General Information

A. Concept

This section sets forth concepts for stormwater management objectives. Development can significantly alter the hydrology within the urbanized portion of a watershed as residential and commercial construction leads to an increase in impervious surfaces in the drainage area. As a result, the response of an urbanized watershed to precipitation is significantly different from the response of a natural watershed. Post-developed peak runoff is expected to exceed pre-developed runoff from a similar storm event. The most common effects are reduced infiltration and decreased travel time, which significantly increases peak discharge rates and runoff volumes. Factors influencing the amount (volume) of runoff include precipitation depth, the infiltrative capacity of soils, soil moisture, antecedent rainfall, cover type, the amount of impervious surfaces, and surface retention. Travel time is determined primarily by slope, length of flow path, depth of flow, and roughness of flow surfaces. To accommodate the higher rates and volumes of stormwater runoff in suburban and higher-density urban development, storm sewer conveyance systems are installed to provide efficient drainage of the landscape. Additional protection is provided through detention and storage structures to control release rates to downstream systems. Traditional design considerations have been the prevention of damage to the development site, streams, drainageways, streets, public and private property from flooding, and to the reduction of soil erosion. With the implementation of the stormwater NPDES Phase I and II regulations, stormwater runoff quality is now an additional management goal for some communities.

B. Informing the Public

Engineers typically use the storm reoccurrence interval (i.e. 100 year storm) in their discussions and presentations on stormwater projects. The reoccurrence interval concept is somewhat difficult for the general public to understand. As a result, many questions have resulted from the significant rainfall and flooding events that have occurred over the past few years. These questions often focus on the 100 year storm event. A common perception is that once this level of storm has been received, it will not occur for another 100 years.

The recurrence interval concept is somewhat difficult to understand for those not trained in hydrology. To provide a greater level of understanding, public presentations should include rainfall information in terms of percentage or probability. Thus, a 100 year reoccurrence interval storm should be expressed as a storm that has a 1% chance of occurring in any one year or a 10% chance of occurring in a 10 year period (see Table 2B-2.01). Describing the storms in terms of percentages may help break down the perception that once a 100 year storm has occurred, it will not occur for another 100 years.

The public should also be informed that the storm frequency used for design is based on past storm occurrences. Inaccuracies result from the extrapolation of that data, especially if the number of data points is limited. In addition, storm events very rarely replicate themselves in terms of rainfall intensity, duration, and location within a drainage basin. As a result, calculating runoff is not an exact science. To further complicate matters, indications from researchers show that rainfall events are becoming more intense and runoff faster in rural areas as well as in urban environments. This compounds the inaccuracies associated with predicting rainfall events and their related runoff.

The public should also be made aware of the difference between a rainfall event and a flood event. This may help them to understand how a small interval rainfall event can actually trigger a large flood event. If streams and rivers are already full and the soil is saturated, the rain cannot be absorbed. The runoff increases and even though the rainfall event may have been a 25 year event, the runoff can exceed a 100 year flood. This can also occur if the storm moves down the drainage basin at the same speed that the runoff is occurring. Conversely, during a dry period a 50 year rainfall event may result in only a 10 year flood event as a result of soil absorbing more moisture and rivers and streams flowing at low levels.

Despite the shortcomings noted above, the information presented here is the best information available and is appropriate for use to design stormwater facilities.

This chapter includes the traditional hydrologic analysis and design of stormwater runoff conveyance for larger storm events to prevent flooding. The traditional management goal for detention and storage has been to manage runoff from larger rainfall events, typically greater than the 5 year recurrence interval (RI). While traditional detention practices can reduce the peak runoff flows from urban development, the increase in runoff volume and frequency of peak flows is not reduced and little improvement in stormwater quality is accomplished.

NPDES Phase I and II communities and those desiring to implement post construction water quality practices are encouraged to reference the Iowa Stormwater Management Manual (http://www.iowadnr.gov/Environmental-Protection/Water-Quality/NPDES-Storm-Water/Storm-Water-Manual), which expands on stormwater management best management practices (BMP's).

The Engineer is encouraged to use cost-effective designs that are hydrologically and hydraulically appropriate through the use of good engineering judgment.

