Hydraulics Section II: Hydraulic Energy

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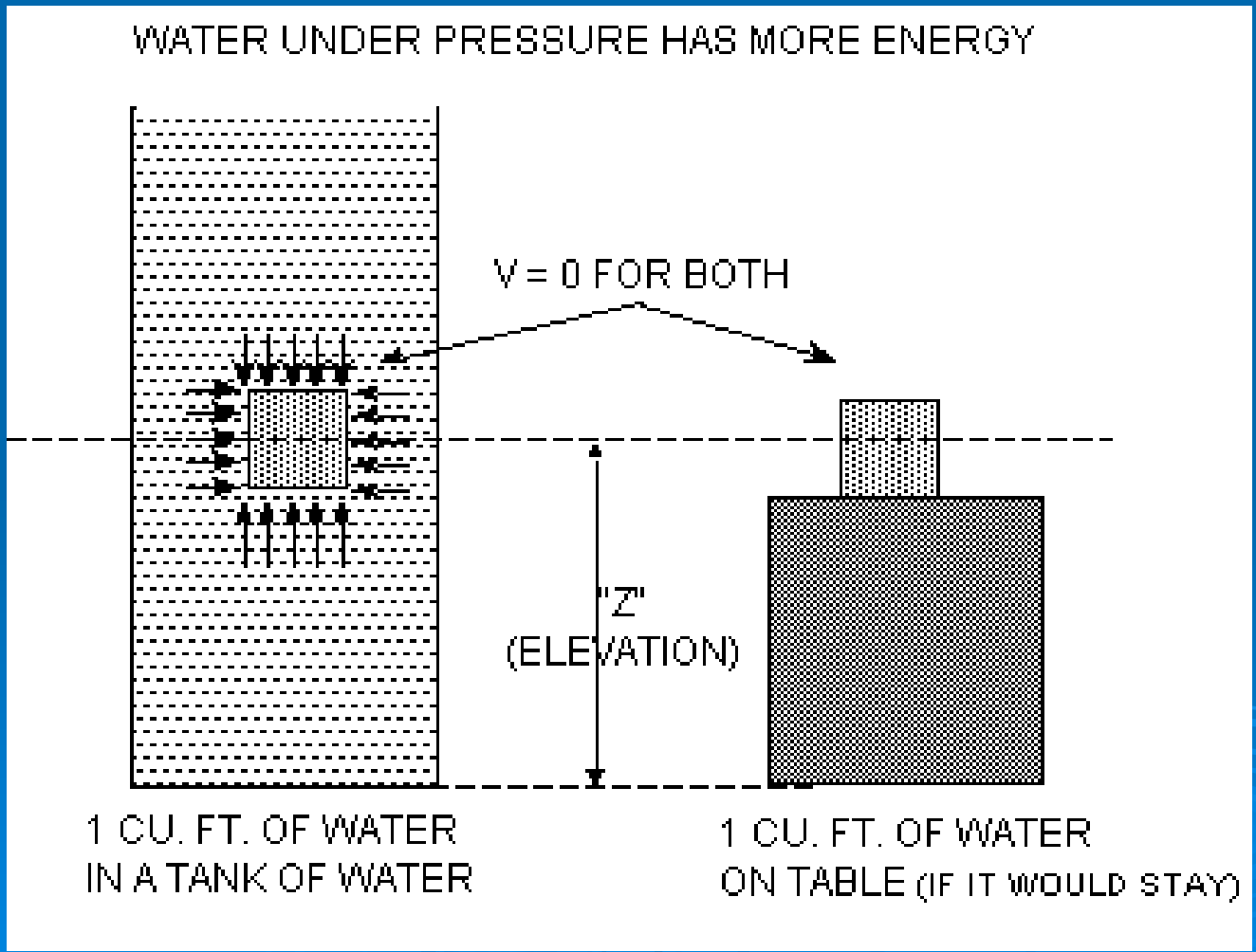
Section Objectives:

- Understand the three forms of Hydraulic Energy: Elevation Head, Pressure Head, and Velocity Head
- Learn the Laws of Conservation of Hydraulic Energy and corresponding equations
- Compute Orifice Flow and Friction Losses
- Understand effects of Water Hammer

