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DR-01.100 THE MANUAL

DR-01.110 General

The Drainage Guidance Manual is an effort to employ the most recent methods and technology for formulating a drainage plan or system for highway projects. The most important product of this procedure is the development of a permanent legal record of the steps taken to arrive at the selection of all the various drainage structures proposed in the plan or system and give reason to that particular selection. This permanent legal record is known as the Final Drainage Folder.

DR-01.120 Chapter Overview

CHAPTER 1: INTRODUCTION--The first chapter introduces the designer to the general contents of the manual. Departmental policies in various areas of drainage are discussed. Responsibilities are outlined. References and support material is provided. The last section is a discussion of the drainage design review process, which coincides with the development of plans for highway projects.

CHAPTER 2: FLOODPLAIN MANAGEMENT--Federal and state agencies regulate highway construction through floodplain management policies. This chapter discusses the guidelines of floodplain management.

CHAPTER 3: DRAINAGE FOLDERS--Field Surveys, Folder Requirements, and Submission Schedules are discussed.

CHAPTER 4: DISCHARGE-- The factors contributing to the runoff are explained in this chapter, with the various formulas used.

CHAPTER 5: CHANNELS AND DITCHES--The control of water, both in collection and diversion, can consist of a pipe and/or open channel network. The hydraulics of the open channel network is explained. The guidelines for many applications and designs are included.

CHAPTER 6: CULVERTS AND HEADWALLS--The hydraulic design and physical standards of culverts are presented. The safety and non-safety headwalls available for use with culverts are discussed.

CHAPTER 7: INLETS AND STORM SEWERS--Surface flow in urban areas is usually collected in inlets that are drained by multi-branched storm sewer systems. The location and sizing requirements for inlets are given. The components of a storm sewer system and methods for sizing are discussed.

CHAPTER 8: BRIDGES--Selection and design of bridges are introduced. The location of a bridge must be determined by giving consideration to upstream and downstream development, environmental impact, and floodplain management. Water surface profiles are analyzed for tendencies to changes, levels of flooding, stream aggradation or degradation, and scour. The hydraulic methods for bridge design are presented.

CHAPTER 9: DAMS AND STORAGE--The detention of water may be an important aspect of hydraulic design. The criteria for dam and detention design is discussed.

CHAPTER 10: EROSION CONTROL--Erosion and sedimentation must be controlled throughout all phases of construction and maintained after completion of the project. Temporary and permanent erosion control measures are described. The guidelines for energy dissipators, regulations and erosion control design are discussed.

CHAPTER 11: RESTORATION-- The restoration of the highway drainage elements may be required by or may result in changes in the hydrology and hydraulics for the upstream area, the downstream area, and the highway itself. This restoration must be reviewed closely for its potential detrimental effects.

CHAPTER 12: COMPUTER PROGRAMS--Several programs have been developed to facilitate drainage design processes. This chapter provides background information for the use of the programs now approved.

APPENDIX A: DRAINAGE FORMS
APPENDIX B: SAMPLE DRAINAGE FOLDER
APPENDIX C: GLOSSARY

DR-01.130 Computerization

This manual makes the assumption that all designers have access to some type of computer system. Previous editions of the manual have provided methods for manual hydraulic calculations. Equations are given for those persons who still wish to employ manual methods.

DR-01.140 Support References

The methodologies employed in this manual have been adopted as a result of careful screening of many hydraulic and hydrologic programs and procedures available to the Engineer today.

DISCHARGE PUBLICATIONS

"Regionalization of Peak Discharges for Streams in Kentucky" a publication of the United States Geological Survey (USGS), details a method of discharge calculations using regionalized regression equations.

"Technique for Estimating Magnitude and Frequency of Floods in Kentucky" published by the USGS provides state wide regression equations.

"Water Resources Data for Kentucky" is published annually by the USGS and contains supplementary annual gage data. The USGS operates many gaging stations throughout Kentucky. Data is accumulated for each station and summarized annually in this report, containing water levels and discharge information that is helpful for designing stream crossings. To have access to all previous data, it will be necessary to get all copies published since 1960.

