Chapter 4

PLANNING AND LOCATION (Hydraulics)

ODOT ROADWAY DRAINAGE MANUAL

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Chapter 4
PLANNING AND LOCATION

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4.1 GENERAL

4.1.1 Objectives

Prior to the design phase, and where appropriate for the scope of the project, proper planning is necessary to locate facilities and adequately identify local concerns, permitting requirements, legal considerations and potential problem categories. This Chapter provides general guidelines and major considerations for evaluating drainage factors during the planning and location process. The hydraulics designer should become involved in the early stages of project development to assist in identifying the potential impacts on hydraulic structures and to become familiar with the constraints that may emerge in the design stage. This Section discusses some of the hydraulic elements that are important in the planning and location stage of project development. For additional discussion, refer to the AASHTO *Highway Drainage Guidelines* (1).

ODOT is often perceived as developers of transportation facilities that have the potential to stimulate secondary activity along the transportation corridor, just as a major residential development can stimulate commercial activity. This secondary activity is typically a local and/or regional planning function that should address, among other issues, overall stormwater management needs in conjunction with other utilities (e.g., water, wastewater, power). Because the transportation corridor may traverse several watersheds, the development of an adequate stormwater management plan can be severely fragmented resulting in significant problems if there is a lack of coordinated planning among interested parties.

4.1.2 Flood Hazards

Flood flow characteristics at a highway stream crossing should be carefully analyzed to determine their impact on the highway and to evaluate the effects of the highway on the flood flow. This evaluation can assist in identifying those locations at which construction and maintenance may be unusually expensive or hazardous. Thus, it is important to identify the flood hazards prior to any highway involvement to determine if the flood hazard may be increased, decreased or remain the same with and without the proposed highway improvement. Flood hazards should include impacts to private property both upstream and downstream (e.g., overtopping floodwaters diverted onto previously unaffected property). Although satisfactory solutions often can be obtained by making only minor changes in selected routes to take advantage of better natural hydraulic features at alternative sites, troublesome and uncertain conditions are sometimes best avoided altogether.

4.1.3 Construction Problems

Serious construction problems can arise because important drainage and water-related factors had been overlooked or neglected in the planning and location phase of the project. With proper planning, many problems can be avoided or cost-effective solutions developed to prevent extended damages. Such problems include:

- soil erosion;
- sediment deposition;
- timing of project stages;
- protection of irrigation systems and continued use during construction;
- contamination of pumping and distribution facilities;
- protection of streams, lakes and rivers;
- protection of wetlands; and
- flood proofing.

The analysis of available data, proper scheduling of work and other aspects involved in the early planning and location studies can alleviate many problems encountered in the construction of drainage facilities.

4.1.4 Maintenance Problems

Planning and location studies should consider potential erosion and sedimentation problems upon completion of highway construction. If a particular location requires frequent and expensive maintenance due to drainage, alternative locations should be considered unless the potentially high-maintenance costs can be reduced by special design. Experience in the project area is the best indicator of maintenance problems, and interviews with maintenance personnel can be extremely helpful in identifying potential drainage problems. Reference to highway maintenance and flood reports, damage surveys, newspaper articles and interviews with local residents can be helpful in evaluating potential problems.

Channel changes, minor drainage modifications and revisions in irrigation systems may require periodic maintenance. Potential damage from the erosion and degradation of stream channels and problems caused by debris can be of considerable significance from the maintenance perspective.

4.2 GENERAL CONSIDERATIONS

4.2.1 Interagency Coordination

Coordination during the project planning and location phase should produce a design that is satisfactory to all interested agencies. Substantial cost savings and other benefits frequently can be realized for highway and water resource projects through coordinated planning among the Federal, State and local agencies that are engaged in water-related activities (e.g., flood control, water resources planning). Interagency cooperation is an essential element for serving the public interests.

See Chapter 2 “Legal Aspects” for more discussion on the responsibilities of the Federal agencies.

4.2.2 Intragency Coordination

Coordination among the units within the ODOT on planning and location studies is important to minimize the duplication of effort. All parties that might be involved in future project work should be informed of any ongoing studies and study results. The coordination among the Design, Planning, Environmental, Right-of-Way and Legal Divisions is very important at this stage.

