Formula 1

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Formula 2

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Formula 3

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Detailed Explanation

The HDS-5 manual serves as the authoritative reference for state DOTs, consulting engineers, and federal reviewers engaged in drainage infrastructure for transportation projects. It emphasizes a risk-informed, performance-based approach—moving beyond prescriptive sizing to consider reliability, uncertainty in hydrologic inputs (e.g., NOAA Atlas 14 rainfall), and consequences of failure. Core technical content includes refined inlet control equations for various inlet configurations (e.g., headwall, beveled, mitered), improved outlet control formulations accounting for tailwater effects and energy losses, and updated contraction/expansion loss coefficients based on physical modeling and CFD validation. The manual also introduces enhanced guidance for fish passage-compatible culvert design, ecological connectivity considerations, and climate-resilient design—including adjustments for non-stationary flood frequency analysis and sea-level rise impacts on coastal culverts. Appendices provide worked examples, nomographs, design checklists, and software implementation notes for widely used tools such as HY-8 and CulvertMaster.

Key Components

#	Component

1	Inlet Control Analysis
2	Outlet Control Analysis
3	Scour and Stability Assessment
4	Culvert Type Selection Criteria
5	Climate-Informed Hydrologic Input Guidance

Applications

#	Application
1	Design of new highway culverts under AASHTO LRFD standards
2	Hydraulic capacity evaluation and retrofit prioritization of existing culverts
3	Floodway encroachment and regulatory compliance documentation (e.g., FEMA, USACE)

Related Concepts

#	Concept
1	Hydraulic Jump
2	Energy Grade Line Analysis
3	Flood Frequency Analysis
4	Open Channel Flow
5	Scour Protection Design

Tags

> culvert, hydraulic design, FHWA, drainage engineering, transportation infrastructure