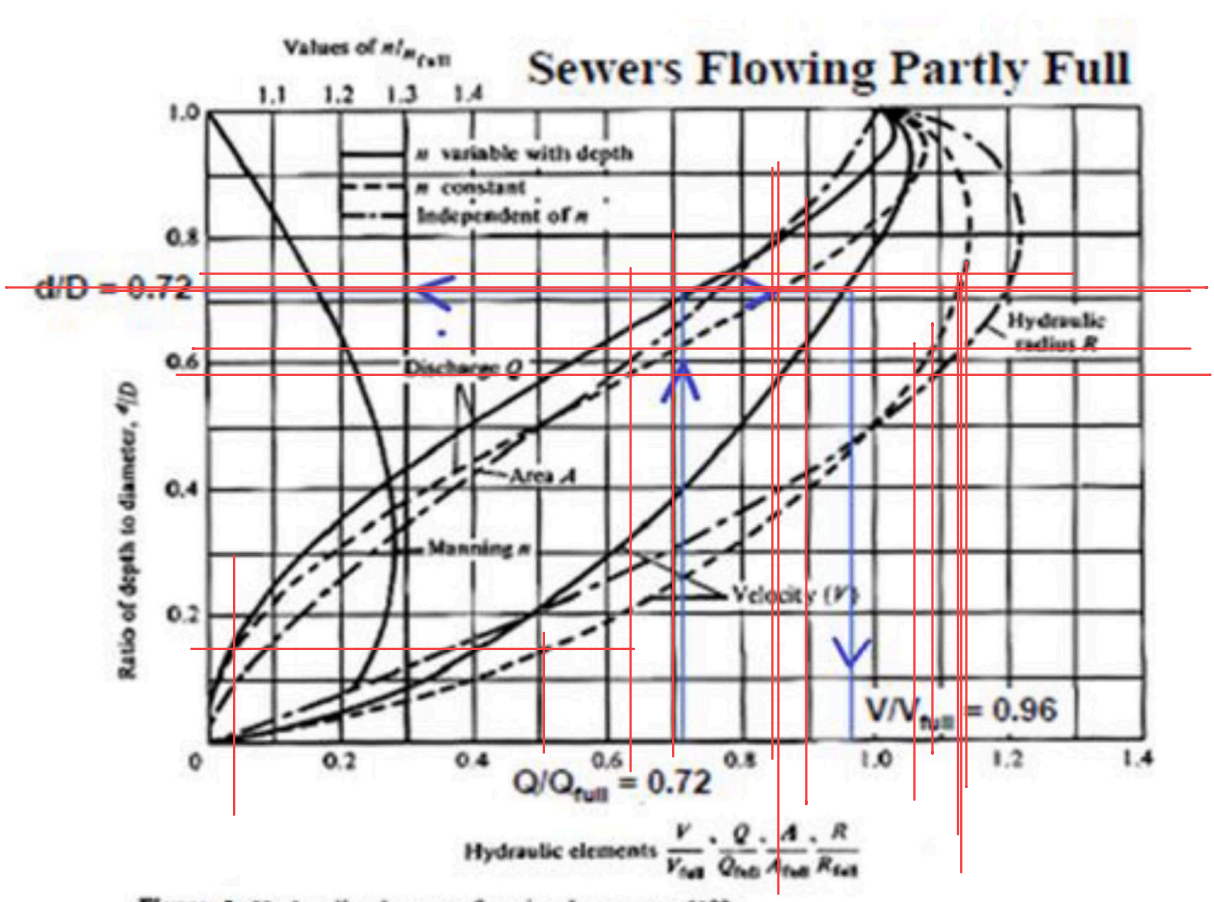
Either up or downfeed zone design would be asked

