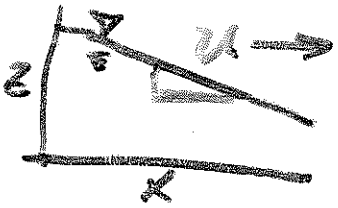
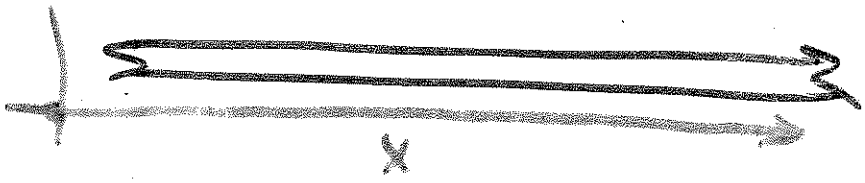
RIVERS

- Gravity-Driven Flow

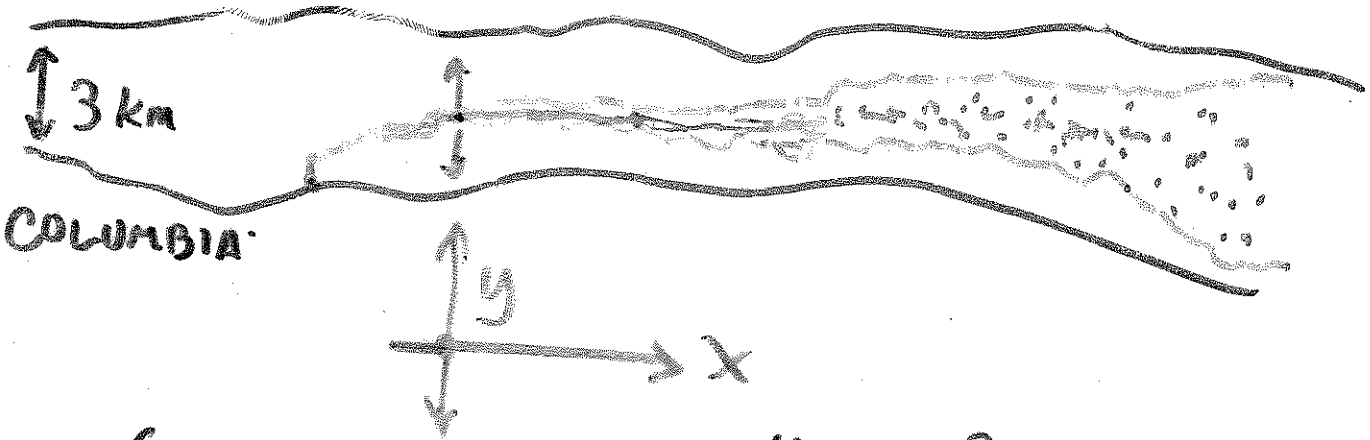


- "Long & Narrow"

