# CHAPTER 21

# RESIDENTIAL SITE IMPROVEMENT STANDARDS

**Authority**

N.J.S.A. 40:55D–40.4.

**Source and Effective Date**

R.2002 d.197, effective May 30, 2002.
See: 33 N.J.R. 3391(a), 34 N.J.R. 2311(b).

**Expiration Date**

Chapter 21, Residential Site Improvement Standards, expires on May 30, 2007.

**Chapter Historical Note**

Chapter 21, Uniform Standards Code for Mobile Homes, was adopted pursuant to authority of N.J.S.A. 52:2D–25.1 et seq. and was filed and became effective December 7, 1972, as R.1972 d.248. See: 4 N.J.R. 260(f), 5 N.J.R. 7(a).

Chapter 21, Uniform Standards Code for Mobile Homes, was amended by R.1974 d.275, effective January 1, 1975. See: 6 N.J.R. 343(a), 6 N.J.R. 427(b); and R.1975 d.166, effective July 1, 1975. See: 7 N.J.R. 200(a), 7 N.J.R. 306(a).

Chapter 21, Uniform Standards Code for Mobile Homes, was repealed by R.1982 d.7, effective February 1, 1982. See: 13 N.J.R. 717(a), 14 N.J.R. 142(a).

Chapter 21, Residential Site Improvement Standards, was adopted as R.1997 d.5, effective January 6, 1997 (operative June 3, 1997). See: 28 N.J.R. 2671(a), 28 N.J.R. 3491(a), 29 N.J.R. 159(a).

The name of Subchapter 1, General Provisions, was changed to General Guidelines by Administrative Correction. See: 29 N.J.R. 2816(a).

Petition for Rulemaking. See: 32 N.J.R. 2621(b).

Chapter 21, Residential Site Improvement Standards, was readopted as R.2002 d.197, effective May 30, 2002. See: Source and Effective Date.

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## SUBCHAPTER 1. GENERAL GUIDELINES

**Law Reviews and Journal Commentaries**

New Residential Site Improvement Standards. Thomas F. Carroll, III, 188 N.J.L.J. 18 (1997).

### 5:21–1.1 Title; division into subchapters

(a) These rules shall be known as the "New Jersey Residential Site Improvement Standards" and are referred to herein as "the rules."

(b) This chapter consists of the following subchapters:

1. "General Provisions," which may be cited throughout the rules as N.J.A.C. 5:21–1 and when referred to in subchapter 1 of this chapter, may be cited as "this subchapter."

2. "Application and Review Procedures," which may be cited throughout the rules as N.J.A.C. 5:21–2 and when referred to in subchapter 2 of this chapter, may be referred to as "this subchapter."

3. "Exceptions, Waivers, and Special Area Standards," which may be cited throughout these rules as N.J.A.C. 5:21–3 and when referred to in subchapter 3 of this chapter, may be referred to as "this subchapter."

4. "Streets and Parking," which may be cited throughout these rules as N.J.A.C. 5:21–4 and when referred to in subchapter 4 of this chapter, may be referred to as "this subchapter."

5. "Water Supply," which may be cited throughout these rules as N.J.A.C. 5:21–5 and when referred to in subchapter 5 of this chapter, may be referred to as "this subchapter."

6. "Sanitary Sewers," which may be cited throughout these rules as N.J.A.C. 5:21–6 and when referred to in subchapter 6 of this chapter, may be referred to as "this subchapter."

7. "Stormwater Management," which may be cited throughout these rules as N.J.A.C. 5:21–7 and when referred to in subchapter 7 of this chapter, may be referred to as "this subchapter."

8. "Referenced Standards," which may be cited throughout these rules as N.J.A.C. 5:21–8 and referred to in subchapter 8 of this chapter, may be referred to as "this subchapter."

### 5:21–1.2 Authority

These rules are promulgated by the Commissioner of the Department of Community Affairs pursuant to the authority of P.L. 1993, c.32 (N.J.S.A. 40:55D–40.1 et seq.)

### 5:21–1.3 Intent and purpose

(a) It is the intent and purpose of these rules:

1. To reduce the multiplicity of standards for residential subdivisions and site improvements which currently exists in this State in order to eliminate unnecessary increases in the cost of housing where there are noncommensurate gains in the protection of public health and safety;

2. To avoid unnecessary cost in the construction process, and to provide site improvement standards that are both sound and cost effective;

3. To ensure predictability in the site improvement standards applicable to residential construction;

4. To provide for development reviews of residential projects that are based, to the greatest extent possible, upon sound objective site improvement standards rather than upon discretionary design standards;

5. To streamline the development approval process and improve the efficiency of the application process by providing a uniform set of technical site improvement standards for land development;

6. To provide the widest possible range of design freedom and promote diversity through performance-oriented site improvement standards; and

7. To separate the policy-making aspects of development review from the making of technical determinations.

### 5:21–1.4 Definitions and abbreviations

The following words, terms, and abbreviations, when used in this chapter, shall have the following meanings, unless the context clearly indicated otherwise. Where a word or term is defined in this chapter and the Municipal Land Use Law (N.J.S.A. 40:55D–1 et seq.), then the definition of that word or term found in the Municipal Land Use Law shall govern. Words and terms found in the Municipal Land Use Law, and defined here for convenience, have been designated by the use of "(MLUL)" following their meaning.

"AASHTO" means American Association of State Highway and Transportation Officials.

"ABS" means acrylonitrile-butadiene-styrene.

"ACI" means American Concrete Institute.

"Administrative Officer" means the clerk of the municipality, unless a different municipal official or officials are designated by ordinance or statute. (MLUL).

"ADT" (see average daily traffic.)

"Aisle" means the traveled way by which cars enter and depart parking spaces.

"Alley" means a service road that provides a secondary means of access to lots.

"ANSI" means American National Standards Institute.

Amended by R.2000 d.480, effective December 4, 2000 (operative June 3, 2001).
See: 32 N.J.R. 2670(b), 32 N.J.R. 4277(a).
In (c), rewrote 3, inserted last sentence of introductory paragraph to 6, rewrote 6ii(4) and (5), inserted reference to AWWA C909 and inserted last sentence in 8, and rewrote 11v; and amended Figure 6.1.

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## SUBCHAPTER 7. STORMWATER MANAGEMENT

### 5:21–7.1 Stormwater management: scope

(a) Stormwater management measures meeting the requirements of this subchapter shall be provided for major developments. Stormwater management systems prepared by design engineers shall emphasize a natural, as opposed to an engineered, drainage strategy. To the maximum extent practicable, stormwater management standards shall be met by incorporating nonstructural stormwater management strategies into a design. Where more than one design or method may be used to comply with the rules, the choice of design approach and the methods used shall rest with the design engineer.

1. For projects that fall below the threshold of major development, as defined, a municipality may require, by ordinance, the control of runoff rate and routing from any site that is the subject of a site plan or subdivision application.

(b) The applicability of a natural approach depends on such factors as site storage capacity, open channel hydraulic capacity, and maintenance needs and resources. Applicability of a stormwater approach also can be limited by regulatory constraints that govern certain structures (for example, dams) or areas (for example, development in a floodplain or wetland).

(c) The person submitting the application for review shall identify the nonstructural strategies incorporated into the design of the project. If the applicant contends that it is not feasible for engineering, environmental, or safety reasons to incorporate any nonstructural stormwater management strategies, identified in (d) below, into the design of a particular project, the applicant shall identify the strategy and provide a basis for the contention of infeasibility.

