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Chapter 21, Uniform Standards Code for Mobile Homes, was repealed by R.1982 d.7, effective February 1, 1982.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.)

"Aggressive Soils" means soils which may be corrosive to metallic pipe or tubing.

"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.

"Applicant" means a developer submitting an application for development. (MLUL).

"Application For Development" means the application form and all accompanying documents required by ordinance for approval of a subdivision plat, site plan, planned development, conditional use, zoning variance, or direction of the issuance of a permit pursuant to the Municipal Land Use Law. (MLUL).

"Approving Authority" means the planning board of the municipality, unless a different agency is designated by ordinance when acting pursuant to the Municipal Land Use Law. (MLUL).

"Arterial Street" means a higher-order, interregional road in the street hierarchy; conveys traffic between centers; should be excluded from residential areas. (See "street hierarchy".)

"ASCE" means American Society of Civil Engineers.

"ASTM" means American Society for Testing and Materials.

"Average Daily Traffic" means the number of vehicles per day that pass over a given point.

"AWWA" means American Water Works Association.

"Barrier Curb" means a curb specially designed to separate opposing traffic on roads or highways.

"Berm" means a mound of soil, either natural or constructed, used for one or more of the following purposes: screen, buffer, separator, landscape feature, noise attenuator, dam, or stormwater control.

"Bicycle-Compatible Roadway" means a road designed to accommodate the shared use of the roadway by bicycles and motor vehicles.

"Bicycle Lane (bike lane)" means a portion of a roadway which has been designated by striping, signing, and pavement markings for the preferential or exclusive use of bicyclists.

"Bicycle Path (bike path)" means a bikeway physically separated from motorized vehicular traffic by an open space or barrier, and either within the highway right-of-way or within an independent right-of-way or easement.

"Bikeway" means any road, path, or way which in some manner is specifically designated as being open to bicycle travel, regardless of whether such facilities are designated for the exclusive use of bicycles or are to be shared with other transportation modes.

"Blow Off" means a device to allow the escape of air, fluid, or sediments from a pipe within which fluid is flowing under pressure greater than atmospheric pressure.

"Board of Adjustment" means the zoning board of adjustment established pursuant to N.J.S.A. 40:55D–69. (MLUL).

"CAFRA" means Coastal Area Facility Review Act.

"Caliper" means the diameter of a tree trunk measured in inches, four feet above ground level.

"Capped System" means a completed water supply and/or sewerage system put in place for future use (contingent upon expansion), rather than to meet immediate development needs.

"Carbonate Rock" means a rock consisting chiefly of calcium and magnesium carbonates.

"Cartway" means the actual road surface area from curbline to curbline which may include travel lanes, parking lanes, and deceleration and acceleration lanes. Where there are no curbs, the cartway is that portion between the edges of the paved, or hard surface, width.

"Centerline Offset of Adjacent Intersections" means the gap between the centerline of roads intersecting a common road, as measured along the centerline of the intersected road.

"Channel" means any natural or man-made waterway or course through which to convey the constant or intermittent flow of water.

"Channelization" means the straightening and deepening of channels, and/or the surfacing thereof, to permit water to move more rapidly or to redirect the flow of surface water.

"Cluster Development" (see "residential cluster".)

"Common Lateral" means a lateral serving more than one dwelling unit.

"Common Open Space" means an open space area within or related to a site designated as a development, and designed and intended for the use or enjoyment of residents and owners of the development. Common open space may contain such complementary structures and improvements as are necessary and appropriate for the use or enjoyment of residents and owners of the development. (MLUL).

"Concept Plan" means a preliminary presentation and attendant documentation of a proposed subdivision or site plan of sufficient accuracy to be used for the purpose of discussion and classification.

"Corporation Stop" (also known as "corporation cock") means a valve which is placed in a building's water or gas service pipe near its junction with the public water or gas main.

"Cul-de-Sac" means a street with a single means of ingress and egress and having a turnaround, the design of which may vary. (See "street hierarchy".)

"Culvert" means a closed or open conduit designed for the purpose of conveying an open channel watercourse under a road, highway, pedestrian walk, railroad embankment, or other type of overhead structure.

"Curb" means a stone, concrete, or other improved boundary marking the edge of the roadway or paved area.

"Cushions" means supportive or protective bedding materials placed underneath piping.

"Dams and Embankments" means artificial dikes, levees, or other barriers, with appurtenances, for the purpose of impounding or retaining water.

"Days" means calendar days. (MLUL).

"Dedication" means an appropriation of land to some public use made by the owner and accepted for such use by or on behalf of the public.

"Density" means the permitted number of dwelling units per gross area of land to be developed. (MLUL).

"Design Engineer" means a person professionally qualified and duly licensed to perform engineering services that may include, but not necessarily be limited to, development of project requirements, creation and development of project design, and preparation of drawings and specifications.

"Design Flood" means the magnitude of a flooding event that a facility is designed to accommodate. This event can also be used as the basis of a water surface elevation, or the delineation of a floodway and flood hazard area.

"Design Professional" means a person professionally qualified and duly licensed to perform engineering or other professional design services that may include, but not necessarily be limited to, development of project requirements, creation and development of project design, and preparation of drawings and specifications.

"Design Standards" means standards that set forth specific improvement requirements.

"Detention Basin" means a stormwater management basin or alternative structure designed to temporarily detain stormwater runoff.

"Developer" means the legal or beneficial owner or owners of a lot or of any land proposed to be included in a proposed development, including the holder of an option or contract to purchase, or other person having an enforceable proprietary interest in such land. (MLUL).

"Development" means the division of a parcel of land into two or more parcels; the construction, reconstruction, conversion, structural alteration, relocation, or enlargement of any building or other structure, or of any mining excavation or landfill; and any use or change in the use of any building or other structure, or land, or extension of use of land, for which permission may be required per the Municipal Land Use Law. (MLUL).

"Development, Conventional" means development other than planned development. (MLUL).

"Development Plan, General" means a comprehensive plan for the development of a planned development, as provided in the Municipal Land Use Law. (MLUL).

"Development, Planned" means unit development, planned unit residential development, residential cluster, planned commercial development, or planned industrial development. (MLUL).

"Development, Planned Unit" means an area with a specified minimum contiguous acreage of 10 acres or more to be developed as a single entity according to a plan, containing one or more residential clusters or planned unit residential developments and one or more public, quasi-public, commercial, or industrial areas in such ranges of ratios of nonresidential uses to residential uses as shall be specified in the zoning ordinance. (MLUL).

"Development, Planned Unit Residential" means an area with a specified minimum contiguous acreage of five acres or more to be developed as a single entity according to a plan, containing one or more residential clusters, which may include appropriate commercial or public or quasi-public uses, all primarily for the benefit of the residential development. (MLUL).

"Development Regulation" means a zoning ordinance, subdivision ordinance, site plan ordinance, official map ordinance, or other municipal regulation of the use and development of land, or amendment thereto adopted and filed pursuant to the Municipal Land Use Law. (MLUL).

"Divided Street" means a street having an island or other barrier separating opposing moving lanes.

"Dolomite" means a carbonate rock that contains more than 15 percent magnesium carbonate.

"Drainage" means the removal of surface water or groundwater from land by drains, grading, or other means and includes control of runoff during and after construction or development to minimize erosion and sedimentation, to assure the adequacy of existing and proposed culverts and bridges, to induce water recharge into the ground where practical, to lessen nonpoint pollution, to maintain the integrity of stream channels for their biological functions as well as for drainage, and the means necessary for water supply preservation or prevention or alleviation of flooding. (MLUL).

"Drainage Facility" means any component of the drainage system.

"Drainage System" means natural and man-made components that contain, convey, absorb, store, treat, or dispose of surface water runoff or groundwater.

"Stabilized Base Course (Bituminous)" means stabilized base course or asphalt concrete base consisting of soil aggregate and bituminous material uniformly mixed and placed on a previously prepared surface.

"Stabilized Earth" means earth or soil, strengthened usually by the mixing of cement or lime with the original material to achieve increased strength, thereby reducing shrinkage and movement.

"Stabilized Turf" means established, mowable vegetation.

"Stormwater Detention" means a provision for temporary storage of stormwater runoff, and the controlled release of such runoff during and after a flood or storm.

"Stormwater Management Measures" means a broad term for structural and nonstructural control of stormwater runoff and nonpoint pollution.

"Stormwater Retention" means a provision for the permanent storage of a fixed volume of water.

"Street" means any street, avenue, boulevard, road, parkway, viaduct, drive, or other way which is an existing State, county, or municipal roadway, or which is shown upon a plat heretofore approved pursuant to law, or which is approved by official action as provided by the MLUL, or which is shown on a plat duly filed and recorded in the office of the county recording officer prior to the appointment of a planning board and the grant to such board of the power to review plats; and includes the land between the street lines, whether improved or unimproved, and may comprise pavement, shoulders, gutters, curbs, sidewalks, parking areas, and other areas within the street lines. (MLUL).

"Street Hardware" means the mechanical and utility systems within a street right-of-way such as hydrants, manhole covers, traffic lights and signs, utility poles and lines, parking meters, and the like.

"Street Hierarchy" means the conceptual arrangement of streets based upon function. A hierarchical approach to street design classifies streets according to function, from high-traffic arterial roads to streets whose function is residential access.

"Street, Loop" means a street that has its only ingress and egress at two points on the same street.

"Stub Street" means a street which is to be extended when the adjacent property is developed.

"Subdivision" means the division of a lot, tract, or parcel of land into two or more lots, tracts, parcels, or other divisions of land for sale or development. The following shall not be considered subdivisions within the meaning of these rules, if no new streets are created: divisions of land found by the planning board or subdivision committee thereof appointed by the chairman to be for agricultural purposes, where all resulting parcels are five acres or larger in size; divisions of property by testamentary or intestate provisions; divisions of property upon court order, including but not limited to judgments of foreclosure; consolidation of existing lots by deed or other recorded instrument; and the conveyance of one or more adjoining lots, tracts, or parcels of land owned by the same person or persons, all of which are found and certified by the administrative officer to conform to the requirements of the municipal development regulations, and are shown and designated as separate lots, tracts, or parcels on the tax map or atlas of the municipality. The term "subdivision" shall also include the term "resubdivision." (MLUL).

"Subdivision, Major" means any subdivision not classified as a minor subdivision. (MLUL).

"Subdivision, Minor" means a subdivision of land for the creation of a number of lots specifically permitted by ordinance as a minor subdivision, provided that such subdivision does not involve a planned development, any new street, or the extension of any off-tract improvement, the cost of which is to be prorated pursuant to N.J.S.A. 40:55D–42. (MLUL).

"Subgrade" means the prepared surface upon which pavements and shoulders are constructed.

"Surface Course" means the placement of the asphalt concrete material on a previously prepared base course.

"Swale" means a low lying or depressed land area commonly wet or moist, which can function as an intermittent drainage way.

"Topsoil" means:

1. The natural, undisturbed surface layer of soil having more organic matter than subsequent layers, a pH of 5.0 to 7.5, and suitable for satisfactory growth and maintenance of permanent, locally-adapted vegetation.

2. Where the original surface layer has been removed, the reapplication of soil material used to cover an area so as to improve soil conditions for establishment and maintenance of adapted vegetation. The reapplied material must be friable, loamy soil reasonably free of debris, objectionable weeds, and stones; have a natural pH of 5.0 to 7.5; have an organic matter content greater than 2.00 percent; and contain no toxic substances which may be harmful to plant growth.

"Traveled Way" means the portion of a cartway used for vehicular travel.

"Trip" means a single or one-way vehicle movement to or from a property or study area.

"ULI" means Urban Land Institute.

"USCGS (also USC&G and USC&GS)" means United States Coast and Geodetic Survey.

"Utility Area" means a flexible space within the right-of-way designated for the installation of utility lines and facilities.

"Utility Authority" means any "sewerage authority" as defined in N.J.S.A.40:14A–3 or any "municipal authority" as defined in N.J.S.A. 40:14B–3.

"Variance" means permission to depart from the literal requirements of a zoning ordinance, pursuant to N.J.S.A. 40:55D–40b., 70c., and 70d. (MLUL).

"Wet Pond" (see "retention basin").

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).
Substituted "Where" for "There" at the beginning of the second sentence in the introductory paragraph; and in "Mountable curb", deleted "flat" preceding "slope".
Amended by R.2002 d.399, effective December 16, 2002.
See: 34 N.J.R. 2615(a), 34 N.J.R. 4412(a).
Added "Multifamily development" and "Parking lot"; deleted "Parking Loop".
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).

5:21–1.5 Scope and applicability

(a) These rules shall govern any site improvements carried out or intended to be carried out or required to be carried out in connection with any application for residential subdivision, site plan approval, or variance before any planning board or zoning board of adjustment created pursuant to the Municipal Land Use Law (N.J.S.A. 40:55D–1 et seq.); or in connection with any other residential development approval required or issued by any municipality or agency or instrumentality thereof.

(b) Except as is otherwise specifically provided, these rules shall control all matters concerning the construction, alteration, addition, repair, removal, demolition, maintenance, and use of any site improvements constructed by a developer in connection with residential development. Except as otherwise required by rules or other permit requirements of the Department of Environmental Protection regarding storm water management, the rules are to be interpreted as the minimum required to ensure public health and safety, and the maximum that may be required in connection with residential development.

(c) These rules shall apply to all site improvement work and appurtenant construction including streets, roads, parking facilities, sidewalks, drainage structures, grading, and utilities which are undertaken by a developer in connection with residential development or use.

1. Where both residential and commercial development are planned in a mixed-use development, these rules shall apply to the residential part or parts of such development where such residential part or parts are discrete and separate from planned commercial parts as evidenced by, for example, separate building(s), separate parking, and separate access features.

2. These rules shall apply to all utilities created by or deriving their authority from municipal ordinance to operate within a given jurisdiction.

