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# Module 1: Stormwater Regulations

Excerpted from Chapter 15, *Stormwater Quality Management*, R. Pitt, forthcoming book

## Introduction

Significant elements of a successful stormwater management program involve regulations and associated public education. Without the support of the community, especially their financial support, stormwater management in an area is destined to failure. This module briefly describes some of the emerging public education activities that

have been shown to be successful. It also describes the history of stormwater regulations in the U.S., including local and state regulations. It also includes a description of an example local watershed protection ordinance. The costs of stormwater management are summarized, along with a popular local funding mechanism, stormwater utility districts.

For any regulations to work there will need to be an existing framework within which to place the regulations (e.g., local ordinances, zoning, planning regulations, etc.) together with dedicated resources to enforce them. Without the institutional systems to set them up and enforce them, they will not be effective. Regulations can be an important pollution prevention practice, with particular application to new developments. This should ensure that the pollution is prevented or controlled at the source, and any implementation and maintenance costs are included as part of the costs of development. Some typical regulations include:

- Land use regulations
  - – zoning ordinances
  - – subdivision regulations
  - – site plan review procedures
  - – natural resource protection
- Comprehensive stormwater control regulations
- Land acquisition

Further details on a regulatory approach are contained in *Handbook: Urban Runoff Pollution Prevention and Control Planning* (Metcalf & Eddy 1993).

## Public Education

Public education can have a significant role to play because an aroused and concerned public has the power to alter behavior at all levels. However if stormwater management plans are not adequately described and if the public opinion is not considered, the public can work against the implementation of a stormwater plan if viewed as an unnecessary extra cost and as a restriction on freedom (Field, *et al.* 1994). Gaining the public support, as with all education, is a continuous process and applies to all sectors of the public. However, Poertner (1980) identified public education as perhaps the most neglected phase of solving stormwater problems. He found that very few areas had good public information or community relations programs. Those that had them found them to be helpful in making the public aware of the needs of the community and in obtaining their support, especially when approving improvement bond ballot issues.

The residential sector is made up of everyone living in a drainage area. Long-range education goals can be tackled through school programs and short-range goals may be achieved through community groups. Advantage should be taken of working with groups looking for community improvement projects and opportunities arising from news media coverage and the associated publicity.

The commercial sector is a fairly large and often diffuse group. Both the owners/managers and their staff will need to be included in any communication activity. Methods of communication may include news announcements in the local press, mailed news items, individual contact, and follow-up contacts to answer questions and to educate new employees. Public education can benefit from failures, such as violations of regulations which result in a citation or fine, and reported in the local press. This not only informs the public about regulations, but it also provides an incentive for the regulations to be followed.

The industrial sector is a smaller group and can be educated by direct contact, education of the consultants from whom industry seeks advice, and by education of trade associations. Indirect education opportunities are provided by speaking to meetings of professional organizations and by writing in professional newsletters and journals. Industrial decision makers are a relatively small group, which, when informed or made aware of their obligations, are likely to respond.

Stormwater managers should also communicate with other public officials and governmental institutions to ensure that they are aware of the stormwater management program and its implications. Examples include: road, sanitation, and parks departments; and workers at public institutions such as hospitals and prisons.

Schumacher and Grimes (1992) gave a detailed description of the Charlotte, NC, public education program, developed as part of their stormwater management program. They recommend a similar program for other areas in order to: 1) inform the public about regulatory requirements, 2) inform the public about financing options, and 3) formally involve special interest groups in the stormwater management process. They recommend that the investment to support the public education component of a stormwater management program be about one to two percent of the annual revenues of the program. Charlotte's four part public education program included the following:

1) Define the issues. The public needs to be aware that federal and possibly state regulatory issues define much of the stormwater program requirements and therefore costs. However, many local concerns also define the specific need. The public education program needs to let the public know how the local government plans to address the specific issues and concerns, and how much it will cost. Explaining the function of a public utility, or other funding mechanism, is also important. Charlotte also conducted extensive telephone surveys to formally identify and quantify local concerns. As an example, even though stormwater pollution control was directly responsible for only about 15% of the total stormwater management costs in Charlotte, respondents surprisingly rated water quality issues much higher than drainage issues. In addition, the survey helped determine the level of funding the residents were willing to pay to support the stormwater management program. About 1/3 of the residents were willing to pay $6 per month, while more than half were willing to pay $3 per month. They therefore found a greater willingness to support the local stormwater management program than they originally thought.

2) Set objectives. The public education program was also needed to inform and educate the stakeholders and the public at large. It was also needed to seek input, and to involve them through the establishment of a citizen task force. Consensus for the stormwater management program was another important goal of the public education program, as well as monitoring the effectiveness of the public education program through follow-up surveys and other vehicles.

3) Identify resources. After the issues and objectives were established, the next step was identifying the available resources. This included public staff and the citizens task force.

4) Outline and conduct activities and tasks. The above three steps enabled this action step to proceed. The development of promotional material, conducting surveys, setting up a hot line, producing newsletters, handling the media, developing slide shows, making presentations at stakeholder meetings and neighborhood meetings, sponsoring special events, and holding public hearings were all important elements of the Charlotte public education program.

Charlotte felt that this program was extremely successful, but recommended several improvements, including having better records of complaints and better cost estimates for the public (specifically, not glossing over details, or dumbing-down information, but making the information clearer in presentations), to use the hot line to measure the program's success, and to form the citizen's task force earlier in the process.

A multi-level, multi-target public education program can help to avoid problems in implementing a stormwater management program. Further information on describing the stormwater management program to the public can be found in *Designing an Effective Communication Program: A Blueprint for Success* (Beech and Dake 1992), and *Urban Runoff Management Information/Education Products* (EPA 1993).

An example of a successful public education effort for stormwater control has been occurring in Tokyo. Local governments in Tokyo have instigated an intensive public education program to encourage stormwater infiltration on private property and to support the Experimental Sewer System (ESS) (Fujita 1993). Local governments prepare various brochures to promote understanding and cooperation. Details of stormwater projects and suggestions for personal actions are also published in local newsletters. The effects and necessity of stormwater infiltration are also often discussed on TV programs and in newspapers. These efforts have been very successful in developing an extremely large stormwater infiltration program that has substantially reduced local flooding and restored groundwater.

Illinois is relying on public education as part of its watershed program (WE&T 1996). The state is asking local stakeholder groups to be key decision makers concerning the future of their watersheds. The Illinois EPA has prepared several education booklets stressing community action. An example is a map showing the 33 watersheds in the state, explains what watersheds are, describes how they are threatened, what the state is doing to protect them, and outlines ways that citizens can be involved in the effort. Local watershed groups have been involved for many years in the state, mainly in developing plans for correcting problems and in identifying funding sources. The state will now provide technical assistance to the watershed groups so they can be more active in correcting the problems (identify and report sources of spills and dumps, collect water quality data, etc.).

Programs to enhance public education and public participation in reducing surface water pollution were required components of the NPDES stormwater management plans submitted by large and medium sized cities to the EPA. The Sewerage and Water Board of New Orleans, the New Orleans Public School System, the Lake Pontchartrain Basin Foundation, and the EPA sponsored a local award winning public education program in New Orleans (Austin, *et al.* 1996). A local art program was supplemented with lake and pumping station tours for school aged children. Much media attention and district-wide efforts went into the program to help explain the unique drainage system of New Orleans, with its below sea level elevation, its system of drainage canals and pump stations to Lake Pontchartrain.

Hennepin Parks, of the Twin Cities area of Minnesota, has been conducting studies concerning the role that household landscaping has on the phosphorus content of runoff (Barten 1996 and Mugaas 1996). They found that runoff from lawns constitute a major portion of the total phosphorus runoff load. Of the181 lawns sampled, they found that 96% had high or very high soil phosphorus levels and that almost all of these lawns (95%) receive applications of phosphorus fertilizers. They also found that phosphorus application rates on golf courses were about 80% less than on residential lawns. The unit area phosphorus discharges from the golf courses were also about 1/10 the unit area discharges from the residential areas. The residential area fertilization rates were in excess of the needs. The Minnesota Extension Service, along with other local agencies, have been conducting public education activities to create a better understanding of the potential impact that residential lawn and landscaping practices can have on the local water resources.

A new resource has recently been announced for environmental education. The National Environmental Education Standards Project at Northern Illinois University published *Environmental Education Materials: Guidelines for Excellence*, which gives guidance for developing and selecting educational materials. They will also publish a resources guide soon, containing a guide to high quality environmental educational materials. It is expected that many examples of educational material will be identified that will be extremely helpful for public education efforts of local urban watershed districts. Another important public education resource is available to stormwater managers. The *Volunteer Monitor* is available free from the editor (supported by EPA) at (415) 255-8049.

An important question concerning public education has been measuring its direct water quality benefits. There has been little debate concerning the intrinsic value of public education in stormwater management. However, there has been no quantified measure of receiving water improvements after its implementation. The Texas Natural Resources Conservation Commission and Texas Watch are conducting an EPA sponsored evaluation of public education programs in Austin (EPA 1996). A paired watershed monitoring program is being conducted in

East Bouldin Creek, one of the most polluted urban creeks in Austin (the study creek), and in nearby Blunn Creek and Harper's Branch (two control creeks). Local citizens, students, and businesses will adopt creek sections and will carry out such projects as revegetating stream banks, placing signs in the watershed, and stenciling storm drain inlets. Volunteers will monitor the three creeks over an extended period of time, including an initial calibration period before any improvements are made to East Bouldin Creek.

## Water Use Regulations

Water use laws in the United States are under the administration of the individual states and were designed to either protect water uses (in the arid Western states), or to prevent water drainage damages (in the more humid Eastern states). The drainage laws (riparian laws) are mostly concerned with the rights of upstream and downstream landowners in protecting their property from excessive runoff. In the common law, runoff water was considered a common enemy so no recourse was available to a land owner for flood damages caused by a neighbor's flood control efforts. This has been modified in most states to allow flood control easements through downstream property, or to allow reasonable use to protect your property, but not to injure the property of another.

Most of the states east of the Mississippi follow the Riparian Doctrine, which entitles adjacent land owners to the full natural flow of the stream. The stream is to be undiminished in both quality and quantity. The water use must be reasonable and can be sold as property. Water cannot be transferred between different water drainage basins however. During water shortages, all riparian owners have equal rights to reasonable use of the water and the supply is shared. Riparian Doctrine is based on the Code Napoleon and Roman Civil Law, and is not part of English Common Law (Krenkel and Novotny 1980).

The Western states have mostly adopted prior appropriation water use laws. Appropriation is made by diverting the water from the water course and applying it to a beneficial use. Early acquired water rights have the highest priority and can take their full share in times of shortages. If the water right is not used, it can be lost. Historically, beneficial uses were measured by their economic value and water quality and wildlife uses had low values. Some states require minimum flows to protect these "uneconomical" uses.

## Water Quality Regulations

Point sources of water pollution are defined in Section 502 of the 1972 Amendments to the Water Pollution Control Act as "any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged." Non-point sources are the remaining pollutant sources, not included in this definition of point sources. This point source definition appears to include almost all water discharges, but important court actions have been necessary to clarify it still further. The most important non-point sources are usually considered to be agricultural, mining, forestry and urban runoff.

Before 1948, almost all water pollution control authority was vested in the states and local governments. The legal powers of the different state agencies varied greatly. Funding of Publicly Owned Treatment Works (POTW) was especially difficult. The Public Health Service Act of 1912 authorized the investigation of pollution in navigable waters, and the Oil Pollution Act of 1924 was to prevent oil discharges into navigable waters. The Water Pollution Control Act (WPCA), PL 80-845, was passed in 1948 to establish some federal authority in abating interstate water pollution. The 1948 act suffered from the use of receiving water standards instead of effluent standards and ineffective enforcement (Hanks, Tarlock and Hanks 1974). The receiving water standards only considered the current uses of the water and were difficult to enforce against any single discharger. It was usually not possible to determine which discharger was responsible when the stream standard was exceeded. The early regulations also placed much of the burden of proof on the enforcement agencies. Most of the following water pollution control legislation has been amendments to this 1948 act. Important amendments were passed in:

- 1956 (making the legislation permanent and to fund construction grants for POTWs),
- 1961 (increased funding for water quality research and construction grants),

- 1965 (increased construction grants and started research concerning combined sewer overflows),
- 1966 (removed the dollar limit on construction grants),
- 1972 (the most important advances to this date),
- 1977 (to extend some of the deadlines established in the 1972 amendments), and
- 1988 (to require discharge permits for stormwater).

The Refuse Act of 1899 (33 USC 407) was used in 1970 to establish a discharge permit system. This act prohibited the discharge of any material, except sewage and runoff, into navigable waterways without a permit from the Dept. of the Army. This law was written during the "Progressive Conservation Era", when multiple uses of natural resources were first seriously considered. The US Supreme Court upheld the applicability of the law for pollution control in 1966. A court decision later invalidated the program in 1971, however. Because of these difficulties, the WPCA Amendments of 1972 (PL 92-500) contained a permit program, called the National Pollutant Discharge Elimination System (NPDES). The NPDES is the enforcement scheme to control effluent from point sources. The permits are required for all point sources and establish discharge limits based on the available control technology. The discharge limits were set for each industry, based on a series of studies that characterized each industry's waste effluents and existing controls. Future discharge limits were reduced as all facilities were to obtain “best available technology economically achievable” (BATEA) by July 1983. New sources were to obtain discharges representative of a “standard of performance” that was much more restrictive. Non-point sources were originally exempt from the NPDES permit program, but stormwater discharges will be included in the NPDES system under the 1988 EPA proposals (FR CFR 122, 123, 124, and 504, as published in the Federal Register of December 7, 1988).

The NPDES was to enable Congress’ goal of no pollutant discharges whatsoever by 1985. Other goals of PL 92-500 included the protection and propagation of fish, shellfish, and wildlife and recreational uses of water by July 1983, to prohibit the discharge of toxic pollutants, to continue the funding of POTWs, to develop areawide wastewater treatment management plans, to fund a major resource and demonstration effort to improve treatment technology, and to protect the rights of the States to reduce pollution and to plan their water resources uses.

The 1977 Amendments (PL 95-217) extended some of the deadlines, but no waivers were allowed for toxic pollutant discharges. Ad valorem taxes by municipalities to fund treatment projects were allowed, incentives were made for innovative technology, and increased emphasis was placed on the areawide treatment planning (Section 208) studies.

The “208” planning studies, which have been completed, recognized the need to control non-point pollution in order to meet the Congressional goals. This section was an incentive to local governments to develop their own plans, with minimal federal input. These plans were to characterize all point and non-point pollutant discharges in designated areas and to develop treatment schemes that would allow the goals to be met. The results of these plans effect the issuance of NPDES permits. Unfortunately, most of these plans were conducted in short time periods with limited technical success. Control measures were recommended with few local demonstrations of their potential success (especially for non-point pollution control). Recognizing these technical short-comings, Congress authorized the Nationwide Urban Runoff Program (NURP) to demonstrate the applicability of various urban runoff control measures in about 30 cities. These studies were completed in 1983 (EPA 1983). With these results, the 208 plans are to be revised under Section 205g. It is foolish to require expensive and possibly low cost-effective controls for point sources when non-point sources are contributing much of the waste loads to a receiving water. Much of these “non-point” discharges are originating from industrial areas (Pitt and McLean 1986) and are mostly caused by “poor housekeeping” (truck spills, dirty storage areas, inadequate refuse collection, etc.), by fugitive air pollutants which settle out over the area, and, possibly most importantly, by direct connections of certain waste streams to the storm drainage system (wash waters, etc.).

There have been various other laws affecting non-point water quality management. The most important ones include the National Environmental Policy Act of 1969 (PL 91-190) which requires environmental impact studies, and the Toxic Substances Control Act of 1965 (PL 94-469).

Several court cases have considered the question of whether urban runoff is a point source (and therefore required to have a NPDES permit under the original program) or a non-point source (and exempt from the permit process, but still subject to applicable discharge standards). Urban runoff enters receiving waters usually through a conduit, or sometimes through a ditch (open channel). The Natural Resources Defense Council (NRDC) v. Costle et al. (568 F.2D 1369, 1977) case found that uniform NPDES discharge limitations were not a necessary precondition for inclusion of agricultural, silvicultural and stormwater runoff point sources into the NPDES program. The regulations (40 CFR Section 125.4, 1975) did, however, specifically exempt separate storm sewers containing only storm runoff uncontaminated by any industrial or commercial activity. This case pointed out that the NPDES program clearly establishes that the discharge of any pollutants is unlawfull: no one has the right to pollute. The pollution continues because of technological limits, not because of any inherent rights to use the nation's waterways for the purpose of disposing of wastes. The exclusion noted above was for administrative reasons, as it was felt that requiring permits on the approximately 100,000 urban runoff point sources would reduce the ability of the EPA to administer the more important industrial and municipal point sources. A plan to use general permits to cover these discharges may be implemented by the states. The District of Columbia Court of Appeals concluded that the Congressional intent was to require permits for all point sources, but that the EPA was also to have flexibility in structuring the permits in the form of general or area permits. The Court concluded that the remedy lies with Congress if the EPA is not responsive.

Pedersen *et al*., v. Washington State Dept. of Trans. (611 P.2D 1293, 1980) stated that: "Separate storm sewers, as defined in this section, are point sources subject to the NPDES permit program. Separate storm sewers may be covered either under individual NPDES permits or under the general permit". The State of Washington, Court of Appeals, found that states are not required to implement general permit programs, so discharges could be required to have individual permits if appropriate general permits are not available.

United States of American v. Frezzo (642 F.2D 59, 1981) stated that the intent of the NPDES regulations “is to exclude from the NPDES permit program all natural runoff from agricultural land which results from precipitation events.” This case further stated: “When water pollution from irrigation ditches results from precipitation events, that pollution is non-point in nature. However, when discharges from irrigation ditches result from the controlled application of water by any person, that pollution is considered point source and subject to the program proposed herein.” Therefore, urban runoff appears to be considered as a point source, while agricultural ditches are non-point sources during rains and point sources during irrigation periods. Again, the 1988 EPA regulations require discharge permits for certain classes of urban runoff discharges.

## Early Court Cases Concerned with the Effects of Urban Runoff

There have been many court cases that have tried to identify the parties responsible for causing problems involving urban runoff. The earliest concerns of urban runoff generally involved flooding or decreased flows. When agricultural or undeveloped land is urbanized, much of the land surface is paved with impervious materials (asphalt and concrete). This increases the runoff volumes and rates during rains, and decreases the receiving water flows during dry periods. Several cases have been tried around the country concerning flooding or decreased flows due to urban development. The Orange County Water District sued the City of Riverside in 1959 (1973 C.A. 2D 137) over these issues. Other cases included one in Michigan in 1963 (371 Mich 209), one in Arizona in 1969 (449 P. 2D 616), one in New Jersey in 1973 (126 N.J. Super. 200), and one in the District of Columbia in 1982 (678 F. 2D 222). The outcomes of these trials was very site specific as the development and current land use information along with many other hydrologic factors determines the magnitude of damages that may occur.

Water quality questions concerning non-point sources have also been addressed in the courts. The effects of salts in roadway runoff was examined in Vermont (362 F. Supp. 627). Pope v. City of Atlanta (240 Ga. 177, 1977) addressed the potential of urban runoff affecting surface water supplies. The Florida Wildlife Federation *et al*., v. Goldschmidt (506 F. Supp. 350, 1981) examined the potential effects of urban runoff when an area is changed from agricultural to urban uses. The EPA is evaluating potential sources of highly toxic synthetic organic

compounds. They have identified urban runoff as one of several potential sources of more than 1,000 toxic organics that have been detected in drinking water supplies (45 FR 77870).

Urban runoff may also affect groundwater. Early studies have detected increased salt concentrations in shallow groundwaters in locations where large quantities of salts are used on roads for ice control. The Sierra Club sued Edwards Underground Water District *et al*., in 1974 (502 F. 2D 43) hoping to protect a local aquifer from the unknown effects of urban runoff. The Environmental Defense Fund et al., sued Costle *et al.*, in 1977 (439 F. Supp. 980) concerning the decreasing recharge of the Long Island aquifer due to urbanization.

## Jurisdiction Over Urban Runoff Problems

The Central Contra Costa Sanitary District in California petitioned the Contra Costa County Superior Court in 1950 (34 C. 2D 845) to determine its authority in controlling urban runoff. The public corporations were directed to construct drainage facilities across private lands as soon as possible. The City of West Lake Hills, Texas v. Westwood Legal Defense Fund (598 S.W. 2D 681) found that a city can prepare and carry out reasonable plans to control pollution resulting from discharges not traceable to a specific source (such as urban runoff). Certain public agencies can therefore be expected to control urban runoff.

Cox (1983) summarized recent water law analyses and found that much attention has been given to questions of federalism relating to implementing of water pollution regulations. Dexter and Schwarzenbart (1982) examined the development of federal common laws of nuisance, relating to water pollution discharges. They felt that Congress did not intend to preempt these common laws with the Clean Water Act. Vance (1982) expressed the need for the federal common law as a mechanism for determining liability of polluters for resulting injury. The elimination of the common law was thought to insulate polluters from liability, especially if pollution across state boundaries was of concern.

## EPA Stormwater Regulations

The EPA regulations to control stormwater runoff were first published in the Dec. 7, 1988 issue of the *Federal Register*. These regulations initiated a permit process for urban runoff, but the reporting information required and the schedules vary depending on the land use and the size of the community. The EPA was required by Section 405 of the Water Quality Act of 1987 to establish permit application requirements for large municipalities (having populations greater than 250,000) and industrial concerns (including construction operations) by February 4, 1989. Permit application requirements for municipalities having populations between 100,000 and 250,000 were to be established by February 4, 1991. The first applications (for the industries and large cities) were to be submitted by February 4, 1990. The applications for the smaller cities were to be filed by February 4, 1992. Permits are now required for smaller cities also, as part of the second phase of the NPDES stormwater permit program.

The phase one general application requirements stressed descriptive information concerning the drainage area, with minimal runoff monitoring requirements. The permit applications mostly relied on the use of simple models to predict annual discharges of pollutants and field analyses for detecting illicit connections and illegal dumping. The permit applications also required a description of any locally required stormwater and construction site runoff controls. Local municipalities were also to establish authority for managing stormwater.

### *Phase 2 Permit Requirements*

The Clean Water Act 402(p)(6) initial phase II rule (for small municipalities) was published on August 7, 1995. Its purpose was to designate additional sources of stormwater that needed to be regulated to protect water quality. It required all unregulated sources of storm water discharges to apply for NPDES permits by August, 2001. It affects millions of industrial/commercial facilities, and almost all construction activities. A Federal Advisory Committee (FACA) helped develop the Phase II rule. The committee's membership included a cross-section of interested stakeholders and they held 14 meetings from 1995 – 1998. They circulated three preliminary drafts for review and comment

When it was finalized, the Stormwater Phase II Rule superseded the August 1995 regulation. The original draft was published in Jan. 9, 1998 *Federal Register* 40 CFR Parts 122 and 123, 63 FR 1563. During the 90-day comment period, more than 550 comments were received. The EPA held public hearings at 6 locations to explain the phase II proposal and to obtain public comment. The final rule was published on December 8, 1999 in the *Federal Register*.

Two new classes of facilities were designated for automatic coverage on a nationwide basis:

1) small municipal separate storm sewer systems located in urbanized areas (about 3,500 municipalities) [phase I included medium and large municipalities]
2) construction activities that disturb less than 5 acres of land (about 110,000 sites a year) [phase I included construction sites larger than 5 acres]

A "no exposure" incentive for phase I sites was also proposed for industrial activities. This would exclude about 70,000 facilities. The NPDES permitting authority would need to issue permits (most likely general permits) by May 31, 2002. The rule would require that regulated small MS4 permit programs contain the following components:

- develop, implement, and enforce a program to reduce discharge of pollutants and protect water quality to the "maximum extent practicable"
- must include six minimum control measures:
  - public education and outreach
  - public involvement and participation
  - illicit discharge detection and elimination
  - construction site storm water runoff control
  - post-construction storm water management in new development and redevelopment
  - pollution prevention and good housekeeping for municipal operations
- must submit a notice of intent (NOI) or permit application and identify for each minimum control measure:
  - best management practices
  - measurable goals
  - timeframe for implementation
  - responsible persons
- must evaluate program and submit reports

Flexibility was intended for the phase II rule by encouraging the use of general permits, by encouraging municipalities to determine appropriate stormwater controls, by not require extensive monitoring by permittees, and by recognizing the use of existing programs, including existing structures and mechanisms for public participation.

