

CHAPTER 1 – EC & Stormwater Regulations

1.1 Manual Overview

The Erosion & Sediment Control and Stormwater Management Manual was designed to help protect Dubuque County's lakes, streams, *wetlands*¹ and quality of life by reducing the negative impacts of *sediment*, rainfall, melting snow and other water *runoff*.

The Manual establishes countywide standards for the quantity and quality of water that runs off land under construction in urban and rural areas, including farms. It also provides flexibility in meeting those standards, recognizing the unique characteristics of each project and site.

Construction site erosion and uncontrolled stormwater runoff from land disturbing and land development activities have significant adverse effects upon regional water resources including the health, safety, property and general welfare of the community, diminishing the public enjoyment and use of natural resources. Effective erosion control, sediment and stormwater management depends on proper planning, design, timely installation and continued maintenance of erosion control and stormwater management practices. Specifically, soil erosion and stormwater runoff can:

- Carry sediment, nutrients, pathogens, organic matter, heavy metals, toxins and other pollutants to regional lakes, streams and wetlands;
- Diminish the capacity of water resources to support recreational and water supply uses and a natural diversity of plant and animal life;
- Clog existing storm drainage systems, increasing maintenance problems and costs;
- Cause bank and channel erosion;
- Increase downstream flooding;
- Reduce groundwater recharge, which may diminish stream base flows and lower water levels in regional lakes, ponds and wetlands;
- Contaminate drinking water supplies;
- Increase risk of property damage and personal injury, and;
- Cause damage to agricultural fields and crops.

A. Administration

The Manual sets countywide standards and gives the necessary flexibility to local governments and developers so they can administer and meet those standards effectively and efficiently.

- The Manual is administered by Dubuque County.
- The Dubuque County stormwater ordinance shall be available for adoption to any city or municipality within Dubuque County, via a 28E agreement.

B. Accepted Hydrologic Methods

The practice of urban stormwater *hydrology* is not an exact science. While the hydrologic processes are well understood, the necessary equations and boundary conditions required to solve them are often quite complex. In addition, the required data is often not available. There are a number of empirical hydrologic methods that can be used to estimate runoff characteristics for a site or drainage sub-watershed:

¹ The use of *italics* indicates the first appearance of a term whose definition appears in Section 1.4 of this chapter.

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- NRCS Urban Hydrology for Small Watersheds (TR-55, 1986)
- U.S. Geological Survey (USGS) regression equations (for stream flows only).
- Small storm hydrology methods using volumetric runoff coefficients (Rv) (Schueler, 1987 and Pitt, 1994)
- Rational Method or Modified Rational Method (for storm sewers only – not approved for detention/retention basin design)

These methods are well documented in urban stormwater hydrology design practice, and have been verified for accuracy in duplicating local hydrologic estimates for a range of design storms. Table 1-1 lists the hydrologic methods and circumstances for their use in various analysis and design applications. Table 1-2 includes some limitations on the use of several of the methods.

Table 1-1: Applications of Hydrologic Methods

Application	NRCS	USGS	Small Storm	Rational
<i>Water quality volume (WQv)</i>			X	
<i>Channel protection volume (CPv)</i>	X			
<i>Overbank flood protection (Qp)</i>	X	X		
<i>Extreme flood protection (Qf)</i>	X	X		
Storage facilities	X		X	
Outlet structures	X			
Storm sewer piping	X			X
Culverts	X	X		X
Small ditches	X			X
Open channels	X	X		X
Energy dissipation	X	X		X

Table 1-2: Limitations of Hydrologic Methods

Method	Limitations
NRCS TR-55	Can be used for watershed sizes of 0-2000 acres. Method can be used for estimating peak flows and hydrographs only for storms producing more than 0.5" of runoff. Can be used for low-impact development hydrologic analysis.
Small Storm Hydrology	Only applicable to storms with rainfall of ~1.25" or less. Produces only peak runoff, total volume, and limited hydrograph information. Results of method can only be used for small rainfall applications such as water quality or recharge.
USGS	Can be only used for watersheds having characteristics similar to the watersheds used to develop the equations (generally 2 square miles or more, and may be limited by stream slope and/or location within the Des Moines lobe landform). Only produces peak flow values for larger, more infrequent storm events than the 2-year storm, no hydrograph. Cannot be used where urbanization or channelization has affected stream characteristics.
Rational	Can be used for watershed sizes of 0-60 acres. Only produces peak flow rate, no hydrograph. Parameters used require wide latitude of subjective judgement by user. Cannot be used for detention basin design.

C. Fees

Fees are set by Dubuque County, and are as follows:

- For any site with 2 acres or more of disturbed area, the fee is \$285 plus \$100 per acre for every acre or portion of an acre over two acres.
- Any development that is considered a subdivision, or requires a plat would be charged the fee's stated above.

Fees may be modified by time to time by the County Engineer.

D. Enforcement

Dubuque County will work with municipalities for consistent enforcement of the county minimum standards.

- The Manual requires builders, developers and other site planners to submit erosion & sediment control and stormwater management plans. If a site is not in compliance with its plan as determined by inspection, a stop-work order may be issued and the administrator may levy fines.

E. Violations

A violation by any person of any provision of this Manual, including the commencing, constructing, causing, or permitting the commencement of any land disturbing activity without submittals as described herein will be subject to abatement, a stop work order, and/or a fine of \$750. The County Engineer may order compliance by written notice of violation setting forth the time within which remediation or restoration must be completed and that if the person fails to complete such remediation or restoration within such time, the County shall cause such remediation or restoration work to be done and the person shall be liable for such costs. The County Engineer may issue an order to stop all construction activities on any property where land disturbing activity is being conducted until conditions of non-compliance are corrected. Construction activity, other than that which is required to correct a condition of non-compliance, prior to the correction of the conditions of non-compliance, shall constitute a further violation.

F. National Pollutant Discharge Elimination System (NPDES)

The Clean Water Act established a set of requirements called the National Pollutant Discharge Elimination System (NPDES). The NPDES regulates stormwater discharges associated with industrial activities, municipal storm sewer systems, and construction sites. The purpose of these regulations is to reduce pollution of the nation's waterways by the implementation of *Best Management Practices (BMPs)*.