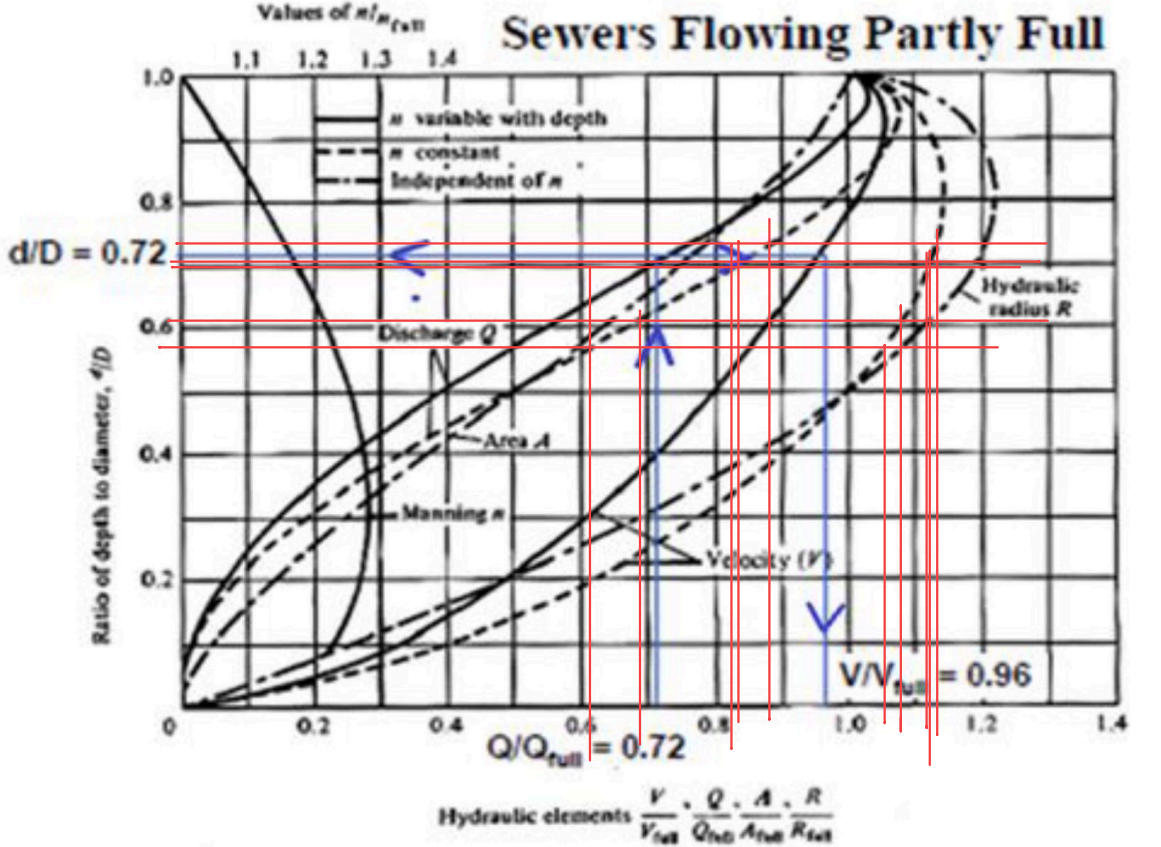
Report → all flush valve

Firefighting demand → same for all

Pump capacity : 8 + 5 [fixed]


1.1
1.2
1.3
1.4
1.0
0.8
0.6
0.4
0.2
0
n variable with depth
n constant
Independent of n
Ratio of depth to diameter d/D
Discharge Q
Area A
Manning n
Velocity V
Hydraulic radius R
0.2
0.4
0.6
0.8
1.0
1.2
1.4


Sewers Flowing Partly Full
Values of n/n_{full}
1.1 1.2 1.3 1.4
1.0
0.8
0.6
0.4
0.2
0
n variable with depth
n constant
Independent of n
d/D = 0.72
Discharge Q
Area A
Manning n
Velocity (V)
Hydraulic radius R
V/V_full = 0.96
Q/Q_full = 0.72
0.2 0.4 0.6 0.8 1.0 1.2 1.4
Ratio of depth to diameter, d/D
Hydraulic elements V/V_full , Q/Q_full , A/A_full , R/R_full


Sewers Flowing Partly Full
Values of n/n_{full}
1.1 1.2 1.3 1.4
n variable with depth
n constant
Independent of n
d/D = 0.72
Discharge Q
Area A
Manning n
Velocity (V)
Hydraulic radius R
Ratio of depth to diameter, d/D
1.0
0.8
0.6
0.4
0.2
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
Q/Q_{full} = 0.72
V/V_{full} = 0.96
Hydraulic elements $\frac{V}{V_{full}}, \frac{Q}{Q_{full}}, \frac{A}{A_{full}}, \frac{R}{R_{full}}$