- Hence often approximated as 1-D (x-dir)
  Esp. w/r/t VELOCITY & FLOW

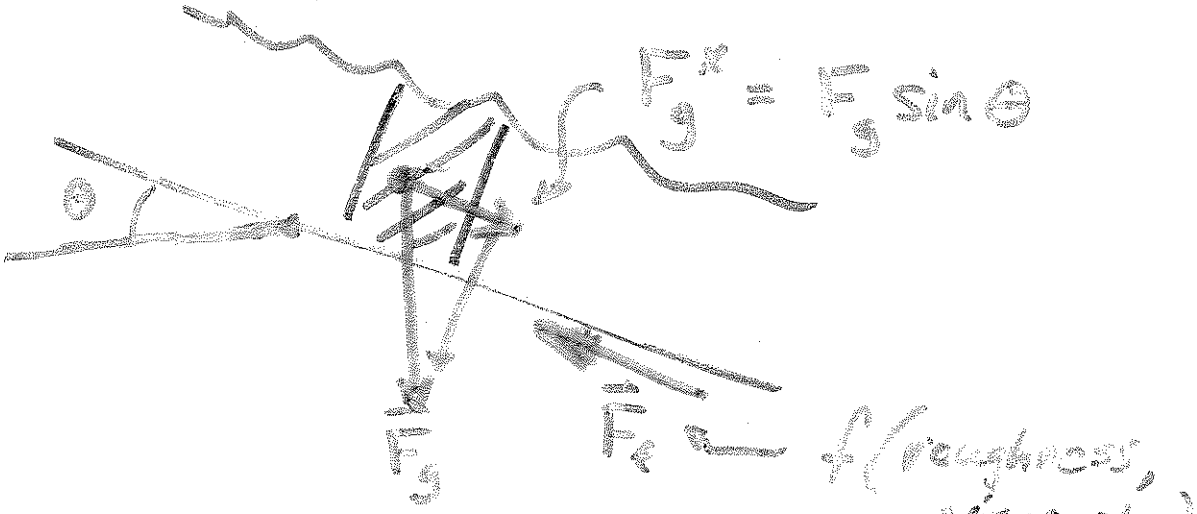


- BUT Also may need to consider TRANSVERSE DISPERSION (y; Horizontal



(Relatively SHALLOW: $y_{max} = 3000$ m
HENCE VERTICAL (DEPTH) AVERAGE $z_{max} = 30$ m)

GRAVITY FLOW:

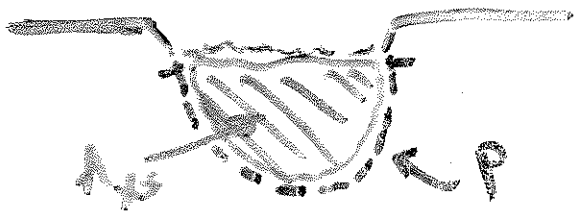


$$\bar{V} = \frac{1.49 R^{2/3} S^{1/2}}{n}$$

MANNING EQN.

R = Hydraulic radius = A_{xs} / wetted perimeter

n = Manning Roughness



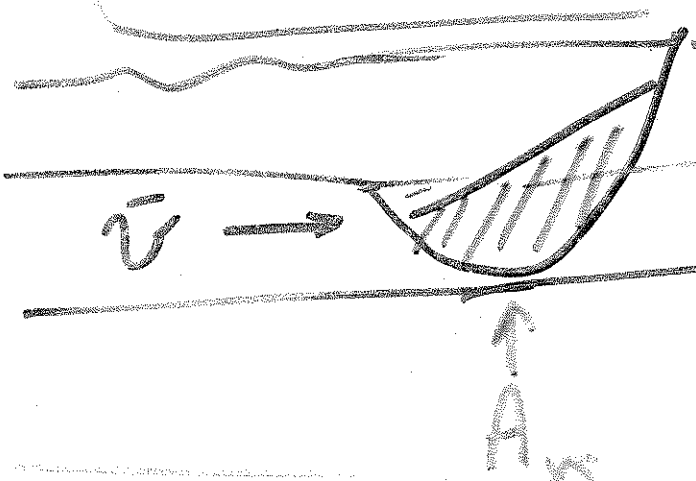
0.01 → 0.05

PIPE "ROUGH" STREAM

FLOW

$$Q = \bar{v} A_{x.s.}$$

$\bar{v}$ = x.s. AVG. VELOCITY



$$\frac{V}{T} : \frac{L^3}{T} = \left[\frac{L}{T}\right]\left[L^2\right]$$

or

$$\bar{v} = \frac{Q}{A}$$

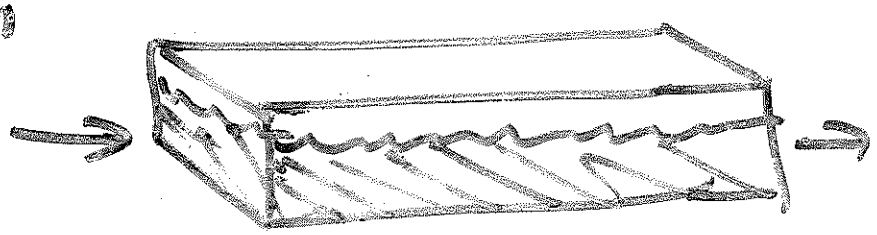
E.g. for known flow, velocity will change with river width & depth ($w \times d = A$)