(d) Nonstructural stormwater management strategies incorporated into site design shall:

1. Protect areas that provide water-quality benefits or areas that are particularly susceptible to erosion and sediment loss;

2. Minimize impervious surfaces and break up or disconnect the flow of runoff over necessary impervious surfaces;

3. Maximize the protection of natural drainage features and vegetation;

4. Minimize the decrease in "time of concentration" from pre-construction to post-construction. "Time of concentration" is defined as the time it takes for runoff to travel from the hydraulically most distant point of the drainage area to the point of interest in the watershed (see the Rational Method equation in N.J.A.C. 5:21–7.2(c)2);

5. Minimize land disturbance including clearing and grading;

6. Minimize soil compaction;

7. Provide low-maintenance landscaping that encourages retention and planting of native vegetation and minimizes the use of lawns, fertilizers, and pesticides;

8. Provide vegetated open-channel conveyance systems discharging into and through stable vegetated areas; and

9. Provide preventative source controls to prevent or minimize the use or exposure of pollutants at a site so that the release of pollutants into stormwater runoff will be prevented or minimized. The source controls include, but are not limited to:

i. Site design features that help to prevent accumulation of trash and debris in drainage systems;

ii. Site design features that help to prevent discharge of trash and debris in the drainage system; and

iii. When establishing vegetation after land disturbance, applying fertilizer in accordance with the Standards for Soil Erosion and Sediment Control in New Jersey at N.J.A.C. 2:90 as administered by the New Jersey Department of Agriculture.

(e) Any land area used as a nonstructural stormwater management measure to meet the performance standards for quantity control at N.J.A.C. 5:21–7.5, water quality at N.J.A.C. 5:21–7.6, or groundwater recharge at N.J.A.C. 5:21–7.7 shall be dedicated to a government agency, subject to a conservation restriction filed with the appropriate County Clerk's office or equivalent restriction that ensures the stormwater measure, or an equivalent stormwater management measure approved by the reviewing agency, is maintained in perpetuity.

(f) Guidance for nonstructural stormwater management strategies is available in the New Jersey Stormwater Best Management Practices Manual (hereafter Best Management Practices Manual), April 2004 edition.

(g) All stormwater collection and conveyance structures shall be designed in accordance with the provisions of this subchapter. Any structures designed to control stormwater runoff volume, flow rate, quality, or groundwater recharge shall be designed and constructed in accordance with these provisions. Where more than one design or method may be used to comply with the rules, choices among design options to meet the volume, rate, quality, and recharge provisions of this subchapter shall rest with the design engineer.

(h) Construction practices shall conform to Standards for Soil Erosion and Sediment Control in New Jersey, N.J.A.C. 2:90.

(i) The standards of this subchapter do not apply to development if alternative design and performance standards exist under a regional stormwater management plan adopted in accordance with the DEP rules, N.J.A.C. 7:15. The standards must be at least as protective as those of this subchapter.

Amended by R.1999 d.374, effective November 1, 1999 (operative May 1, 2000).
See: 31 N.J.R. 477(a), 31 N.J.R. 3259(a).
Inserted a new (c); recodified former (c) through (g) as (d) through (h); in the new (e)1, inserted "there is a uniform flow, as defined by the following conditions:" following "only when" in the last sentence; and in the new (g), substituted a reference to three feet per second for a reference to two feet per second.
Administrative correction.
See: 32 N.J.R. 684(b).
Amended by R.2005 d.56, effective February 7, 2005.
See: 36 N.J.R. 4025(a), 37 N.J.R. 481(c).
Rewrote the section.

**5:21–7.2 Stormwater calculations: runoff estimation techniques**

(a) Drainage area stormwater management requires the determination of a watershed runoff hydrograph that displays the peak discharge rate and volume over time. The hydrograph shall compare pre-and post-development conditions. In computing pre-construction stormwater runoff, the design engineer shall account for all significant land features and structures, such as ponds, wetlands, depressions, hedgerows, or culverts, that may reduce pre-construction stormwater runoff rates and volumes. For the purpose of calculating runoff coefficients and groundwater recharge, there is a presumption that the pre-construction condition of a site, or portion thereof, is a wooded land use with good hydrologic condition. The term "runoff coefficient" applies to both the Natural Resources Conservation Service (NRCS) of the United States Department of Agriculture (USDA) methodology of the TR–55 program (see (c)1iii below) and the Rational and the Modified Rational Methods (see (c)1i and (c)1ii, respectively, below). Both the Rational and Modified Rational methods are described in "Appendix A–9 Modified Rational Method" in the Standards for Soil Erosion and Sediment Control in New Jersey at N.J.A.C. 2:90. A runoff coefficient or a groundwater recharge land cover for an existing condition may be used on all or a portion of a site if the design engineer verifies that the hydrologic condition has existed on the site or portion of the site for at least five years without interruption immediately prior to the time of application. If more than one land cover has existed on the site during the five years immediately prior to the time of application, the land cover with the lowest runoff potential shall be used for the computations. In addition, there is the presumption that the site is in good hydrologic condition (if the land-use type is pasture, lawn, or park), with good cover (if the land-use type is woods), or with good hydrologic condition and conservation treatment (if the land use is cultivation).

(b) Design engineers shall use the runoff hydrograph peak rate to determine the configuration and sizes of pipes, channels, and other routing or flow-control structures. They shall use the hydrograph to determine the size of stormwater management facilities.

(c) For the runoff peak rate of discharge calculation, design engineers shall have the option to choose the methodology to estimate peak rate of discharge.

1. Design engineers shall calculate peak rate of runoff in accordance with the following procedures and methods, incorporated herein by reference:

i. For relatively small drainage areas of up to one-half square mile (320 acres), the peak rate of runoff may be calculated by the Rational Method, its derivatives, or the referenced methods that follow.

ii. Where the project necessitates reductions in the rate of runoff or the calculation of runoff volume in accordance with N.J.A.C. 5:21–7.5, the Modified Rational Method must be used. The use of the Modified Rational Method is limited to drainage areas of 20 acres or less.

iii. NRCS's *Urban Hydrology for Small Watersheds, Technical Release No. 55 (TR–55).*

iv. NRCS's *Computer Program for Project Formulation—Hydrology, Technical Release No. 20 (TR–20).*

v. *HEC–HMS Hydrologic Modeling System*, version 2.2, May 2003, Hydraulic Engineering Center, U.S. Army Corps of Engineers, used in appropriate conditions with appropriate values.

2. The equation for the Rational Method is:

$$Q_p = C\,I\,A$$

Where

$Q_p$ = the peak runoff rate in cubic feet per second

C = the runoff coefficient

I = the average rainfall intensity in inches per hour occurring at the time of concentration $t_c$ in minutes

A = the size of the drainage area in acres

i. Typical C values for 100–year frequency storm events appear in Table 7.1.

ii. The Rational Method is most accurate when dealing with uniform drainage areas. Design engineers may divide nonuniform drainage areas into "uniform" sub-drainage areas and calculate the runoff from each of these areas separately, or they may use the weighted average technique for a composite drainage area. Design engineers also may use runoff coefficients from the following sources, incorporated herein by reference:

(1) *HEC–22 Urban Drainage Design Manual,* Second Edition FHWA–NHI–01–021, August 2001, U.S. Department of Transportation, Federal Highway Administration, as supplemented or amended to date.

