Project Data Inputs

Enter Project Number:

Enter Upper Station Limit:

Enter Lower Station Limit:

Choose Channel Location: (Right, Center, Left)

Soil Inputs and Shear Strength

Choose USCS Soil Classification Symbol: (GW, GP, GM, GC, SW, SP, SM, SC, MH, ML, CH,

CL)

> Enter Plasticity Index (PI)*:
> *(Enter 0 for nonplastic soils)

> Enter soil D75 (inches):

Program determines permissible soil shear stress according to:

USCS Symbol	Plasticity Index (-)	Grain Size (in)	Permissible Soil Shear Stress (lb/ft^2)
GW, GP	< 10	0.05 in $\leq$ D$_{75}$ $\leq$ 2 in	$\tau_p = \alpha D_{75}$
GM	$10 \leq PI \leq 20$		$\tau_p = (0.006 * PI - 0.03) \, {}^{lb}/_{ft^2}$
GM	$20 < PI$		$\tau_p = 0.085 \, {}^{lb}/_{ft^2}$
GC	$10 \leq PI \leq 20$		$\tau_p = (0.005 * PI + 0.05) \, {}^{lb}/_{ft^2}$
GC	$20 < PI$		$\tau_p = 0.15 \, {}^{lb}/_{ft^2}$
SW, SP	PI < 10	D$_{75}$ < 0.05 in	$\tau_p = 0.02 \, {}^{lb}/_{ft^2}$

SW, SP	PI < 10	0.05 in ≤ D$_{75}$ ≤ 2 in	$\tau_p = \alpha D_{75}$
SM, SC, ML, CL	PI < 10	D$_{75}$ < 0.05 in	$\tau_p = 0.02 \, ^{lb}/_{ft^2}$
SM, SC, MH, ML, CL	10 ≤ PI ≤ 20		$\tau_p = 0.006 * PI - 0.03 \, ^{lb}/_{ft^2}$
SM, SC, MH, ML, CL	20 < PI		$\tau_p = 0.085 \, ^{lb}/_{ft^2}$
CH	20 < PI		$\tau_p = 0.12 \, ^{lb}/_{ft^2}$

Where D_{75} = grain size at which 75% of soil is finer (in) and α = unit conversion constant = 0.4

(CU). Entries outside the range of defined PI or soil grain size should return "undefined".

Grass Inputs and Roughness Characteristics

Choose grass type: (Sod, Mixed, or Bunch)

Sod: spreading grass, such as Bermuda
Bunch: limited spreading, such as Ryegrass
Mixed: combined sod and bunch grasses

Choose Stem Height (ft): (0.25, 0.5, 0.75, 1.0)

Choose Density of Grass Coverage:

(Excellent = 500 stems/ft^2, Good = 300 stems/ft^2, Poor = 100 stems/ft^2)

The grass roughness coefficient is then determined based on the Kouwen resistance equation:

$$C_n = \alpha C_s^{0.10} h^{0.528}$$

Where C_n = grass roughness coefficient

C_s = density-stiffness coefficient

h = stem height (ft)

α = unit conversion 0.237 (CU).

Assuming a density-stiffness coefficient (C_s):

= 49 for excellent grass cover   (CU units)

= 9 for good grass cover   (CU units)

= 0.73 for poor grass cover   (CU units)

The grass roughness coefficient will range from 0.1-0.3 for roadside channels, with 0.2 being representative of most conditions.

Channel Input and Dimensions

Choose Channel Geometry: (Trapezoidal, Rectangular, Triangular, Parabolic)

Input Left Side Slope (ft/ft): Enter slope as horizontal feet per vertical foot

Input Right Side Slope (ft/ft): Enter slope as horizontal feet per vertical foot

Input Channel Bottom Width (ft)

Input Longitudinal Slope (ft/ft)

Input Initial Estimate of Flow Depth (ft): Enter 1 ft for default

Input Channel Discharge (ft^3/sec)

Calculated Channel Parameters

Clicking "Calculate Channel Parameters & Lining Acceptability" starts the program calculations to determine permissible shear stress on the vegetation.