The construction site regulations extends existing phase I regulation for construction coverage to all sites that result in the disturbance of 1 acre or more, but less than 5 acres (designated nationwide) and for all sites that result in disturbance of less than 1 acre (potential designation by permitting authority). The rule requires the use of an ordinance that controls erosion and sediment to the maximum extent practicable, controls other waste at construction sites, sets waivers by the permitting authority, and qualifies local and state programs. The phase II rule waives coverage for construction sites that have a rainfall erosivity factor (NRCS RUSLE rainfall factor "R") of less than 2 (during the period of construction) ("low rainfall"), an annual soil loss of less than 2 tons/acre/year ("low erosion potential"), or a watershed plan, or TMDL assessment, that addresses the pollutants of concern

The rule:

1) ensures control of other waste at construction sites (discarded building materials, concrete truck washout, sanitary waste, etc.)
2) implements appropriate best management practices (such as silt fences, temporary detention ponds, etc.)

3) requires pre-construction reviews of site management plans
4) receives and consider public information
5) requires regular inspections during construction
6) has penalties to ensure compliance

If local regulations incorporate the following principles and elements into its stormwater program, then it would be considered as a "qualifying" program that meets Federal requirements.

- Five Principles
  1) good site planning
  2) minimize soil movement
  3) capture sediment
  4) good housekeeping practices
  5) mitigation of post-construction stormwater discharges

- Eight Elements
  1) program description
  2) coordination mechanism
  3) requirements for nonstructural and structural BMPs
  4) priorities for site inspections
  5) education and training
  6) exemption of some activities due to limited impacts
  7) incentives, awards, and streamlining mechanisms
  8) description of staff and resources

The timeframes for implementation of the new municipal and construction permits are 2 to 3 years for permit issuance and NOIs within 90 days of permit issuance.

### *Summary of the Total Maximum Daily Load (TMDL) Program*

Another important emerging regulation affecting drainage and stormwater quality is the TMDL program. The following is summarized from the report of the Federal Advisory Committee on the TMDL Program, published on July 1998.

The TMDL program is aimed specifically at assuring attainment of water quality standards by requiring the establishment of pollutant loading targets and allocations for waters identified as not now in attainment with those standards. Section 303(d)(1) of the Clean Water Act provides that states, with EPA review and approval, must identify waters not meeting standards, and must establish total maximum daily loads (TMDLs) for them to restore water quality. If the states do not complete these actions, EPA must do so.

The Clean Water Act has produced significant and widespread improvements in water quality over the last quarter-century. Knowledge and understanding of water quality problems and the tools to address those problems have advanced in that time as well, but many waters still do not meet State water quality standards, and TMDLs have not been established for most of those waters.

The final National Water Quality Inventory Report to Congress for 1996 indicated that of the 19% of the nation's rivers and streams that have been evaluated, 35% do not fully support water quality standards, or uses, and 8% are considered threatened. Of the 72% of estuary waters evaluated, 38% are not fully supporting uses/standards and 4% are threatened. Of the 40% of lakes, ponds and reservoirs evaluated (not including the Great Lakes), 39% are not fully supporting uses/standards and 10% are threatened.

Under section 303(d)(1), states are required to identify and establish a priority ranking for waters not meeting water quality standards, taking into account the severity of the pollution and the uses to be made of the waters. The EPA is required to review each state's list of impaired waters. Once the list is established, the states are to

develop a TMDL for each listed water. The EPA is also required to review each TMDL (within 30 days of submittal by the State). If the EPA does not approve the list of impaired waters or the state's TMDL plan, it is required to establish acceptable lists and plans. A water may be in nonattainment for some parameters, but not for others. Generally, the TMDL program uses a parameter specific approach. However, the use of a broad, watershed approach, considering all water quality problems and their related causes and solution, is to be preferred and encouraged.

In general, a TMDL is a quantitative assessment of water quality problems, contributing sources, and pollution reductions needed to attain water quality standards. The TMDL specifies the amount of pollution or other stressor that needs to be reduced to meet water quality standards, allocates pollution control, or management responsibilities among sources in a watershed, and provides a scientific and policy basis for taking actions needed to restore a waterbody.

In 1991, the EPA published guidance explaining the role of TMDLs in watershed protection. In 1992, the EPA amended its regulations to describe in greater detail requirements for states to submit lists of waters needing TMDLs. Among other things, the revised regulations required states to submit lists every two years and to target waters for which TMDLs would be developed during the next two years. Over the past few years, the EPA has continued to publish several additional guidance and policy documents relating to section 303(d)(1) lists and TMDL development.

Beginning in 1986, and escalating since 1996, environmental public interest organizations have filed numerous lawsuits under the Clean Water Act's citizen suit provision (section 505) alleging that the EPA had failed to carry out its mandatory duty to disapprove inadequate state section 303(d)(1) lists and/or TMDLs, or to carry out state program responsibilities where states have failed to do so.

By mid 1998, all states had EPA-approved 1996 section 303(d)(1) lists, but the content and scope of these lists varied greatly. Development of TMDLs has been initiated at an increasing pace in some states, but most TMDLs remain to be completed. Many of the waters still needing TMDLs are impaired by contributions from both point and nonpoint sources. The EPA has undertaken a variety of steps to strengthen the TMDL program.

The following are Internet links to various descriptions of the national TMDL program, and to selected southeastern state programs (including 303d listed streams):

**General Information for the TMDL Program**
http://www.epa.gov/owow/tmdl/index.html
http://www.tmdls.net/

EPA Region 4 Stormwater Permit Information
http://www.epa.gov/region4/water/permits/stormwater.html

General EPA TMDL Information and National 303(d) Listings
http://www.epa.gov/owow/tmdl/states.html

Model Sediment TMDL Assessment Protocol (Limno-Tech)
http://www.nahb.org/fileUpload_details.aspx?contentID=33072

Sediment TMDL Protocol (EPA)
http://www.stormwaterauthority.org/assets/sediment.pdf

Pathogen TMDL Protocol (EPA)
http://www.stormwaterauthority.org/assets/pathogen_all.pdf

**Selected Southeastern State Programs**

**Alabama**

General Alabama TMDL program description and links:
http://www.adem.state.al.us/WaterDivision/WQuality/TMDL/WQTMDLInfo.htm

EPA fact sheet for AL 303(d) listed streams:
http://oaspub.epa.gov/waters/state_rept.control?p_state=AL

Storm Water Management Authority, Jefferson County
http://www.swma.com/

**Mississippi**

Mississippi TMDL reports and 303(d) listed streams:

http://www.deq.state.ms.us/MDEQ.nsf/pdf/TWB_2002_303dList/$File/MS2002303dListEV.pdf?OpenElement

MS TMDL program
http://www.deq.state.ms.us/MDEQ.nsf/page/TWB_Total_Maximum_Daily_Load_Section?OpenDocument

**Georgia**

Georgia TMDL program and reports (scroll down to Water Quality – Watershed Information, and below)
http://www.dnr.state.ga.us/dnr/environ/gaenviron_files/gaenviro.htm

**Tennessee**

EPA fact sheet for TN 303(d) listed streams:
http://oaspub.epa.gov/waters/state_rept.control?p_state=TN

TN Stormwater Permit program
http://www.state.tn.us/environment/permits/conststrm.php

**Florida**

EPA fact sheet for FL 303(d) listed streams:
http://oaspub.epa.gov/waters/state_rept.control?p_state=FL

Status of FL TMDL program
http://www.stormwaterauthority.org/assets/153TShelley.PDF

FL Stormwater Permit program
http://www.dep.state.fl.us/water/stormwater/npdes/MS4_1.htm

## *Summary of Stormwater Regulations*

Water use regulations have been in place in many nations for hundreds of years. These regulations are generally concerned with protection against flooding, and/or sharing water during periods of scarcity. Water quality regulations were first instigated to permit or protect basic beneficial uses of receiving waters, initially restricted to navigation and waste assimilation. In recent decades, protection has been extended to include a broader range of environmental and recreational-based uses.

Early regulations affecting stormwater were based on drainage goals, although some progressive communities did include stormwater quality objectives in local regulations affecting stormwater discharges. The Clean Water Act NPDES program was modified in the late 1980s to specifically include non-point sources of water pollutants. The phase I and phase II stormwater discharge permit programs have now affected most communities in the nation. Another important emerging issue affecting stormwater (and traditional discharges) is the TMDL program affecting all listed impaired waters. These impaired waters must now have a watershed-based allocation and treatment plan to ensure compliance with water quality standards.

## Construction Site Runoff Problems

- Water quality impairment results from sediment discharged, plus associated pollutants (>70% of P and N in the nations streams from eroded sediment)
- Siltation is second largest cause of impaired water quality in the nations rivers and lakes
- Large amounts of sediment reduce stream flow capacity and destroy important aquatic life habitat
- Effects from construction erosion runoff extends well downstream of construction sites
- Erosion rates from construction sites can be 10X erosion rates from row crops and 100X erosion rates from forests or pastures
- Typical construction site erosion yields are 10 to 150 tons/acre/year

### *Site Specific Factors Affecting Construction Site Erosion in Birmingham Area*

- Rainfall Energy (Alabama has highest in the nation)
- Soil Erodibility (northern part of state has fine grained, highly erosive soils)
- Site Topography (northeastern part of state has steep hills under development)
- Surface Cover (usually totally removed during initial site grading)

### *Alabama Rainfall Energy*

- Rain energy directly related to rainfall intensity
- Rainfall erosion index varies from 250 to 550+ for Alabama (most of state about 350) – highest in the U.S.
- Months having greatest erosion potential are February and March, while September through November have the lowest erosion potential

### *Factors Affecting Controllability of Construction Site Runoff*

- Runoff characteristics (flow volume and rate): high because of about 50 to 65 in/yr rainfall and intense storms
- Sediment quantity and particle size (from 70 construction site runoff samples from Birmingham area):
  - Measured suspended solids concentrations at Birmingham area construction sites ranged from 100 to more than 25,000 mg/L (overall median about 4,000 mg/L).
  - Turbidity ranged from about 300 to >50,000 NTU, with an average of about 4,000 NTU
  - Particle sizes: 90% were smaller than about 20 μm (0.02 mm) in diameter and median size was about 5 μm (0.005 mm).
  - Local construction site erosion discharges are about 100 tons/acre/year

**Monitored Local Birmingham Construction Site Runoff Quality**

| | Low intensity rains (<0.25 in/hr) | Moderate intensity rains (about 0.25 in/hr) | High intensity rains (>1 in/hr) |
|---|---|---|---|
| Suspended solids, mg/L | 400 | 2,000 | 25,000 |
| Particle size (median), μm | 3.5 | 5 | 8.5 |

Difficult to effectively use design standards from elsewhere due to high flow energies, high SS concentration concentrations, and very small particle sizes.

### *Actual Field Performance of Most Construction Site Erosion Controls has been Disappointedly Low*

• Excellent filter fence installations (well maintained and well constructed) provide about 50% control, maximum. Typical monitored performance has shown negligible benefits due to installation and maintenance problems.
• Rock berms in channels are more robust, but still less than about 25% suspended solids control.
• Sediment ponds can be designed to provide good control (>50%) of suspended solids, but they would have to be very large (about 2% of drainage area) to provide significant removal of fine sediment. Effluent turbidity is still typically high.

### *Prevention is the Best and Typically Least Expensive Solution*

1) divert flows around exposed soils
2) schedule site activities to minimize amount of exposed soil
3) use temporary mulch
4) use erosion control blankets in sensitive areas (concentrated flow channels, steep slopes)

## Local and State Controls of Urban Runoff

Many states and cities throughout the United States have regulations that require developers to construct runoff control facilities. Many of these regulations are initially used to only regulate runoff flow rates or to reduce construction erosion losses. Some state court cases have resulted in runoff controls being required as part of the environmental impact statement process (such as Maryland v. U.S. Postal Service, 487 F. 2D 1029, 1973 and Veterans Administration Hospital in Tennessee 48 FR 11551, 1983). In the opinion of Parsippany v. Costle (503 F. Supp. 314, 1979), it was recommended that municipalities within the drainage basin adopt regulations that stipulate the use of detention and sedimentation basins.

Many state and local agencies throughout the country are currently using construction site erosion and stormwater control ordinances for newly developing areas, as shown on Tables Erosion-1 through Stormwater-12. These tables are derived from a report prepared by the Watershed Management Institute (1997) for the EPA. The Institute compiled a wealth of information derived from an extensive survey they sent to numerous state and local stormwater management agencies throughout the U.S. These tables attempt to list some of the main features of these programs, covering both erosion and stormwater control.

**Table Erosion 1. Erosion and Sediment Control Exemptions and Waivers**

| Jurisdiction | Exemptions and Waivers |
|---|---|
| City of Alexandria, VA | <2,500 s.f. |
| City of Austin, TX | Agriculture; state facilities, projects disturbing < 1,000 s.f. |
| City of Bellevue, WA | None |
| City of Fort Collins, CO | Single family homes |
| City of Olympia, WA | Agriculture; forestry; public & private projects in right-of-way that add no impervious surface, grading projects that don't require grading permit |
| City of Orlando, FL | Single family homes not part of subdivision |
| City of Seattle, WA | Agriculture, forestry, WA DOT projects that comply with Puget Sound Highway Runoff Program, projects discharged directly to receiving water or piped storm drain (under certain conditions), < 750 s.f. new impervious surface or < 2,000 s.f. total impervious surface |
| District of Columbia | Agriculture, forestry, projects that disturb < 500 s.f. or total cost < $2,500. |
| City of Winter Park, FL | None |
| Baltimore County, MD | Agriculture, activities disturbing < 5,000 s.f. |
| Clark County, WA | Agriculture, forestry, projects disturbing < 2,000 s.f. |
| King County, WA | Agriculture; single family homes exempt from detailed ES control plan |
| Kitsap County, WA | Agriculture (Kitsap SWCD stormwater related activities funded by county stormwater program |
| Maricopa County, AZ | N/A because state NPDES program exempts projects disturbing < 5 acres |
| Montgomery County, MD | Agriculture, projects disturbing < 5,000 s.f. |

| | |
|---|---|
| Prince George's County, MD | Agriculture |
| Snohomish County, WA | Agriculture |
| Somerset County, NJ | See New Jersey State Soil Conservation Committee Program Summary. |
| Washington County, OR | None |
| Urban Drainage and Flood Control District (Denver) | State NPDES permit exempts activities disturbing < 5 acres; other requirements depend on regulations of 10 local government programs |
| Northeastern Illinois Planning Commission | Agriculture, forestry, activities disturbing < 5,000 s.f., activities disturbing < 500 s.f. if next to water |
| South Florida Water Management District | Agriculture using closed water management systems |
| Southwest Florida Water Management District | Agriculture (with site specific Conservation Plan with appropriate BMPs); forestry (complying with "Florida Silviculture BMP Manual"); single family homes not in subdivision |
| Suwannee River Water Management District | Agriculture (with site specific Conservation Plan with appropriate BMPs); forestry (complying with "Florida Silviculture BMP Manual"); single family homes not in subdivision |
| State of Delaware | Agriculture |
| Florida Department of Environmental Protection | Agriculture (if using approved Conservation Plan with appropriate BMPs); forestry (complying with "Florida Silviculture BMP Manual"); single family homes not in subdivision |
| Maryland Department of the Environment | Agriculture; activities disturbing < 5,000 s.f. or 100 cu. yds. |
| State of New Jersey | Agriculture, forestry, single family homes not part of larger development, activities disturbing < 5,000 s.f. |
| State of North Carolina | Construction sties < 5 acres and not located; within ½ mile of a water classified as a High Quality Water, in a coastal county and draining to a saltwater or other classified water, and located in a non-coastal county and draining to or within one mile of a water classified as a High Quality Water or an Outstanding Resource Water. |
| State of Pennsylvania | Timber harvesting disturbing < 25 acres; agricultural plowing & tilling pursuant to conservation plan; activities disturbing < 5 acres |
| State of South Carolina | Agriculture, forestry, single family homes not part of large development, utility operations with certificate of environmental compatibility |
| State of Virginia | Agriculture; forestry; activities disturbing < 10,000 s.f.; mining & gas exploration activities |
| Washington State Department of Ecology | Agriculture, forestry operation (except for forest conversions); activities disturbing < 1 acre; single family homes |

**Table Erosion 2. Erosion and Sediment Control Preferred Practices**

| Jurisdiction | Preferred Practices |
|---|---|
| City of Alexandria, VA | Sediment basins & traps designed to capture 15 cu. yds/acre drainage area. |
| City of Austin, TX | Sediment basins & traps designed to capture 1,800 cu. yds/acre drainage area. |
| City of Bellevue, WA | Sediment basins & traps to contain runoff volume from: 10 yr storm for sites < 5 ac., or > 0.25 mi from waters; 20 yr storm for sites > 5 ac. or < 0.25 mi from waters |
| City of Fort Collins, CO | Sediment basins & traps designed for 100 cu. yds/acre |
| City of Olympia, WA | Sediment basins & traps to hold 2-yr (24 hr) storm volume. |
| City of Orlando, FL | Sediment basins & traps to capture 2.33 yr (6 hr) storm. |
| City of Seattle, WA | Sediment traps to retain runoff volume from 2 yr (24 hr) storm. Basins sized to settle medium silt soil particles (0.02 mm) during peak discharge from 10 yr (24 hr) storm. |
| District of Columbia | Sediment basins & traps to capture 1,800 cu. ft./acre drainage area. |
| City of Winter Park, FL | Sediment basins & traps to capture 67 cu. yds./acre drainage area. |
| Baltimore County, MD | Sediment basins & traps to contain 1,800 cu. yds runoff from drainage area. |
| Clark County, WA | Sediment traps to hold 2 yr (24 hr) storm runoff; basins to treat 10 yr (24 hr) storm. |
| King County, WA | Sediment traps to treat 2 yr (24 hr) storm runoff; basins sized for 10 yr (24 hr) storm. |
| Kitsap County, WA | Sediment traps & basins to treat runoff from 2 yr (24 hr) storm. |
| Maricopa County, AZ | None |
| Montgomery County, MD | Sediment basins & traps to capture 1,800 cu. ft/acre drainage area (to be changed to 3,600 cu. ft./ac.) |

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|---|---|
| Prince George's County, MD | Sediment basins & traps to capture 1,800 cu. ft/acre drainage area (to be changed to 3,600 cu. ft./ac.) |
| Snohomish County, WA | Sediment basins & traps to capture runoff from 10 yr (24 hr) storm |
| Somerset County, NJ | See New Jersey State Soil Conservation Committee Program Summary. |
| Washington County, OR | Sediment basins & traps to capture runoff from 10 yr (24 hr) storm (RARELY USED) |
| Urban Drainage and Flood Control District (Denver) | Sediment basins & traps to retain 0.25 in of runoff from site. |
| Northeastern Illinois Planning Commission | Sediment basins & traps to capture runoff from 10 yr storm |
| South Florida Water Management District | None |
| Southwest Florida Water Management District | Sediment basins & traps to capture 67 cu. yds./acre drainage area |
| Suwannee River Water Management District | Sediment basins & traps to capture 67 cu. yds./acre |
| State of Delaware | Sediment traps & basins to retain 3,600 cu. ft./acre of contributing drainage area. |
| Florida Department of Environmental Protection | Sediment basins & traps to capture 67 cu. yds./acre |
| Maryland Department of the Environment | Sediment basins & traps to treat 1 in of runoff from disturbed area |
| State of New Jersey | Sediment basins & traps to retain 1 inch of runoff from disturbed area |
| State of North Carolina | Preventive Measures (nonstructural controls) |
| State of Pennsylvania | Sediment basins to treat 7,000 cfs/acre; sediment traps to treat 2,000 cfs/acre (max. 5 acres) |
| State of South Carolina | Sediment basins & traps to achieve 80% removal of average annual total suspended solids loading |
| State of Virginia | Sediment basins to capture 134 cu. yds/acre |
| Washington State Department of Ecology | Sediment basins & traps to detain 10 yr (24 hr) developed condition design storm |

**Table Erosion 3. Erosion and Sediment Control Allowed Practices**

| Jurisdiction | Allowed Practices |
|---|---|
| City of Alexandria, VA | Silt fences, gravel const. entrance, slope protection, temp. & perm. veg. stabilization |
| City of Austin, TX | Construction sequencing, rock berms, filter dikes, diversion swales, temporary & permanent vegetation stabilization |
| City of Bellevue, WA | Seasonal limits on disturbed area, silt fence, gravel construction entrance, wheel washes; slope protection; temporary & permanent vegetation stabilization |
| City of Fort Collins, CO | Straw bales, surface roughening, diversions, gravel filters, filter fence, inlet barriers, terraces, temporary & permanent vegetation stabilization |
| City of Olympia, WA | Seasonal limits on disturbed area, silt fence, straw bales, gravel construction entrance, slope protection, inlet prot., temp. & permanent vegetation stabilization |
| City of Orlando, FL | Silt fences, gravel construction entrance, inlet protection, temporary & permanent vegetation stabilization, limited exposed areas |
| City of Seattle, WA | Silt fences, gravel construction entrance, wheel wash, slope protection, inlet protection, temporary & permanent vegetation stabilization |
| District of Columbia | Silt fences, vehicle wash area, straw bales, stabilized construction entrance, inlet protection, temporary & permanent vegetation stabilization |
| City of Winter Park, FL | Silt fences, straw bales, inlet & slope protection, temp. & perm. veg. stabilization. |
| Baltimore County, MD | Silt fences, straw bales, inlet & slope protection, temp. & perm. veg. stabilization. |
| Clark County, WA | Seasonal limits on disturbed area, stabilized construction entrance, wheel wash, slope drain, straw bales, silt fence, mulching, temp. & perm. vegetation stabilization. |
| King County, WA | Seasonal limits on disturbed area, mulching, silt fences, gravel construction entrance, slope drains, temporary & permanent vegetation cover. |
| Kitsap County, WA | Seasonal limits on land disturbance, gravel construction entrance, wheel wash, silt fences, straw bales, slope drains, mulching, temp. & perm. vegetative stabilization |
| Maricopa County, AZ | None |
| Montgomery County, MD | Mulching, sodding, staged clearing, silt fences, gravel construction entrances, temporary & permanent vegetation |
| Prince George's County, MD | Mulching, sodding, staged clearing, silt fences, gravel construction entrances, temporary & permanent vegetation |

| | |
|---|---|
| Snohomish County, WA | Mulching, seasonal limitation on disturbed area, silt fences, gravel construction entrance, slope drains, temporary & permanent vegetative stabilization |
| Somerset County, NJ | See New Jersey State Soil Conservation Committee Program Summary. |
| Washington County, OR | Silt fences, gravel construction entrances, diversions, bio-bags, straw, compost, temporary & permanent vegetation cover |
| Urban Drainage and Flood Control District (Denver) | Mulching, silt fences, temporary & permanent vegetation cover |
| Northeastern Illinois Planning Commission | Temporary & permanent vegetative cover; mulching; seeding; sodding; erosion blankets; silt fences; gravel construction entrances; outlet stabilization |
| South Florida Water Management District | None listed. |
| Southwest Florida Water Management District | Mulching; sodding, staged clearing, silt fences, gravel construction entrance, temporary & permanent vegetative cover |
| Suwannee River Water Management District | Mulching, sodding, staged clearing, silt fences, gravel construction entrances, temporary & permanent vegetation |
| State of Delaware | Silt fences, straw bales, gravel construction entrances, diversions, slope drains, temporary & permanent vegetation stabilization |
| Florida Department of Environmental Protection | Mulching, sodding, staged clearing, silt fences, gravel construction entrances, temporary & permanent vegetation |
| Maryland Department of the Environment | Mulching, sodding, staged clearing, silt fences, gravel construction entrances, temporary & permanent vegetation |
| State of New Jersey | Mulching, sodding, staged clearing, silt fences, gravel construction entrances, temporary & permanent vegetation |
| State of North Carolina | Preventative measures, detention and retention ponds and infiltration devices such as infiltration basins, trenches or underground trenches and dry wells |
| State of Pennsylvania | Silt fences, temp. & perm. vegetation, diversions, rock filters, riprap, inlet protection |
| State of South Carolina | Mulching, sodding, staged clearing, silt fences, gravel construction entrances, temporary & permanent vegetation |
| State of Virginia | Sediment traps, silt fences, temp. & perm. veg., diversions, daily street cleaning |
| Washington State Department of Ecology | Seasonal disturbed area limits, staged clearing, silt fences, gravel construction entrance, mulching, sodding, temporary & permanent vegetative cover, slope drains |