These booklets may be obtained either from the Department of Commerce, Division of Minerals Research, Frankfort, the Kentucky Geological Survey Office, Lexington, or the USGS Office, Louisville.

FHWA PUBLICATIONS

The following publications by the Federal Highway Administration (FHWA) are recommended as references. Criteria and procedures therein may be applied where there is no conflict with that of the Transportation Cabinet. As indicated below, some of these booklets are available from the U.S. Government Printing Office. The rest have a limited distribution.

Highways In The River Environment, February 1990
NHI Course No. 13010, Participant Notebook
Publication No. FHWA-HI-90-016

HYDRAULIC ENGINEERING CIRCULARS

HEC NO. 1 - Selected Bibliography of Hydraulic and Hydrologic Subjects, 1983

HEC NO. 9 - Debris-Control Structures, 1971

*HEC NO.11 - Design of Riprap Revetment, 1989

*HEC NO.12 - Drainage of Highway Pavements, 1984

*HEC NO.14 - Hydraulic Design of Energy Dissipators for Culverts and Channels, 1983

*HEC NO.15 - Design of Stable Channels With Flexible Linings, 1988

HEC NO.17 - The Design of Encroachment on Flood Plains Using Risk Analysis,1981

HEC NO.18 - Evaluating Scour at Bridges, 1993

HEC NO.19 - Hydrology, 1984

HEC NO.20 - Stream Stability at Highway Structures, 1991

HYDRAULIC DESIGN SERIES (HDS)

*HDS NO. 1 - Hydraulics of Bridge Waterways, 1978

*HDS NO. 3 - Design Charts for Open Channel Flow, 1961

*HDS NO. 4 - Design of Roadside Drainage Channels,1965

*HDS NO. 5 - Hydraulic Design of Highway Culverts, 1985

* Available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

AASHTO Publications

"HIGHWAY DRAINAGE GUIDELINES,1992", AASHTO is a recent publication that gives a thorough introduction to drainage design. Contact AASHTO, Washington, D. C.

"MODEL DRAINAGE MANUAL,1991", AASHTO is a recent publication that gives a methodology of drainage design. Contact AASHTO, Washington, D. C.

OLD DRAINAGE FOLDERS

The Drainage Section also will make available on request, a copy of an archived drainage folder. These folders are kept in State records for 50 years and may be used for supplemental reference. It takes about 7-10 days to get a folder from Archives.

MAPS

State, County, Community, and topography maps are available through the Division of Planning, Frankfort, and the Department of Commerce, Map Sales, Frankfort.

Flood Insurance Maps are available from the Federal Emergency Management Agency, phone 800-133-1363.

County Soil Studies are available from the Soil Conservation Service.

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DR-01.200 DEPARTMENTAL POLICIES

DR-01.210 General

Proper stormwater management is essential to preserve and promote the public health, social well-being, economic development, and public safety. This manual contains guidelines and policies to be followed in highway drainage design that meet the above goals. Conveyance of surface waters through the transportation system must be made without an adverse environmental impact.

DR-01.220 Drainage Design

For this guidance manual, the term "Drainage" includes all hydraulics, hydrology, installation technology, environmental considerations, and other procedures involved in determining the proper size, type, and location of drainage structures or systems proposed involved in Kentucky's system of urban and rural highways, streets, and roads.

The drainage design of any highway project shall conform to Transportation Cabinet policies, procedures, standards, and specifications, as well as other Federal, State and Local requirements. The goals of highway drainage design are to:

1. Remove water from the highway;

2. Prevent surface water from reaching the highway;

3. Drain potential ponding areas from highway fills;

4. Drain areas undercut by highway excavation;

5. Release these waters at an adequate outlet;

6. Allow existing streams to pass through the highway.

These goals shall be accomplished in the most economical means while disturbing the surrounding environment as little as possible. For this purpose, the design policies of the Department of Highways are:

1. Determine the existing flow conditions at a site;

2. Design a drainage system for the proposed work that does not "significantly" change the quality or quantity of flow upon completion of the work.

The post-development discharge and velocity should not significantly exceed the pre-development discharge and velocity. In some instances this will require the use of energy dissipators and/or detention basin storage before disposal.