Pressure Head

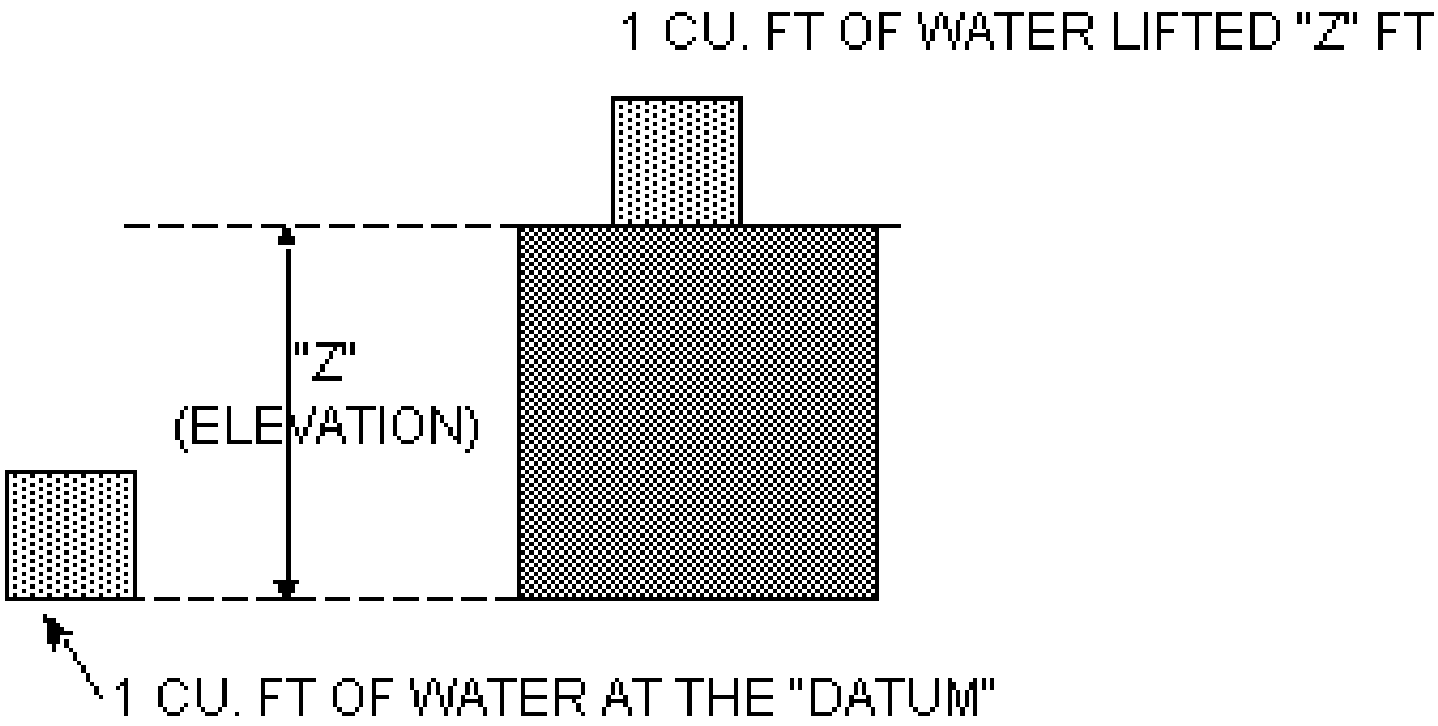
Pressure head adds to the total energy of a unit volume of water at an arbitrary elevation “z”