3. Choice among options contained in these rules shall be the applicant's unless otherwise specified in these rules.

(d) Nothing contained in these rules shall be construed to limit the powers of any municipality to establish and enforce any requirement concerning:

1. Layout, arrangement, and location of improvements, shade trees, landscaping, or reservation of areas for public use, pursuant to N.J.S.A. 40:55D–38;

2. Preservation of existing natural resources; arrangement of physical elements for safe and efficient vehicular and pedestrian circulation, by, for example, traffic calming measures as described in "Residential Street Design and Traffic Control," by W. S. Homburger et al. (Institute of Transportation Engineers, 1989), parking, and loading; screening, landscaping, and location of structures; or conservation of energy and use of renewable resources; pursuant to N.J.S.A. 40:55D–41; or

3. Use, bulk, height, number of stories, orientation, and size of buildings and other structures; the percentage of lot or development area that may be occupied by structures, lot sizes and dimensions, floor area ratios, or other measures to control development intensity; or the provision of adequate light and air pursuant to N.J.S.A. 40:55D–65.

(e) The provisions of these rules shall not preempt or in any way affect the exercise of any authority by the State or any county government with respect to site improvements conferred by any State law or any rule promulgated thereunder. Nor shall these rules be in any way interpreted to modify or otherwise affect rules promulgated pursuant to the Pinelands Commission Act, N.J.S.A. 13:18A–1 et seq. (N.J.A.C. 7:50). It is the intent of these rules to be consistent with all other applicable laws, rules and regulations. Where these rules and any other State or county laws, rules or regulations establish differing requirements, then the requirements of these rules shall govern, except where any such differing requirement is more restrictive.

(f) These rules shall not apply to driveways on private property held in fee-simple as individual residential lots outside of the public right-of-way, including common driveways established by easements shared by more than one but not more than four dwelling units on private property.

(g) These rules are intended to ensure the public health, safety, and welfare insofar as they are affected by site improvement work, and shall be so construed.

Administrative correction.
See: 29 N.J.R. 1296(a).
Amended by R.1998 d.399, effective August 3, 1998.
See: 30 N.J.R. 1660(a), 30 N.J.R. 2861(a).
In (b), inserted "Except as otherwise required by rules or other permit requirements of the Department of Environmental Protection regarding storm water management, the" at the beginning of the second sentence.
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), inserted "but not more than four".

Case Notes

Department of Community Affairs' insignificant deviations from Model Subdivision and Site Plan Ordinance to be adopted pursuant to Residential Site Improvement Standards Act were within its incidental powers. New Jersey League of Municipalities v. Department of Community Affairs, 158 N.J. 211, 729 A.2d 21 (N.J. 1999).

Storm water management regulation promulgated by Department of Community Affairs (DCA), which conflicted with storm water management regulation promulgated by the Department of Environmental Protection, was invalid. New Jersey State League of Municipalities v. Department of Community Affairs, 310 N.J.Super. 224, 708 A.2d 708 (A.D.1998).

5:21–1.6 Development over limestone geologic formations

(a) A number of areas in northern New Jersey are underlain by solution-prone carbonate rocks (limestone, dolomite, and marble) which pose unusual and complex problems in relation to development activities. As such, these areas are quite sensitive to development improvements and may require special investigative, design, and construction techniques to protect both the eventual property owner as well as those in the immediate surroundings. It is not the intention of these site improvement standards to address such unusual subsurface conditions or to attempt to supersede definitive local ordinances addressing such concerns.

(b) Any proposed revisions to the standards established by the Site Improvement Advisory Board may be submitted for Board consideration by any municipality shown on the list set forth in the Appendix to this subchapter, incorporated herein by reference, or by any municipality where those materials are found to be present. Proposed revisions to the within standards shall be reviewed by the technical committee and recommended to the Site Improvement Advisory Board for approval.

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 a reference to Board consideration for a reference to consideration, and substituted a reference to the Appendix for a reference to Appendix 1–A.

5:21–1.7 Administration and enforcement

(a) Wherever a municipality has enacted an ordinance which requires subdivision and/or site plan approval pursuant to N.J.S.A. 40:55D–37, then the planning board of such municipality shall ensure that the plans and plats for any residential development subject to review under such ordinance comply with the requirements of these rules before issuing a preliminary or final approval.

(b) Whenever a zoning board of adjustment created pursuant to N.J.S.A. 40:55D–69 grants subdivision or site plan approval pursuant to the provisions of N.J.S.A. 40:55D–76(b), then that board shall ensure that any plans and plats comply with the requirements of these rules before issuing a preliminary or final approval.

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

5:21–1.8 Approval

(a) All materials, equipment, and devices required to be approved by a board or official pursuant to N.J.A.C. 5:21–1.7 shall be constructed and installed in accordance with such approval.

(b) The standards referenced in these rules and listed in N.J.A.C. 5:21–8 shall be considered a part of the requirements of these rules to the prescribed extent of each reference. Where differences occur between provisions of these rules and referenced standards, the provisions of these rules shall apply, except as provided in N.J.A.C. 5:21–1.5(e).

Administrative correction.
See: 29 N.J.R. 1296(a).
Administrative change.
See: 33 N.J.R. 691(b).

5:21–1.9 Violations

(a) Where any site improvement is required to meet any part of these rules pursuant to the requirements of any ordinance adopted pursuant to N.J.S.A. 40:55D–37, Subdivision and Site Plan Review and Approval, or N.J.S.A. 40:55D–62, Zoning, then any failure of any person to construct such site improvements in accordance with the requirements of these rules shall constitute a violation of the Municipal Land Use Law (N.J.S.A. 40:55D–1 et seq.). Any person responsible for such failure shall be subject to such penalties and enforcement procedures as are provided by that law and by any valid ordinance adopted pursuant thereto which may be initiated by the administrative officer designated by the ordinance (N.J.S.A. 40:55D–18).

(b) In addition to any remedy provided by (a) above, any failure to comply with the requirements of these rules, where compliance is required, shall constitute a failure to meet the conditions of the construction permit and/or certificate of occupancy issued pursuant to the State Uniform Construction Code Act (N.J.S.A. 52:27D–119 et seq.). Notification from the approving authority or from the municipal engineer acting on behalf of the approving authority that any of the requirements of these rules that are conditions of the Construction Permit and/or Certificate of Occupancy

have not been met shall subject any person responsible for such failure to the remedies provided under the State Uniform Construction Code Act.

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

5:21–1.10 Operative date

(a) These rules shall be operative on June 3, 1997. The requirements of any municipal ordinances or rules adopted by any instrumentality deriving authority therefrom in effect on that date which establish rules or requirements for any matter within the scope of these regulations shall be deemed to have been repealed and of no further force or effect.

(b) Any project for which preliminary subdivision or site plan approval has been given prior to June 3, 1997 shall continue to be subject to the municipal development ordinance under which it was approved.

(c) Any project for which application is made after June 3, 1997 shall be governed by these rules.

(d) These rules shall not be construed as requiring the revision or amendment of any application for site plan or subdivision approval which is pending on June 3, 1997. Such pending applications may, however, be amended provided that any such amendments shall meet the requirements of these rules.

1. For any project for which a completed application has been submitted on or before the operative date of these rules, but which has not yet received preliminary approval, the applicant shall have the option of amending the application in its entirety to comply with these rules or of requesting that the municipality continue to review the application under the municipal ordinances in effect at the time of application.

(e) For a period of six months following the operative date of a technical revision to the standards, applicants may submit a complete application to be reviewed under the standards in effect immediately prior to the technical revision. Provided that the application is deemed complete within the meaning of the Municipal Land Use Law, the planning board or zoning board of adjustment, as appropriate, shall review the application based on the technical standards in force immediately prior to the operative date of the revision to the standards. This grace period shall only apply to technical revisions to the standards.

(f) In the case of a subdivision or project for which a complete application has been submitted but for which preliminary approval has not been issued by the operative date of any technical change to the standards, review shall continue and approval shall be granted based on the standards in force immediately prior to the operative date of the revision to the standards.

Amended by R.2004 d.35, effective January 20, 2004.
See: 35 N.J.R. 3981(a), 36 N.J.R. 447(a).
Added (e) and (f).

5:21–1.11 Validity

If any provision of these rules or the application thereof to any person or circumstances is held invalid, the invalidity shall not affect other provisions or applications of the rules which can be given effect, and to this end the provisions of the rules are severable.

APPENDIX

NEW JERSEY MUNICIPALITIES LIMESTONE AREAS

County		Municipality
Hunterdon	Alexandria Township	Hampton Borough
	Bethlehem Township	Holland Township
	Bloomsbury Borough	Lebanon Township
	Califon Borough	Tewksbury Township
	Clinton Township	Union Township
	Clinton Town	
Morris	Chester Township	Mount Olive Township
	Jefferson Township	Mt. Arlington Borough
	Mendham Township	Randolph Township
	Mendham Borough	Rockaway Township
	Minehill Township	Roxbury Township
	Montville Township	Washington Township
	Morris Township	Wharton Borough
Passaic	Bloomingdale Borough	Wanaque Borough
	Ringwood Township	West Milford Township
Somerset	Bedminster Township	Peapack/Gladstone Borough
	Far Hills Borough	
Sussex	Andover Township	Lafayette Township
	Andover Borough	Montague Township
	Branchville Borough	Newton Town
	Byram Township	Ogdensburg Borough
	Frankford Township	Sandyston Township
	Franklin Borough	Sparta Township
	Fredon Township	Stillwater Township
	Green Township	Vernon Township
	Hamburg Borough	Walpack Township
	Hampton Township	Wantage Township
	Hardyston Township	
Warren	Allamuchy Township	Independence Township
	Alpha Borough	Knowlton Township
	Belvidere Township	Liberty Township
	Blairstown Township	Lopatcong Township
	Franklin Township	Mansfield Township
	Frelinghuysen Township	Oxford Township
	Greenwich Township	Phillipsburg Township
	Hackettstown Town	Pohatcong Township
	Hardwick Township	Washington Township
	Harmony Township	Washington Borough
	Hope Township	White Township

† Listing established by the Department of Environmental Protection, Division of Science and Research (April 1995)

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

SUBCHAPTER 2. APPLICATION AND REVIEW PROCEDURES

5:21–2.1 Application and review procedures

The procedure for municipal review and action on applications for residential subdivisions and/or site plans shall not be affected by anything contained in these rules, and shall continue to be as set forth in the Municipal Land Use Law (MLUL), N.J.S.A. 40:55D–1 et seq. and in municipal ordinances adopted pursuant to the MLUL. This review shall include a review for compliance with these rules.

5:21–2.2 Application form and checklist (Reserved)

SUBCHAPTER 3. EXCEPTIONS, WAIVERS, AND SPECIAL AREA STANDARDS

5:21–3.1 Exceptions

(a) The municipal approving authority may grant such de minimis exceptions from the requirements of the site improvement standards as may be reasonable and within the general purpose and intent of the standards if the literal enforcement of one or more provisions of the standards is impracticable or will exact undue hardship because of peculiar conditions pertaining to the development in question.

(b) An application for an exception pursuant to this section shall be filed in writing with the municipal approving authority and shall include:

1. A statement of the requirements of the standards from which an exception is sought;

2. A statement of the manner by which strict compliance with said provisions would result in practical difficulties; and

3. A statement of the nature and extent of such practical difficulties.

Proposed Code Change:

Supporting Statement (Reason for change should include an "authoritative source" and cost analysis where appropriate.):

Changes to the technical requirements in the standards must be based on recommended site improvement standards that are published by an academic or professional institution or organization, similar to those used in the original Rutgers Model Subdivision and Site Plan Ordinance.

New Rule, R.2001 d.352, effective October 1, 2001.
See: 33 N.J.R. 1237(a), 33 N.J.R. 3427(a).

SUBCHAPTER 4. STREETS AND PARKING

Subchapter Historical Note

Administrative change.

See: 35 N.J.R. 609(b).

5:21–4.1 Street hierarchy

(a) Streets shall be classified in a hierarchy with design tailored to function. The street hierarchy definitions contained within this section are applicable only to local residential streets and are not to be considered related to the U.S. Department of Transportation, Federal Highway Administration's Functional Classification of Highways.

(b) The street hierarchy system shall be defined by road function and average daily traffic (ADT), calculated by trip generation rates from the current edition of *"Trip Generation"* by the Institute of Transportation Engineers, as indicated in Table 4.1 below. Trip generation rates from other sources may be used if the applicant demonstrates to the appropriate approving authority that these sources better reflect local conditions. In addition, the applicant shall investigate the opportunities for, and availability of, transit facilities and, if appropriate, consider their impact(s) on motor vehicle traffic trip generation rates per dwelling unit.

(c) Each residential street shall be classified and designed to meet the standards for one of the street types defined in Table 4.2 below. The entire length of the street need not be designed based on the highest ADT where the ADT varies along the street's length. However, each street segment between intersections shall be designed based on the highest ADT served in that segment.

(d) The municipality and the developer shall determine the highest order street required to be used in a given residential development, considering all of the following:

1. The size of the development (number and type of units). For example, using size to determine the highest order of street required, a development of up to 150 single-family detached units would not require any minor collectors or streets of a higher order;

2. The actual or potential development of adjacent sites (whether there is likely to be traffic passing through from neighboring developments). A "potential" development means a development having approvals granted, applications pending, or undergoing preliminary review; and

3. The streets proposed for that area, if any, as contained in the municipal master plan.

TABLE 4.1

AVERAGE DAILY MOTOR VEHICLE TRAFFIC TRIP GENERATION PER DWELLING UNIT[1]

Land use[2]	Peak rate
Single-family detached housing	10.1
Townhouse	5.9
Low-rise apartment	7.2
Mid-rise apartment	5.5
High-rise apartment	5.0
Mobile home park	5.0
Retirement community	2.8
Recreational homes (owner occupied)	3.2

Notes:

[1] The trip generation rates listed are guidelines only. The actual use of trip generation rates is derived by the use of regression analysis and should be computed only by professionals proficient in the use of the ITE Trip Generation manual. The "Land Use" definitions are based on the ITE manual with slight modifications to address inconsistencies contained within the ITE manual.

[2] For two-family dwellings (duplexes), apply the values for single-family dwellings to each unit.

