SOMERSET COUNTY PUBLIC WORKS HANDBOOK

SOMERSET COUNTY
DEPARTMENT OF PUBLIC WORKS

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ENGINEERING DIVISION

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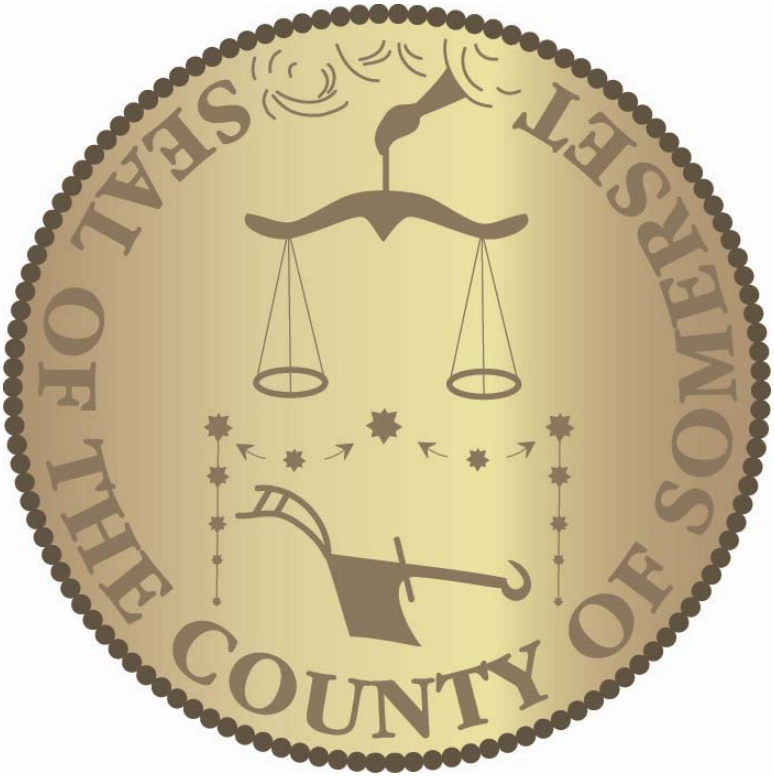
2011



2011 Somerset County Board of Chosen Freeholders

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INTENT OF DOCUMENT

The purpose of this document is to provide guidance for consulting engineering firms in the preparation of design documents and construction plans for improvements under Somerset County jurisdiction.

The *Somerset County Land Development Review Resolution* is also to be referenced in conjunction with this document for all land development projects requiring County Planning Board approval. A pre-design meeting is required for all projects that involve a County traffic signal, bridge or significant modifications to a County roadway.

Specific details and notes for incorporation into construction plans are not contained within this document. Instead, the applicable county details are available on the County website at http://www.co.somerset.nj.us/division/engineering.html. For roadway improvements to County roads that involve anything more significant than a simple pavement widening, A.A.S.H.T.O. standards must be followed. The N.J.D.E.P. Stormwater Rules and Best Practices Manual must be followed in design of stormwater management facilities.

The design of all traffic control devices shall be based on the requirements of the *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD), latest edition which can be found at http://www.mutcd.fhwa.dot.gov/. Material specifications for traffic control devices are to be in accordance with NJDOT's *Standard Specifications for Road and Bridge Construction*, latest edition, available at http://www.state.nj.us/transportation/eng/specs/, and Somerset County's *Supplementary Specifications* that will be provided to the design engineer at the aforementioned pre-design meeting.

The preparation of roadway and/or bridge construction plans shall be based on NJDOT's *Standard Specifications for Road and Bridge Construction*, latest edition, and Somerset County's *Supplementary Specifications* that will be made available at the pre-design meeting.

1.1 Disclaimer

The material in this handbook has been prepared in accordance with generally recognized design and construction principles and practices, and serves as an accepted design standard. However, users should recognize that certain situations might call for variation from its provisions, subject to sound engineering judgment and the discretion of the County Engineer.

Periodically, amendments to this handbook will be issued by the Bridge, Traffic, Land Development or Highway Sections of the Somerset County Engineering Department. Before the design phase of any project is initiated, it is imperative that this department be contacted in order to ascertain if any amendments were issued since the publication of this document. The Engineering Department's phone number is (908) 231-7024.

LAND DEVELOPMENT IMPROVEMENTS

2.1 Permits

1. The applicant is responsible for obtaining all necessary permits required for a proposed construction project. The application of permits from other review agencies should be coordinated with the County's review of the project. For example, an application to NJDEP for a stream encroachment permit to construct or extend a County bridge should be deferred until the County has accepted the bridge's alignment, waterway opening, wingwall configuration, and so on.

2. Engineering acceptance of all construction documents expires two (2) years from the date of acceptance. If an acceptance expires, the plans must be resubmitted and reviewed for conformance to current requirements. After any necessary revisions are made to bring the construction plans up to current standards, the two-year acceptance period will once again commence.

3. Although the acceptance of the construction plans will expire every two years, this does not affect the acceptance status with the County Planning Board or other review agencies.

2.2 Road-Opening Permit

Prior to any excavation or disturbance within the right-of-way of any County roadway, a road- opening permit is to be obtained from the Somerset County Department of Public Works. Refer to Somerset County's *Specifications and Fee Schedules for Road Openings* (http://www.co.somerset.nj.us/division/engineering.html) for more information pertaining to road-opening permits.

2.3 Frontage Improvements

1. Pavement widenings and curbing shall be constructed along the frontage of sites to be developed, that abut a County road and at all intersections and as directed by the County Engineer. Smooth horizontal and vertical alignments of the curb shall be pursued to adequately match existing conditions, provide proper drainage control and to meet AASHTO standards. All abrupt angle points along the frontage of sites to be improved are to be eliminated or minimized as directed by the County Engineer. Curbing offsets from the striped centerline shall be determined by the County Engineer.

2. The width of pavement widenings shall be consistent with the County's Master Plan or as directed by the County Engineer to reflect anticipated traffic volumes, turning movements and other considerations related to the safety and convenience of motorists.

3. Paved tapers shall be constructed to transition from the end of a pavement widenings to the existing edge of pavement. Tapers are to be a minimum of 75 feet long or as determined by the County Engineer. Curbing is not to be constructed along tapers unless directed by the County Engineer.

4. Object markers (type 2, 6" x 12", white) shall be installed every 20 feet along the pavement taper and shall be 2 feet behind the edge of pavement. If an object is in the area of the taper, then type OM-3R markers, 12" x 36", shall be used.

5. Cross sections shall be provided every 50 feet in the area of the proposed widening and are to extend a minimum of 50 feet beyond the limits of construction or as directed by the County Engineer.

6. Pavement widenings shall be designed in accordance with the County Pavement Widening detail found at http://www.co.somerset.nj.us/division/engineering.html.

7. A proposed top-of-curb profile is to be provided for the County Road and is to extend a minimum of 50 feet beyond the limit of construction and /or property limits. The profile is to include:

   a. All necessary vertical curve data and tangent grades that are coordinated with stations on the plan.

   b. The bottom and top of proposed curb elevations every 50 feet, at all low points, and at the points for curvature and points of tangency of side road/access drive returns.

   c. All existing and proposed utilities and stormwater systems.

8. The type of curbing to be constructed shall match that of neighboring sites or as determined by the County Engineer. All applicable details are to be provided that are consistent with County standards.

9. If depressed curbs are required, details are to be provided that are consistent with County standards.

10. Curb sections 10 feet long are to be provided on both sides of all type “B” inlets.

2.4 Typical Sections

A typical road section is to be provided for each proposed condition (e.g., full-depth pavement, mill/overlay, superelevation,) and must be based on the following criteria.

1. All sections are to be drawn at a scale large enough to clearly show pavement specifications, all pertinent dimensions, and necessary information.

2. Pavement specifications must be in conformance with County standards.

3. The roadway's cross-slope is be approximately 2 percent, but may vary between 1 and 4 percent for road widenings to match existing conditions and as needed to provide a smooth top of curb profile.

4. The area behind the curb is to be graded at a 2 percent slope for a distance of 10 feet or to the proposed right-of-way line, and then at a maximum slope of 3 horizontal to 1 vertical to meet the existing ground surface.

5. Existing and proposed centerlines and right-of-way lines are to be shown and clearly dimensioned.

6. Station limits must be given for each section that relates to each roadway condition within the limits of the project.