**Table Erosion 4. Erosion and Sediment Control Design Criteria Publications**

| Jurisdiction | Design Criteria Publications |
|---|---|
| City of Alexandria, VA | Virginia Erosion and Sediment Control Handbook. |
| City of Austin, TX | City's Environmental Criteria Manual |
| City of Bellevue, WA | Bellevue Development Standards, Chapter 2 and Construction and Water Quality (King County Conservation District) |
| City of Fort Collins, CO | Fort Collins Storm Drainage Design Criteria and Construction Standards |
| City of Olympia, WA | Olympia Drainage Design and Erosion Control Manual; Stormwater Management Manual for the Puget Sound Basin, Volume II |
| City of Orlando, FL | Orlando Urban Stormwater Management Manual, Florida Development Manual: A Guide to Sound Land & Water Management |
| City of Seattle, WA | City of Seattle Pollution Control Guidelines for Construction Sites: Appendix A, Erosion and Sedimentation Control BMPs |
| District of Columbia | District of Columbia Erosion and Sediment Control Handbook |
| City of Winter Park, FL | Florida Development Manual: A Guide to Sound Land and Water Management |
| Baltimore County, MD | Maryland Standards and Specifications Handbook |
| Clark County, WA | Stormwater Management Manual for the Puget Sound Basin, Volume 2 |
| King County, WA | Stormwater Management Manual for the Puget Sound Basin |
| Kitsap County, WA | Stormwater Management Manual for the Puget Sound Basin (Chapter II) |
| Maricopa County, AZ | None |
| Montgomery County, MD | Maryland Standards and Specifications Handbook |
| Prince George's County, MD | Maryland Standards and Specifications Handbook |
| Snohomish County, WA | Snohomish County Stormwater Management Manual (based on criteria in Puget Sound manual) |
| Somerset County, NJ | See New Jersey State Soil Conservation Committee Program Summary. |
| Washington County, OR | Erosion Control Plans Technical Guidance Handbook |
| Urban Drainage and Flood Control District (Denver) | Urban Storm Drainage Criteria Manual, Volume 3 - BMPs |
| Northeastern Illinois Planning Commission | Best Management Practices for Northeastern Illinois, NIPC |

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|---|---|
| South Florida Water Management District | Florida Development Manual: A Guide to Sound Land and Water Management (Chapter 6) |
| Southwest Florida Water Management District | Florida Development Manual: A Guide to Sound Land and Water Management (Chapter 6) |
| Suwannee River Water Management District | Florida Development Manual: A Guide to Sound Land and Water Management (Chapter 6) |
| State of Delaware | Delaware Erosion and Sediment Control Handbook |
| Florida Department of Environmental Protection | Florida Development Manual: A Guide to Sound Land and Water Management (Chapter 6) |
| Maryland Department of the Environment | Maryland Erosion and Sediment Standards and Specifications Manual |
| State of New Jersey | Standards for Soil Erosion and Sediment Control in New Jersey |
| State of North Carolina | State of North Carolina: Stormwater Management Guidance Manual and Stormwater Management Site Planning |
| State of Pennsylvania | Discharge rate for temporary basins = 1.6 cfs/acre (2 yr storm); for permanent basins, discharge rate = 2.75 cfs/acre (25 yr storm); |
| State of South Carolina | A Guide to Site Development and Best Management Practices for Stormwater Management and Sediment Control; South Carolina Stormwater Management and Sediment Control Hand Book for Land Disturbing Activities |
| State of Virginia | Virginia Erosion and Sediment Control Handbook; Erosion and Sediment Control Field Manual |
| Washington State Department of Ecology | Stormwater Management Manual for Puget Sound Basin |

**Table Stormwater 1. Stormwater Management Program Exemptions and Waivers**

| Jurisdiction | Exemptions and Waivers |
|---|---|
| City of Alexandria, VA | <2,500 s.f. |
| City of Austin, TX | Agriculture, state facilities, single family homes platted lots, & subdivisions (min. lot size > 5 acres) |
| City of Bellevue, WA | Agriculture, forestry, single family homes not part of plat |
| City of Fort Collins, CO | Agriculture, forestry not covered in ordinance |
| City of Olympia, WA | Agriculture, forestry, single family homes, other minor projects |
| City of Orlando, FL | Single family homes not part of subdivision |
| City of Seattle, WA | Agriculture, forestry (except when converting to other uses), WA DOT projects that comply with Puget Sound Highway Runoff Program, projects discharged directly to receiving water or piped storm drain (under certain conditions), < 750 s.f. new impervious surface or < 2,000 s.f. total impervious surface |
| District of Columbia | Agriculture, forestry, single family homes (lot size > 2 acre), projects disturbing < 5,000 s.f. |
| City of Winter Park, FL | Single family homes not part of subdivision |
| Baltimore County, MD | Agriculture, forestry, residential < 2 acre lot size AND disturb < 5,000 s.f. |
| Clark County, WA | Agriculture, forestry, projects < 2,000 s.f. impervious, industrial/commercial projects < 1,000 s.f. new impervious surface |
| King County, WA | Projects < 5,000 s.f. impervious surface; projects w/ discharge < 0.5 cfs; single family homes not part of plat |
| Kitsap County, WA | Agriculture (volun. use of BMPs endorsed by local SWCD); forestry (ES controls during & after harvest); single family homes < 5,000 s.f. impervious (exempt (rate control), must have ES control); roof runoff infiltration recommended (may be req'd) |
| Maricopa County, AZ | Agriculture, mining, single family homes not part of plat |
| Montgomery County, MD | Agriculture, forestry, single family homes w/ lots < 2 acres |
| Prince George's County, MD | Agriculture, forestry |
| Snohomish County, WA | Agriculture; projects < 5,000 s.f. impervious; projects which collect stormwater from more than 5,000 sq. ft. drainage area |
| Somerset County, NJ | Agriculture, forestry, developments not contributing to downstream impacts |
| Washington County, OR | Agriculture, forestry, single family homes not part of plat |
| Urban Drainage and Flood Control District (Denver) | N/A - local governments may have permitting programs |

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|---|---|
| Northeastern Illinois Planning Commission | Agriculture, forestry |
| South Florida Water Management District | Agriculture using closed water management systems |
| Southwest Florida Water Management District | Agriculture (w/ site specific Conservation Plan - appro. BMPs); forestry (complying with "Florida Silviculture BMP Manual"); single family homes not in subdivision |
| Suwannee River Water Management District | Agriculture (with site specific Conservation Plan with appropriate BMPs); forestry (comply w/ "Florida Silviculture BMP Manual"); single family homes not in subdivision |
| State of Delaware | Agriculture (if using Farm Conservation Plan prepared by local Soil and Water Conservation District); forestry; single family homes; projects disturbing < 5,000 s.f. |
| Florida Department of Environmental Protection | Agriculture (with site specific Conservation Plan with appropriate BMPs); forestry (comply w/ "Florida Silviculture BMP Manual"); single family homes not in subdivision |
| Maryland Department of the Environment | Agriculture, single family homes (min. lot size > 2 acres); developments which discharge to tidewaters, served by storm drain system, or cause < 10% increase in peak discharge rate (2 yr storm) |
| State of New Jersey | Agriculture; forestry, single family homes not part of larger development; developments which are minor subdivision (< 2 lots) or disturb < 100 s.f. |

Continued

**Table Stormwater 1. Stormwater Management Program Exemptions and Waivers (Cont.)**

| Jurisdiction | Exemptions and Waivers |
|---|---|
| State of North Carolina | Construction sties < 5 acres and not located; within ½ mile of a water classified as a High Quality Water, in a coastal county and draining to a saltwater or other classified water, and located in a non-coastal county and draining to or within one mile of a water classified as a High Quality Water or an Outstanding Resource Water. |
| State of Pennsylvania | Agriculture; forestry; developments which have specified amount of impervious area (depending on watershed) |
| State of South Carolina | Agriculture, forestry, single family homes not part of large development, utility operations with certificate of environmental compatibility |
| State of Virginia | Single family homes not part of larger development; agriculture; forestry; projects disturbing < 1 acre; mining & oil gas operations elsewhere permitted |
| Washington State Department of Ecology | Agriculture, forestry (except for forest conversions); activities disturbing < 1 acre; single family homes |

**Table Stormwater 2. Stormwater Management Program Preferred Practices**

| Jurisdiction | Preferred Practices |
|---|---|
| City of Alexandria, VA | NONE, but developers use non-land intensive practices |
| City of Austin, TX | Sedimentation/filtration basins (stormwater quality); dry detention systems (flood control); wet detention, retention/irrigation, filter strips. |
| City of Bellevue, WA | NONE, but require site specific stormwater plan using appropriate BMPs (wet detention, swales, filters, catch basin inserts, oil-water separators, coalescing plate separators. NO INFILTRATION (slow perc soils w/ easy clogging). |
| City of Fort Collins, CO | NONE |
| City of Olympia, WA | Treatment hierarchy: constructed wetlands for > 12 ac impervious; wet ponds & sand filters for < 12 ac impervious; biofiltration for < 12 ac impervious; wet detention vaults for < 2 ac impervious |
| City of Orlando, FL | Off-line retention, filtration, dry and wet detention |
| City of Seattle, WA | NONE |
| District of Columbia | Infiltration preferred, but sand filtration often used (less land req'd). Wet & dry detention, swales, dry wells, rooftop detention, underground detention |
| City of Winter Park, FL | Retention |
| Baltimore County, MD | Infiltration preferred AND required when percolation rate > 0.17 in/hr. Extended dry detention, wet detention, sand filters |

| | |
|---|---|
| Clark County, WA | Infiltration basins or trenches preferred (req'd in A and B soils); biofiltration swales, wet detention ponds, filter strips, constructed wetlands, sand filters. |
| King County, WA | Source controls including forest retention & erosion control; treatment including grass swales, wet detention ponds, filter strips, wet vaults |
| Kitsap County, WA | Wet detention & biofilt.; infiltration, ext. dry detention, const. wetlands, sand filtration |
| Maricopa County, AZ | Infiltration practices since retention required for all new development |
| Montgomery County, MD | Infiltration (when feasible) & sand filters, in combination with dry detention, for discharges to thermally sensitive waters; wet detention/wetland ponds or extended detention in combination with other practices |
| Prince George's County, MD | Infiltration, extended dry or wet detention, bioretention, grit & oil separators |
| Snohomish County, WA | Infiltration where appropriate; filtration; biofiltration; wet detention |
| Somerset County, NJ | Dry detention basins; vegetated swales; wet detention ponds; constructed wetlands; infiltration NOT ALLOWED |
| Washington County, OR | None specified; swales, extended dry detention, wetland ponds favored; infiltration NOT ALLOWED |
| Urban Drainage and Flood Control District (Denver) | Extended detention basins & retention ponds; modular porous pavement; wetland basins & channels |
| Northeastern Illinois Planning Commission | Extended detention basins; swales, infiltration, vegetative buffers (esp. when combined with detention) |
| South Florida Water Management District | Retention, exfiltration trenches, grass swales, wet detention ponds |
| Southwest Florida Water Management District | Retention, exfiltration trenches, pervious pavement, grass swales, wet detention, detention with filtration, wetland systems; "BMP Treatment Train" encouraged |
| Suwannee River Water Management District | Retention, exfiltration trenches, pervious pavement, grass swales, wet detention, detention with filtration, wetland systems; "BMP Treatment Train" encouraged |

Continued

**Table Stormwater 2. Stormwater Management Program Preferred Practices (Continued)**

| Jurisdiction | Preferred Practices |
|---|---|
| State of Delaware | Wet detention ponds & constructed wetlands; extended dry detention & sand filter; infiltration (least preferred) |
| Florida Department of Environmental Protection | Retention, exfiltration trenches, pervious pavement, grass swales, wet detention, detention with filtration, wetland systems; "BMP Treatment Train" encouraged |
| Maryland Department of the Environment | Infiltration, swales, retention, detention (preferred order) |
| State of New Jersey | Extended detention; wet ponds; permanent pools; infilt. basins; vegetative filters |
| State of North Carolina | Preventive Measures (nonstructural controls) |
| State of Pennsylvania | None |
| State of South Carolina | Wet detention, dry detention, infiltration |
| State of Virginia | None, but regulations have design criteria for detention, retention & infiltration |
| Washington State Department of Ecology | Infiltration preferred; pervious & modular pavement; grass swales; vegetated filters; extended dry detention; wet detention ponds; constructed wetlands; sand filters |

**Table Stormwater 3. Stormwater Management Program Currently Used Practices**

| Jurisdiction | Infiltration Basin | Infiltration Trench | Filter | Wet Detention Pond | Extended Dry Detention Pond | Peak Detention Control | Biofiltration | Dry Wells | Swales | Wetlands | Grit/Oil Separators | Underground Detention |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| City of Alexandria, VA | 1 | 2 | 6 | 3 | 2 | | | | | | | |
| City of Austin, TX | | | 100 | 4 | 4 | 120 | | | | | | |
| City of Bellevue, WA | | | 1 | | 8 | | 13 | | | | | |
| City of Olympia, WA | 10 | 10 | | 20 | | 20 | 40 | | | | | |
| District of Columbia | | | 10 | | 2 | | | 72 | | | | |
| Clark County, WA | | | | 35 | | | 150+ | 1000+ | 20 | 4 | | |
| Montgomery County, MD | | 75 | 5 | 14 | 10 | 5 | 21 | | | 15 | | |
| Prince George's County, MD | 2 | 100 | | 43 | 10 | 16 | | | | | 43 | 9 |
| Somerset County, NJ | | | | 2 | 24 | | | | | 2 | | |
| Washington County, OR | | | 4 (compost) | | 10 | | | | 25 | | | |
| South Florida Water Management District | 200 | 100 | | 600 | | | | | 400 | | | |
| Southwest Florida Water Management District | 1457 | 54 | 507 | 581 | | | | | | 55 | | |
| State of Delaware | 4-6 | 22 | 15-30 | 125-175 | | | 19-24 | | 9-19 | 4 | | |
| Florida Department of Environmental Protection | 316 | | 158 | 15 | | | | | 53 | | | |
| Maryland Department of the Environment | 531 | | | | 464 | | | | 153 | 47 | 285 | |
| State of South Carolina | 325 | 4 | | 100 | 25 (+ 150 not extended) | 175 | | | 400 | 3 | | |

**Table Stormwater 4. Stormwater Management Program Water Quality Performance Standards**

| Jurisdiction | Water Quality Performance Standards |
|---|---|
| City of Alexandria, VA | New development - no net increase in pollutant loading; Redevelopment - decrease loadings by 10%. |
| City of Austin, TX | No adverse water quality impacts |
| City of Bellevue, WA | No specified standard |
| City of Fort Collins, CO | None |
| City of Olympia, WA | 80% removal suspended solids |
| City of Orlando, FL | 80% reduction average annual total suspended solids loading |
| City of Seattle, WA | No specified standard |

| | |
|---|---|
| District of Columbia | Oil & Grease < 10 mg/L; reduce organic waste by min. of 85% from confined animal operations |
| City of Winter Park, FL | 80% reduction average annual total suspended solids loading |
| Baltimore County, MD | 80% reduction average annual total suspended solids loading |
| Clark County, WA | No specified standard |
| King County, WA | No specified standard |
| Kitsap County, WA | No specified standard |
| Maricopa County, AZ | No specified standard |
| Montgomery County, MD | Meet state water quality standards |
| Prince George's County, MD | Meet state water quality standards |
| Snohomish County, WA ( standards under adoption) | No specified standard |
| Somerset County, NJ | Treat 1.25 in (2 hr) storm |
| Washington County, OR | Remove 65% of total phosphorus |
| Urban Drainage and Flood Control District (Denver) | Treat 80th percentile runoff event volume |
| Northeastern Illinois Planning Commission | Minimize adverse impacts |
| South Florida Water Management District | 80% reduction average annual total suspended solids loading; compliance with state water quality standards |
| Southwest Florida Water Management District | 80% reduction average annual total suspended solids loading; compliance with state water quality standards |
| Suwannee River Water Management District | 80% reduction average annual total suspended solids loading; compliance with state water quality standards |
| State of Delaware | 80% reduction of annual total suspended solids loading |
| Florida Department of Environmental Protection | 80% reduction of annual total suspended solids loading |
| Maryland Department of the Environment | No specified standard |
| State of New Jersey | 80% reduction of total suspended solids |
| State of North Carolina | 85% removal of total suspended solids (TSS) |
| State of Pennsylvania | No specified standard |
| State of South Carolina | 80% reduction of annual total suspended solids loading |
| State of Virginia | No specified standard (draft proposed) |
| Washington State Department of Ecology | No specified standard |

**Table Stormwater 5. Stormwater Management Program Water Quality Design Criteria**

| Jurisdiction | Water Quality Design Criteria |
|---|---|
| City of Alexandria, VA | Treat 1st 1/2 inch of runoff from impervious surfaces using appropriate BMPs. |
| City of Austin, TX | Sedimentation/filtration to treat min. 1/2" + 0.1" for each 10% increase in impervious area above 20%; WITHIN BARTON SPRINGS ZONE - No increase in pollutant loading for 13 parameters listed in Save Our Springs Ordinance |
| City of Bellevue, WA | Treat runoff from 6 month (24 hr.) storm using appropriate BMPs. |
| City of Fort Collins, CO | None |
| City of Olympia, WA | Treat runoff volume of 6 month (24 hr) storm |
| City of Orlando, FL | Treat greater of: 1st 1/2 inch of runoff or runoff from 1st inch of rainfall |
| City of Seattle, WA | Treat runoff from 6 month (24 hr.) storm |
| District of Columbia | Treat 1st 1/2 inch of runoff or difference in runoff volume from 15 yr (post-development) and 2 yr (pre-development) storms |
| City of Winter Park, FL | Treat 1st inch of runoff by retention |

| | |
|---|---|
| Baltimore County, MD | Treat 1st 1/2 inch of runoff from impervious surfaces using appropriate BMPs. |
| Clark County, WA | Treat runoff from 6 month (24 hr) storm with appropriate BMPs |
| King County, WA | Treat 1/3 of runoff from 2 yr (24 hr) storm |
| Kitsap County, WA | Treat runoff from 6 month (24 hr) storm per WDOE requirements |
| Maricopa County, AZ | Follow state NPDES regulations |
| Montgomery County, MD | Treat 1st 1/2 inch of runoff using appropriate practices |
| Prince George's County, MD | Treat 1st 1/2 inch of runoff using appropriate practices |
| Snohomish County, WA (standards under adoption) | Treat post-development runoff from 6 month (24 hr) storm with appropriate BMPs |
| Somerset County, NJ | Discharge 90% total inflow volume within 18 hr (SF resid.) or within 36 hrs (MF resid. or non-resid.) |
| Washington County, OR | Treat 0.36 in of runoff (4 hr storm) from new impervious using appropriate BMPs |
| Urban Drainage and Flood Control District (Denver) | Treatment volume depends on imperviousness & detention time - max. value for 100% impervious is 0.5 in runoff. |
| Northeastern Illinois Planning Commission | Depends on treatment practice: 6 mo storm for swales & runoff from 2 in storm for other practices |
| South Florida Water Management District | Treatment volume varies from 1.0 in to 2.5 in times % impervious area; dry pretreatment required for discharge to sensitive waters |
| Southwest Florida Water Management District | Treatment volume varies from 0.5 in to 1.5 in, depending on practice used, receiving water type, amt. Impervious surface |
| Suwannee River Water Management District | Treatment volume varies from 0.5 in to 2.0 in, depending on practice used, receiving water type, amt. Impervious surface |
| State of Delaware | Treat 1st inch of runoff by approved BMPs |
| Florida Department of Environmental Protection | Treatment volume varies from 0.5 in to 1.5 in, depending on practice used, receiving water type, amt. Impervious surface |
| Maryland Department of the Environment | Manage difference between post-development & pre-development rate for 2 yr & 10 yr storms |

Continued

**Table Stormwater 5. Stormwater Management Program Water Quality Design Criteria (Continued)**

| Jurisdiction | Water Quality Design Criteria |
|---|---|
| State of New Jersey | Manage storm > 1.25 in. in 2 hrs or 1 yr (24 hr) storm with release outflow of 90% of volume w/in 18 hrs (resid.) & w/in 36 hrs (non-resid.) |
| State of North Carolina | Varies with proximity to and the classification of the receiving water and also may be determined by local rules |
| State of Pennsylvania | Some municipalities requires practices |
| State of South Carolina | Treatment volume varies from 0.5 in (wet ponds) to 1 in (dry detention, retention) with drawndown w/in 24 hrs |
| State of Virginia | Treat 0.5 in runoff from project area; detention basins release over 30 hours; infiltration must percolate w/in 48 hrs; retention basins must have permanent pool 3 times greater than treatment volume |
| Washington State Department of Ecology | Treat runoff from 6 month (24 hr) storm using BMPs appropriate for site |

**Table Stormwater 6. Stormwater Management Program Peak Discharge Performance Standards**

| Jurisdiction | Peak Discharge Performance Standards |
|---|---|
| City of Alexandria, VA | No increase in rate. |
| City of Austin, TX | No increase in peak rate, no increase in streambank erosion. |
| City of Bellevue, WA | 100 year storm protection |
| City of Fort Collins, CO | Depending on basin, can require detention with no increase in rate |
| City of Olympia, WA | No increase in rate. |
| City of Orlando, FL | No increase in rate. |
| City of Seattle, WA | No increase in rate. |
| District of Columbia | No increase in peak rate. |
| City of Winter Park, FL | None - rely on SJRWMD requirements |
| Baltimore County, MD | No increase in rate. |
| Clark County, WA | No specified standard |
| King County, WA | Base protection standard & stream protection standard |
| Kitsap County, WA | No specified standard |
| Maricopa County, AZ | No increase in velocity & peak rates of washes |
| Montgomery County, MD | No specified standard |
| Prince George's County, MD | No increase in rate. |
| Snohomish County, WA ( standards under adoption) | No increase in rate. |
| Somerset County, NJ | Performance standards set by county watershed models |
| Washington County, OR | No increase in rate. |
| Urban Drainage and Flood Control District (Denver) | Performance standards depend on storm and location |
| Northeastern Illinois Planning Commission | No increase in rate. |
| South Florida Water Management District | No adverse impacts |
| Southwest Florida Water Management District | No adverse impacts |
| Suwannee River Water Management District | No adverse impacts |
| State of Delaware | No increase in rate. |
| Florida Department of Environmental Protection | None - set by local government |
| Maryland Department of the Environment | No specified standard |
| State of New Jersey | Match pre-development conditions; non-erosive |
| State of North Carolina | Varies with proximity to and the classification of the receiving water and also may be determined by local rules |
| State of Pennsylvania | Performance standard set in local watershed plan |
| State of South Carolina | No increase in rate. |
| State of Virginia | No increase in rate. |
| Washington State Department of Ecology | No specified standard; minimize bank erosion |