The drainage plan shall be based on traffic service needs, compatibility with local drainage systems, and the function of the facility in total storm drainage for the area. Consideration also should be given to potential maintenance problems and traffic hazards that may result due to clogged inlets and sediment deposition.

Before project construction, careful planning for adequate temporary drainage measures should be employed to insure not only the protection of the environment, but also of the project itself. There are acceptable methods of erosion control and temporary/permanent drainage controls described in this manual.

DR-01.230 Highwater Records

Record and near-record flooding events occur at various times on one or more watersheds in Kentucky. These events provide opportunities to check the effect of flood waters on highway structures and collect data about the damage that the highway sustains. This information is most useful on these particular streams. District representatives are encouraged to record and submit as much data as possible for designing future structures. Photographs and video recordings are the most beneficial records of flooding events and damage. They can reveal any flood damage to structures or highways and indicate whether or not the structures are functioning properly.

Floods of record magnitude are rare, and the opportunity seldom arises to get actual field information. Field documentation is important, both as an aid in current construction design and as a tool for the improvement of overall design procedures.

The high water data, as listed in 3-240, should be obtained whenever possible and sent to the Division of Design, Drainage Section.

DR-01.240 Aggregate Channel Lining

In channel situations, preventive measures against soil erosion and protection of the environment must be considered. It is the desire of this agency to encourage the design of stable channels. Since Kentucky is the Southeast's leading producer of aggregate materials, aggregate channel lining will be used, extensively. Alternatives will be considered only when they prove to be more effective or more economical in the individual situation. Aggregate channel lining allows for maximum protection from erosion, is aesthetically pleasing, and is now more cost effective than other lining types.

DR-01.250 Project Changes

The Drainage Section shall be notified of any project that is cancelled, incorporated into another project, or split into sections that contain some degree of drainage design. Modifications in drainage design for projects past the drainage inspection stage shall be submitted for review in a drainage folder format.

Major changes in the scope of a project and/or submission of incomplete or error-ridden folders are reasons to require re-submission of any drainage folder.

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DR-01.300 RESPONSIBILITIES

DR-01.310 General

Drainage design personnel should be familiar with the responsibilities of various parties involved in the drainage design and review process.

DR-01.320 The Drainage Section

The primary purpose of the Drainage Section, Division of Design is to review the drainage design of all projects that either directly or indirectly affect Kentucky's system of highways. The Drainage Section will review floodplain encroachments, bridges, cross drains greater than 48" or its equivalent, and urban drainage systems.

This Section is made up of the Chief Drainage Engineer, other Drainage Engineers, and support personnel. The Drainage Engineers are assigned several highway Districts. It is the responsibility of each Drainage Engineer to assure that all drainage design follows current Departmental practices, standards and specifications and applicable Local, State and Federal regulations.

The Drainage Engineer shall attend and/or conduct all meetings, inspections, or other drainage-related reviews that take place during the plans development process. This Engineer will provide expertise in all areas related to the proposed project drainage plan or system; offer comments and/or recommendations; and determine where corrections should be made when current practices, methodologies, or procedures are violated.

The Drainage Section will aid the highway Districts in the implementation of drainage design in their areas to the extent that there is but one interpretation of the drainage requirements throughout the state according to this manual.

DR-01.330 The District

Each Highway District shall follow the procedures stated in this manual when approving or recommending a proposed drainage design for 48" pipe or its equivalent or smaller. Each district shall appoint drainage personnel to review consultant and district projects for compliance.

DR-01.240 The Designer

Regardless of the source of a drainage design, whether it is a Federal, State, Local, or Private entity, each has the responsibility to become familiar with the policies, procedures, and accepted methodologies as outlined in this manual. Periodic updates and revisions to the manual will be issued, either through manual revisions or "Division of Design Drainage Memorandums."

