TYPE III : ZONE SETTLING

- → Sewage treatment
- Water softening
- Floc treatment of very turbid water

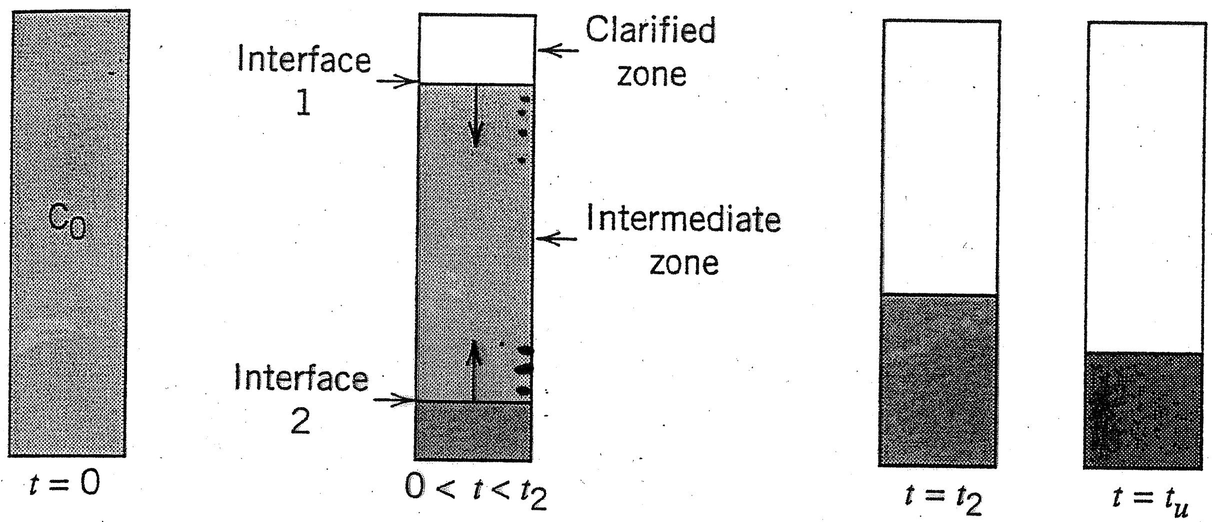
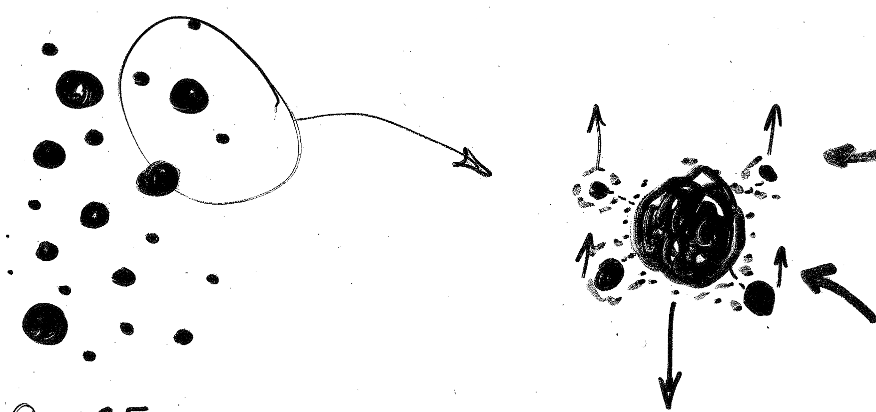