**Table Stormwater 7. Stormwater Management Program Peak Discharge Design Criteria**

| Jurisdiction | Peak Discharge Design Criteria |
|---|---|
| City of Alexandria, VA | Post-development peak rate less than or equal to pre-development rate for 2-yr. & 10-yr. (2 hr.) storm |
| City of Austin, TX | Post-development rate < pre-development for 2, 10, 25, 100-yr (24 hr) storm |
| City of Bellevue, WA | < 5 ac. → <0.2 cfs/acre; > 5 ac. → post-development <= pre-development for 2 yr & 10 yr (24 hr.) storm |

| | |
|---|---|
| City of Fort Collins, CO | Post-development rate for 100 yr (1 to 3 hr) storm < historic 2-yr (1 to 3 hr) storm |
| City of Olympia, WA | Post-development rate not exceed pre-development for 2 yr & 100 yr (24 hr) storm. Max. release rates 0.04 cfs/acre (2-yr) & 0.35 cfs/acre (100 yr) |
| City of Orlando, FL | Post-development peak rate < pre-development rate for 25-yr (24 hr) storm |
| City of Seattle, WA | < 0.2 cfs/acre for 25 yr (24 hr) storm for < 9,000 s.f.; < 15 cfs/acre for 2 yr (24 hr) storm for > 9,000 s.f. |
| District of Columbia | Post-development < pre-development rate for 2 yr, 10 yr, & 100 yr (24 hr) storms |
| City of Winter Park, FL | Post-development rate < pre-development rate for 25 yr (24 hr) storm |
| Baltimore County, MD | Post-development rate < pre-development rate for 2 yr & 10 yr (24 hr) storms |
| Clark County, WA | Post-development < pre-development rate for 2 yr, 10 yr, & 100 yr (24 hr) storms |
| King County, WA | Base protection: post-development rate < pre-development rate for 2 yr & 10 yr storm; stream protection: post-development rate < pre-development rate for 100 yr storm; control duration for 2 to 50 yr storm |
| Kitsap County, WA | Post-development rate < 50% of pre-development rate for 2 yr (24 hr) storm, & pre-development rate for 10 yr & 100 yr (24 hr) storms [SBUH analysis] |
| Maricopa County, AZ | Site specific analysis required. |
| Montgomery County, MD | Post-development < pre-development rate for 2 yr (24 hr) storm & when necessary, for 10 yr & 100 yr (24 hr) storm |
| Prince George's County, MD | Post-development peak rate < pre-development rate for 2 yr & 10 yr (24 hr) storms, & for 100 yr (24 hr) storm if downstream flooding potential |
| Snohomish County, WA ( standards under adoption) | Post-development < pre-development rate for 10 yr & 100 yr (24 hr) storm; if no infiltration, rate of detained volume release < 50% of pre-development rate |
| Somerset County, NJ | Post-development rate < percentage of pre-development rate: 2 yr storm (50%); 10 yr storm (75%); 100 yr storm (80%) |
| Washington County, OR | Post-development < pre-development rate for 25 yr (24 hr) storm |
| Urban Drainage and Flood Control District (Denver) | Post-development peak rate for 2 yr, 5 yr, 10 yr, 50 yr, 100 yr storm < historic (undeveloped) rate for 5 yr & larger storms |
| Northeastern Illinois Planning Commission | Post-development < pre-development rate w/ max. 0.15 cfs for 100 yr (24 hr) storm |
| South Florida Water Management District | Post-development < pre-development rate for 25 yr (3 day) storm (unless downstream designed for higher rate) |
| Southwest Florida Water Management District | Post-development < pre-development rate for 25 yr (24 hr) storm |
| Suwannee River Water Management District | Post-development < pre-development rate for critical duration storm (storm up to 100 yr (24 hr) that produces greatest change) |

Continued

**Table Stormwater 7. Stormwater Management Program Peak Discharge Design Criteria (Continued)**

| Jurisdiction | Peak Discharge Design Criteria |
|---|---|
| State of Delaware | Post-development < pre-development rate for 2 yr & 10 yr (24 hr) storms; northern 20% of state - same control for 100 yr (24 hr) storm |
| Florida Dept. of Environmental Protection | Post-development < pre-development rate for 10 yr to 25 yr (24 hr) storm |

| | |
|---|---|
| Maryland Department of the Environment | Post-development rate < pre-development rate for 2 yr & 10 yr storms |
| State of New Jersey | Post-development rate & volume < pre-development rate & volume for 2 yr, 10 yr, & 100 yr (24 hr) storm |
| State of North Carolina | Varies with proximity to and the classification of the receiving water and also may be determined by local rules |
| State of Pennsylvania | Level of control (design & rate) established by local gov. in its watershed plan |
| State of South Carolina | Post-development < pre-development rate for 2 yr, 25 yr (24 hr) storm; must pass 100 yr (24 hr) storm |
| State of Virginia | Post-development < pre-development rate for 2 yr & 10 yr storms; duration is 24 hr storm (SCS Method) or critical storm (Rational Method) |
| Washington State Department of Ecology | Post-development < 50% pre-development rate for 2 yr (24 hr) storm; post-development < pre-development rate for 10 yr & 100 yr (24 hr) storm |

**Table Stormwater 8. Stormwater Management Program Volume Performance Standards**

| Jurisdiction | Volume Performance Standards |
|---|---|
| City of Alexandria, VA | None |
| City of Austin, TX | None |
| City of Bellevue, WA | 100 year storm protection |
| City of Fort Collins, CO | None |
| City of Olympia, WA | Maintain 100 year volume on site |
| City of Orlando, FL | In closed basins |
| City of Seattle, WA | None |
| District of Columbia | None |
| City of Winter Park, FL | None |
| Baltimore County, MD | None |
| Clark County, WA | Maintain groundwater recharge; maintain existing flows & levels in downstream channels |
| King County, WA | None - under study |
| Kitsap County, WA | Only for certain downstream waters |
| Maricopa County, AZ | No increase allowed (flood prevention) |
| Montgomery County, MD | None |
| Prince George's County, MD | None |
| Snohomish County, WA ( standards under adoption) | No specified standard |
| Somerset County, NJ | Offset increased runoff volumes and flow durations that create or add to channel erosion |
| Washington County, OR | None |
| Urban Drainage and Flood Control District (Denver) | None |
| Northeastern Illinois Planning Commission | Minimize increases to lessen downstream flooding, enhance recharge & base flow |
| South Florida Water Management District | No increase in rate; maintain ground water recharge & downstream baseflow |
| Southwest Florida Water Management District | In closed basins, no increase for design storm |
| Suwannee River Water Management District | No net increase in flood storage |
| State of Delaware | No specified standard |
| Florida Department of Environmental Protection | None - set by local government (rare except in closed basin) |
| Maryland Department of the Environment | No specified standard |
| State of New Jersey | Approximate pre-development hydrology (proposed) |
| State of North Carolina | Varies with proximity to and the classification of the receiving water and also may be determined by local rules |

| | |
|---|---|
| State of Pennsylvania | No specified standard |
| State of South Carolina | None |
| State of Virginia | No specified standard |
| Washington State Department of Ecology | No specified standard; goal to recharge aquifer, maintain baseflows |

**Table Stormwater 9. Stormwater Management Program Volume Design Criteria**

| Jurisdiction | Volume Design Criteria |
|---|---|
| City of Alexandria, VA | None |
| City of Austin, TX | None |
| City of Bellevue, WA | For detention systems, require multiple release rate |
| City of Fort Collins, CO | None |
| City of Olympia, WA | Infiltrate all of 100-yr volume if percolation rate on-site > 6 in/hr. Between 0.5 & 6 in/hr, must infiltrate part of volume |
| City of Orlando, FL | Retain runoff from 100 yr (24 hr) storm |
| City of Seattle, WA | None |
| District of Columbia | None |
| City of Winter Park, FL | None |
| Baltimore County, MD | None |
| Clark County, WA | Post-development < pre-development volume for 2 yr (24 hr) storm; post-development < pre-development volume for 10 yr & 100 yr (24 hr) storms for downstream channels |
| King County, WA | None |
| Kitsap County, WA | Post-development < pre-development volume for 100 yr (7 day) storm using SBUH analysis |
| Maricopa County, AZ | Retain runoff volume from 100 yr (2 hr) storm |
| Montgomery County, MD | None |
| Prince George's County, MD | Infiltration required if soil percolation rate > 0.17 in/hr |
| Snohomish County, WA ( standards under adoption) | Infiltrate runoff from 2 yr (24 hr) storm to extent site conditions allow |
| Somerset County, NJ | Reduce 2 yr peak rate by 50% |
| Washington County, OR | None |
| Urban Drainage and Flood Control District (Denver) | None |
| Northeastern Illinois Planning Commission | Promote minimizing imperviousness & maximizing infiltration |
| South Florida Water Management District | Post-development < pre-development volume for all storms up to 100 yr (24 hr) storm |
| Southwest Florida Water Management District | Post-development < pre-development volume for all storms up to 100 yr (24 hr) storm |
| Suwannee River Water Management District | Post-development < pre-development volume for all storms up to 100 yr (24 hr) storm |
| State of Delaware | None |
| Florida Department of Environmental Protection | Post-development < pre-development volume for 25 yr to 100 yr (24 hr) storm |
| Maryland Department of the Environment | None |
| State of New Jersey | Post-development 2-yr peak = 50% of pre-development; post-development 10 yr & 100 yr peak = 75% existing |
| State of Pennsylvania | May be set by watershed plan |
| State of South Carolina | None |
| State of Virginia | None |
| Washington State Department of Ecology | Infiltrate runoff from 2 yr (24 hr) storm to extent site conditions allow |

**Table Stormwater 10. Stormwater Management Program Source Controls**

| Jurisdiction | Source Controls |
|---|---|
| City of Alexandria, VA | Developing Non-Structural BMP Handbook for Auto-Related Businesses (pub. 1995) |
| City of Austin, TX | "Save Our Springs" ordinance requires all land uses within Barton Springs to use source controls including limits on turf grass & landscaped areas, integrated pest management, chemical storage restrictions, homeowner education packets (lawn care, pest treatment, recycling, household waste disposal, general watershed information) |
| City of Bellevue, WA | Encouraged esp. for construction and gasoline-related and food-related activities. |
| City of Fort Collins, CO | Encouraged in city's NPDES MS4 permit proram. Favor pollution prevention for all land uses. Passive treatment methods incorp. Into master planned drainages to promote habitat protection. |
| City of Olympia, WA | Encouraged for all land uses; maintenance plans inc. pollution source control for site. Encourage roofing operations or storage areas, placing berms around barrel for secondary containment, directing wash water to sanitary sewer, proper disposal, good housekeeping |
| City of Orlando, FL | Encouraged on all land uses. |
| City of Seattle, WA | Enc. All land uses; inspect comm. & indust. Business served by sep. storm sewers; Enc. Roofing for storage areas, berms around barrels for sec. Contain., directing wash water to sanitary sewer, proper waste disposal, good housekeeping (esp. around outside dumpsters) |
| District of Columbia | Oil recycling, good housekeeping, street sweeping, natural system conservation – all land uses |
| City of Winter Park, FL | Good housekeeping, landscaping, eduction on commercial and multifamily residential projects |
| Baltimore County, MD | Encouraged all land uses; rec. limit imperviousness & using buffers to protect streams & wetlands |
| Clark County, WA | Recomm. Specific land uses, inc. manu., transp. & communication, wholesale/retail sales, service business, public land activities; inc. fuel station, vehicle/equip. wash areas, storage/loading of solid/liquid mat'l, veg. Mgmt practices. |
| King County, WA | Enc. All land uses – urban (citizen & business education); agriculture (density limits on livestock & limit animal access to streams); construction (clearing limits in wet season) |
| Kitsap County, WA | Recomm. Manu., transp. & commun., wholesale/retail sales, service business, public land activity; inc. fuel station, vehicle/equip. wash areas, storage/loading of materials, vegetative mgmt |
| Maricopa County, AZ | Pollution prevention plans that emphasize general housekeeping & using less toxic materials |
| Montgomery County, MD | Gen. Public info.; edu. Re: proper use of fertilizers/pesticides, proper disposal of oil, antifreeze, & other haz wastes; practices to imp. Health of riparian zones (esp. in proposed special protection areas) |
| Prince George's County, MD | As required by County's NPDES municipal storm sewer system permit. |
| Snohomish County, WA (stds under adoption) | Encouraged for commercial and industrial land uses; inc. mat'l handling, roofing, proper plumbing |
| Somerset County, NJ | Encouraged for all land uses. Include material protection & storage, spill prevention & clean-up, fertilizer & pesticide use & management |
| Washington County, OR | Encourage 25 ft wide buffers – stream corridors & wetlands (new developments); cover prac. Emph. |
| Urban Drainage and Flood Control District (Denver) | Encouraged all land uses; inc. minimizing DCIA, grass buffers, swales, good housekeeping practices |
| Northeastern Illinois Planning Commission | Encouraged for all land uses |
| South Florida Water Management District | Dry pretreatment for industrial & commercial land uses; no discharges of industrial waste or hazardous & toxic substances into stormwater system |
| Southwest Florida Water Management District | Agriculture has site specific farm plan with appropriate BMPs; BMPs include irrigation management, nutrient & pesticide management, field layout, wetland avoidance, buffers. |
| Suwannee River Water Management District | Indust. & comm.; no disch. Indus. Waste, haz or toxic substance in storm sewer; contain. Plans req'd |

Continued

**Table Stormwater 10. Stormwater Management Program Source Controls (Continued)**

| Jurisdiction | Source Controls |
|---|---|
| Florida Dept. of Environmental Protection | Encourage poll. prev. source controls; emph. educ. for students, citizens, businesses, elected officials, & practitioners - stress interrelationships & how to abate "Pointless Personal Pollution." |
| State of New Jersey | Site plan/design; nat. feature preserve; min. disturbance/impervious cover; nat. landscape; fertilizer/pesticide controls; haz waste collection |
| State of Pennsylvania | Encouraged for agricultural activities; include tillage practices, animal waste/ nutrient management |
| State of South Carolina | Encourage for truck stops, indust., large comm., multi-family resid.; inc. cover loading docks & other handling areas; street sweep (inc. parking); dry cleaning trash handling areas; sequencing const. |
| State of Virginia | Enc. alt. to struct. controls; inc. cluster devel., min. imperv. surf. & curbs, open space acquisition, floodplain mgmt, wetlands & steep slope prot., vegetation |
| Washington State Department of Ecology | Recomm. specific land uses, inc. manu., transp. & comm., wholesale/retail sales, service business, public land activity; inc. fueling stations, vehicle/equip. wash areas, storage/loading, vegetative mgmt |

**Table Stormwater 11. Stormwater Management Program Other Requirements**

| Jurisdiction | Other Requirements |
|---|---|
| City of Alexandria, VA | Downstream evaluation required for protection of downstream channel stability. |
| City of Austin, TX | Downstream evaluation required for protection of downstream channel stability. |
| City of Bellevue, WA | Downstream evaluation required with maximum velocity specified to assure downstream channel stability |
| City of Fort Collins, CO | Downstream evaluation required for discharges to master planned facilities. No criteria for downstream channel stability |
| City of Olympia, WA | Downstream evaluation required with maximum velocity specified to assure downstream channel stability |
| City of Orlando, FL | Downstream evaluation required for protection of downstream channel stability. |
| City of Seattle, WA | Downstream evaluation required with maximum velocity specified to assure downstream channel stability |
| District of Columbia | Downstream evaluation required for protection of downstream channel stability. |
| City of Winter Park, FL | Lakefront residential units must direct runoff to pervious areas. Downstream evaluation NOT REQUIRED to assure protection of downstream channel stability. |
| Baltimore County, MD | Downstream evaluation required for suitable outfall and downstream channel stability. |
| Clark County, WA | Downstream evaluation of capacity required if pre-development runoff calculations do not assume undisturbed forest in determining runoff curve number. |
| King County, WA | Downstream evaluation required for min. ¼ mile or 15% of drainage system w/ downstream channel stability required when stream protection standard applies |
| Kitsap County, WA | Downstream evaluation required for at least ¼ mile with downstream channel stability evaluated; flooding & water quality impacts evaluated |
| Maricopa County, AZ | Downstream evaluation required for any off-site discharges (prevent increase in downstream flooding potential); Downstream channel stability evaluation required where potential problem exists. |

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| Montgomery County, MD | Downstream evaluation required for downstream channel stability |
| Prince George's County, MD | Downstream evaluation required for downstream channel stability |
| Snohomish County, WA (stds under adoption) | Downstream evaluation required for downstream channel stability |
| Somerset County, NJ | Downstream evaluation required for downstream channel stability |
| Washington County, OR | Downstream evaluation required to prevent increase in downstream flooding potential with detention or increased conveyance capacity used as mitigation; no evaluation of channel stability required. |
| Urban Drainage and Flood Control District (Denver) | Downstream evaluation may be required, esp. if no master plan for area; downstream channel stability required using grade control or bank erosion control |
| Northeastern Illinois Planning Commission | Downstream evaluation recommended; 2 yr storm peak discharge rate of 0.04 cfs/acre to minimize channel erosion |
| South Florida Water Management District | Downstream evaluation required for natural systems (downstream channel stability) |
| Southwest Florida Water Management District | Downstream evaluation required for downstream channel stability |
| Suwannee River Water Management District | Downstream evaluation required for downstream channel stability |
| Florida Dept. of Environmental Protection | Downstream evaluation required for downstream channel stability |

Continued

**Table Stormwater 11. Stormwater Management Program Other Requirements (Continued)**

| Jurisdiction | Other Requirements |
|---|---|
| Maryland Department of the Environment | Downstream evaluation required for downstream channel stability |
| State of New Jersey | Downstream evaluation required for no increase in peak velocities & downstream channel stability |
| State of Pennsylvania | Downstream evaluation may be required by local government |
| State of South Carolina | Downstream evaluation required with maximum velocity specified to assure downstream channel stability |
| State of Virginia | Downstream evaluation NOT required, but discharge must not cause instability of downstream channel |
| Washington State Department of Ecology | Downstream evaluation required for downstream channel stability; stream channel erosion BMPs must have correction factor which ranges from 20 to 50% of design volume depending on amount of impervious surface |

**Table Stormwater 12. Stormwater Management Program Publications**

| Jurisdiction | Publications |
|---|---|
| City of Alexandria, VA | City's Supplement to the Northern Virginia BMP Handbook |
| City of Austin, TX | Environmental Criteria Manual; Guidance for Compliance with the Technical Requirements of the SOS Ordinance |
| City of Bellevue, WA | BP How To Manual; Water Quality Protection for Bellevue Business; Consumer Choices - Car Care, Lawn & Garden Care, Home & Bldg. Maintenance; Business Partners, Storm Drain Stenciling Brochure; Stream Team Guidebook or Brochure; IPM Notebook |

| | |
|---|---|
| City of Fort Collins, CO | Fort Collins Storm Drainage Design Criteria and Construction Standards; Stormwater Utility Brochure, Community Streams - Clean or Under Attack Brochure; Irrigation Ditches Brochure |
| City of Olympia, WA | Olympia Drainage Design and Erosion Control Manual; Stormwater Management Manual for Puget Sound |
| City of Orlando, FL | Orlando Urban Stormwater Management Manual |
| City of Seattle, WA | City of Seattle Pollution Control Guidelines for Construction Sites: Appendix B; Guidelines for Controlling Pollutants Other Than Sediment on Construction Sites |
| District of Columbia | Oil Recycling; The D.C. Urban Homeowner's Guide on Ground Maintenance |
| Clark County, WA | County ordinances; Stormwater Management Manual for the Puget Sound Basin |
| Kitsap County, WA | Ordinance, Stormwater Program booklet & brochure, Stormwater Management Manual for the Puget Sound Basin |
| Maricopa County, AZ | Arizona NPDES stormwater regulations; Drainage Design Manual for Maricopa County (Volume I: Hydrology; Volume II: Hydraulics; Volume III: Erosion Control) |
| Montgomery County, MD | County stormwater regulations, checklists, and design guidances |
| Prince George's County, MD | County Stormwater Management Design Manual, 1991; Design Manual for Use of Bioretention in Stormwater Management, 1993; pamphlets on lawn care, car care, etc. |
| Snohomish County, WA (standards under adoption) | State of the Waters: 1993 Assessment; Stormwater Characterization and Pollution Load Estimattes (May 1994); 1993-94 Watershed Education Program Final Report and Evaluation (Sept. 1994); Stormwater Management Manual for the Puget Sound Basin; numerous publications on watershed management plans for several watersheds and regional detention siting or design reports |
| Somerset County, NJ | Source controls, fertilizer, & pesticide use by residents. |
| Washington County, OR | Erosion Control Plans Technical Guidance Handbook; Portland/USA Water Quality Facilities Technical Guidance Handbook; King County Hydrology/Hydraulics Method Handbook |
| Urban Drainage and Flood Control District (Denver) | Urban Storm Drainage Criteria Manual, Volumes 1 and 2 (rev. 1991); Urban Storm Drainage Criteria Manual, Volume 3 - BMPs (1992) |
| Northeastern Illinois Planning Commission | Model Stormwater Drainage and Detention Ordinance; Urban Stormwater Best Management Practices for Northeastern Illinois |
| South Florida Water Management District | Management and Storage of Surface Waters, Part IV, Applicant's Handbook |
| Southwest Florida Water Management District | Management and Storage of Surface Waters, Part IV, Applicant's Handbook |
| State of Delaware | Delaware Stormwater Standards and Specifications Manual |
| Florida Department of Environmental Protection | Florida Development Manual: A Guide to Sound Land and Water Management (BMP Design Manual); Florida Silviculture BMP Manual; Stormwater Management: A Guide for Floridians; Model Local Government Stormwater Management Program |
| State of New Jersey | New Jersey Guide to Stormwater Management Practices (BMP Manual); New Jersey Nonpoint Source and Stormwater Best Management Practices Manual |
| State of Pennsylvania | |
| State of South Carolina | A Guide to Site Development and Best Management Practices for Stormwater Management and Sediment Control; South Carolina Stormwater Management and Sediment Control Hand Book for Land Disturbing Activities |
| State of Virginia | Stormwater Management Handbook (available January 1996) |
| Washington State Department of Ecology | Stormwater Management Manual for the Puget Sound Basin |

The following is a summary of some of the current statewide stormwater management programs.

### *Alabama*

Alabama has NPDES delegated authority from the USEPA. ADEM (Alabama Department of Environmental Management) issues general permits through its Industrial Branch as well as its Mining and Nonpoint Source Section. ADEM requires Municipal Stormwater Permits for Birmingham, Huntsville, Montgomery and Mobile. Construction site sedimentation and erosion control regulations are implemented by the Mining and Nonpoint Source Section of ADEM. Along the Gulf of Mexico construction site discharges and other industrial operations

are regulated by the Coastal Zone Management Program (Thompson). Local communities can also provide additional requirements. As an example, Mobile has experienced flooding problems for many years. An engineering study identified 92 separate stormwater drainage projects having an estimated cost of about $100 million (Steeves and Chapman 1988). This study recommended that a stormwater management utility be established within the City's Department of Public Works. In 1987, after many public meetings, Mobile adopted a water management plan and approved the concept of a user's fee to pay for these needed stormwater drainage improvements. Besides flood control objectives, this utility would also monitor water quality and plan for future water quality improvement projects. The annual operations and maintenance budget for this utility was estimated to be about $3.5 million. The estimated fees to pay for this service would be about $3 per household per month.

### *Alaska*

Alaska does not have NPDES permitting authority. However, permits issued by the USEPA become state permits once the Alaska Department of Environmental Conservation demonstrates its ability to issue and enforce these permits. Aside from the basic EPA stormwater permit requirements, the state of Alaska also requires a “qualified personnel provided by the discharger” to inspect certain areas. These areas include disturbed areas of construction sites that have not been stabilized, storage areas exposed to precipitation, structural control measures and locations of entrance and exit to the site. These designated areas must be inspected within 24 hours of any rain event greater than 0.5 inches.

### *Arizona*

Stormwater permits in Arizona are issued by the USEPA, as the state does not have permitting authority. Therefore the stormwater permit requirements are nearly identical to those in the general nationwide program, with a few additional requirements. Arizona requires a secondary containment system able to hold the entire contents of the largest single tank plus adequate freeboard to accommodate a 25-year, 24-hour rain event for industries storing chemicals defined as priority under SARA. Best management practices have been outlined with regard to runoff control. These BMPs are currently required for agricultural operations using nitrogen fertilizers. Other sources of runoff, such as urban stormwater runoff, resource extraction, grazing and siviculture will soon be subject to BMP compliance as well. Several cities in Arizona have additional regulations to prevent pollution from stormwater discharge. Examples of these additional regulations are the cities of Phoenix, Tempe and Mesa all require retention basins to control construction site runoff.

### *Arkansas*

Arkansas has delegated stormwater permitting authority, meaning it issues and regulates its own permits based on the guidelines set forth by the EPA. In addition to these guidelines, the state has established some numeric effluent limitations. For example, coal pile runoff should not exceed concentrations of 50 mg/L maximum suspended solids and pH must be within 6-9. The state has determined parameters which must be measured by permittees as well. Primary metal industries and wood treatment facilities must sample for $BOD_5$, and land disposal facilities must test for ammonia and nitrate plus nitrite nitrogen.