2.5 Cross Sections

Cross sections are to be included in the construction plans for all roadway improvement projects. The following criteria must be followed in the preparation of cross sections:

1. The cross sections shall be prepared at a scale of 1" = 5' in the horizontal and vertical planes.

2. Centerline stationing, cross slopes, extent of milling/full-depth pavement and grading beyond the edge of pavement or curbline must be shown and must correspond with the Typical Section and the information shown on the plans and profile.

3. Existing pavement elevations are to be shown for the centerline, edge of pavement, and proposed saw-cut line.

4. Proposed elevations are to be shown for the centerline, edge of proposed pavement or bottom and top of the proposed curb.

5. The cross section must continue far enough beyond the proposed curbline or edge of pavement to clearly show that existing conditions will be met in accordance with the standards listed for typical sections.

6. Sections are to be provided at all driveways and side streets to show how proposed conditions meet existing conditions.

7. Areas to be topsoiled, strip cut, and strip filled are to be clearly indicated on the cross sections along with the quantities for cut, fill, topsoiling, stripping cut and stripping fill.

8. Existing and proposed right-of-way lines are to be accurately shown.

9. The cross sections must clearly depict areas of widening, with boxed-out sections representing the limits of full-depth pavement to be constructed. The cross sections must also show boxed-out sections along with the limits and depths of milling. The proposed pavement depth in overlay areas shall be a minimum of 2" in the County road.

10. In pavement-widening areas, the cross sections must clearly show the proposed cross slope between the edge of the existing pavement and the proposed bottom of curb. Whenever possible, a 2 percent cross slope is to be maintained (see Road-Widening Detail). However, the cross slope may vary between 1 and 4 percent as needed to achieve a smooth top-of-curb profile.

2.6 Horizontal and Vertical Alignment

The horizontal and vertical alignments of a roadway must be designed in accordance with the latest editions of *A Policy on Geometric Design of Highways and Streets* and the *Roadway Design Manual* (http://www.state.nj.us/transportation/eng/documents/RDME/). In designing horizontal curves, it is necessary to establish the proper relationship between design speed and curvature, and also their joint relationship with superelevation. Horizontal alignment must afford at least the minimum stopping sight distance for the design speed at all points on the roadway.

2.7 Stormwater Drainage and Conveyance

All roadway designs shall include provisions for the complete and efficient drainage of stormwater runoff from the roadway and associated areas through the construction or reconstruction of stormwater drainage or conveyance systems. In general, such systems shall be capable of conveying the maximum discharge for which they are designed and of transporting suspended solids in such a manner as to minimize deposition within the system. All stormwater conveyance systems shall be designed in accordance with the methods and criteria presented below. However, the County reserves the right to require additional and/or alternative methods or criteria which, in the opinion of the County Engineer, are warranted for a specific project in order to comply with the requirements of the *Somerset County Land Development Review Resolution.*

2.8 Design Hydrology

All stormwater conveyance systems in County roadways shall, as a minimum, be capable of conveying the peak runoff from a 25-year storm event under full flow conditions. Unless otherwise directed by the County Engineer, this peak runoff rate shall be estimated using either the Rational Method or the rainfall-runoff methodology of the USDA Soil Conservation Service (SCS). Care should be taken in the design of any stormwater conveyance system to insure that downstream peak discharges are not increased due to the construction of the system.

2.9 Rational Method

In general, use of the Rational Method shall be limited to drainage areas equal to or less than 20 acres; however, it may also be used for larger drainage areas if the hydrologic characteristics of the area are in reasonable conformance with the Method's theoretical assumptions. Therefore, stormwater conveyance system designers should confer with the County Engineering Department prior to using the Rational Method for drainage areas larger than 20 acres. Drainage area limits shall be determined from topographic maps that are supplemented by field reconnaissance, storm sewer maps and other appropriate data.

Rainfall intensities (i) used in a Rational Method design shall be based upon a design storm duration equal to the drainage area's Time of Concentration (TC), which shall be defined as the time required for stormwater runoff to travel from the most hydraulically distant point in the drainage area to the point at which the peak runoff rate is to be computed. It should be noted that the TC may vary with storm frequency and that, in certain instances, the estimated TC should reflect future or ultimate development conditions instead of existing conditions.

The TC shall be computed by use of the methodology contained in *Technical Release 55—Urban Hydrology for Small Watersheds* (TR-55) available online at http://www.wsi.nrcs.usda.gov/products/w2q/H&H/docs/other/TR55_documentation.pdf from the Somerset-Union Soil Conservation District, or by other standard engineering techniques. However, when utilizing the TR-55 methodology, it is recommended that a maximum Manning's *n* value of 0.40 be utilized in the computation of sheet flow travel time by use of the Kinematic Wave equation (see Equation 3-3 and Table 3-1 in TR-55).

Rainfall intensities (*i*) shall be taken from "Somerset County Rainfall Intensity/Duration/Frequency Curves", available on the County website at http://www.co.somerset.nj.us/division/engineering.html and the Somerset County Engineer's Office, which has been developed by the County Engineering Department from historic rainfall data for various locations in the County. Alternative intensity-duration-frequency relationships may only be used upon approval by the County Engineer.

Runoff coefficients (*C*) used in a Rational Method design shall be based upon the values contained in the NJDOT Roadway Design Manual – Chapter 10 which is available online at http://www.state.nj.us/transportation/eng/documents/RDM/. A Hydrologic Soil Group determination of the soils in the drainage area shall be in accordance with the *Soil Survey of Somerset County* available online at http://websoilsurvey.nrcs.usda.gov/app/ from the Somerset-Union Soil Conservation District. It should be noted that, in certain instances, the estimated runoff coefficient for a drainage area should reflect future or ultimate development conditions instead of existing conditions.

It should be noted that use of the recommended runoff coefficients (*C*) in Table 3.13.1 requires the determination of the relative size of the various land surfaces within a drainage area and the computation of a composite or weighted average coefficient for the total drainage based upon the relative size and selected runoff coefficient for each surface. In computing the weighted average coefficient, the selected runoff coefficients for all surfaces

(except those considered to be impervious, such as roofs and areas covered with asphalt or concrete) shall first be multiplied by the values shown in Table 3.13.2 for the selected design storm frequency. These multipliers are intended to address the more intense rainfall rates associated with extreme storm events and their effects on standard runoff coefficient values.

2.10 NRCS Rainfall-Runoff Method

The design of stormwater conveyance systems for roadways using the rainfall-runoff methods of the SCS shall be performed in accordance with the *Part 630 Hydrology National Engineering Handbook*, available online at http://directives.sc.egov.usda.gov/RollupViewer.aspx?hid=17092, including the SCS Runoff Equation and Dimensionless Unit Hydrograph. Drainage area limits shall be determined from topographic maps that are supplemented by field reconnaissance, storm sewer maps and other appropriate data.

When utilizing the TR-55 methodology to calculate time of concentration, the following is required:

1. A maximum Manning's *n* value of 0.40 and a maximum flow length of 100 feet be utilized to compute sheet flow travel time by the use of Equation 3-3 and Table 3-1 in TR-55

2. A maximum flow length of 1,000 feet be utilized to compute shallow concentrated flow travel time by the use of Figure 3-1 in TR-55. The minimum time of concentration shall be 10 minutes. Urban Hydrology for Small Watersheds TR-55 is available online at http://www.wsi.nrcs.usda.gov/products/w2q/H&H/docs/other/TR55_documentation.pdf.

2.11 Design Hydraulics

Unless otherwise directed by the County Engineer, the hydraulic design of the stormwater conveyance system shall be based upon Manning's Equation by the use of appropriate roughness coefficients (*n*). A range of typical Manning's *n* values for a variety of surfaces and conveyance measures is presented in Table 4.11 of this document. It should be noted that final *n* values should reflect the relative depth of flow and the condition of the surface or measure.

In addition, the design of all stormwater conveyance systems shall include consideration of the hydraulic losses encountered at inlets, outlets, drain inlets, junctions, manholes, bends and other system components by the use of standard loss coefficients. A loss coefficient of 1.0 is recommended at the outlets of such systems that discharge under pressure or full flow conditions.

Design velocities in reinforced concrete pipe or over reinforced concrete surfaces and gabion-lined surfaces shall not exceed 15 feet per second (fps) or the manufacturer's recommended value, whichever is less. The design of gabion or riprap shall be in accordance with the *Standards for Soil Erosion and Sediment Control in New Jersey*, published by the NJ State Soil Conservation committee.