Source: Institute of Transportation Engineers, Trip Generation (Washington, D.C.: ITE, 1982), 3rd Edition. The table was updated with data from the 6th Edition of the manual published by ITE in 1997. The peak ADT rates take into consideration Saturday and Sunday rates, as well as weekday rates.

DEFINITIONS

Land use	Definition
Single-family detached housing	Any single-family detached home on an individual lot.
Townhouse	Attached multiple-family dwelling units where the only separation between units is vertical.
Apartment	A dwelling unit located within the same building with at least three other dwelling units.
Low-rise apartment	Apartments in buildings that have one or two levels (floors).
Mid-rise apartment	Apartments in buildings that have more than two levels (floors) and less than ten levels.
High-rise apartment	Apartments in buildings with ten or more levels (floors).
Mobile home park	Generally trailers shipped, sited and installed on permanent foundations and in areas that typically have community facilities, such as recreation rooms, swimming pools, and laundry facilities.

Land use	Definition	Land use	Definition
Retirement community	Residential units similar to apartments and condominiums usually restricted to adults or senior citizens, and located in self-contained villages. Special services such as medical, dining, and retail facilities may be available.	Recreational home	Dwellings usually located in a resort containing local services and complete recreational facilities. These are often second homes used by the owner or rented on a seasonal basis.

TABLE 4.2
RESIDENTIAL STREET HIERARCHY DEFINITIONS

Street type	Description	Average daily traffic (maximum)
Residential Access‡	Lowest order, other than rural street type, of residential streets Provides frontage for access to lots and carries traffic with destination or origin on the street itself. Designed to carry the least amount of traffic at the lowest speed. All, or the maximum number of housing units, shall front on this class of street.	
	† Residential access streets of "loop" configuration, that is, two ways out, should be designed so no section conveys an ADT greater than 1500. Each half of a loop street may be classified as a single residential access street, but the total traffic volume generated on the loop street should not exceed 1500 ADT, nor should it exceed 750 ADT at any point of traffic concentration.	1,500†
Residential Neighborhood‡	A type of residential access street conforming to traditional subdivision street design, and providing access to building lots fronting on a street and parking on both sides of street.	
	‡ Applicant may choose either the RESIDENTIAL ACCESS or the RESIDENTIAL NEIGHBORHOOD street type for new streets. See section 4.8(b) for specific right-of-way and cartway width requirements for new streets that are a continuation of an existing street.	
Minor Collector	Middle order of residential street. Provides frontage for access to lots and carries traffic of adjoining residential access streets. Designed to carry somewhat higher traffic volumes than lower-order streets such as rural and residential access streets, with traffic limited to motorists having origin or destination within the immediate neighborhood. Is not intended to carry regional traffic.	
	Each half of a loop-configured minor collector may be classified as a single minor collector street, but the total traffic volume conveyed on the loop should not exceed 3,500 ADT, nor should it exceed 1750 ADT at any point of traffic concentration.	3,500
Major Collector	Highest order of residential streets. Conducts and distributes traffic between lower-order residential streets and higher-order streets—arterials and expressways. Carries the largest volume of traffic at higher speeds. Function is to promote free traffic flow; therefore, parking should be prohibited and direct access to homes from this level of street should be avoided. Collectors should be designed so they cannot be used as shortcuts by non-neighborhood traffic.	7,500
Special Purpose Streets		
Rural	A rural street is a street that serves dwellings on lots that are one acre or greater, AND primarily serves as access to abutting building lots, AND has no on-street parking, AND has lot-to-street access designed so vehicles do not back out of lots onto the street. Rural streets shall only connect to rural streets, rural residential lanes, or mixed-use collectors. However, a rural street shall not connect two mixed-use collectors.	500
Rural residential lane	A rural residential lane is a street that serves dwellings on lots that are two acres or greater, AND primarily serves as access to abutting building lots, AND has no on-street parking, AND has lot-to-street access designed so vehicles do not have to back out of lots onto the street. Rural residential lanes shall only connect to rural streets, rural residential lanes, or mixed-use collectors. However, a rural residential lane shall not connect two mixed-use collectors.	200

Street type	Description	Average daily traffic (maximum)
Alley	A service road that provides a secondary means of access to lots. On same level as residential access street, but different standards apply. No parking shall be permitted; alleys should be designed to discourage through traffic. ADT level shall not exceed that of a residential access street.	500
Cul-de-sac[1]	A street with a single means of ingress and egress and having a turnaround, the design of which may vary. A divided-type entrance roadway to at least the first cross street, with median of sufficient width to ensure freedom of continued emergency access by lanes on one side, shall not be considered part of a cul-de-sac. Parking lots with a single means of ingress and egress shall not be included within the definition of cul-de-sac.	250
Marginal access street	A service street that runs parallel to a higher-order street and provides access to abutting properties and separation from through traffic. May be designed as residential access street or minor collector, according to anticipated daily traffic.	1,500 (residential access total) 3,500 (minor collector total)
Divided street	Municipalities may require streets to be divided to provide alternate emergency access, protect the environment, or avoid grade changes. Design standards should be applied to the combined dimensions of the two street segments, as required by the street class.	
Multifamily access cul-de-sac	A street with a single means of ingress and egress, which serves multifamily development, that provides a means for vehicles to turn around.	1,000
Multifamily court	A street with a single means of ingress and egress, which serves multifamily development, that does not provide a means for vehicles to turn around. The length of multifamily courts is limited to 300 feet.	Note[2]

Notes:

[1] Streets serving multifamily developments with a single means of ingress and egress shall be classified as multifamily access cul-de-sacs.

[2] There is no ADT limit for multifamily courts specified because the length of the court will effectively limit the ADT to acceptable levels.

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 (c), added a second sentence; and in Table 4.2, added a third sentence in the Cul-de-sac Description, and substituted a reference to non-parallel parking for a reference to perpendicular parking in the Parking Loop Description.
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).
Rewrote Table 4.1 and in Table 4.2, rewrote the description of "Rural residential lane".
Amended by R.2002 d.399, effective December 16, 2002.
See: 34 N.J.R. 2615(a), 34 N.J.R. 4412(a).
In Table 4.1, inserted "Trip General" preceding "manual" in the second sentence of foonote 1, and added footnote 2; rewrote Table 4.2.
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).

5:21–4.2 Cartway width

(a) Cartway width for each street classification shall be determined by parking and curbing requirements that are based on intensity of development.

(b) Intensity of development shall be based on dwelling units per gross acre as follows:

Intensity	Dwelling Units per Gross Acre[†]
Low	Less than or equal to 4
Medium	More than 4 and less than or equal to 8
High	More than 8

Note: [†]In determining the intensity of development, the gross acreage shall not include dedicated common open space or other such areas restricted from future development.

(c) Cartway widths for each street classification are as shown in Table 4.3 below.

(d) Cartway width also shall consider possible limitations imposed by sight distances, climate, terrain, and maintenance needs.

(e) Municipalities may require additional cartway width for major or minor collectors which are part of a designated bike route as indicated in the bicycle circulation part of the municipal master plan to make them consistent with the AASHTO guidelines for bicycle-compatible streets.

TABLE 4.3

CARTWAY AND RIGHT–OF–WAY WIDTHS

Street type[a]	Total avg. daily traffic	Traveled way	No. of parking lanes[b]	Parking lane width	Cartway width	Curb or shoulder[h]	Sidewalk or graded area[j]	Right-of-way width[i]
Residential access	1,500† †(loop—750 each half)							
a. Parallel parking								
Low intensity		21 feet	1	7 feet	28 feet	None	1 SW 1 GA	50 feet
Medium intensity		21 feet	1	7 feet	28 feet	Curb	2 SW	50 feet
High intensity (on-street parking)		21 feet	1	7 feet	28 feet	Curb	2 SW	50 feet
b. Nonparallel parking (all intensities)								
One-side parking		24 feet	1	18 feet		Curb	2 SW[n]	54 feet
Two-side parking		24 feet	2	36 feet		Curb	2 SW[n]	72 feet
c. No parking								
High intensity (off-street parking)		20 feet	0	0 feet	20 feet	None	2 SW	50 feet
Neighborhood (all intensities)	1,500	16 feet	2	14 feet	30 feet[c]	Curb	2 SW	50 feet
Minor Collector[l]	3,500							
Low intensity[d] with no parking		20 feet	0	0 feet	20 feet	None	1 SW 1 GA	50 feet
Low intensity with one parking lane		21 feet	1	7 feet	28 feet	Curb	1 SW 1 GA	50 feet
Medium and High intensities								
With one parking lane		21 feet	1	7 feet	28 feet	Curb	2 SW	50 feet
With two parking lanes		22 feet	2	14 feet	36 feet	Curb	2 SW	60 feet
With off-street parking		22 feet	0	0 feet	22 feet	Curb or shoulder	2 SW	50 feet
Major Collector[l]	7,500							
Low intensity		24 feet	0	0 feet	24 feet	None	2 SW	50 feet
Medium and High intensities		24 feet	0	0 feet	24 feet	Curb or shoulder	2 SW	50 feet if curb, 54 feet if shoulder
Special Purpose Streets								
Rural street[k]	500	20 feet	0	0 feet	20 feet	None	2 GA	40 feet
Rural lane[k]	200	18 feet	0	0 feet	18 feet	None	2 GA	40 feet
Alley (one way)					9 feet			11 feet
Alley (two way)		18 feet	0	0 feet	18 feet	None	2 GA	22 feet
Cul-de-sac (stem)[e]	250							
Marginal access street[f]								
Divided street[g]								
Multifamily access cul-de-sac[m]	1,000							
Multifamily court[o]	Note[p]							

NOTES:

[a]See Table 4.2 for definitions of street hierarchy and N.J.A.C. 5:21–4.2 for definitions of low, medium, and high intensity of development.

[b]Parking lane refers to parallel parking, except in the case of residential access streets with nonparallel parking, which have perpendicular parking.

[c]The 30 foot cartway would accommodate two seven foot parking lanes and a 16 foot traveled way.

[d]20 foot minor collector cartways are permitted only when there is no direct building lot access to or from the street in question.

[e]Cartway widths of cul-de-sac stems should conform to the applicable street type. Right-of-ways for cul-de-sac stems shall extend a minimum of eight feet beyond the cartway. Cul-de-sacs shall provide for a cartway turning radius of 40 feet and a right-of-way line eight feet beyond the edge of the cartway.
[f]Cartway and right-of-way widths of marginal access streets and right-of-way requirements should conform to standards of either residential access or minor collector streets, as dictated by average daily traffic. If the classification is a minor collector requiring a 36 foot cartway, cartway width may be reduced to 28 feet, since frontage is restricted to one side of the street.
[g]Cartway widths of divided streets should conform to standards of street classification, as dictated by anticipated average daily traffic, and be applied as aggregate dimensions of two street segments. Divided streets shall be provided with cut-throughs at a maximum of 1,200 foot intervals.
[h]See N.J.A.C. 5:21–4.3(c) for additional requirements.
[i]Right-of-way width applies only to streets proposed for dedication as shown on approved plans.
[j]See N.J.A.C. 5:21–4.5(b) for additional requirements.
[k]Rural streets and rural lanes are permitted only within developments which do not exceed an average daily traffic count of 500 and 200, respectively.
[l]Municipalities may require additional width for major or minor collectors which are part of a designated bicycle route as indicated in the circulation part of the municipal master plan to make them consistent with the AASHTO guidelines for bicycle-compatible streets.
[m]Cartway widths of multifamily cul-de-sac stems should conform to the applicable residential access street type. Cul-de-sacs shall provide for a cartway turning radius of 40 feet or other suitable means for vehicles to turn around, such as hammerheads. Where not located on private property, a right-of-way line eight feet beyond the edge of the cartway shall be provided.
[n]Sidewalks provided for streets with nonparallel parking shall be placed in accordance with N.J.A.C. 5:21–4.5(e).
[o]Cartway and right-of-way widths for multifamily courts shall comply with the design criteria for residential access streets, based on the parking configuration. Multifamily courts need not be provided with a means of turning around; however, their length shall not exceed 300 feet.
[p]There is no ADT limit for multifamily courts; however, the length of a multifamily court is limited to 300 feet.

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 Table 4.3, combined Medium and High Intensity Street Types, changed Parking Loop Right-of-Way Widths, rewrote Note e, added "as shown on approved plans" at the end of Note i, and added Note l.
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 (b), substituted "8" for "15" under Dwelling Units per Gross Acre; inserted (e); and in Table 4.3, inserted footnote "m" amd all references thereto in the body of the table.
Public Notice: Special area standards.
See: 33 N.J.R. 897(a).
Amended by R.2002 d.399, effective December 16, 2002.
See: 34 N.J.R. 2615(a), 34 N.J.R. 4412(a).
Rewrote Table 4.3.
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.2004 d.35, effective January 20, 2004.
See: 35 N.J.R. 3981(a), 36 N.J.R. 447(a).
Revised Table 4.3.
Administrative correction.
See: 36 N.J.R. 949(a), 1751(b).

5:21–4.3 Curbs or curbs and gutters

(a) Curbs or curbs and gutters shall be used for drainage purposes, safety, and delineation and protection of pavement edge. Where, based on stormwater management system design, there is determined to be a problem with runoff, curbs or curbs and gutters shall be used.

(b) Curb requirements shall vary according to street hierarchy and intensity of development, in accordance with the requirements set forth in Table 4.3 in N.J.A.C. 5:21–4.2. Generally, curbs shall be required on streets with on-street parking.

(c) Where curbing is not required, edge definition and stabilization shall be furnished for safety reasons, and to prevent pavement unraveling. Curbing may be required for: stormwater management, road stabilization, delineation of parking areas, 10 feet on each side of drainage inlets, intersections, corners, and tight radii.

(d) Curb requirements may be waived by the appropriate municipal approving agency, and shoulders and/or drainage swales used when it can be shown that: shoulders are required by CAFRA; soil and/or topography make the use of shoulders and/or drainage swales preferable; and/or the community desires to preserve its rural character by using shoulders and/or drainage swales instead of curbs. In cases of medium development intensity, the curbing requirement may be waived where front setbacks exceed 40 feet and it can be demonstrated that sufficient on-site parking exists.