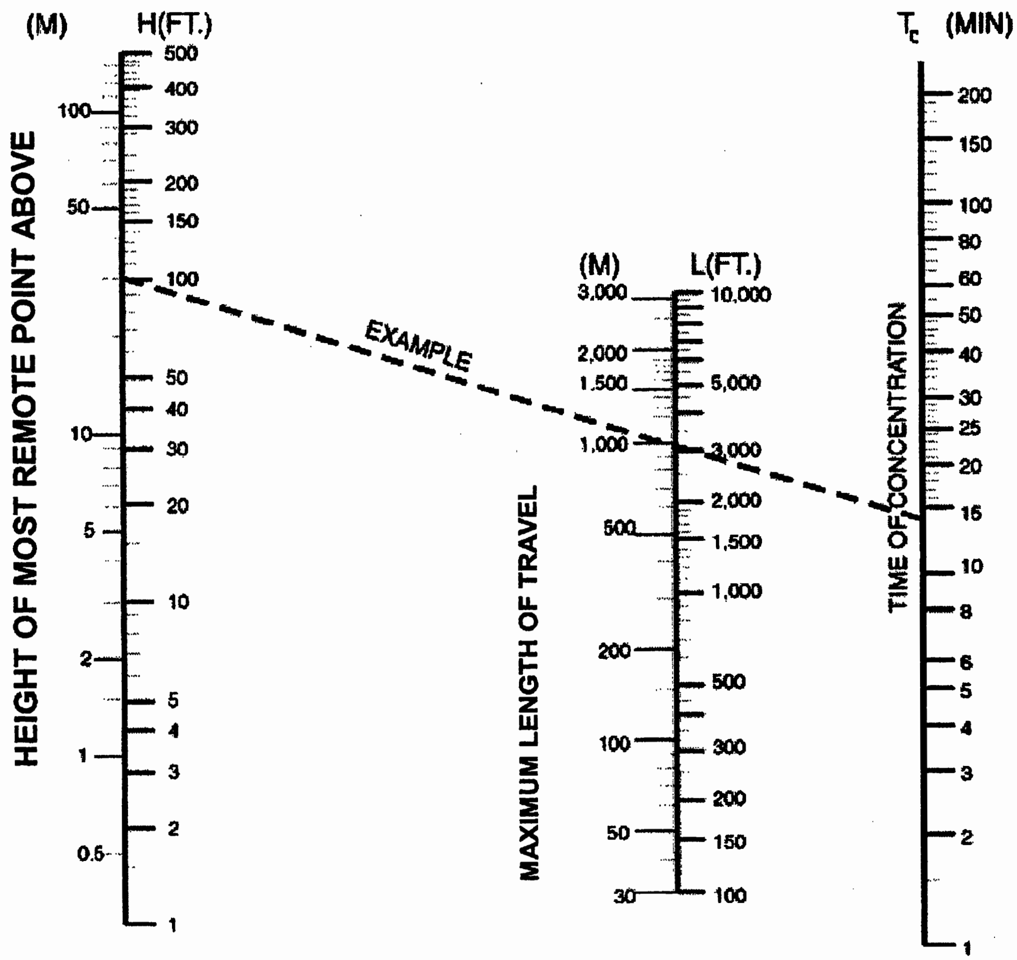
(2) New Jersey Department of Transportation (NJ DOT) *Roadway Design Manual,* November 2001, as revised through March 28, 2003.

3. Design engineers may estimate time of concentration ($t_c$) with Figure 7.1, Time of Concentration nomograph, from *Roadway Design Manual,* NJ DOT, November 2001, as revised through March 28, 2003. Use of this figure is limited to the design of storm sewer systems. For other purposes, design engineers shall use the procedures outlined in Chapter 3 of *Urban Hydrology for Small Watersheds, Technical Release No. 55 (TR–55),* U.S. Department of Agriculture, NRCS.

# FIGURE 7.1

## TIME OF CONCENTRATION

**Example**
Height = 100 ft.
Length = 3000 ft.
Time of Concentration = 14 Min.




**Notes:**
Use Nomograph $T_c$ for natural basins with well-defined channels, for overland or bare earth, and for mowed grass roadside channels.

For overland flow, grassed surfaces, multiply $T_c$ by 2.

For overland flow, concrete or asphalt surfaces, multiply $T_c$ by 0.4.

For concrete channels, multiply $T_c$ by 0.2.

Based on a study by P.Z. Kirpich, Civil Engineering, Vol.10, No.6, June 1940, p.362

TABLE 7.1

TYPICAL RUNOFF COEFFICIENTS (C VALUES) FOR 100 YEAR FREQUENCY STORM

| Land Use Description | | Hydrologic Soil Group A | B | C | D |
|---|---|---|---|---|---|
| Cultivated land: | | | | | |
| without conservation treatment | | 0.49 | 0.67 | 0.81 | 0.88 |
| with conservation treatment | | 0.27 | 0.43 | 0.61 | 0.67 |
| Pasture or range land: | | | | | |
| poor condition | | 0.38 | 0.63 | 0.78 | 0.84 |
| good condition | | NA | 0.25 | 0.51 | 0.65 |
| Meadow: good condition | | NA | NA | 0.44 | 0.61 |
| Wood or forest land: | | | | | |
| thin stand, poor cover, no mulch | | NA | NA | 0.59 | 0.79 |
| good cover | | NA | NA | 0.45 | 0.59 |
| Open spaces, lawns, parks, golf courses, cemeteries: | | | | | |
| good condition, grass cover on 75% or more of area | | NA | 0.25 | 0.51 | 0.65 |
| fair condition, grass cover on 50–75% of area | | NA | 0.45 | 0.63 | 0.74 |
| Commercial and business areas (85% impervious) | | 0.84 | 0.90 | 0.93 | 0.96 |
| Industrial districts (72% impervious) | | 0.67 | 0.81 | 0.88 | 0.92 |
| Residential: | | | | | |
| Average lot size | Average impervious | | | | |
| 1/8 acre | 65% | 0.59 | 0.76 | 0.86 | 0.90 |
| 1/4 acre | 38% | 0.25 | 0.55 | 0.70 | 0.80 |
| 1/3 acre | 30% | NA | 0.49 | 0.67 | 0.78 |
| 1/2 acre | 25% | NA | 0.45 | 0.65 | 0.76 |
| 1 acre | 20% | NA | 0.41 | 0.63 | 0.74 |
| Paved parking lots, roofs, driveways, etc. | | 0.99 | 0.99 | 0.99 | 0.99 |
| Streets and roads: | | | | | |
| paved with curbs and storm sewers | | 0.99 | 0.99 | 0.99 | 0.99 |
| gravel | | 0.57 | 0.76 | 0.84 | 0.88 |
| dirt | | 0.49 | 0.69 | 0.80 | 0.84 |

Note: NA denotes information is not available; design engineers should rely on another authoritative source.

Source: New Jersey Department of Environmental Protection, Technical Manual for Land Use Regulation Program, Bureaus of Inland and Coastal Regulations, Stream Encroachment Permits (Trenton, New Jersey: Department of Environmental Protection, Revised September 1995) p. 12.