The Designer should keep in mind that the procedures and methodologies in this manual are guidelines. It is understood there are other acceptable engineering techniques and technologies for drainage design. If there are better ways of providing the required information, the Transportation Cabinet is open to innovative suggestions. However, when the Designer elects to use other avenues of drainage design, with which the Cabinet is not familiar, delays in processing drainage designs and submittals will occur. It is the Designer's responsibility to inform and educate the Cabinet in all areas of the procedures employed in a drainage design not covered in this manual. This is especially true where computer software is used and has been developed elsewhere. Full documentation of all procedures that differ from that discussed in this manual shall be provided by the Designer at no expense to the Cabinet. The Cabinet reserves the right to approve or deny the use of these procedures used to produce a drainage design or system.

The Designer is responsible for developing the documentation for COE permits, FEMA No-Rise Certifications, and FEMA Letter of Map Revisions. An additional copy of the Final Drainage Folder shall be required for submittal to FEMA for their review.

DR-01.350 FHWA

Federally funded project require review by the Atlanta and Washington, D. C. offices when the project includes:

Bridges with unusual features or 125,000 square feet or greater deck area,
Storm sewers with greater than 200 cfs outfall,
Storm sewers with greater than 5 acre-feet of storage,
Pumping stations, or
Highway fill dams with 50 acre-feet storage or greater than 25 feet high.

Two additional copies of the Preliminary and Final Drainage Folders will be submitted to the Drainage Section to be forwarded to FHWA for their review.

DR-01.400 THE REVIEW PROCESS

DR-01.410 General

The Drainage Section shall be notified of all pending meetings, conferences, or inspections in order that a Drainage Engineer may attend. The drainage review of any magnitude will proceed, following this schedule established and coordinated by the Central Office, Division of Design:

1. Pre-Design Conference
2. Preliminary Line and Grade Inspection
3. Preliminary Drainage Folder
4. Drainage Inspection
5. Drainage Inspection Report
6. Final Plans-in-Hand Inspection
7. Advance Situation Folder
8. Final Drainage Folder
9. Review of Final Plans

DR-01.420 Pre-Design Conference

The Pre-Design Conference is necessary when a private consultant firm is responsible for the design phase of a project. This conference is to outline what is desired by the Central Office in the design and construction of the project. The consultant will be provided with guidelines (including drainage) to follow to produce results that are consistent with current design requirements for each project.

DR-01.430 Preliminary Line and Grade Inspection

The preliminary line and grade inspection is held after the designer has established tentative horizontal and vertical alignments for a project. The alignment is to be surveyed, clearly marked, then field reviewed by representatives of the Division of Design, the respective District Office, and the consultant firm employed in the design of the project.

The preliminary drainage folder shall be submitted to the District office for transmittal to the Drainage Section before the preliminary line and grade inspection for all projects that have bridges, bridge-size culverts, and major channel changes, or those which may be of a potential controversial nature. This does not include projects where three or more alternative alignments are to be considered at the inspection.

DR-01.440 Preliminary Drainage Folder

After the necessary field surveys are completed, a preliminary drainage folder is prepared. The preliminary drainage folder is the initial document for presenting hydraulic design data supporting a recommended structure. Two copies of the preliminary folder, for consultant-designed projects, shall be sent to the appropriate District Office for review. The District shall make a cursory review of the large situations and a thorough review of the 48" and smaller drainage elements. No piecemeal or incomplete submissions are acceptable. Incomplete folders will be returned directly to the consultant. Otherwise, the District will endorse the preliminary folder cover of one of the copies and forward it to the Drainage Section.

The preliminary drainage folder, for projects designed by the State, shall be endorsed by the district reviewer and transmitted to the Drainage Section.

DR-01.450 Drainage Inspection

The Drainage Engineer responsible for a particular project shall conduct the drainage inspection. An on-site inspection shall be made of proposed structure sites for most projects. Attendence is mandatory for the designer of the project. District Office representatives also shall attend the inspection when the project is designed by a consultant. Other interested parties and governmental agencies concerned with a project will be advised by the District Office and invited to participate.

Formal drainage inspections may be conducted with other inspections, or as a separate event when deemed necessary by the Drainage Engineer. The Drainage Section also may waive the Drainage Inspection for any project after office review of the necessary submittals. This waiver would normally apply to projects that are very minor in scope where an onsite visit would provide very little additional information.