Elevation Head

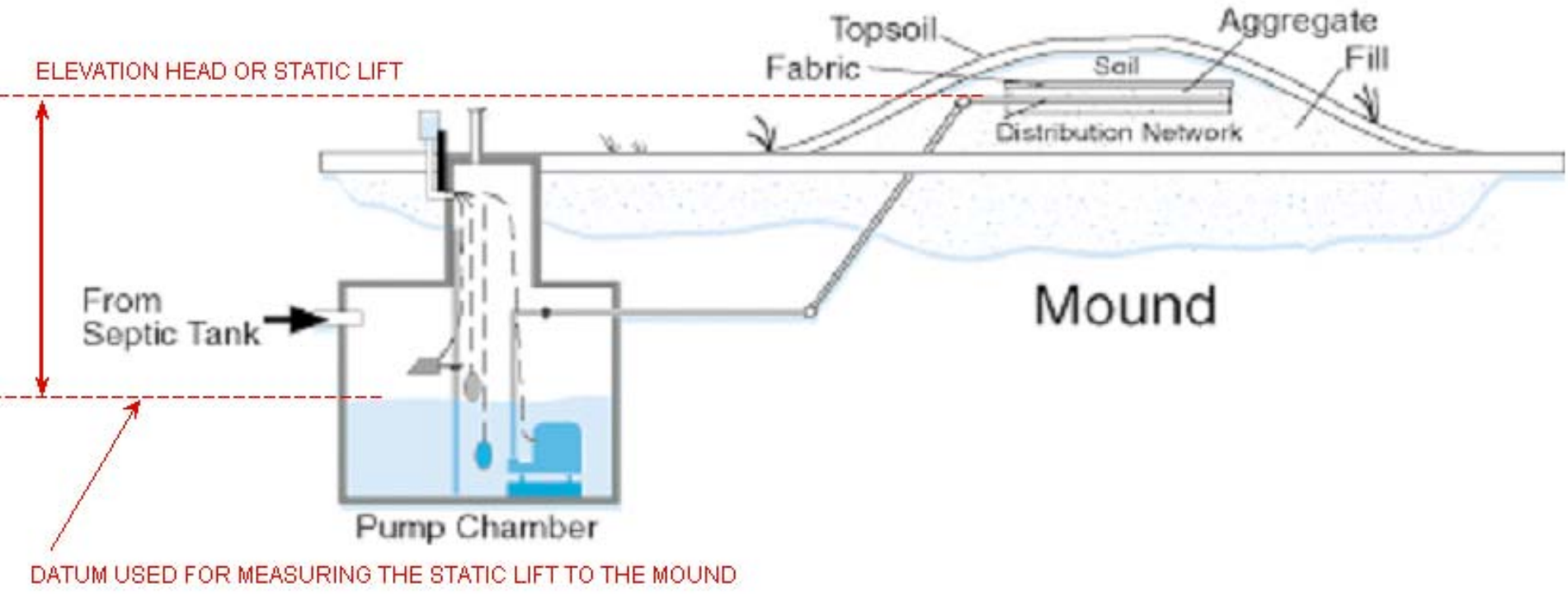
Carry a bucket of water up a flight of stairs and the work you have done in part goes into potential energy of the water.

1 CU. FT OF WATER LIFTED UP "Z" FEET
HAS Z X 62.4 FT-LBS OF POTENTIAL ENERGY
ADDED TO IT, OR SIMPLY IT HAS 10' OF ELEVATION "HEAD"