TABLE 7.2

MANNING'S ROUGHNESS COEFFICIENTS

| Closed Conduits | Smooth | Normal | Rough |
|---|---|---|---|
| Cast Iron | | | |
| Coated | 0.010 | 0.013 | 0.014 |
| Uncoated | 0.011 | 0.014 | 0.016 |
| Clay | | | |
| Vitrified Sewer | 0.011 | 0.014 | 0.017 |
| Vitrified sewer with manholes | 0.013 | 0.015 | 0.017 |
| Common drainage tile | 0.011 | 0.013 | 0.017 |
| Concrete | | | |
| Culvert strait and free of debris | 0.010 | 0.011 | 0.013 |
| Culvert with bends, connections | 0.011 | 0.013 | 0.014 |
| Finished | 0.011 | 0.012 | 0.014 |
| Sewer with manhole inlets | 0.013 | 0.015 | 0.017 |
| Unfinished steel form | 0.012 | 0.013 | 0.014 |
| Unfinished smooth wood form | 0.012 | 0.014 | 0.016 |
| Unfinished rough wood form | 0.015 | 0.017 | 0.020 |
| Metal, Corrugated | | | |
| Subdrain | 0.017 | 0.019 | 0.021 |
| Storm drain | 0.021 | 0.024 | 0.030 |
| Polyvinyl Chloride (PVC) | 0.010 | 0.010 | 0.010 |
| Polyethylene (PE) | 0.008 | 0.009 | 0.011 |
| Steel | | | |

| Closed Conduits | Smooth | Normal | Rough |
|---|---|---|---|
| Lockbar and welded | 0.010 | 0.012 | 0.014 |
| Riveted and spiral | 0.013 | 0.016 | 0.017 |
| Wrought Iron | | | |
| Black | 0.012 | 0.014 | 0.015 |
| Galvanized | 0.013 | 0.016 | 0.017 |
| Lined or Built-up Channels | Minimum | Normal | Maximum |
| Asphalt | | | |
| Smooth | 0.013 | 0.013 | |
| Rough | 0.016 | 0.016 | |
| Brick | | | |
| Glazed | 0.011 | 0.013 | 0.015 |
| In cement mortar | 0.012 | 0.015 | 0.018 |
| Cement | | | |
| Neat surface | 0.010 | 0.011 | 0.013 |
| Mortar | 0.011 | 0.013 | 0.015 |
| Concrete | | | |
| Trowel finish | 0.011 | 0.013 | 0.015 |
| Float finish | 0.013 | 0.015 | 0.016 |
| Finished with gravel on bottom | 0.015 | 0.017 | 0.020 |
| Unfinished | 0.014 | 0.017 | 0.020 |
| Gunite (good section) | 0.016 | 0.019 | 0.023 |
| Gunite (wavy section) | 0.018 | 0.022 | 0.025 |
| On good excavated rock | 0.017 | 0.020 | |
| On irregular excavated rock | 0.022 | 0.027 | |
| Concrete Bottom Float Finished with sides of | | | |
| Dressed stone in mortar | 0.015 | 0.017 | 0.020 |
| Random stone in mortar | 0.017 | 0.020 | 0.024 |
| Cement rubble masonry, plastered | 0.016 | 0.020 | 0.024 |
| Cement rubble masonry | 0.020 | 0.025 | 0.030 |
| Dry rubble or rip rap | 0.020 | 0.030 | 0.035 |
| Dressed Ashlar | 0.013 | 0.015 | 0.017 |
| Gravel Bottom Sides of | | | |
| Formed concrete | 0.017 | 0.020 | 0.025 |
| Random stone in mortar | 0.020 | 0.023 | 0.026 |
| Dry rubble or rip rap | 0.023 | 0.033 | 0.036 |
| Masonry | | | |
| Cement rubble | 0.017 | 0.025 | 0.030 |
| Dry rubble | 0.023 | 0.032 | 0.035 |
| Metal, Corrugated | 0.021 | 0.025 | 0.030 |
| Steel, Smooth Surface | | | |
| Unpainted | 0.011 | 0.012 | 0.014 |
| Painted | 0.012 | 0.013 | 0.017 |
| Wood | | | |
| Planed, untreated | 0.010 | 0.012 | 0.014 |
| Planed, treated | 0.011 | 0.012 | 0.015 |
| Unplaned | 0.011 | 0.013 | 0.015 |
| Plank with battens | 0.012 | 0.015 | 0.018 |
| Lined with roofing | 0.010 | 0.014 | 0.017 |
| Vegetal Lining | 0.030 | | 0.500 |
| Excavated, Dredged, or Natural Channels | Minimum | Normal | Maximum |
| Channels Not Maintained and Brush Uncut | | | |
| Dense weeds, high flow depth | 0.050 | 0.080 | 0.120 |
| Clean bottom, brush on sides | 0.040 | 0.050 | 0.080 |
| Same, highest stage of flow | 0.045 | 0.070 | 0.110 |
| Dense brush, high stage | 0.080 | 0.100 | 0.140 |
| Drag Line—Excavated or Dredged | | | |
| No vegetation | 0.025 | 0.028 | 0.033 |
| Light brush or banks | 0.035 | 0.050 | 0.060 |
| Earth, Straight and Uniform | | | |
| Clean, recently completed | 0.016 | 0.018 | 0.020 |
| Clean, after weathering | 0.018 | 0.022 | 0.025 |
| Gravel, uniform section, clean | 0.022 | 0.025 | 0.030 |
| Short grass, few weeds | 0.022 | 0.027 | 0.033 |

| Closed Conduits | Smooth | Normal | Rough |
|---|---|---|---|
| Earth, Winding and Sluggish | | | |
| No vegetation | 0.023 | 0.025 | 0.030 |
| Grass, some weeds | 0.025 | 0.030 | 0.033 |
| Dense weeds or aquatic plants | 0.030 | 0.035 | 0.040 |
| Earth bottom and rubble sides | 0.028 | 0.030 | 0.035 |
| Stony bottom and weedy banks | 0.025 | 0.035 | 0.040 |
| Cobble bottoms and clean sides | 0.030 | 0.040 | 0.050 |
| Rock Cuts | | | |
| Smooth and uniform | 0.025 | 0.035 | 0.040 |
| Jagged and irregular | 0.035 | 0.040 | 0.050 |
| Minor Streams (top width at flood stage < 100 ft) | | | |
| (a) Streams on plain | | | |
| 1. Clean, straight, full stage, no rifts or deep pools | 0.025 | 0.030 | 0.033 |
| 2. Same as above, but some stones and weeds | 0.030 | 0.035 | 0.040 |
| 3. Clean, winding, some pools and shoals | 0.033 | 0.040 | 0.045 |
| 4. Same as above, but some weeds and stones | 0.035 | 0.045 | 0.050 |
| 5. Same as above, lower stages, more ineffective slopes and sections | 0.040 | 0.048 | 0.055 |
| 6. Same as 4, but more stones | 0.045 | 0.050 | 0.060 |
| 7. Sluggish reaches, weedy, deep pools | 0.050 | 0.070 | 0.080 |
| 8. Very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush | 0.075 | 0.100 | 0.150 |
| (b) Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages | | | |
| 1. Bottom: gravels, cobbles, and few boulders | 0.030 | 0.040 | 0.050 |
| 2. Bottom: cobbles with large boulders | 0.040 | 0.050 | 0.070 |

