CHAPTER 4

Stormwater Runoff

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STORMWATER RUNOFF

Criteria Development Reasoning

The problems associated with stormwater runoff in rapidly urbanizing watersheds have become well-known. These problems relate to both the quantity and quality of stormwater runoff. Major problems include increased flooding magnitude and frequency, accelerated stream channel erosion, and water quality degradation.

The basic underlying cause of these problems is not difficult to understand. The hydrologic systems which have reached a natural equilibrium over centuries simply cannot adjust gracefully to the sudden impact of urban development. Flooding occurs because the increased volume and peak rate of runoff exceeds the natural carrying capacity of the streams more often. Stream channel erosion accelerates due to suddenly increased flow velocities and flooding frequency. The water quality itself is degraded by sedimentation and because numerous other pollutants become available to be washed off the land surface and into the streams, rivers and lakes.

Studies have shown that most natural stream channels are formed with a bankfull capacity to pass runoff from a storm with a 1.5- to 2-year recurrence interval. As upstream development occurs, the volume and velocity of flow from these relatively frequent storms increase. Consequently, even smaller storms with less than 1-year recurrence intervals begin to cause streams to flow full or flood.

According to Leopold (76), stream channels are subject to a 3- to 5-fold increase in the frequency of bankfull flows in a typical urbanizing watershed. This increase in the flooding frequency places a stress on the channel to adjust its shape and alignment to accommodate the increased flow. Unfortunately, this adjustment takes place in a very short time period (in geologic terms), and the transition is usually not a smooth one. Meandering stream channels which were once parabolic in shape and covered with vegetation, typically become straight, wide rectangular channels with barren vertical banks. This process of channel erosion often causes significant property damage, and the resulting sediment which is generated is transported downstream, further contributing to channel degradation.

One strategy for dealing with this problem is to increase the carrying capacity and stability of affected streams through channel modifications (e.g., straightening, widening, lining with non-erodible material, etc.). This strategy may be employed most effectively on man-made channels or small, intermittent streams. Significant modifications to natural, continuous flowing steams, however, can be the subject of intense local controversy.

Wherever modification to natural flowing streams are being considered, extreme care must be taken to weigh the benefits of such modifications against the cost and the concerns of the local citizens. Where channel modifications are necessary, an attempt should be made to incorporate conservation practices which will minimize adverse impacts to fish, wildlife, and the aesthetic quality of the stream.

The following stormwater runoff requirements were developed to provide localities with maximum flexibility to deal with their stormwater runoff problems according to local needs

and priorities. The only condition which is imposed statewide is that all local stormwater runoff criteria must contain provisions for the control of off-site erosion and sedimentation.

Statewide Stormwater Runoff Standard

The Erosion and Sediment Control Regulations (Minimum Standard #19) require that properties and waterways downstream from new development sites shall be protected from erosion due to increases in the volume, velocity, and peak flow rate of stormwater runoff. (See Chapter 8 for the text of the law and regulations.) In the absence of a local stormwater management program, the following criteria shall apply:

A. Increased volumes of sheet flow that may cause erosion or sedimentation on adjacent property must be diverted to a stable outlet, adequate channel or detention facility.

B. Concentrated stormwater runoff leaving a development site must be discharged directly into an adequate natural or manmade receiving channel, pipe or storm sewer system.

An adequate channel is defined as "a watercourse that will convey a chosen frequency storm event without overtopping its banks or causing erosive damage to the bed, banks and overbank sections of the watercourse."

A receiving channel may be considered adequate if the total drainage area to the point of analysis in the channel is 100 times greater than the contributing drainage area of the project site.

For natural channels, the two-year frequency storm is used to verify that stormwater will not overtop the channel banks nor cause erosion of the channel bed or banks.

For manmade channels, the ten-year frequency storm is used to verify that stormwater will not overtop the channel banks and the two-year storm is used to demonstrate that stormwater will not cause erosion of the channel bed or banks.

For pipes and storm sewer systems, the ten-year frequency storm is used to verify that stormwater will be contained within the pipe or storm sewer.

C. If existing natural receiving channels or previously constructed manmade channels or pipes are not adequate, the applicant must choose one of the following options.

1. Improve the channels to a condition where the ten-year frequency storm will not overtop the channel banks and the two-year frequency storm will not cause erosion to the channel bed or banks. The applicant must provide evidence of permission to make the improvements.

2. Improve the pipe or storm sewer system to a condition where the ten-year frequency storm is contained within the appurtenances. The applicant must provide evidence of permission to make the improvements.