4.2.3 Legal Aspects

The legal aspects related to drainage are discussed in Chapter 2 “Legal Aspects.” Generally, the goal in highway drainage design is to perpetuate natural drainage as much as it is practical within the requirements of a highway construction project and to prevent damage that could have reasonably been avoided.

In water law matters, hydraulics designers should recognize that the State is generally held to a higher standard than a private citizen even though, in theory, the State should be granted the same rights and liabilities. In general, hydraulics designers should not address a question of law without the aid of legal counsel. When drainage problems are known to exist or can be identified, consider drainage and flood easements or other means of avoiding future litigation, especially where a problem could be caused or aggravated by the construction of a highway.

In the planning and location phase of a project, the hydraulics designer should document the history and current status of existing conditions or problems and supplement the record by photographs and descriptions of field conditions. Thoroughness is essential, because ODOT could be held responsible for flooding or erosion damage caused by conditions that existed prior to highway construction if ODOT cannot prove those pre-existing conditions with the evidence available in the documentation of the project file.

4.2.4 Environmental Review Process

The ODOT Environmental Programs Division is responsible for implementing ODOTs environmental process in coordination with the project designer and includes:

- identifying the environmental class of action; and

- performing any necessary environmental studies (e.g., wetlands impacts, archeological impacts, Section 106 impacts).

For all projects, some level of environmental analysis is required. The environmental studies should comply with all Federal, State and local laws and regulations related to environmental quality and should identify all environmental impacts of the project, both positive and negative. If the project under study requires a Federal action, then the NEPA rules relating to environmental analyses must be followed.

It is important to document the environmental findings for the proposed project in the environmental document, including any alternatives that received consideration. Encroachments onto adjacent areas (including environmental encroachments) should be avoided where practical. Identifying environmental considerations early in the planning process can prevent major implementation problems as the design and construction of the project proceeds.

4.2.5 Permits

The Federal, State and local permits that will be needed for a highway project should be identified in the environmental document early in the planning stages. Prior to initiating design work, the project designer should review the environmental document with the Environmental Programs Division, as appropriate, to identify any regulatory commitments, constraints and permits required. Permits should be obtained before construction begins. Examples include:

- stormwater discharge permits (NPDES),
- dredge and fill permits (Section 404 USACE),
- floodplain encroachment (FEMA),
- surface-water management permits (OWRB),
- county and city permits,
- navigational clearances (US Coast Guard Section 9), and
- water quality (Section 401 DEQ).

See Chapter 15 “Permits” for further information on water-related permits in Oklahoma.

4.2.6 Location Considerations

For both culverts and bridges, a primary hydraulic consideration for facility location in highway planning is the identification and evaluation of floodplain encroachments for a stream crossing. Floodplains should be identified early in the location process by consulting existing NFIP mapping. Of primary importance is the identification of regulatory floodways so that they can be avoided or accommodated.

The principal factors to be considered in locating a stream crossing that involves encroachment within a floodplain are:

- floodplain extent;
- river type (e.g., straight or meandering);
- geomorphology (e.g., geologic configuration and evolution);
- river characteristics (e.g., stable or unstable);
- river geometry and alignment;
- hydrology;
- hydraulics;
- needs of the area;
- livestock and wildlife access;
- landowner impacts;
- local concerns; and
- social, economic and environmental concerns.

For river crossings and encroachments, HDS 6 *River Engineering for Highway Encroachments — Highways in the River Environment* (2) discusses hydraulic and environmental considerations. The publication provides thirteen hypothetical examples of typical river environments and identifies possible local, upstream and downstream effects of highway encroachments. HDS 6 discusses twelve case histories of actual river crossings in the United States that illustrate the qualitative response of various types of encroachments.

Chapter 15 “Permits” discusses floodplains and the NFIP in detail.