TABLE 7.3

CUMULATIVE AND INCREMENTAL RAINFALL DISTRIBUTIONS FOR THE WATER QUALITY STORM

| Time (minutes) | Cumulative Rainfall (inches) | Incremental Rainfall (inches) | Time (minutes) | Cumulative Rainfall (inches) | Incremental Rainfall (inches) |
|---|---|---|---|---|---|
| 0 | 0.0000 | 0.0000 | 65 | 0.8917 | 0.2667 |
| 5 | 0.0083 | 0.0083 | 70 | 0.9917 | 0.1000 |
| 10 | 0.0166 | 0.0083 | 75 | 1.0500 | 0.0583 |
| 15 | 0.0250 | 0.0084 | 80 | 1.0840 | 0.0340 |
| 20 | 0.0500 | 0.0250 | 85 | 1.1170 | 0.0330 |
| 25 | 0.0750 | 0.0250 | 90 | 1.1500 | 0.0330 |
| 30 | 0.1000 | *0.0250 | 95 | 1.1750 | 0.0250 |
| 35 | 0.1330 | 0.0330 | 100 | 1.2000 | 0.0250 |
| 40 | 0.1660 | 0.0330 | 105 | 1.2250 | 0.0250 |
| 45 | 0.2000 | 0.0340 | 110 | 1.2334 | 0.0084 |
| 50 | 0.2583 | 0.0583 | 115 | 1.2417 | 0.0083 |
| 55 | 0.3583 | 0.1000 | 120 | 1.2500 | 0.0083 |
| 60 | 0.6250 | 0.2667 | | | |

4. The National Engineering Handbook, Part 630 (Hydrology) and Part 650 (Engineering Field Handbook) also may be used.

5. When using the Rational Method, rainfall intensity as a function of duration and storm frequency shall be based upon Figure 7.2, Rainfall Intensity Curves, below

and/or local rainfall frequency data, where available, for the two-, 10–, 25–, and 100–year storms. Design engineers shall use the Cumulative and Incremental Rainfall Distributions in Table 7.3 for the water quality storm. Figure 7.2 shows rainfall intensity curves for Trenton, New Jersey. Design engineers may use this information for other parts of the State or they may substitute local rainfall frequency data, when available. More current data for Trenton and other areas of the State may be obtained from the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service, which is part of the U.S. Department of Commerce. See http://www.nws.noaa.gov/ohd/ hdsc. In all instances, design engineers shall use a minimum time of concentration of 10 minutes. For storm sewer design, a 10–year to 25–year storm frequency consistent with localized circumstances should be considered as a minimum, unless special circumstances are involved such as inadequate downstream stormwater facilities, lack of positive overland relief, or evidence of local flooding. In such special circumstances, design engineers shall design facilities to accommodate, as a minimum, the following storm frequencies:

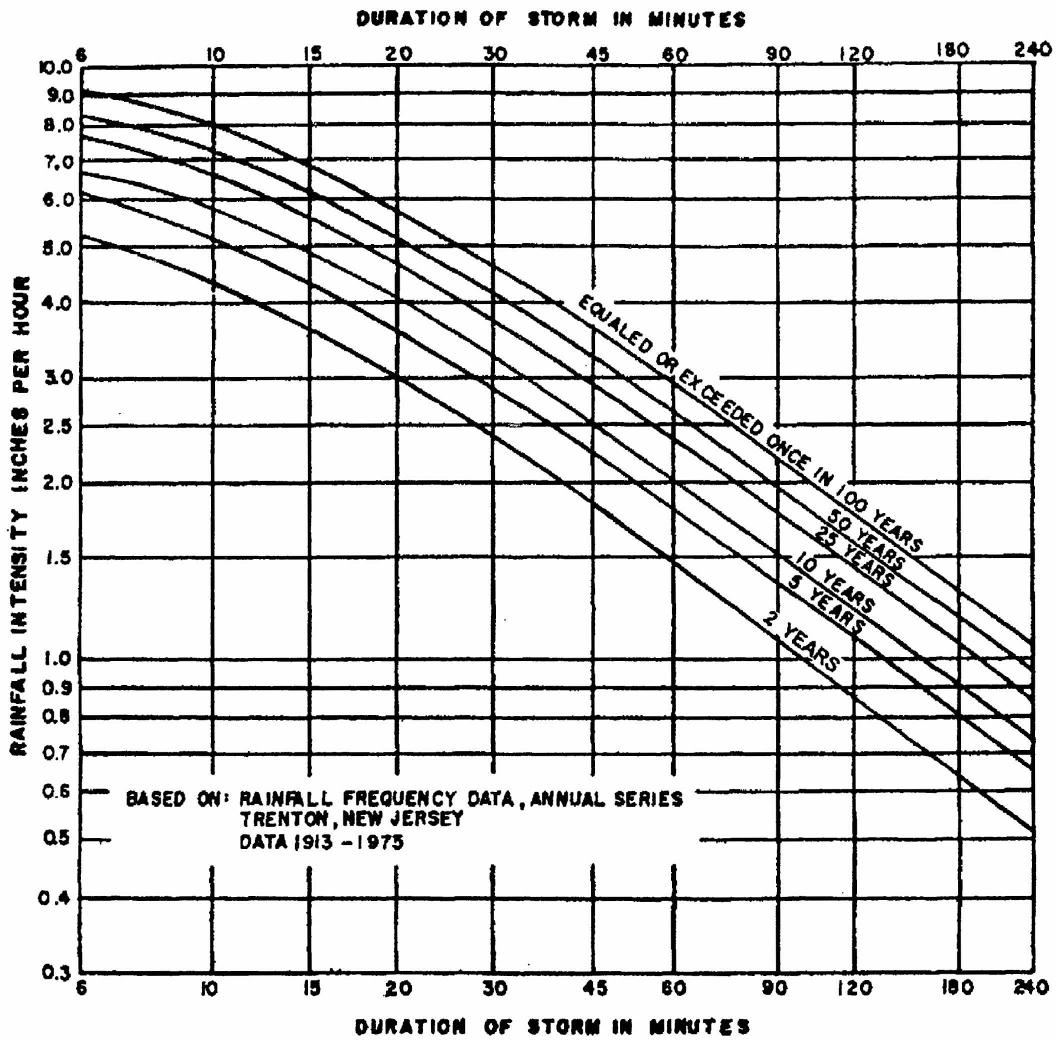
i. Ten-year storm for storm drain systems where excess flow, up to the 100–year storm, can continue downgrade in the street and not exceed the gutter capacity. Also, 10–year storms shall be used at low points in storm drain systems with overland relief that is routed through the stormwater quantity control structure.

ii. Twenty-five-year storm where flow in a storm drain is totally carried by pipe when conditions under (c)5i above do not apply provided all overland relief up to the 100–year storm is routed through the stormwater quantity control structure.

iii. Twenty-five-year storm for culvert design where the culvert will be located in streams shown on the New Jersey State Atlas or the United States Coast and Geodetic Survey maps. Culverts with an upstream drainage area of 50 acres or more shall be designed to accommodate a 100–year frequency storm in accordance with Flood Hazard Area Control Regulations, N.J.A.C. 7:13–2.16.

iv. Twenty-five-year storms for open channels where the upstream drainage area is less than 50 acres. When the upstream drainage area is 50 acres or more, design engineers shall design open channels to accommodate the 100–year storm in accordance with Flood Hazard Area Control Regulations, N.J.A.C. 7:13–2.16.

