

Administrative correction.
See: 29 N.J.R. 1296(a).

5:21-7.5 Stormwater Management: system design— detention facilities

(a) Development shall use the best available technology to accommodate stormwater management by natural drainage strategies where possible and practicable. Detention facilities, when required or selected, shall be designed, constructed, and maintained according to the following standards.

(b) Design engineers shall coordinate structural detention requirements with nonstructural practices, such as cluster land-use development, open space acquisition, stream encroachment, and flood-hazard controls.

(c) Detention and all other stormwater facilities shall conform to the New Jersey Department of Environmental Protection's Stormwater Management Rules, at N.J.A.C. 7:8-3.4. Design engineers shall also adhere to, when applicable, the stormwater design requirements in the following rules:

1. Coastal Zone Management Rules, N.J.A.C. 7:7E;
2. Dam Safety Standards, N.J.A.C. 7:20;
3. Soil Erosion and Sediment Control Standards, N.J.A.C. 2:90-1;
4. Flood Hazard Area Regulations, N.J.A.C. 7:13;
5. Pinelands Regulations, N.J.A.C. 7:50-6.81 through 6.88; and
6. Freshwater Wetlands Protection Act Rules, N.J.A.C. 7:7A.

(d) Where detention facilities are deemed necessary, they shall accommodate site runoff generated from two-year, 10-year, and 100-year storms as routed to the basin, considered individually, unless the detention basin is classified as a dam, in which case the facility also must comply with the Dam Safety Standards, N.J.A.C. 7:20.

1. These design storms shall be defined as either a 24-hour storm using Type III rainfall distribution when using U.S. Soil Conservation Service procedures (such as TR-20 or TR-55 tabular method), or the design storm resulting in the greatest storage volume to achieve the required outflow using a design method such as the Modified Rational Method. Runoff greater than that occurring from the 100-year, 24-hour storm will be passed over an emergency spillway.

i. A map of approximate geographic boundaries for S.C.S. rainfall distributions presented on page B-2 of the June 1986 edition of TR-55 shows all of New Jersey in the Type III region. Although the May 1982 version of TR-20 does not include a standard S.C.S. 24-hour, cumulative Type III distribution rainfall table like it

does for Type I, IA, and II, there is a test version (Version 2.04TEST) of the program available from the S.C.S. which does. The Type III distribution also can be manually added to a TR-20 model by using a RAINFL table.

2. Detention facilities shall be designed to accommodate runoff from the development of the site for the two-, 10-, and 100-year storm events so that pre-development peak flow rates that impact on downstream properties, watercourses, and/or drainage systems are not increased.

3. Where there is not a regional stormwater plan, as specified below in (d)4, then the design engineer shall design detention facilities such that the post-project construction peak runoff for the two-year storm event is 50 percent of the pre-project construction peak runoff rate. The post-project construction peak runoff rates for the 10 and 100-year storm events shall be 75 and 80 percent, respectively, of the pre-project construction peak runoff rates. It should be noted that these percentages only apply to the portion of the post-project runoff from the site under development. Offsite runoff may be computed at 100 percent of the pre-project rate.

4. If a Phase II stormwater management plan for the region or watershed exists, consistent with stormwater rules administered by the New Jersey Department of Environmental Protection, N.J.A.C. 7:8, then the design engineer may design stormwater management systems to conform to the plan. For some parts of the watershed, this may mean a detention basin is unnecessary.

5. If the development site is not part of a Phase II regional or watershed stormwater management plan, then the design engineer may model the watershed, consistent with regulations administered by the Department of Environmental Protection, and design stormwater management facilities to conform to that plan. This analysis shall include impacts of existing development and all potential future development in the drainage area. For some parts of the watershed, this may mean detention is unnecessary.

(e) Design engineers shall locate detention facilities (either "wet" or "dry") so as not to interfere or adversely affect existing surface waters on the site or adjacent to the site. Excavation for detention facilities shall be designed to be the maximum practical distance above seasonally high groundwater elevation. In the case of "wet" detention facilities, storage may only be presumed to be available above the elevation of the seasonal high groundwater. If the facility is designed as an infiltration basin, the bottom of the basin shall be a minimum of two feet above the elevation of the seasonally high water table.

(f) The following list of general structural criteria shall be used to design stormwater detention basins.