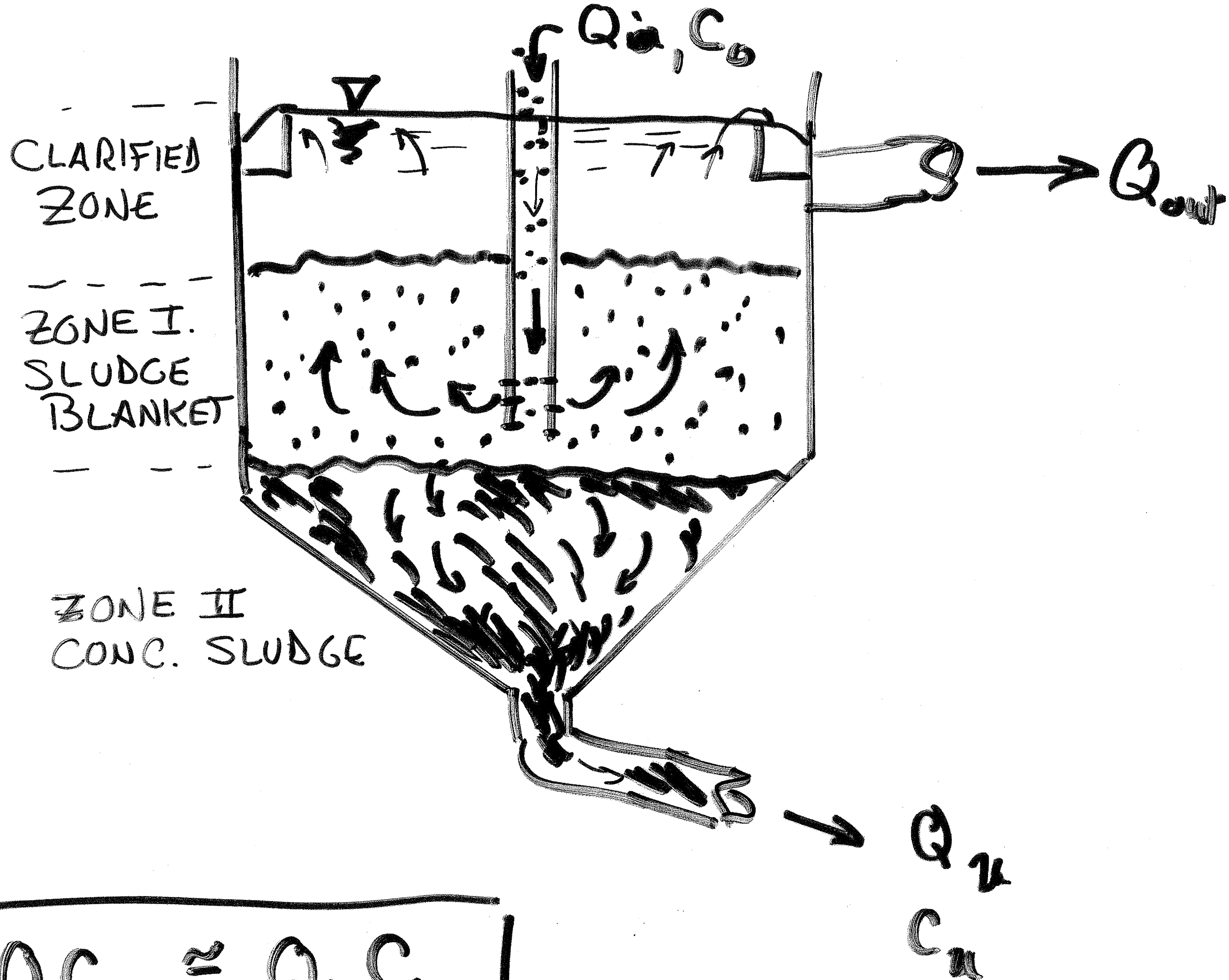
Figure 11.21 Progression of zone sedimentation.



SLOW PARTICLE HINDER FAST PARTICLES

FAST PARTICLES ACCELERATE SLOW PARTICLES

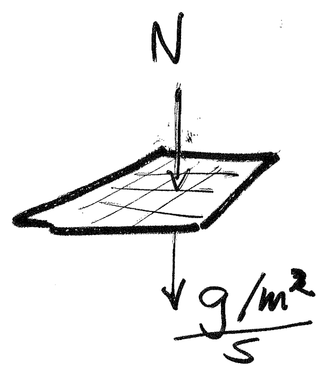
CLOSE CONTACT → VISCOUS INTERACTIONS AMONG PARTICLE



$$QC_0 \cong Q_u C_u$$

$$\frac{Q}{Q_u} = \frac{C_u}{C_0} = \text{LARGE \#}$$

$$N \equiv \text{mass flux} = \frac{\text{mass}}{\text{time} \cdot \text{unit area}}$$