Figure 7.2
RAINFALL INTENSITY CURVES




Note: Adapted from Figure 2.1-2 in the NJDEP Technical Manual for Stream Encroachment Permits.

6. The size of the drainage area shall include onsite and offsite lands contributing to the design point.

7. Computer software adaptations of the Rational Method or the NRCS's TR–55 are acceptable, provided

their data and graphic printout allow review and evaluation.

(d) Design engineers shall use a consistent method to calculate peak rate of runoff and volume when computing runoff hydrographs. If TR–55, TR–20, HEC–HMS, or another recognized method is used to calculate peak rate of runoff, then the same method shall be used to determine volume. If the Rational Method is used for peak flow calculations, design engineers shall use the Modified Rational Method to calculate peak volume to be used for basin routing. Both the Rational and Modified Rational Methods are described in "Appendix A–9 Modified Rational Method" in the Standards for Soil Erosion and Sediment Control in New Jersey at N.J.A.C. 2:90. A maximum drainage area of 20 acres shall be used for the Modified Rational Method.

(e) In computing stormwater runoff from all design storms, the design engineer shall consider the relative stormwater runoff rates and/or volumes from pervious and impervious surfaces separately to accurately compute the rates and volume of stormwater runoff from the site. To calculate runoff from unconnected impervious cover, urban impervious area modifications as described in NRCS TR–55, Urban Hydrology for Small Watersheds or other approved methods may be employed.

Administrative correction.
See: 29 N.J.R. 1296(a).
Amended by R.1999 d.374, effective November 1, 1999 (operative May 1, 2000).
See: 31 N.J.R. 477(a), 31 N.J.R. 3259(a).
In (b), substituted "size" for "necessity for, and sizing" in the second sentence; in (c), added a third sentence in 2i, and inserted new third and fourth sentences in the introductory paragraph of 4; in (d), inserted "when computing runoff hydrographs" at the end of the first sentence; and in Table 7.1, added a reference to Minor Streams.
Administrative correction.
See: 32 N.J.R. 684(b).
Amended by R.2004 d.35, effective January 20, 2004.
See: 35 N.J.R. 3981(a), 36 N.J.R. 447(a).
In (c)3, amended Figure 7.1.
Administrative correction.
See: 36 N.J.R. 1751(b).
Amended by R.2005 d.56, effective February 7, 2005.
See: 36 N.J.R. 4025(a), 37 N.J.R. 481(c).
Rewrote the section.

### 5:21–7.3 Design of runoff collection system

(a) Design engineers shall determine hydraulic capacity for open-channel or closed-conduit flow based on the Manning equation, or charts/monographs based on this equation. The hydraulic capacity is termed Q and expressed as discharge in cubic feet per second as follows:

$$Q = (1.486/n)AR^{2/3}S^{1/2}$$

where

n = Manning's roughness coefficient

A = Cross-sectional area of flow in square feet

R = Hydraulic radius in feet, R = A/P where P is equal to the wetted perimeter, measured in feet and defined as the length of a line of contact between the flowing water and the channel.

S = Slope of energy grade line in feet per foot

The Manning's roughness coefficients used by design engineers appear in N.J.A.C. 5:21–7.2, Table 7.2.

1. A direct application of Manning's equation may be used for piped storm sewer systems. As an option, design engineers can use a standard step backwater calculation for storm sewer systems if the use of this approach is deemed appropriate by the designer. For other than pipe storm sewer systems, design engineers shall apply Manning's equation only when there is uniform flow, as defined by the following conditions:

i. The bottom slope of the channel, energy grade line, and water surface (hydraulic grade line) are parallel;

ii. The flow regime is in the turbulent range of Reynolds number; and

iii. The boundaries of the cross section of the channel do not move;

2. The design of open channels and conduits shall take tailwater effects into consideration.

(b) Velocities in open channels, excluding water quality swales, at design flow shall not be less than 0.5 of a foot per second and not greater than a velocity that will begin to cause erosion or scouring of the channel. Design engineers shall determine permissible velocities for swales, open channels, and ditches using methods presented in Standards for Soil Erosion and Sediment Control in New Jersey at N.J.A.C. 2:90.

(c) Velocities in closed conduits at design flow shall be at least two feet per second but not more than the velocity that will cause erosion damage to the conduit, per the manufacturer's specifications. Minimum allowable pipe slopes shall produce velocity of at least three feet per second when the flow depth is full or half the pipe diameter.

(d) Design engineers shall base culvert capacity on inlet/outlet analysis, as specified in Hydraulic Design of Highway Culverts, Hydraulic Design Series (HDS) No. 5, Report No. FHWA–IP–85–15, U.S. Department of Transportation, Federal Highway Administration, September 1985, incorporated herein by reference.

(e) Design engineers shall determine pipe size based on design runoff, conduit entrance conditions, and hydraulic capacity.

In (b), in second sentence substituted "gutter line flow" for "distance between inlets".
Public Notice: Notice Regarding the Publication of two Notices of Adoption in the December 16, 2002 New Jersey register.
See: 34 N.J.R. 4343(a), 4412(a), 35 N.J.R. 219(b).
Amended by R.2005 d.56, effective February 7, 2005.
See: 36 N.J.R. 4025(a), 37 N.J.R. 481(c).
Rewrote the section.

### 5:21–7.5 Stormwater management: quantity control

The control of the quantity of runoff shall comply with the DEP Stormwater Management Rules at N.J.A.C. 7:8–5 and 6 reprinted in Appendix B of this subchapter.

Administrative correction.
See: 29 N.J.R. 1296(a).
Administrative correction.
See: 29 N.J.R. 2816(a).
Public Notice: Egg Harbor Township special area standards.
See: 30 N.J.R. 3700(a).
Amended by R.1999 d.374, effective November 1, 1999 (operative May 1, 2000).
See: 31 N.J.R. 477(a), 31 N.J.R. 3259(a).
Rewrote the section.
Administrative correction.
See: 32 N.J.R. 684(b).
Amended by R.2000 d.480, effective December 4, 2000 (operative June 3, 2001).
See: 32 N.J.R. 2670(b), 32 N.J.R. 4277(a).
In (f)1ii, inserted "when required by the municipal engineer" in the first sentence.
Amended by R.2004 d.35, effective January 20, 2004.
See: 35 N.J.R. 3981(a), 36 N.J.R. 447(a).
In (f)v(2), rewrote the fourth uncodified paragraph.
Administrative correction.
See: 36 N.J.R. 1751(b).
Repeal and New Rule, R.2005 d.56, effective February 7, 2005.
See: 36 N.J.R. 4025(a), 37 N.J.R. 481(c).
Section was "Detention basins and other stormwater facilities".

### 5:21–7.6 Stormwater management: water quality

Water quality for stormwater management systems, including special water resource protection areas for Category One Waters and their perennial or intermittent tributaries, shall comply with the DEP Stormwater Management Rules at N.J.A.C. 7:8–5 and 6 reprinted in Appendix B of this subchapter.