1. Detention components: principal basin control structure (quantity control), as follows:

i. Principal basin control structures will consist of orifice and/or weir control devices. Design engineers shall design orifices based upon the following equation:

$$Q = C A (2gH)^{0.5}$$

where

- Q = the flow rate in cubic feet per second
- C = 0.6 (The orifice flow coefficient "C" may vary, depending on entrance conditions. Design engineers may use other coefficients with appropriate references.)
- A = cross-section area of flow in square feet
- H = the vertical distance in feet between the center of the orifice and the water surface
- 2g = 64.4 feet per second²

To minimize the chance of clogging, orifices intended solely for runoff quantity control will be at least six inches in diameter (or its equivalent). All joints are to be watertight. In addition, trash racks and/or anti-vortex devices shall be required. When weirs are used alone or in conjunction with orifices, design engineers shall use the following equation:

$$Q = C_w L(h)^{3/2}$$

where

- Q = the flow rate in cubic feet per second
- C_w = 3.2 (design engineers may use other coefficients with appropriate references)
- L = length of the weir in feet
- h = the vertical distance in feet between water surface elevation and the crest of the weir.

All weirs shall be constructed as part of a reinforced concrete structure with appropriate grates.

ii. Eight-inch-thick, anti-seep collars are to be installed along outlet pipes. Reinforcement steel shall be No. 5 bars at 12 inches both ways, with two inches of cover on both faces (minimum).

iii. Where necessary for stability of the outlet pipe, a concrete cradle shall be provided.

iv. All principal basin control structures shall be precast or reinforced concrete. All joints are to be watertight.

v. Suitable lining shall be placed upstream and downstream of principal basin control structures, as necessary, to prevent scour and erosion. Such lining shall conform to Standards for Soil Erosion and Sediment Control in New Jersey, N.J.A.C. 2:90, promulgated by the N.J. State Soil Conservation Committee.

2. Detention components: emergency spillways, as follows:

i. Vegetated emergency spillways shall have side slopes not exceeding three horizontal to one vertical.

ii. Maximum velocities in emergency spillways shall be checked based on the velocity of the peak flow in the spillway resulting from the routed Emergency Spillway Hydrograph. The design of the emergency spillway will be based on the 100-year inflow to the basin, except for class IV dams, which shall comply with the Dam Safety Standards, N.J.A.C. 7:20 The design of the emergency spillway assumes the principal spillway is malfunctioning and will not allow any discharge or flow. Where maximum velocities exceed those contained in Table 7.5 below, suitable lining shall be provided.

iii. Where maximum velocities exceed the allowable velocities for soil stability as determined in the Standards for Soil Erosion and Sediment Control in New Jersey, N.J.A.C. 2:90, promulgated by the N.J. State Soil Conservation Committee, suitable lining should be provided. Design engineers also may check maximum velocities in emergency spillways based on the velocity of the peak flow in the spillway resulting from the routed Emergency Spillway Hydrograph. Where maximum velocities exceed those contained in Table 7.5 below, suitable lining shall be provided. Linings shall meet specifications required in Hydraulic Engineering Circular No. 15—Design of Stable Channels with Flexible Linings, published by the U.S. Department of Transportation, Federal Highway Administration or Standards for Soil Erosion and Sediment Control in New Jersey, N.J.A.C. 2:90, promulgated by the State Soil Conservation Committee, New Jersey Department of Agriculture.

TABLE 7.5

PERMISSIBLE VELOCITIES FOR EMERGENCY SPILLWAYS WITH UNIFORM STANDS FOR VARIOUS WELL-MAINTAINED GRASS COVERS

Ground Cover	Slope Percent	Permissible Velocities On:	
		Erosion-resistant soils (fps)	Easily eroded soils (fps)
Kentucky bluegrass	5-10	6	4
Lawn grass mixture	0-5	5	4
	5-10	4	3
Weeping lovegrass			
Alfalfa	0-5	3.5	2.5
Crabgrass			

Note: fps = feet per second
 Source: Soil Conservation Service, U.S. Department of Agriculture (Washington, D.C.: Government Printing Office, 1959). Cited in ULI-ASCE-NAHB, Residential Storm Water Management: Objectives, Principles, and Design Considerations (Washington, D.C.: Government Printing Office, 1975).