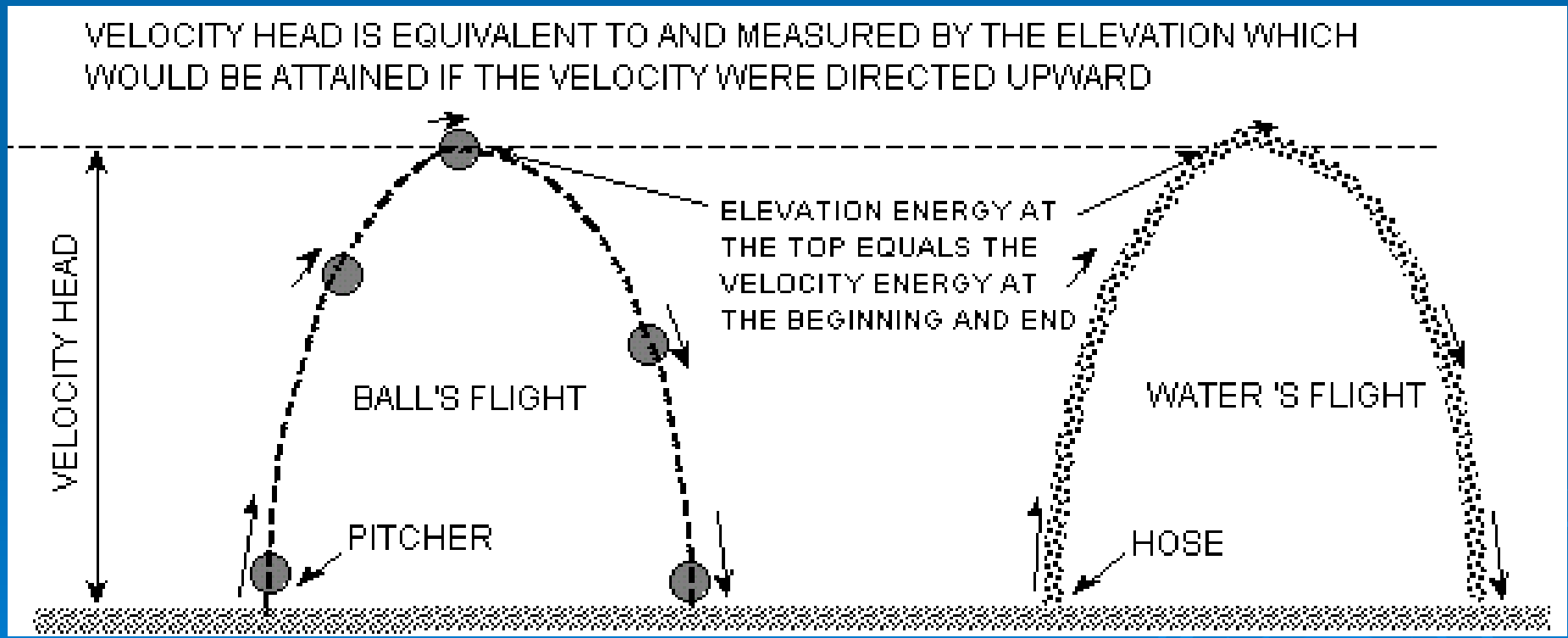
Elevation Head or Static Lift

Elevation Head is also known as 'Static Lift'



Velocity Head

The Velocity Head of water is similar to the rise and fall of water balloons launched into the air.



Conservation of Energy

$\underline{P1/density + V1^2/2g + Z1}$ + Energy Added (pump head) =
Initial Hydraulic Energy