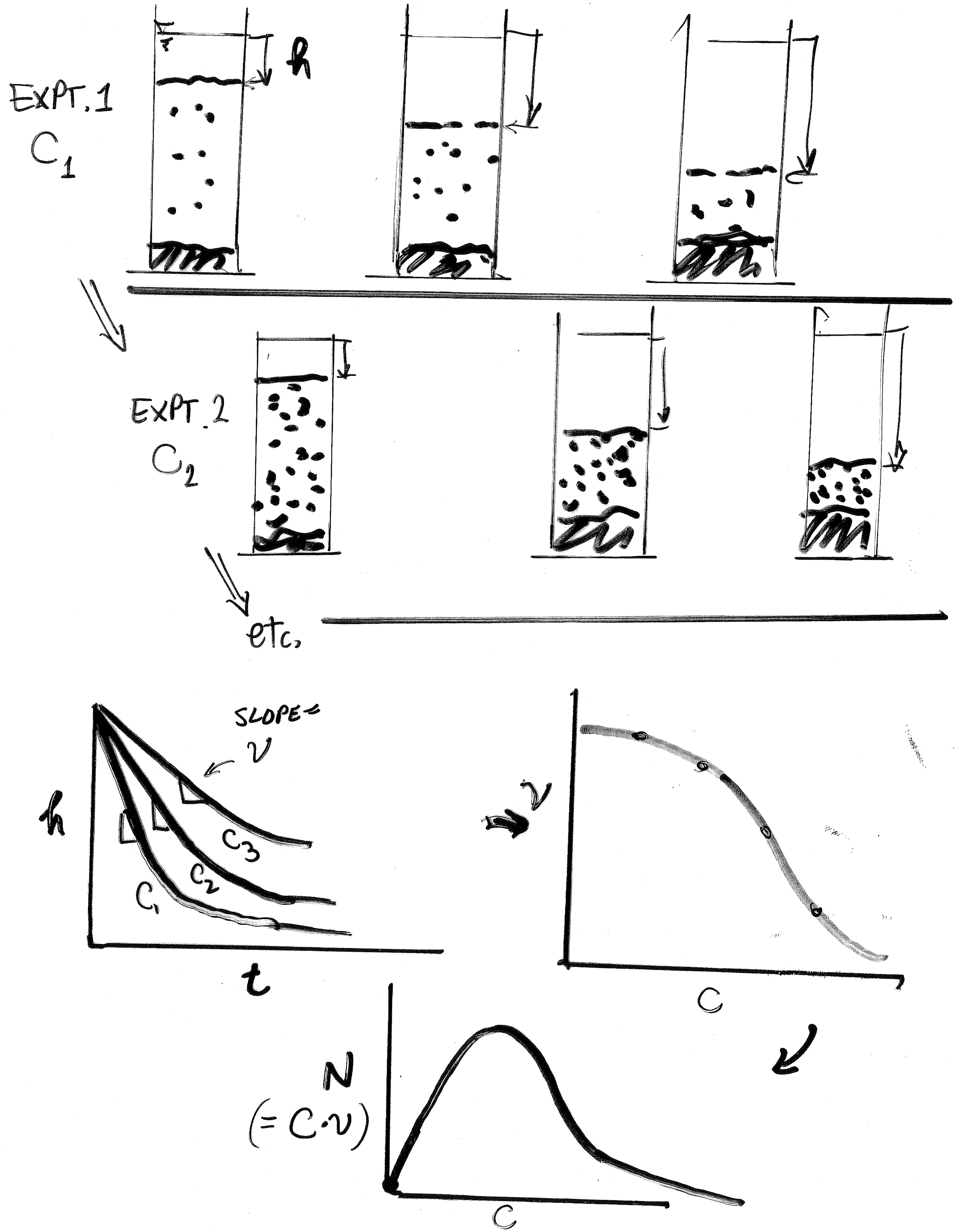


$$QC = \frac{\text{vol.}}{\text{time}} \cdot \frac{\text{mass}}{\text{vol}} = \frac{\text{mass}}{\text{time}}$$