2.12 Conduit Outlet Protection

Conduit outlet protection shall be provided where outlet velocity will cause erosion. Conduit outlet protection shall be designed in accordance with the publication *Standards for Soil Erosion and Sediment Control in New Jersey*.

Where velocities exceed 15 feet per second or where conduit outlet protection requirements result in an excessively large riprap pad, an energy dissipator may be used. Energy dissipators shall be designed in accordance with the Federal Highway Administration's HEC-14: *Hydraulic Design of Energy Dissipators for Culverts and Channels* which is available online at http://www.fhwa.dot.gov/engineering/hydraulics/pubs/06086/.

If possible, storm sewer systems shall be designed so that the final most downstream segment shall not exceed a 2 percent pipe slope. Use of upstream drop manholes is encouraged where necessary to meet this goal so that outlet velocities are minimized.

2.13 Drainage Plan Requirements

1. Stormwater conveyance systems located in the County road are to be combination drain systems unless otherwise directed by the County Engineer.

2. Inlets are to be placed a minimum of every 300 feet, at all low points, and where necessary to ensure proper drainage of the County road.

3. Inlets are to be provided at or near the end of the improvements, where necessary, so as to avoid excessive disturbance during any future extension of the improvements.

4. Gutterline slopes shall be greater than 1 percent. Where this is not possible, additional inlets are to be provided to ensure proper drainage.

5. Existing ditches located along or near the traveled way of County roads are to be piped with the development of the site.

6. Proposed pipes should be located so as to minimize disturbances to the existing topography and to avoid conflicts with utilities.

7. The class, size, length, slope and inverts of each pipe are to be shown on the plans. Class IV concrete shall be used, and the minimum diameters shall be 15" for cross drains and 18" for drainage systems parallel to the road.

8. Grading and inverts must reflect a minimum ground cover of 1 foot over all pipes.

9. The proposed stormwater conveyance system must end at a safe and adequate discharge point which is to be clearly shown on the plans.

10. Conversions of existing drainage structures in pavement widening area that result in flat grates or manholes in the travelled way shall not be permitted. When a County road is to be widened and the existing drainage system is not under or behind the proposed curbline, the system shall be removed or demolished as required by the County Engineer. New type "B" inlets are to be provided at the proposed curbline/edge of pavement.

2.14 Intersection Design

The layout of land development proposals must be designed to account for the County's access requirements when access is proposed to a County Road. Every effort is to be made to minimize access points to the County Road. When subdivisions or site plans result in new access points to County roads, one of the following courses of action may be required in keeping with the County policy of minimizing access points to a County road:

1. Utilize an alternative access location(s) to nearby side streets instead of the County Road.

2. The frontage can be reversed so that lots contiguous to the County road will front on an internal street with no direct access to the County road.

3. Use a shared driveway by way of a shared driveway easement or cross access agreement.

4. Utilize a shared apron design for the portion of the driveways located in the County right-of-way.

If it is determined by the Office of the County Engineer that none of the methods outlined above are feasible, the intersection design standards outlined below must be followed.

2.15 Minimum Intersection Treatment

The minimum intersection treatment for all proposed side streets and major access drives shall consist of the following:

1. Geometric designs of the roadway are to be in accordance with *A Policy on Geometric Design of Highways and Streets*, latest edition, and the *Roadway Design Manual*.

2. Curb radii and lane widths are to be set so that a single unit design vehicle will be able to complete turning maneuvers without infringing on the sidewalk or non-roadway areas of the intersection or disrupting traffic flow in other adjacent lanes of the intersection. All intersections with a County road are to accommodate, as a minimum, a "Single Unit Vehicle" as defined in AASHTO *A Policy on Geometric Design*. Intersections which service, or are expected to service, a large percentage of semi-tractor trailers are to accommodate a WB-67 design vehicle unless otherwise approved by the County Engineer.

3. The location of new access points must take into account existing and other new or pending access points in close proximity to avoid conflicting left turns from the County Road.

4. The approaches where vehicles queue while waiting to enter the intersection should be designed with a relatively flat grade, with a maximum grade not to exceed 5 percent.

5. Curbing shall be constructed a minimum of 125 feet from the point of curvature of curb returns in the County road. The dimensional setback and alignment of the proposed curb with respect to the centerline of the County road shall be as directed by the County Engineer's office.

6. Requirements for sight distance and stormwater drainage and conveyance, as defined elsewhere herein, shall be incorporated into the location and design of the new intersection.

7. Any safety-related improvements deemed necessary by the County Engineer shall be installed at all intersections.

8. An intersection grading plan is to be provided for all intersections at a minimum scale of 1" = 20'. The grading plan must show the proposed bottom and top of curb elevations at the point of curvature, point of tangency and midpoints of all curb returns and be free of superfluous information. Spot pavement elevations are to be shown throughout the intersection area as needed to ensure proper drainage.

9. All necessary information to ensure smooth curb profiles and proper drainage of the intersection must be shown on the plans (top and bottom curb elevations and spot elevations).

10. The proposed roadway or access drive should intersect the County road at or as close to 90 degrees as possible (the minimum acceptable angle of intersection is 75 degrees).

11. The minimum radius of curb returns for a proposed roadway is 25 feet. A minimum radius of 15 feet may be considered for driveways. Larger curb returns may be required based upon specifications as presented herein.

12. Clear-sight areas, consistent with County standards are to be shown at all intersections. All sight obstructions located in these areas must be shown to be removed. Easements may have to be acquired from adjoining property owners to accommodate the minimum intersection requirements. For information on acquiring easements and parcels, refer to Chapter 5 of the *Somerset County Land Development Review Resolution.*

13. Ramps for the physically disabled (depressed curbs) must be provided at all curbed intersections.

14. Whenever possible, trench drains, flat grates and manholes are not to be located in the anticipated wheel-path of vehicles.

2.16 Intersection Sight Distance

1. Clear sight areas are to be established at all access points to the County road. The clear sight area is the area located between the path of an oncoming vehicle traveling in the County road and the driver's line of sight in a vehicle about to enter the County road. Somerset County's criteria for establishing the driver's line of sight is based on two factors: the speed of the vehicles traveling along the County road and the location of the driver's eye in the vehicle entering the road. This line of sight provides the driver with the minimum sight distance for safe access to the County road.

2. For passenger vehicles, the sight distance requirements shall be based on an eye height of 3.5 feet on the minor road to an approaching vehicle height of 4.25 feet. The horizontal measurement shall be from a point on the minor road that is 15 feet from the edge of the traveled way. Sufficient sight distance should be provided to allow the driver on the minor road to cross the major road without requiring approaching traffic to reduce speed. As a minimum, the sight distance (in feet) must be 10 times the design speed (in mph) for the stopped vehicle to cross a two-lane road.

3. As an alternative, visibility time can be used for the driver exiting a driveway to see an approaching vehicle. A value of 7 seconds is approximately equivalent to the 10-times-the-design-speed criteria for a two-lane highway.

4. The sight distance for trucks, buses and larger vehicles is considerably longer than that for passenger vehicles. Where an intersection is expected to service a large percentage of truck traffic, a minimum sight distance visibility time of 11 seconds is required. Corrections to this must be made where the intersection legs are on other than flat grades (see *A Policy on Geometric Design*).

5. Where traffic on one leg of the intersection is controlled by stop signs, the driver on the minor road must have sufficient sight distance for a safe departure from the stopped position.

6. The following information must be submitted for review and approval in order to determine the required clear-sight areas.

   a. The horizontal and vertical alignment of the County road must be shown a minimum of 500 feet in each direction from the proposed intersection.

   b. The actual line of sight from the driver's eye in a vehicle leaving the subject site must be clearly shown in a vertical and horizontal plane. See the above for locating the driver's-eye position on the plan.

   c. All sight obstructions which are located in the required clear-sight areas are to be clearly identified on the plan.

   d. The existing right-of-way line is to be shown a minimum distance of 500 feet in each direction from the proposed driveway/roadway. All property lines in this area are also to be shown.

7. The construction plan shall clearly show the line of sight and shall note that all sight obstructions located in the clear-sight areas are to be removed and the area is to be restored as directed by the County Engineer.

8. Sight easement lines are to be established a minimum of 5 feet behind the accepted line of sight to ensure that the line of sight will be kept clear of all obstructions. The metes and bounds description of the sight easement is to be shown on the construction plan and on the filed document. See the *Somerset County Land Development Review Resolution* (http://www.co.somerset.nj.us/planweb/pdf/ldcomp.pdf) for more information regarding sight easements.