NPDES Stormwater Permit Requirements:

Phase I areas (large urban areas and major industries)

- Under permit since early 1990s
- Individual municipal permits all include a program element for new development or "post-construction" BMPs

Phase II areas (small urban areas and additional industries)

- Under Iowa Individual MS4 Permit since early 2003
- Permit includes new development requirements

New development BMP's are required under NPDES permits. The intent of incorporating BMPs in new private development and public capital projects is to prevent any net detrimental change in runoff quantity or quality resulting from new development and

redevelopment. Typical permit requirements that are now being included in all Phase I MS4 permits and are incorporated in the Phase II Iowa General Permits include:

- Specific thresholds for “priority projects” that must include both source and treatment control BMPs in the completed projects.
- A list of source control (both non-structural and structural) BMPs and treatment control BMPs to be included or considered
- Specific water quality design volume and/or water quality design flow rate for treatment control BMPs
- A requirement for flow control BMPs when there is potential for downstream erosion
- Adopt a standard model or template for identifying and documenting selected BMPs, including a plan for long-term operations and maintenance of BMPs.

Additional information regarding projects that require an NPDES permit can be obtained from the Iowa DNR’s website at <http://www.iowadnr.com/water/stormwater/index.html>

1.2 Site and Regional Planning

Good stormwater management does not begin with site disturbance and construction. Decisions about lot layout, building density, location of public rights-of-way, protection of sensitive areas, and preservation of open space all have an impact on the quality and quantity of stormwater runoff.

When using site-planning techniques to control stormwater, designers should keep local zoning, land division and building codes in mind. Many communities have adopted site design or land division criteria to serve a variety of land use goals that may or may not directly relate to stormwater runoff.

Examples include:

- Preserving neighborhood or rural character
- Protecting specific natural or scenic resources
- Promoting smooth traffic flow
- Allowing for future land division
- Ensuring adequate pedestrian, bicycle or emergency vehicle access

Usually, such goals complement or reinforce good design for stormwater control. However, in some cases, such as choosing between grid-pattern or cul-de-sac street layouts, the designer may need to strike a balance between competing land use goals. For example, in a community seeking to promote traditional neighborhood design, engineered stormwater basins may be preferable to a curvilinear street layout.

Many techniques can be employed during the site planning and design stage of development to reduce the volume of runoff, thus reducing the need for structural practices to store and treat stormwater. Design and location of stable outlets for site runoff is also important to consider at this time, to avoid causing problems for downstream neighbors. Consider implementing the following techniques (which are listed in order of priority) and manage runoff as close to the source as possible to minimize the volume of stormwater runoff.

A. Identify and Avoid Sensitive Areas

Local variations in topography, soil types, vegetation and hydrology can have a significant influence on the nature and amount of stormwater runoff. The first step in site planning for stormwater management should be identification and mapping of areas that:

- Contain features that could be adversely impacted by stormwater runoff (such as wetlands, floodplains, lakes, streams, and shallow fractured bedrock);
- In their natural state, contribute to *infiltration*, soil and water retention, *groundwater recharge* or temperature control (such as highly pervious soils, native grasslands, woodlands or hydric soils);
- Provide natural drainage ways for surface water runoff (such as *intermittent or perennial streams*, natural or artificial drainage ways); or
- Could be a source of sedimentation, channelized flow or erosion if disturbed (such as steep slopes or easily eroded soils).
- Contain cultural resources, which are protected by federal law. Cultural resources can be found at: <http://www.ia.nrcs.usda.gov/technical/culturalresources.html>

Development should be designed and construction operations planned to avoid disturbing these areas wherever possible. Federal, state or local regulations protect some natural features, such as wetlands or navigable waterways. Changes in volume and direction of stormwater flow resulting from development or other stormwater practices should be carefully designed and controlled to avoid secondary impacts to natural areas. For example, increased runoff volume can erode streambeds and banks or damage natural wetlands without careful consideration early in the planning process.

Working around sensitive areas should be incorporated as part of the preliminary design, which not only avoids these areas but also highlights them as natural amenities that add value to the development. These sensitive areas complement the functions and values provided by the countywide network of open space corridors.

B. Minimize Impervious Surfaces

Impervious surfaces are the primary source of runoff in both small and large storm events. Hence, the single most effective means of reducing runoff volume is by minimizing the site's impervious surface area.

1. Preserve and Reproduce Pre-Development Hydrologic Conditions

- *Utilize natural drainage flow paths.* Dubuque County strongly recommends the use of grass waterways, vegetated drainage channels and/or water quality swales along street right-of-ways or back lots to channel runoff without abrupt changes in the direction of flow.
- *Restore soil permeability.* Use practices such as deep tilling, chisel plowing and incorporating organic matter into the upper soil layer to restore soil infiltration capacity on heavily disturbed sites. When soil is compacted, its capacity to infiltrate water is greatly diminished. On heavily disturbed sites where practices are used to restore soil permeability, the county may waive the requirement to lower the soil permeability class rating in hydrologic calculations (see 3.2.B, Chapter 3, below).
- *Minimize directly connected impervious area.* Any impervious surface that drains into a catch basin, area drain, or other conveyance structure is a "*directly connected impervious area (DCIA)*." Impervious surfaces also increase the runoff rate (reducing the runoff time of concentration) and runoff volume, which may cause higher peak flows downstream, and increase flood and erosion potential. To minimize directly connected impervious areas, downspouts and driveways should be directed to pervious areas, where feasible. This promotes infiltration and reduces the velocity of runoff water. Other strategies for minimizing connected impervious area include

directing sheet flow through vegetated areas and locating impervious areas so they drain to vegetated buffers or other pervious areas.

- *Use bioretention and other practices to increase infiltration.* Bioretention basins are engineered practices that use natural processes, including microbial soil processes, infiltration, and evapotranspiration to improve stormwater quality. *Rain gardens*, often very attractive, are one type of practice commonly designed for residential lots to soak up rainwater from roofs, driveways, and lawns.
- *Include green infrastructures.* Developed areas may provide self-treatment of runoff via the use of green infrastructures if properly designed and drained. Green infrastructures may consist of conserved natural spaces, large landscaped areas (including parks and lawns), grass/vegetated swales, and turf block paving areas. The infiltration and bio-treatment inherent to such areas may provide the treatment control necessary. These areas therefore act as their own BMP, and no additional BMPs to treat runoff should be required.

2. Site and Lot Vegetation

- *Predevelopment vegetation.* Maintain as much predevelopment vegetation as possible. Vegetation prevents erosion and absorbs water and, therefore, reduces runoff volume.
- *Swales.* Use shallow grassed roadside swales, boulevards and sunken parking lot islands with check dams instead of curb and gutter storm drain systems to handle runoff, wherever possible.
- *Natural buffers and drainage ways.* Maintain natural buffers between development sites and water bodies. Buffers slow runoff, remove sediment and enhance infiltration. Natural depressions and channels should be maintained to slow, store, and infiltrate water.