The Arkansas Department of Pollution Control and Ecology publishes guidance for detention ponds and erosion control. If a study of a proposed development indicates flooding problems, a development permit would be denied without stormwater control. Examples of acceptable controls are on-site storage, off-site storage or an improved drainage system. The method used for stormwater detention is the modified rational hydrograph method. This guidance includes tables and graphs for determining time of concentration and rain intensity. The required volume of detention is evaluated according to the following methods (Contractor’s Guidance):

A. Volume of detention for projects of less than 50 acres shall be evaluated by the ‘simplified volume formula’.
B. Volume of detention for projects 50 acres or greater but less than 200 acres may be evaluated either by the “simplified volume formula” or the “modified rational hydrograph method”.
C. For projects larger than 200 acres, the owner’s engineer shall submit a proposed method of evaluation for the sizing of the retention basin or detention basin to the Department Public Works.

The method will be evaluated for a professional acceptance, applicability and reliability by the City Engineer. No detail review for projects larger than 200 acres will be rendered before the method of evaluation of the retention or detention basin is approved.

D. Other analytical methods of evaluation of volume of detention require approval by the City Engineer.

E.

### *California*

California is an NPDES delegated state with general permitting authority, however the state has instituted a fairly large number of requirements stricter than those outlined by the EPA. In contrast to the EPA permit, California has established that the primary activity at a facility does not necessarily determine the category of industrial activity at a location. Each area of the facility is treated differently. For example at a school, although its primary activity is education, the vehicle service area is nevertheless treated as a transportation area. Whether the activity is primary or auxiliary is of no concern under the regulations, each use is considered individually under the permit. Strict guidelines are also in effect as to sources considered to be point sources. Sheet flow from a parking lot is considered to be a point source requiring a permit. This is not the case in most states. Monitoring programs are also stricter than those in effect nationally; guidelines for establishing these programs and the objectives they must accomplish are clearly outlined in the regulations. Sampling must include pH, total suspended solids, specific conductance, and total organic carbon, as well as toxic chemical specific to an individual site. The state has determined that it is not feasible at this time to establish numeric limits for those parameters not listed under a specific industry. Construction site permits require erosion and sediment controls, post-construction stormwater controls, and inspection of the site before anticipated storm events, and after these events to evaluate the effectiveness of the measures taken.

### *Colorado*

Colorado issues its own stormwater permits as an NPDES delegated state. The state has established some numeric effluent limitations. Concentrations of pollutants are limited for the following industries; phosphate manufacturing, fertilizer manufacturing, petroleum refining, cement manufacturing, and coal pile runoff. Construction sites having stormwater permits must be inspected every 14 days and after any precipitation or snowmelt event that causes surface runoff. Coal mining permits establish specific numeric limits for effluents at active and post-mining outfalls. In addition to these limits, control measures also govern drainage control, subsidence, acid runoff control, grading, and other reclamation activities. Any drainage from coal mines must flow into a treatment pond, which is then treated as a point source discharge. In order to obtain a municipal stormwater permit, an area must first establish a record of all stormwater outfalls requiring a large amount of monitoring. Secondly, a stormwater management program must be established. Ben Urbonas of the City of Denver, at a 1987 Maryland training program, reported that simple peak runoff rate controls were not adequately protecting Denver’s streams. Urbanization increased flooding flow rates by about two times in the Denver area, but the critical pollutant carrying flows associated with common storms were increased by several hundred times. Denver then began concentrating on the use of on-site detention, along with sand filters coupled to extended detention facilities, to better control stormwater quality.

### *Connecticut*

NPDES permitting authority has been delegated to the state of Connecticut by the USEPA. Permit guidelines have been made more stringent for some specific permits. Industrial sites must have additional means by which to store potentially hazardous materials and measures must be made so that the storage of chemical must be under a roof to minimize stormwater contamination. Salt storage piles must follow the same general guidelines. Monitoring must be done for a range of pollutants three times a year. Acute biomonitoring tests must be conducted yearly for a large number of permittees. Also, industrial stormwater permits disallow visible floatables including scum, except for those naturally occurring. Construction permits also have a relatively large number of additional requirements. Sediment basins are required to accommodate drainage areas greater than five acres of disturbed soil. Construction permits also require full descriptions of measures to be taken to eliminate or reduce stormwater runoff when construction is finished. Permittees need to install stormwater management programs

that will remove 80 percent of total suspended solids from stormwater. Velocity dissipation devices are also required.

### *Delaware*

Delaware is an NPDES delegated permitting state, following for the most part the general guidelines set forth by the EPA. The state has established additional regulations to address stormwater runoff by construction activities. No more than 20 acres of a single development may be disturbed at a time, and any site that is not worked for more than 14 days must be stabilized. In new developments, stormwater management measures are required. Permanent measures must remove 80 percent of the total suspended solids for the site and be capable of storing runoff from storms up to 100 years. Acceptable BMPs are detention ponds, retention ponds, or sand filter systems. The method encouraged by the state is the development of wetlands to manage the stormwater.

### *District of Columbia*

The District of Columbia does not have NPDES permitting authority and therefore permits for this region are issued by the USEPA. It follows that this region's regulations are nearly identical to those enforced nationally. However there have been some additional restrictions put on industrial dischargers. A numeric limit of 50 mg/L total suspended solids has been set for effluent consisting entirely of coal pile runoff. It is unlawful to meet this limit by merely diluting the runoff with other flows, such as stormwater. Values for pH from coal runoff must fall between 6 and 8.5. In the Chesapeake Bay drainage, industrial dischargers must provide control measures to achieve a 40 percent reduction in nitrogen and phosphorous loads entering the waters of the bay.

### *Florida*

Florida has had stormwater regulations since 1979 (Livingston 1988). The initial Stormwater Rule was revised in 1982 and requires a stormwater permit for all new stormwater discharges and for modifications to existing discharges that were modified to increase flow or pollutant loadings. This state permit program had to be implemented within the framework of the Clean Water Act. Required best management practices must be designed according to site specific conditions and are to be monitored to ensure correct performance. If the monitoring indicates poor performance, the controls must be corrected.

Controls that may be required for specific projects include grass drainage swales, percolation ponds, wet detention ponds with filtration, and wetland treatment. Florida has encouraged innovative control designs that promote multiple uses and that can be located on city owned property. Examples of recent innovative controls include the construction of a spreader swale that causes stormwater to overflow onto a city park for percolation. Existing lakes are also being modified to enhance their stormwater control capabilities.

Florida is a state with NPDES permitting authority. Additional regulations have been placed on several industries. For example, SWP3 site descriptions for construction sites must include rational method estimates of runoff coefficients for before, during and after the construction project. Post construction controls are to be designed to remove at least 80% of the average annual pollutant loads from a given site whose discharge flows into Outstanding Florida waters. These controls may include stormwater detention structures, retention structures, the use of vegetated swales, or other such similar measures. Velocity dissipation devices must be employed to supply non-erosive outfall discharges. The main goal of these stipulations is to "equalize pre and post development stormwater peak discharge rates and volumes". The state has stormwater management programs at the state, watershed and local level. In 70 communities in the state, stormwater utilities have been set up and financed by local user fees. Charges are applied based on parcel size and proportion of impervious area to natural area.

### *Georgia*

The Georgia Erosion and Sediment Control Act of 1975 requires that a permit be obtained for many land disturbing activities. These permits examine specific development and erosion control plans but were not required to specifically address stormwater quality controls.

Local governments can adopt ordinances to enforce this law, but the State's Environmental Protection Division of the Georgia Department of Natural Resources will have permitting and enforcement responsibilities if no local regulations are passed. However, local review of erosion control plans by the regional Soil and Water Conservation District must be provided. The Natural Resources Conservation Service (NRCS) is commonly asked to provide technical assistance in these reviews. Georgia erosion control plans are prepared with little specific guidance from the Erosion and Sediment Control Act and therefore rely on close working relationships with the local NRCS offices.

Georgia is a permitting state under the NPDES program. The major difference in Georgia's stormwater regulation is the addition of the Georgia Erosion and Sedimentation Act of 1975. This act requires a permit for any land disturbing activity larger than 1.1 acres.

### *Hawaii*

Hawaii has NPDES delegated permitting authority. All permittees in this state must comply with the states basic water quality criteria, which lists prohibited substances. Examples of these are; oil, materials that will form objectionable sludge, substances that will affect the taste or odor of water, pathogenic organisms and others. Discharges are further restricted as to the specific concentrations allowed. They can not contain pollutants in 24-hour average concentrations greater than the values obtained by multiplying the minimum dilution by the applicable standards, and non-carcinogenic pollutants in 30-day average concentrations. For construction sites, BMP plans must be implemented to control construction runoff, these controls must be checked weekly during dry periods and within 24 hours after any rainfall event of 0.5 inches or greater. Pre-construction groundcover may not be disturbed more than 20 days before construction begins. Temporary soil erosion measures must be used where construction will continue for 30 days or more. Measures must be taken to ensure that runoff does not cause erosion. Examples of these measures are; runoff must be discharged through a lined channel or pipe and "all surface water" flowing toward a construction area should be diverted. Muddy waters that have been pumped from a construction site must be held in a settling basin and treated before being released. In addition to the state regulations many local city and county governments have additional regulations for controlling stormwater pollution.

Monitoring requirements are outlined for industrial dischargers. Stormwater pollution control plans (SWPCP's) must be developed and implemented by industrial dischargers. These SWPCP's parallel the U.S. EPA's basline SWPCP's. Hawaii requires a secondary containment system for industries handling chemicals defined as priority under SARA.

### *Idaho*

Idaho does not have NPDES permitting authority, its permits are issued by the U.S.EPA, Region 10. The state has an additional voluntary program for controlling agricultural non-point source pollution. Idaho has additional regulations for runoff from silvicultural and mining sites. The following table "summarizes the current regulations for storm water pollution control" in Idaho.

| Land Use Activity | Agency of Local Function | Permit, Approved Process, or Authority | Type of Construction |
|---|---|---|---|
| **Plan Review** | | | |
| Storm Water Pollution Prevention Plan Review (optional at local level) | U.S. Environmental Protection Agency (EPA) | National Pollutant Discharge Elimination System (NPDES) discharge permits | industrial, commercial and residential over 5 acres |
| Drainage Plan review | Local public works or building department | Consult local authority | commercial, residential |

| | | | |
|---|---|---|---|
| **Storm Water Discharges** | | | |
| To a right-of-way | Local or county highway district | Consult local authority | industrial, commercial, residential |
| To a natural waterway | EPA and/or local/watershed-based authority | NPDES discharge permit | industrial, commercial, residential |
| To a privately-owned canal or drain | Local canal or drainage district or EPA | Permission from local canal company or drainage district, NPDES discharge permit | industrial, commercial, residential |
| To a Bureau of Reclamation (BOR) canal | BOR, EPA | Permission from BOR, NPDES discharge permit | industrial, commercial, residential |
| From selected industrial facilities | EPA | NPDES stormwater discharge permit | Industrial |
| **Storm Water Disposal** | | | |
| To subsurface through an injection well | Idaho Department of Water Resources (IDWR) regional office | Underground Injection Control (UIC) Program | Industrial, commercial, residential |
| **Site Preparation/Construction** | | | |
| All new development/ redevelopment | Local public works or building department | Local or county ordinance(s) | commercial, residential |
| Construction over 5 acres | EPA | NPDES stormwater permit | industrial, commercial, residential |
| Development project potentially impacting an existing highway | Idaho Transportation Department, Local or county highway district | Idaho Code, Title 18, Chapter 39, Section 7-8 | industrial, commercial, residential |
| Development project potentially impacting an existing drainage facility | Local public works or building department, Canal company, Drainage district | Local or county ordinance(s) | industrial, commercial, residential |
| **Dewatering** | | | |
| Discharges to right-of-way | Local or county highway district | Consult local authority | industrial, commercial, residential |
| Discharge to a privately-owned canal or drain | Local canal company, Drainage district | Permission form canal company or drainage district, NPDES discharge permit | industrial, commercial, residential |

| Land Use Activity | Agency of Local Function | Permit, Approved Process, or Authority | Type of Construction |
|---|---|---|---|
| **Other Permits** | | | |
| Stream Channel Alteration | IDWR | Stream Channel Alteration Permit | industrial, commercial, residential |
| Filling of wetlands other natural waterways of the U.S. | U.S. Army Corps of Engineers 343-0671 | 404 (dredge and fill) permit | industrial, commercial, residential |

Source: *Catalog of Storm Water Best Management Practices for Idaho Cities and Counties.*

### *Illinois*

Illinois has NPDES delegated permitting authority from the USEPA. The Illinois EPA has general permitting requirements similar to the EPA's baseline general permit for the following; industrial dischargers, stormwater pollution prevention plans (SPW3), and construction sites disturbing five or more acres of land. Individual municipalities have provisions in their building codes to regulate construction site erosion. The state of Illinois does not regulate detention ponds used for flow attenuation purposes. Those facilities are regulated by some Illinois counties. The Illinois EPA publishes the *Illinois Urban Manual* which includes Soil conservation Service Conservation Practice Standards "Impoundment Structure – Full Flow" and "Impoundment Structure – Routed". This agency also distributes the U.S. EPA publication, *Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.*

### *Indiana*

Indiana has NPDES delegated general permitting authority from the USEPA. Indiana issues general stormwater permits for industrial dischagers and construction sites disturbing five or more acres of land. IDEM (Indiana Department of Environmental Management) also regulates stormwater runoff from certain industries using NPDES wastewater permits. Examples of these industries would include the steel and coal mining industries. There are no state level requirements for storm water (only) detention ponds. A facility is free to build one if and how they choose. Sometimes to control flooding, at the local level, there are requirements for storm water detention. If a pond is going to receive wastewater in addition to storm water (i.e., process wastewater) then it would be considered a water pollution treatment/control facility, and there are criteria that must be met.

### *Iowa*

Iowa has NPDES delegated permitting authority. Regulations instituted by the state dictate that facilities in sensitive watersheds that contribute to the water quality problems of the area must follow more stringent guidelines. Coal pile runoff is subject to numeric limits of less than 50 mg/L total suspended solids, and pH must be between 6 and 9. The state has also passed sedimentation and erosion regulations for agricultural and construction sites. These laws are enforced on a complaint driven basis, and can lead to an order to undertake corrective action.

### *Kansas*

NPDES permitting authority has been delegated to the state of Kansas by the U.S. EPA. The Kansas Department of Health and Environment (KDHE) administers the NPDES program which follows the EPA's baseline general permit with additional requirements for conforming to water quality standards established by the state. Construction site permitees are required to prepare stormwater pollution prevention plans (SPW3s). However, industrial stormwater dischargers are not required to develop SPW3s. A sediment basin is required for construction sites were 10 or more acres of land are disturbed at one time. The basin will provide at least 3,600 cubic feet of storage per acre drained, unless the flows are diverted around both the disturbed area and the sediment basin. KDHE has a nonpoint source pollution program and the Department of Agriculture has statewide authority to develop pesticide management areas. One of these has been instituted for the area over the Delaware River.

### *Kentucky*

Kentucky is another state with NPDES delegating authority. In Kentucky, this program falls under the Kentucky Pollution Discharge Elimination System (KPDES) permit program administered by the Kentucky Division of Water. This program applies to construction sites that will disturb five or more acres of land and other industrial facilities. Required BMPs for industrial dischargers are similar to EPA's baseline general permit. Construction site permits suggest BMP's that are baseline and are mostly voluntary. However, mandatory requirements at local municipalities levels are required to be included and implemented.

### *Louisiana*

Louisiana is an NPDES delegated state with the authority to issue its own discharge permits. In addition to the guidelines set forth by the EPA, Louisiana has implemented some supplementary standards. Numeric limits have been set for industrial dischargers that limit the amount of total organic carbon that may be discharged to 50 mg/L and oil and grease discharges are limited to 15 mg/L. Oil and Gas exploration activities have standards for COD (daily max 100 mg/L), total organic carbon (50mg/L), and oil and grease (15 mg/L). These activities are also limited in the amount of chlorides they may discharge into brackish waters. Facilities covered by industrial permits must have a stormwater pollution prevention plan that outlines how numeric limits will be achieved. This plan must also identify potential pollution sources and describe the practices that will reduce pollution and fulfill permit requirements. Louisiana has also developed state stormwater regulations that require a Louisiana Water Pollution Discharge System permit if the potential for water contamination exists, or large volumes of stormwater will be discharged, or in areas where industrial materials are stored. Coastal areas are also of great concern and are therefore subject to additional regulations. Projects within coastal areas must be designed to avoid discharge of nutrients into coastal waters, and to prevent the alteration of oxygen concentration. Development may not damage streams, wetlands, or other features of the environment, and must attempt to avoid the destructive discharges of sediment, pathogens, or toxic substance and to prevent reductions in the productivity of the waters. Attention must also be paid to dissolved oxygen content and heavy metals.

### *Maine*

Maine does not have NPDES permitting authority, therefore its permits are issued by Region 1 of the U.S. EPA. The program requirements are similar to EPA's baseline, however, the Maine Department of Environmental Protection (DEP) Bureau of Land Quality has developed the Natural Resources Protection Act that imposes additional regulations intended to protect the quality of the receiving water. Under this act, nearly all types of water bodies, as well as dunes, fragile mountain areas, wildlife habitats and wetlands are protected through regulations covering activities of concern. Permits are required when the soil will be altered, or discharges (including fill) may be introduced into these areas. Maine's Stormwater Management Law requires construction permits for proposed projects; in the direct watershed of a water body most at risk with 20,000 square feet or more impervious area, or in any watershed with 1 acre or more of impervious area or 5 acres or more of disturbed area. This law contains rule standards regarding construction site stormwater quantity and quality. The peak flow of stormwater must not exceed the peak flow prior to construction and does not increase the peak flow of the receiving waters. To protect the quality of the receiving waters three standards are contained in the rule; Total Suspended Solids (TSS), phosphorous, and basic stabilization. The following table is a summary of these standards

.

| **Project Location/Type** | **Standards** |
|---|---|
| Watershed of a lake not most at risk. Project with <3 acres of impervious area or ≤ 5 acres of disturbed area | Basic Stabilization Standard |
| Watershed of a lake most at risk (severely blooming lake) | Basic Stabilization Standard and Phosphorous Standard |
| Watershed of a lake most at risk (Not severely blooming lake) Project with ≥ 3 arces of disturbed area | Basic Stabilization Standard and Phosphorous Standard |
| Watershed of a lake most at risk (Not severely blooming lake) Project with <3 acres of impervious area and <5 acres of disturbed area | Basic Stabilization Standard and 80% TSS Standard<br>or<br>Basic Stabilization Standard and Phosphorous Standard |
| Direct watershed of a lake other than a lake most at risk and project with > 3 acres of impervious area | Basic Stabilization Standard and Sliding Scale TSS Standard<br>or<br>Basic Stabilization Standard and Phosphorous Standard (may be waived by DEP) |

| Project Location/Type | Standards |
|---|---|
| Direct watershed of a lake other than a lake most at risk and project with ≥5 acres of disturbed area and <3 acres impervious area | Basic Stabilization Standard and Phosphorous Standard |
| Direct watershed of a coastal wetland most at risk | Sliding Scale TSS Standard |
| Watershed of a river, stream, or brook most at risk and the project drains to the waterbody at or above a public water supply intake | Basic Stabilization Standard and Sliding Scale TSS Standard |
| Watershed or a river, stream, or brook identified as a sensitive or threatened area and drains to the waterbody at or within two miles above a public water supply intake | Basic Stabilization Standard |

Source: *A developer's Guide to the Main Stormwater Management Law (Organized Areas).*

There is also a law which regulates the location of subdivisions and other developments and the effects they may have on an area. The DEP must review most large projects with respect to their runoff plan, groundwater discharge and effects on wildlife and noise.

### *Maryland*

Maryland enacted their first statewide erosion control legislation in 1970 (McElroy and Halka 1985). This initial legislation required an erosion control plan before a building permit was granted. It also required that all Maryland cities and counties adopt grading and sediment control ordinances acceptable to the Maryland Water Resources Administration. After ten years experience with this legislation, they found that it was ineffective because of a lack of consistency in the local ordinances, inadequate local administrative commitment, inadequate field inspections, and inadequate enforcement processes. It was concluded that most of the communities did not have the necessary financial resources to adequately fund the program. Therefore, several changes were made to the legislation. As of 1978, all project engineers or foremen in charge of on-site clearing were required to attend a State training program. In 1984, all inspection and enforcement operations were assumed by the State and the inspection staff was increased to 34 people. The delegation of this authority to the local governments did not work and was therefore taken back by the State, with more authority.

The objective of the Maryland stormwater program was to maintain as nearly as possible natural runoff characteristics. Infiltration and detention facilities are important control practices used to meet this objective. They found that a more comprehensive approach was needed to control stormwater runoff than was provided with a peak flow criterion alone. They therefore give consideration to volume reduction, low flow augmentation, water quality control, and ecological protection.

The State of Maryland prepared a model stormwater ordinance in 1985 for consideration by local governments. Because of their involvement in on-going efforts to improve water quality in Chesapeake Bay, Maryland is also retro-fitting stormwater controls in existing developed areas. Their nonpoint pollution control program also includes agricultural sources, shoreline protection, retention of existing forestland, providing conservation easements, controlling dredging and fill projects, controlling mining area runoff, and repairing failing septic tanks.

NPDES permits are issued through the state of Maryland. Releases of oil and other hazardous substances must be prevented or minimized in stormwater discharges. The state has also established a sediment and erosion control program for implementation at construction sites, which includes requirements for runoff controls. Stormwater management is a requirement at construction sites both during and after construction activity. Developers must implement runoff controls for 2 and 10 year storm events that will restrict the flow from exceeding the pre-development level. A list of recommended BMPs is provided by the state with the most preferred being infiltration devices, followed by vegetative swales, retention ponds, and detention ponds.

### *Massachusetts*

Permits in Massachusetts are issued by the USEPA as the state does not have permitting authority. It does however impose some state specific regulations on the permits. New or increased stormwater discharges to coastal or outstanding resource waters are ineligible for permits. In order to minimize erosion, outfall pipes must be set back from receiving waters whenever the discharges are increased, or the system altered in any way. BMPs are also outlined for use in stormwater management in the state, and it is stated that the best practical method of treatment must be employed in maintaining the goals of the program.

### *Michigan*

The Michigan Environmental Protection Act of 1970 imposed a duty on all governmental agencies and individuals to prevent and minimize water pollution, while carrying on normal activities (Dean 1981). A number of Michigan court cases thereafter determined that local governments had the responsibility to consider the environmental effects of new subdivision developments, including stormwater effects. Previously, the Michigan Subdivision Control Act of 1967 required local drain commissioners to review subdivision plat proposals only to assure adequate drainage.

A number of county drainage laws in Michigan now also affect stormwater quality. As an example, Oakland County prefers the use of infiltration of stormwater in wetlands, lowlands, and depressions to the use of dry detention basins in providing drainage control. Infiltration can have a positive effect on preventing surface water quality degradation caused by stormwater discharges, while dry detention ponds have little stormwater quality benefit. In addition, almost all of the 35 Oakland County local governments encourage the use of swales and other on-site controls. Wet detention ponds are also used when necessary. However, many local governments are concerned by the lack of maintenance of detention facilities and therefore discourage their use.

Michigan issues its own permits under the delegated authority of the USEPA. Of particular note is Michigan's requirement for certification of stormwater operators. Each industrial facility with a general permit must have treatment and control measures and these must be carried out by a certified individual. A list of requirements are also provided for applicants of the permit, some of these are; erosion controls must be properly implemented, inspection of controls must be performed on a pre-determined basis, containment for spills of material must be provided, waste material produced in the treatment of stormwater must be properly disposed, and there are several guidelines as to certified operators.

### *Minnesota*

Minnesota has NPDES delegated authority. Construction site controls more stringent than the national standard have been applied in this state. They are as follows; temporary protection must be provided for areas of exposed soil with a continuous positive slope within 100 feet from a water of the state or other devices connected to a water of the state. Exposed soils on positive slope areas must be protected either temporary or with permanent cover within these following timeframes:

| Type of slope | Area has not been or will not be worked by contractor for |
|---|---|
| Steeper than 3:1 | 7 days |
| 10:1 to 3:1 | 14 days |
| Flatter than 10:1 | 21 days. |

In addition, the bottoms of temporary drainage ditches must be stabilized within 100 feet of the receiving water within 24 hours of the ditch being connected to the water. In order for a pipe to be connected to a drainage ditch, it must first be equipped with a velocity dissipation device. Sedimentation BMPs must be installed on the down-gradient perimeters of the site before any up-gradient activities may begin. These BMP's must remain in place until the site has been permanently stabilized. Vehicle transport of sediment must also be minimized.