9. Where left turns are permitted in conflict with opposing through traffic, the left-turn sight distance should be checked to ensure that the left-turning driver has adequate sight distance to judge whether or not a gap in the oncoming traffic is sufficient to safely complete a turn.

2.17 Deceleration Lanes

When directed by the County Engineer, the construction of a deceleration lane shall be provided at access points to the County road. The minimum width of this lane will be 12 feet (the width is in addition to the pavement-widening which is required along the frontage).

The length of the deceleration lane will be determined on the basis of the design speed of the road versus a 15 mph turning speed, and the grade of the approach, in accordance with AASHTO criteria. In no case will the length of the lane be less than 185 feet as measured from the end of the driveway radius, and, in addition to this, a tapered transition of 145 feet shall be constructed.

2.18 Acceleration Lanes

Depending on the travel speed, volumes on the County road and other considerations, the County Engineer may require the construction of an acceleration lane for access points to a County road.

The length of this lane will be determined on the basis of the design speed of the road versus a 0 mph stopped condition (for stop-controlled intersections) and the grade of the approach, in accordance with AASHTO criteria. In no case will the length of the lane be less than 190 feet as measured from the end of the driveway radius. The acceleration lane shall also include a tapered transition length no less than $L = WS^2 \div 60$ for design speeds less than 40 mph, and $L = SW$ for speeds greater than 40 mph, where S = the design speed and W = the width of the acceleration lane.

2.19 Left-Turn Slots

1. Channelized left-turn "slots" or "pockets" on a County road may be required at entrances to site access drives or other intersections that are affected by the site traffic. This depends on the peak hour volume of the left-turning traffic versus the opposing through traffic on the road.

2. The necessity for left-turn slots, and the length of such slots at unsignalized intersections, shall be determined by using the methodology in M.D. Harmelink's "Volume Warrants for Left-Turn Storage Lanes at Unsignalized Grade Intersections," *Highway Research Record*, No. 211.

3. The taper from the full-width channelization to the storage lane shall be accomplished by using a 75- to 80-foot-radii reverse curve.

2.20 Stopping Sight Distance

As stated in the *Roadway Design Manual*, "The minimum stopping sight distance is the distance required by the driver of a vehicle, travelling at a given speed, to bring the vehicle to a stop after an object on the road becomes visible. Stopping sight distance is measured from the driver's eyes, which are assumed to be 3.5 feet above the pavement surface, to an object 0.5 foot high on the road."

For specific design criteria for stopping sight distance, refer to this manual or *A Policy on Geometric Design of Highways and Streets*, latest edition.

2.21 Channelization (Islands/Medians)

At intersections where the proper course of travel is not immediately obvious, it may be advantageous to separate turning movements with channelization. Channelization may be required for one or more of the following purposes:

1. Separation of conflicts
2. Control of angle of conflict
3. Reduction of excessive pavement areas
4. Regulation of traffic and indication of proper use of intersection
5. Protection of pedestrians
6. Protection and storage of turning and crossing vehicles
7. Location of traffic control devices

Channelization shall be designed in accordance with the *Manual on Uniform Traffic Control Devices* (http://www.mutcd.fhwa.dot.gov/), latest edition. All pavement markings are to be thermoplastic.

The use of curbed islands may be desirable, particularly in the case of items 5 and 7 above. Where curbed islands are used, the intersection should have fixed-source lighting or appropriate pavement markings and signing delineations. The design of curbed islands (size, designation, etc.) is to be in accordance with AASHTO's specifications.

2.22 Ramps for the Physically Disabled

At curbed intersections, depressed curbs and ramps shall be provided within the sidewalk or pedestrian island and conform to the current standards for ADA compliance.

2.23 Signalized Intersections

The installation of a traffic signal may be required at the intersection of a County road by the County Planning Board in conjunction with either an access or off-tract improvement. All traffic signals shall be designed in accordance with the *MUTCD*, latest edition.

NJDOT's *Roadway Design Manual*, Section 12, "Traffic Signal Systems," is to be used as a guide in the planning and design of all traffic signal systems; however, the following guidelines for the design and construction of traffic signals supersede any conflicting information found in Section 12 of the manual.

2.24 Traffic Signal Analysis

The methodology used to analyze the capacity of a signalized intersection shall be in accordance with that outlined in of the latest edition of the *Highway Capacity Manual* by the Transportation Research Board, National Research Council. Preferably, the analysis shall be performed using the latest version of the Highway Capacity Software developed by the US Department of Transportation, Federal Highway Administration, or similar software based on the same methodology. The analysis is to be submitted to the County Engineering Division.

The following conditions are to be utilized in the analysis:

3. A saturation flow rate of no more than 1,900 vehicles per hour.

4. Clearance intervals of no less than 3 seconds “yellow” and no less than 1 second “all red.” (Timings will depend on the speed of approach and the distance required to “clear” conflicting movements.)

2.25 Traffic Signal Geometry

1. Storage bays shall be of a sufficient length to accommodate 150 percent of the turning vehicles.

2. Eight-inch solid white lines shall be used to separate approach lanes at an intersection. The length of such lines shall be 66 percent of the length of the corresponding bay.

3. Curbs are to be provided at all intersection legs for a minimum distance of 100 feet beyond the point of curvature of the curb radii.

4. All centerlines (double yellow lines) are to be spaced so that there is a clear 6" space between the 4" lines.

2.26 Traffic Signal Indications

1. There shall be a minimum of three vehicular indications per approach. Preferably two (as a minimum, one) of the indications are to be located within the “cone of vision” as per the *MUTCD*.

2. Independent traffic signal assemblies for the same approach are to be utilized where possible so that one indication will be visible in the event that any one traffic signal assembly is “knocked down” by an errant vehicle.

3. Five-section heads shall be used for protected/permitted indications (fiber optic lenses are not allowed).

4. All signal indications shall have L.E.D. lamps and are to be wired separately back to the controller.

5. Crosswalks and pedestrian indications are to be provided unless extenuating circumstances preclude their installation. Pedestrian indications are to be the "countdown" type.

2.27 Traffic Signal Assemblies and Control

1. Span wire-mounted indications shall be used for temporary installations only.

2. Aluminum poles (TSS Type "K" or "T") shall be located a minimum of 5 feet behind the curbline.

3. Mast arms greater than 25 feet in length will require a steel pole (TSS Type "S"). Steel poles are to be located at least 10 feet from the face of curb.

4. Controllers are to be located within the intersection so as not to interfere with the sight distance of right-turning vehicles on the minor street approach.

5. Underground conduits are to be a minimum of 4" in diameter; however, conduits containing only loop leads may be 1-1/2" provided that a 40 percent fill is not exceeded. Conduits installed under existing concrete sidewalks or bituminous concrete shall be classified as Type CUR. All conduit shall be rigid nonmetallic, schedule 80, and separate conduit runs shall be either Type CUR or CUG. Conduits under the road are to be installed by the open cut method.

2.28 Vehicle Detection

Vehicle detection shall be accomplished with the use of a video tracking unit (VTU). The VTU shall be the shelf-mounted Econolite Autoscope 704120 or an approved equal. The following guidelines are to be used in designing areas of presence detection on the approaches to a signalized intersection.

1. Delay-call detection is to be provided on right-turn lanes where a "right turn on red" is permitted and where permitted left-turn lanes exist.

2. The vehicle-extension interval is to be two seconds.

3. The front edge of the area of detection must be no more than 10 feet from the curbline of the intersecting roadway projected across the approach being detected.

4. In no case shall any portion of the detection extend beyond the projection of the curbline into the intersection area.

5. The front edge of the detection immediately behind the stop line shall be no more than 3.5 feet from the stop bar.

6. Lateral spacing shall be 3 feet from a curb or pavement edge and 3 feet from a painted line.

2.29 Design of Driveways

The layout of land development proposals must be designed so as to minimize the number of driveways onto the County road. New driveways are to be located and designed so as to provide the maximum amount of sight distance. When new driveways are proposed onto a County road, their locations must be accepted by the County Engineer and a Road Opening Permit is to be obtained prior to any construction on a new access point to the County road. The following requirements pertain to access points to the County road in order to minimize access points to the County road.

1. The frontage can be reversed so that lots contiguous to the County road will front on an internal street with no direct access to the County road.

2. Shared driveways are to be utilized where practical.

3. A shared apron is to be utilized for that portion of the driveway located in the County right-of-way.

4. Pursue an alternative access location to nearby side streets instead of the County Road.

5. When a land development project results in a new access point to a County road that can be utilized by other nearby sites, access to those sites shall be made to the new access points when directed by the County Engineer.