Before the drainage inspection, the project centerline and the survey base line shall be staked and/or flagged. The inlet and outlet of proposed structures shall be staked and/or flagged as to be readily identified. Excessive vegetation shall be cleared so project and structure centerline can be seen.

The Party Chief, or other personnel familiar with the field survey, shall be present for the Drainage Inspection so details of high water information, data on existing structures, etc., may be discussed. Direct communication with the field party is beneficial when additional field work is required as a result of the inspection. A person, or persons, familiar with access to the project shall be present at the inspection.

DR-01.460 Drainage Inspection Report

A drainage inspection report shall be written by the designer of a project. "Designer," in this context, means the District, Consulting Firm, or other agency responsible for the development of the plans.

When a formal drainage inspection is conducted separately from any other inspection, a separate drainage inspection report shall be prepared by the designer.

When the formal drainage inspection is held with other inspections, the drainage inspection report shall be made an addendum to the inspection's report.

Where a consultant firm or other agency is the designer, the inspection report shall be addressed to the District Engineer for Preconstruction. The inspection report shall be addressed to the Central Office Location Engineer when the project is designed at the District level.

It shall be the responsibility of the District Preconstruction Engineer and the Central Office Location Engineer to obtain the Drainage Engineer's comments and/or endorsement of the report. The drainage inspection report will be deemed as invalid without the Drainage Engineer's comments and/or endorsement.

When the drainage inspection is held with another inspection, the drainage comments shall be grouped at the end of the inspection report. This includes drainage-related comments and recommendations made by any member of the inspection team.

The drainage inspection report shall be divided into General Comments and Specific Comments.

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GENERAL COMMENTS

General Comments and recommendations are those which apply to the entire project. They are obtained from the plans in general, or are applicable to the drainage folder in general, or may arise from proposed designs that contradict guidance contained in the Drainage Manual.

SPECIFIC COMMENTS

Specific Comments are those directed at the individual drainage structures on the project. These comments and recommendations are obtained from a combination of the drainage folder and plan review. Every drainage structure on the project for which there is a Drainage Design Summary Sheet (Form TC 61-100), in the drainage folder, as well as additional structures proposed by the inspection team or those which may have been omitted from the folder, shall be listed by station, length, size, structure type, and skew. Specific comments concerning the structure or approval of the structure selection then follow. Group items, such as: storm sewers, inlet spacing, ditch analyses, and entrance pipes may be listed by the group name following all the other structures on the project. Only those items which merit comments within the group need to be listed, as discussed above. The remainder of the items within the group can be approved by using the statement: "Remainder of _____ Group is approved as presented."

Upon receipt of the endorsed drainage inspection report, the Designer shall incorporate the recommendations and/or changes into the advance situation folder and/or final folder as applicable. Unless specifically requested, further submittals other than the advance situation and final folders are not required.

A copy of the inspection report that contains the drainage report comments and recommendations, which has been reviewed and endorsed by the Drainage Engineer, shall be included in the advance situation folder and final folder with a written response by the designer to each comment indicating compliance with the recommendations. In those instances where the designer does not comply with the recommendations, the reasons shall be stated. This procedure will expedite the review of final designs.

DR-01.470 Final Joint Inspection

A final joint inspection is held before a project is let to construction. This onsite (in most instances), inspection includes representatives from all disciplines concerned with the project. This can involve officials from the Consultant; the District Office; The Central Office, and any other interested parties who wish to inspect the plans to insure the final design and plans are correct and acceptable and that the final plans reflect the intentions of the project. Where the drainage inspection report has been previously issued, and the results of the joint inspection require changes in the drainage plan, a supplemental drainage inspection report will be prepared by the designer.

DR-01.480 Advance Situation Folder

The advance situation folder is a document for the Central Office, Division of Bridges. It is required for bridges, cast-in-place box culverts, arch culverts, long span structures, and special design structures. The requirements for the contents of the advance situation folder are listed in the "Division of Bridges Guidance Manual," Chapter 66-02.