Amended by R.1999 d.374, effective November 1, 1999 (operative May 1, 2000).
See: 31 N.J.R. 477(a), 31 N.J.R. 3259(a).
Rewrote the section.
Amended by R.2002 d.399, effective December 16, 2002.
See: 34 N.J.R. 2615(a), 34 N.J.R. 4412(a).
Rewrote (b)1.
Public Notice: Notice Regarding the Publication of two Notices of Adoption in the December 16, 2002 New Jersey register.
See: 34 N.J.R. 4343(a), 4412(a), 35 N.J.R. 219(b).
Repeal and New Rule, R.2005 d.56, effective February 7, 2005.
See: 36 N.J.R. 4025(a), 37 N.J.R. 481(c).
Section was "Stormwater management; water quality".

### 5:21–7.7 Recharge

Groundwater recharge of stormwater shall be in accordance with the DEP Stormwater Management Rules at N.J.A.C. 7:8–5 and 6 reprinted in Appendix B of this subchapter.

New Rule, R.2005 d.56, effective February 7, 2005.
See: 36 N.J.R. 4025(a), 37 N.J.R. 481(c).

### 5:21–7.8 Detention basins and other stormwater management facilities

(a) When structural measures are used, they shall comply with the requirements of these rules and the Best Management Practices Manual, April 2004 edition.

(b) Design engineers shall locate detention facilities (either "wet" or "dry") so as to not interfere with 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 seasonal high ground water elevation. In the case of "wet" detention facilities, storage may only be presumed to be available above the elevation of the seasonal high ground water. 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 seasonal high water table. The determination of the seasonal high water table shall be made by the applicant's engineer.

(c) Design of outlets from detention basins and other stormwater management facilities shall account for tailwater effects up to the flood hazard design flood elevation.

(d) 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 sectional 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 second$^2$.

To minimize the chance of clogging, orifices intended solely for runoff quantity control will be at least two and one half 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. Trash racks and/or anti-vortex devices shall be installedat the intake to the outlet structure as appropriate, and shall haveparallel bars with one-inch spacing between bars to the elevation of the water quality design storm. For elevations higher than the water quality design storm, the parallel bars at the outlet structure shall be spaced no greater than one-third the width of the diameter of the orifice or one-third the width of the weir, with a minimum spacingbetween bars of one inch and a maximum spacing between bars of six inches.The spacing shall be designed so as not to adversely affect the hydraulicperformance of the outlet pipe or structure. In addition, the design oftrash racks shall comply with the requirements of (d)6 below. ply with the requirements of (d)6 below.

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

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

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

vi. 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.

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 routing the spillway design storm hydrograph as defined in the NJ DEP Dam Safety Rules (N.J.A.C. 7:20) for all detention facilities classified as dams and the 100–year storm hydrograph for all other facilities (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 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, at N.J.A.C. 2:90, 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 routing the spillway design storm hydrograph as defined in the NJ DEP Dam Safety Rules (N.J.A.C. 7:20) for all detention facilities classified as dams and the 100–year storm hydrograph for all other facilities. 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 in the Standards for Soil Erosion and Sediment Control in New Jersey as cited above.

TABLE 7.5
PERMISSIBLE VELOCITIES FOR EMERGENCY SPILLWAYS WITH UNIFORM STANDS FOR VARIOUS WELL–MAINTAINED GRASS COVERS

| | | Permissible Velocities On: | |
|---|---|---|---|
| Ground Cover | Slope Percent | 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 Crabgrass | 0–5 | 3.5 | 2.5 |

Note: fps = feet per second

Designs are not limited to the ground covers shown above. Design engineers may use reinforced grass technologies and other types of ground cover in accordance with appropriate authoritative standards.

Source: Soil Conservation Service, U.S. Department of Agriculture (Washington, DC: Government Printing Office, 1959). Cited in ULI–ASCE–NAHB, Residential Storm Water Management: Objectives, Principles, and Design Considerations (Washington, DC: 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 the Dam Safety Standards, N.J.A.C. 7:20.

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) The 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 any of the following conditions exist: pervious layers are not intercepted by the cutoff wall; 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 riprap, 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, TR 56, and Riprap for Slope Protection Against Wave Action, TR 69. Both reports are published by the NRCS 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 show 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. In earthen berms and embankment ponds, acceptable pipe materials are corrugated polyethylene, reinforced concrete, polyvinyl chloride, 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 for polyvinyl chloride (PVC) pipe. Design engineers shall provide for seepage control if the conduit is of smooth pipe larger than eight inches in diameter.

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) |
|---|---|---|
| | schedule 40 | 15 |
| 4 or smaller | schedule 80 | 20 |
| | SDR 26 | 10 |
| | schedule 40 | 10 |
| 6, 8, 10, 12 | schedule 80 | 15 |
| | SDR 26 | 10 |

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

v. Seepage along pipes extending through embankments shall be controlled by use of a filter and drainage diaphragm, unless it is determined that anti-seep 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 anti-seep collars are used in lieu of a drainage diaphragm, they shall have a 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 anti-seep collar(s) shall increase by 15 percent the seepage path along the pipe. When anti-seep collars are used in lieu of a drainage diaphragm, the design engineers shall use the following criteria to determine the size and number of anti-seep collars.

Let V = vertical projection and minimum horizontal projection of the anti-seep 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 anti-seep collars.

The ratio $(L+2nV)/L$ shall be at least 1.15. Anti-seep 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 anti-vortex 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 six feet per second.

(2) If chutes or drops are used for the principal or emergency spillways, they shall be designed according to standards in NRCS's Part 650 (Engineering Field Handbook) and National Engineering Handbook, Part 630 (Hydrology), 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) Drain fill 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 earth fill.

(2) Selected drain fill and backfill material shall be placed around structures, pipe conduits, and anti-seep 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 layers. 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 drain fill or anti-seep 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, at N.J.A.C. 2:90.

xi. In a principal spillway, pipe materials shall conform to the appropriate specifications. Anti-seep 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 to ensure proper functioning of the basin outlets.

ii. Bar spacing for trash racks shall be in accordance with (d)1ii above.

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 pounds per square foot.

vi. Every outlet structure of a basin shall have escape provisions in or on the structure. Escape provisions include the installation of permanent ladders, steps, rungs, or other features that provide easily accessible means of egress from the stormwater management basin. 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 2½ feet. Ledges shall be comprised of two steps, each four to six feet in width, one located approximately 2½ feet below the permanent water surface, and the second located one to 1½ 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.

(e) Guidelines for the following stormwater management practices are found in the Best Management Practices Manual, April 2004 edition.

1. Bioretention systems;

2. Constructed stormwater wetlands;

3. Dry wells;

4. Extended detention basins;

5. Infiltration structures;

6. Manufactured treatment devices;

7. Pervious pavement;

8. Sand filters;

9. Vegetative filters; and

10. Wet ponds.

New Rule, R.2005 d.56, effective February 7, 2005.
See: 36 N.J.R. 4025(a), 37 N.J.R. 481(c).

### 5:21–7.9 Maintenance requirements

The maintenance of stormwater management measures shall comply with the DEP Stormwater Management Rules N.J.A.C. 7:8–5 and 6 reprinted in Appendix B of this subchapter.

New Rule, R.2005 d.56, effective February 7, 2005.
See: 36 N.J.R. 4025(a), 37 N.J.R. 481(c).