Other requirements for the spacing and maximum number of driveways are outlined in Chapter 4 of the *Somerset County Land Development Review Resolution.*

2.30 Non-residential Driveway Standards

1. The dimensions of driveways shall be so designed so as to adequately accommodate the volumes and types of vehicles expected on a daily basis. The use of channelized islands in any driveway will produce variations in the driveway width as necessary to ensure efficient and safe traffic movements. The minimum curbline opening for driveways with two-way operations shall be 26 feet. The minimum curbline opening for driveways with one-way operations shall be 18 feet. Curbline openings may be reduced accordingly when striped parallel parking spaces are located near the driveway.

2. Curb radii are to be designed as geometric designs of the roadway and are to be in accordance with A Policy on Geometric Design of Highways and Streets, latest edition, and the Roadway Design Manual. Curb radii and lane widths are to be set so that truck traffic will be able to complete turning maneuvers without infringing on the sidewalk or non-roadway areas of the intersection or disrupting traffic flow in other adjacent lanes of the intersection. All intersections with a County road are to accommodate, as a minimum, a "Single Unit Vehicle" as defined in A Policy on Geometric Design. Intersections which service, or are expected to service, a large percentage of semi-tractor trailers are to accommodate a WB-67 design vehicle unless otherwise approved by the County Engineer. The minimum acceptable curb radius for a driveway is 15 feet.

3. A maximum profile grade of 6% is to be maintained for the portion of the driveway within the Master Plan right of way of the County road. Vertical curves are to be utilized to ensure a smooth transition between the driveway and the County road. Driveway profiles are to be designed in accordance with the operating characteristics of vehicles and to adequately blend into the final topography in the area of the driveway.

4. The portion of the driveway located within the County's Master Plan right-of-way shall be paved in accordance with the County's pavement specifications shown on the County's Road-Widening detail found on the County website.

5. No non-residential driveway or access road shall be located closer than fifty feet (50') to a property line. Unless a shared driveway/access treatment is being utilized.

6. The intersection of the driveway with the County road is to be coordinated with the design of frontage improvements at the site and in accordance with applicable requirements for the minimum treatment of intersections as defined herein.

7. Design standards for the intersecting angle with a County road are as follows:

    a. For two-way, undivided driveways, the angle between the driveway centerline and roadway edge shall be designed based on safety considerations and should be as near to 90 degrees as possible. In no case shall the driveway form an angle of less than 75 degrees with the intersection.

    b. Driveways used for one-way operations and right-turns only shall not form an angle smaller than 45 degrees with the roadway edge unless acceleration or deceleration lanes are provided. In no case shall an exit driveway form an angle of less than 30 degrees.

2.31 Residential Driveway Standards

The following design criteria apply to residential driveways having access to a County road:

1. New driveways are to be located so as to provide sufficient sight distance. All sight obstructions along the property frontage or within the County right-of-way are to be cleared.

2. Driveway aprons are to be constructed so as not to impede gutterline flow along the County road. If a pipe is needed, only new Class IV reinforced concrete pipe shall be used. The minimum length of pipe to be installed shall be 24 feet, and the minimum pipe diameter shall be 12" (Driveway Apron Detail). In cases where there is insufficient cover over the pipe, the County Engineering Division may consider the use of a cast iron pipe with a diameter of no less than 10". For driveways using a shared driveway apron, the minimum pipe length is 32 feet and the apron shall be paved to the right-of-way line with 4 inches stabilized base course and 1 ½ inches of top course.

3. A maximum profile grade of 6% is to be maintained for the portion of the driveway within the Master Plan right of way of the County road. Vertical curves are to be utilized to ensure a smooth transition between the driveway and the County road. Driveway profiles are to be designed in accordance with the operating characteristics of vehicles and to adequately blend into the final topography in the area of the driveway.

4. Driveway aprons shall be paved with of 3" of stabilized base course and 1½" of top course to the County Master Plan right-of-way. Existing ditches located along or near the traveled way of County roads in the area of new driveways that present a safety concern are to be piped with the development of the site.

5. No residential driveway shall be located closer than 15’ to a property line unless a shared driveway is being utilized.

6. Proposed pipes should be located so as to minimize disturbances to the existing topography and to avoid conflicts with utilities.

7. The minimum driveway opening at the edge of pavement or curbline shall be 18 feet. If the driveway is located in a “downtown” type of area where on-street parking is provided, the curbline opening may be reduced to 12 feet if needed to better accommodate on-street parking.

8. Driveways shall be designed to permit vehicles to turn around instead of having to back onto the County road.

2.32 Right-of-Way Dedications

1. The objective of a right-of-way dedication being made as a condition of County Planning Board approval for a land development application is for the County to acquire clean title to that portion of the subject property located between the centerline of the County road and the new right-of-way line. If a previously recorded document transferring any portion of this area to the County cannot be confirmed, the parcel to be dedicated is to contain the area along the frontage of the site from the painted centerline to the new right-of-way line. Any uncertainty as to the extent of the owner's rights, title and interest in this area can be addressed with the inclusion of the following language in the recording instrument;

   This dedication is made together with all rights, title and interest that the owner may have in the "certain road" contiguous to the tract from which this dedication is made.

2. Right-of-way dedications to the County of Somerset shall be recorded by deed in the County Clerk's Office after the document to be recorded has been reviewed and accepted by the County Engineer's office. The following shall appear on the deed of dedication:

   The recording of this dedication shall not be construed to be an acceptance of the roadway or improvements located therein. Nor shall any such acceptance in any way obligate the County of Somerset to maintain or exercise jurisdiction over such roadway until said road/improvements have been accepted by the County. Additionally, it is acknowledged that Somerset County shall not be responsible for the maintenance of any sidewalk improvements.

3. If a final plat is to be recorded, the dedicated area must be identified as *"Area dedicated to Somerset County for roadway purposes"*.

4. The alignment of the new right-of-way line shall be parallel and/or concentric to the striped centerline of the County road with a centerline offset that conforms to the Master Plan width as depicted on the *Somerset County Road Functional Classification System*, which is available in the *Somerset County Land Development Review Resolution* (http://www.co.somerset.nj.us/planweb/pdf/ldcomp.pdf), unless otherwise directed by the County Engineer's Office.

5. Monuments are to be set at all angle points, beginning and ends of curves and where the new right-of-way line intersects the out bound of the tract from which the dedication is being made.

6. The parcel being dedicated must close to a tolerance of one-hundredth of a foot (0.01').

7. The point of beginning for the dedicated area must be clearly noted and located in the outbound of the tract from which the dedication is being made. The point of beginning is to be tied to the nearest side street or referenced to a specific call in a prior recorded document.

8. The area of the dedication is to be shown to the nearest square foot.

9. The metes and bounds of the dedicated area must be reviewed and accepted by the County Engineer's Office prior to filing.

10. The standard County form must be used for recording dedications. The form is available on the County website or from the County Planning Board office.

2.33 Easements

See Chapter 5, Section II of the Somerset County Land Development Review Resolution for information regarding easements which may be required as part of a road improvement project.

2.34 Global Positioning System (GPS) Control Monuments

1. Refer to the County's *Land Development Review Resolution* to determine a developments requirements for GPS monumentation.

2. The location of GPS monuments is to be coordinated with the County Surveyor prior to any monuments being set.

3. The setting of GPS monuments shall meet a minimum horizontal accuracy of +/- seven-hundredths of a foot (2cm) and a minimum vertical accuracy of +/- one-tenth of a foot (3cm).

4. The GPS monument must conform to the detail for the GPS Monument found on the County website.

5. The Somerset County GPS Monumentation Project Surveyor's Certification Form must be completed by the surveyor that set the monuments and submitted to the County with the completed GPS Monument Description sheet for review and acceptance. Both of these documents are available on the County website.

TRAFFIC IMPACT REPORT

3.1 Purpose & Threshold Criteria

This section provides guidance to traffic engineers, developers and transportation consultants regarding the content of traffic impact studies submitted in conjunction with land development applications in Somerset County. By following the guidelines presented herein, it is anticipated that substantial efficiencies will be achieved in the preparation and review of traffic impact reports. In addition, when the same criteria are applied to the various traffic impact reports prepared by different engineers, the reports will be more consistent.