3. Streets and Roads

- *Road length.* Minimize subdivision roadway length by using a roadway layout with the least pavement length suitable for the site's topography and other planning goals.
- *Road width.* Work within local zoning requirements and planned unit development provisions to minimize road width by narrowing road sections and/or reducing on-street parking. On-street parking may be restricted to one side of the street or eliminated altogether. Pavement and right of-way width must still meet minimum standards described in local land division and zoning ordinances, and should allow for safe vehicular travel and emergency vehicle access.
- *Design road patterns to match landforms.* In rolling terrain, for example, local streets should branch from collector streets and end in short loops or cul-de-sacs, where consistent with other local ordinances and land use goals. Some local ordinances and plans seek to create traditional grid patterns or limit the use of cul-de-sacs to address traffic, neighborhood character or other design objectives.

4. Lot Layout

- *Rooftops.* Reduce the impervious rooftop area by minimizing the building footprint of houses or utilizing green roof technology. Use vertical space rather than horizontal house layouts. Sod or vegetative "green roofs" rather than conventional roofing materials.
- *Driveways.* Where permitted under local driveway, zoning or land division ordinances, reduce impervious driveway area by using shared driveways, limiting driveway width, using pervious pavement, and using reduced building setbacks.

- *Parking lots.* For commercial sites, reduce overall impervious area by providing compact car spaces, eliminating excessive or unnecessary spaces, utilizing shared parking, minimizing stall dimensions, incorporating efficient parking lands, and using pervious materials in spillover parking areas.

C. Low-Impact Development (LID) and Conservation Subdivision Design

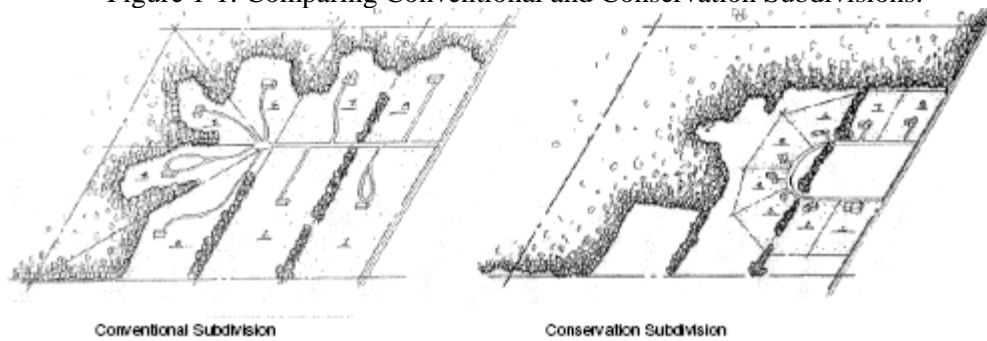
Many of the practices and techniques discussed above are commonly referred to as “low-impact design” or “conservation subdivision design”. Both low impact designs and conservation subdivisions have common goals; however, they have different strategies in obtaining that goal.

Low Impact Development is a site design strategy with a goal of maintaining predevelopment hydrologic conditions by managing runoff at the source using uniformly distributed stormwater management facilities. Instead of conveying and treating stormwater in large facilities located at the bottom of drainage areas, LID addresses stormwater through small, cost-effective landscape features located at the lot level. The low-impact analysis and design approach focuses on the following hydrologic analysis and design components:

- i. Runoff curve number (RCN): Minimizing change in post-development hydrology by reducing impervious areas and preserving more trees and meadows to reduce the storage requirements to maintain the pre-development runoff volume.
- ii. Time of concentration (Tc): Maintaining the pre-development Tc in order to minimize the increase of the peak runoff rate after development by lengthening flow paths and reducing the length of the runoff conveyance systems.
- iii. Infiltration: Manage water quality volume through infiltration.
- iv. Retention: Providing permanent pool storage for volume and peak control, as well as water quality control, to maintain the same storage volume as the pre-development condition.
- v. Detention: Providing additional storage above permanent pool levels, if required, to maintain the same peak runoff rate and/or prevent flooding for storm recurrence intervals \geq 5-10 years.

Conservation subdivision designs are characterized by common open space and clustered compact lots. The purpose of a conservation subdivision is to protect sensitive and valuable open space, habitat and other environmental resources while allowing for the maximum number of residences under current community zoning and subdivision regulations. Figure 1-1 compares a conventional subdivision layout with a subdivision incorporating conservation design practices.

Figure 1-1: Comparing Conventional and Conservation Subdivisions.



Source: Ordinance for a Conservation Subdivision, UWEX, Brian Ohm.

During plan review, LID and conservation subdivision design and other practices may need to be evaluated to ensure that the land division meets or exceeds subdivision ordinance requirements or planned-unit development (PUD) approval procedures.

D. Watershed-Wide Planning for Stormwater Management

The Dubuque County Manual, while focusing on plans and practices to meet the erosion control and stormwater needs of particular sites, encourages watershed-wide planning. Ideally, stormwater management should be conducted as part of a watershed plan.

In watershed-wide planning, communities can work together across municipal boundaries to identify potential locations for regional stormwater treatment facilities, and coordinate on-site basins and outlets to reduce the effect of combined peak discharges after storm events. They can also collectively identify areas where stormwater treatment facilities should not be located, e.g. in hydric or alluvial soils, and target areas where they are preferred, e.g. deep sandy soil. Such a collaborative approach may result in significant cost savings from economies of scale and shared responsibility.

E. Regional Stormwater Management

Using individual, onsite structural stormwater management facilities for each development is the typical approach for downstream flood control. The developer finances the design and construction of these management facilities, and is initially responsible for all operation and maintenance. A potential alternative approach is for a community to install strategically-located regional stormwater management facilities in a sub-watershed rather than require onsite management facilities. Regional stormwater management facilities are designed to manage stormwater runoff from multiple projects and/or properties through a local jurisdiction-sponsored program, where the individual properties may assist in the financing of the facility, and the requirement for onsite management facilities is either eliminated or reduced. Table 1-3 lists some advantages and disadvantages of regional facilities as compared to individual on-site facilities.