$\underline{P2/density + V2^2/2g + Z2}$ + Head Losses
Final Hydraulic Energy

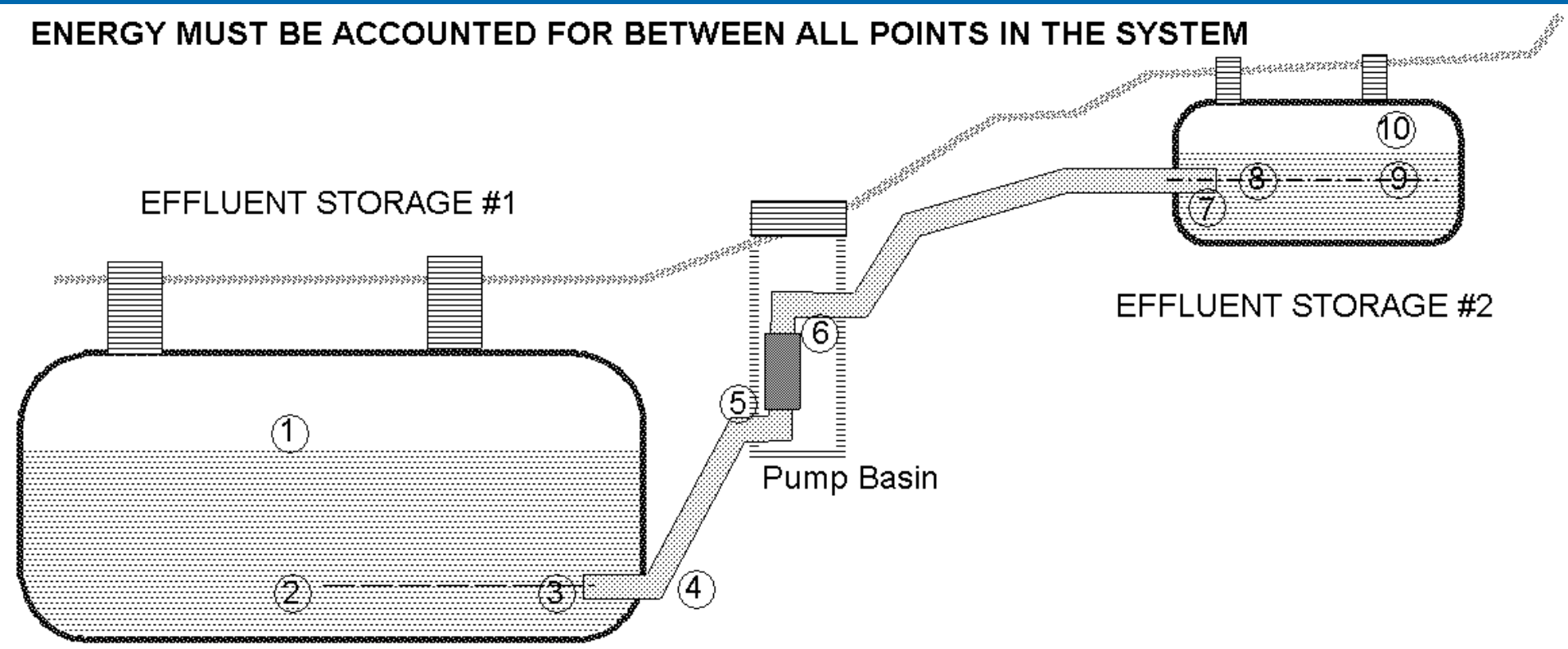
Pressure Head @1 + Velocity Head @1 + Elevation Head @ 1 + Pump Head Added