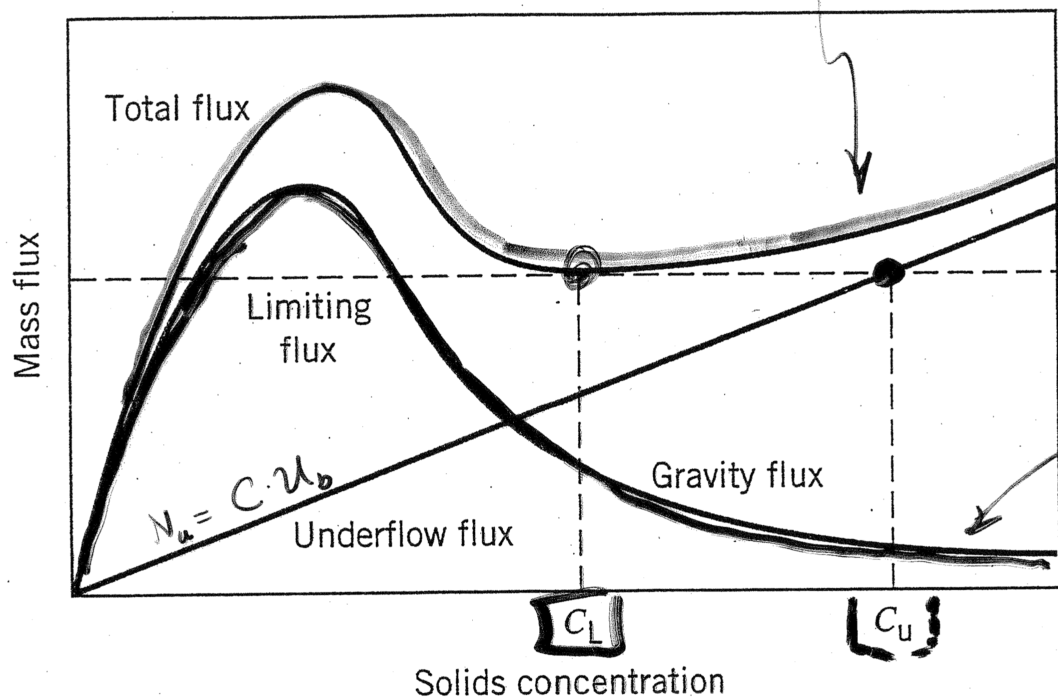
$$\therefore N = \frac{QC}{A}$$

So for LIMITING (SLOWEST) FLUX: N_L ⟹ $A_s \geq \frac{QC_0}{N_L}$

DESIGN SIZE


EXPT. 1
C1
h
EXPT. 2
C2
etc.
SLOPE = v
h
t
C3
C2
C1
v
C
N
(= C·v)
C

ACTUAL CLARIFIER OPERATES AT TOTAL FLUX



BUT...

LAB TESTS GIVE US GRAVITY FLUX DATA

Figure 11.29 Total mass flux as a function of concentration.

$$N_g = C v_h \quad (v_h = \text{HINDERED VELOCITY})$$

$$\& \quad v_h = a e^{-bC}$$

But

$$\underset{(\text{TOTAL})}{N} = N_g + N_u = C v_h + C U_b$$

where $U_b = \dfrac{Q_u}{A_s}$ ← UNDER-FLOW

SIZE: $A_s \geq \dfrac{Q C_o}{N_L}$ ← INPUT LOADING; ← LIMITING (MIN.) FLUX

UNDERFLOW: $N_L = N_u \Rightarrow C_u U_B = N_L$

(N_L: SETTLING OUT; N_u: LEAVING)