Table 1-3: Advantages and Disadvantages of Regional Stormwater Management Facilities

Advantages	Disadvantages
Reduced construction costs	Determining an effective location can be difficult
Reduced operation and maintenance costs	Initial capital costs can be high
Ability to serve as a recreational and aesthetic amenity for a community	Substantial planning, financing and permitting are required.
Ability to maximize the intent of the proposed project. (The area set aside for stormwater management facilities is minimized)	The local government may need to establish a stormwater utility or alternative program to fund and implement stormwater control.
Higher assurance of maintenance	
Mitigates existing developments with insufficient stormwater management facilities while also providing for future development	

If a community decides to implement a regional stormwater control, it must ensure that the conveyances between the individual upstream developments and the regional facility can handle the design peak flows and volumes without causing adverse impact or property damage. Full build-out conditions in the regional facility drainage area should be used in the analysis. In addition, unless the system consists of completely man-made conveyances (i.e. storm drains, pipes, concrete channels, etc.); onsite structural management facilities for water quality and downstream channel protection will be required for all developments within the facility’s drainage area.

Federal water quality provisions do not allow the degradation of water bodies from untreated stormwater discharges, and it is U.S. EPA policy to not allow regional stormwater management facilities that would degrade stream quality between the upstream development and the regional facility. Without onsite water quality and channel protection, regional management facilities do not protect smaller streams upstream from the facility from degradation and stream bank erosion. Upstream inundation from a regional facility impoundment can eliminate floodplains, wetlands, and other habitat. Further, without adequate channel protection, aquatic habitats and water quality in the channel network upstream of a regional facility may be degraded by stream bank erosion if they are not protected from bank-full flows and high velocities. Based on these concerns, both the EPA and the U.S. Army Corps of Engineers have expressed opposition to in-stream regional stormwater control facilities. In-stream facilities should be avoided if possible, and will likely be permitted on a case-by-case basis only.

1.3 Manual Applicability, Performance Standards, & Management Practices

A. Construction Site Erosion Control

1. Applicability:

Construction site erosion control plans and permits are required for any of the following:

- Land disturbance of 4,000 square feet or more.
- Land disturbance on a slope more than 6%.

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- Land disturbance involving excavation and/or filling more than 200 cubic yards of material.
- Land disturbance of more than 100 lineal feet of road ditch, grass waterway, or other area where surface drainage flows in open channels.
- New public or private roads or access drives longer than 150 feet.
- Development that requires a land division.
- Land disturbance less than 2,000 square feet that has a high risk of soil erosion or water pollution, as determined by local ordinance administration.
- Land disturbance of any size within any of the following areas:
 - Within the watershed of a cold water stream.
 - Within 300 feet of the *ordinary high-water mark* of any navigable water or 1000 feet of a lake or pond.
 - Within the 100 year *floodplain*.
 - Within 75 feet of a shoreland wetland or inland wetland.

2. Performance Standards:

- **Acceptable Soil Loss Limits:** Maximum rate of off-site sediment yield permitted from projects requiring an erosion control plan and permit is 5 tons per acre per year leaving the site as determined by the Revised Universal Soil Loss Equation 2 (RUSLE-2) Worksheet or by other methods as approved by the County Engineer.

3. Management Practices:

A comprehensive guide to managing erosion on construction sites has been developed by the Iowa Department of Natural Resources. The “Iowa Construction Site Erosion Control Manual” can be found on the Internet at

http://www.iowadnr.gov/water/stormwater/forms/construction_man.pdf

Stabilization control measures listed in this guide include grass channels, dust control, mulching, seeding and fertilizing, silt fence, sod, surface roughening, vegetative filter strip, compost blankets, compost filter tubes, rolled erosion control products (RECPs), wattles, flocculants, and turf reinforcement mats (TRMs).

Structural control measures listed in this guide include benches, compost filter berms, check dams, temporary slope drains, energy dissipaters, flotation silt curtains, rock chutes and flumes, gabions, inlet protection, jetties, level spreaders, rock outlet protection, retaining walls, stabilized construction entrances, rip-rap, sediment barriers, sediment basins, streambank protection, stream channel enhancement, subsurface drainage, and diversion structures.

The guide contains figures and tables summarizing the appropriate use of each of the measures listed, as well as providing specifications and installation guidelines for each. The use of this guide is strongly encouraged when choosing management practices for a construction site.

B. Post-Construction Stormwater Management and Water Quality Protection

1. Applicability:

Stormwater management plans and permits are required for any of the following:

- Required for new development and redevelopment site with 1-acre or more of land disturbing area.
- Development requiring a subdivision plat.

- Commercial or industrial development that requires a certified survey map.
- Any new development or redevelopment, regardless of size, with a Standard Industrial Classification (SIC) code that falls under the NPDES Industrial Stormwater Permit program or a *hotspot land use*.

2. Performance Standards:

- Post-development runoff shall be infiltrated such that a rainfall depth of 1.25 inches is recharged to the ground (*Recharge Volume, Rev*). Infiltration shall be limited to the volume infiltrated in 24 hours.
 - Exclusion: If the site is unsuitable for infiltration as determined by the County Engineer, the *applicant* may submit engineering evidence such as clay soil or karst that may suggest that the site may require alternative infiltration practices such as a treatment train.
- If the above infiltration standard cannot be met due to an exclusion permitted by the County Engineer, provide water quality treatment for the runoff resulting from a rainfall depth of 1.25 inches (*Water Quality Volume, WQv*).
- If the above infiltration standard cannot be met due to an exclusion permitted by the County Engineer, provide no increase in runoff temperature originating from sites in cold-water community watersheds using a thermal impact model approved by the Dubuque County Engineer. Affected sites are those located within the watershed of the following rivers and streams:
 1. Upper Portions of Catfish Creek
 2. Monastery Creek
 3. Hogan's Branch
 4. Point Hollow Creek (aka White Pine Hollow)
 5. Bloody Run
 6. Cloie Branch
 7. Little Maquoketa River, Middle (aka Bankston Creek) and South ForksMaps of these areas are located in Appendix D of this manual.
- If during construction the plans require a spring to be crossed or encroached upon, a stormwater conveyance system may be installed; however, the natural course of the spring must not be redirected or altered.
- Post-development peak runoff rates for 24-hour storm events must not exceed the following peak runoff rates for the same event:
 - Exclusion: Sites where 1-year post-development peak discharge is less than 2.0 cfs.
 - *Channel Protection Volume (CPv)*: Provide 24 hours of extended detention of the runoff from the 1 and 2-year, 24-hour *design storm event* to reduce bank-full flows and protect downstream channels from erosive velocities and unstable conditions. To avoid excessively small outlet restrictions, the minimum peak outflow need not be less than 0.25 cfs. Ownership for all detention basin areas (wet or dry) will be the responsibility of the homeowners association. In conjunction with ownership, any maintenance responsibilities regarding detention basin falls under the responsibility of the homeowners association.
 - *Overbank Flood Protection (Qp)*: Post-development peak runoff rates for the 2-, 10-, and 25-year, 24-hour storm event must not exceed the pre-settlement peak runoff rate for the same event. Post-development peak rates may be further restricted by available capacity of downstream drainage systems.
 - *Extreme Flood Protection (Qf)*: Post-development peak runoff rates for the 100-year, 24-hour storm event must not exceed the pre-development peak runoff rate for

the same event. Post-development peak rates may be further restricted by available capacity of downstream drainage systems.

