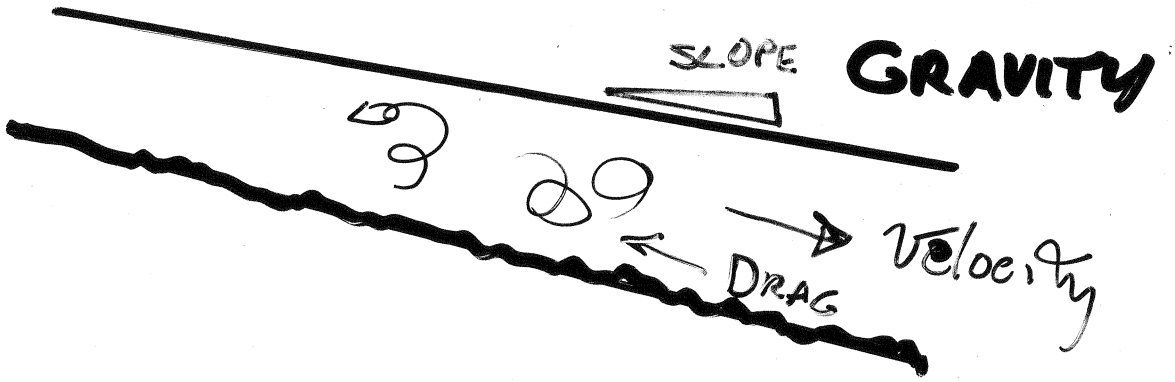
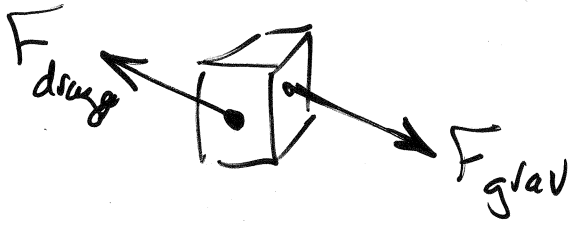
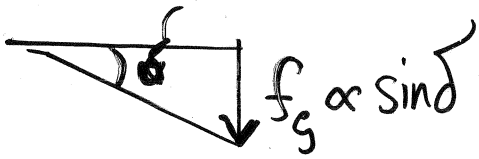
PHYSICAL TRANSPORT IN RIVERS







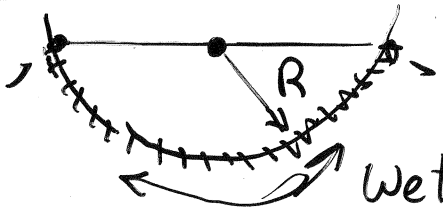
At steady velocity

$$F_{drag} = F_{grav}$$

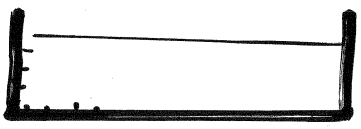
EMPIRICAL FACTORS: Manning or Chezy FRICTION FACTORS

FUNDAMENTAL PHYSICS: Slope & wetted contact area

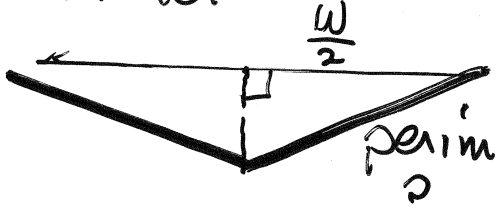
HYDRAULIC RADIUS: $R \equiv \frac{A_{x.s.}}{\text{Wet. Perim.}}$