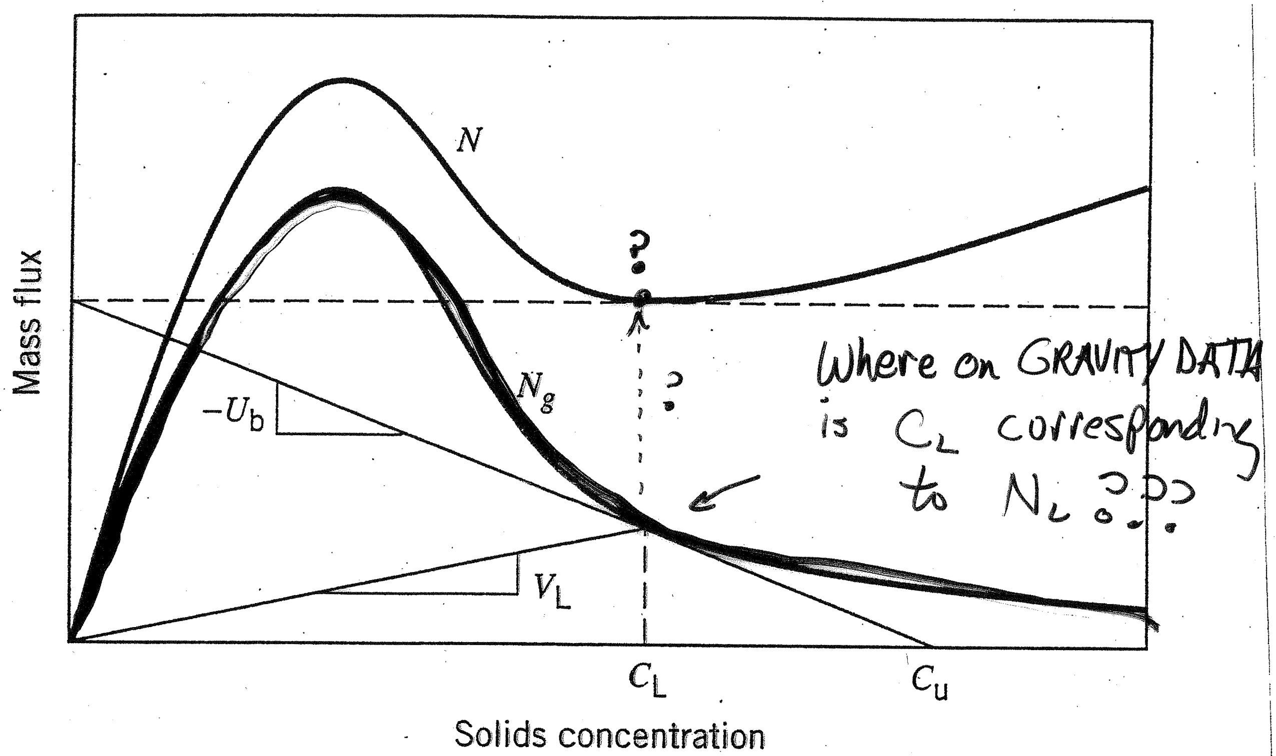


Figure 11.30 Alternate method for determining N_L.

$$N_L = N_{gL} + C_L U_b$$

OR

$$N_{gL} = N_L - C_L U_b$$

IN GENERAL: $N_g = N_L - C U_b$

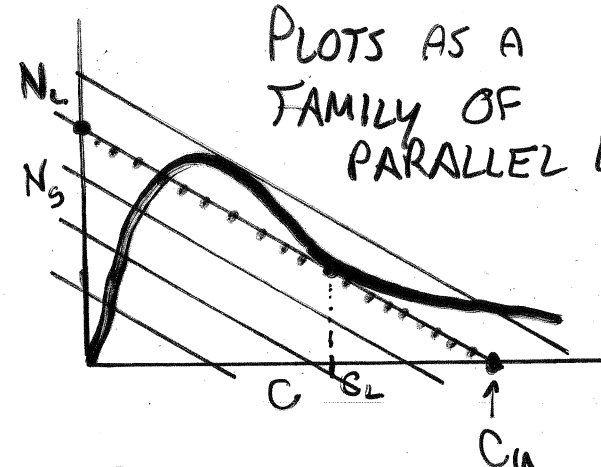
PLOT THIS LIN. FCN:

FOR A GIVEN U_b PLOTS AS A FAMILY OF PARALLEL LINES

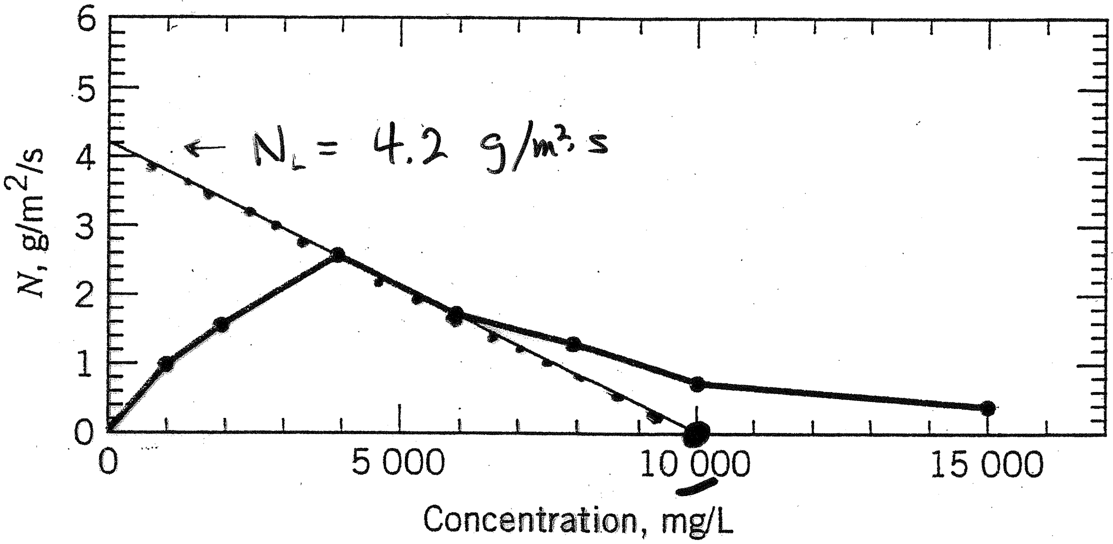
LIMIT VALUES:

AT	
$C = 0$	$\rightarrow N_g = N_L$
$C = C_u$	$\rightarrow N_g = 0$

AND $N_g = N_{gL}$ AT $C = C_L$



So, find the line that matches $[N_L - C U_b]$ to N_g DATA CURVE



$Q = 2300 \text{ m}^3/\text{d}$

$TSS = C_o = 2100 \text{ mg/L}$

WANT: $C_u \approx 10{,}000 \text{ mg/L}$

- What is Q_u (underflow rate)
- Size?