Table 1-4: Summary of Dubuque County unified stormwater sizing criteria for management of stormwater quality and quantity

Sizing Criteria	Recommended Method
<p>Recharge Volume Rev</p>	<p>The runoff resulting from a rainfall depth of 1.25 inches or less. Equal to WQv. Goal is to recharge groundwater and maintain stream baseflow and temperature. Goal may be reduced or eliminated if site conditions warrant. $Rev = (Rv)(A)(P)/12$ Rv = site runoff volume coefficient A = site drainage area (acres) P = design rainfall depth = 1.25 inches</p>
<p>Water Quality Volume WQv</p>	<p>The runoff resulting from a rainfall depth of 1.25 inches or less. Equal to Rev. Goal is to reduce average annual post-development total suspended solids loadings by 80%. Goal is met if Rev is completely infiltrated. $WQv = (Rv)(A)(P)/12$ Rv = site runoff volume coefficient A = site drainage area (acres) P = design rainfall depth = 1.25 inches</p>
<p>Channel Protection Storage Volume Cpv</p>	<p>Provide 24 hours of extended detention of the runoff from the 1-year and 2-year 24-hr duration storm event to reduce bank-full flows and protect downstream channels from erosive velocities and unstable conditions.</p>
<p>Overbank Flood Protection Qp</p>	<p>Provide peak discharge control of the 2-, 10-, and 25-year storm events through detention controls and/or additional infiltration measures. Downstream conveyance capacity may require additional peak discharge control.</p>
<p>Extreme Flood Protection Qf</p>	<p>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.</p>

- **Intakes:** Storm sewer intake points (inlet grates, endwalls, etc.) should have a minimum capacity to convey the post-development condition 10-year peak flow rate.
- **Storm sewers:** Storm sewers should have a minimum capacity to convey the post-development condition 10-year peak flow rate. Provisions should be made for the 25- and 100-year peak flow rate when overland flow is not allowed or available. A minimum cleaning velocity of 3 fps should be used for the design storm. Storm sewer and surface water conveyance easements should be dedicated to the associated homeowners associations for each site. For those storm sewers that will handle footing drains, the following additional discharge (Q) values should be used:
 - a. For less than 50 houses, Q = 5.0 gpm (0.011 cfs) per house.
 - b. For greater than 50 houses, Q = 250 gpm (0.556 cfs) plus 2.5 gpm (0.0056 cfs) per house for each additional house over 50.
- **Culverts:** Culverts should have capacity to convey the following:
 - a. Post-development condition 25-year peak flow rate without the headwater depth exceeding the diameter of the culvert.
 - b. Post-development condition 50-year peak flow rate without the headwater depth exceeding one foot over the top of the culvert.

- c. Post-development condition 100-year peak flow rate without the headwater depth exceeding one foot below the low point of the roadway/embankment, unless there are other, more restrictive elevations.
- *Ditches:* Ditches should have capacity to convey the post-development condition 50-year peak flow rate within the ditch banks. Provisions should be made for the post-development condition 100-year peak flow rate to flow overland. Surface water flowage easements should be provided to the general public for all designed drainage ways and overland flow paths.
- *Outlet Stabilization:* Stable outlets must have the capacity to handle the designed outflow from the pond outlet or pipe conveyance structures they serve. If the outlet is to be vegetated, it should be constructed and established before installation of other stormwater or erosion control structures. Outlet stabilization shall be designed based on the expected outlet discharge from the 10-year, 24-hour storm event.
- *Open Channel Stabilization:* To prevent channels from eroding, the channel lining must be adequate to carry the design velocity and volume. Where velocities are higher than 5 ft/sec or where the channel must carry prolonged flow, the channel should be lined with riprap or other armoring material. Channel linings shall be designed based on the expected channel velocity from the 10-year, 24-hour storm event.

3. Management Practices:

A comprehensive guide to managing stormwater on post-development sites has been developed by the Iowa Department of Natural Resources. The “Iowa Stormwater Management Manual” can be found on the Internet at <http://www.ctre.iastate.edu/pubs/stormwater/index.cfm>

Rate control measures listed in this guide include dry detention basins, wet detention basins, low-impact development (LID) and DCIA minimization strategies, infiltration systems, and constructed wetlands.

Conveyance design measures listed in this guide include street flow, intake capacity, storm sewer sizing, culvert hydraulics and sizing, open channel flow design, groundwater barriers, and stormwater swale systems.

Stormwater infiltration measures listed in this guide include infiltration basins, bioretention systems, infiltration trenches, soil quality restoration, and native landscaping.

Stormwater quality measures listed in this guide include wet detention basins, stormwater swale systems, bioretention systems, constructed wetlands, and native landscaping.

The guide contains figures and tables summarizing the appropriate use of each of the measures listed, as well as providing specifications and installation guidelines for each. The use of this guide is strongly encouraged when choosing management practices for post-development stormwater.

Other guides may be used to design outlet stabilization measures. Acceptable guidelines include the Denver Urban Drainage and Flood Control District publication “Design of Low Tailwater Riprap Basins for Storm Sewer Pipe Outlets”, the FHWA publication

HEC-14, and other practices found in Iowa, Wisconsin, Nebraska, and Minnesota Department of Transportation design standards.

1.4 Submittal Requirements

***PLEASE NOTE** A DNR issued General Permit #2 will continue to be necessary prior to the beginning of any construction activity that disturbs more than one or more acres or which is part of a larger project that disturbs one or more acres in total.*

A. Construction Site Erosion Control

The submittal of an erosion control plan will require a descriptive narrative of the site, a site plan, and other supporting documents. Note that many of the items coincide with the Iowa DNR's Storm Water Pollution Prevention Plan (SWPPP) requirements.

