3.0 Pipe Outfalls and Rundowns

Pipe outlets represent a persistent problem due to concentrated discharges and turbulence of flow reaching this point of transition in an open channel. Too often, the designer focuses efforts on a culvert inlet and its sizing with outlet hydraulics receiving only passing attention. Appropriate pipe end treatment and downstream erosion protection at pipe outfalls is critical to protect the structural integrity of the pipe and to maintain the stability of the adjacent slope. Further discussion regarding appropriate treatment at pipe outfalls is included in the following sections.

Photograph 9-28. Pipe outfalls are recommended over rundowns due to the high failure rate of rundowns.

The use of rundowns to convey storm runoff down a channel bank is discouraged due to their high rate of failure and the resulting maintenance and repair burden. Instead, use a pipe to convey runoff to a point just above the channel invert (normally 1 foot for small receiving streams or ponds and up to 2 feet for large receiving channels).

3.1 Pipe End Treatment

Pipe end treatment consists of a flared end section, toe wall, headwall, wingwall or combination of treatments to protect the outfall from failure and provide a stable transition from hard to soft conveyance elements. Further discussion regarding these treatments follows.

Photograph 9-29. Pipe end failure resulting in loss of the flared end section

3.1.1 Flared-End Sections and Toe Walls

Flared end sections may be installed on both the inlet and outlet ends of culverts or storm drain systems. Erosion is likely at the outlet and possible at the inlet. Construction of a concrete toe wall (cutoff) is will protect the culvert from damage if inlet or outlet protection fails. At the outlet, provide scour protection including cutoff wall and use joint fasteners immediately upstream of the outlet. Protection at the upstream end can also help control seepage in the storm drain trench. See the Culverts chapter for discussion on inlet improvements.

Concrete toe walls include a footing and stem wall as shown in Figure 9-29 although the footing is optional for pipes 48 inches or less. Freezing depth should dictate the depth of the wall. The depth shown in the details represents freezing depth in the UDFCD region. Included is a design table for pipes 18 to 72 inches. The wall length shown allows an approximate 3(H):1(V) final ground slope from the flared-end section invert to the top outside edge of wall. Note that for large diameter flared-end sections, the wall lengths are quite large. It may be advantageous to use a combination headwall/wingwall approach or consider incorporating boulders for pipes larger than 36 inches in diameter. Always evaluate public safety including the need for pedestrian railing where a potential fall of 36 inches or more as possible. Along with the toe wall, install two joint fasteners between the flared end section and the last pipe section. Install these roughly at the ten o'clock and two o'clock positions and trim joint fastener threads flush with the interior bolts. Left untrimmed, these can catch debris and reduce pipe capacity. Joint fasteners are not necessary for flared end sections on the entrance of culverts or storm drains.

Figures 9-29 and 9-30 are applicable to both ends of a culvert or storm drain system. It is the design engineer's responsibility to assess the need for a cutoff wall. Factors to consider include:

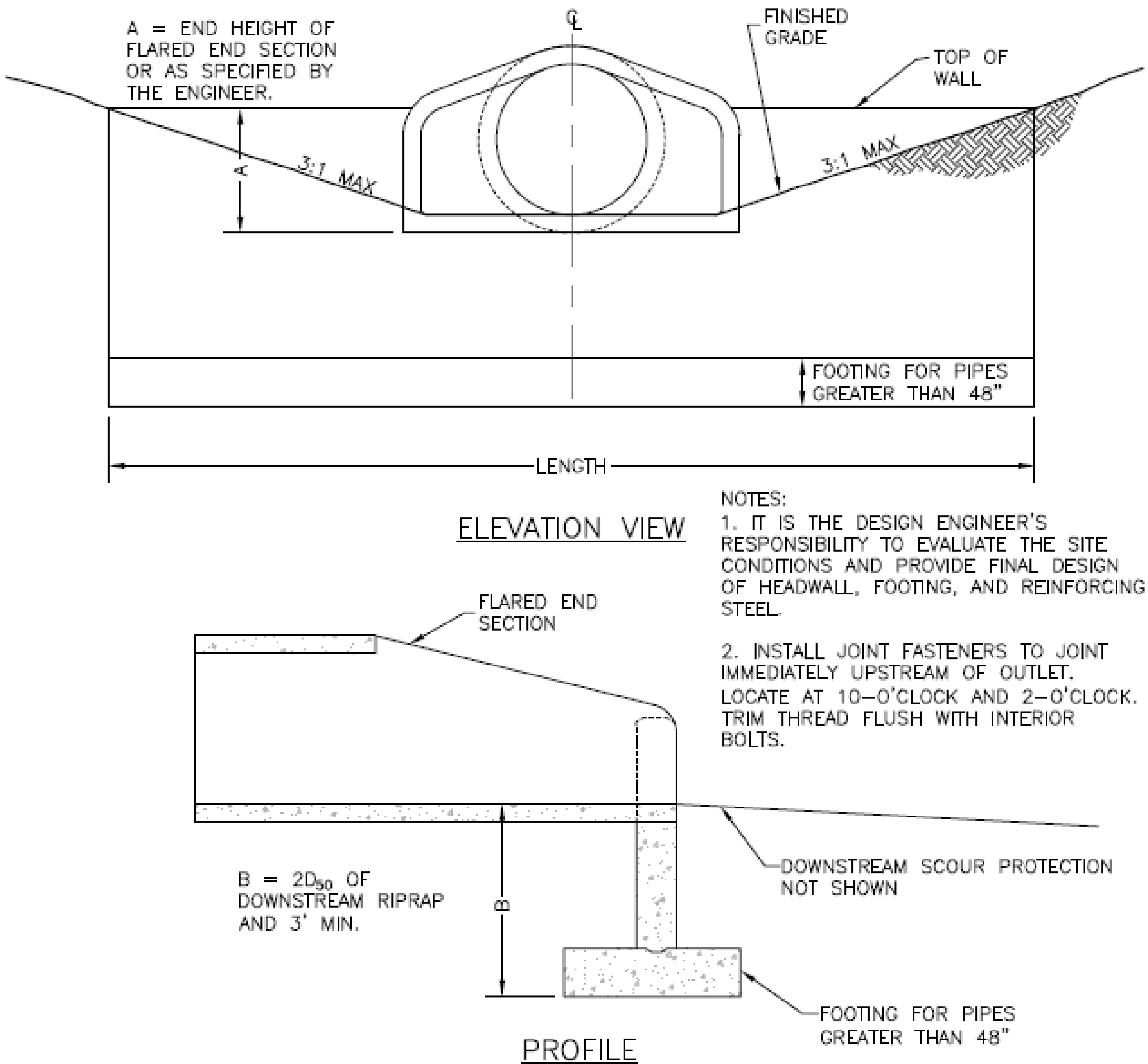
- The slope of the culvert or storm drain system is steep;
- The surrounding subsoils are granular or otherwise susceptible to erosion and/or piping;
- Potential for the roadway to wash out and the associated impact to public safety.

3.1.2 Concrete Headwall and Wingwalls

Concrete headwalls are an acceptable alternative to flared-end sections at pipe inlets and outlets. Figure 9-31 provides design guidance and a headwall design table for the design of a concrete headwall at a pipe inlet or outlet. When a 3(H):1(V) final ground slope from the pipe invert to the top outside edge of wall is used, the wall length can become quite long. Headwalls can be paired with wingwalls or boulders in order to reduce the overall headwall length. For 18" to 36" diameter pipes, headwalls can be paired with loosely placed boulders as shown in Figure 9-32. The addition of boulders can enhance the appearance of the end treatment and significantly reduce the wall length.

Storm drain outfalls into large river systems (e.g., the South Platte River) often require special consideration with respect to the channel bank geometry and base flow water surface elevation. Figure 9-33 provides general layout information for the construction of a headwall with wingwalls. It is the design engineer's responsibility to evaluate the site conditions and provide final design of headwall, wingwalls, footings, and reinforcing steel.

On large receiving streams, UDFCD encourages the use of wingwalls that are constructed perpendicular to the receiving channel centerline (or headwall), thereby reducing the impact to the channel overbanks. Further discussion regarding structure requirements for outfalls into large river systems is in Section 3.2.4.



HEADWALL DESIGN TABLE

PIPE SIZE	LENGTH, MIN
18"	7'–0"
24"	8'–0"
30"	10'–0"
36"	12'–6"
42"	15'–9"
48"	17'–6"
54"	19'–6"
60"	21'–6"
66"	22'–6"
72"	24'–0"

Figure 9-29. Flared end section (FES) headwall concept