## APPENDIX A

### CORRUGATED METAL PIPE STANDARDS

Corrugated metal pipe, when approved by the municipal engineer, shall meet the requirements and be installed in the following manner. Corrugated metal pipe for drainage structures is allowed in accordance with the map below. In areas with acid waters (shaded area on the map), design engineers may use aluminum alloy, provided the environmental limitations below are met. In neutral/alkaline waters (unshaded on the map), aluminum, aluminum-coated steel type 2, and polymeric-coated steel may be used, provided the environmental limitations below are met. Water pH and resistivity values must fall within the ranges shown below. Samples should be measured in accordance with ASTM G51 and G57. Avoid sampling water during storm events or for two days following a storm to insure more typical readings. If there are severe corrosive conditions (pH <4), fiber-bonded steel pipe should be used.

### ENVIRONMENTAL LIMITS FOR CORRUGATED METAL PIPE

| Pipe type | pH | Resistivity values (ohm-cm) |
|---|---|---|
| aluminum | 4–9 | > 500 |
| aluminum-coated type 2 | 5–9 | >1500 |
| polymeric coated | 5–9 | >1500 |
| fiber bonded | <4 | — |

If the design velocity is greater than 10 feet per second, a one-half bituminous coating and paved invert in accordance with ASTM A849 (AASHTO M190) is required.

Minimum depth of coverage shall be as follows:

MINIMUM DEPTH OF COVERAGE FOR

CORRUGATED METAL PIPE

| Pipe diameter (inches) | Minimum cover (inches) from top of pipe to bottom of flexible payment or top of rigid pavement |
|---|---|
| 12 inches to 48 inches | 12 inches |
| 54 inches of more | Per manufacturer's recommendations |

Corrugated aluminum pipe shall conform to the requirements of ASTM B745 (AASHTO M196) for types I, II, IR, IIR, and III.

Corrugated aluminum-coated steel type 2 pipe shall conform to the requirements of ASTM A760 (AASHTO M36) for types I, II, IR, IIR, ands III and have an aluminum-one ounce type 2 coating as specified in ASTM A929 (AASHTO M274).

Corrugated polymeric-coated steel pipe shall conform to the requirements of ASTM A762 (AASHTO M36) for types I and II and have a polymeric 10/10 coating as specified in ASTM A743 (AASHTO M246).

Corrugated fiber-bonded steel pipe shall conform to the requirements of ASTM A760 (AASHTO M36) for types I and II and have an aramid fiber composite coating as specified in ASTM A885. In addition, the pipe shall be bituminous coated as specified in ASTM A849 (AASHTO M190).

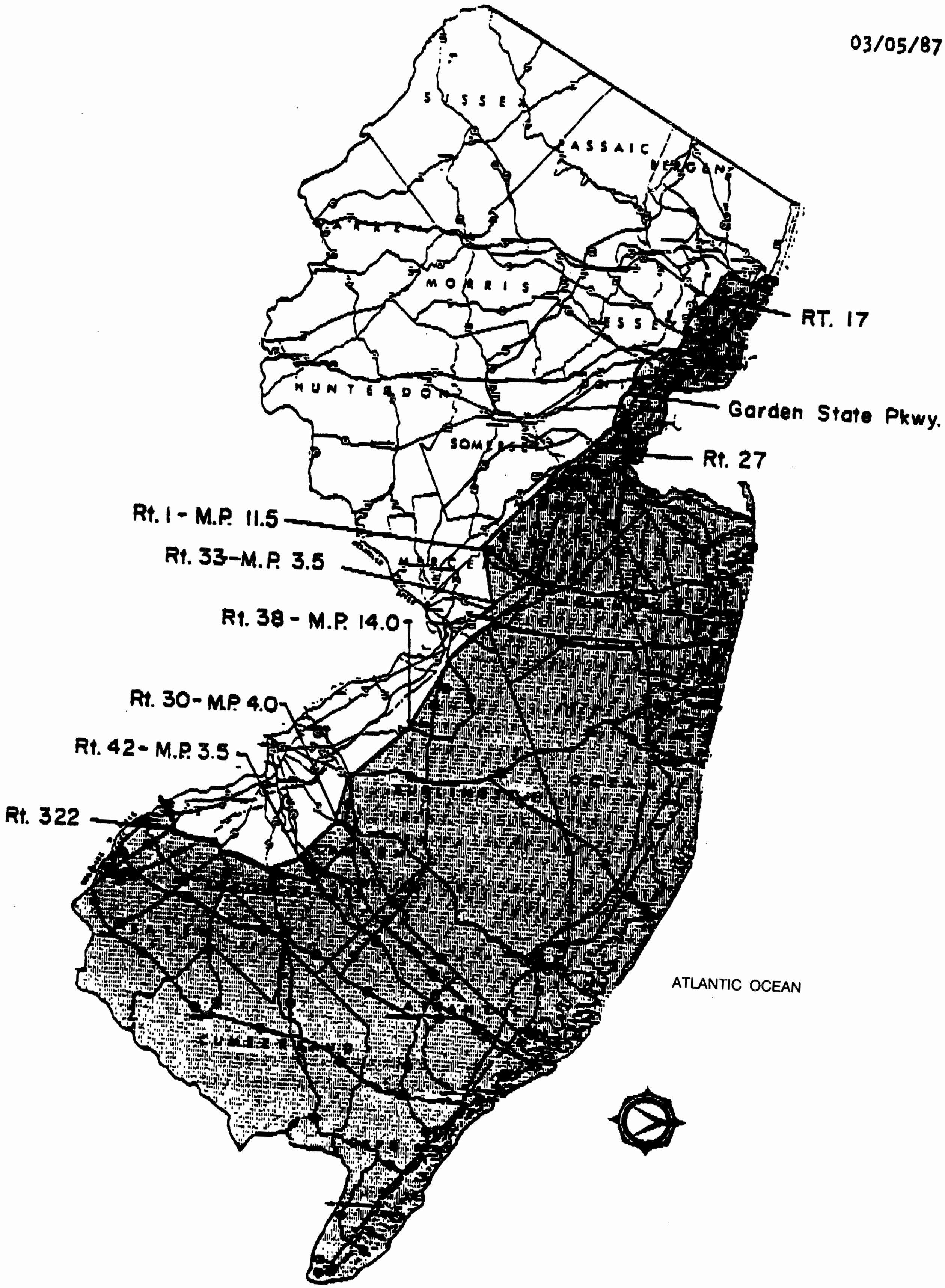
Corrugated metal pipe shall be fabricated with annual corrugations by riveted lap joint construction or with helical corrugations and a continuous weld or lock seam extending from end to end of each length of pipe.

Connecting bands shall be manufactured in accordance with ASTM A760 (steel) or B745 (aluminum) and have the same base metal and coating as the corrugated metal pipe. All pipe ends shall be annularly reformed a minimum of two corrugations.

Fittings and end sections shall be of the same base metal and coating as the corrugated metal pipe.

Corrugated metal pipe shall be installed per ASTM A798 (steel) or ASTM B788.

Maximum cover and structural design of corrugated metal pipe shall be per ASTM A796 (steel) or ASTM B790.


03/05/87
SUSSEX
PASSAIC
MORRIS
HUNTERDON
RT. 17
Garden State Pkwy.
Rt. 27
Rt. 1 - M.P. 11.5
Rt. 33-M.P. 3.5
Rt. 38 - M.P. 14.0
Rt. 30 - M.P. 4.0
Rt. 42 - M.P. 3.5
Rt. 322
ATLANTIC OCEAN