SIZE: $A_s \geq \frac{QC_o}{N_L} = \frac{(2300 \text{ m}^3/\text{d})(2100 \text{ mg/L})}{4.2 \text{ g/m}^2\text{s}} \times \left[\text{UNIT CONV}\right]$

$A_s \geq 13.3 \text{ m}^2$ ← MINIMUM SURF. AREA

UNDERFLOW:

MASS OUT = MASS IN

$Q_u C_u = Q C_o$

$Q_u = \frac{C_o}{C_u} Q = \frac{2100 \text{ mg/L}}{10{,}000 \text{ mg/L}}\left(2300 \frac{\text{m}^3}{\text{d}}\right) = 483 \text{ m}^3/\text{d}$

CRITERIA FOR SIZING A CLARIFIER

FLOW $\Rightarrow$ $\dfrac{\text{FLOW}}{\text{AREA}}$ = overflow rate

↑ SETTLING VELOCITY DATA

DETENTION TIME (hr)

HORIZONTAL VELOCITY (ft/min)

WEIR LOADING (gpd/ft)

flow from the center is collected into the effluent channel attach to the outside wall by overflowing a V-notch weir mounted along the edge of the channel. The settled

attached to continuous chains that are supported and driven by sprocket wheels mounted on the inside walls of the tank. In a warm climate, the scrapers can be hung i