Rough / Final quiz

20/09

Plumbing

Types → direct — municipal to user
indirect — municipal to building OHT to user

Pipes → Galvanized iron pipe (GI Pipe)
thin coating of zinc deposited on steel to protect from corrosion

Strongen than copper pipe
Economical than " "

Corrode easily in soft & acid water
Costlier than PVC

Used in sewen line

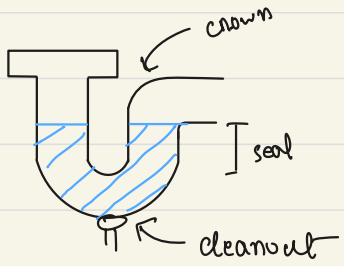
Asbestos cement pipe → Made using asbestos & cement
very cheap but easily break and heavy
used as vent pipe, soil pipes, rainwater pipes

PVC → Polyvinyl Chloride
Lightwt, easy to install, corrosion resistant

1. UPVC → Unplasticized PVC
Used for cold water supply ($T \leq 45°C$)
2. Plasticized PVC → lower strength lower working temp than UPVC
3. Chlorinated PVC → More flexible
Fun both hot & cold ($T \leq 120°C$)

Cheaper than GI pipes

Traps : Stops gases from coming into building.



Good qualities : (i) Always maintain min water seal (50 mm)
(ii) Interior smooth surface
(iii) Non-adsorbent material
(iv) Diameter ≥ fixture outlet dia
(v) Access door for cleansing

Floor trap, gully trap, P trap, Q trap, S trap, Bottle trap

Must not become dry → pour water periodically

Plumbing system :

Up feed → simple, pumped
Downfeed

Drainage → Soil stack, waste stack, vent pipes

Soil pipe → conveys blackwater (water & solid) from water closets, urinals, etc into sewer
vented at top
Larger dia than waste pipe

waste pipe → conveys greywater from sinks, showers, etc.
Narrower than soil pipe

soil stack, waste stack → vertical

vent pipe → pipe above waste or soil stack to allow gas escape.

Example:

25 storey — 10'/floor

50 psi at public main

men & women toilet at alternating floor

3 water closet or 1 water closet + 2 pedestal urinals, and 2 lavatory

Flush tank at 24 & 25th floor

Flush valve at rest

Max pressure = 50 psi

15 psi

Flush valve → large discharge from source

8 psi

Flush tank → large discharge from adjacent reservoir

Faucet → flexible conn. stream from src.

Zoning:

1. Fixture units:

24–25 floor, each = 3×5 ⩾ 5+2×10 = 15
+ 2×2 ⓒ = 4
19 FU

1–23 floor, each = 3×10 ⩾ 10+2×10 = 30
+ 2×2 = 4
34 FU

∴ Total = 2×19 + 23×34 = 820 FU

2. GPM = 184 gpm

3. Friction loss: 3" dia → 6 psi/100'
4" dia → 1.4 psi/100'

4. Loss due to water meter: ⟶ 3.5 psi (4" meter);

5. upfeed zone:

main pressure = meter loss + friction loss + static loss + min first pressure + branch loss

$\Rightarrow 50 = 3.5 + 1.5(70+h)\frac{1.4}{100} + 0.434h + 15 + 1$

$\Rightarrow h = 68.8'$ ⟶ 6 storey

1 storey underground

∴ 5 storey

6. Downfeed zone:

max pressure = static gain − ~~friction~~

$\Rightarrow 50 = 0.434h \Rightarrow h = 115'$ ∴ tank 25' above top fixture

$115' - 25' = 90'$ → 9 storey

$2 \times 9 + 5 = 23$ floor

Incr. allowable max pressure for downfeed

$50 + 10 \times 0.434 = 54.34'$

∴ 1–5 → upfeed

15–6 → downfeed

25–16 → downfeed

Design / upfeed: frictional allowance → dia

1. Frictional all = $50 - 3.5 - 60 \times 0.434 - 15 - 1$ psi

$= 4.46$ psi

$\rightarrow \frac{4.46}{1.5(70+60)} \times 100 = 2.29$ psi/100'