3. Detention components: dams, as follows:

i. Dam refers to any artificial dike, levee, or other barrier with appurtenant works that is constructed to impound water on a permanent or temporary basis and raises the water level five feet or more above the usual, mean, low-water height when measured from the downstream toe-of-dam to the emergency spillway crest, or, in the absence of an emergency spillway, the top of the dam.

ii. Design engineers shall design all dams in accordance with Dam Safety Standards, N.J.A.C. 7:20, administered by the New Jersey Department of Environmental Protection.

4. Detention basin berms and embankment ponds, as follows:

i. A detention basin berm is a water impoundment made by either constructing an embankment (a facility referred to as an embankment pond), or excavating a pit or dugout that does not qualify as a dam. Detention basin berms constructed by the second method are referred to as excavated ponds.

ii. Site conditions shall be such that runoff from the design storm can safely pass through: a natural or constructed emergency spillway designed to accept the entire 100-year flow; a combination of a principal spillway and the emergency spillway designed to ensure passage of the 100-year flow when either the principal spillway and/or the emergency spillway flows are impeded by debris; or a principal spillway designed so as to allow it to continue to function reliably, passing the 100-year flow, when impeded by debris.

(1) Drainage area of the pond shall be protected against erosion so that expected sediment does not shorten the planned effectiveness of the structure.

(2) When necessary, embankment ponds shall have foundation cutoff walls of relatively impervious material under the berm. The cutoff walls shall extend up to abutments as required and be deep enough to extend into a relatively impervious layer, or provide for a stable structure when combined with seepage control. The cutoff trench shall have a bottom width adequate to accommodate the equipment used for excavation, backfill, and compaction operations. Cutoff wall side slopes shall not be steeper than one horizontal to one vertical. The cutoff walls shall extend up to the normal water line and the minimum depth shall be at least three feet.

(3) Design engineers shall include seepage controls if pervious layers are not intercepted by the cutoff, seepage creates swamping downstream, such control is needed to insure a stable embankment, or special problems may require drainage for a stable berm. Seepage may be controlled by foundation, abutment, or embankment drains; reservoir blanketing; or a combination of these measures.

(4) The minimum top width for a berm shall be six feet. The minimum top width of dams should be 10 feet.

(5) All slopes must be designed to be stable. If needed to protect the slopes of the berm, special measures such as rock rip-rap, sand gravel, fabrics, geofabrics, geomembranes, or special vegetation shall be provided, as specified by the standards in: Guide

for Design and Layout of Vegetative Wave Protection for Earth Dam Embankments, Technical Release No. 56, and Riprap for Slope Protection Against Wave Action, Technical Release No. 69. Both reports are published by the U.S. Department of Agriculture, Soil Conservation Service, and are incorporated herein by reference.

(6) The minimum elevation of the top of the settled embankment shall be one foot above the water surface in the detention basin, with the emergency spillway flowing at the design depth. The minimum difference in elevation between the crest of the emergency spillway and the settled top width of the structure shall be two feet for all berms having more than a 20-acre drainage area or more than 20 feet in effective height. Design engineers shall increase the design height of the structure by the amount needed to insure that after settlement the height of the berms equals or exceeds the design height. This increase shall not be less than five percent, except where detailed soil testing and laboratory analysis shows that a lesser amount is adequate.

(7) Design engineers shall place a pipe conduit with needed appurtenances under or through the berm except where rock, concrete, or other types of mechanical spillways are used or where the rate and duration of flow can be safely handled by a vegetated or earth spillway.

iii. The design elevation of the top of all embankments and berms shall be one foot or greater than the maximum water surface elevation in the basin, when stormwater from the 100-year flood passes over the emergency spillway. The design height, defined as the vertical distance from the top to the bottom of the deepest cut, shall be constructed to insure that the top elevation will be maintained following all settlement.

(1) When the design discharge of the principal spillway is considered in calculating peak outflow through the emergency spillway, the crest elevation of the inlet shall be such that the full flow will be generated in the conduit before there is discharge through the emergency spillway. The inlets and outlets of the principal spillway shall be designed to function satisfactorily for the full range of flow and hydraulic head anticipated. The capacity of the pipe conduit shall be adequate to discharge long-duration, continuous, or frequent flows without flow through the emergency spillways. The pipe diameter shall be no less than six inches. If the pipe conduit diameter is larger than 10 inches, its design discharge may be considered when calculating the peak outflow rate through the emergency spillway.

