Chapter 1 - Introduction

This Fourth Edition of the Urban Drainage Design Manual provides technical information for understanding, assessing, and addressing drainage design for transportation infrastructure. This chapter describes the purpose and scope, organization, target audience, and units used in the manual.

1.1 Purpose and Scope

This manual provides a comprehensive and practical guide for the design of storm drainage systems associated with transportation facilities. The focus is to support the design of storm drainage systems that collect, convey, and discharge stormwater flowing within and along the highway right-of-way. The manual covers the design of most types of drainage systems associated with highways except for 1) cross drainage facilities such as culverts and bridges and 2) subsurface facilities. For culverts and bridges, the Federal Highway Administration (FHWA) has prepared two reference manuals in their Hydraulic Design Series (HDS): *Hydraulic Design of Highway Culverts* (HDS-5) (FHWA 2012a) and *Hydraulic Design of Safe Bridges* (HDS-7) (FHWA 2012b). The FHWA addresses subdrainage design in *Geotechnical Aspects of Pavements* (FHWA 2006b).

This manual provides methods and procedures for the hydrologic and hydraulic design of storm drainage systems. Design methods include evaluating rainfall and runoff magnitude, as well as the design of pavement drainage, gutter flow, inlet design, median and roadside ditch flow, drainage structure design, and storm drain piping. Methods also include procedures for the design of detention facilities, review of urban water quality practices, and review of stormwater pump stations.

A goal of this manual is to support planning, implementation, and stewardship of sustainable, resilient, and reliable transportation networks. The FHWA describes sustainability as considering three primary values or principles: social, environmental, and economic (FHWA 2022c). The goal of sustainability is the satisfaction of basic social and economic needs, both present and future, and the responsible use of natural resources, all while maintaining or improving the well-being of the environment on which life depends.

Commonly, society views sustainability through a lens of balancing the needs of the environment with the economic needs of roadway and bridge development. Balancing the environment with social values results in what is bearable by both society and the environment while balancing the social and economic results in what is equitable. Sustainability results when all three values (social, environmental, and economic) are satisfied and in balance. For FHWA, a sustainable highway project satisfies basic social and economic needs, makes responsible use of natural resources, and maintains or improves the well-being of the environment.

Considering transportation equity for underserved populations is important element of a sustainable approach to highways. Transportation equity is relevant under all three primary values of sustainability. Past Federal transportation investments have too often failed to consider transportation equity for all community members, including traditionally underserved and underrepresented populations (USDOT 2022). “Underserved populations” include minority and low-income populations but may also include many other demographic categories that face challenges engaging with the transportation process and receiving equitable benefits (See FHWA 2015). The U.S. Department of Transportation (USDOT or Department) has committed to pursuing a comprehensive approach to advancing equity for all (USDOT 2022.; and Executive Order 13985, 86 FR 7009 (2021)). Equity in transportation seeks the consistent and systematic fair, just, and impartial treatment of all individuals, including individuals who belong to traditionally underserved communities or populations (USDOT 2022).

Resilient and reliable design of storm drainage systems for transportation facilities is also essential in addressing the significant and growing risk presented by climate change. (USDOT 2021). In the transportation context, this risk is many-faceted, including risks to the safety, effectiveness, equity, and sustainability of the Nation's transportation infrastructure and the communities it serves. The USDOT recognizes that the United States has a "once-in-a-generation" opportunity to address this risk, which is increasing over time (USDOT 2021; see also Executive Order 14008 on Tackling the Climate Crisis at Home and Abroad, 86 FR 7619 (2021)). Addressing the risk of climate change is also closely interlinked with advancing transportation equity because of the disproportionate impacts of climate change on vulnerable populations, including older adults, children, low-income communities, and communities of color. The USDOT intends to lead the way in addressing the climate crisis.

The FHWA believes that this manual will be useful for aligning and integrating these concepts and principles of sustainability within the context of the design of storm drainage systems associated with transportation facilities.

1.2 Organization

This manual consists of 12 chapters, a glossary, list of acronyms, reference section, and appendices. This chapter, **Chapter 1**, provides discussion of the purpose, background, organization, and units.

Chapter 2 provides an overview of Federal policy as it relates to urban stormwater drainage analysis and design. This context guides work in stormwater management through a series of statutes and regulations.

Chapter 3 describes high-level concepts of system planning and outlines considerations for successful design. These include data requirements, agency coordination, concept development, and design.

Chapter 4 outlines hydrologic procedures for estimating rainfall and flow amounts that will drive the type, size, and configuration of the drainage system. The chapter includes selection of a design storm which establishes the overall capability of the drainage system to manage runoff.

Chapters 5, 6, and 7 describe detailed methods and information for designing the surface collection components of a comprehensive stormwater drainage system—roadway pavement drainage, roadside and median channels, and inlets, respectively. Each of these captures water from the land surface to preserve safe roadway facilities.

Chapters 8 and 9 address the subsurface system of storm drain structures and conduits, respectively. These components convey the collected stormwater to an offsite or discharge location.

Chapter 10 describes the design of detention and retention facilities when needed to manage stormwater quantity. These facilities can attenuate flood peaks and redistribute flood volumes.

Chapter 11 outlines the selection and design of stormwater quality best management practices (BMPs). These tools assist designers in improving the water quality of discharges offsite or to receiving waters to mitigate potential negative water quality impacts.

Chapter 12 addresses pump stations. Stormwater drainage systems primarily rely on gravity to convey stormwater away from roadways safely. When this is not an option, stormwater pump stations provide an alternative.

1.3 Target Audience

The target audience of this manual includes a wide cross-section of users with Federal, State, and local highway agencies, and consultants with roadway and drainage design responsibilities. While an understanding of basic hydrologic and hydraulic principles will be helpful, readers with varying backgrounds and expertise, including those with limited knowledge in urban drainage design, will find the manual useful.

Those with an interest in addressing the growing risk presented by climate change to transportation infrastructure may also find this manual helpful. It provides information they may find valuable as they explore ways to implement climate and resilience strategies in the design of storm drainage systems for transportation facilities.

The FHWA provides additional reference information on hydrologic topics in *Highway Hydrology* (HDS-2) (FHWA 2002). Other supporting resources include *Design and Construction of Urban Stormwater Management Systems* (ASCE 1992) and numerous basic hydrology and hydraulic textbooks.

This manual does not have the force and effect of law and it is not meant to bind the public in any way. The FHWA intends any descriptions of processes and approaches to provide illustrative insights into the underlying scientific and engineering concepts and practices rather than any proscribed guidance or requirements.

1.4 Units in this Manual

This manual uses English customary units (CU). However, in limited situations both CU and SI (metric) units are used or only SI units are used because these are the predominant measure used nationwide and globally for such topics. In these situations, the manual provides the rationale for the use of units. Appendix A summarizes information on units and unit conversions.

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