A traffic impact study shall be submitted for all subdivisions, land developments, or conditional use/concept development proposals that will generate 50 or more trips. However, the County Engineer may require any land development proposal to be accompanied by a traffic impact study when it is determined by the County Engineer that the project may impact a County Facility. Alternatively, the County Engineer may waive the requirement to submit a traffic impact study if it is determined by the County Engineer that the project will not impact any County Facilities.

For any project located within a Transportation Development District, Transportation Improvement District or Corridor Improvement Area, a traffic impact study is required to be submitted. The transportation planner/traffic engineer for the developer shall seek guidance from the County Planning Board or Office of the County Engineer in regard to the need for a traffic impact study to satisfy County requirements. For larger projects, this may result in the need to resolve certain issues in a "scoping" meeting prior to preparation of the study.

3.2 Content Requirements

It is understood that a traffic impact study may also be required for approval of the proposed site development at both the municipal and state level. The following requirements are considered the minimum necessary for review by the Somerset County Planning Board. Additional information needed to satisfy the requirements of other jurisdictions, such as State Highway Access Management Code requirements as set forth in NJAC 16:47 (http://www.state.nj.us/transportation/business/accessmgt/NJHAMC/), may also be included.

3.3 Site Description/Proposed Access

The site description shall include the type of project; square footage by use (e.g., office, retail, medical, etc.), number of dwelling units, or other appropriate units to indicate the size of the project; location map(s); construction staging; and the completion date(s) of the development. A brief description of major existing and proposed land developments within the study area (with anticipated dates of completion, where available) shall be included. The report shall also contain a description of the proposed internal transportation system. This includes internal vehicular, bicycle, and pedestrian circulation, all proposed ingress and egress locations, parking conditions, traffic channelization, and traffic control devices at intersections within the site.

Where appropriate, the site design shall encourage public transportation usage, such as by positioning the building proximately to the roadway, providing adequate turning radii at access points to allow a bus to enter the development, designating a bus shelter and signage along adjacent roadways, or reserving such areas for future use.

A sight distance analysis shall be performed for all existing and proposed unsignalized intersections affected by the development. The level of detail for this analysis shall be resolved in discussions with the Office of the County Engineer.

3.4 Roadway Inventory

The study shall describe the external transportation system within the analysis area. Major County intersections in the study area shall be identified and sketched. All existing and proposed public transportation services and facilities within a one-mile radius of the site shall be documented. All future highway improvements, including proposed construction and traffic signalization, shall be noted. High-accident areas, as determined by municipal and/or County officials, shall be described.

3.5 Scope of Study

The area to be studied will vary with the quantity and quality of site-generated traffic and the excess capacity of the existing highway network. The impact analysis should extend as far as the site-generated traffic has a significant impact. Normally this would be limited to the points of access and adjacent intersections. However, for large developments, an analysis may extend a considerable distance from the site.

As a general rule, the study area should encompass all County roads and intersections where traffic generated by the development is expected to increase existing traffic volumes by either 10 percent or 100 vehicles per hour. Where doubt exists, the transportation engineer should seek guidance from the County Planning Board or the Office of the County Engineer prior to submitting the traffic impact study report. The County will also identify those critical intersections and roadway sections which deserve special attention during the study.

3.6 Traffic Data

1. Traffic counts shall be conducted by the applicant or, if available, obtained from the County for locations within the study area for a typical weekday. All traffic counts must be taken within one year of submission of the Traffic Impact Study unless directed otherwise by the County Engineer. Count data shall be summarized by 15-minute intervals over a peak two-hour period for both AM and PM peak periods, and for a weekday midday period and/or weekend peak periods if so directed by the County Engineer. During the count period, there shall be no conditions such as detours, accidents or inclement weather that could affect traffic volumes. Traffic counts shall not be taken on or near holidays or other special events when traffic may not be representative of average daily traffic conditions. Any counts conducted during a period when school is not in regular session may, at the discretion of the County Engineer, may be required to be repeated.

2. Intersection turning-movement counts shall be conducted during the hours of 7:00 to 9:00 AM and 4:00 to 6:00 PM so as to coincide with the typical commuter peak hours. If necessary, additional counts shall be conducted to coincide with the expected peak hour of the site; for example, counts for a retail development shall also be conducted on a Saturday. The classification of vehicles must be sufficient to address the needs of the capacity analysis. All count sheets shall be included in the appendix to the report.

3. It is desirable to conduct automatic traffic recorded (ATR) counts at selected locations within the study area. This is especially important if the intersection turning-movement counts were conducted at several intersections on different days. The ATR counts shall be used to factor intersection counts to an average daily condition. Existing traffic volumes for each design hour shall be depicted in a traffic flow diagram.

4. Levels of service shall be determined for each study location. As described later in this section, the analysis procedures shall be consistent with the current version of the *Highway Capacity Manual* published by the Transportation Research Board.

3.7 Generation Rates (ITE)

Site traffic should be determined using information contained in the current version of the *Trip Generation Manual* published by the Institute of Transportation Engineers (ITE). Any departure from ITE rates must be substantiated by actual data collected for similar land uses in the field. Desirably, such data should be obtained within Somerset County. The ITE land use category that most closely resembles the proposed use must be identified.

Assumptions in regard to the amount of transit use and carpooling/vanpooling shall also be documented with supporting evidence. Developers may be required to achieve such rates if the departure from ITE data is significant. Pass-by traffic rates shall be based on the current version of the *Trip Generation Handbook* published by ITE unless directed otherwise by the County Engineer.

3.8 Trip Distributions

The geographic distribution of generated trips can be determined by one of the following techniques:

1. Market studies conducted by the developer.

2. Experienced judgment and knowledge of local conditions (must be verified with local officials).

3. ZIP Code address locations of employees, or of employees in similar industries in similar locations.

4. Area-wide travel model results that include trip tables by trip purpose.

5. Gravity Model (Quick Response System or *National Cooperative Highway Research Program Report 187*).

The results shall be accompanied by a schematic diagram that shows the geographic distribution as a percentage of site-generated vehicle trips at the cordon boundary of the study area. An example of this diagram is shown in the Trip Distance detail.

3.9 Trip Assignments

Site-generated trips shall be assigned to the roadway network based upon the trip distribution to the limits of the study area. If applicable, pedestrian volumes shall be derived and assigned to pedestrian crossings. Any unusual assignment characteristics, such as the effect of pass-by trips, shall be well-documented.

The resulting trip assignments shall be shown on a schematic diagram. For each design hour, both inbound and outbound trips shall be depicted with all associated turning movements. An example of this diagram is shown in the Trip Assignment detail.

3.10 Design Year

For analysis purposes, the design year shall correspond to the development's anticipated year of completion. For phased developments, multiple design years shall be utilized that include improvements in place each year.

Background traffic growth shall be derived by extrapolating trend data which is available from municipal, county or state sources. Deviations from such trends will be accepted only if accompanied by satisfactory documentation. If specific development approvals have been obtained for nearby properties, the traffic from those developments shall be specifically included in the analysis in addition to background growth.

3.11 Analysis (HCM Software)

For each design hour, traffic volumes shall be derived as follows. "No-Build" volumes shall represent existing traffic plus background growth and other development traffic expected in the design year. "Build" volumes combine No-Build volumes and site-generated traffic volumes. No-Build and Build volumes shall be depicted in traffic flow diagrams, an example of which is shown in Figure 1.

Traffic signal timings shall be based on the timing directives maintained on file by the County Engineer and shall account for any planned modifications to the timings.

Capacity analyses shall be performed using the methodology contained in the *Highway Capacity Manual*, latest edition. Preferably, all analyses will employ the latest version of the Highway Capacity Software. SYNCHRO or similar modeling software may be utilized with approval from the County Engineer. For signalized intersections, the operational analysis, rather than the planning analysis, technique shall be used. Any deviations from the default values shall be well-documented. All capacity analysis sheets shall be included in the appendix to the report, along with a CD-ROM that contains appropriate digital files.

3.12 Interpretation of Results (L.O.S. Definitions)

Results of the capacity analyses shall be shown for all County roadways and intersections impacted by the development for the Existing, No-Build and Build conditions. All roadways and intersections that are projected to operate in the Build condition at a Level-of-Service (LOS) worse than "D" shall be considered deficient.

For signalized intersections, level-of-service criteria are stated in terms of the average control delay per vehicle for a 15-minute analysis period. The upper limit of LOS "D" is defined as a control delay of 55.0 seconds.

3.13 Mitigation to No-Build Condition

Mitigation measures must be proposed for all roads and intersections that are projected to operate in the Build condition at worse than LOS "D" and worse than the No-Build condition. Specific recommendations shall be included that will improve operations under the Build conditions to a level not worse than the No-Build conditions.