(2) Pipe conduits under or through the berm shall be capable of withstanding external loading without yielding, buckling, or cracking. Flexible pipe

strength shall not be less than that necessary to support the design load with the maximum of five percent deflection. The inlets and outlets shall be structurally sound and made of materials compatible with those of pipe. All pipe joints shall be made watertight by the use of couplings, gaskets, or caulking.

iv. Acceptable pipe materials are corrugated polyethylene, reinforced concrete, and ductile iron. When necessary for stability, concrete and ductile pipe shall be laid in a concrete bedding. Corrugated polyethylene pipe exposed to direct sunlight shall be made of ultraviolet-resistant materials and protected by coating or shielding, or provisions for replacement should be made as necessary. Connections of corrugated polyethylene pipe to less flexible pipe or structure must be designed to avoid stress concentrations that could rupture the plastic. Design engineers shall follow specifications in Table 7.6 below for polyvinyl chloride (PVC) pipe.

TABLE 7.6

ACCEPTABLE PVC PIPE FOR USE IN EARTH BERMS[†]

Normal pipe size (inches)	Schedule for standard dimension ratio (SDR)	Maximum depth of fill over pipe (feet)
4 or smaller	schedule 40	15
	schedule 80	20
	SDR 26	10
6, 8, 10, 12	schedule 40	10
	schedule 80	15
	SDR 26	10

[†] Polyvinyl chloride pipe, PVC 1120 or PVC 1220, conforming to ASTM D1785 or ASTM D2241.

Design engineers shall provide for seepage control if the conduit is of smooth pipe larger than eight inches in diameter.

v. Seepage control along pipes extending through embankments shall be controlled by use of a filter and drainage diaphragm, unless it is determined that antiseep collars will adequately serve the purpose.

(1) The drain is to consist of sand meeting fine concrete aggregate requirements (at least 15 percent passing through the No. 40 sieve, but no more than 10 percent passing through the No. 100 sieve). If unusual soil conditions exist, design engineers shall make a special design analysis. The drain shall be a minimum of two-feet thick and extend vertically upward and horizontally at least three times the pipe diameter, and vertically downward at least 18 inches beneath the conduit invert. The drain diaphragm shall be located approximately parallel to the centerline of the embankment. The drain shall be outletted at the embankment downstream toe, preferably using a drain backfill envelope continuously along the pipe where it exits in the embankment. Protecting drain fill from the surface erosion will be necessary.

(2) When antiseep collars are used in lieu of a drainage diaphragm, they shall have watertight connection to the pipe. Maximum spacing shall be approximately 14 times the minimum projection of the collar measured perpendicular to the pipe. Collar material shall be compatible with the pipe materials. The antiseep collar(s) shall increase by 15 percent the seepage path along the pipe. When antiseep collars are used in lieu of the drainage diaphragm, the design engineers shall use the following criteria to determine the size and number of antiseep collars.

Let V = vertical projection and minimum horizontal projection of the antiseep collar in feet.

Let L = length in feet of the conduit within the zone of saturation, measured from the downstream side of the riser to the toe drain or point where the phreatic line intercepts the conduit, whichever is shorter.

Let n = number of antiseep collars.

The ratio of the length of the seepage ($L + 2nV$) is to be at least 1.15. Antiseep collars should be equally spaced along part of the barrel within the saturated zone at distances of not more than 25 feet.

vi. Closed circuit spillways designed for pressure flow must have adequate antivortex devices. To prevent clogging of the conduit, an appropriate trash guard shall be installed at the inlet or riser.

vii. Emergency spillways convey the design flow safely past earth embankments when the principal or auxiliary spillway is disabled. Design engineers shall provide for an emergency spillway for each basin.

(1) Emergency spillways shall provide for passage of the design flow at a safe velocity to a point downstream where the berm will not be endangered. The maximum permissible velocity in the exit channel shall be four feet per second, where only sparse vegetative cover can be expected; where excellent vegetative cover and a vigorous sod can be expected and maintained, the maximum permissible velocity is 6 feet per second.