Temporary sedimentation basins must be provided to collect runoff from disturbed sites of 10 or more continuous acres. Basins shall provide 1800 $ft^3$ per acre drained storage below the outlet pipe. The basin outlets must be

designed to prevent short circuiting and discharge of floating debris.

The Minnesota Pollution Control Agency (MPCA) publishes a Best Management Practice manual entitled "Protecting Water Quality in Urban Areas". The MPCA issues NPDES/SDS General Storm Water permits for Industrial and Construction activity. These permits list the requirements at the Federal and State level. The Industrial activity permit covers "facilities discharging storm water associated with industrial activity as defined in 40 CFR 122.26(b)(14)". This permit requires a storm water pollution prevention plan, including drainage maps, significant materials inventory, and exposure evaluation; BMP's categorized as source reduction, diversion, and treatment; implementation schedule; inspections and maintenance; reporting; etc. The construction activity permit covers erosion control and inspection and maintenance requirements for construction activities, which disturb five or more acres of total land area.

### *Mississippi*

Permits are issued by the state of Mississippi under authority delegated to it through the EPA NPDES program. Mississippi issues nine different types of general stormwater permit including one for construction sites and one that is a baseline permit. Special criteria for chlorides, sulfates and total dissolved solids apply to all discharges into the Mississippi River. Stormwater permits state that discharges must be free of debris, oil scum or other floating material except in trace amounts, eroded soils that will form objectionable deposits, suspended solids, turbidity, and color at levels higher than the receiving water, and chemical concentrations higher than the state limits allow. Stormwater controls, including erosion control measures, are required for all construction sites. These must divert flow away from disturbed soils, keep exposed soil time and area to a minimum, implement BMPs and remove sediment from stormwater before it leaves the site. Sediment basins are required for site with drainage areas over five acres. The recommended capacity of the basin (SCS manual) should be 67 $yd^3$ per acre drainage area, with maximum surface area and an outlet as far from the inlet as possible. Stormwater controls must be described with respect to vegetative controls, structural controls, post-construction controls, and measures to minimize vehicle transport of sediment.

### *Missouri*

Missouri has a unique method for funding nonpoint runoff controls. In 1983, the Missouri legislature passed a constitutional amendment to increase the state sales tax by 0.1 percent to increase state funding for parks and historical sites, and for soil conservation (Howland 1985). State voters, in turn, passed the amendment in the 1984 general election. This tax increase will only be in effect for five years (from 1985 to 1990) and the soil conservation portion (about $15 million per year) will mostly be used for cost-sharing of agricultural runoff controls. However, this funding method could also be used to fund urban stormwater controls.

Missouri has NPDES delegated permitting authority. Construction site permits similar to the EPA's general construction permit are required for sites disturbing 5 or more acres of land, over the life of the project. Construction sites over 10 acres are required to construct sedimentation basins. The basin shall be sized to contain 0.5 inch of sediment from the drainage area and to be able to contain a 2-year, 240hour storm. Industrial specific Stormwater Pollution Prevention Plans are required for general industrial permits. Permits for some activities in this state place numeric effluent limits on stormwater discharges with respect to oil and grease, total suspended solids, pH and other pollutants.

### *Montana*

Montana has NPDES delegated permitting authority. The Montana Department of Environmental Quality (DEQ) issues three general permits; a permit authorizing discharges from construction sites, a permit authorizing discharges associated with industrial activity and a permit for oil and gas, and mining activities.

### *Nebraska*

Nebraska has NPDES delegated permitting authority. Nebraska Department of Environmental Quality (NDEQ) issues two general permits; a permit authorizing discharges from construction sites of 5 acres or more and a

permit authorizing discharges associated with industrial activity. Permittees of either general permit are required to develop and implement a Storm Water Pollution Prevention Plan (SWPPP) that will; minimize erosion on disturbed areas, minimize the discharge of sediment and other pollutants in storm water runoff and maintain compliance with the requirements of the permit. A detention pond is required on construction sites where slopes are equal to or steeper than 3:1. Clay soils are present in many areas of Nebraska and when erosion occurs suspended clay particles are not efficiently removed simply by use of a detention facility. Therefore, use of a detention pond does not circumvent the need to implement erosion and sediment controls. NDEQ does not have authority related to flow management issues, only water quality issues. Many local municipalities require new developments to construct permanent detention basins for the purpose of storm water flow management. These requirements are intended to help prevent and reduce downstream flooding that would otherwise result from the increase in runoff that typically occurs with development. SWPPs for industrial permittees does not require use of detention basins.

### *Nevada*

Nevada has NPDES delegated permitting authority. The state general permit is identical to the U.S. EPA's baseline NPDES stormwater program. Construction sites disturbing five or more acres, industrial facilities and mining sites are covered by this permit. Specific BMP's are not required. Detention facilities are regulated by local governments. In the Lake Tahoe area there are stricter regulations administered by the Tahoe Regional Planning Agency.

### *New Hampshire*

New Hampshire does not have NPDES permitting authority. Its permits are issued by Region 1 of the U.S. EPA. The program requirements are identical to EPA's. In addition, the state has a shoreline protection program that issues site specific permits for construction sites; in or on the border of surface waters, with contiguous area of 50,000 $ft^2$ if within a protected shoreline, or 100,000 $ft^2$ or more in all other areas.

### *New Jersey*

New Jersey has NPDES delegated permitting authority. The Department of Environmental Protection (DEP) issues two general permits; a permit authorizing discharges from construction sites of 5 acres or more and a permit authorizing discharges associated with industrial activity. Industrial dischargers must implement a SWPPP. Construction sites disturbing 5,000 $ft^2$ of land are regulated by state erosion and sediment control laws.

### *New Mexico*

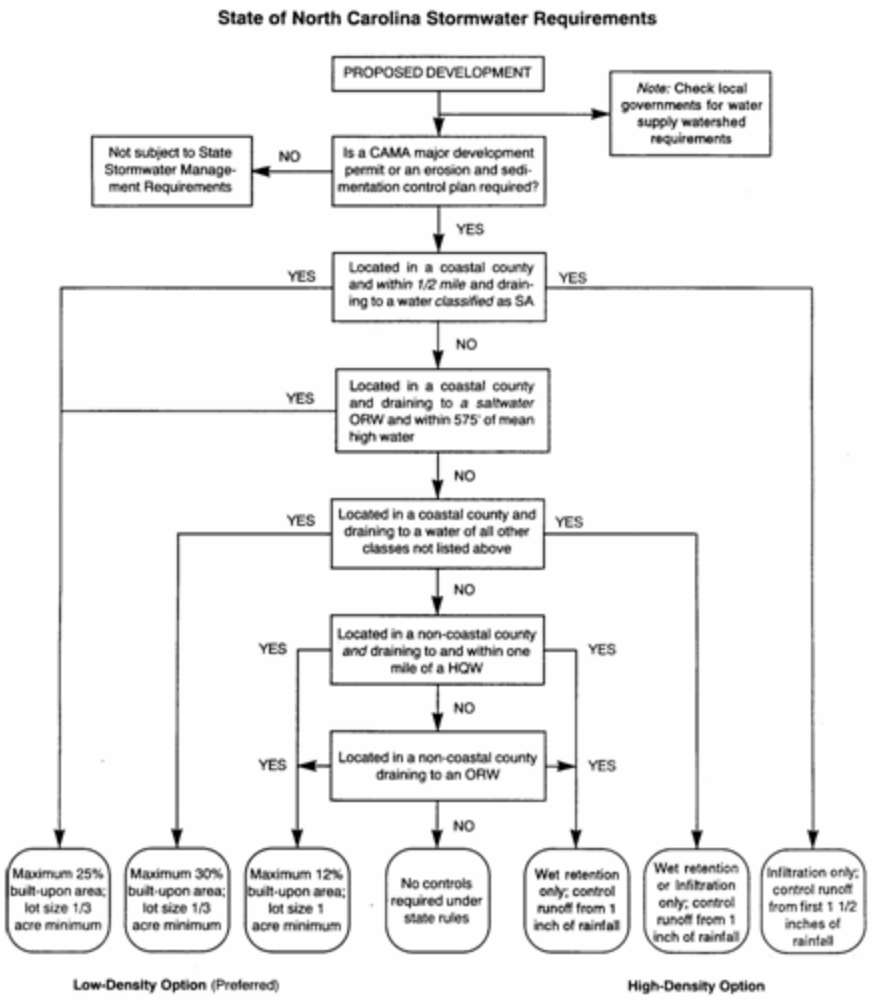
New Mexico is a non-delegated state for the NPDES program. The NPDES program is under the direction of the U.S. EPA, Region 6 in Dallas, Texas. Questions about this program can be directed to the Stormwater Hotline at 800 245-6510.

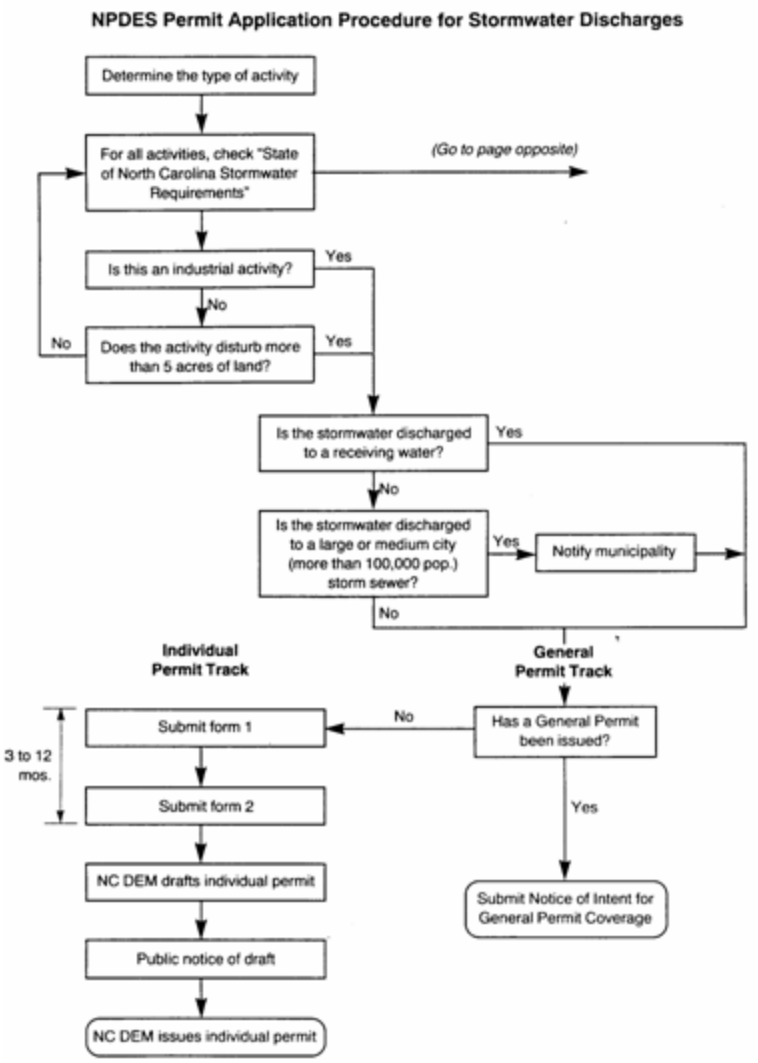
### *New York*

New York has NPDES delegated permitting authority. The state includes some additional requirements in its construction permits. Structural practices must be built to divert stormwater from exposed soils and limit runoff from these areas. State guidelines also mandate that there may not be any visible and substantial changes with respect to color, taste, odor or turbidity downstream from construction sites. Vegetative and structural practices must be used to ensure that stormwater discharges do not vary significantly from pre-development conditions.

### *North Carolina*

North Carolina presently issues 23 types of general permits with include a permit for construction sites disturbing five or more acres of land and permits for various types of industrial activities. All types of permits require the implementation of a SWPPP. The state also imposes a set of regulations specific to stormwater for coastal waters, outstanding waters of the state, high quality waters, and water supply waters. To help the public determine what regulations are applicable for a project or industrial activity the following flow charts are published by the state in their *Stormwater Management Guidance Manual.*


State of North Carolina Stormwater Requirements
PROPOSED DEVELOPMENT
Note: Check local governments for water supply watershed requirements
Is a CAMA major development permit or an erosion and sedimentation control plan required?
NO
Not subject to State Stormwater Management Requirements
YES
Located in a coastal county and within 1/2 mile and draining to a water classified as SA
YES
YES
NO
Located in a coastal county and draining to a saltwater ORW and within 575' of mean high water
YES
NO
Located in a coastal county and draining to a water of all other classes not listed above
YES
YES
NO
Located in a non-coastal county and draining to and within one mile of a HQW
YES
YES
NO
Located in a non-coastal county draining to an ORW
YES
YES
NO
Maximum 25% built-upon area; lot size 1/3 acre minimum
Maximum 30% built-upon area; lot size 1/3 acre minimum
Maximum 12% built-upon area; lot size 1 acre minimum
No controls required under state rules
Wet retention only; control runoff from 1 inch of rainfall
Wet retention or infiltration only; control runoff from 1 inch of rainfall
Infiltration only; control runoff from first 1 1/2 inches of rainfall
Low-Density Option (Preferred)
High-Density Option




### *North Dakota*

North Dakota has NPDES delegated permitting authority. The North Dakota Department of Health (NDDH) issues three general permits; a permit for construction sites disturbing 5 or more acres of land, a permit for industrial activity and a permit for mining activities.

### *Ohio*

Ohio issues its own NPDES permits under authority delegated by the USEPA. The state imposes additional runoff guidelines. Revegetation of construction sites must be achieved on a specified time scale, regulations apply to the protection of waters flowing near a site, and statewide regulations require the use of sediment ponds if sediment fences are determined to be insufficient. Ponds capable of holding 67 cubic yards of runoff per acre are required.

### *Oklahoma*

NPDES permits in Oklahoma are issued by the state. Oklahoma Pollution Discharge Elimination System (OPDES) administers the NPDES program. OPDES's permit is identical to EPA's construction permit. Several

cities in Oklahoma require builders and developers to design detention facilities so that the rate of runoff from a new building or development does not exceed the historic before development or construction runoff.

Industries in the state are subject to additional regulations. Oklahoma plans to adopt EPA's multi-sector permit for industrial sites. Whole effluent toxicity testing is required for dischargers twice annually. The Oklahoma Conservation Commission coordinates the runoff programs in the state, which are voluntary and provide assistance in making management decisions.

### *Oregon*

Oregon has delegated NPDES permitting authority. Discharge limits are set for some industrial stormwater dischargers for certain parameters. These parameters typically include settleable solids, debris, conductivity and *enterococci*.

### *Pennsylvania*

The state of Pennsylvania has NPDES delegated permitting authority. The general permit for industrial dischargers resembles EPA's baseline with the following the following numeric limits: 7 mg/L for dissolved iron, pH is to range from 6 to 9, and a limit of 50 mg/L total suspended solids has been established for coal pile runoff. The state's general construction permit covers sites between 5 and 25 acres, unless the runoff from the site will be discharged into a protected water of the state. Any disturbed area, regardless of size, must implement erosion controls. For disturbed areas less than 5 acres sedimentation traps with the capacity of 2,000 $ft^3$ may be used. A sedimentation basin is required at construction sites disturbing more than 5 acres. The basin must; have a capacity of 7,000 $ft^3$ per acre, have a 24" freeboard and have outlets designed to pass a minimum flow of 2 $ft^3$ per second per acre. A permit is required for timber harvesting operations that would disturb more than 25 acres of land. Water quality based limits may be established for any discharger to ensure adequate water quality in receiving waters.

### *Rhode Island*

Rhode Island has NPDES permitting authority. The state has developed some additional regulations above the baseline EPA guidelines. Rhode Island has standard for stormwater practices that include BMPs that must be incorporated into developments. Local governmental agencies may regulate stormwater discharges, but, their regulations must be at least as strict as the state regulations. To limit suspended solids releases, the state's Coastal Zone Management Program requires new developments within 200 feet from a shoreline to remove 80% of the suspended solids discharged from a site after development.

### *South Dakota*

South Dakota has NPDES delegated permitting authority from the USEPA. The South Dakota Department of Environment and Natural Resources (DENR) has general permitting requirements similar to the EPA's baseline general permit for industrial dischargers and construction sites disturbing five or more acres of land.

### *Tennessee*

Tennessee has NPDES delegated permitting authority. In addition to the basic requirements, the state has developed some additional provisions. At construction sites, vegetative and structural management techniques must be applied. Examples of these are: clearing and grubbing is minimized, soil exposure must be minimized through sequencing, large projects must be built in stages, strict checking and maintenance of controls is required, a responsible individual must be established and temporary and permanent soil stabilization measures must be used.

### *Texas*

Austin has had a watershed protection ordinance since 1981 after it was found that continued urban development was having adverse affects on the local groundwater supply. This ordinance was amended in 1986 and contains

specific standards for development within critical watersheds (Austin 1986). The Austin program is currently funded by a combination of user's fees and city general revenues. Common controls in all proposed land uses include buffer zones adjacent to all streams where no development is allowed, severe building restrictions on slopes greater than 15 percent, and required setbacks from springs, seeps, and sinkholes. Many innovative erosion and stormwater controls have been used in Austin, including sand filters, portable filter fence supports, and suspension of all City required building inspections for any site in violation of their erosion and stormwater control plan. Porous pavement is not considered an effective stormwater quality control when protecting groundwater, and is therefore not given any credit when calculating allowable impervious covers. Austin also has an on-going monitoring program to evaluate the performance and required maintenance of stormwater controls.

Texas is in the process of becoming an NPDES delegated state. Until that time, its permits will be issued by the USEPA. Texas has established probably the most extensive list of numeric standards for stormwater discharges. Twelve parameters have established discharge limits in this state they are as follows; arsenic, barium, cadmium, chromium, copper, lead, manganese, mercury, nickel, selenium, silver and zinc.

### *Utah*

Utah has NPDES delegated permitting authority. In addition to the basic permit requirements, the state imposes supplementary regulations in some cases. Coal mining facilities are subject to restrictions on the total maximum flow and concentrations of total suspended solids in their discharges. To remediate these concerns, mines must use sedimentation controls, such as detention ponds, and mine site dewatering. Dewatering discharges are subject to limits in the concentration of iron, total dissolved solids, pH, suspended solids, and grease. The Salt Lake City Stormwater Utility has been established and institutes a user fee for use of stormwater systems. Several other cities in Utah have adopted similar plans.

### *Vermont*

The state of Vermont has permitting authority under the NPDES program. A statewide permitting program has been established as well that requires treatment and volume control measures to manage runoff from new developments once construction is completed. These management plans, including project designs, hydrologic calculations and planned controls, must all be submitted to the DEP. Permits are issued on a site specific basis. These are often issued with the stipulation that post development discharge rate does not exceed that of the area before development. Sites have guidelines to follow during the construction phase as well. Ten environmental criteria have been established, addressing: wetlands, headwaters, floodways, streams, shorelines, traffic concerns, water and air pollution, waste disposal, esthetics, and impacts on wildlife habitats.

### *Virginia*

Virginia has NPDES delegated permitting authority. As with most states, Virginia has instituted some additional guidelines. With respect to development, post construction pollutant concentrations must not increase compared to pre development concentrations. The Chesapeake Bay area uses phosphorous as an indicator pollutant. Sites that undergo redevelopment must implement measures to achieve a 10 percent reduction in average pollutant loads. Construction activities sponsored by the state also have a set of stormwater regulations they must follow.

### *Washington*

The city of Bellevue has had a storm drainage utility since 1974. Its primary mission is to “manage the storm and surface water system, to maintain a hydrologic balance, to prevent property damage, and to protect water quality for the health, safety, and enjoyment of citizens and for the preservation and enhancement of wildlife habitat” (Bissonnette 1985). Bellevue stresses the use of natural drainage systems to transport and dispose of stormwater. Swales, lakes, ponds, wetlands, and detention ponds form important parts of this system. In 1985, the utility's operating budget was more than $5 million and the 1980 to 1985 capital improvement budget was about $13 million. The necessary revenues are obtained through user service fees, assessed according to the amount of runoff and pollutants generated for each area served.

A number of cities throughout the U.S. currently have storm drainage utilities, mostly modeled after Bellevue's. These utility districts all charge a fee to provide urban runoff control services. Bellevue's runoff and receiving waters were extensively studied during the Nationwide Urban Runoff Program. It was found that the beneficial uses of the streams were being seriously impaired by excessive flows, erosion, and sedimentation (Pitt and Bissonnette 1984). These problems are currently being reduced by runoff and erosion controls. It is expected that metallic and organic toxicants will also need to be controlled in future years in Bellevue.

### *West Virginia*

West Virginia has been granted NPDES permitting authority by the USEPA. West Virginis issues two general permits, one for industrial dischargers and one for construction sites disturbing three or more acres of land. Construction sites having a drainage area of 5 acres or less should have a sediment trap with a storage volume equal to 3,600 $ft^3$ per acre. Sites over 5 acres should have a sediment basin which will provide a storage volume equal to 3,600 ft3 per acre. The state has established additional numeric effluent limitations for coal piles with respect to pH, and total suspended solids.

### *Wisconsin*

Wisconsin has had a priority watershed protection program for more than 15 years. This program involves extensive state-funded cost sharing to retro-fit nonpoint water pollution controls in watersheds that cannot meet water quality objectives with point source controls alone. Initially, this program almost exclusively involved agricultural water pollutant sources, with little urban runoff controls. In 1983, the state legislature passed legislation requiring the preparation of a model ordinance to control construction site erosion and stormwater runoff (Pitt 1986). The State of Wisconsin will spend about $100 million over the next twenty years in retro-fitting urban runoff controls in the priority watersheds. In order to protect this investment, all state funded and conducted construction, along with urban areas participating in the priority watershed program, are required to follow these ordinances.

The Wisconsin model ordinance for the control of construction site erosion has been adopted by many communities, including Milwaukee. This ordinance includes basic controls to reduce such erosion sources as vehicle tracking and dewatering of excavations, along with required diverting of upslope waters, mulching of disturbed areas, and the use of downstream sedimentation controls. Extensive plan reviews and site inspections are also included in the ordinance. The ordinance is supplemented with a manual to ensure uniform design and appropriate applications of construction control practices.

Wisconsin has NPDES delegated permitting authority. The DNR limits its stormwater program to municipalities in urban areas with documented water quality problems. These municipalities are required to collect data and assess their specific stormwater problems as well as develop a plan to address these concerns. Permits mandate that municipalities: make and meet a timeline for development of a stormwater program, implement a successful program that reduces and prevents stormwater pollution, screen all storm sewer outfalls for sewer connections and other improper waste disposal, estimates pollutant loadings to the waters of the state, calculates the concentrations and constituents of pollutants in stormwater, monitor stormwater with respect to pollutant loads, assess the effectiveness of their stormwater program, and report on their progress.

### *Wyoming*

Wyoming has NPDES delegated permitting authority. The state has imposed additional controls on construction site activities. Sites that discharge into perennial water bodies must not increase the turbidity by more than 10-15 turbidity units above the background. Discharges into water bodies that are ephemeral are exempt from this standard but may not deposit sediment that degrades the habitat. All stormwater control devices must remove 80% of total suspended solids. Sites must establish structured runoff control plans with a designated responsible individual. Sites with a high potential for soil erosion should identify and implement BMP's to control erosion.

## Example Construction Site Erosion Control and Stormwater Management Requirements

The following discussion presents the requirements for an example watershed protection ordinance. These provisions were developed while preparing the state-wide model ordinance for the State of Wisconsin and the Watershed Protection Ordinance for the City of Birmingham, AL. The Birmingham ordinance was to protect a public water supply watershed that is under significant development pressure.

