For each type of control, different factors and formulas are used to compute the hydraulic capacity of a culvert. Under inlet control, the cross sectional area of the culvert, inlet geometry, and HW elevations at the entrance are of primary importance. Outlet control involves the additional consideration of the outlet channel TW elevations and the slope, roughness, and the length of the culvert barrel.

Discussions of these two types of control, and charts for selecting a culvert size for a given set of conditions, are included in the FHWA publication HDS 5 .

2. Headwater:

HW is the depth of the upstream water surface measured from the invert of the culvert entrance.

It is not always economical or practical to use all of the available HW, especially where debris must pass through the culvert or where the natural gradient is steep and high outlet velocities are objectionable.

3. Tailwater:

Tailwater (TW) depth is either critical depth at the culvert outlet or the downstream channel flow depth, whichever is higher.

A5.2.1.3. Culvert design procedures

General procedure to follow when designing a culvert is summarised in the steps below. Design Engineer shall refer to a detailed reference on culvert theory and design methods, such as the FHWA publication HDS 5. Culvert spans more than 6 m, or a width paralleling the roadway centreline, may be subject to additional performance measures, as described in Section A5.2.1.

a) Calculate the culvert design flows:

- The crossing culvert are designed for 50 years storm return intervals for freeways, expressways, and arterials and check the 100-year design for upstream flooding or overtopping. For collector and local roads, 25-year design storm return intervals is recommended for design and 50 – year for check the upstream flooding or overtopping.

b) Determine the allowable headwater (HW) elevation:

- Circular and box culverts shall be designed such that the ratio of the HW to diameter (D) during the design flow event is less than or equal to 1.25 ($HW_i/D \leq 1.25$). HW_i/D ratios larger than 1.25 are permitted, provided that existing site conditions, such as available ponding areas on deeper fills warrant a larger ratio. The maximum allowable HW_i/D ratio shall never exceed 3.

c) Determine the TWL elevation at the design flow:

- Hydraulic conditions downstream of the culvert site shall be evaluated to determine a TWL depth for the design discharge. For culvert outlets operating under free-fall conditions, such as a cantilevered pipe; critical depth and equivalent hydraulic grade line are determined using procedures as discussed below.
- For culverts discharging to an open channel, normal depth of flow in the channel shall be evaluated using procedures presented in Section A5.1.1.3