3.14 Recommendations

Specific recommendations that are proposed to mitigate deficiencies shall include, but are not limited to, the following elements:

a. Internal circulation and external road design

b. Traffic signal installation or phasing/timing changes

c. Traffic system management techniques

d. Traffic demand management

e. All proposed physical roadway improvements shall be shown in sketches.

Existing and future public transportation services shall also be addressed. If applicable, a listing of actions to be undertaken to encourage public transportation usage shall be included.

3.15 Phased Projects

In instances where a proposed development will be constructed in stages, the study must reflect the traffic impacts of the entire development as proposed for a given build-out year. Projects with an anticipated build-out beyond five years from the date of site plan approval (or the date of the traffic volume database) may require the applicant to submit one or more supplemental reports that include new traffic counts, the background traffic growth rate, and an updated list of major development projects located within the study area of the applicant's project.

3.16 Determination of Pro-Rata Share Contribution

After reviewing the traffic report, the County Planning Board will specify the road improvements that will be required as part of off-tract improvements. The probable construction cost of these improvements will be estimated by the County Engineer's Office. The developer's contributions for these improvements will be based on the following formula for each improvement:

$$C_{ai} = \frac{t_{ai}}{\sum_{j=a}^{z} t_{ji}} C_i$$

where
Cai = Development *a* share of the cost for improvement *i*

tai = Peak hour traffic from development *a* traversing roadway segment *i*

tji = Total peak hour traffic from all developments (including development *a*) in the study area that traverses roadway segment *i*

Ci = Total estimated cost of roadway improvement *i*

STORMWATER MANAGEMENT

4.1 General Stormwater Management Measures

This chapter has been prepared to aid in the design and review of stormwater management facilities in Somerset County. Recognizing the uniqueness of each design and the essential role that engineering judgment fulfills in the design environment, the criteria presented in this chapter has been so prepared as to preserve the role of both the design and review engineers in the decision-making process. In keeping with this thinking, the chapter is not to be considered a design manual, but rather a guide for the proposed project.

In accordance with the County Planning Act, all land development projects that directly or indirectly affect a County facility for which the County is responsible for construction, maintenance or proper functioning shall be designed in accordance with County standards.

In general, Somerset County requires stormwater management measures in accordance with N.J.A.C. 7:8 and the New Jersey Best Management Practice Manual. Consequently, all projects submitted to the County for review must use the methodologies outlined in the *New Jersey Stormwater Best Management Practices Manual* (latest edition) available online at http://www.njstormwater.org/bmp_manual2.htm.

For all "Major Development" defined herein as projects with an acre or more of land disturbance or an increase of impervious area of ¼ acre or more, water quantity as defined in N.J.A.C. 7:8 will be required. For all "Major Developments" that increase impervious area by a ¼ acre or more, the water quality requirements of N.J.A.C. 7:8 will also be required. For developments that are not Major Developments but discharge either directly or indirectly to a county facility, Somerset County retains the right to require additional stormwater analyses and management measures as necessary to safeguard County facilities. Somerset County also reserves the right to modify the criteria contained herein to meet the requirements of special cases warranting such changes.

The criteria and guidance presented in this document are not intended to supersede any municipal, state or federal requirements having more restrictive provisions or conditions.

4.2 Stormwater Management Requirements for Major Development

Stormwater management measures for major developments shall be developed to meet the erosion control, stormwater runoff quantity and stormwater quality standards in N.J.A.C. 7:8. N.J.A.C. 7:8 is available online at http://www.nj.gov/dep/rules/rules/njac7_8.pdf. To the maximum extent practicable, those standards shall be met by incorporating nonstructural stormwater management strategies into the design. If those strategies alone are not sufficient to meet those standards, structural stormwater management measures necessary to meet those standards shall be incorporated into the design.

The design shall incorporate a maintenance plan for the stormwater management measures incorporated into the design of a major development.

4.3 Stormwater Management Facility Submission Requirements

The following list of items and project data should be submitted to Somerset County for approval. It should be noted that all documents must be signed and sealed.

1. Stormwater Management Report presenting the pertinent design computations for the proposed facility including hydrologic, hydraulic, and structural designs used to design the proposed facility.

2. Plan showing location of the proposed Stormwater Management Facility and drainage area.

3. Copies of all correspondence from NJDEP, including review reports, permits, and approval letters.

4. Topographic map depicting the limits of the drainage area tributary to the proposed stormwater management facility. Topographic map of any proposed stormwater management facility depicting both existing and proposed contours as well as the principal and emergency spillways and all other related construction in and around the proposed stormwater management facility. Map scale and contour interval should be of sufficient scale to accurately calculate stage-storage relationships and identify ridgelines. Where necessary, separate plans of selected areas (e.g., at inlet and outlet structures) at enlarged scales should also be included to ensure that the grading can be achieved, and can be accurately constructed. Information on how to physically locate the facilities, and construction details, must be included on the plan. For basins the plan must include a table showing the design's stage/storage and stage/discharge relationship.

5. Pre-development and post-development drainage area maps are to be included in the stormwater management report. The subareas shall clearly be shown. The paths used to determine the times of concentration (Tc) for each subarea are to be clearly shown on the drainage area maps. Points shall be indicated that subdivide the path into sheet, shallow concentrated, and channel flows. The different types of flow are to be delineated along the Tc paths together with ground cover, slope and length of each segment.

6. Results of the subsurface soil investigation. Infiltration tests will be required for proposed infiltration and groundwater recharge facilities. The location of the subsurface test pit(s) must be shown on the plans and stated in a geotechnical report. In accordance with the procedures required by the NJDEP, the depth to seasonally high groundwater table at the site under the proposed location of the outlet structure shall be provided.

7. A completed Nonstructural Point System available online at http://www.njstormwater.org/ and if required by N.J.A.C. 7:8, the Low Impact Development Checklist, located in Appendix A of the NJ BMP Manual.

8. Property lines and owners of all adjacent properties.

9. The Somerset County General Notes shall be included on all plan sets.

10. A properly recorded Stormwater Management Facility Maintenance Plan.

4.4 Erosion Control

The minimum design and performance standards for erosion control are those established under the Soil Erosion and Sediment Control Act, N.J.S.A. 4:24-39 et seq. and implementing rules. The Soil Erosion and Sediment Control Act can be located online at http://capeatlantic.org/SESCChapter25%20Act.htm.

4.5 Runoff Quantity Standards

In order to control stormwater runoff quantity impacts, the design engineer shall complete one of the following:

1. Demonstrate through hydrologic and hydraulic analysis that for stormwater leaving the site, post-construction runoff hydrographs for the 2, 10, and 100-year storm events do not exceed, at any point in time, the pre-construction runoff hydrographs for the same storm events;

2. Demonstrate through hydrologic and hydraulic analysis that there is no increase, as compared to the pre-construction condition, in the peak runoff rates of stormwater leaving the site for the 2, 10, and 100-year storm events and that the increased volume or change in timing of the stormwater runoff will not increase flood damage at or downstream of the site. This analysis shall include the analysis of impacts of existing land uses and projected land uses assuming full development under existing zoning and land use ordinances in the draining area;

3. Design stormwater management measures so that the post-construction peak runoff rates for the 2, 10, and 100-year storm events are 50, 75, and 80 percent, respectively, of the pre-construction peak runoff rates. The percentages apply only to the post-construction stormwater runoff that is attributable to the portion of the site on which the proposed development or project is to be constructed.

4.6 Stormwater Runoff Quality Standards

Water quality for stormwater management systems, including special water resource protection areas for Category One Waters and their perennial or intermittent tributaries, shall comply with the DEP Stormwater Management Rules at N.J.A.C. 7:8-5 and 6. The Rules are available online at http://www.nj.gov/dep/rules/rules/njac7_8.pdf

Stormwater management measures shall be designed to reduce the post-construction load of total suspended solids (TSS) in stormwater runoff by 80 percent of the anticipated load from the development site, expressed as an annual average. Stormwater management measures

shall only be required for water quality control if an additional ¼ acre of impervious surface is created on a developed site.

If there is more than one onsite drainage area, the 80 percent TSS removal rate shall apply to each drainage area, unless the runoff from the subareas converge on site in which case the removal rate can be demonstrated through a calculation using a weighted average.