A detailed evaluation of these factors is part of the location hydraulics study. Where a suitable crossing location has been selected, specific crossing components can then be determined. When necessary, these include:

- the geometry and length of the approaches to the crossing,
- probable type and approximate location of the abutments,
- probable number and approximate location of the piers,
- estimated depth to the footing supporting the piers (to protect against local scour),
- the location of the longitudinal encroachment in the floodplain,
- the amount of allowable longitudinal encroachment into the main channel, and
- the required river training works to ensure that river flows approach the crossing or the encroachment in a complementary way.

Exact information on these components is usually developed during the design phase.

4.3 STORMWATER QUALITY AND QUANTITY

To be truly effective, a stormwater management plan should consider the total scope of development (i.e., transportation, residential, commercial, industrial, agricultural). ODOT coordination with the responsible State and local agencies is essential to ensure that the proposed facilities are compatible with the long-term needs of the area. ODOT can provide important information to State and local agencies wishing to develop a comprehensive stormwater management plan without assuming responsibility for the planning and decision-making process for the entire watershed.

4.3.1 Quality

The planning for drainage and stormwater management facilities should include a consideration of the potential problems associated with stormwater quality. The quantification of the levels of contaminants that are being washed off a roadway is complicated by the variable effects of and the periods between storm events. The contributory factors are rainfall intensity, street surface characteristics and particle size. The varying interaction of these factors makes it difficult to precisely estimate the impact that discharge will have on water quality.

In general, erosion and sediment transport should be limited by developing and implementing an erosion and sediment control plan that addresses both temporary and permanent control practices. See Chapter 13 “Erosion and Sediment Control.”

4.3.2 Quantity

Determinations of stormwater quantity are primarily useful for evaluating and mitigating the environmental impact of a project. Without detention ponds (basins, storage areas), land development increases peak runoff rates and volumes from storm events. Appropriate hydrologic and hydraulics calculations presented in this *Manual* should be made to determine the required conveyance through the ODOT right-of-way and to aid in mitigating impacts to property owners.

Procedures contained in this *Manual* should be used to evaluate the capacity of a facility to accomplish the following controls for a specific area:

- Reduce runoff rates by increasing infiltration and by storing precipitation and runoff where it falls and releasing it slowly.
- Protect areas subject to flood damages by keeping runoff confined to drainage facilities (e.g., pipes or channels and by building appropriate flood-control facilities).
- Keep floodplain encroachment outside the limits of regulated floodways.

During the planning and location stage of a project, the hydraulics designer should consider the following when planning for stormwater runoff:

- Assess the capacity/adequacy of existing drainage systems.
- Assess the compatibility of the proposed design discharge frequencies with the adopted drainage plans and regulatory criteria.
- Assess the potential need for retention or detention storage areas if the increase in stormwater runoff cannot be handled by other project features. See Chapter 12 "Storage Facilities."
- Assess the availability of right-of-way to construct a retention or detention pond within or outside the right-of-way. Determine the availability of alternative sites for storage of stormwater. See Chapter 12 "Storage Facilities."
- Identify any unusual groundwater or soil conditions (e.g., impermeable soil layers) and locate the water table.
- Identify any jurisdictional, permitting or economic restrictions, such as MS4 Stormwater program requirements, or Total Maximum Daily Load (TMDL) limits.
- Identify any unusual site conditions (e.g., woods, wetlands).

4.4 DATA IDENTIFICATION DURING PLANNING AND LOCATION

Chapter 5 “Data Collection” provides an in-depth discussion on data collection as it pertains to all elements of drainage design and discusses the methods of data collection. This includes:

- sources of data,
- types of data needed,
- data collection,
- field reviews, and
- drainage surveys.

Refer to Chapter 5 “Data Collection” for ODOT practices on data collection.

4.5 REFERENCES

1. **AASHTO.** *Highway Drainage Guidelines, Volume 1 Hydraulic Considerations in Highway Planning and Location.* 4th Edition. Washington, DC : American Association of State Highway and Transportaiton Officials, 2005.

2. **FHWA.** *River Engineering for Highway Encroachments -- Highways in the River Environment, Hydraulic Design Series No. 6.* Washington, DC : Federal Highway Administration, U.S. Department of Transportation, 2001. FHWA-NHI-01-004.