(e) A municipality may designate a curb type by ordinance. Where curb type is not established by municipal ordinance, flexibility regarding curb type shall be permitted as long as the curb type accommodates the system of drainage proposed. Generally, curbs should be constructed of concrete or granite block. Curbing materials shall accommodate the purposes set forth in (c) above.

(f) Curbs shall be constructed according to the specifications set forth in N.J.A.C. 5:21–4.17.

(g) Curbing shall be designed to provide a curb ramp in compliance with the Americans with Disabilities Act or the Barrier Free Subcode of the New Jersey Uniform Construction Code (N.J.A.C. 5:23–7) at street intersections, as applicable.

(h) Where curbs and gutters are used and where the street is part of a designated bike route as indicated in the bicycle circulation part of the municipal master plan, the municipality may require that the cartway width be increased by one foot on each side of a street that uses a curb and gutter.

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).
Added (h).

5:21–4.4 Shoulders

(a) Shoulders should be used instead of curbs when:

1. Shoulders are required by CAFRA;

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).
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 Figure 4.1, amended (1 of 5), (2 of 5) and (3 of 5).
Amended by R.2002 d.399, effective December 16, 2002.
See: 34 N.J.R. 2615(a), 34 N.J.R. 4412(a).
Added Figure 4.1 (4 of 6); the elements of Figure 4.1 redesignated from "of 5" to "of 6"; amended Figure 4.1 (3 of 6).
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.2004 d.35, effective January 20, 2004.
See: 35 N.J.R. 3981(a), 36 N.J.R. 447(a).
In (c), amended 3, 5 and 6 of 6 in Figure 4.1.

5:21–4.18 Sidewalks and bikeways construction standards

(a) The following apply to sidewalks and graded areas:

1. Sidewalks of concrete shall be four inches thick except at points of vehicular crossing, where they shall be at least six inches thick. At vehicular crossings, concrete sidewalks shall be reinforced with welded wire fabric mesh or an equivalent.

2. Concrete, air-entrained sidewalks shall be Class B concrete, having a 28–day verification strength of 4,500 p.s.i. Other materials may be permitted, depending on the design of the development.

3. Graded areas shall be planted with grass or treated with other suitable ground cover, and their width and cross slope shall correspond to that of sidewalks.

(b) The following apply to bikeways:

1. The construction of bikeways shall conform to the New Jersey Department of Transportation Planning and Design Guidelines for Bicycle Compatible Roadways and Bikeways (November 1995) and the AASHTO Guide for the Development of Bicycle Facilities (1999), incorporated herein by reference.

2. Bicycle-safe drainage grates shall be used in the construction of all residential streets.

Administrative correction.
See: 29 N.J.R. 1296(a).
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).
Rewrote (b)1.
Amended by R.2002 d.399, effective December 16, 2002.
See: 34 N.J.R. 2615(a), 34 N.J.R. 4412(a).
In (a)2, substituted "Class B concrete" for "Class C concrete" and substituted "4,500 p.s.i." for "4,000 p.s.i.".
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).

5:21–4.19 Street grade, intersections, pavement, and lighting construction standards

(a) The following apply to street grade:

1. Minimum street grade permitted for all streets shall be 0.5 percent.

2. Maximum street grade shall vary by road hierarchy with flatter grades required for roads with higher ADTs, in accordance with the requirements shown in Table 4.6. Where terrain makes it necessary, the allowable maximum grade may be increased by up to two percent, but shall not exceed a maximum grade of 16 percent.

(b) The following shall apply to intersections:

1. Street intersections shall be as nearly at right angles as possible and in no case shall be less than 75 degrees.

2. New intersections along one side of an existing street shall, if possible, coincide with an existing intersection on the opposite of each street. Where provided, offsets shall be at least 150 feet between right-of-way centerlines.

3. Intersections shall be rounded at the curbline with the street having the highest radius requirement, as shown in Table 4.6 below, determining the minimum standard for all curblines.

4. Intersections shall be designed with a flat grade wherever practical.

5. The minimum centerline radius, minimum tangent length between reverse curves, and curb radii shall be as shown in Table 4.6 below.

6. Sight triangles shall be in accordance with AASHTO's "A Policy on Geometric Design of Highways and Streets" standards and based on the speed limits established by the government agency having jurisdiction. Sight triangle easements shall be required and shall include the area on each street corner that is bounded by the line which connects the sight or "connecting" points located on each of the right-of-way lines of the intersecting street. The planting of trees or other plantings, or the location of structures exceeding 30 inches in height that would obstruct the clear sight across the area of the easements, shall be prohibited, and a public right-of-entry shall be reserved for the purpose of removing any object, material or otherwise, that obstructs the clear sight.

TABLE 4.6
STREET GRADE AND INTERSECTION DESIGN CRITERIA

	Street Hierarchy				
	Special purpose street: alley	Special purpose street: cul-de-sac	Rural, residential access, and neighborhood	Minor collector	Major collector
Minimum Grade	0.5%	0.5%	0.5%	0.5%	0.5%

	Special purpose street: alley	Special purpose street: cul-de-sac	Rural, residential access, and neighborhood	Minor collector	Major collector
Maximum Grade	15%	12%	12%	10%	8%
Maximum Grade of Secondary Street within 50 feet of Intersection†	5%	5%	5%	5%	5%
Minimum Center–Line Radius	100 ft	100 ft	100 ft	150 ft	300 ft
Minimum Tangent Length between Reverse Curves	0 ft	50 ft	50 ft	100 ft	150 ft
Curb Radii	20 ft	25 ft	25 ft	30 ft	35 ft

Note: †As measured from the nearest right-of-way line.

(c) Pavement shall be designed using either Figures 4.2 through 4.5, the structural number method, or the alternate pavement design methods referenced in (c)3 below.

1. Pavement design using figures: Pavement design for special-purpose streets (cul-de-sac, rural, etc.), residential access, neighborhood, minor collector, and major collector shall follow the specifications shown in Figures 4.2 through 4.5 based on the street type. Subgrade categories are shown in Table 4.7 below.

2. Structural number method: As an alternative to using Figures 4.2 through 4.5, applicants may design pavement using the structural numbers found in Table 4.9 below.

i. The designated structural number must be achieved by choosing the appropriate layers of bituminous stabilized surface course (Mix I–4, Mix I–5), bituminous stabilized base course (Mix I–2, stone mix), bituminous stabilized base course (Mix I–2, gravel mix), dense graded aggregate base course, soil aggregate base course, and subbase. The structural values and minimum layer thicknesses for the various materials are listed in Table 4.8 below.

TABLE 4.8

PER–INCH STRUCTURAL VALUE FOR VARIOUS PAVING MATERIALS

Layer material	Structural value per-inch thickness	Minimum thickness
Bituminous stabilized concrete surface (Mix I–4, Mix I–5)[1]	0.44	2 inches
Bituminous stabilized base course (Mix I–2, stone mix)[2]	0.44	3 inches
Bituminous stabilized base course (Mix I–2, gravel mix)[2]	0.37	3 inches
Dense graded aggregate base course[2]	0.14	4 inches
Soil aggregate base course[2]	0.11	4 inches
Subbase	0.08	6 inches

Notes:

1 Materials for asphalt concrete surface shall conform to Section 404.02 of the New Jersey Department of Transportation's Standard Specification for Road and Bridge Construction (1989).

2 Materials for asphalt concrete base shall conform to Sections 301.02 and 304.02 of the New Jersey Department of Transportation's Standard Specification for Road and Bridge Construction (1989).

ii. Thicknesses shall be provided in 0.5 inch increments.

TABLE 4.9

STRUCTURAL NUMBER VALUES AS A FUNCTION OF ADT AND M_r[1]

	SN_0 prior to two-inch asphalt concrete surface course		
Maximum ADT[2]	M_r = 3,000 psi Poor Subgrade	M_r = 5,000 psi Medium Subgrade	M_r = 7,500 psi Good/Excellent Subgrade
200	1.60	1.15	0.84
250	1.69	1.23	0.91
500	1.99	1.49	1.14
750	2.17	1.65	1.29

1,000	2.31	1.77	1.40
1,250	2.42	1.87	1.48
1,500	2.52	1.95	1.55
1,750	2.60	2.02	1.61
2,000	2.67	2.08	1.67
2,250	2.73	2.13	1.72
2,500	2.79	2.18	1.76
2,750	2.84	2.23	1.80
3,000	2.89	2.27	1.84
3,250	2.93	2.31	1.88
3,500	2.97	2.35	1.91
3,750	3.17	2.52	2.06
4,000	3.21	2.55	2.09
4,250	3.24	2.58	2.12
4,500	3.28	2.61	2.15
4,750	3.31	2.64	2.17
5,000	3.34	2.67	2.20
5,250	3.37	2.69	2.22
5,500	3.40	2.72	2.24
5,750	3.42	2.74	2.26
6,000	3.45	2.76	2.28
6,250	3.48	2.79	2.30
6,500	3.50	2.81	2.32
6,750	3.52	2.83	2.34
7,000	3.55	2.85	2.36
7,250	3.57	2.87	2.38
7,500	3.59	2.89	2.39

Notes:

1 All subgrades shall be considered "poor," unless the applicant proves otherwise through CBR testing or field evaluation of soil classification. Test results shall be reviewed by the municipal engineer.

2 ADT ranges for street types listed in the standards are as follows:

Rural Residential Lane	0–200
Cul-de-sac	0–250
Rural Street	0–500
Alley	0–500
Multifamily Access Cul-de-sac	0–1,000
Residential Access	0–1,500
Residential Neighborhood	0–1,500
Minor Collector	1,501–3,500
Major Collector	3,501–7,500

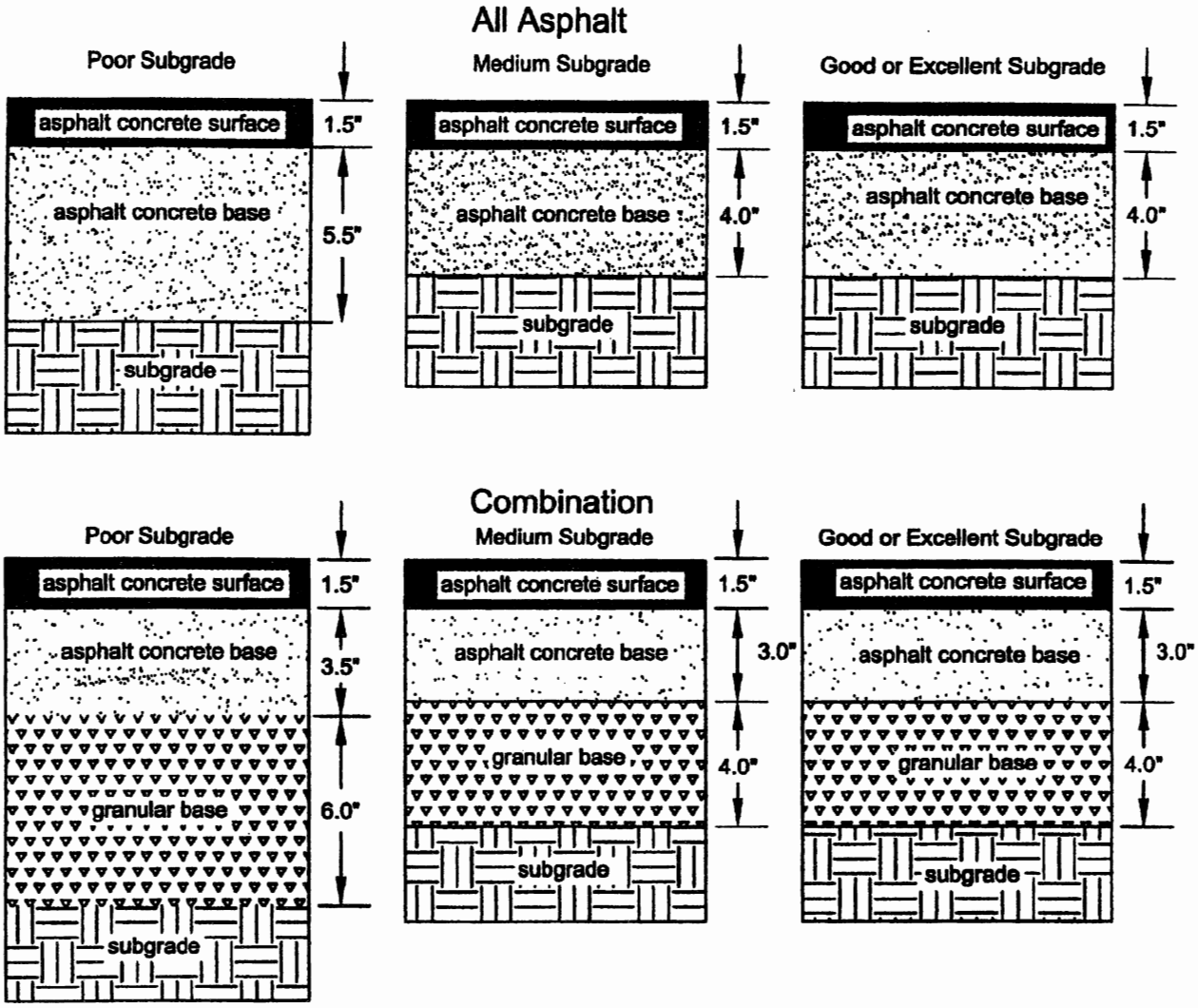
Source: The Table is derived from the AASHTO Guide for Design of Pavement Structures (1993).

3. Alternate pavement design: Alternate pavement design shall be allowed provided it conforms with one of the following: AASHTO Method of Flexible Pavement Design, AASHTO Method of Rigid Pavement Design, Fatigue Strength Method of Design, Multilayer Elastic Analysis, or the National Crushed Stone Association Design, incorporated herein by reference.