3. Develop a site design that will not cause the pre-development peak runoff rate from a two-year frequency storm to increase when runoff discharges into a natural channel or will not cause the pre-development peak runoff rate from a ten-year storm to increase when runoff discharges into a manmade channel.

4. Provide a combination of channel improvements, stormwater detention or other measures which is satisfactory to the plan-approving authority to prevent downstream erosion.

D. If the applicant chooses an option that includes stormwater detention, the applicant must obtain approval from the locality of a plan for maintenance of the detention facility. The plan must establish the maintenance requirements of the facility and identify the person responsible for performing the maintenance.

E. All hydrologic analyses must be based on the existing watershed characteristics and the ultimate development condition of the project site.

F. In applying these stormwater runoff criteria, individual lots in a residential subdivision development are not considered separate development projects. Instead, the residential subdivision development, as a whole, is considered to be a single development project. Hydrologic parameters that reflect the ultimate subdivision development must be used in all engineering calculations.

G. Proposed commercial or industrial subdivisions must apply these stormwater runoff criteria to the development as a whole. Hydrologic parameters that reflect the ultimate subdivision development must be used in all engineering calculations.

Applying the Criteria

The following commentary is intended to aid the handbook user in understanding and applying the stormwater runoff criteria in the Erosion and Sediment Control Regulations (Minimum Standard #19) for localities which have not adopted comprehensive stormwater management programs.

The basic concept of the state criteria is simple. An applicant must show that the runoff from the development project, (from a 2-year frequency storm) will not damage adjacent properties, or exceed the capacity or cause erosion of receiving streams. This must be proven by engineering calculations in the erosion and sediment control plan. The following items should be considered when determining compliance:

1. The stormwater runoff requirements apply to all land development projects which require an erosion and sediment control plan under state law. With regard to residential subdivision projects, the criteria should be applied to the entire subdivision development, not to the individual lots.

2. The stormwater runoff criteria apply primarily at points of concentrated discharge along the perimeter of the development site. However, the project must also be designed so that increased sheet runoff (e.g., runoff from newly paved areas) will not cause damage to adjacent properties. Such increased sheet flows should be diverted to an outlet where the stormwater runoff criteria can be applied.

3. The applicant must show that, wherever concentrated stormwater will be discharged from the site (e.g., pipe or channel outlets), there is an adequate channel or pipe to receive the flow and carry it into the natural drainage system.

4. Each receiving channel must be tested for adequacy. A channel is considered adequate if any of the following conditions can be met:

   a. The bankfull capacity of the natural receiving channel is sufficient to pass the post development peak flow from the 2-year frequency storm and the channel velocity (2-year frequency storm) does not exceed the permissible (non-erodible) velocity of the channel lining.

   b. The bankfull capacity of the manmade receiving channel is sufficient to pass the post development peak flow from the 10-year frequency storm and the channel velocity (2-year frequency storm) does not exceed the permissible (non-erodible velocity of the channel lining.)

      [Engineering procedures for determining channel adequacy are contained in Chapter 5.]

   c. The 10-year frequency storm is contained within the pipe or storm sewer system.

   d. The contributing drainage area of the development site is less than 1% of the total drainage area to the point of consideration in the channel.

   e. There is no increase in the peak runoff rate for the 2-year frequency storm (for natural receiving channels) or the 10-year frequency storm (for manmade receiving channels) at the point of discharge after development

5. If the receiving channel is found to be inadequate, the applicant must incorporate measures to either improve the receiving channel to an adequate

condition, or detain runoff on his site so that the post-development peak runoff rate for the 2-year storm will not exceed the pre-development peak rate. The plan-approving authority may also approve a combination of channel improvements and detention or other measures deemed satisfactory to protect the channel.

6. If a channel-improvement option is chosen, the applicant must obtain necessary easements and comply with applicable regulations regarding channel modifications. Channel improvements must extend downstream until an adequate channel section is reached or until a point is reached where the total drainage area is at least 100-times greater than the drainage area of the development site.

7. If a stormwater detention option is chosen, the applicant must submit a plan for the continued maintenance requirements of the structure and designate someone who has consented to be responsible to carry out the maintenance. The local government may choose to accept the maintenance responsibility for detention structures. However, where this is not done, the responsibility must be borne by the landowner, a homeowners association, or other legal entity. In this case, a maintenance agreement should be executed between the responsible entity and the local government.