The advance situation folder should be prepared after the drainage inspection has been approved by the Drainage Engineer and the final joint inspection report has been approved by the Central Office Location Engineer. This folder shall reflect the recommendations of the drainage inspection report and/or final joint inspection report. A written statement concerning each comment from the final joint inspection report should be enclosed indicating compliance and/or non-compliance with the recommendations.

Two copies of the advance situation folder, for consultant projects, shall be submitted to the District Office. The District will review the folder for compliance with the drainage inspection report. If revisions are necessary, the District may return the folder to the consultant for modifications or request additional information for insertion into the folder. By endorsing the folder cover, the District signifies acceptance of the design as presented. The District will then forward both copies of the folder to the Division of Bridges, with a letter of transmittal.

The Advance Drainage Folders, for projects designed by the State, shall be endorsed by the district reviewer and transmitted to the Division of Bridges.

The Division of Bridges may forward a copy of this folder to the Drainage Section for review if there are questions concerning the drainage documentation.

The advance situation folder must be submitted soon after the final joint inspection, preferably within a month. If significant alterations result from the final joint inspection, a longer period will be allowed.

DR-01.490 Final Drainage Folder

The final drainage folder is the record drainage document for an entire project. It contains the final recommended structures and the data supporting their selection. A complete list of the required contents and format for the final drainage folder may be found in Chapter three. The record final folder shall contain the drainage structures for the entire project. Multiple folders are acceptable only where it is impractical to assemble all the required material in one folder. Multiple folders shall be clearly labeled "Volume 1 of 2," "Volume 2 of 2," etc.; and all volumes must be submitted in a single transmittal to the Drainage Section.

The Consultant shall submit the original final folder and copy(ies) to the District Office. The District will review the small drainage and make a cursory review of the folder for compliance of its contents. The District shall submit folders for their projects to the District Review personnel for this review. If satisfactory, the folder(s), endorsed by the District, shall be forwarded to the Drainage Section along with a letter of transmittal.

The Drainage Section will review the record final folder for accuracy and completeness. Any errors or omissions in the final folder shall be corrected by the designer. Final folders containing major or special design structures will be forwarded to the Division of Bridges and FHWA for their use. Other folders remain in the Drainage Section until after construction. Folders sent to the Division of Bridges will remain in their files until the structure is constructed. Then the folder is returned to the Drainage Section where pertinent data is extracted. Finally, the record final folder will be catalogued by the Drainage Section and stored with the State Archives for a period of 50 years.

DR-01.4100 Review of Final Plans

The Drainage Engineer performs one last review of the project drainage after the final plans are submitted to the Central Office. The plans will be reviewed to determine if the drainage aspects have been included and to check plan information against the final folder.

Ditch notes are reviewed for comparison with the folder. An example of ditch notes follow:

DITCH CONSTRUCTION NOTES

Station(s)	Location	Size-Shape	Lining Type	Quantity	D	T
20+50-22+80	Left	2'F.B.Surf	Cl. III	45 tons	2'	2'
18+00-24+00	Right	4'F.B.Surf	Sod	40 sqyd	1'	-
24+00-25+00	Right	Spl. V	-	-	-	-
24+00	Outlet	4'F.B.	Cl. III	20 tons	2'	2'
24+00	Inlet	2'F.B.	Cl. II	8 tons	1'	2'

Erosion control measures are reviewed to see if 80 % of the construction silt can be trapped before the runoff leaves the project.

Drainage structures are reviewed for the inclusion of Flood Evaluation. This Evaluation should have a note similar to this:

Q_* = _____
HW_* = _____
Q_{100} = _____
HW_{100} = _____

* Design Year Return Interval

Inlets and outlet of culverts, ditches, etc. should be reviewed to see if they are within Right-of-Way, or permanent easements.

Major channel work should be reviewed to see if the change in the Floodway is within Right-of-Way or permanent easement.

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The designer will be notified when there are major discrepancies in the plans. Undocumented and unapproved drainage alterations will delay the review process. The designer may be required to come to the Central Office and correct both the plans and the final drainage folder. The final plans may be returned to the designer only when authorized by the Director, Division of Design. The final folder may be returned to the designer for corrections, but will be considered as non-existent until the corrected folder is returned to the Drainage Section.

NOTES AND COMMENTS