Floor	FU	Acc FU	GPM	Dia (in)
main		820	184	3.5
1	34	170	85	3
2	34	136		
3	34	102		
4	34	68		
5	34	34		

Downfeed:

OHT → 25th

→ $\frac{24 \times 0.434 - 8.1}{1.5(24+10)} = 2.78'/100'$

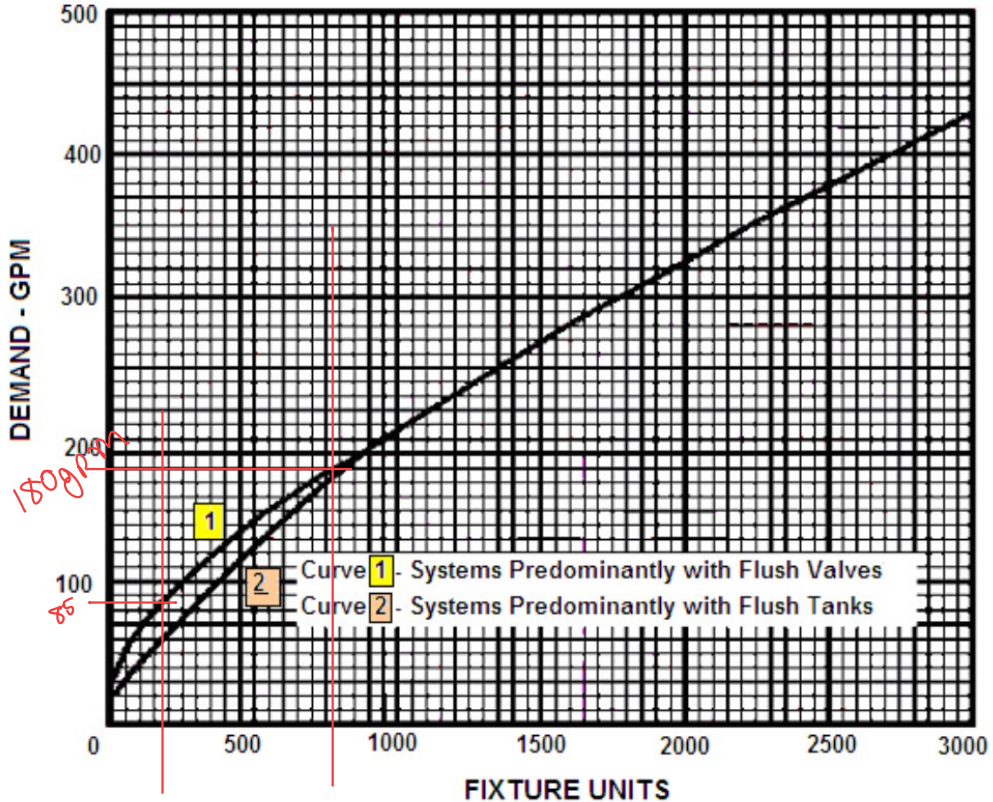
25th → 23rd

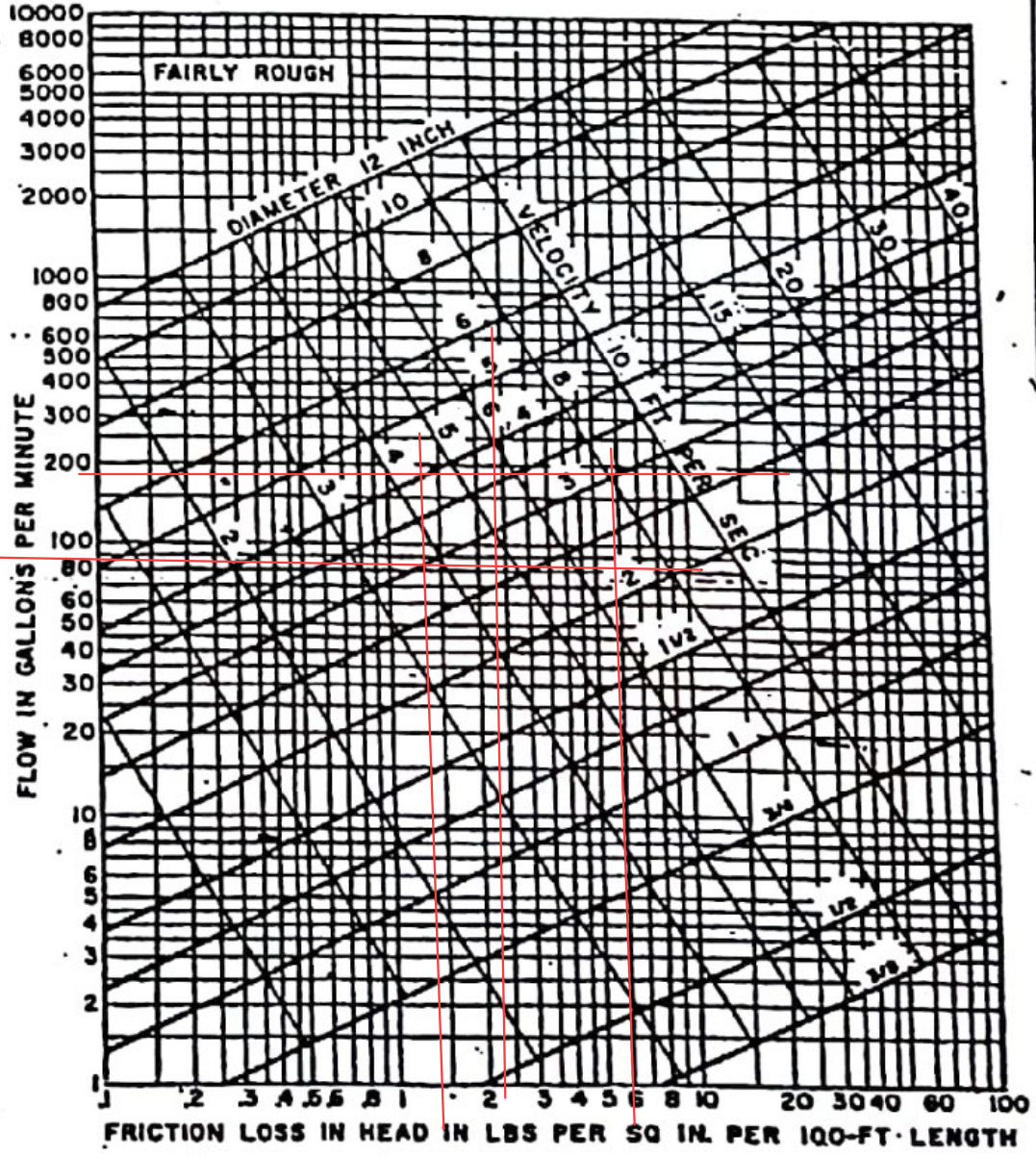
→ $\frac{9 + 20 \times 0.434 - 16}{1.5 \times 20} \times 100 = 5.6 \text{ psi}/100'$