(d) Lighting (Reserved)

Figure 4.2

Pavement Sections for Rural Residential Lanes, Rural Streets, Cul-de-Sacs, and Alleys (ADT ≤ 500) (EAL≤ 30,000)



Source: N.J.S.M.E., *Asphalt Handbook for County and Municipal Engineers*, 3rd Edition, March 2000. The figures were derived by applying the Asphalt Institute's *Thickness Design – Full Depth Asphalt Pavement Structures for Highways and Streets.*

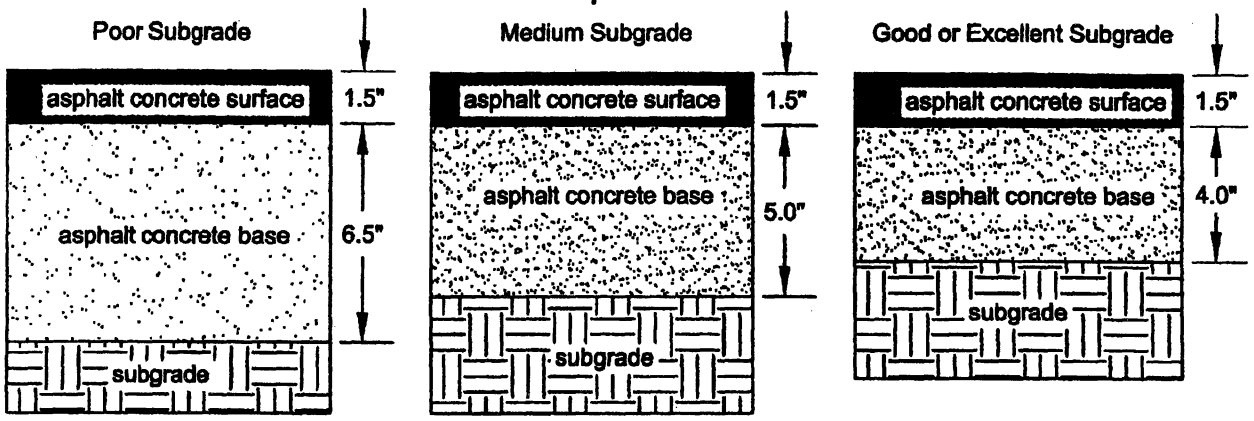
NOTES:

1. Materials for the asphalt concrete surface shall conform to Section 404.02 of the New Jersey Department of Transportation's *Standard Specifications for Road and Bridge Construction* (1989).
2. Materials for the asphalt concrete base shall conform to Sections 301.02 and 304.02 of the N.J. Department of Transportation's *Standard Specifications for Road and Bridge Construction* (1989).
3. Thicknesses may have to be constructed in multiple lifts, based on equipment capabilities.
4. The granular base shall be dense graded aggregate conforming to Section 901.08 or soil aggregate designated I-5 conforming to Section 901.09 and shown in Table 901-2 of the N.J. Department of Transportation's *Standard Specifications for Road and Bridge Construction* (1989).
5. All subgrades shall be considered "poor," unless the applicant proves otherwise through CBR testing or field evaluation of soil classification. Test results shall be reveiwed by the municipal engineer.
6. Subgrade compaction shall be approved by the municipal engineer.
7. Drawings are based on the following design assumptions: A 20-year design period with staged construction is used. Base courses are designed to withstand the construction traffic anticipated during a 3-year construction period and have a residual life of 17 years at the end of the 3-year period. The entire pavement section, base course plus finish course, is designed to withstand the traffic loading for the remaining 17 years of the 20-year design period.

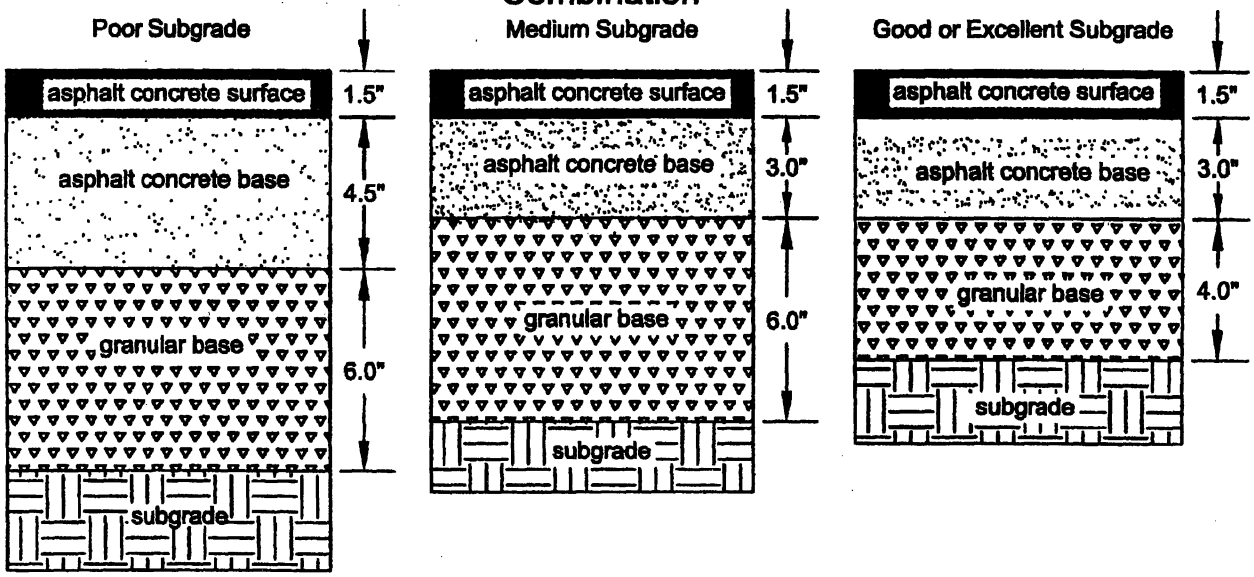
Figure 4.3

Pavement Sections for Residential Access and Neighborhood Streets (ADT ≤ 1,500)(EAL ≤ 80,000)

All Asphalt



Combination

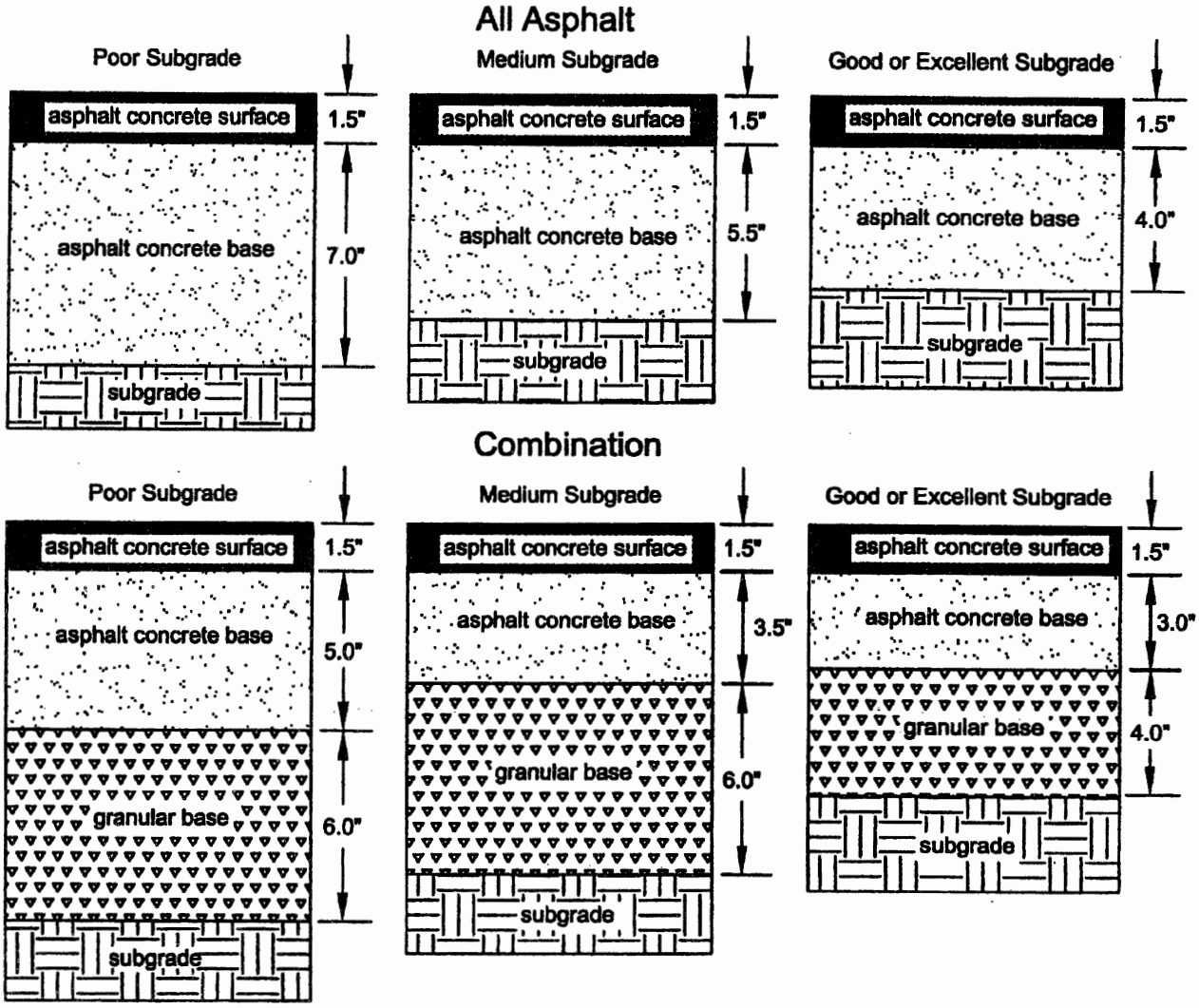


Source: N.J.S.M.E., *Asphalt Handbook for County and Municipal Engineers*, 3rd Edition, March 2000. The figures were derived by applying the Asphalt Institute's *Thickness Design – Full Depth Asphalt Pavement Structures for Highways and Streets.*

NOTES:

1. Materials for the asphalt concrete surface shall conform to Section 404.02 of the New Jersey Department of Transportation's *Standard Specifications for Road and Bridge Construction* (1989).
2. Materials for the asphalt concrete base shall conform to Sections 301.02 and 304.02 of the N.J. Department of Transportation's *Standard Specifications for Road and Bridge Construction* (1989).
3. Thicknesses may have to be constructed in multiple lifts, based on equipment capabilities.
4. The granular base shall be dense graded aggregate conforming to Section 901.08 or soil aggregate designated I-5 conforming to Section 901.09 and shown in Table 901-2 of the N.J. Department of Transportation's *Standard Specifications for Road and Bridge Construction* (1989).
5. All subgrades shall be considered "poor," unless the applicant proves otherwise through CBR testing or field evaluation of soil classification. Test results shall be reveiwed by the municipal engineer.
6. Subgrade compaction shall be approved by the municipal engineer.
7. Drawings are based on the following design assumptions: A 20-year design period with staged construction is used. Base courses are designed to withstand the construction traffic anticipated during a 3-year construction period and have a residual life of 17 years at the end of the 3-year period. The entire pavement section, base course plus finish course, is designed to withstand the traffic loading for the remaining 17 years of the 20-year design period.

Figure 4.4
Pavement Sections for Minor Collectors (ADT≤ 3,500) (EAL ≤ 200,000)

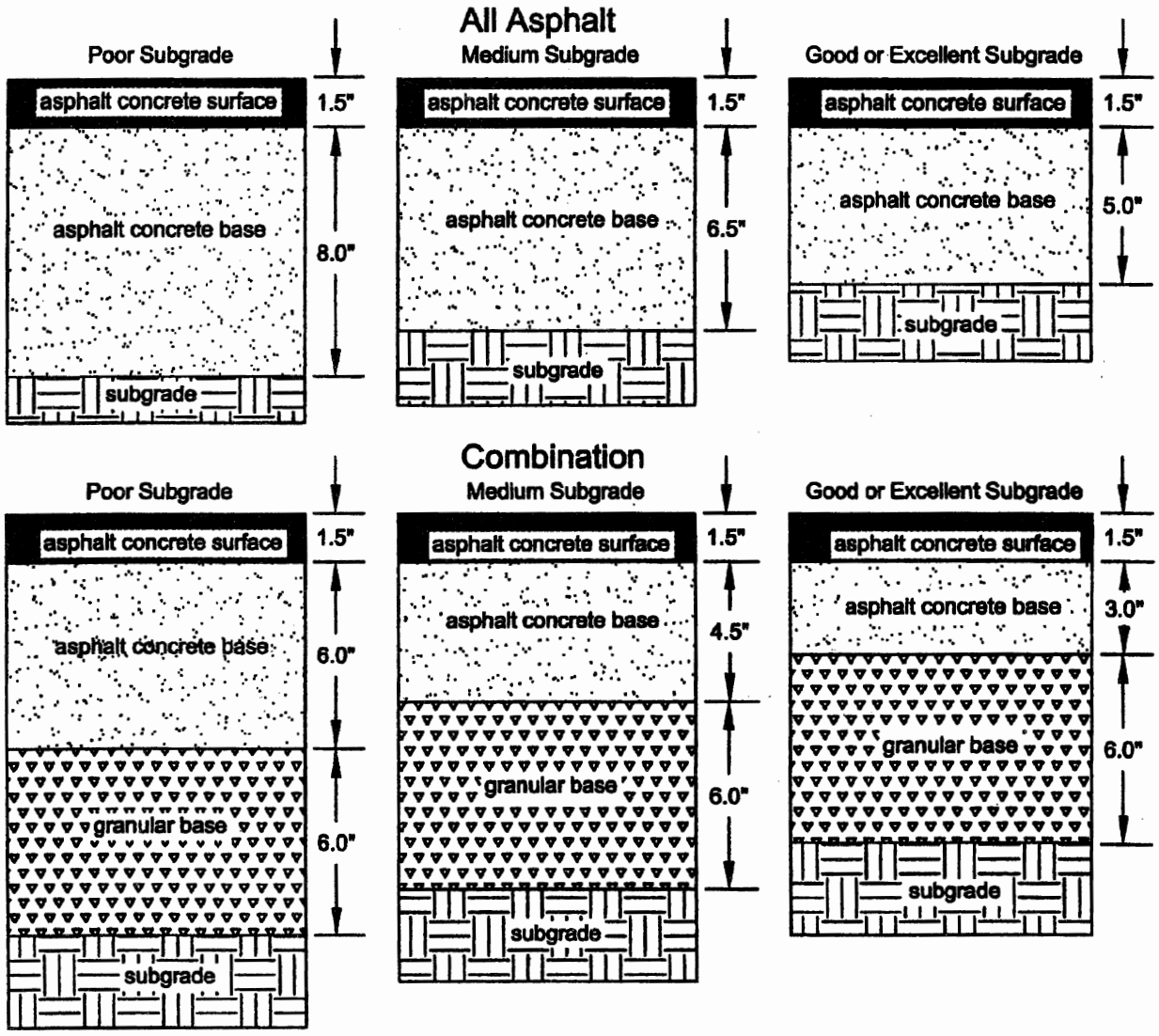


Source: N.J.S.M.E., *Asphalt Handbook for County and Municipal Engineers* , 3rd Edition, March 2000. The figures were derived by applying the Asphalt Institute's *Thickness Design -- Full Depth Asphalt Pavement Structures for Highways and Streets.*