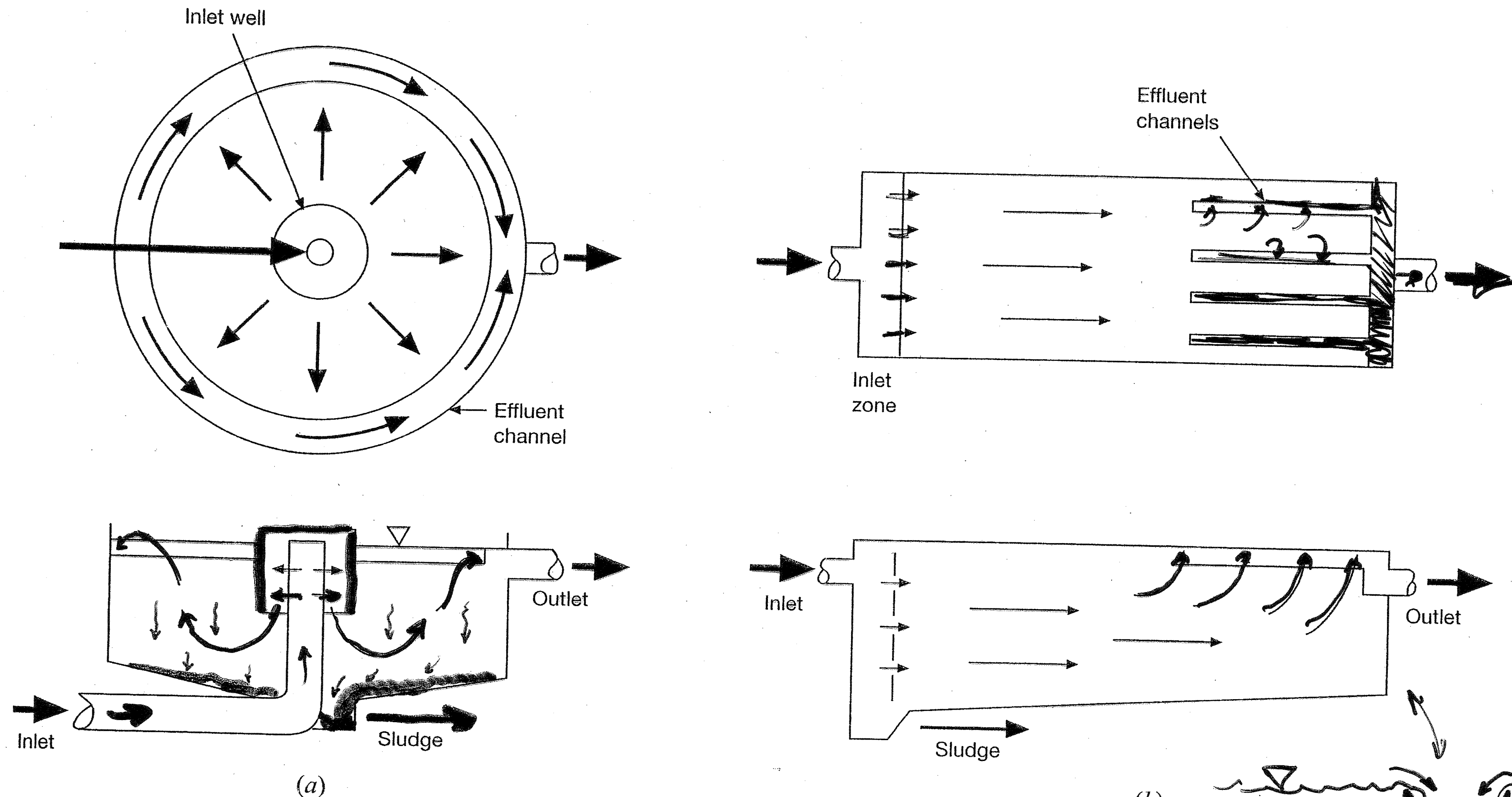
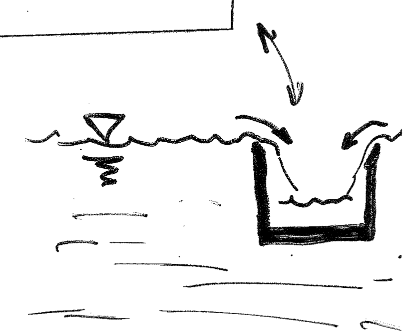
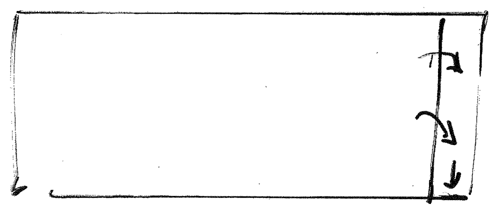
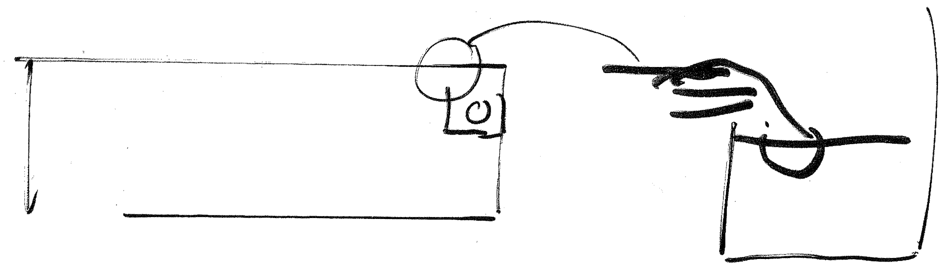


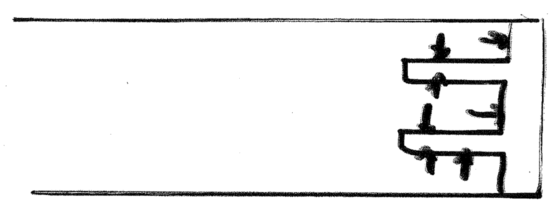
Figure 7-8 Plan and cross-sectional diagrams of sedimentation tanks used in water treatment. (*a*) In a circular tank, water enters behind a central inlet well and flows radially to an effluent channel around the perimeter of the tank. (*b*) In a rectangular tank, water enters an inlet zone for distribution, flows horizontally through the tank and rises to overflow into multiple effluent channels.