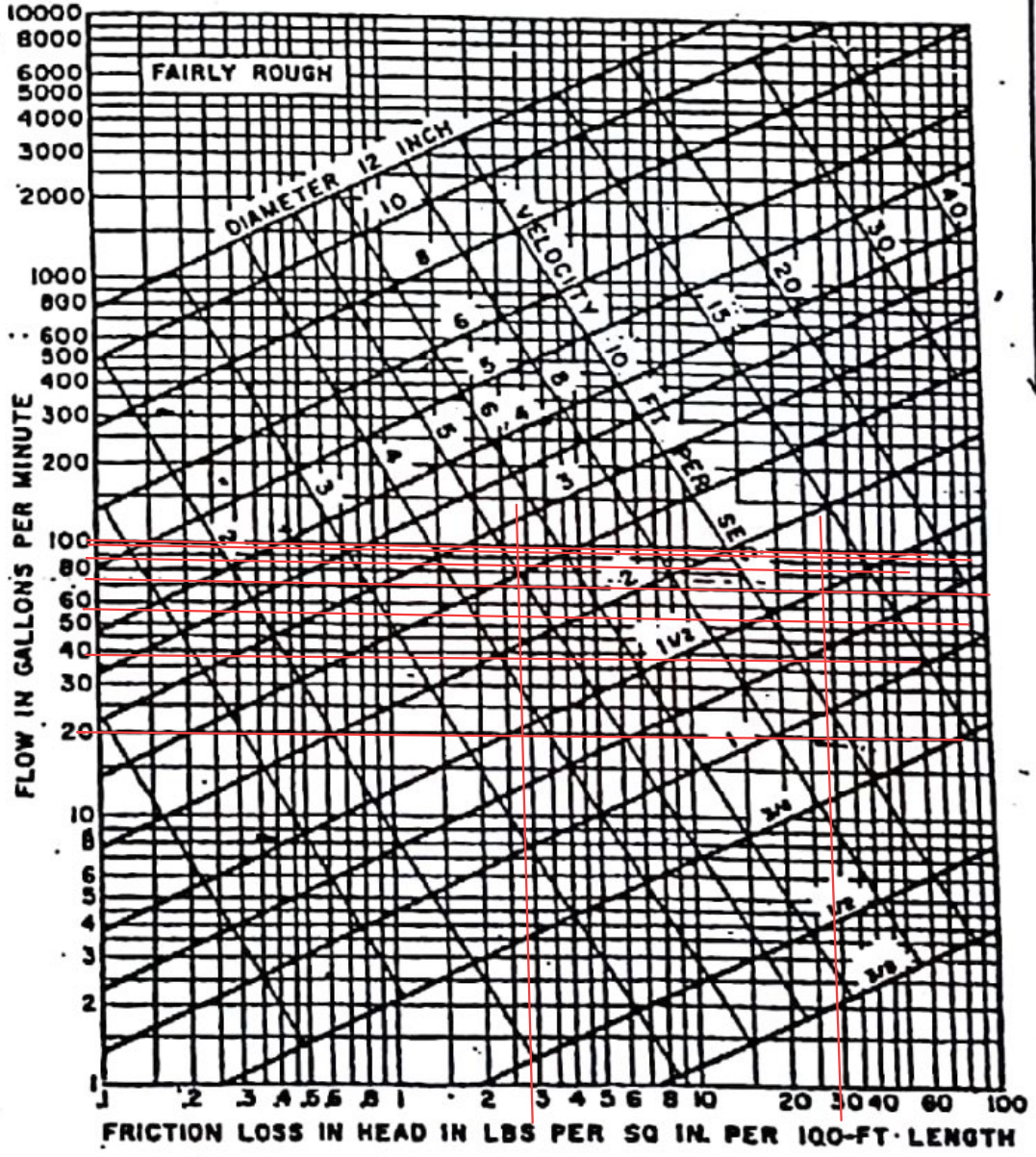
23rd — 16th

→ $\frac{16 + 10 \times 0.434 - 16}{1.5 \times 10} = 28.93 \text{ psi}/100'$

FIGURE - 1


500
400
300
200
100
0
500
1000
1500
2000
2500
3000
DEMAND - GPM
FIXTURE UNITS
1
2
Curve 1 - Systems Predominantly with Flush Valves
Curve 2 - Systems Predominantly with Flush Tanks
180gpm
85


FAIRLY ROUGH
DIAMETER 12 INCH
10
8
6
5
4
3
2
1½
1
¾
½
⅜
VELOCITY
FT. PER SEC.
40
30
20
15
10
9
8
7
6
5
4
3
2
1½
1
FLOW IN GALLONS PER MINUTE
10000
8000
6000
5000
4000
3000
2000
1000
800
600
500
400
300
200
100
80
60
50
40
30
20
10
8
6
5
4
3
2
1
.2 .3 .4 .5 .6 .8 1 2 3 4 5 6 8 10 20 30 40 60 100
FRICTION LOSS IN HEAD IN LBS PER SQ IN. PER 100-FT. LENGTH


FAIRLY ROUGH
DIAMETER 12 INCH
10
8
6
5
4
3
2
1½
1
¾
½
VELOCITY 10 FT. PER SEC.
40
30
20
15
10
8
6
5
4
3
2
1½
1
FLOW IN GALLONS PER MINUTE
10000
8000
6000
5000
4000
3000
2000
1000
800
600
500
400
300
200
100
80
60
50
40
30
20
10
8
6
5
4
3
2
1
.2 .3 .4 .5 .6 .8 1 2 3 4 5 6 8 10 20 30 40 60 100
FRICTION LOSS IN HEAD IN LBS PER SQ IN. PER 100-FT. LENGTH