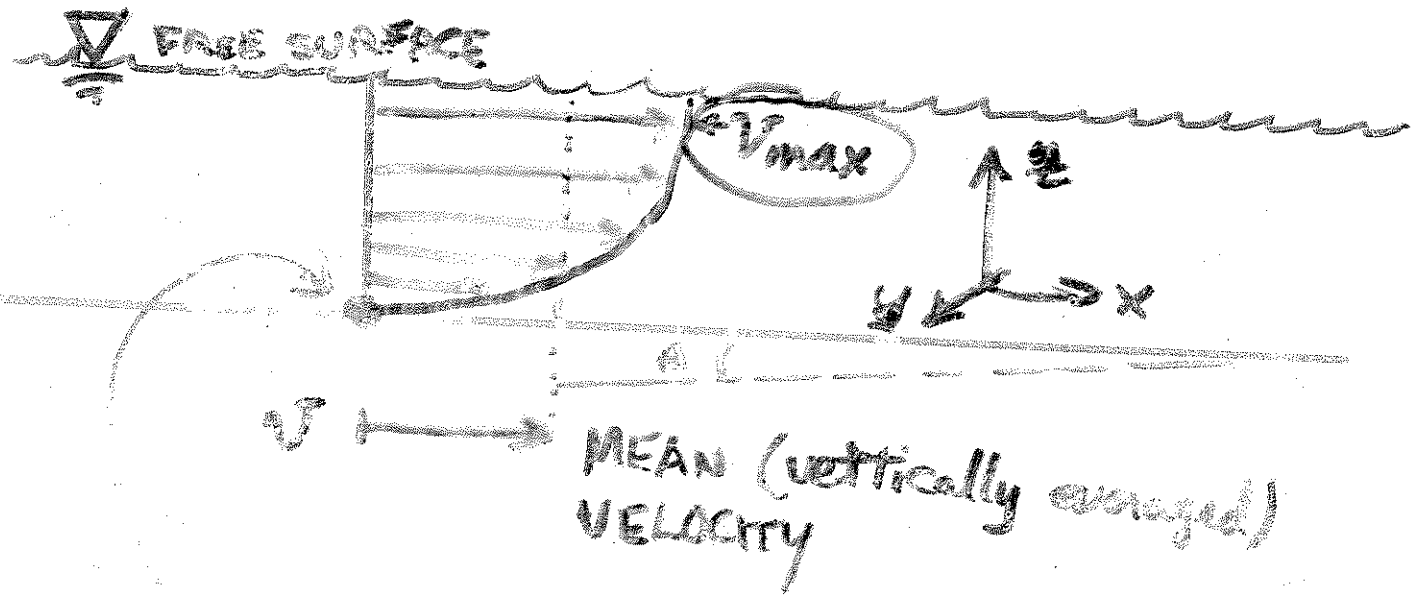
- Also: FLOW MEASUREMENT in streams

1. Find velocity 2. Measure area $Q = \bar{v}A$

VELOCITY DISTRIBUTION IN RIVERS

"Open Channel Flow"