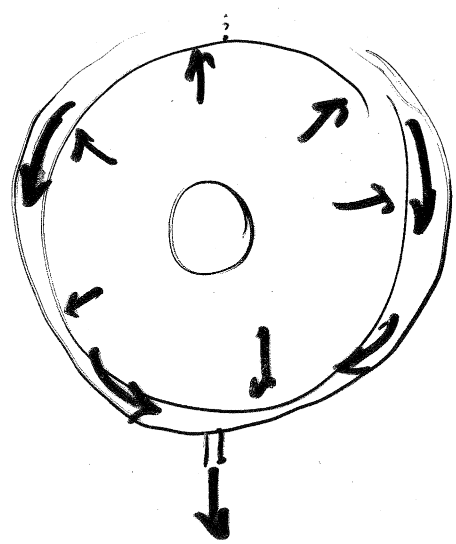


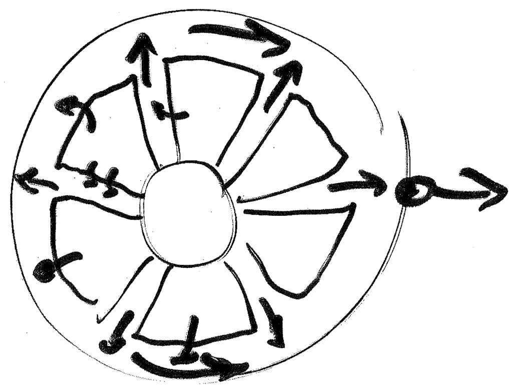
WEIR/LAUNDER DESIGN











Weir loading Rate = $\frac{m^3}{d} \cdot \frac{1}{m \text{ LINEAR LENGTH}}$

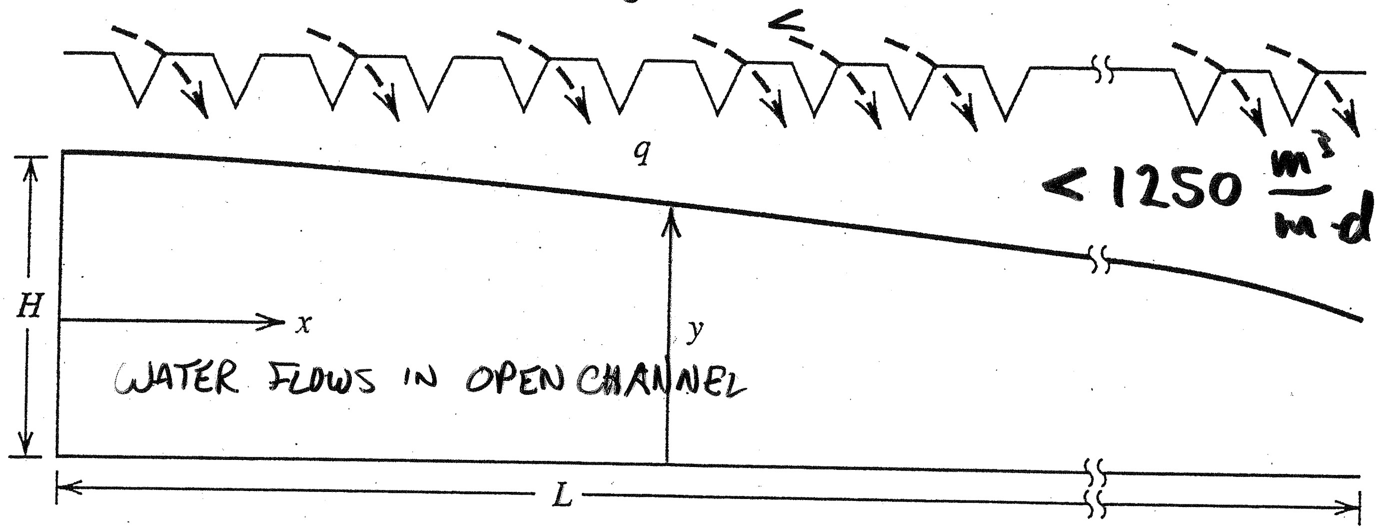
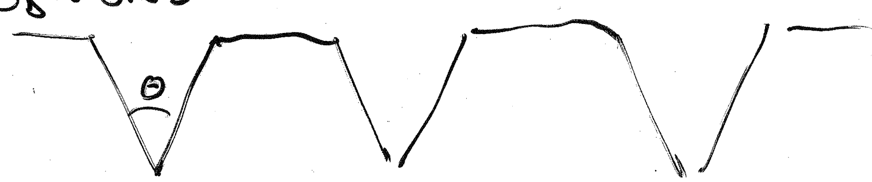


Figure 11.32 Definition sketch for flow in a launder.

$$Q = \frac{8}{15} C_D \sqrt{2g} \tan\frac{\theta}{2} H_w^{5/2}$$

θ = angle $\quad H_w$ = water depth $\quad \frac{w}{2H_w} = \tan\frac{\theta}{2}$

$C_D \approx 0.62$



Basic Design Considerations:

1. Enough slope (depth) to allow drainage + 5-10 cm "free fall depth"

2. Weir LENGTH is a Clarifier Design factor