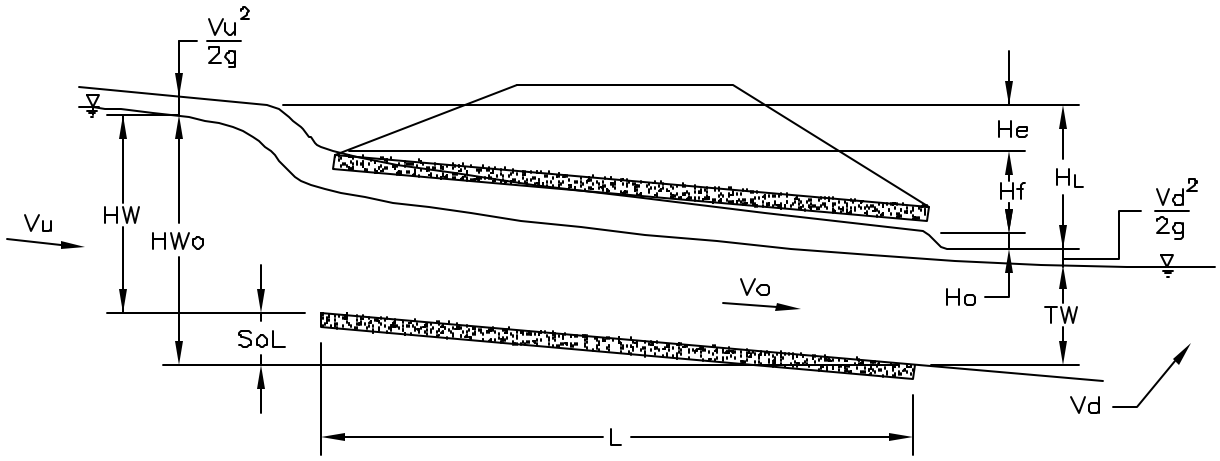
In most situations where large culverts are used, the tailwater, or depth of flow in the channel at the culvert outlet, is less than the height of the culvert. Unlike a small culvert, a large culvert rarely flows full, even under design flow conditions. The profile sketch below indicates the usual flow pattern in a large culvert or a hydraulically short culvert. The water surface profile is similar to that for a bridge.



PROFILE SKETCH

The above profile sketch assumes constant velocity within the culvert barrel and should provide reasonably accurate results for both full and part full flow conditions, provided either of the following conditions are met:

1) TW > Dc & HW ≤ 1.5D (Based on inlet and outlet control)
2) TW < Dc & [TW + L(Sf−So)] > Dc

Equating the total energy between the upstream and downstream sections:

$$HWo + \frac{Vu^2}{2g} = TW + \frac{Vd^2}{2g} + H_L$$

$$HWo = TW + \frac{Vd^2}{2g} + H_L - \frac{Vu^2}{2g}$$

Where:
- HWo = Headwater depth above outlet
- TW = Tailwater depth at outlet
- Dc = Critical depth in barrel
- Vu = Approach velocity
- Vd = Downstream velocity
- Vo = Outlet velocity
- H_L = Total energy loss
- L = Length of culvert
- So = Slope of culvert (also stream bed slope), (ft/ft)