C. Conditions

1. Design data provided by the Project Engineer should demonstrate that investigations include:

   a. The function of the streets as part of the stormwater system, including level of anticipated flooding of street surfaces and encroachment into driving lanes.

   b. Gutters and intakes are adequate to prevent excessive flooding of streets and right-of-ways.

   c. Culverts and storm pipes are designed to sufficient size.

   d. Adequate overland relief with proper easements for storms larger than the design storm.

   e. Street grades are coordinated with lot drainage; lot drainage slopes will not be less than 1 1/2% to minimize ponding, and not excessive to cause uncontrollable erosion.

   f. Spot elevations should be listed at each rear lot corner, at the mid-point of the side yard line, and along the proposed drainage ways and easements.

2. The Project Engineer should evaluate drainage alternatives to handle the runoff and select the optimum design that will strike a balance between initial capital costs, maintenance costs, and public protection. Consideration should also be given to safety, environmental protection, and maintenance of the drainage system. Care should be exercised in developing drainage systems that depend solely on a specified protection level. Designers need to keep in mind that rainfall and runoff events seldom, if ever, occur at a specified frequency or duration. Therefore, at critical locations, additional protection should be considered, depending upon the drainage basin

characteristics and the degree of protection necessary downstream.

The following are examples of locations where damage can occur at the specified design frequency and duration when emergency spillways or outlets are not made available.

- Drainage ways between buildings such as housing and in backyards.
- Enclosed storm sewers adjacent to private property, where a single inlet could be plugged, resulting in significant damage to adjacent property.
- Single-lot or multiple-lot stormwater detention.

3. In addition to the potential damage in these particular areas, maintenance of the stormwater conveyance needs to be considered. Private-owner or homeowner association maintenance has the advantage of simplified responsibilities, without direct cost to the general taxpayer. The disadvantage is when the homeowner or association is not capable of maintaining a stormwater system on a continuous basis. Other options to be considered are delayed transfer of ownership from builder to homeowner's association, to ensure proper stormwater conveyance system operation; or the issuance of a performance or maintenance bond by the builder, valid for a specified period of time. When the stormwater conveyance system is significant enough that the normal individual or group of individuals does not have the means for continuous maintenance, other maintenance alternatives need to be developed that involve Jurisdiction-owned facilities. This would involve construction and maintenance by the Jurisdiction, funded through:
   - A one-time charge to the developer that is placed into a stormwater escrow account for immediate or future stormwater improvements.
   - A stormwater utility assessment (either a one time lump sum or monthly charge).
   - Construction of the stormwater facility by the developer that would be owned and maintained by the Jurisdiction.

4. Runoff analysis should be based upon proposed land use, and should take into consideration all contributing runoff from areas outside of the study areas.

5. All undeveloped land lying outside of the study area should be considered as fully developed based upon the Jurisdiction's comprehensive plan. The project designer should check with the Jurisdiction regarding upstream conditions.

6. If future land use of a specific undeveloped area is unknown, the runoff coefficient should be established on a conservative basis. The probable future flow pattern in undeveloped areas should be based on existing natural topographic features (existing slopes, drainage ways, etc.). Average land slopes in both developed and undeveloped areas may be used in computing runoff. However, for areas in which drainage patterns and slopes are established, these should be utilized.

7. Flows and velocities that may occur at a design point when the upstream area is fully developed should be considered. Drainage facilities should be designed such that increased flows and velocities will not cause erosion damage.

8. The primary use of streets should be for the conveyance of traffic. The computed amount of runoff in streets should not exceed the requirements set forth herein.

9. The use of detention and natural drainage ways is recommended and encouraged whenever possible. The changing of natural drainage way locations may not be approved unless such change is shown to be without unreasonable hazard and liability, substantiated by thorough analysis and investigation.

10. Restrictive covenants, surface flowage easements, and impoundment easements may be required to be executed and recorded to provide for the protection and maintenance of grassed drainage

swales and grassed drainage detention areas within build-up areas.

If the Jurisdictional Engineer's approval is given to the use of natural ditches, the Project Engineer should show that the project will have minimum disruption of the existing environment and covenants may be required to be executed and recorded to provide protection. The Jurisdictional Engineer may allow changes in the ditch, provided state and federal guidelines and regulations will be followed.

11. In the design of storm drainage systems, consideration should be given to both surface and subsurface sources. Subsurface drainage systems should be designed where required. The discharge from such underdrain systems should not flow over sidewalks or onto streets after completion of the project.

