Physical modelling: laboratory models
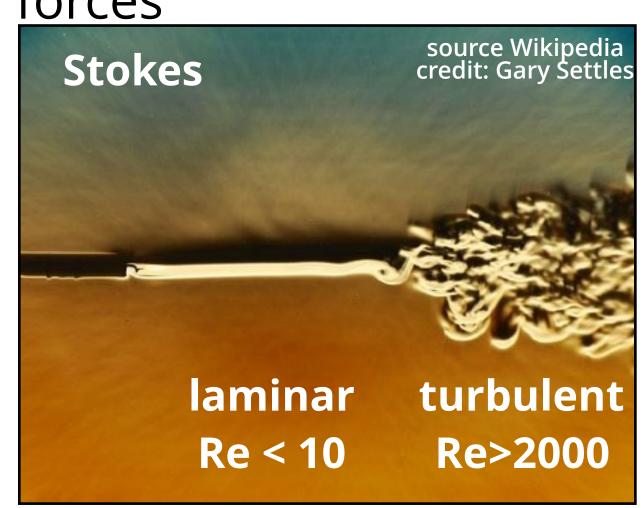
WRL | Coastal Imaging
Water Research Laboratory

Scaling problems - Buckingham Pi theorem

- Reynolds number : inertial forces / viscous forces

$$\pi_1 = V^1 \ L^1 \ F^0 \ \rho^1 \ \mu^{-1} \ g^0 = V \ L \ \rho \ / \ \mu = Re$$

Equality in Re will ensure that viscous forces are correctly scaled

Stokes

source Wikipedia
credit: Gary Settles

laminar   turbulent

Re < 10   Re>2000

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Physical modelling: laboratory models

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Scaling problems - Buckingham

Fr Between 1.7 and 2.5
A - Prejump Stage

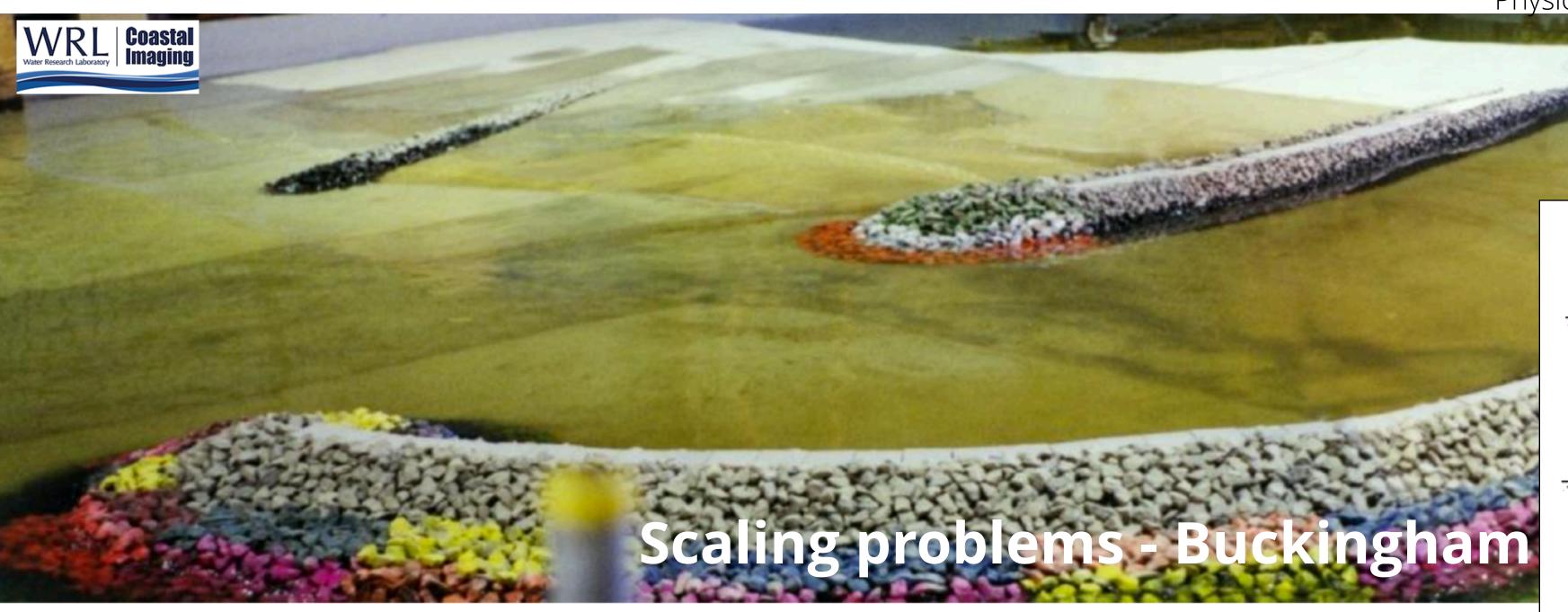Roller   Oscilating Jet

Fr Between 2.5 and 4.5
B - Transition Stage

Fr Between 4.5 and 9.0
C - Range of Well-Balanced Jumps

Fr Higher than 9.0
D - Effective Jump but Rough Surface Downstream

- Froude number: ratio of flow inertia to gravity

$$\pi_2 = V^1\ L^{-1/2}\ F^0\ \rho^0\ \mu^0\ g^{1/2} = V\ /\ (gL)^{1/2} = Fr$$

- Fr=1: critical flow
- Fr>1: supercritical flow (fast rapid flow)
- Fr<1: subcritical flow (slow/tranquil flow)