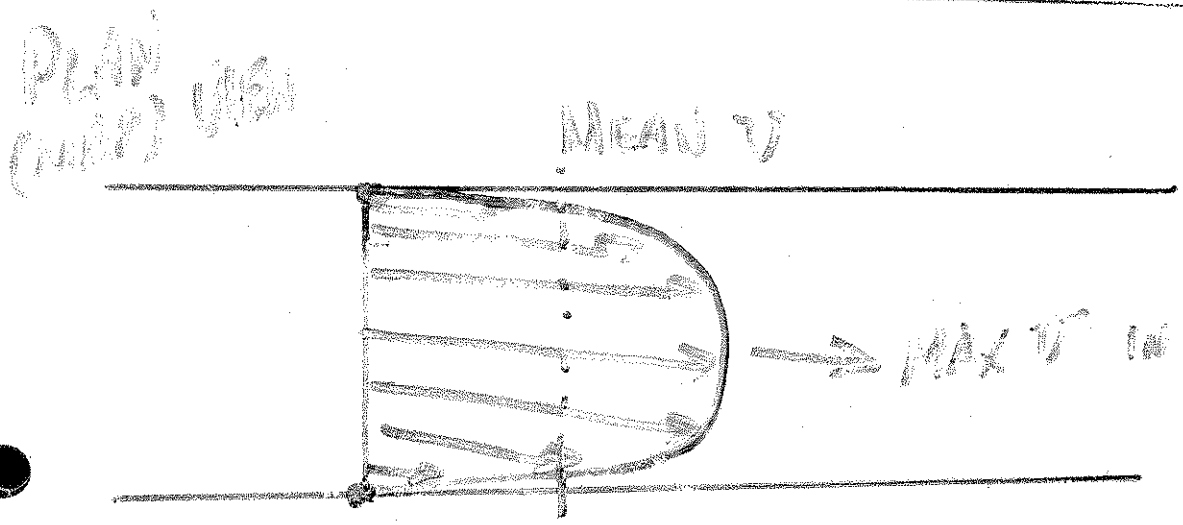




$\bar{V}$ → MEAN (vertically averaged) VELOCITY

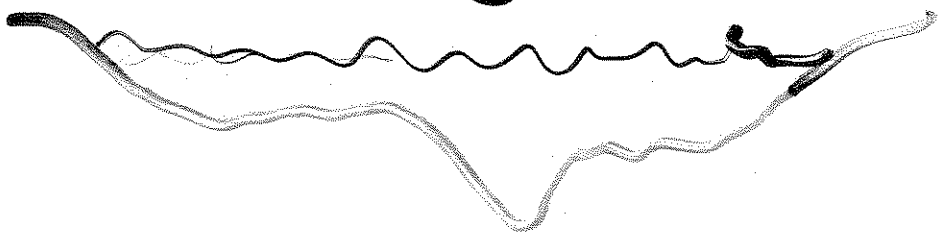
$V = 0 \; @ \; z = 0$

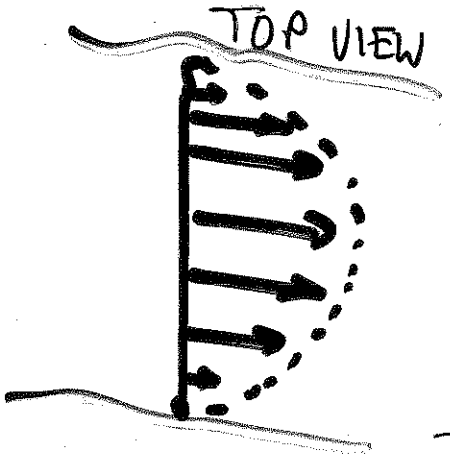
"NO SLIP CONDITION"

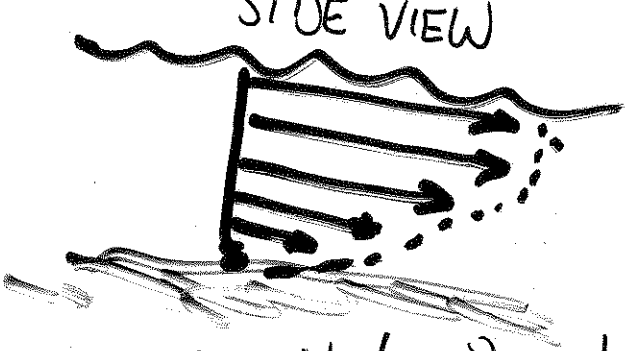


VELOCIMETRY

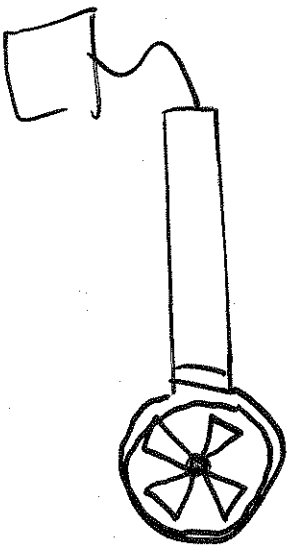
All sorts of ways to measure velocity directly



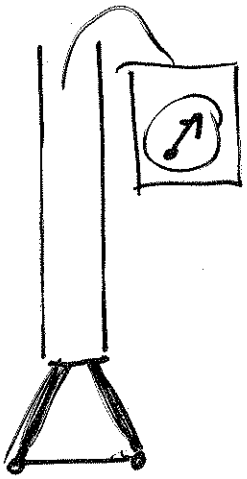




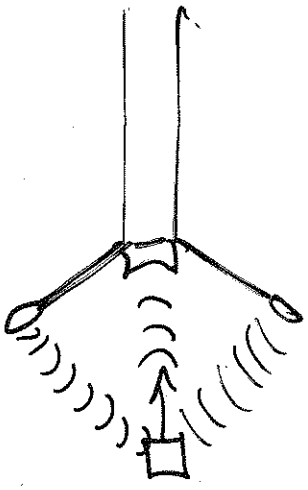
TROUBLE IS: Velocity varies with distance from boundaries



PROPELLER TYPE



"HOT WIRE" ANEMOMETER



ACOUSTIC DOPPLER VELOCIMETER