NOTES:

1. Materials for the asphalt concrete surface shall conform to Section 404.02 of the New Jersey Department of Transportation's *Standard Specifications for Road and Bridge Construction* (1989).
2. Materials for the asphalt concrete base shall conform to Sections 301.02 and 304.02 of the N.J. Department of Transportation's *Standard Specifications for Road and Bridge Construction* (1989).
3. Thicknesses may have to be constructed in multiple lifts, based on equipment capabilities.
4. The granular base shall be dense graded aggregate conforming to Section 901.08 or soil aggregate designated I-5 conforming to Section 901.09 and shown in Table 901-2 of the N.J. Department of Transportation's *Standard Specifications for Road and Bridge Construction* (1989).
5. All subgrades shall be considered "poor," unless the applicant proves otherwise through CBR testing or field evaluation of soil classification. Test results shall be reveiwed by the municipal engineer.
6. Subgrade compaction shall be approved by the municipal engineer.
7. Drawings are based on the following design assumptions: A 20-year design period with staged construction is used. Base courses are designed to withstand the construction traffic anticipated during a 3-year construction period and have a residual life of 17 years at the end of the 3-year period. The entire pavement section, base course plus finish course, is designed to withstand the traffic loading for the remaining 17 years of the 20-year design period.

Figure 4.5
Pavement Sections for Major Collectors (ADT ≤ 7,500) (EAL ≤ 400,000)



Source: N.J.S.M.E., *Asphalt Handbook for County and Municipal Engineers*, 3rd Edition, March 2000. The figures were derived by applying the Asphalt Institute's *Thickness Design – Full Depth Asphalt Pavement Structures for Highways and Streets.*

NOTES:

1. Materials for the asphalt concrete surface shall conform to Section 404.02 of the New Jersey Department of Transportation's *Standard Specifications for Road and Bridge Construction* (1989).
2. Materials for the asphalt concrete base shall conform to Sections 301.02 and 304.02 of the N.J. Department of Transportation's *Standard Specification for Road and Bridge Construction* (1989).
3. Thicknesses may have to be constructed in multiple lifts, based on equipment capabilities.
4. The granular base shall be dense graded aggregate conforming to Section 901.08 or soil aggregate designated I-5 conforming to Section 901.09 and shown in Table 901-2 of the N.J. Department of Transportation's *Standard Specifications for Road and Bridge Construction* (1989).
5. All subgrades shall be considered "poor," unless the applicant proves otherwise through CBR testing or field evaluation of soil classification. Test results shall be reveiwed by the municipal engineer.
6. Subgrade compaction shall be approved by the municipal engineer.
7. Drawings are based on the following design assumptions: A 20-year design period with staged construction is used. Base courses are designed to withstand the construction traffic anticipated during a 3-year construction period and have a residual life of 17 years at the end of the 3-year period. The entire pavement section, base course plus finish course, is designed to withstand the traffic loading for the remaining 17 years of the 20-year design period.

TABLE 4.7
SUBGRADE CATEGORIES
A. BASED ON STRENGTH TEST

Subgrade category	California Bearing Ratio (Cbr)	Resilient Modules Mr Value
Good to excellent	+10	Above 15,000
Medium	+5 to 9	7,500 to 13,500
Poor	2 to 4	3,000 to 6,000

B. BASED ON SOIL CLASSIFICATION

Subgrade category	Material	Unified System[a]	AASHTO System[a]
Good to excellent	Gravels and sands	GW, GP, GM, GC, SW, SP, SM, SC	A–1, A–2–4, A–2–5, A–2–6, A–2–7, A–3
Good or poor	Silts and clays	ML, CL, OL, MH, CH, OH	A–4, A–5, A–6, A–7–5, A–7–6

Notes: [a]Refers to categories of soil types and properties
Sources: Per the Rutgers Model Subdivision and Site Plan Ordinance by David Listokin and Carole W. Baker, January 1987—Original strength test and soil classification information derived from the Asphalt Institute, "Thickness Design—Full–Depth Asphalt Pavement Structures for Highways and Streets," MS–1, 8th Edition, August 1970 in Robert F. Baker et al. (editor), Handbook of Highway Engineering. Inclusion of SW, SP, SC soil classifications based on information from the Portland Cement Association's Thickness Design for Concrete Highway and Street Pavements.

Revised CBR strength test and M_r value information are from the Asphalt Handbook for County and Municipal Engineers, November 1991 (Second Edition), published by the New Jersey Society of Municipal Engineers.

Administrative correction.
See: 29 N.J.R. 1296(a).
Administrative correction.
See: 29 N.J.R. 2816(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 (b)2; and in Table 4.6, deleted Intersection Standard heading, and substituted a reference to Maximum Grade of Secondary Street for a reference to Maximum Grade.
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).
Rewrote (c); amended Figures 4.2 and 4.3; and inserted Figures 4.4 and 4.5.
Amended by R.2002 d.399, effective December 16, 2002.
See: 34 N.J.R. 2615(a), 34 N.J.R. 4412(a).
Added new (c), including Tables 4.8 and 4.9; deleted former (c); recodified former (d) as new (c)3; added new Figures 4.2 through 4.5 and deleted former Figures 4.2 through 4.5.
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).
Administrative correction.
See: 35 N.J.R. 2494(a).

5:21–4.20 Curves

(a) Vertical and horizontal curves shall be designed in accordance with AASHTO's "A Policy on Geometric Design of Highways and Streets" standards, incorporated herein by reference.

(b) Sight easements on vertical and horizontal curves shall be required and determined based on the sight distance requirements contained in AASHTO's "A Policy on Geometric Design of Highways and Streets" standards, taking into consideration the speed limits established by the government agency having jurisdiction. Residential access, residential neighborhood, and rural street design shall be based on a speed limit of 25 miles an hour. Minor collector street design shall be based on a speed limit of 30 miles per hour. Major collector design shall be based on a speed limit of 30 miles per hour or five miles over the anticipated posted speed limit, whichever is higher.

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 (b), substituted "shall" for "should" in the second and third sentences, deleted "and major" following "Minor" in the third sentence, and the last sentence was added.
Administrative correction.
See: 35 N.J.R. 2494(a).

SUBCHAPTER 5. WATER SUPPLY

5:21–5.1 Water supply system

Water supply systems, where installed, shall conform to the standards contained in this subchapter.

5:21–5.2 Capacity

(a) The water supply system shall be adequate to handle the necessary flow, based on complete development of the tract.

(b) When plans for future development necessitate oversizing of the water supply system, the municipality or utility authority may enter into an agreement with the developer to address the fair share of the costs.

(c) The demand rates for all uses shall be considered in computing the total system demand. Where fire protection is provided in accordance with (e) below, the system shall be capable of providing the required fire demand plus the required maximum daily residential demand, or the peak hour flows indicated in Table 5.2 below, whichever is greater. The maximum daily demand shall be calculated by multiplying the average daily residential demand indicated in Table 5.1 by a factor of 1.5.

(d) Average daily residential consumption shall be computed in accordance with the housing unit type and size data shown in Table 5.1. The peak daily flows shall be computed by applying a peaking factor of three times the average daily residential consumption. The municipality may require deviations in the peaking factor value provided appropriate documentation and justification for the deviation from the standards is provided.

(e) The design of the on-site water distribution system shall be adequate to provide fire protection as per ISO standard, *Fire Suppression Rating Schedule,* or per AWWA M31, "Manual of Water Supply Practices—Distribution System Requirements for Fire Protection," ISO method on pages 3–9, incorporated herein by reference.

TABLE 5.1
WATER DEMAND/GENERATION BY TYPE /SIZE OF HOUSING

Type/size housing	Number of residents	Residential Water Demand[a] (daily) (gallons per day)
Single-family detached		
2 bedroom	2.13	215
3 bedroom	3.21	320
4 bedroom	3.93	395
5 bedroom	4.73	475
Garden Apartment		
1 bedroom	1.57	120
2 bedroom	2.33	175
3 bedroom	3.56	270
Townhouse		
1 bedroom	1.69	125
2 bedroom	2.02	150
3 bedroom	2.83	210
4 bedroom	3.67	275
High-rise		
studio	1.07	80
1 bedroom	1.34	100
2 bedroom	2.14	160
Mobile home		
1 bedroom	1.73	130
2 bedroom	2.01	150
3 bedroom	3.47	260

Notes: [a] Based on 100 gallons per person per day for single-family detached units and 75 gallons per person per day for other housing types (rounded).
Source: U.S. Census, Public Use File—New Jersey (Units built 1975-1980).

TABLE 5.2
DESIGN STANDARDS FOR PEAK HOUR FLOW

Total houses served	Peak hourly rates (gallons per minute per house)
5	8.0
10	5.0
50	3.0
100	2.0
250	1.3
500	0.8
750	0.7
1,000 or more	0.6

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 (c); and in Table 5.2, added Peak Hourly Rate for 1,000 or more Total Houses Served.

5:21–5.3 System design and placement

(a) System design and placement shall comply with the following construction specifications, incorporated herein by reference: all applicable NJ Department of Environmental Protection (NJDEP) rules, the American Water Works Association (AWWA) standards, and in the Pinelands Area, the Standards of the Pinelands Comprehensive Management Plan, with the strictest standards governing.

(b) Distribution mains of the overall system shall be connected into loops so that the supply may be brought to the consumer from more than one direction. In balancing loops in a design, the Hardy-Cross, or an equivalent, method shall be used (see subchapter Appendix, incorporated herein by reference). Manning roughness coefficients listed in Table 7.1 in N.J.A.C. 5:21–7.1 may be used in these calculations. Dead-end lines shall be permitted within the design of a looped system provided that there are no more than 20 dwelling units permanently, or no more than 50 dwelling units temporarily, on a dead-end line. When dead-end lines are used, they shall be provided with a hydrant or blowoff at the terminus as a means of flushing.

(c) Valves, except on a permitted dead end, shall be located on distribution mains so that no more than one hydrant would be out of service as a result of a single water main break. They shall be located in all small branches off larger mains; and where eight-inch or larger mains lines intersect, a valve shall be located in each branch. At street intersections, valves shall be located near pipe intersections for ease in finding in the event of a water main break.

(d) In addition to the above requirements, water mains shall be valved so that not more than one-fifth of a mile would be affected by a single water main break. Geared valves on 16–inch mains or larger shall be furnished when required by the municipality.

(e) Gate valves shall be cast-iron body with double-disc gates, bronze mounted conforming to AWWA C500 or resilient-seated wedge, non-rising stem mechanical joint conforming to AWWA C509. Butterfly valves shall conform to AWWA C504. The type of valve to be used shall be as specified by the municipality or utility authority. Valve interior openings shall be full size, and valves on 16–inch mains or larger shall be geared and have suitable bypasses. Valve boxes shall be of the adjustable type with the cover marked "water" and direction of valve operation indicated.

(f) No pipe shall be placed on private property unless the owner of the land is to own or operate the pipe, or an easement deeded to the municipality or utility authority is obtained. All easements shall be a minimum of 20–feet wide unless depth of pipe, soil conditions, or additional utilities require wider. Where the easement is located adjacent to a right of way, the municipality or authority may approve a narrower easement.

(g) A building service connection shall be comprised of a corporation stop at the main, a curb stop, and a water meter. When the meter is located outside a building, an additional shut-off valve shall be installed on the discharge side of the meter. When the meter is located inside a building, valving shall be in accordance with the Plumbing Subcode of the Uniform Construction Code (N.J.A.C. 5:23–3.15). Curb stops and water meters shall be located as specified by the public or private water supplier.

1. Common water service connections shall be permitted where allowed by the Plumbing Subcode of the Uniform Construction Code (N.J.A.C. 5:23–3.15).

(h) Where water system extensions are constructed by developers and meter fees are not paid by the developer, the water meter(s) shall be furnished by the developer and shall be of a manufacture and type approved by the municipality or utility authority. The meter(s) shall read in volume units as determined by the municipality or utility authority. Where meter fees are paid by the developer, the meter(s) shall be furnished by the municipality or utility authority.

(i) Pipe size shall comply with the following requirements:

1. Water mains shall be a minimum diameter of eight inches except at the end of a permanent cul-de-sac, unless another size is required for fire flow and other criteria. A six-inch main may be used when it serves not more than 20 dwelling units and only one fire hydrant.

2. Building service connection pipe shall be a minimum diameter of three-quarter inch.

3. Design capacity of water mains shall be such as to maintain a minimum pressure of 20 pounds per square inch (psi) at street level under all flow conditions.