1. Site Description including the following items:
 - a. The nature of the construction activity (e.g. roadway construction, utility construction, single family residential construction, etc.) and major soil-disturbing activities (i.e. clearing, grading, utility work, paving, home building, etc.).
 - b. An estimate of the total area of the project site and the total disturbed area.
 - c. Watershed size for each drainage area to determine how much of the area to be developed is affected by other drainage flowing through the construction site; to design culvert sizes and drainage channels' to determine the sediment produced by the site under construction.
 - d. A summary of available information describing the existing soil and soil properties (e.g. type, depth, infiltration, erodibility, etc.). A Dubuque County soils map and properties table is located in Appendix C.
 - e. Information describing the quality of the stormwater runoff currently discharged from the site (required only if data exists, it is not necessary to collect and analyze runoff).
 - f. The name of the receiving waters and ultimate receiving waters of runoff from the site. If the site drains into a municipal storm sewer system, identify the system, and indicate the receiving waters to which the system discharges.
 - g. List the anticipated sequence of major construction activities and clearly describe the order for implementation of the control measures.
 - h. Describe the temporary and permanent stabilization control measures used.
 - i. Describe the maintenance procedures required to keep the controls functioning in an effective manner. For each type of erosion or sediment control practice utilized, a description of the proper methods for maintenance must be provided. In addition, maintenance should include removal of sediment from streets, ditches, or other off-site areas.
 - j. Describe practices for preventing hazardous materials that are stored on the site from contaminating stormwater.
 - k. When there is a possibility for non-stormwater related discharges from the site, they must be identified and include a description of the measures that will be implemented to prevent these flows from becoming contaminated by hazardous materials or sediment. Allowable non-stormwater related flows include flows from sump pumps, fire hydrant and potable waterline flushing, vehicle washing,

external building washdown, pavement washwater, air conditioning condensate, springs, and footing drains, provided that they are not contaminated by detergents or spills/leaks of toxic/hazardous materials.

1. Describe a method to limit the off-site tracking of sediment by vehicles.
2. A site map (or maps) including the following items:
 - a. Limits of soil-disturbing activities – define construction boundaries to limit the disturbance to the smallest area possible. Identify areas to be preserved or left as open space, existing drainage patterns, drainage areas for each discharge location (including off-site drainage), proposed grading, *surface waters* and wetlands, and locations where stormwater is discharged to surface water.
 - b. Plan drawing of site to show the location of property lines, lot dimensions, limits of impervious area, land cover type, natural and artificial water features, 100-yr flood plain boundaries, wetland boundaries, and locations of proposed erosion controls.
 - c. A plan note stating that areas not subject to construction activity for 21 days or more must have stabilizing measures initiated within 14 days after construction activity has ceased.
 - d. A plan note stating that any waste materials from the site must be properly disposed of.
 - e. In conformance with IDNR General Permit #2 Part IV D.2.A(2)(a), for disturbed drainage areas smaller than 10 acres, a sediment basin or sediment control along the sideslope and downslope boundaries of the construction area is required. For sites with 10 acres or more of disturbed drainage areas that drain to a common location, a sediment basin providing 3600 cf of storage per acre drained is required where attainable. The storage requirement does not apply to flows from undisturbed areas or stabilized areas that have been diverted around the sediment basin. When sediment basins of the size required are not attainable, other methods of sediment control that provide an equivalent level of protection are required.
3. Other supporting materials:
 - a. Revised Universal Soil Loss Equation 2 (RUSLE-2) Worksheet or computations from other approved methods to show that 5.0 ton/Ac/yr soil loss standard is being met.
 - b. Section 161A.64 of the Code of Iowa requires that prior to performing any “land disturbing” activity (not including agricultural activities), a signed affidavit must be filed with the local Soil and Water Conservation District stating that the project will not exceed the soil loss limits stated. (Note: this requirement is not a condition of the NPDES General Permit No. 2.)
 - c. List additional state or local regulations that apply to the project.
 - d. List any applicable procedures or requirements specified on plans approved by state or local officials.
 - e. A fee will be required to cover the cost for reviewing the erosion control plans and for performing two site visits. A financial guarantee to ensure that the project will be completed may also be required.
 - f. Inspections are required every seven calendar days, and within 24 hours of the end of a 0.5 inch or greater storm. A sample inspection form must be submitted. The inspections must include the following:
 - i. Inspect disturbed areas and areas used for storage of materials for evidence of pollutants leaving the site and/or entering the storm drainage system.

- ii. Inspect erosion and sediment control measures identified in the written site description and plan to ensure they are functioning correctly.
 - iii. Inspect discharge locations to ascertain if the current control measures are effective in preventing significant impacts to the receiving waters.
 - iv. Inspect locations where vehicles enter/exit the construction site for signs of sediment tracking. All entrances and exits shall be stabilized with a tracking pad. In addition, any roads where construction tracking leaves gravel, dust or sediment, must be swept at the end of every workday.
 - v. Prepare an inspection report that lists the date, the name of the inspector, and the inspector's qualifications. The report must summarize the inspection and note any maintenance of the controls or changes to the written site description and plan that are required.
 - vi. Implement required maintenance or changes to the written site description and plan identified during the inspection within seven calendar days following the inspection.
 - vii. Inspections should be held to Iowa DNR SWPPP requirements.
 - viii. The County, at their sole discretion, may perform spot checks and inspections at any time without warning.
- g. A certification statement by responsible parties. The owner shall sign a certification statement substantially similar to that found in Iowa DNR General Permit #2 Part IV D.7.B. Additionally, the designer, contractor(s) and/or subcontractor(s) shall sign the certification statement if they are responsible for implementing, inspecting, and/or maintaining any measure in the plan. Under many circumstances, the identity of the contractor and any subcontractors implementing the pollution prevention measures may not be known at the time of plan submittal, therefore, additional space should be left on the certification form in order to add responsible parties. The contractor responsible for maintaining the measures in the plan can then complete this information, as it becomes available. Note that many owners will contractually assign all responsibility for implementing, inspecting, and/or maintaining any measure in the plan to the contractor. Under this situation, any fines levied against the owner will normally be passed along to the contractor.

B. Post-Construction Stormwater Management and Water Quality Protection

The submittal of site development project will require a descriptive narrative of the site, a site plan, and other supporting documents. They are provided as a minimum guide and are not to be construed as the specific information to be supplied on every project drainage report, and other information may be required. Pre-settlement, pre-development, and post-development conditions for any given site will require analysis unique to that area.