Based on the initial depth estimate, the channel geometric parameters are calculated (area A, wetted perimeter, top width, and hydraulic radius (R)). Applied shear stress is calculated according to:

$$\tau_o = \gamma R S_o$$

where γ=unit weight of water (62.4 lb/ft^3) and S_o= longitudinal slope.

Manning's roughness is determined according to:

$$n = \alpha C_n \tau_o^{-0.4}$$

Where n = Manning's roughness, τ_o = mean boundary shear stress (lbft^2), α = unit conversion = 0.213 for (CU).

Next, the flowrate is determined according to:

$$Q = \frac{\alpha}{n} AR^{2/3} S^{1/2}$$

where α= unit conversion =1.49 (CU) and n = Manning's coefficient.

The program iterates until the design flowrate = the calculated flowrate, then the maximum shear stress on the channel bottom is determined according to:

$$\tau_d = \gamma d S_o$$

where d = depth of flow.

The permissible vegetation/soil shear stress is then determined according to:

$$\tau_p = \frac{\tau_{p,soil}}{(1-C_f)} \left(\frac{n}{n_s} \right)^2$$

Where

τ_p = permissible shear stress on vegetative lining (lb/ft^2)

$\tau_{p,soil}$ = permissible soil shear stress (lb/ft^2)

C_f = grass cover factor:

       Sod: Excellent = 0.98; Good = 0.90; Poor = 0.75

       Mixed: Excellent = 0.82; Good = 0.75; Poor = 0.62

       Bunch: Excellent = 0.55; Good = 0.50; Poor = 0.41

n_s = soil grain roughness

$n_s = 0.016$, when $D_{75} < 0.05$ in (1.3mm),

Otherwise: $n_s = \alpha\left(D_{75}\right)^{1/6}$

Where D_{75} = grain size at which 75% of soil is finer, mm (in)

n = Manning's roughness coefficient

If the permissible vegetation/soil shear stress is greater than the maximum shear stress on the channel bottom, the grass only is an acceptable lining. If not, the required category of TRM protection is reported.

Riprap calculations

Clicking "Calculate Riprap" results in the following:

For riprap sizing, the area of flow, wetted perimeter, top width, hydraulic radius, discharge, velocity, and depth of flow are calculated using the same equations as previous. However, Manning's roughness coefficient for riprap is determined according to:

$$n = \frac{0.262 d_a^{1/6}}{2.25 + 5.23\log\left(\frac{d_a}{D_{50}}\right)}$$

where n = Manning's roughness, D_{50} = median riprap size (ft), and d_a = average flow depth in channel (ft).

Riprap can then be sized according to (HEC15, 2005):

$$D_{50} = \frac{SF \cdot d \cdot S_o}{F_*(SG-1)}$$

Where SF = safety factor, d = maximum channel depth, S_o = channel slope, F_* = Shields parameter, and SG = specific gravity of rock.

The Shields parameter varies as a function of Reynolds number, which is determined according to:

$$R_e = \frac{V_* D_{50}}{\nu} \qquad \text{where:} \qquad V_* = \sqrt{g d_a S}$$

where V_* = shear velocity, S=slope, and ν = kinematic viscosity.

The resulting Shields parameter and safety factor are given as follows (HEC15, 2005):

Reynolds Number	F$_*$	SF
$\leq 4\text{x}10^4$	0.047	1.0
$4\text{x}10^4 < \text{Re} < 2\text{x}10^5$	Linear interpolation	Linear interpolation
$\geq 2\text{x}10^5$	0.15	1.5

Submit Data

Once the calculations have been completed, click "Submit Data". You will receive a data submitted message, and can then return to enter the next section of the project.

Download Data

To retrieve stored data, click the link titled **Generate Report**.

Enter the **Project Number**, then click **submit**. (Note: if you only want a specific station for the project number, enter the project number and the upper and lower station limits).

Click "**Download Report**", and the project information will download as a .csv file that can be opened in Excel.