### *Rationale and Purpose*

The objective of an effective construction site erosion control and stormwater management ordinance is to protect the local water resources from water quality degradation from many potential sources and activities. Specific provisions of the ordinance may:

- control development and related activities which may increase pollution from these sources,
- to provide for treatment practices which promote the public health, safety, and general welfare, and
- to restrict or prohibit discharges which are dangerous to, or potentially may increase pollution of, the watershed and public water supply.

### *Standards and Specifications for Construction Site Erosion Control*

Actual monitoring of construction sites (especially research on the yields and delivery of construction site erosion material) has found that type of development (i.e., land use) has very little effect on erosion rates. Instead, construction site erosion losses vary with the amount of land disturbed, the duration of that disturbance and the presence of erosion controls. A watershed protection ordinance, therefore, should require erosion control for all types of development and exclude only small construction projects (such as those disturbing less than 2,000 square feet, or involving excavation and/or filling of less than 500 cubic yards of material). Thus, projects such as home additions or household gardening activities will generally be too small to require control, while construction of most individual homes and all larger types of development would require control.

Construction site monitoring projects have also revealed that sediment delivery (the amount of sediment leaving its source compared to the amount entering the receiving water) is very close to 100 percent. Almost all of the sediment from construction areas that disturb more than about ten percent of a watershed, and about one-half of that from construction areas that disturb less than ten percent, actually reach the receiving water. These very large delivery ratios probably result from the normal practice of installing the storm drainage system during the initial construction phase, because sediment travels much more efficiently in conventional storm drainage systems than in natural sheetflows and small tributary streams. The early installation of storm drainage systems also apparently makes sediment yield and delivery insensitive to site slope. A watershed protection ordinance, therefore, should not exempt construction projects on the basis of percentage disturbance of a watershed, or construction site slope.

Vague regulations and general criteria regarding erosion control sometimes found in many erosion control ordinances should be replaced by criteria that specify when and where specific control practices are to be used. Such guidance should help site engineers as well as site plan reviewers and inspectors. In addition, specific criteria should promote more uniform construction site erosion control throughout the watershed.

**Purpose of Erosion Control Requirements**

The main purpose of construction control requirements contained in a watershed protection ordinance is to prevent erosion sediment and other pollutants from leaving construction sites. The secondary purpose is to significantly reduce the quantity of any “escaped” material that reaches receiving waters. Past research projects that have characterized construction erosion discharges and transport processes have concluded that very large amounts of sediment, phosphorus, and other pollutants erode from most construction sites. Sediment yields from uncontrolled construction sites may, for example, be several hundred to several thousand times the annual sediment yields from most developed urban areas. Small areas of active construction may therefore contribute much more pollution to a receiving water than entire cities or surrounding agricultural lands. By requiring

reasonable and effective construction site erosion controls for most developing areas, discharges of many pollutants to receiving waters can be greatly reduced.

**Site Erosion Control Requirements**

Site erosion control requires three elements to protect downslope property, the storm drainage system, and receiving waters. The first involves diverting water from upslope, undisturbed areas so that it does not flow across disturbed land. This preventive measure can reduce the volume of water and energy available to transport soil exposed by construction activity.

The second element requires mulching disturbed ground at time intervals that permit necessary grading but that also reduce erosion losses during intense rains. Site erosion control, on-site mulch or temporary vegetation is needed in order to control erosion from disturbed sites during periods of site inactivity or when the erosion potential is very high. In many areas of the country, storms having high erosion potential can occur at any time, so immediate on-site mulching is a very important aspect of effective construction site erosion control. A risk assessment of the erosion potential of Jefferson County, AL, rains showed that rains occur about every three days (Water Quality Engineers 1981a). Although about three rains could occur during any seven-day period, the probability of a rain with high erosion potential during any seven-day period is relatively low. The probability increases with longer periods of time, however. A time limit of 14 days of no activity before mulching is required on portions of the construction site is a compromise between potential erosion damage and construction scheduling problems. Unfortunately, many disturbed sites are left inactive for periods much longer than 14 days, resulting in very high probabilities of severely erosive rains occurring when sites are left disturbed and inactive. Stabilization of these inactive but disturbed areas is needed, therefore, to prevent site erosion, to eliminate the cost of regrading severely eroded areas, and to protect off-site areas from erosion products. In many cases, better timing of grading operations could also reduce the time an area is left disturbed.

The third site erosion control element requires downslope controls to minimize the quantity of erosion products that leave the site. This element is necessary because significant exposed land will always occur at construction sites. Moreover, plantings can require several weeks to become established and capable of reducing erosion. For small sites (less than 10 acres) with no channelized flow, filter fences or other perimeter controls are probably adequate. These controls are fragile, however, and suitable only for sheetflows at low velocities. When larger flows can be expected, sedimentation basins are needed because high flow rates can quickly destroy filter fences.

Downslope controls alone cannot offer adequate protection from severely erosive rains that may occur at any time during the construction season. Because such rains could completely and quickly wash out a filter fence or silt-in a sedimentation basin if a site had no other protection, downslope controls should be installed in conjunction with above-site flow diversions and site mulching or planting. Together, these three erosion control elements can significantly reduce potential erosion damage, which can be very expensive, if not impossible, to remedy once it has occurred. Nevertheless, occasional severe rains occurring at the “wrong time” in relation to site protection requirements may still cause downstream damage. The intent of a watershed protection ordinance is to give site planners and engineers as much flexibility as possible in applying required specifications and standards to proposed projects. Although construction site controls may appear restrictive, they allow many choices about matters such as location of storage piles, mulch types, timing of grading, etc.

**Summary of Erosion Control Requirements**

All erosion control efforts should consist of three basic elements:

1) divert upslope water around the disturbed site, or pass it through the site along a protected channel,

2) expose disturbed areas for the shortest possible time (allowing a maximum time limit of about 14 days for disturbed land before required protection), either through improved construction phase scheduling, or through temporary or permanent mulching, and

3) treat any runoff water before it leaves the site (by perimeter filter fencing, or if a “large” site, with a sediment pond).

This triple approach is needed because of the potential failure of any one system due to random rains that may cause severe site and erosion damage. As an example, if a temporary seeding is not fully established, a moderate rain of greater than 0.5 inch (which may occur about every 10 days in the Birmingham, AL, area) can easily wash it away. In addition, special consideration needs to be given to:

- construction wastes (don’t allow their burial on the site),
- tracking restrictions (all main site roads, which have greater than about 25 vehicles per day traffic, and all site entranceways have to be graveled, and travel is restricted off these graveled areas),
- treat dewatering wastes before discharge,
- protect storm drain inlets (with straw bale or filter fence barriers),
- locate material storage piles away from storm drain inlets (by at least 50 feet), and if left for a long time (greater than 14 days), then they must be covered, mulched, or surrounded with a perimeter filter fence or straw bale barrier,
- direct all on-site concentrated runoff (especially down steep slopes) along protected channels, or in flexible down drains, and
- have contractor inspect all erosion controls on the site and make necessary repairs at least weekly and after large rains (greater than about 0.5 inch).
- construction vehicle maintenance must be accomplished in special protected areas.

## *Standards and Specifications for Stormwater Runoff Control*

**Purpose of Stormwater Control Requirements**

The primary intent of a watershed protection ordinance’s stormwater criteria is to reduce water quality problems, not to control urban flooding problems. Significant peak flow rate reductions can be expected for many storms, however, because the general stormwater criteria are based on stormwater volume goals. When runoff volumes are reduced, similar peak flow rate reductions will also occur if the stormwater controls are carefully designed.

Peak flow rate (flooding) criteria cannot be adequately developed without a detailed, basinwide, site-specific hydrologic analysis. If adequate hydrologic analyses have been conducted for an area, then peak flow rate criteria should be considered in the design criteria.

Simple criteria limiting predicted post-development peak flow rates to predevelopment values are very common nationwide. These flow rate criteria usually result in the use of many small detention basins scattered throughout an area. This approach can result in significant on-site drainage system construction cost savings to the developer by allowing smaller, and therefore less expensive, drainage system components between the on-site peak flow rate control device (such as a dry detention basin) and the municipal drainage system. In many cost analyses, this drainage cost savings has been shown to more than offset the cost of the peak flow rate control devices. Unfortunately, these criteria have resulted in few regional flood reduction benefits, and in many cases, they have actually increased downstream flooding.

When stormwater management is discussed, many people view flood control as the major concern. Although the major purpose of a watershed protection ordinance is not to control flooding problems, the management strategies

it contains can be used to significantly reduce runoff volumes of frequent events and to somewhat reduce water volumes of infrequent, large flooding events. The design procedures for many of the stormwater management options can be used to produce the dual benefits of reducing water pollution discharges and reducing water volumes and flow rates. In any case, basinwide planning for water quality and for flood control need to be better coordinated.

A watershed protection ordinance should require the disposal of runoff waters to reasonably prevent inundation, erosion, or deposit of floatable matter, sediment, or siltation onto property of others, or cause degradation of the waters of the watershed.

The criterion to protect channel scour and bank erosion of open channels refers to the NRCS maximum permissible flow rates for channels having various linings on different slopes. The maximum flow rate criteria is applicable for bank-full conditions, and not to a single storm.

**General Runoff Volume Criteria**

The flow volume criteria used in the watershed protection ordinance will result in system-wide drainage savings, even if no local hydrologic analyses are available. When basinwide hydrologic and water quality analyses are available, they should be considered in the design of the permanent stormwater drainage system.

The general runoff volume criteria included in this example watershed protection ordinance are designed to maintain post-development water balance conditions similar to those that occurred before development, and to permit achieving those conditions at reasonable costs related to development intensity. Low density residential developments, for example, are not expected to require any controls beyond typical grass roadside drainage swales. In contrast, a shopping center will be required to have an on-site wet detention basin (for pretreatment) and a relatively large infiltration system. In all cases, the added costs to meet stormwater criteria will be only a small fraction of site development costs and will be many times less expensive than the costs of retro-fitting controls into developed areas.

This example watershed protection ordinance stresses water volume criteria because they are much more important than peak water velocity criteria in achieving water quality and quantity benefits simultaneously, especially in the absence of basinwide hydrologic analyses. Meeting runoff volume criteria also gives developers and engineers more flexibility than they would have in meeting most peak flow rate criteria. Pollutant discharges are best related to runoff volumes (not flow rates) and that common small to moderate sized storms account for the majority of runoff volume. As an example, Water Quality Engineers (1981b) found that rains less than about 0.5 inch in depth produced most of the nutrient, organic, and heavy metal pollutant discharges, and more than 60 percent of the runoff volume discharges in the Birmingham area.

Pollutant concentrations do not vary greatly for different rain depths for the same area. Therefore, reductions in runoff volume through the use of volume criteria can result in similar pollutant discharge reductions. Similarly, many peak runoff rate prediction methods (including the NRCS curve number procedure) directly relate peak runoff flow rates with runoff volume. Therefore, if the runoff volume is reduced by 80 percent, approximately 80 percent reductions in runoff pollutant discharges and peak flow rates may also be expected.

Infiltration devices are usually needed to meet this volume criteria. They require a wide variety of “design” storms if they have storage volumes (such as for infiltration trenches). Simple spreading areas, however, are designed for the rain having the greatest intensity (inches per hour). Wet detention basin designs depend on both rain intensities and freeboard storage capacities. For a complex project requiring a combination of different types of stormwater management controls, evaluating a set of “design” storms is, therefore, necessary.

The general water volume limitations are based on U.S. Natural Resources Conservation Service (NRCS) “curve numbers” (CN) for different soil hydrologic groups (SCS 1986). Most engineers and planners are quite familiar with the NRCS curve numbers and their use for designing drainage facilities. The curve numbers are highly

dependent on land development and relate expected runoff volumes to different rain types. Higher curve numbers indicate more runoff than lower curve numbers for similar soil and rain conditions. As examples, undeveloped land has lower curve numbers than most residential land, and residential land has lower curve numbers than shopping centers.

According the NRCS (SCS 1986), typical medium density residential areas, with curbs and gutters, located on sandy soils (A or B soil types) have curve numbers of about 75. Commercial areas have curve numbers of about 90, and industrial areas have curve numbers of about 85 for these same conditions. The runoff volume standards in this example watershed protection ordinance would require that all developed areas having the same native soil type, irrespective of land use, have the same discharge volumes. Areas having large curve numbers would therefore require greater efforts to reduce the CN values to acceptable values, compared to areas that have smaller curve numbers. Reducing the curve number from 85 to 70 (such as would be required for the above industrial area) would result in a runoff volume (and therefore approximate pollutant yield and peak flow rate) reduction of about 50 to 90 percent, depending on the rain depth.

The general flow-limiting criteria are used to determine the allowable runoff flow volumes for applicable proposed land developments. The curve number criteria were selected to be sensitive to existing limitations in natural soil infiltration capabilities. If the undisturbed soils have a low infiltration capability (such as a type D soil), then the soil would naturally produce more runoff than a soil having a larger infiltration capability (such as a type A, B, or C soil). Thus, different curve number criteria were selected to produce resultant runoff volumes that would be somewhat greater than undisturbed conditions (to attempt to reasonably match the natural hydrologic cycle). This would allow limited development without extensive stormwater management requirements. Stormwater management efforts for similar proposed developments in different soils would be similar. If highly intensive levels of development are proposed (such as a shopping center), then correspondingly greater stormwater management efforts would be required than for less intensive developments having larger amounts of pervious areas.

Some low levels of development (such as low density residential developments) are probably possible for most soil conditions with very few stormwater controls. In many higher density residential developments, it is also probable that very few extensive stormwater controls are needed, beyond roadside grass drainage swales. If a developer has previously installed curb and gutter systems, then it will be very difficult to meet the general criteria without an extensive infiltration system. Similarly, if local ordinances require roof drains to be connected to an underground drainage system, much more expensive infiltration devices will probably be required.

As examples of the types of controls needed to meet these CN criteria, residential areas may only require the use of grass drainage swales (or infiltrating catchbasins in steep areas). In contrast, commercial areas may require extensive use of infiltration trenches for roof and parking area runoff. Industrial areas could also achieve these runoff goals with grass swales, but infiltration devices (including grass swales) in manufacturing areas should not be used because of the potential for groundwater contamination. Roof runoff from most non-manufacturing areas, however, could be reduced through infiltration practices with little potential for groundwater contamination. All subsurface infiltration devices should be protected with pretreatment. Pretreatment may be simple catchbasins or wet detention ponds, depending on the size of the facility, and should be designed to remove the larger particulates that may clog the infiltration device. The use of a runoff volume performance criteria allows the site developers flexibility, in contrast to requiring specific devices.

The extensive reduction of runoff volumes for one-year storms is the basis of the general stormwater runoff requirements. This level of control will significantly reduce pollutants from common, small storms and will also significantly reduce pollutants from larger, less frequent storms. For example, controlling one-year storms may result in up to 40 percent reductions of water volumes and pollutants for 10-year storms and about 15 percent reductions for 100-year storms. It is recognized that large, infrequent storms (such as the 100-year storm commonly used in flood plain ordinances) create flooding problems much greater than attendant water pollution problems. Detailed site-specific and basinwide hydrologic analyses are needed before effective flood control

standards can be determined. It is not possible to develop effective flood control criteria without this specific information, and comprehensive flood control criteria are therefore not included in this example watershed protection ordinance.

Practices that control urban runoff water pollution can be best used to treat smaller, more frequent storms than large storms. Many control practice designs, such as for infiltration trenches, detention basins, and grass swales can be very sensitive to storm runoff volume. It would be very expensive to construct urban runoff controls in sizes sufficient to control large, rare storms. The one-year storm design criterion, however, allows moderately priced but substantial pollutant and volume reductions for common storms while also providing important partial control during large storms.

Besides the obvious benefits of reducing pollutant discharges to the public water supply, reducing runoff volumes and concurrent flow rates can also reduce other stresses on the receiving waters. These benefits include reducing channel scour and bank erosion and helping to maintain or stabilize refuge areas for fish and other aquatic life. In addition, reducing runoff volumes and flow rates reduces the flushing of fish and other aquatic organisms during peak flows, further improving the aquatic environment. In most cases, the general water volume limitations will result in water velocity and water elevation reductions similar in magnitude to volume reductions. Regulating runoff volumes also helps to maintain groundwater recharge to small streams in near-natural conditions, which stabilizes low flows during dry, summer conditions.

Certain controls (specifically wet detention basins) can be designed to provide significant water velocity (flood control) benefits in addition to water pollutant reduction benefits. A very important benefit to riparian owners and public works officials is the flood control benefit associated with water velocity and water surface elevation reductions. If sufficient flood control benefits are realized through upland controls, then there should be no need to channelize reaches of receiving waters that have important aquatic life, recreation, and aesthetic benefits.

**Purpose and Benefits of Specific Runoff Control Requirements**
The use of other controls, such as filtration and ponds, is given a lower priority than infiltration devices. However, there are several situations where wet detention ponds are preferred. A watershed hydraulic analysis is needed to determine the most efficient locations and sizes for dry detention ponds used for runoff flow rate control. Generally, hydraulic detention should be discouraged in the lower reaches of a watershed and preferentially located in upper reaches. If runoff was detained in the lower reaches of the watershed, the peak portions of upper watershed hydrographs may unhappily coincide with relatively high flows from the detained areas. This would result in greater peak flows than if no detention was practiced. Therefore, wet detention ponds used for water quality control should be designed with minimal flow rate effects, unless a large scale hydraulic analysis indicates that hydraulic detention would be beneficial.

Wet detention ponds are needed in areas that have large pollutant potentials and where infiltration controls can not be used because of possible groundwater contamination. Large parking or storage areas (paved or unpaved) greater than one acre in size need on-site wet detention ponds to serve as pre-treatment devices before infiltration. Smaller areas may be better served with large catchbasins, or sand filters, as infiltration pretreatment. Shopping centers are the most significant example of these areas. Additionally, industrial areas greater than about 3 acres need to be served with on-site wet detention ponds, with no infiltration. Large residential areas, especially if having high density single family or multi-family units, could also effectively use wet detention ponds as part of the landscaping plans to supplement the infiltration program.

Many of the specific requirements contained in this example ordinance require some type of on-site infiltration with pretreatment and possibly wet detention. These relatively costly on-site controls can significantly reduce local government costs for maintaining off-site drainage systems and areawide runoff controls. If a utility district, or other assessment procedure is available to recover operation and maintenance costs, then well designed and located regional runoff controls could be substituted for some of these required on-site controls. It can be very

costly for a city to operate and maintain regional stormwater facilities if it is unable to recover its costs from the major stormwater volume and pollutant generators.

Industrial areas have been found to produce very large portions of the total urban runoff wasteload in cities, especially of heavy metals and toxic organics 6. Unfortunately, much of this material is discharged during dry weather, possibly as part of wash operations or minor spills. Wet detention basins at the outfalls of industrial developments are needed to control runoff from the industrial sites and to offer an opportunity to remove any dry weather industrial spills and discharges. Reported spills that enter the stormwater drainage system in industrial areas may also be contained for cleanup in outfall wet detention basins. Installation of required detention basins during the early phases of a construction project (before the drainage system is installed) can significantly reduce sediment transport from a construction site to receiving waters.

Certain specific requirements are needed for areas or developments that are likely to produce significant water volume or pollutant discharges. Large roofs produce substantial portions of the total runoff volumes from commercial and many industrial areas. Roof runoff is relatively unpolluted, however, except for high zinc concentrations from galvanized roof drainage systems. Paved parking and storage areas also produce large volumes of runoff, and this water can be heavily polluted, especially in manufacturing or heavy industrial areas. While infiltration of roof runoff from large roofs can produce significant water volume reductions, it cannot be used when roof runoff may be heavily contaminated, as may occur in manufacturing industrial areas. Where groundwater contamination is likely (such as when the groundwater is close to the surface), wet detention basins may be the best control device.

Industrial areas pose an important exception to large, integrated detention basins. Public water contact in industrial area wet detention basins should be discouraged because they have very poor water quality. Industrial discharges should also be kept separated in their own detention basins to optimize any special controls that may be needed.

Wet detention basin design criteria are mostly in the form of design specifications. They leave as much flexibility as possible to development planners and engineers while giving agency personnel sufficient guidance for reviewing expected stormwater management performance. The simple design specifications for detention basins (especially the required surface areas and pool volume) vary for each type of area to be treated, based on extensive field studies and analyses of many specific conditions.

**Discharge Quality Requirements for Stormwater**
Discharge standards in a watershed protection ordinance offer an extra level of protection to protect sensitive downstream uses, such as public water supplies. However, the application of common in-stream criteria to stormwater discharges will likely result in many violations that will be difficult and very costly to control and may not be necessary. As an example, the following list shows typical stormwater pollutant concentrations and typical drinking water supply criteria:

- fecal coliform bacteria, typically about 50,000 org/100mL (compared to objectives of 100 to 400 org/100mL).
- copper, typically about 50 μg/L (compared to objectives of about 5 μg/L).
- zinc, typically about 100 μg/L (compared to objectives of about 30 μg/L).
- lead, typically about 50 μg/L (compared to objectives of about 25 μg/L).
- chromium, as high as 300 μg/L in industrial areas (compared to objectives of about 100 μg/L).

- phenolics (especially pentachlorophenol), typically about 1 to 5 μg/L (compared to objectives of about 1 μg/L).

- PCBs, as high as 400 ng/L in industrial areas (compared to objectives of about 1 ng/L).

- Dieldrin, Endrin, and Heptachlor, as high as about 40 ng/L each in residential areas (compared to objectives of about 1 or 2 ng/L).

In addition, certain organic priority pollutants have been routinely found in urban runoff, especially various phthalate esters and PAHs. *Psuedomonas aeroginosa* is the most common bacterial pathogen found in urban runoff, frequently occurring in populations greater than one thousand organisms per 100 mL. Conventional nutrients and organics may also occur in important concentrations in urban runoff, including:

- COD, about 100 mg/L.

- Phosphorus, about 0.5 mg/L.

- Phosphates, about 0.1 mg/L.

- Total Kjeldahl nitrogen, about 2 mg/L.

- Ammonia nitrogen, as high as about 0.4 mg/L.

- Nitrate nitrogen, about 0.6 mg/L.

$BOD_5$ may be only about 10 mg/L in urban runoff, but 20-day BOD values (as associated with urban runoff sediment) can produce as much as five times the oxygen demand as the standard BOD test indicates.

**Selection of Stormwater Controls**

The most important stormwater control requirements (the "general criteria" used to calculate allowable runoff volumes) are presented as performance specifications. Designers have many options available to meet these general performance requirements. The specific stormwater requirements are more restrictive because of unique pollution potentials of different types of projects. Several control practices are most obvious for several source areas:

- Roof drainage. Direct roof runoff to pervious areas or infiltration devices.

- Landscaping areas. If large enough, these areas act as effective grass filter strips and infiltration devices.

- Walkways. Grade to adjacent pervious areas, porous pavement or grass filter strips.

- Driveways. Grade to adjacent pervious areas, porous pavements or grass filter strips.

- Paved parking and storage areas. Grit chambers with sand filters, or detention basins, for pretreatment before infiltration.

- Paved streets. Street cleaning and discharge to roadside grass drainage swales.

Additional stormwater control devices can be applied to storm drainage inlets and storm sewerage. These may include infiltration devices, perforated underground storm drainage systems, roadside grass swales, or catchbasin

cleaning. Outfall controls also may include many options, but the most efficient are typically wet detention basins, especially if followed by infiltration devices.

Many of these options can be used together very well. Infiltration devices, for example, can treat runoff from rains having relatively low intensities but long durations (and therefore large rain volumes). Infiltration devices also remove most pollutants and flow volume from the runoff. However, they discharge these pollutants to the soil and groundwater systems, requiring careful consideration. In all cases, local groundwater contamination potential must be evaluated to reduce the probability of contaminating groundwater with stormwater infiltration. For this reason, a watershed protection ordinance should contain design guidelines that may restrict the use of infiltration devices. Detention basins, on the other hand, work well with high intensity, low volume rains, but do not reduce soluble forms of the pollutants or flow quantities. Therefore, the use of sedimentation and infiltration devices can be used together to treat many runoff pollutants for a wide range of rain conditions.