1. Project Report Narrative including the following items:
 - a. A cover sheet with project name and location, name of firm or agency preparing the report, Professional Engineer's signed and sealed certification, and table of contents. Number each page of the report.
 - b. The nature of the construction activity (e.g. roadway construction, utility construction, single family residential construction, etc.), an estimate of the total area of the project site, and the total anticipated impervious area.
 - c. Watershed size for each drainage area (both onsite and offsite) to determine how much of the area to be developed is affected by other drainage flowing through

- the site and to design appropriately sized storm sewer, culverts, and drainage channels.
- d. Describe pre-settlement/pre-development land use, topography, drainage patterns (including overland conveyance of the 100-year storm event), and natural and manmade features. Describe pre-development ground coverage, soil type, and physical properties, such as *hydrologic soil group* and infiltration. Pre-settlement ground coverage should be assumed as open prairie in any non-wooded area.
 - e. Describe post-developed land use and proposed grading, change in percent of impervious area, and change in drainage patterns. If an existing drainage way is filled, the runoff otherwise stored by the drainage way will be mitigated with stormwater detention, in addition to the post-development runoff.
 - f. Describe contributing off-site drainage patterns, land use, and stormwater conveyance. Identify undeveloped contributing areas with development potential and list assumptions about future development runoff contributed to the site.
 - g. Discussion of soils located on site and their suitability for infiltration. If infiltration meets the exclusion criteria, state why.
 - h. Describe the features that will be installed to control rate of runoff, pollutants in stormwater, and infiltration in the post-development condition.
 - i. Indicate what permits have been applied for and received, including but not limited to IDNR Notice of Intent, Dubuque County flood permit for sites affecting FEMA FIRM Zone A, ACOE Section 401 and/or 404 permits for work in waterways or wetlands.
 - j. Pre-settlement and pre-development runoff analysis, including:
 - Describe overall watershed area and relationship between other watersheds or sub-areas. Include a pre-settlement/pre-development watershed map in the report appendix.
 - The typical method used to predict runoff and peak discharge is the NRCS TR-55 method. Other methods may be used only with the preapproval of the County Engineer. If other methods are used, describe the method and provide documentation of correspondence with County Engineer regarding the method.
 - Describe method used to calculate the time of concentration. Describe runoff paths and travel times through sub-areas. Show and label the runoff paths on the pre-settlement/pre-development watershed map. Pre-settlement runoff paths should be assumed to match pre-development with respect to location and slope.
 - List runoff coefficients or curve numbers applied to the drainage areas. The RCNs listed in Table 1-4a shall be used in all hydrologic calculations for pre-settlement conditions required for determining Q_p limits (2-, 10-, and 25-year events). These RCNs have been selected with the intent to mimic hydrologic conditions that existed in Iowa prior to settlement and farming. The RCNs listed in Table 1-4b shall be used in all hydrologic calculations for pre-development conditions required for determining Q_f limits (100-year event). These RCNs have been selected with the intent to reflect hydrologic conditions that exist after settlement and farming. If a geotechnical study of the site was used to determine HSG, provide boring logs and locations in the appendix of the report. If a soil survey was used to determine HSG, cite it in the references.

Table 1-5a: RCNs for Projects in Dubuque County (Pre-settlement Conditions, 2-thru 25-year events)

Cover Type	Curve Numbers for Hydrologic Soil Group			
	A	B	C	D
Non-wooded Areas ¹	30	58	71	78
Wooded Areas ²	30	55	70	77

¹ RCNs are equivalent to the TR-55 listed values for meadow in good condition with the intent to mimic pre-settlement conditions. Apply to any pre-development condition area which is not wooded.

² RCNs are equivalent to the TR-55 listed values for woods in good condition.

Table 1-5b: RCNs for Projects in Dubuque County (Pre-development 100-year events and all Post-development storm events)

Cover Type	Curve Numbers for Hydrologic Soil Group			
	A	B	C	D
Continuous Cropped Agricultural Use ¹	55	69	78	82
Continuous Mature Wooded Area ²	30	55	70	77
Continuous Meadow Area ³	30	58	71	78
Lawn and Pasture Areas ⁴	39	61	74	80
Impervious Area ⁵	98	98	98	98

¹ RCNs are equivalent to mid-range TR-55 listed values for row crops and legume crops (excluding crops mown for hay) were conservation practices are used.

² RCNs are equivalent to the TR-55 listed values for woods in good condition.

³ RCNs are equivalent to the TR-55 listed values for meadow (ungrazed and unmowed) in good condition.

⁴ Areas include residential lawns, golf courses, cemeteries, grazed or mowed farm pasture, and other areas with short grass.

⁵ Areas include roofs, sidewalks, paved streets and roads (excluding right-of-way), curbs, paved parking lots and driveways.

- The typical precipitation model and rainfall duration used for the design storm is the NRCS Type II 24-hour distribution. Total 24-hour rainfall amounts for given frequency shall reflect data from Bulletin 71, “Rainfall Frequency Atlas of the Midwest” as displayed in Table 1-5 below. Other methods (such as a user-defined model based on collected precipitation data) or durations (such as a critical duration analysis) may be used only with the preapproval of the County Engineer. If other methods are used, describe the method and provide documentation of correspondence with County Engineer regarding the method.

Table 1-6: Dubuque County 24-hour Rainfall Depth for Various Storm Events

Return Period	Rainfall Depth (in)
1-yr	2.32
2-yr	2.91
5-yr	3.67
10-yr	4.31
25-yr	5.11
50-yr	5.73
100-yr	6.36

- Provide summary table(s) of model results including drainage area, time of concentration, frequency, peak discharge, and accumulative routed flows at critical points within the development (if any) and at development boundaries. At a minimum, flow rates for pre-settlement 2-, 10-, and 25-year storms and pre-development 100-year storm must be provided.
- k. Post-Development runoff analysis, including:
- Describe overall watershed area and sub-areas. Discuss if the post development drainage area differs from the pre-development drainage area. Include a post development watershed map in the report appendix.
 - The method used to predict runoff and peak discharge will be the same as used in the pre-development analysis, except for variables changed to account for the developed conditions.
 - The time of concentration method used will be the same as used in the pre-development analysis. Describe change in times of concentration due to development (i.e. change in drainage patterns). Show and label the runoff paths on the post-development watershed map.
 - List runoff coefficients or curve numbers applied to the drainage areas. The RCNs listed in Table 1-4b (above) shall be used in all hydrologic calculations for post-development conditions. Include an analysis of the proposed increase in impervious area and describe the change in runoff volume due to development. Directly connected impervious area (roads, front of houses, etc) shall be separated out from pervious area and unconnected impervious areas (backs of houses, etc) in the determination of a weighted RCN. Provide a summary of the total directly connected impervious area and the total unconnected impervious area for each sub-watershed/catchment.
 - The precipitation model storm event, total rainfall, and total storm duration will be the same as used for the pre-development model.
 - Provide summary table(s) of model results including drainage area, time of concentration, frequency, peak discharge, and accumulative routed flows at critical points within the development (if any) and at development boundaries. At a minimum, flow rates for 1-, 2-, 10-, 25-, and 100-year storms must be provided.
 - Summary of post-development runoff:
 - 1) Description of BMP including water quality practices (methodology).
 - 2) Provide table(s) including drainage area, time of concentration, frequency, duration, and peak discharge. Summarize in narrative form the change in hydrologic conditions due to the development.
 - 3) Post-developed discharge should take into account any upstream offsite detention basins and undeveloped offsite areas assumed to be developed in the future with stormwater detention.
- l. Rate control structure and conveyance system analysis, including:
- Describe any detention basin locations by discussing existing topography and relationship to basin grading. Determine if rock deposits will affect construction and if a high water table precludes basin storage. Floodplain locations should be avoided.
 - The detention basin size in final design should be based upon actual hydrograph routing for the design storms controlled by the basin. Note the