Equals

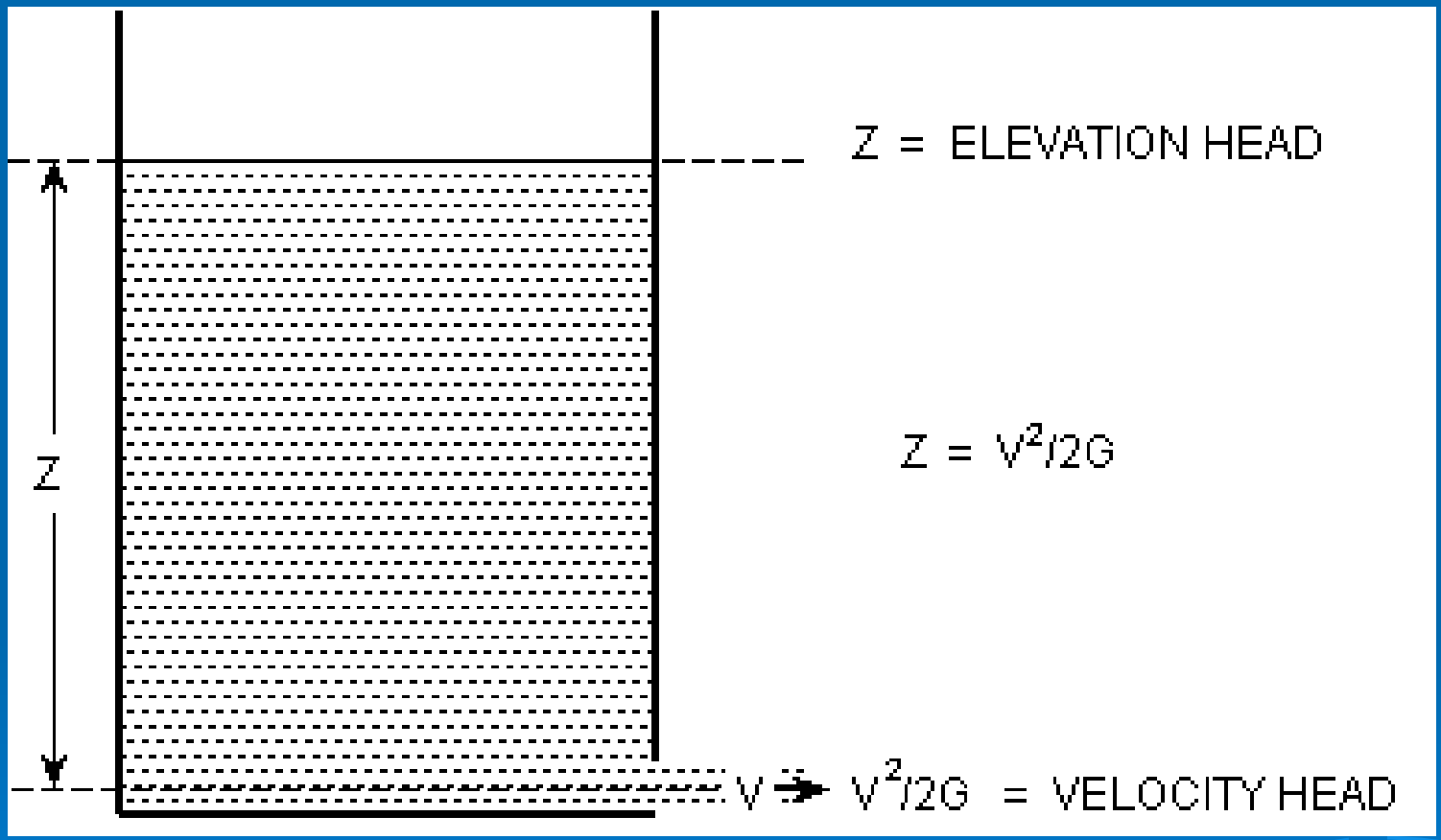
Pressure Head @2 + Velocity Head @2 + Elevation Head @ 2 + Friction Losses

Energy Between Points

The Energy at each point in this system must be appropriately calculated and accounted for.



Orifice Flow



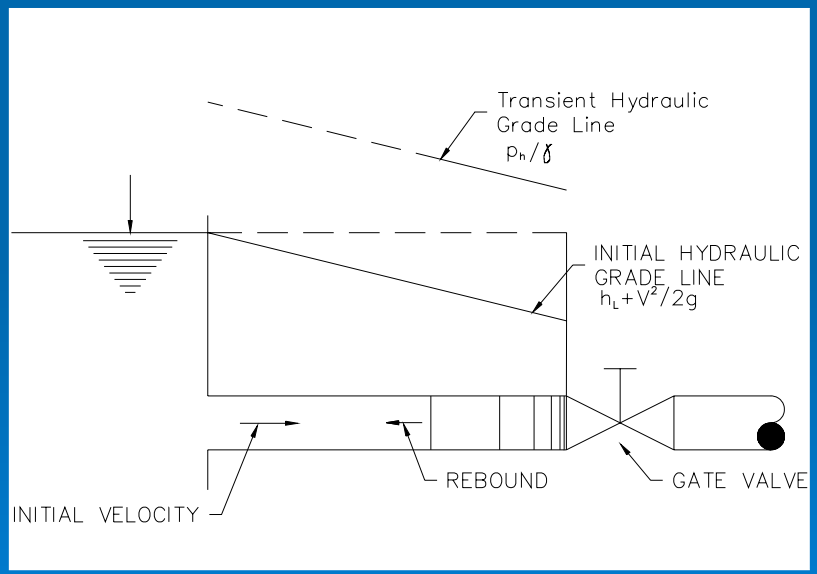
$Q_{orifice} = C * D_{orifice}^{2} * Z^{1/2}$

Where $C = k * \pi / 4 * (2g)^{1/2}$

Water Hammer

Rapidly closing or opening a valve causes pressure transients in pipelines, known as water hammer.

Energy Grade Line



Surge Line