(j) Pipe materials used in the construction of water mains shall be cement-lined ductile iron, prestressed concrete cylinder pipe, reinforced concrete pressure pipe, or PVC pipe. All pipe and appurtenances shall comply with the applicable AWWA standards in effect at the time of application. All standards referenced in this section are incorporated herein by reference.

1. Ductile iron pipe, appurtenances, and fittings shall comply with ANSI/AWWA C110/A21.10 (fittings), C111/A21.11 (gasket joints), C115/A21.15 (flanged joints), and C151/A21.51 (pipe). Thickness shall be designed in accordance with ANSI/AWWA C150/A21.50. It shall be cement-mortar lined in accordance with ANSI/AWWA C104/A21.4. Joints shall be gasketed push-on joints or mechanical joints in conformance with ANSI/AWWA C111/A21.11. The exterior of the ductile iron pipe shall be covered with an asphaltic epoxy-type coating. In aggressive soils, ductile iron pipe wrapped in polyethylene in accordance with ANSI/AWWA C105/A21.5 shall be used.

2. Prestressed concrete cylinder pipe with rubber and steel joints shall conform to ANSI/AWWA C301; reinforced concrete pressure pipe (steel cylinder type) shall meet ANSI/AWWA C300; concrete pressure pipe (bar wrapped steel cylinder type) shall meet ANSI/AWWA C303.

3. PVC pipe, appurtenances, and fittings shall conform to ANSI/AWWA C900 or AWWA C909 for pipe sizes four inches to 12 inches and shall conform to AWWA C905 for sizes 14 inches through 36 inches. Joints shall be elastomeric-gasket couplings of a corresponding size. Laboratory performance requirements, as specified in ASTM D3139, shall be met. Solvent-cement couplings shall not be permitted. PVC pipe installations shall be provided with a metallic locator tape.

4. Where transitions to flanged fittings are made, adapters approved by the municipality or water purveyor shall be used.

5. Building service connection pipe shall be type K copper or polyethylene (PE) pressure pipe that complies with ANSI/AWWA C901.

(k) Pipe bedding and backfill shall be installed in accordance with the pipe manufacturer's recommendations.

1. The municipality or the authority may require the developer to provide an opinion of a professional engineer relative to the suitability of the on-site material to be used as backfill. The municipality or authority shall rely on this opinion.

2. Where the on-site material is deemed suitable, the opinion shall specify the appropriate installation methods for the material. Where the on-site material is deemed not suitable, the opinion shall specify modification or replacement of the material and the appropriate installation for the specified material.

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 (e); recodified former (e) through (j) as (f) through (k); in the new (f), added a third sentence; in the new (h), substituted a reference to volume in units for a reference to gallons and cubic feet; and rewrote the new (j).
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 (d), substituted "one-fifth" for "one-quarter" in the first sentence and added "when required by the municipality" in the second sentence; in (g), rewrote 1 and deleted 2; and in (j)3 inserted reference to AWWA C909.

5:21–5.4 Fire hydrants

(a) Hydrants shall be spaced to provide necessary fire flow. The average building area served per hydrant shall not exceed 120,000 square feet. In addition, the distance between any dwelling and a hydrant shall not exceed 400 feet when measured along the street right-of-way.

(b) Size, type, and installation of hydrants shall conform to the following specifications, incorporated herein by reference, as appropriate:

1. Size, type, and installation of hydrants shall be in accordance with the requirements of the municipality or the water purveyor or shall conform to the AWWA Standard for Dry Barrel Fire Hydrants, ANSI/AWWA C502. Hydrants shall have at least three outlets; one outlet shall be a pumper outlet; the other outlets shall be at least two-and-one-half-inch nominal size. The pumper outlet shall face the street. All outlet nozzles shall be at least 12 inches above the adjoining grade. When a concrete slab is provided around the hydrant riser, the flange where the hydrant connects to the riser shall be at least two inches above adjacent grade. Street main connections shall not be less than six inches in diameter. Hose threads on outlets shall be compatible with existing municipal equipment and shall either conform to NFPA 1963 or shall match existing municipal requirements. A valve shall be provided on connections between hydrants and street mains. All pipe, fittings, and appurtenances supplying fire hydrants shall be AWWA or ASTM approved.

2. All fire hydrants shall conform to NFPA Standard 291.

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 (b)1.

APPENDIX

HARDY-CROSS METHOD

The Hardy-Cross method is a trial-and-error method in which the adjustments to be made in the assumed values are computed and are therefore controlled. Convergence of errors is often rapid, and sufficient precision in the results can ordinarily be had by three adjustments. Two methods may be used: the method of balancing heads or the method of balancing flows. The method of balancing heads is as follows:

1. Assume any distribution of discharge.

2. Compute the head loss in each element by means of Eq. (1): $h=kq_0^x$.

3. With due attention to sign, compute the total head loss around each elementary closed circuit: $\Sigma h=\Sigma kq_0^x$.

4. Compute also for each elementary circuit without reference to sign the sum: $\Sigma xkq_0^{(x-1)}$.

5. To balance the head in each circuit (so that $\Sigma kq^x=0$), set up a counterbalancing flow equal to

$$\Delta = \frac{\Sigma kq_0^x \text{ (with due attention to direction of flow)}}{\Sigma xkq_0^{(x-1)} \text{ (without reference to direction of flow)}} \quad (4)$$

6. Compute the revised flows, and repeat the process until the desired accuracy is obtained.

The flow correction Δ for each circuit places the heads for that circuit substantially in balance if Δ is small. Since some elements of each circuit are common to other circuits, however, the balance of heads in each circuit is disturbed by subsequent adjustments in other circuits. Hence several traverses of the system are required before satisfactory precision is obtained. The proof of the method is as follows:

$$q = q_0 + \Delta$$

in which q = actual discharge for any element

q_0 = assumed discharge
Δ = required flow correction

Then

$$kq^x - k(q_0 + \Delta)^x = k(q_0^x + xq_0^{(x-1)}\Delta + \cdots)$$

The remaining terms in the preceding expansion may be neglected if Δ is small as compared with q_0. For a single circuit,

$$\Sigma kq^x = 0$$

and from above,

$$\Sigma kq^x = \Sigma kq_0^x + \Delta\Sigma xkq_0^{(x-1)}$$

Therefore,

$$\Delta = -\frac{\Sigma kq_0^x}{xkq_0^{(x-1)}} \quad (4)$$

If Δ is large compared with q_0, Eq. (4) does not give a close approximation of the value of Δ because of the neglect of the terms beyond the second term in the expansion. This neglect is not usually important, however, particularly if subsequent adjustments bring rapid convergence.

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.

SUBCHAPTER 7. STORMWATER MANAGEMENT

5:21–7.1 Stormwater management: general system strategy

(a) Stormwater management systems prepared by design engineers shall emphasize a natural, as opposed to an engineered, drainage strategy.

(b) The applicability of a natural approach depends on such factors as site storage capacity, open channel hydraulic capacity, and maintenance needs and resources. N.J.A.C. 5:21–7.6(c)4 references authoritative sources on natural and nonstructural approaches. 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). (See N.J.A.C. 5:21–7.5(c).)

(c) Where a municipal ordinance requires the control of runoff from a site that is the subject of a site plan or subdivision application, then the runoff shall be estimated in accordance with provisions of this subchapter. Any structures designed to control volume or rate of flow shall be designed and constructed in accordance with these provisions. Where this subchapter does not include provisions for a particular technique or method, then the design and construction shall be in accordance with best management practices listed in N.J.A.C. 5:21–7.6(b)4.

1. All stormwater collection and conveyance structures shall be designed in accordance with the provisions of this subchapter.

(d) Construction practices shall conform to Standards for Soil Erosion and Sediment Control in New Jersey, N.J.A.C. 2:90, as administered by the New Jersey Department of Agriculture.

(e) 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 = Mannings roughness coefficient

A = Cross-section 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 roughness coefficients used by design engineers appear in Table 7.1 in N.J.A.C. 5:21–7.2.

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: the bottom slope of the channel, energy grade line, and water surface (hydraulic grade line) are parallel; where the flow regime is in the turbulent range of Reynolds number; and where the boundaries of the cross section of the channel do not move.

(f) 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, N.J.A.C. 2:90, New Jersey State Soil Conservation Committee, Division of Rural Resources, New Jersey Department of Agriculture, revised to date.

(g) 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, as 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 of the pipe diameter.

(h) 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 here in by reference.

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).

5:21–7.2 Runoff estimation techniques

(a) Watershed stormwater management requires the determination of a watershed runoff hydrograph that displays and compares the peak discharge rate and volume. Both

parameters shall compare pre- and post-development conditions. The design engineer shall determine the status of the drainage area. All significant land features such as ponds, depressions, or hedgerows that increase ponding factors shall be considered by the design engineer to compute pre-development runoff. If the design engineer is able to verify that a given hydrologic condition has existed on the site for a period of at least five years prior to the time of computation, then this existing condition may be used by the design engineer to determine runoff coefficients. As an alternative, however, the design engineer should assume the drainage area in the pre-development condition to be in good hydrologic condition (if the lands are pastures, lawns, or parks), to have good cover (if the lands are woods), or to have had conservation treatment (if the lands are cultivated).

(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 also shall use runoff volume calculations generated by the hydrograph to determine the size of detention and retention 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. 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:

1. For areas greater than 320 acres, design engineers shall calculate peak rate of runoff in accordance with the following procedures and methods, incorporated herein by reference.

i. *Urban Hydrology for Small Watersheds, Technical Release No. 55 (TR–55),* U.S. Department of Agriculture, Soil Conservation Service, Engineering Division, as supplemented or amended to date;

ii. *Computer Program for Project Formulation—Hydrology, Technical Release No. 20 (TR–20),* U.S. Department of Agriculture, Soil Conservation Service, Engineering Division, as supplemented or amended to date; or

iii. The New HEC–1 Flood Hydrograph Package, Technical Paper No. 82, 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

t_c = time of concentration in minutes

A = the size of the drainage area in acres

i. Typical C values for 100 year frequency storm events appear in Table 7.2 below. Coefficients for recurrence intervals more frequent than the 100–year storm should be reduced in accordance with Table 7.3 below. Impervious surfaces are not subject to adjustment.

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) *Design of Roadside Drainage Channels—Hydraulic Design Series No. 4, Report No. FHWA–EPD–86–103,* May 1965, U.S. Department of Transportation, Federal Highway Administration, as supplemented or amended to date; and

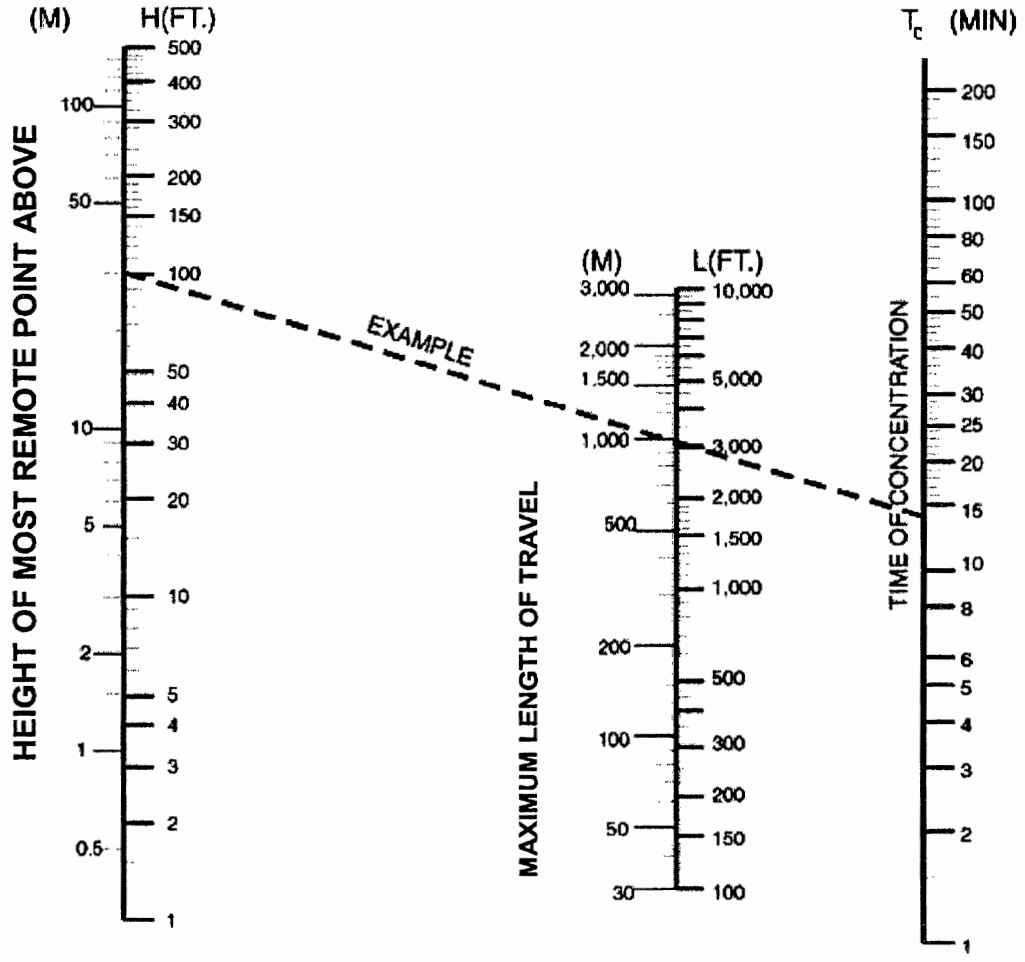
(2) *Airport Drainage,* AC 150/5320–5B, U.S. Department of Transportation, Federal Aviation Administration, July 1970, as supplemented or amended to date.

3. Design engineers may estimate time of concentration (t_c) with Figure 7.1, Time of Concentration nomograph from *Design Manual—Roadway*, New Jersey Department of Transportation, Division of Roadway Design, Bureau of Roadway Design Standards, May 1992, below. 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 *Technical Release No. 55, Urban Hydrology for Small Watersheds (TR–55)*, U.S. Department of Agriculture, Soil Conservation Service, Engineering Division, as supplemented or amended to date.