**Special Considerations for the Control of Stormwater Toxicants**
Serious concentrations of toxicants that commonly exceed carcinogenic alert levels and cause abundant cancerous tumors in fish have been found in urban runoff receiving waters. Some of the more abundant toxic organics are most likely originating from wood preservatives (especially pentachlorophenols, or “penta”, and creosote components) and have been found in many urban runoff and source area sheetflow samples. Industrial areas having large amounts of preserved wood stored uncovered on paved storage areas may be the most important source. Extensive use of treated wood utility poles located adjacent to drainage gutters may also be important pentachlorophenol and creosote compound sources in residential areas. Residential use of CCA (copper, chromium and arsenic mixtures) and penta-treated wood seems to be increasing.

Other organic carcinogenic compounds frequently observed in urban runoff include polycyclic aromatic hydrocarbons, or PAHs (from fossil fuel combustion) and chlordane. There is little that can be done to control the PAHs, besides possible research in combustion technology and controls (for vehicles, industrial sources and residential wood, coal and fuel oil burning). Chlordane is frequently used in soil treatment for insects, especially by commercial pest exterminators. Their use for specific problems and soil types should be evaluated and more restrictive use guidelines adopted.

Another area of potential urban runoff concern that is increasing substantially in urban areas is the use of commercial lawn maintenance companies. There is very little control of their services, and there have been some complaints of excessive overspray and allergic reactions to their products. These complaints are very difficult to confirm, but recent observations of fertilizers, herbicides, and insecticides in urban runoff from “well-maintained” residential areas indicate overuse of many products. Better local control of such products, usage rates, and application procedures (especially restrictions on windy days or immediately preceding rains) is warranted.

Another important source of toxicants in urban runoff is leakage of gasoline from underground storage tanks and runoff from automobile service stations and repair facilities. The EPA, as part of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), has passed rules to reduce leakage from underground storage tanks. More than 95 percent of the 2 million underground storage tanks in the U.S. hold petroleum products and about 80 percent of the tanks in use are unprotected bare steel tanks that are most likely to leak (Engineering Times 1988). The EPA has estimated that about 100,000 of the nation’s existing underground storage tanks are currently leaking and another 350,000 may begin to leak soon (Boutacoff 1988). Corrosion of steel tanks and structural collapse of fiberglass tanks are the most common causes for underground tank leakage. The EPA found that unprotected steel tanks may begin to corrode and leak 2 to 20 years after installation, depending on soil conditions and installation methods. The cost of cleaning up after an underground tank leak can very high, ranging from about $200 to $400 per cubic yard of contaminated soil. Costs can range into the millions, even for a small leak, if groundwater is contaminated (Boutacoff 1988).

The EPA rules were applicable after December 1988 and have different regulations pertaining to underground petroleum storage and underground chemical storage tanks (Newport 1988). The 701 chemicals affected by the Superfund regulations will need to have secondary containment systems along with leak detection and cathodic protection systems, while underground petroleum storage tanks will only require leak detection systems and cathodic protection. The cost of leak detection systems was estimated to be between $3,000 and $8,000 per gas station, while retro-fitting cathodic protection could cost between $10,000 and $50,000 (Engineering Times 1988).
All existing underground petroleum tanks must be upgraded by 1998, while all new tanks must contain the required controls. The EPA rules do allow states to require more stringent regulations (Florida Environment 1988 and Massey 1988).

Leakage from an underground storage tank can contaminate large areas of groundwater along with surface waters. This is of special concern in where sinkholes and associated Karst geological features can allow rapid movement of groundwater throughout an extensive area. Contaminated groundwater can rapidly move from the point of contamination to surface discharge locations in a watershed. As noted above, the EPA rules will allow state and local governments to impose stricter rules than they are promoting. It is expected that many areas will require the use of secondary containment systems for petroleum product storage tanks (Boutacoff 1988).

Additional restrictions on vehicle service facilities are also included in this example watershed protection ordinance. It will also be necessary to work with the fire department to develop appropriate response actions when dealing with spills of gasoline and other hazardous and toxic materials. In all cases, flushing the spilled material into the storm drain system must be avoided.

This example watershed protection ordinance also specifies specific surface runoff controls that are to be used at all vehicle service and repair facilities. The runoff from paved parking and storage areas, and especially gas station areas, has been found to be heavily contaminated with many pollutants. As an example, the following list summarizes the concentrations of some of the toxicants observed in 17 warm weather sheetflow samples obtained during monitoring of these areas in Toronto (Pitt and McLean 1986):

| toxicant | observations | typical criteria |
|---|---|---|
| phenols | 3 to 35 ug/L | 1 ug/L |
| copper | 0.05 to 3 mg/L | 0.005 mg/L |
| lead | 0.1 to 1 mg/L | 0.025 mg/L |
| zinc | 0.1 to 3 mg/L | 0.03 mg/L |

The above concentrations of toxicants found in these parking and storage area sheetflow samples were generally greater than observed elsewhere in the watersheds. The concentrations of toxicants from these types of areas are all much greater than typical concentration objectives. These areas are usually found to contribute most of the toxicant pollutant loadings to the stormwater outfalls. Therefore, this example watershed protection ordinance requires special control practices to treat runoff from vehicle service and repair areas.

The required runoff controls include a three section chamber that is intended to reduce a broad range of toxicants found in the runoff. The multi-chambered treatment tank (MCTT) would meet this criterion (Pitt, *et al*. 1997). The runoff enters the first chamber and passes over a cascade aerator to remove highly volatile components. The first chamber also serves as a grit chamber to remove the largest particles. The second chamber serves as a settling chamber to remove smaller particles and has flow baffles to encourage removal of floatatable pollutants. The water then enters the final chamber containing a sand/peat filter to remove most of the remaining toxicants in the stormwater.

### *Need for Adequate Design and Inspection*

Adequate design specifications, especially those based on local experience, can minimize potential urban runoff problems. Construction site erosion controls may fail for several reasons. Unusual rains that exceed the design

capacities of even correctly constructed and maintained control facilities may cause their failure. Most construction erosion controls are relatively fragile and cannot survive large rains. However, a wet detention basin installed early during the construction period will act as a good sediment trap during a wide range of rains. In-stream detention facilities that receive large amounts of runoff from above a construction project can be easily damaged during large rains. The basin must be cleaned (dredged) often during construction and after final landscaping, for the construction period can produce as much sediment as many years of "normal" urban runoff. Large rains can also damage filter fences and other barriers and can severely erode culverts and waterway diversions. Failed controls are not only unable to reduce expected large amounts of erosion materials during severe rains but also may discharge previously retained sediment.

Improperly located, designed, constructed, or maintained control devices produce little benefit. A common example of a poor location for a control device is the placement of filter fences in established waterways that drain large areas. Filter fences slow down water passing through them and create small detention areas. Particles then settle from the ponded water. They are designed as small wet detention basins, based on their allowable water seepage rates (outfall velocities), and not as filtration devices. They are supposed to be used to control shallow sheetflows. When placed in channels draining areas that are too large, backed up water may topple the filter fence, or the stream may increase in elevation and collapse the fencing, or the water may flow around the filter fence edges. Similar problems exist when straw bales are placed in large waterways. These devices are best used to control sheetflows before they enter the drainage channels. If large drainage channels cannot be diverted and must pass through a project, filter fencing must be placed appropriately to control sheetflows entering the channel. Well designed wet detention (sediment) basins may also be needed below the site.

Probably the most common reason for failure of construction site erosion control devices is inadequate maintenance. These devices are often reluctantly installed and then ignored. If control devices are properly constructed, but not properly or frequently maintained, very little benefit may be expected. Newly installed devices will perform as initially expected until their "capacity" is exceeded. Filter fences, for example, should be maintained before the material that accumulates behind them becomes excessive. More importantly, the integrity of the fence also needs to be checked frequently. Many filter fences at construction sites are undermined or bypassed because of large flows or large sediment accumulations. Sedimentation basins, silt traps, catchbasins, etc., also need to be cleaned frequently. The cleaning frequency of these devices located in areas undergoing construction can be quite high because of the very large discharges of sediment from construction sites. Rill or gully erosion must be corrected immediately when first observed. Similarly, mulched or planted areas need frequent inspections and corrections before large amounts of material are lost.

Erosive rains can occur any time during the construction season. It is obviously not reasonable to expect all exposed areas to be protected immediately after disturbance. The watershed protection ordinance is designed to offer a reasonable amount of protection during site development. If the erosion potential is large (such as for extensive grading operations for initial site layout, etc.), then extra protection measures are needed.

This example watershed protection ordinance's general stormwater runoff volume criteria stress maintaining the natural infiltration rate as much as possible. Since limiting surface runoff volume usually requires infiltration of the runoff, care must be taken to prevent groundwater contamination. Uncontrolled infiltration of polluted runoff, especially when it contains soluble compounds, can contaminate groundwater. Therefore, the watershed protection ordinance requires pretreatment and restricts infiltration of runoff if a groundwater contamination potential exists, such as when the water table is less than three feet from the surface. If infiltration is not feasible, then alternate controls (such as wet detention basins) are required.

Proper plan reviews and adequate inspections by administrative officials can prevent many of the problems caused by improper location, construction, and maintenance of construction erosion and stormwater control devices.

## *Requirements for an Example Watershed Protection Ordinance*

1. Permit requirements.

a. Anyone who proposes to develop a site within the watershed district must apply for a permit. Permit applications must include construction drawings or as-built surveys, depending on the size and type of the activity.

b. Site and drainage plans are also required for all but small activities. Activities that only need to supply construction drawings for a permit include interior or exterior alterations for an existing residential structure. However, if the exterior activities involve disturbing more than 2000 square feet or more than 400 cubic yards of material, the erosion control requirements will still apply.

c. An as-built survey, but not a site plan or a drainage plan, is required if the activity is for exterior alterations of an existing structure and will not increase the total impervious area of the site by more than 1,000 square feet. However, if these activities involve disturbing more than 2,000 square feet or more than 400 cubic yards of material, the erosion control requirements will still apply.

d. Site plans will be required for all other activities. These plans must include the following information:

- Identification of the project and applicant,
- dimensions of the boundaries and legal descriptions of the site,
- locations, dimensions, and elevations of all existing and proposed structures and site improvements (including roads, excavations, drainage facilities, and sewage facilities),
- locations and dimensions of all impervious surfaces and soil descriptions, and
- relations and distances to watershed tributaries within one mile of the site.

e. Drainage plans are also required for all other developments. These plans must be scale drawings, prepared by a civil engineer and include the following information:

- Existing and final elevations,
- flow components from different source areas (such as roof runoff, parking area runoff, etc.), and
- proposed erosion and stormwater controls.

The civil engineer shall also certify that the drainage facilities are designed in accordance with the watershed protection ordinance and will protect adjacent properties and the water supply.

f. Information demonstrating the compliance of the development to the ordinance requirements is also required for all developments required to submit site and drainage plans. This information should include runoff calculations, descriptions of all site survey information required to support the calculations (such as soil borings, infiltration tests, etc.), descriptions of all impervious surfaces, pre- and post-development soil conditions on the site (including descriptions of anticipated fill material and infiltration performance after placement), and design calculations for all required runoff controls. Narrative descriptions of the erosion and stormwater controls (how they will be used to address specific ordinance requirements) should also be included.

g. The application shall also include certifications from the proper authorities demonstrating compliance with applicable county storm sewer and sanitary sewer or septic tank regulations. The application must also contain an affidavit from the owner concerning compliance with the hazardous and toxic waste and material provisions of the watershed protection ordinance. An affidavit must also be included describing solid waste pick up and disposal services, if the site

is not served by the local solid waste disposal service. A copy of the waste hauler contract must also be included in the application.

2. Setback from streams.

a. No development is to occur within the 100 year flood plain. A no-development setback of 100 feet shall also be preserved for any third order, or greater stream, including lakes or small ponds. The setback buffer shall be 50 feet for second order streams, and at least 25 feet for first order streams. No land clearing or other construction activity is permitted in the setback zone.

b. If the land slope exceeds 12 percent, then the setback requirements are increased by 300 percent.

c. In addition, alterations of a tributary channel are not permitted unless specifically approved.

3. Prohibition of certain uses.

a. No heavy manufacturing uses are permitted in the watershed. These uses are defined as those exclusively included in the city's M-2 zoning classification.

b. The storage or use of hazardous or toxic wastes or substances is restricted in any water supply watershed. The specific materials are defined as those listed in various EPA regulations. The amount of material that can be stored in any water supply watershed is limited to 1/10 of the EPA's "reportable quantities." These materials may only be used for the purpose of normal and routine maintenance and use.

c. Chemically treated wood (containing CCA, pentachlorophenol, or cresote) cannot be used within 15 feet of impervious areas that drain to any drainage system. Treated wood must be stored in covered facilities, protected from rain.

4. Requirements for adequate septic or sanitary sewer systems.

a. All developments must be connected to available sanitary sewers. Available sanitary sewers are defined as being within 500 feet of the proposed development site.

b. Existing septic systems must be inspected and approved by the county health department, or licensed inspectors, at least every 5 years, and improved as necessary. In water supply watersheds, new septic systems are only permitted on residential lots larger than 2 acres, and non-residential lots must have at least 2 acres for each 300 gallons of anticipated sanitary sewage flow per day.

5. Requirements for construction site erosion control.

a. Construction site erosion controls are required for all sites having any of the following characteristics:

- grading, clearing, excavation, or land filling activities affecting more than 2,000 square feet,
- excavation and filling operations involving more than 500 cubic yards of material,
- constructing, enlargement, or relocation of streets, highways, roads, or bridges,
- laying, repairing, replacing, or enlarging more than 300 feet of underground pipe or facility.

b. Wastewater from site dewatering operations must be controlled to limit the discharge of particles greater than 50 μm. This control can be obtained by using simple sedimentation devices sized according to the maximum dewatering pumping rates.

c. All building material and other wastes must be removed from the site for disposal in licensed disposal facilities. No wastes or unused building materials shall be buried, dumped, or discharged at the site.

d. Each site shall have graveled access drives and parking areas to reduce the tracking of sediment onto public or private roads. All unpaved roads on the site carrying more than 25 vehicles per day shall also be graveled. Any sediment or debris tracked onto public or private roads shall be removed daily by street cleaners.

e. All storm drain inlets must be protected from erosion materials.

f. Upslope water must be diverted around disturbed areas, or existing channels passing through the site must be protected from erosion runoff.

g. All construction activities must be conducted in a logical sequence to minimize the area of bare soil disturbed at any one time.

h. Disturbed areas exposed for 14 or more days must be stabilized with mulches, temporary vegetation, permanent vegetation, or by other equivalent control measures.

i. Wet detention ponds are required to treat all runoff leaving construction sites, if more than 10 acres are disturbed at one time, or if a channel originates on the site. If less than 10 acres are disturbed at one time, then filter fences, straw bales, or equivalent sediment controls are required along the downslope contours of disturbed areas on the construction site.

j. Roof runoff must be directed to stabilized surfaces.

k. All uncovered soil or dirt storage piles, containing more than 10 cubic yards of material, should be located more than 25 feet from a roadway or drainage channel. If these piles remain for 14 or more days, then their surfaces must be stabilized. If the piles will be in place for less than 14 days, then their perimeters must be surrounded by filter fencing or straw bales. Dirt or soil storage piles located less than 25 feet from the road, containing more than 10 cubic yards of material, and in place for 14 or more days must be covered with tarps or other control. If the piles will be in place for less than 14 days, then their perimeters must be surrounded by filter fencing or straw bales. Storm drain inlets must be protected from potential erosion from near street storage piles by filter fencing or other appropriate barriers.

l. All potentially pollutant-generating vehicle maintenance activities conducted on the construction site (such as lubrication, oil changes, engine repairs, etc.) are to be conducted at a special approved location on the site, protected from rain.

6. Requirements for drainage and stormwater control.

a. The maximum velocity of stormwater runoff under bank-full conditions shall not exceed the U.S. Natural Resources Conservation Service's recommended guidelines for the channel lining material and slope.

b. If the proposed project is a single residential lot located in an area having an existing stormwater drainage system (a platted subdivision or certified survey), then the general runoff volume requirements can be met by either demonstrating compliance with the curve number requirements, or by:

- discharging roof runoff to pervious areas having flow distances of at least 15 feet before reaching impervious surfaces, or discharging to an infiltration device, and

- slope all driveways towards adjacent landscaped areas.

c. If the proposed project is a residential or other nonindustrial certified survey, then the general runoff volume requirements can be met by either demonstrating compliance with the curve number requirements, or by:

- following the same requirements for roof and driveway runoff as listed above, plus directing runoff from paved parking and storage areas to pervious areas as sheetflows, and having flow distances of at least 50 feet, or
- using a grass swale or other infiltrating stormwater drainage system designed to infiltrate all flows from common one-year storms, if groundwater conditions allow.

d. All other developments must meet the general runoff volume requirements by demonstrating compliance with the curve number requirements:

| hydrologic soil group | allowable curve number |
|---|---|
| A (sandy soils) | 54 |
| B | 70 |
| C | 80 |
| D (clayey soils) | 85 |

(these curve numbers correspond to residential districts with 0.5 acre lots, and are also close to the conditions for open space areas with lawn/park in fair condition, or pasture or rangeland in fair condition)

The general water volume limitations are based on U.S. Natural Resources Conservation Service (NRCS, was SCS) “curve numbers” (CN) for different soil hydrologic groups (SCS 1986). Most engineers and planners are familiar with the SCS curve numbers and their use for designing drainage facilities. The curve numbers are highly dependent on land development and relate expected runoff volumes to different rain types. Higher curve numbers indicate more runoff than lower curve numbers for similar soil and rain conditions. As examples, undeveloped land has lower curve numbers than most residential land, and residential land has lower curve numbers than shopping centers.

Typical medium density residential areas, with curbs and gutters, located on noncompacted sandy soils (A or B soil types) have curve numbers of about 75. Commercial areas have curve numbers of about 90, and industrial areas have curve numbers of about 85 for these same conditions. The runoff volume criteria would require that all developed areas having the same native soil type, irrespective of land use, have the same discharge volumes. Areas having large curve numbers would therefore require greater efforts to reduce the CN values to acceptable values, compared to areas that have smaller curve numbers. Reducing the curve number from 85 to 70 (such as would be required for the above industrial area in areas having B soils) would result in a runoff volume (and therefore approximate pollutant yield and peak flow rate) reduction of about 50 to 90 percent, depending on the rain depth.

The general flow-limiting criteria are used to determine the allowable runoff flow volumes for applicable proposed land developments. The curve number criteria were selected to be sensitive to existing limitations in natural soil infiltration capabilities. If the undisturbed soils have a low infiltration capability (such as a type D soil), then the soil would naturally produce more runoff than a soil having a larger infiltration capability (such as a type A, B, or C soil). Thus, different curve number criteria were selected to produce resultant runoff volumes that would be somewhat greater than undisturbed conditions (to attempt to reasonably match the natural hydrologic cycle). This would allow limited

development without extensive stormwater management requirements. Stormwater management efforts for similar proposed developments in different soils would be similar. If highly intensive levels of development are proposed (such as a shopping center), then correspondingly greater stormwater management efforts would be required than for less intensive developments having larger amounts of pervious areas.

Some low levels of development (such as low density residential developments) are probably possible for most soil conditions without extensive stormwater controls. In many higher density residential developments, it is also probable that very few extensive stormwater controls are needed, beyond roadside grass drainage swales. If a developer has previously installed curb and gutter systems, then it will be very difficult to meet the general criteria without an extensive infiltration system. Similarly, if local ordinances require roof drains to be connected to an underground drainage system, much more expensive infiltration devices will probably be required.

As examples of the types of controls needed to meet these CN criteria, residential areas may only require the use of grass drainage swales (or infiltrating catchbasins in steep areas). In contrast, commercial areas may require extensive use of bioretention areas for roof and parking area runoff. Industrial areas could also achieve these runoff goals with grass swales, but infiltration devices (including grass swales) in manufacturing areas should not be used because of the potential for groundwater contamination. Roof runoff from most non-manufacturing areas, however, could be reduced through infiltration practices with little potential for groundwater contamination. All subsurface infiltration devices should be protected with pretreatment. Pretreatment may be simple catchbasins or wet detention ponds, depending on the size of the facility, and should be designed to remove the larger particulates that may clog the infiltration device. The use of a runoff volume performance criteria allows the site developers flexibility, in contrast to requiring specific devices.

e. Specific stormwater requirements apply for certain conditions:

- Large roofs totaling more than 10,000 square feet must direct the roof runoff to infiltration devices, depending on groundwater conditions. All runoff from all 1-year storms shall be infiltrated.
- Medium parking lots and storage areas, having areas between 5,000 to 500,000 square feet must direct this runoff to critical source area control devices, such as the multi-chambered treatment train (MCTT) and then to infiltration devices. All runoff from all 1-year storms shall be infiltrated. If groundwater conditions prevent the use of infiltration devices, then wet detention ponds must be used.
- Large parking lots and storage areas, having areas greater than 500,000 square feet, must use wet detention basins before infiltration devices (such as percolation ponds). All runoff from all 1-year storms shall be infiltrated. Groundwater conditions may prevent the use of infiltration devices.
- Industrial sites less than 100,000 square feet must pretreat their runoff with critical source area control devices, such as the multi-chambered treatment train (MCTT), before discharge. These devices are designed to remove all particles greater than 5 μm for the common one year storms.
- Industrial sites greater than 100,000 square feet must pretreat their runoff in wet detention ponds before discharge. Additional treatment may be needed for all industrial areas.
- Vehicle service and repair facilities require the use of special treatment devices to reduce volatile, particulate, and floatable pollutants using critical source area control devices, such as the multi-chambered treatment train (MCTT). The discharge from these devices is to be directed either to a grass lined infiltration area or to a sand filter. All runoff from all 1-year storms shall be infiltrated (if groundwater conditions

permit). Underground storage tanks must also be protected with leak detectors and cathodic protection systems. Secondary containment may also be needed.

f. All stormwater is to be pretreated before using infiltration devices (can be accomplished by grass filtering in swales or bioretention areas, or infiltrating through surface soils in residential areas, for example). Surface infiltration devices (such as grass spreading areas, grass swales, bioretention areas, and percolation ponds) are to be used. Subsurface infiltration devices (except for roof runoff), especially dry wells extending to the saturated zone, are not to be used, except under special circumstances when adequate pretreatment can be demonstrated. Commercial and industrial area runoff will need specialized pretreatment to demonstrate lack of groundwater contamination potential.

g. All stormwater discharges must also meet any stormwater quality requirements specified in the watershed protection ordinance. Compliance will be tested with periodic monitoring of runoff quality.

### *Potential Applicability of Example Stormwater Runoff Quality Requirements for Different Land Uses*

Only three land use development characteristics affect the applicability of the specific runoff requirements summarized above. These are:

- Large roofs (greater than 10,000 square feet, or about 0.23 acre);
- Medium parking and storage areas (between 5,000 and 500,000 square feet, or about 0.11 acre); and
- Large parking and storage areas (greater than 500,000 square feet, or about 11.5 acre).

The following list summarizes the land uses to which the specific requirements probably would apply:

1. Criteria for Areas Having Large Roofs and Medium Sized Parking Areas

- Multi-family residences (except duplexes). Probably all proposed developments.
- Schools (because of paved playgrounds). Probably all proposed school projects.
- Hospitals. Probably all proposed projects.
- Strip commercial areas. Many proposed projects.
- Office buildings. Probably most proposed office developments.
- Parks and golf courses. Some of these “open space” developments have large parking areas or roofs that would require specific stormwater controls.

2. Criteria for Large Parking and Storage Areas

- Shopping Centers. Almost all shopping center developments have very large parking areas.

## Summary of Regulations and Public Education as Stormwater Control Benefits

Much has been occurring with public education in stormwater management in recent years. Many local communities are relying on it as one of the major tools in their stormwater management plans because of its relatively low cost. Unfortunately, the water quality benefits of public education has not been established. The current Austin, TX, effort will be the first direct monitoring activity to attempt to quantify the water quality benefits of public education. Irrespective of the outcome of that study, public education must always be considered an important part of any stormwater management program. The example of Charlotte, NC, points out many important benefits of an extensive public education program, especially in obtaining support for the stormwater management program, the establishment of a stormwater utility district, and in funding. Tokyo's extensive public education program has been very successful in encouraging private land owners to install infiltration facilities at their own cost. Even if no measurable water quality improvements can be detected in a watershed where storm drainage inlets have been stenciled, the public support and their active participation in the program enables other elements of the program to proceed and succeed. In all cases, very little stormwater quality improvement has occurred anywhere in the absence of mandated regulations.

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