(2) If chutes or drops are used for the principal or emergency spillways, they shall be designed according to standards in the U.S. Department of Agriculture, Soil Conservation Service's *Engineering Manual for Conservation Practices* (1984), or the U.S. Department of Agriculture's *National Engineering Handbook*, section 5, "Hydraulics;" section 11, "Drop Spillways;" and section 14, "Chute Spillways;" incorporated herein by reference. The minimum capacity of a structural spillway shall be that required to pass the peak flow expected from the design storm.

viii. For excavated basins, provisions shall be made where needed for a principal spillway, emergency spillway, and embankment in accordance with the embankment and berm criteria described in this section.

(1) Where soil conditions and safe maintenance practices allow, side slopes of the excavated basin shall be stable and no steeper than three horizontal to one vertical.

ix. The material placed in the fill shall be free of detrimental amounts of sod, roots, frozen soil, stones more than six inches in diameter (except rock fills), and other objectionable material.

(1) Drainfill shall be kept from being contaminated by adjacent soil materials during placement by either placing it in a cleanly excavated trench, or by keeping the drain at least one foot above the adjacent earthfill.

(2) Selected drainfill and backfill material shall be placed around structures, pipe conduits, and antiseep collars at about the same rate on all sides to prevent damage from unequal loading. Fill material shall be placed and spread beginning at the lowest point in the foundation and then bringing it up in continuous horizontal layers thick enough that the required compaction can be obtained. The fill shall be constructed in continuous horizontal. If openings or sectionalized fills are required, the slope of the bonding surfaces between the embankment in place and the embankment to be placed shall not be steeper than the ratio of three horizontal to one vertical. The bonding surface shall be treated the same as that specified for the foundation to insure a good bond with the new fill.

(3) The distribution and gradation of materials shall be such that no lenses, pockets, streaks, or layers of material shall differ substantially in texture or gradation from the surrounding material. If it is necessary to use materials of varying texture and gradation, the more impervious material shall be placed in the center and upstream parts of the fill. If zoned fills of substantially differing materials are specified, the zones shall be placed according to lines and grades shown on the drawings. The complete work shall conform to the lines, grades, and elevations shown in the drawings or as staked in the field.

(4) The moisture content of the fill material shall be adequate for obtaining the required compaction. Material that is too wet shall be dried to meet this requirement, and material that is too dry shall be wetted and mixed until the requirement is met. Construction equipment shall be operated over each layer of fill to insure that the required compaction is obtained. Special equipment shall be used if needed to obtain the required compaction. If a minimum required density is specified, each layer of fill shall be compacted as necessary to obtain that density.

(5) Fill adjacent to structures, pipe conduits, and drainfill or antiseep collars shall be compacted to a density equivalent to that of the surrounding fill by hand tamping or by using manually directed power tampers or plate vibrators. Fill adjacent to concrete structures shall not be compacted until the concrete has had time to gain enough strength to support the load.

x. All permanent and temporary stabilization should be applied pursuant to the Standards for Soil Erosion and Sediment Control in New Jersey, N.J.A.C. 2:90.

xi. In a principal spillway, pipe materials shall conform to the appropriate specifications. Antiseep collars shall be made of materials compatible with that of the pipe and shall be installed according to the manufacturer's instructions. It may be firmly and uniformly bedded throughout its length, and shall be installed to the line and grade shown on the drawings.

xii. The mix design and testing of concrete shall be consistent with the size requirements of the job. Mix requirements or necessary strength shall be specified. The type of cement, air entrainment, slump, aggregate, or other properties shall be specified as necessary. All concrete is to consist of a workable mix that can be placed and finished in an acceptable manner. Necessary curing shall be specified. Reinforcing steel shall be placed as indicated on the plans and shall be held securely in place during concrete placement. Subgrades and forms shall be installed to line and grade, and the forms shall be mortar tight and unyielding as the concrete is placed.

xiii. Foundation and embankment drains, if required, shall be placed to the line and grade shown on the drawings. Detailed requirements for drain material and any required pipe shall be shown in the drawing and specifications for the job.

xiv. Concerning excavated basins, the compacted excavation shall conform to the lines, grades, and elevations shown on the drawings or as staked in the field.

xv. Concerning embankment and excavated berms, construction operations shall be carried out so that erosion and air and water pollution are minimized, and held within legal limits. All work shall be conducted in a skillful manner. The completed job shall present a workmanlike appearance.