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

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			
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			

Closed Conduits	Smooth	Normal	Rough
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
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 7.2

RUNOFF COEFFICIENTS (ANTECEDENT MOISTURE CONDITION) AMCII

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				
⅛ acre	65%	0.59	0.76	0.86	0.90
¼ acre	38%	0.25	0.55	0.70	0.80
⅓ acre	30%	NA	0.49	0.67	0.78
½ 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 7.3

ADJUSTMENT FACTORS FOR RUNOFF COEFFICIENTS

Frequency of Event (years)	Runoff Coefficient Adjustment Factor
2 to 10	0.80
25	0.88
50	0.96
100	1.00

Note: These adjustment factors are from a similar table presented on page 3–61 of *Design of Urban Highway Drainage, The State of the Art,* Report No. FHWA–TS–79–225, U.S. Department of Transportation, Federal Highway Administration, Offices of Research and Development, Implementation Division (HDV–21), August 1979.
The values in this table are to be used with the Rational formula, where the runoff coefficient is taken from Table 7.2.

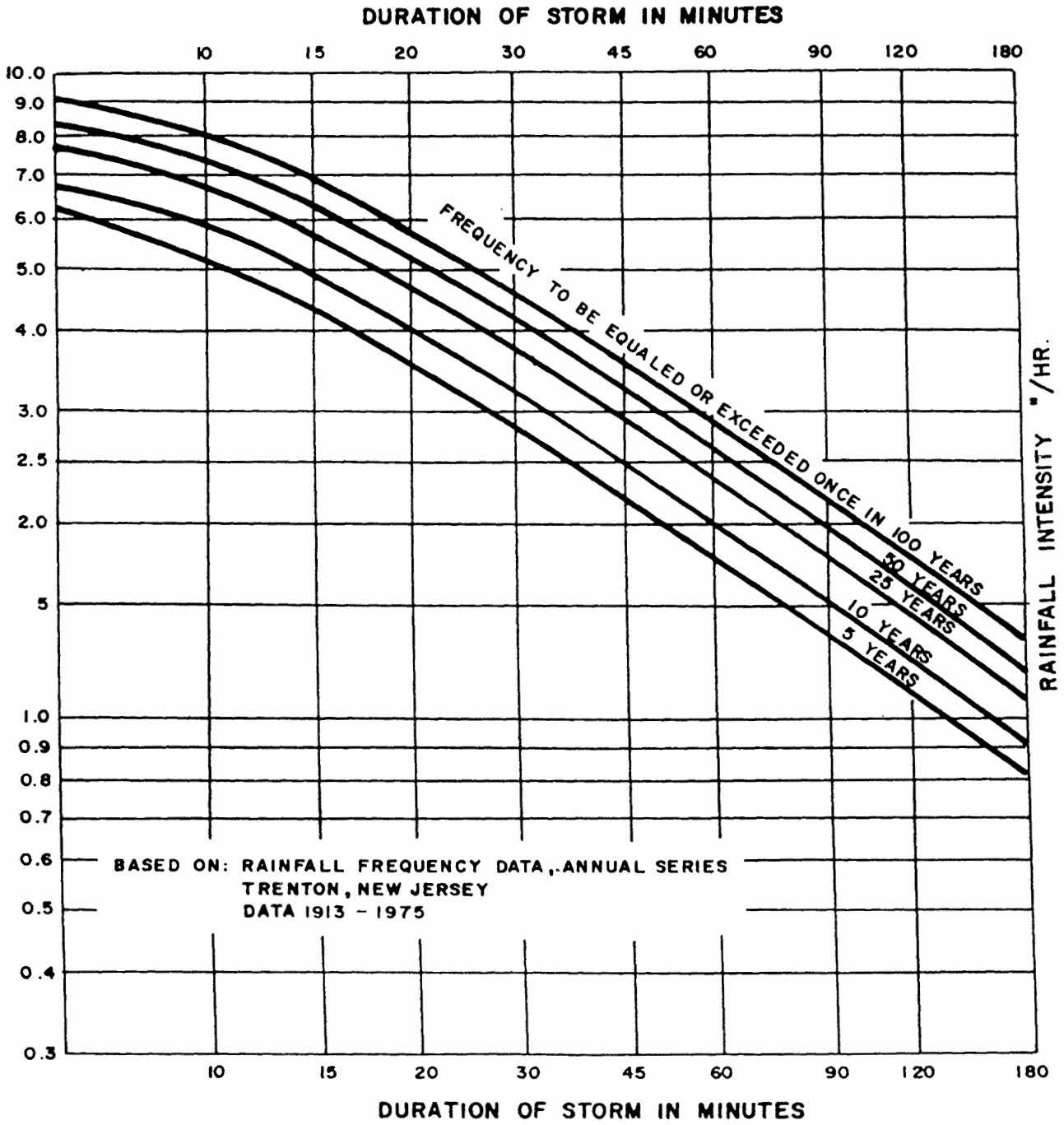
4. When using the Rational Method, rainfall intensity as a function of duration and storm frequency shall be based upon Figure 7.2 Rainfall Intensity Curves below and/or local rainfall frequency data, where available. A copy of Figure 7.2 also appears in the New Jersey Department of Transportation's Design Manual—Roadway, May 1992. 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. 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 can continue downgrade in the street and not exceed the gutter capacity. Also, ten-year storms shall be used at low points in storm drain systems with overland relief.

ii. Twenty-five-year storm where flow in a storm drain is totally carried by pipe when conditions under (c)4i above do not apply.

FIGURE 7.2

RAINFALL INTENSITY CURVES



iii. Twenty-five-year storm for culvert design where the culvert will be located in streams shown as a blue line 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.

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

6. Computer software adaptations of the Rational Method or the S.C.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, or HEC–1 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, the design engineer shall use the Modified Rational Method to calculate peak volume to be used for basin routing. A maximum drainage area of 20 acres shall be used for the Modified Rational Method.

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).

5:21–7.3 Runoff collection system design

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

(b) In general, no pipe size in the storm drainage system shall be less than 15 inches in diameter. Design engineers may use a 12–inch diameter pipe as a cross-drain to a single inlet. Design engineers shall use the Manning equation to determine hydraulic capacity of pipes.

(c) All discharge pipes shall terminate with an appropriate precast concrete or flared-end section or concrete headwall with or without wingwalls, as conditions require. Design engineers shall consider such site conditions as slope, soil stability, vegetation, grade, and size of conduit to determine whether or not to use wingwalls.

(d) Materials used in the construction of storm sewers shall be constructed of reinforced concrete, ductile iron, or corrugated polyethylene, or, when approved by the municipal engineer, corrugated metal. The most cost-effective materials shall be permitted that conform to local site conditions and reflect the relevant operations, maintenance, and system character of the municipal stormwater system. Specifications referred to, such as ASTM or AWWA, shall be the latest revision in effect at the time of application.

1. The following apply to reinforced concrete pipe:

i. Circular reinforced concrete pipe and fittings shall meet the requirements of ASTM C76.

ii. Elliptical reinforced concrete pipe shall meet the requirements of ASTM C507.

iii. Joint design and joint material for circular pipe shall conform to ASTM C443.

iv. Joints for elliptical pipe shall be bell and spigot or tongue and grove sealed with butyl, rubber tape, rubber ring gaskets, or external sealing bands conforming to ASTM C877.

v. All pipe shall be Class III, minimum unless loading conditions call for stronger pipe (that is, higher class).

vi. The minimum depth of cover over the concrete pipe shall be as designated by the American Concrete Pipe Association in Table 7.4 below as follows.

TABLE 7.4

MINIMUM DEPTH OF COVERAGE OVER CONCRETE PIPE

Pipe Diameter (in inches)	ASTM Class Pipe	Minimum Cover (surface to top of pipe in inches)
12	III	17
	IV	12
	V	7
15	III	16
	IV	11
	V	7
18	III	16
	IV	10
	V	6
24	III	15
	IV	6
	V	6

Pipe Diameter (in inches)	ASTM Class Pipe	Minimum Cover (surface to top of pipe in inches)
30	III	10
	IV	6
	V	6
36 & above	III	6
	IV	6

Minimum depth of coverage as designated by the American Concrete Pipe Association.

vii. Minimum depth of cover standards for ductile iron and corrugated polyethylene pipe shall conform to manufacturer standards.

2. Ductile iron pipe shall conform to ANSI/AWWA C151/A21.51. Joints shall conform to ANSI/AWWA C111/A21.11 or ANSI/AWWA C115/A21.15 as appropriate. Pipe shall be designed in accordance with ANSI/AWWA C150/A21.50. The outside of the pipe shall be coated in accordance with ANSI/AWWA C151/A21.51, and the inside lined in accordance with ANSI/AWWA C104/A21.4. Ductile iron pipe shall be installed in accordance with AWWA C600.

3. Corrugated polyethylene pipe shall conform to AASHTO M252 for three through 10 inches and AASHTO M294 for sizes 12 inches and larger. All pipes greater than 12 inches in diameter shall be Type S, unless conditions dictate otherwise. Materials shall conform to ASTM D3350, "Standard Specification for Polyethylene Plastics Pipe and Fittings Materials." Pipe joints and fittings shall be compatible with the pipe material and shall conform to the same standards and specifications as the pipe material. Pipe couplers shall not cover less than one full corrugation on each section of pipe. Installation shall be in accordance with ASTM D2321, "Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity–Flow Applications." Backfill material shall be placed in six-inch lifts and compacted to 95 percent minimum dry density, per AASHTO T99. In areas of high groundwater tables, design engineers shall check for floatation.

4. Corrugated metal pipe, when approved by the municipal engineer, shall meet the requirements and be installed in the manner specified in the subchapter appendix.

(e) Pipe bedding and backfill shall be provided as specified in *Design and Construction of Urban Stormwater Management Systems,* ASCE Manuals and Reports of Engineering Practice No. 77, 1993, incorporated herein by reference. Bedding and backfill for any pipe material not covered by this manual shall be installed in accordance with manufacturer's recommendations. The municipal engineer may require the developer to provide professional certification as to the suitability of backfill material and where such suitability does not exist, any modifications needed to use on-site material and the appropriate methods to install this material. The municipal and/or utility engineer shall rely on this certification.

(f) No pipe shall be placed on private property unless the owner of the land is to own or operate the pipe, or an easement deeded to the municipality is obtained. All easements shall be a minimum of 20–feet wide unless depth of pipe, soil conditions, or additional utilities require wider. Where the easement is located adjacent to a right-of-way, the municipality may approve a narrower easement.

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 (d), inserted a reference to Table 7.4 in 1vi, rewrote 2, and rewrote the first sentence in 3.
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).
Rewrote (f).

5:21–7.4 Inlets, catch basins, manholes, and outlets

(a) Design engineers shall design inlets, catch basins, and manholes in accordance with the New Jersey Department of Transportation's *Standard Specifications for Road and Bridge Construction* (1989). Design engineers shall use bicycle-safe grates. For Type A inlets, they should use a frame and single grate. Type B inlets require a frame, grate, and curb-type inlet with back piece. Type E inlets require a frame and double grate.

(b) Inlet spacing depends on the inlet capacity. Maximum gutter line flow is 400 feet. The maximum capacity of a curb inlet shall be six cubic feet per second. Area inlets in parking lots should be limited to three cubic feet per second.

(c) Manholes shall be precast concrete or concrete block coated with two coats of portland cement mortar outside the manhole. Masonry brick may be used to make vertical adjustment to rims, as long as the adjustments are 12 inches or less. In acidic soils, all manholes shall have two coats of black bitumastic waterproofing applied per manufacturer's instruction.

(d) If precast manhole barrels and cones are used, they shall conform to ASTM Specification C478, with round rubber gasketed joints, conforming to ASTM Specification C923. Both ASTM Specifications are incorporated herein by reference. Maximum absorption shall be eight percent in accordance with ASTM Specification C478, method A.

(e) If precast manholes are used, the top riser section shall terminate less than one foot below the finished grade, and the manhole cover shall be flush with the finished grade.

(f) Manhole frames and covers shall be of cast iron, conforming to ASTM Specification A48, Class 30, incorporated herein by reference, and be suitable for H–20 loading

capacity. Manhole covers in remote locations may have a locking device.

(g) Outlet grates, fences, and other safety features for stormwater management facilities shall conform with New Jersey Department of Environmental Protection's Stormwater Management Rules, N.J.A.C. 7:8. Safety requirements for detention basin and other stormwater facilities are incorporated in N.J.A.C. 5:21–7.5(f)6.

(h) The channel should be, insofar as possible, a smooth continuation of the pipe. The pipe may be laid through the manhole and the top half removed by saw cut. The completed channel should be U-shaped. The channel height shall be three-fourths of the diameter of the pipe.

(i) The bench should provide good footing for a workman and a place where minor tools and equipment can be laid. It must have a slope of four to eight percent.

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).
Amended by R.2002 d.399, effective December 16, 2002.
See: 34 N.J.R. 2615(a), 34 N.J.R. 4412(a).
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).

5:21–7.5 Detention basins and other stormwater 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, riparian buffers, 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 municipalities require the use of detention facilities, design engineers shall design the basins to 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 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 watershed stormwater management plan for the region or watershed exists, approved and adopted pursuant to the New Jersey Department of Environmental Protection rules at N.J.A.C. 7:8, then the design engineer shall design stormwater management systems to conform to that 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 watershed stormwater management plan, then the design engineer may model the watershed to be consistent with regulations administered by the Department of Environmental Protection and shall design stormwater management facilities to conform to that model. 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 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 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. The determination of the seasonal high water table shall be made by the applicant's engineer.

(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 second^2

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 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).

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 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 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. 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 below 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)
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 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 antiseep collar(s) shall increase by 15 percent the seepage path along the pipe. When antiseep collars are used in lieu of a 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 rise to the toe drain or point where the phreatic line intercepts the conduit, whichever is shorter.

Let n = number of antiseep collars.
The ratio (L + 2nV)/L shall 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.