12. Land grading of the project site should be performed to take advantage of existing contours and minimize soil disturbance. Steep slopes should be avoided. If steep slopes are necessary, an attempt should be made to save natural grasses, shrubs, and trees on these slopes and re-establish ground cover and permanent erosion control measures as soon as possible.

13. The planning and design of drainage systems should be such that problems are not transferred from one location to another. Outfall points and velocities should be designed in such a manner that will not create flooding hazards downstream.

14. Where a master drainage plan for a Jurisdiction is available, the flow routing for both the minor storm and major storm runoff should conform to said plan. Drainage easements conforming to the master plan will be required and should be designated on all drainage drawings and subdivision plats.

15. Any proposed building or construction of any type of structure including retaining walls, fences, etc., or the placement of any type of fill material that will encroach on any utility or drainage easement, requires written approval of the Jurisdiction. Such structure will not impair surface or subsurface drainage from surrounding areas.

16. The design for stormwater management facilities should comply with the following:

    a. Local Jurisdiction's design standards

    b. Requirements and standards of the Iowa DNR (for large detention or retention structures)

    c. Plumbing code

    d. Iowa Code regarding drainage law

    e. In case of a conflict between the above design standards, the most restrictive requirement should apply

17. Construction should comply with the most recent edition of the SUDAS Specifications. All details, materials, and storm sewer appurtenances should comply with these specifications.

18. The Environmental Protection Agency (EPA) approved the Final Stormwater Rule under the National Pollutant Discharge Elimination System (NPDES). Under this rule, qualified projects are required to have stormwater discharge permits. An erosion and sediment control plan should be developed according to the guidelines presented in Chapter 7 - Erosion and Sediment Control.

D. Unified Sizing Criteria

1. **General Information:** This section provides a brief description of the unified sizing criteria utilized as part of overall stormwater management. The unified sizing criteria are intended to be used collectively, to address overall stormwater impacts, including both stormwater quality and quantity, of site development. When used as a set, the unified criteria control the entire range of hydrologic events, from the smallest runoff producing rainfalls (≥ 0.1 inches) to the 100 year storm.

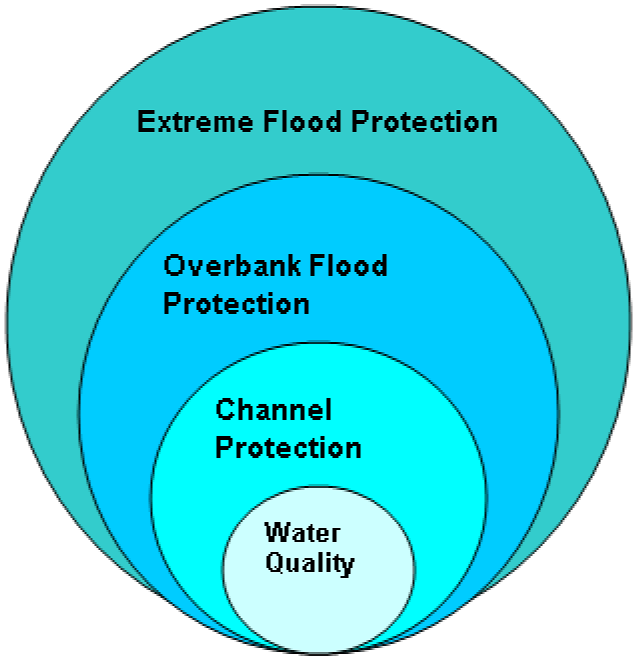
   While this manual does not address stormwater quality requirements (refer to the Iowa Stormwater Management Manual for stormwater quality design), the overall unified sizing criteria is summarized in Table 2A-1.01 and Figure 2A-1.01 below to give the designer an understanding of how each criterion fit together in the overall stormwater management approach.