(1) Measures and construction methods that enhance fish and wildlife values shall be incorporated as needed and practical. Ground cover to control erosion shall be established as needed and practical. Fencing shall be provided as needed.

5. Detention facilities in flood hazard areas, as follows:

i. Detention development must comply with all applicable regulations under the Flood Hazard Area Control Act, N.J.S.A. 58:16A-50 et seq.

6. The following safety provisions shall apply to stormwater management basins and parts thereof.

i. Trash racks shall be installed at the intake to the outlet from the stormwater management basin if the intake has a diameter of 12 inches or greater.

ii. Trash racks shall be designed to have parallel bars with no greater than six-inch spacing. The spacing shall be designed so as not to adversely affect the hydraulic performance of the outlet pipe or structure.

iii. The average velocity of flow through a clean trash rack is not to exceed 2.5 feet per second under the full range of stage and discharge. Velocity is to be computed on the basis of the net area of opening through the rack.

iv. Any outlet structure with an overflow grate must have the grate secured but removable for emergencies and maintenance. Grate spacing shall be no greater than two inches across the smallest dimension.

v. Trash racks and overflow grates shall be constructed and installed to be rigid, durable, and corrosion resistant and shall be designed to withstand a perpendicular live loading of 300 lbs/ft sq.

vi. Every outlet structure of a basin shall have escape provisions in or on the structure. Free-standing outlet structures may be excluded at the discretion of the approving authority.

vii. Safety ledges shall be constructed on the slopes of all new retention basins with a permanent pool of water deeper than two-and-one-half feet. Ledges shall be comprised of two steps, each four to six feet in width, one located approximately two-and-one-half feet below the permanent water surface, and the second located one to one-and-one-half feet above the permanent water surface.

viii. In new stormwater management basins, maximum interior slopes for earthen dams, embankments, or berms shall not exceed three horizontal to one vertical.

ix. Municipalities or other specified agencies may grant a variance or exception from these safety standards if they determine in writing that such variance or exception will not constitute a threat to the public safety.

7. Stormwater management facilities shall be regularly maintained to insure they function at design capacity and to prevent health hazards associated with debris buildup and stagnant water.

i. Maintenance and upkeep responsibility depend on ownership of the facilities. If the drains, basins, and/or other features of the stormwater system in the residential development are part of a public drainage system, then the municipality or an appropriate public entity is responsible for maintenance and upkeep. If part or all of the residential stormwater management system is privately owned, then the privately owned portion of the system must be privately maintained, unless the municipality or other appropriate public agency agrees to assume responsibility for the facilities. The terms of the agreement shall be in a form satisfactory to the municipal attorney and may include but are not limited to maintenance easements, personal guarantees, deed restrictions, covenants, and bonds.

ii. In cases where there is common ownership of property that is not part of a publicly owned drainage system, a homeowner's association or similar permanent entity may be established as the agent responsible for upkeep, absent an agreement with the municipality or other appropriate public entity.

Administrative correction.

See: 29 N.J.R. 1296(a).

Administrative correction.

See: 29 N.J.R. 2816(a)

5:21-7.6 Stormwater management: water quality

(a) In addition to addressing water quantity generated by development, a stormwater management system shall also prevent, to the greatest extent feasible, an increase in nonpoint pollution.

(b) Stormwater management shall provide for the control of a water quality design storm. The water quality design storm shall be defined as the one-year frequency S.C.S. Type III, 24-hour storm or 1.25 inches of rainfall falling uniformly in two hours.

(c) The water quality design storm shall be controlled by best management practices. These include, but are not limited to, the following:

1. In "dry" detention basins, provisions shall be made to ensure that the runoff from the water quality design storm is retained, such that not more than 90 percent will be evacuated prior to 18 hours. The retention time shall be considered a brim-drawdown time and therefore shall begin at the time of peak storage. The retention time shall be reduced in any case that would require an outlet size diameter of three inches or less. Therefore, three-inch-diameter orifices shall be the minimum allowed. This minimum is only for water-quality outlets. If this minimum outlet size does not allow for the detention time required, then additional techniques shall be used to remove total suspended solids.

2. In permanent ponds or "wet" basins, the water quality requirements of this ordinance shall be satisfied where the volume of permanent water is at least three times the volume of runoff produced by the water quality design storm.