Wastewater conveyance system

Sewerage network → seperate
combined
partially combined

building conn. → branch → main → trunk → interceptor

Components → domestic
industrial
infil.
storm

PF. → industrial → 2.1
institutional → 4.0
Comm. → 1.8
Resi. → graph

n_{min} = 0.013 new PVC

D_{min} = 200 mm (8 in)

v_{min} = 2 fps (0.6 m/s)

V_{max} = > 2 m/s

Manholes → inspection / maintenance

Placement → change in size
slope
dir
len ?!

must not be >350' apart [D < 24" (600 mm)]

Design: $Q = \frac{1}{n} A R^{2/3} \sqrt{S}$

$Q = \frac{1}{n} \frac{\pi D^2}{4} \left(\frac{D}{4}\right)^{2/3} \sqrt{S}$



Resi → 0.8

Comm → 1.8 → 0.8

Insf → 4.0 → 0.8

Indus → 2.1 → 0.9

Resi → P.F → P w.w

$Q = \frac{1}{n} A R^{2/3} \sqrt{S}$

$A = \frac{\pi D^2}{4}$ $R = \frac{D}{4}$

$S = 0.0033$

→ D

0.18, 0.12

→ 0.2

0.21 → 0.25

$V_{full} \rightarrow \frac{1}{n} R^{2/3} \sqrt{S}$

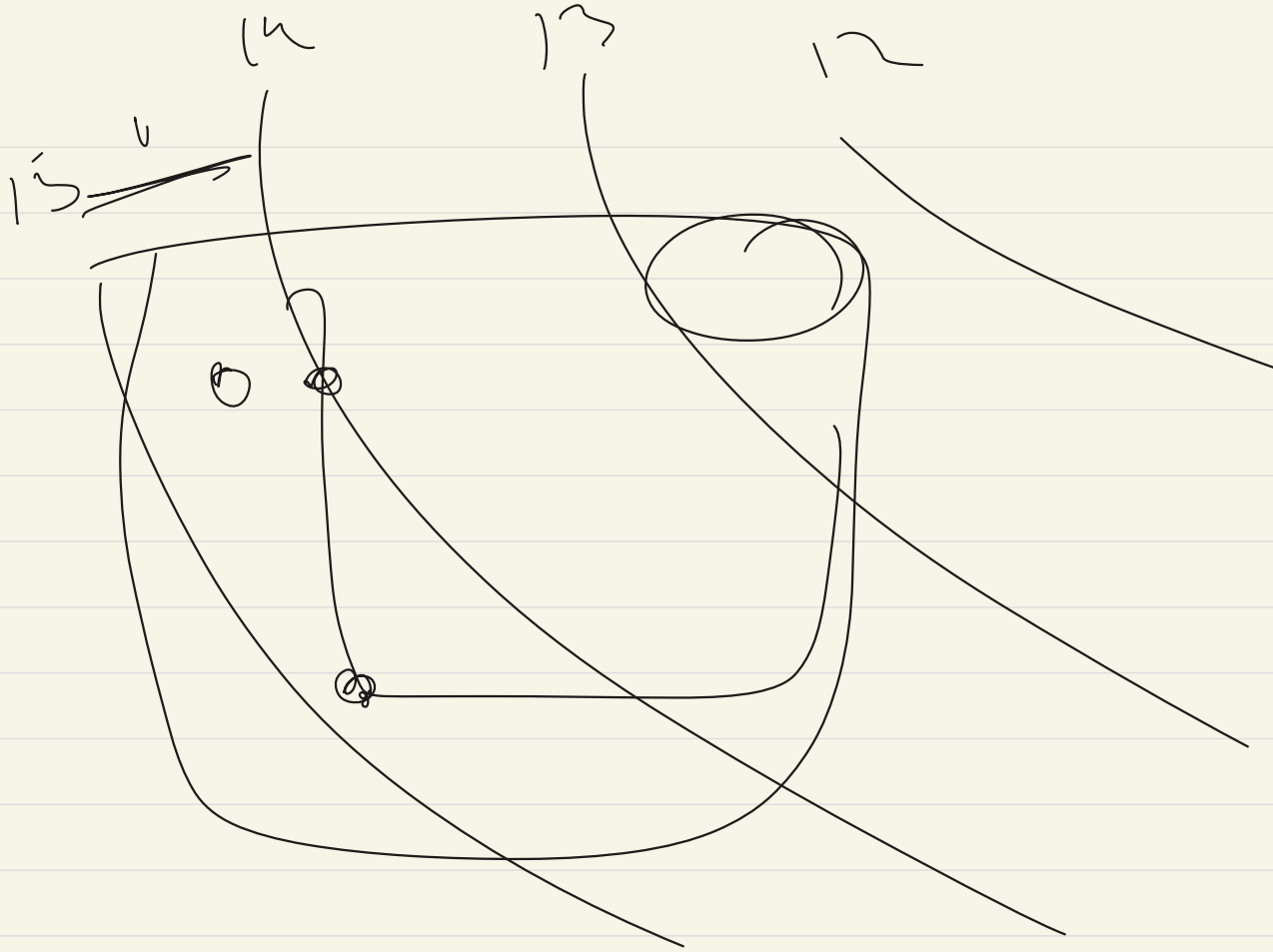
$Q_{full} \rightarrow$ —

Q/Q full → V/V full, d/D

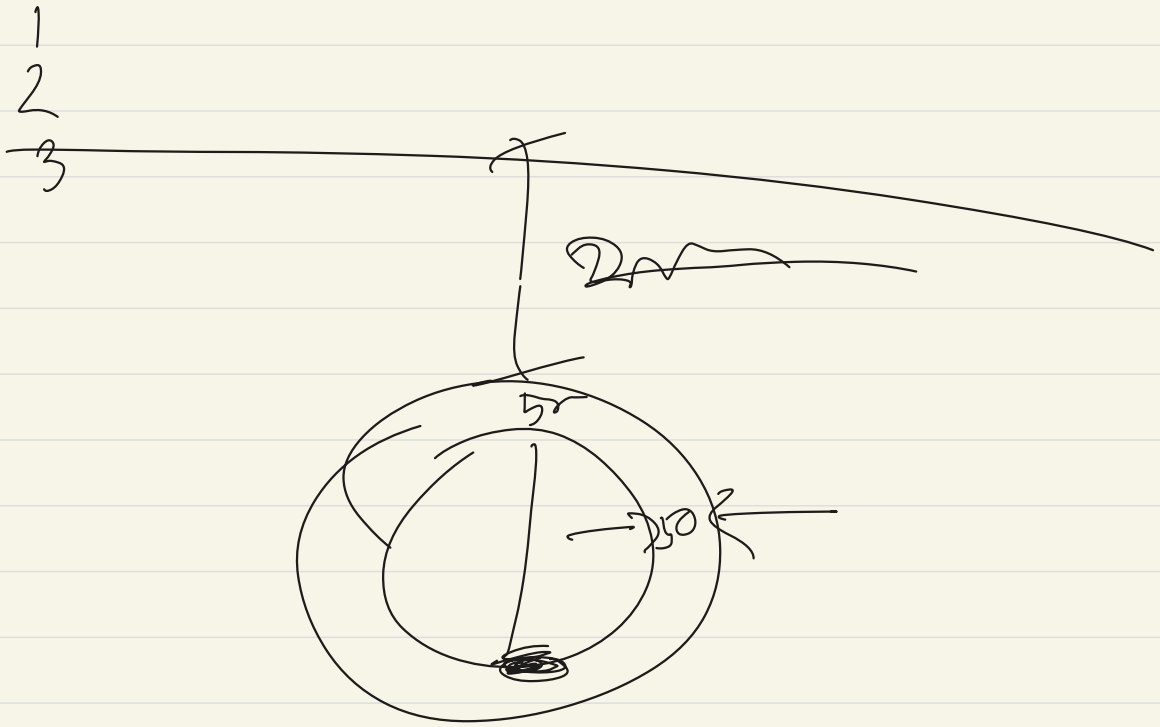
V → ↓

Vmin = 2 fps (0.6 m/s)

→ 2 m/s



GL GL PU PL Co



Branched

$$H\,(ft) = 4f \frac{L}{D} \frac{v^2}{2g} \qquad f = 0.01$$

$$H\,(psi) = H_{ft} \times \frac{62.4}{144}$$

qw

pw

A

Re

away sever in

leak