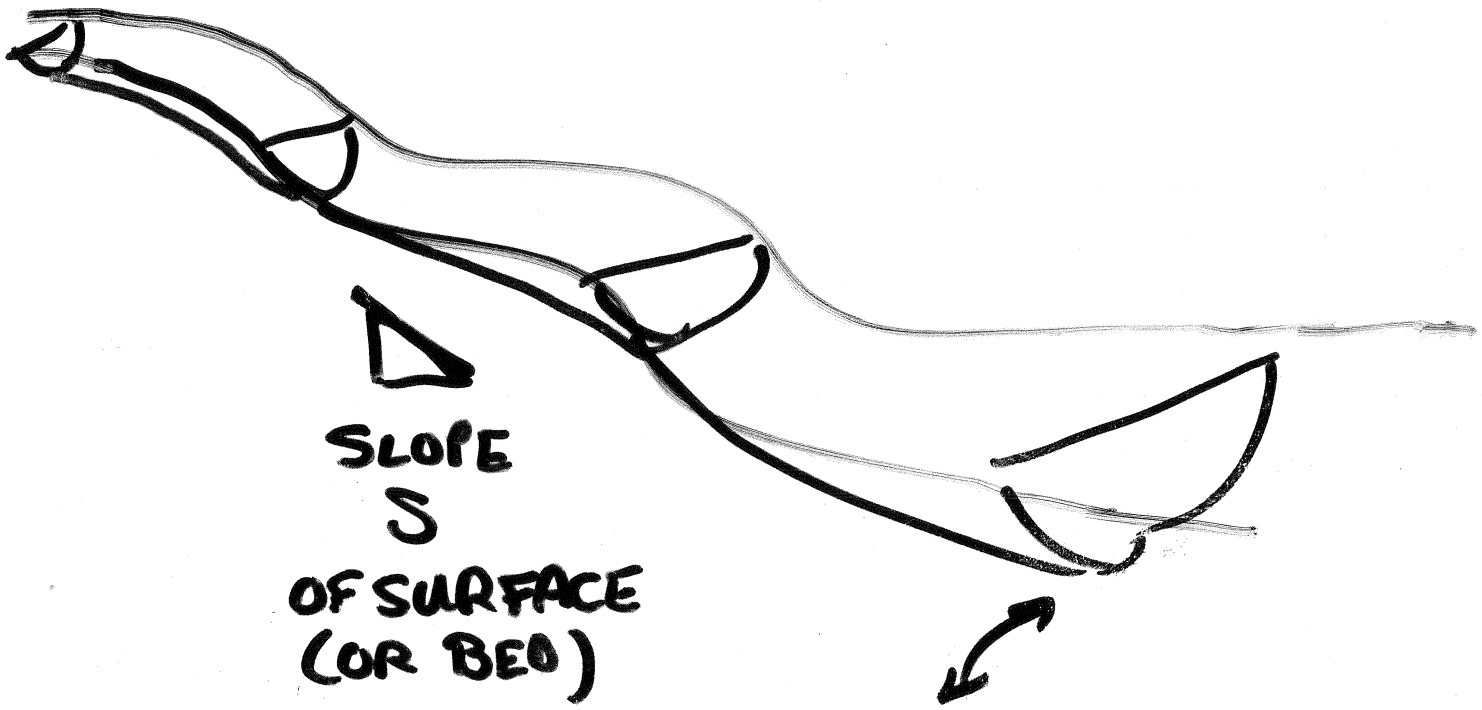
Wetted perimeter

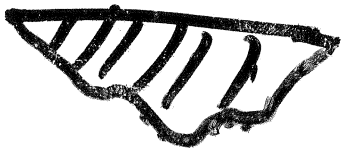


perim = w + 2d

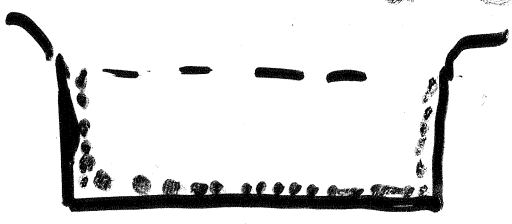


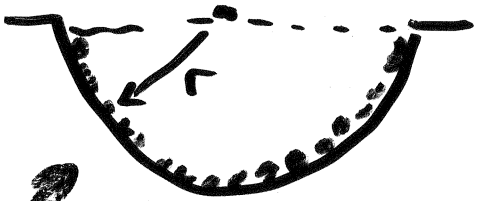
Gravity Driven Advection

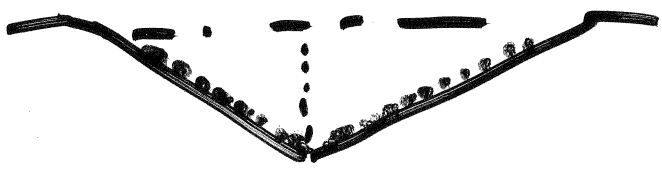




R = Hydraulic Radius $\equiv \frac{A_{xs}}{\text{wetted Perimeter}}$







$R = r$

for ideal semicircle

VELOCITY EQNS $v = f(\text{SLOPE})$

Chezy

$$V = C\sqrt{RS}$$

Manning

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

NEED DATA

1. Slope: Difference in water level relative to some datum (MSL) per axial distance.

2. Manning or Chezy Coefficients (empirical; tabulated)

3. Need A_{xs} & wetted perimeter
   - Estimate from width & depth
   - Or (better) measure in field

MANNING: More common for rivers but developed orig. for pipes & open channels

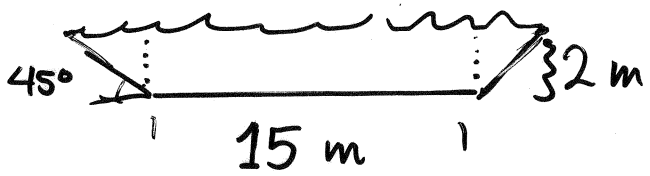
$$V = \frac{1.49\, R^{2/3} S^{1/2}}{n}$$

MUST USE R in feet
V = ft/s (fps)

$n \cong 0.035$ for winding streams
$\approx 0.04 - 0.05$ for rough, rocky beds

EXAMPLE

WINDING, MOD. SHALLOW RIVER ...



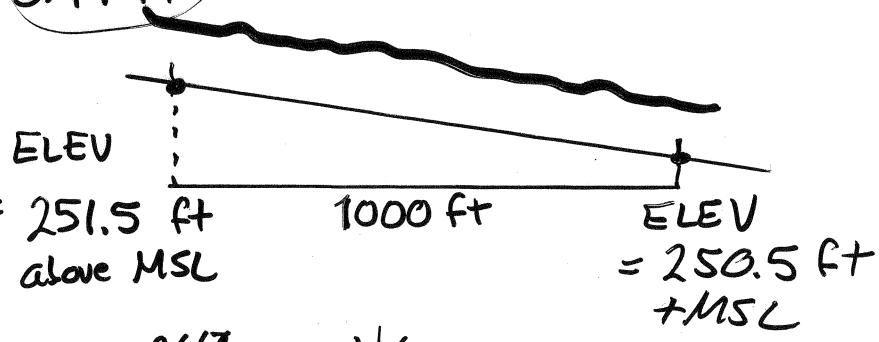
$$R = \frac{A_s}{Perim} = \frac{(15\,m \times 2\,m) + (2\,m \times 2\,m)}{15\,m + (2\sqrt{2} + 2\sqrt{2})\,m} = \frac{34\,m^2}{20.6\,m}$$

$R = 1.65\,m = 5.41\,ft$

$n = 0.035$

$S = \frac{1\,ft}{1000\,ft}$

$S = 0.001$



$$V = \frac{1.49(5.4)^{0.667}(0.001)^{1/2}}{0.035} = 4.1\ fps$$