

From Flow to Force: The Fluid Mechanics of Sediment Transport

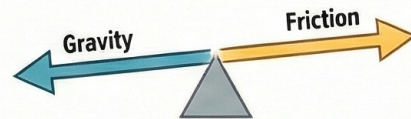
THE CORE PRINCIPLE: BED SHEAR STRESS

Shear Stress, Not Velocity, Is the Primary Driver

This force initiates motion, controls transport rates, and forms riverbed features.

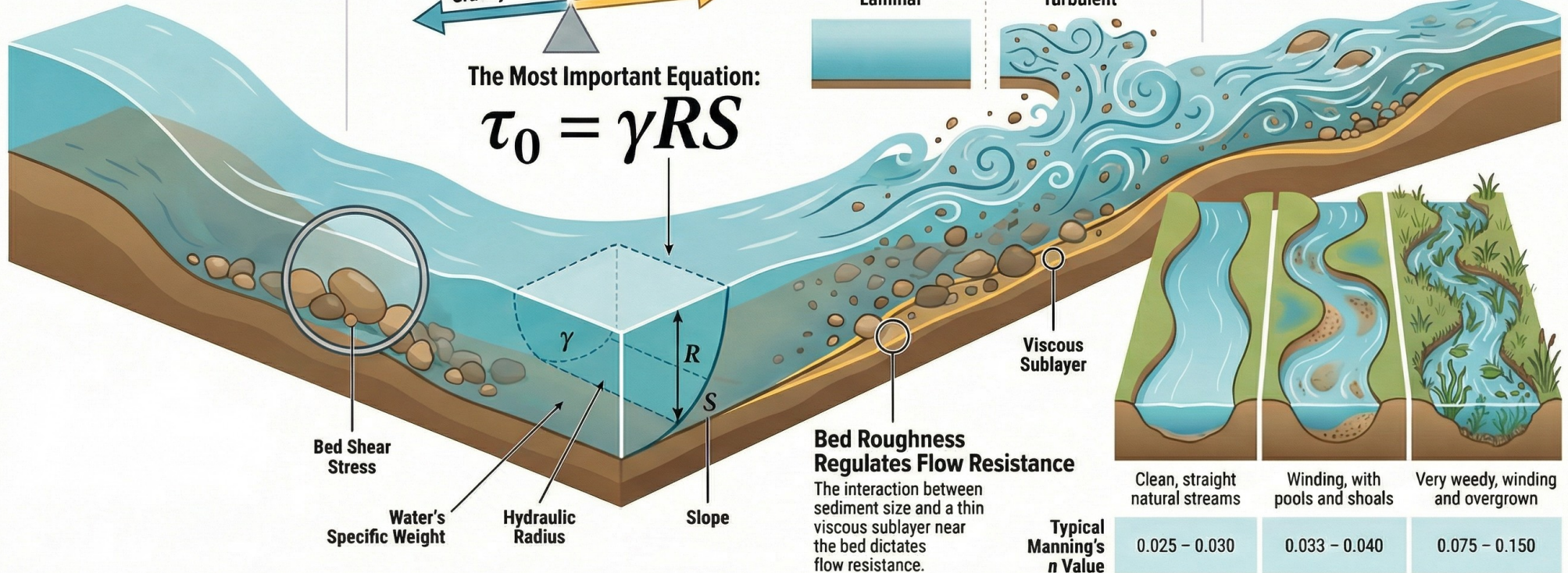
A Balance of Forces in Uniform Flow

The downslope driving force of gravity is balanced by the resisting frictional force.



The Most Important Equation:

$$\tau_0 = \gamma RS$$



Bed Shear Stress

Water's Specific Weight

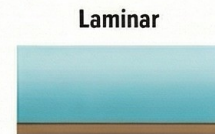
Hydraulic Radius

Slope

CHARACTERIZING FLOW & RESISTANCE

Laminar vs. Turbulent Flow

Natural sediment-transporting flows are almost always turbulent, with chaotic mixing that helps move sediment.



Turbulent



Manning's 'n': A Practical Measure of Resistance

This empirical coefficient aggregates resistance from bed material, vegetation, and channel shape.

Viscous Sublayer

Bed Roughness Regulates Flow Resistance

The interaction between sediment size and a thin viscous sublayer near the bed dictates flow resistance.



Clean, straight natural streams

Winding, with pools and shoals

Very weedy, winding and overgrown

Typical Manning's n Value

0.025 – 0.030

0.033 – 0.040

0.075 – 0.150