Table 2A-1.01: Summary of the Recommended Unified Stormwater Sizing Criteria for Management of Stormwater Quality and Quantity

Sizing Criteria	Recommended Method
Water Quality Volume, WQv	Treat the runoff from 90% of the storms that occur in an average year. For Iowa, this equates to providing water quality treatment for the runoff resulting from a rainfall depth of 1.25 inches or less. Goal is to reduce average annual post-development total suspended solids loadings by 80%.
Recharge Volume, Rev	Fraction of WQv, depending on pre development soil hydrologic group.
Channel Protection Storage Volume, Cpv	Provide 24 hours of extended detention of the runoff from the 1 year 24 hour duration storm event to reduce bank-full flows and protect downstream channels from erosive velocities and unstable conditions.
Overbank Flood Protection, Qp	Provide peak discharge control of the 5 year storm event such that the post-development peak rate does not exceed the downstream conveyance capacity and/or cause overbank flooding in local urban watersheds. Some jurisdictions may require peak discharge control for the 2 year storm event.
Extreme Flood Protection, Qf (Major Storm)	Evaluate the effects of the 100 year storm on the stormwater management system, adjacent property, and downstream facilities and property. Manage the impacts of the extreme storm event through detention controls and/or floodplain management.

Figure 2A-1.01 illustrates the relative volume requirements of each of the unified stormwater sizing criteria, as well as demonstrates that the criteria are “nested” within one another, i.e., the extreme flood protection volume requirement also contains the overbank flood protection volume, the channel protection volume, and the water quality treatment volume.

Figure 2A-1.01: Relationship of the Unified Stormwater Sizing Criteria



Source: Adapted from Georgia Stormwater Manual, Vol. 2, 2001

As previously mentioned, this manual does not address the stormwater quality aspects of the unified sizing criteria. Additional information for the stormwater quality criteria, including overbank and extreme flood protection, is provided below.

2. **Overbank Flood Protection Volume Requirements (Qp):** The primary purpose of the overbank flood protection volume sizing criteria is to prevent an increase in the frequency and magnitude of out-of-bank flooding generated by development (e.g., flow events that exceed the bank-full capacity of the channel and therefore must spill over into the floodplain). Overbank flood protection for the 10 year storm is only required if local approval authorities have no control of floodplain development, no control over infrastructure and conveyance system capacity design, or determine that downstream flooding will occur as a result of the proposed development.

   For most regions of the state, the overbank flood control criteria equates to preventing the post-development 5 year (or 10 year), 24 hour storm peak discharge rate (Qp_5) from exceeding the pre-development peak discharge rate. In some local jurisdiction drainage systems, piped conveyance constraints may dictate the use of a 2 year pre-development peak discharge for post-development flows. In many jurisdictions, the storm sewer intake and piping capacity is sized for conveyance of the 5 year frequency runoff. For control of local flooding for areas connected to these conveyance systems, the upstream release rate must be restricted to meet the existing conveyance capacity to prevent local flooding of streets and properties. For drainage areas connected directly to open channel conveyances (swales and natural stream channels), the 10 year frequency runoff discharge is used.

3. **Extreme Flood Volume (Qf):** The intent of the extreme flood criteria is to prevent flood damage from large storm events and maintain the boundaries of the pre-development 100 year Federal Emergency Management Agency (FEMA) and/or locally designated floodplain.

This is typically done in two ways:

a. 100 Year Control: Requires storage to attenuate the post development 100 year, 24 hour peak discharge (Qf) to pre-development 100 year rates. The Qf is the most stringent and expensive level of flood control, and is generally not needed if the downstream development is located out of the 100 year floodplain. In many cases, the conveyance system leading to a stormwater structure is designed based on the discharge rate for the 10 year storm (Qp_{10}). In these situations, the conveyance systems may be the limiting hydrologic control.

b. Reserve Ultimate 100 Year Floodplain: 100 year storm control may be required by an appropriate review authority in the following cases.
- Buildings or developments are located within the ultimate 100 year floodplain
- The reviewing authority does not completely control the 100 year floodplain

Hydraulic/hydrologic investigations may be required to demonstrate that downstream roads, bridges, and public utilities are adequately protected from the Qf storm. These investigations typically extend to the first downstream tributary of equal or greater drainage area or to any downstream dam, highway, or natural point of restricted stream flow. Specific requirements for floodplain management and construction of infrastructure and/or excavation within the floodway can be found in Iowa Administrative Code 567, Chapters 70-75.

E. Floodplain Management

Although not a direct element of the municipal stormwater conveyance design, floodplain management should be considered along with the overall stormwater management plan to manage the floodplain as it relates to the various stormwater conveyance means, pipes, culverts, streams, and open channels.

Floodplain management, when integrated with the overall stormwater management program, provides a regulatory means to improve the surface water system throughout the municipality.

F. References

Georgia Stormwater Manual. Vol. 2. 2001.