- TR-55 approximate method of sizing detention basins (TR-55 Chapter 6) may result in storage errors of 25%, and should not be used in final design.
- The top of any dike used in forming a detention basin should be a minimum of one foot above the 100-year storage elevation. Large detention basin design may require IDNR approval (See Iowa Administrative Code Title V, Chapter 70).
 - Discuss the basin outlet design in terms of performance during low and high flows and downstream impact. Note that a single-stage outlet (i.e. one culvert pipe) may not be appropriate because of its inability to detain post-developed runoff from storms less than the 10-year interval. A more desirable outlet has two or more stages (such as a riser structure with an orifice) which will serve to detain runoff for low-flow events of a 2-year storm, and pass greater storm events via the riser outlet.
 - Design the spillway for high flows using weir and/or spillway design methods. The steady-state open channel flow equation is not intended for use in spillway design.
 - Describe methods to protect the basin during overtopping flow.
 - Describe channel protection/lining and velocity dissipation at outlets.
 - Provide a summary table of the respective volumes and discharge rates for the project area after routing through rate control structures, and a comparison to the calculated allowable release rate from the site for the 2-, 10-, 25-, and 100-yr storm events.
- m. Infiltration basin analysis, including:
- Describe any basin locations by discussing existing topography and relationship to basin grading. Floodplain, high groundwater, and high bedrock locations should be avoided.
 - The available infiltration rate and resulting footprint size and depth of basin required to capture the Water Quality Volume.
- n. Wet detention (retention) basin analysis, if the site conditions do not allow for infiltration of the WQv.
- o. Extended detention basin analysis. Discuss the basin outlet design in terms of extended detention during 1- and 2-year post-development condition rainfall events. Note that a single-stage outlet (i.e. one culvert pipe) may not be appropriate because of its inability to detain post-developed runoff from storms less than the 10-year interval. A more desirable outlet has two or more stages (such as a riser structure with an orifice) which will serve to provide extended detention via the orifice and pass greater storm events via the riser outlet.
- p. Thermal impact analysis, if the site is in a thermally-sensitive watershed. If the WQv is infiltrated, it is assumed that thermal impacts are zero.
2. A site map (or maps) including the following items:
- a. A preliminary plat (with pre-and post-development topography) may be used to show the proposed development. Minimum scale of 1 inch = 500 feet or larger to ensure legibility should be used for all drainage areas. (Drawings no larger than 24 inches by 36 inches should be inserted in 8-1/2 inch by 11-inch sleeves in the back of the bound report). The plat is to show street layout and/or building location on a contour interval not to exceed 2 feet. The map must show on- and off-site conditions. Label flow patterns used to determine times of concentration. Drainage plans (preliminary plat or topography map) must extend a minimum of

- 250 feet from the edge of the proposed preliminary plat boundary, or a distance specified by Jurisdiction. The limits of swale and ditch easements should be established based upon the required design frequency. This includes 100-year overflow easements from stormwater controlled structures.
- b. Identify areas of the site located within the floodway or floodplain boundaries as delineated on flood insurance rate maps, or as determined by other engineering analysis. Identify wetland areas on the site, as delineated by the National Wetlands Inventory, or as determined by a specific wetland study.
 - c. Soil map or geotechnical information.
 - d. Location and elevations of Jurisdictional benchmarks. All elevations should be on Jurisdictional datum.
 - e. Proposed property lines (if known).
 - f. Existing drainage facilities and structures, including existing roadside ditches, drainage ways, gutter flow directions, culverts, etc. All pertinent information such as size, shape, slope location, 100-year flood elevation, and floodway fringe line (where applicable), should also be included to facilitate review and approval of drainage plans.
 - g. Proposed drainage facilities and structures, including storm sewers and open drainage ways, right-of-way and easement width requirements, 100-year overland flow easement, proposed inlets, manholes, culverts, erosion and sediment control, water quality (pollution) control, infiltration basins, energy dissipation devices, and other appurtenances.
 - h. Cross sections and profiles of road ditches, designed to carry storm flows and to ensure non-erosive velocities.
 - i. Proposed outfall point(s) for runoff from the study area.
 - j. The 100-year flood elevation and major storm floodway fringe (where applicable) are to be shown on the plans, report drawings, and plats (preliminary and final). In addition, the report should demonstrate that the stormwater system has adequate capacity to handle a 100-year storm event, or provisions are made for overland flow.
 - k. Show the critical minimum lowest opening elevation of buildings for protection from major and minor storm runoff.
3. Supporting computations. Computations may be done by hand or with computer software. If software was used, attach computer-generated reports and output and underline and label results, such as the peak discharge. Provided computations must include:
- a. Runoff coefficients and curve numbers for each sub-watershed
 - b. Total impervious area (ft² and % of total drainage area)
 - c. Times of concentration for each sub-watershed
 - d. Storm sewer design summaries
 - e. Peak runoff calculations – Show results in tabular format and pre- and post-developed hydrographs
 - f. Detention basin design – Show tabular stage-storage-discharge results and inflow/outflow hydrographs. Include both extended-detention and rate control results.
 - g. Water Quality Volume calculations
 - h. Infiltration basin design calculations
 - i. Open channel flow calculations. For ditches that drain areas over two square miles in urban areas and over ten square miles in rural areas, design may require

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the Iowa Department of Natural Resources (IDNR) approval (See Iowa Administrative Code Chapter 567.71).

- j. Culvert design calculations or nomographs. For culverts that drain areas over two square miles in urban areas and over ten square miles in rural areas, design may require the Iowa Department of Natural Resources (IDNR) approval (See Iowa Administrative Code Chapter 567.71).
- k. Erosion protection design.