Georgia Department of Transportation

Revised October 11, 2013

Method to Estimate Sediment Storage Volume for Rock Filter Dams and Stone Check Dams

$$V_1 = \frac{1}{27}\left[\frac{W_1 S_p L_1{}^2}{2} + \frac{S_p{}^2}{6S_{xf}} L_1{}^3 + \frac{S_p{}^2}{6S_{xb}} L_1{}^3\right]$$

Rock filter dams and stone check dams are of like shape, so their storage volume equations are identical. Note from Figure-1 below, the total volume: $V_t = V_1 + V_2$. Note that $V_1 \gg V_2$. Although V_2 is negligible, it can be calculated similarly.

V_1 – Sediment storage volume above ditch (yd^3).
W_1 – Ditch bottom width (ft).
S_p – Profile slope of ditch (ft/ft).
L_1 – Distance sediment can be stored from the toe of dam (ft).
S_{xf} – Ditch foreslope (ft/ft).
S_{xb} – Ditch backlope (ft/ft).
S_{cd} – Check dam face slope (ft/ft).
d – Sediment storage height of dam (ft) where $S_p L_1 \leq d$.
a – Horizontal distance of ditch foreslope (ft).
b – Horizontal distance of ditch backslope (ft).

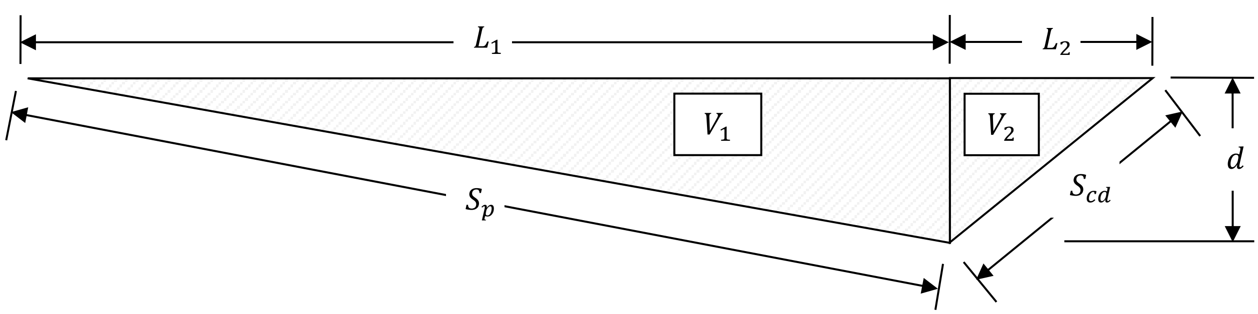
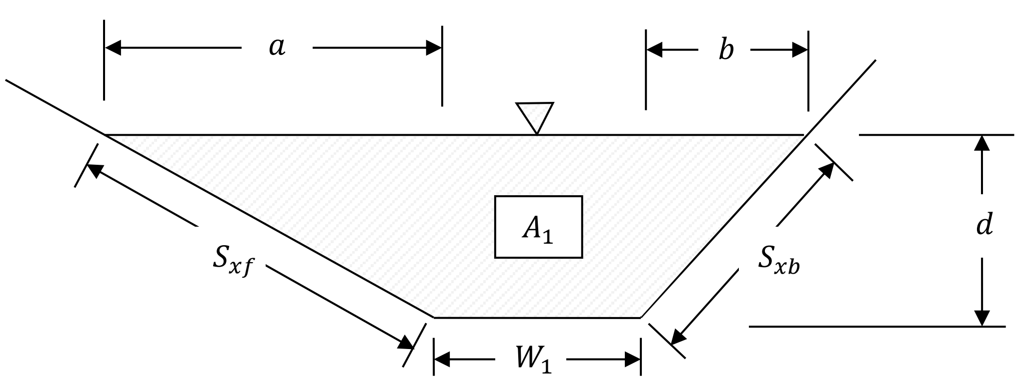


Figure-1: Profile View of the Ditch – (Not to Scale)



Office of Design Policy & Support
Jon Griffith, P.G., P.E., & Dylan Eagleton

Figure-2: Cross-Section View of the Ditch at Toe of Rock Filter Dam (A_1) – (Not to Scale)

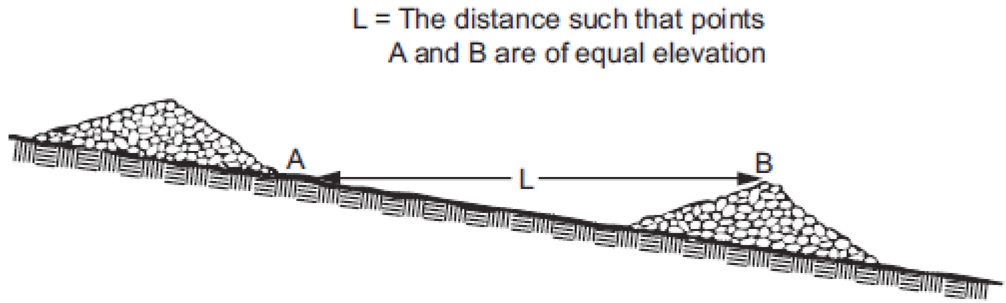


Figure-3: Spacing Between Rock Filter Dams and Stone Check Dams

To prevent backwater, as a general rule, do not space rock filter dams so the top of the downstream dam is higher than the bottom of the upstream dam.

Derivation of Sediment Storage Formula

$$A_1 = W_1 d + \tfrac{1}{2} da + \tfrac{1}{2} db$$

A_1 is cross-sectional area of trapezoidal ditch.

$$a = \frac{d}{S_{xf}} \quad \text{and} \quad b = \frac{d}{S_{xb}}$$

Horizontal offset of foreslope and backslope.

$$A_1 = W_1 d + \frac{d^2}{2S_{xf}} + \frac{d^2}{2S_{xb}}$$

Substitute for a and b in A_1.

$$d = S_p L$$

Sediment storage height of rock filter dam.

$$A_1 = W_1 S_p L + \frac{{S_p}^2 L^2}{2S_{xf}} + \frac{{S_p}^2 L^2}{2S_{xb}}$$

Substitute for d in A_1.

$$V_1 = \int_{L_o=0}^{L_1} \left(W_1 S_p L + \frac{{S_p}^2 L^2}{2S_{xf}} + \frac{{S_p}^2 L^2}{2S_{xb}} \right) \mathbf{d}L$$

V_1 is based on the area as a function of the storage length.

$$V_1 = \frac{W_1 {S_p}^2 L^2}{2} + \frac{{S_p}^2 L^3}{6S_{xf}} + \frac{{S_p}^2 L^3}{6S_{xb}} \Bigg]_0^{L_1}$$

Integrate the equation.

$$V_1 = \frac{1}{27}\left[\frac{W_1 S_p {L_1}^2}{2} + \frac{{S_p}^2}{6S_{xf}} {L_1}^3 + \frac{{S_p}^2}{6S_{xb}} {L_1}^3 \right]$$

Convert to cubic yards.

Georgia Department of Transportation

Revised October 11, 2013

Office of Design Policy & Support
Jon Griffith, P. G. , P. E. , & Dylan Eagleton