



CHAPTER 10. CONDUIT OUTLET STRUCTURES
Design Checklist for Conduit Outlet Structure Design

Yes	No	N/A	Design Requirements
I. GENERAL LAYOUT INFORMATION			
			A. Inlet and Outlet Configuration
			1. Conduits 54-inches in diameter and larger within urbanized portions of the County include headwalls and wingwalls.
			2. Conduits 48-inches in diameter and smaller within the urbanized portions of the County include headwalls/wingwalls or flared end sections.
			3. In rural portions of the County, the use of flared end sections and riprap stabilization in lieu of concrete headwalls/wingwalls must be approved by the County.
			B. Safety Rails
			1. Conduit headwalls and wingwalls include guardrails, handrails, or fencing in conformance with building codes and roadway design safety requirements.
			2. Handrails are provided at locations with frequent pedestrian and/or bicycle traffic.
			3. Handrails are 42-inches in height for pedestrian traffic.
			4. Handrails are 54-inches in height for bicycle traffic.
			5. Acceptable materials used for handrails include, but are not limited to, galvanized steel, painted steel, aluminum, and chain link fence.
			C. Flared End Sections
			1. All flared end sections include toe walls at the outlet. See Figure 10-1 for toe wall configuration details.
			2. All flared end sections at conduit outlets have a minimum of three joints mechanically locked with joint fasteners. See Figure 10-2 for pipe outfall joint restraint requirements.
			D. Conduit Elevations Relative to Drainageways
			1. Inlet and outlet elevations of an in-line culvert match the drainageway elevations upstream and downstream.
			2. A storm sewer outlet invert elevation is set 1 to 2 feet above the natural channel bottom.
II. CONDUIT OUTLET EROSION PROTECTION SELECTION AND DESIGN CRITERIA			
			A. Selection of conduit outlet erosion protection is in accordance with Table 10-1.
			B. Riprap Lining
			1. Riprap at a culvert outlet is designed in accordance with Section 7.0 of the Major Drainage Chapter of the UDFCD Manual.
			2. Riprap is used for outlet Froude numbers up to 2.5.
			3. The conduit outlet invert elevation is flush with the top of the riprap channel protection.



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Yes	No	N/A	Design Requirements
			C. Low Tailwater Riprap Basin
			1. Low tailwater riprap basin is designed in accordance with Section 3.4 of the Hydraulic Structures Chapter of the UDFCD Manual.
			D. Concrete Impact Stilling Basin
			1. The use of a concrete impact stilling basin was approved by the County prior to design.
			2. A concrete impact stilling basin is designed in accordance with Sections 3.2 and 3.3 of the Hydraulics Structures Section of the UDFCD Manual.
			E. Concrete Baffle Chute
			1. The use of a concrete baffle chute was approved by the County prior to design.
			2. A concrete baffle chute is designed in accordance with Sections 3.2 and 3.3 of the Hydraulic Structures Section of the UDFCD Manual.



**CHAPTER 10. CONDUIT OUTLET STRUCTURES
Construction Plans Checklist**

Yes No N/A Construction Plan Requirements

I. CONDUIT OUTLET STRUCTURE PLAN VIEW, the following information is shown:

			A. Title block with project information, including a list of sheet revisions and an approval block
			B. Boundaries of project and plan sheet layout (key map)
			C. Existing and proposed roadways, sidewalks and other surface features
			D. Existing and proposed drainageways, irrigation ditches, culverts and storm sewer pipes
			E. Existing and proposed utilities (overhead and underground)
			F. Existing and proposed conduit(s)
			G. Existing and proposed contours
			H. Stationing along project control line
			I. Right-of-way and easement lines
			J. North arrow and scale bar
			K. Limits of proposed conduit outlet erosion protection
			L. Label existing erosion protection to be removed
			M. Label existing conduit to be removed

II. CONDUIT OUTLET STRUCTURE PROFILE/CROSS SECTION, the following information is shown:

			A. Title block with project information, including a list of sheet revisions and an approval block
			B. Horizontal and vertical scale bars
			C. Labels for extent (length), thickness, material, slope and finished grade elevation of outlet protection.
			D. Existing and proposed ground along outlet structure cross section
			E. Existing and proposed utilities along outlet structure cross section
			F. Station(s) and offset(s) from conduit outlet protection to project control line

III. CONDUIT OUTLET STRUCTURE DETAILS, the following information is shown:

			A. Include any additional structure details or special connections that are not included in the Arapahoe County Standard Details or Colorado Department of Transportation M & S Standard Plans
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