4.7 Hydrology

Hydrology shall be calculated using historical gauged stream flows, the rational method or the NRCS methodology. Other methods may be used but are subject to the approval of the County Engineer. The County encourages the use of publicly available electronic data including soils, land use and topography. This data should be field verified by the design engineer and is available from the NJDEP website at http://www.nj.gov/dep/gis/, from the County or from the municipality, in which the project is located.

Delineation of the entire drainage area(s) to the point of reference must be provided for existing and developed conditions. Paths used in determining times of concentration are to be clearly illustrated on the drainage area map(s). The different types of flow are to be delineated along the Tc paths together with slope and length of each segment. Reference points must be selected at locations sufficiently downstream of the disturbed areas to accurately reflect changes in runoff characteristics resulting from the development.

When utilizing the *TR-55* methodology to calculate time of concentration, the following is required:

1. A maximum Manning's n value of 0.40 and a maximum flow length of 100 feet be utilized to compute sheet flow travel time by the use of Equation 3-3 and Table 3-1 in TR-55 and

2. A maximum flow length of 1,000 feet shall be utilized to compute shallow concentrated flow travel time by the use of Figure 3-1 in TR-55. The minimum time of concentration shall be 10 minutes. *Urban Hydrology for Small Watersheds TR-55* is available online at http://www.wsi.nrcs.usda.gov/products/w2q/H&H/docs/other/TR55_documentation.pdf.

In computing stormwater runoff from all design storms, the design engineer shall consider the relative stormwater runoff rates and/or volumes of pervious and impervious surfaces separately to accurately compute the rates and volumes of stormwater runoff from the site.

If the invert of the outlet structure of a stormwater management measure is below the flood hazard design flood elevation as defined as N.J.A.C. 7:13, the design engineer shall take into account the effects of tailwater in the design of structural stormwater management measures. N.J.A.C. 7:13 *Flood Hazard Area Control Act Rules* is available online at http://www.nj.gov/dep/landuse/7-13.pdf.

The stormwater report shall include hydrograph reports which include: hydrograph type, storm frequency, drainage area, total precipitation, storm duration, curve number and time of concentration utilized in the creation of hydrographs.

4.8 Rational Method and Modified Rational Method

The Rational Method shall be utilized for peak flow and the Modified Rational Method for hydrograph computations. When utilizing the Modified Rational Method, the required critical storm duration must be used to determine volume of runoff. For information on "critical storm duration", refer to Appendix A-9 in the *Standards for Soil Erosion and Sediment Control in New Jersey*. One can attain a copy of the Standards by contacting the District Office at Cape Atlantic Conservation District 6260 Old Harding Highway, Mays Landing, New Jersey 08330. In general, use of the Rational Method shall be limited to drainage areas equal or less than 20 acres. However, it may also be used for large drainage areas if the hydrologic characteristics of the area are in reasonable conformance with the Method's theoretical assumptions. Therefore, stormwater conveyance system designers should confer with the County Engineering Division prior to using the Rational Method for drainage areas larger than 20 acres. Drainage area limits shall be determined from topographic maps that are supplemented by field reconnaissance, storm sewer maps and other appropriate data.

Rainfall intensities (*i*) used in the Rational Method design shall be based upon a design storm duration equal to the drainage area's Time of Concentration (Tc), which shall be defined as the time required for Stormwater runoff to travel from the most hydraulically distant point in the drainage area to the point at which the peak runoff rate is to be computed.

Rainfall intensities (*i*) shall be taken from *Somerset County Rainfall Intensity/Duration/Frequency Curves* available on the County website http://www.co.somerset.nj.us/engineering, which has been developed by the County Engineering Division based on historic rainfall data for various locations in the County. Alternative intensity-duration-frequency relationships may only be used upon approval by the County Engineer. Figure 5-3: NJDEP 1.25-inch/2-hour Rainfall Intensity-Duration Curve, located in the NJBMP manual, available online at http://www.njstormwater.org/bmp_manual2.htm, shall be utilized for the stormwater quality design storm. When using the Modified Rational Method to compute a stormwater quality design storm hydrograph, the entire 2-hour storm duration at an average intensity of 0.625-inchs/hour can be used. A minimum time of concentration of 10 minutes shall be used.

Runoff Coefficients (C) used in a Rational Method design shall be based upon the values contained in the NJDOT Roadway Design Manual – Chapter 10 which is available online at http://www.state.nj.us/transportation/eng/documents/RDM/. A Hydrologic Soil Group (HSG) determination of the soils in the drainage area shall be in accordance with the *Soil Survey of Somerset County* available from the Somerset-Union Soil Conservation District or online at http://www.nj.nrcs.usda.gov/technical/soils.

4.9 NRCS Method

The rainfall-runoff methods of the NRCS shall be performed in accordance with the *Part 630 Hydrology National Engineering Handbook*, available online at http://directives.sc.egov.usda.gov/RollupViewer.aspx?hid=17092 , including the NRCS Runoff Equation and Dimensionless Unit Hydrograph. Drainage area limits shall be determined from topographic maps that are supplemented by field reconnaissance, storm sewer maps and other appropriate data.

The water quantity design storm event shall be the SCS 24-Hour Type III Storm. Details of the SCS Type III Storm are presented in TR-55. The values shown below in Table 4.8 shall be used.

Table 4.8
24-Hour Design Rainfall

Storm Frequency (years)	24-hour Design Rainfall (inches)
1	2.8
2	3.3
5	4.3
10	5.0
25	6.2
50	7.2
100	8.2

The NJDEP 1.25-inch/2-hour stormwater quality design storm shall be used to compute runoff volumes, peak rates and hydrographs. Information about the NJDEP 1.25-inch/2-hour stormwater quality design storm is presented in the NJBMP manual available online at http://www.njstormwater.org/bmp_manual2.htm.

Table 4-8: NJDEP 1.25-Inch/2-Hour Stormwater Quality Design Storm Cumulative and Incremental Rainfall Distributions					
Time (minutes)	Cumulative Rainfall (inches)	Incremental Rainfall (inches)	Time (minutes)	Cumulative Rainfall (inches)	Incremental Rainfall (inches)
0	0.0000	0.0000	65	0.8917	0.2667
5	0.0083	0.0083	70	0.9917	0.1000
10	0.0166	0.0083	75	1.0500	0.0583
15	0.0250	0.0084	80	1.0840	0.0340
20	0.0500	0.0250	85	1.1170	0.0330
25	0.0750	0.0250	90	1.1500	0.0330
30	0.1000	0.0250	95	1.1750	0.0250
35	0.1330	0.0330	100	1.2000	0.0250
40	0.1660	0.0330	105	1.2250	0.0250
45	0.2000	0.0340	110	1.2334	0.0084
50	0.2583	0.0583	115	1.2417	0.0083
55	0.3583	0.1000	120	1.2500	0.0083
60	0.6250	0.2667			

Runoff curve numbers (CN's) used in the NRCS Method shall be taken from Tables 2.2a,b,c and d of the TR-55 Manual June, 1986 edition available online at http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=22162.wba. A Hydrologic Soil Group (HSG) determination of the soils in the drainage area shall be in accordance with the Soil Survey of Somerset County available online at http://websoilsurvey.nrcs.usda.gov/app/.

4.10 Analytic Techniques and Computer Models

Design engineers shall use a consistent method to calculate peak rate of runoff and volume when computing runoff hydrographs. If *TR-55, TR-20, HEC-HMS*, or another recognized method is used to calculate peak rate of runoff, then the same method shall be used to determine volume. If the Rational Method is used for peak flow calculations, design engineers shall use the Modified Rational Method to calculate peak volume to be used for basin routing.

Hydrologic calculations may be performed using computer programs. If a computerized version of a deterministic model is to be utilized, the ACOE's *HEC-1 Flood Hydrograph Package or the more recent HEC-HMS Hydrologic Modeling System* is preferred since it is the basis for most of the rainfall-runoff models developed by the County Engineering Division. These programs are available for download online at http://www.hec.usace.army.mil/software/hec-hms/. However, all technically sound and applicable methods are acceptable, provided that suitable documentations regarding the soundness and applicability is provided.

4.11 Design Hydraulics

Unless otherwise directed by the County Engineer, the hydraulic design of the stormwater conveyance system shall be based upon Manning's Equation by the use of appropriate roughness coefficients (n). A range of typical Manning's n values for a variety of surfaces and conveyance measures is presented in Table 4.11 It should be noted that final n values should reflect the relative depth of flow and the condition of the surface or measure.

In addition, the design of all stormwater conveyance systems shall include consideration of the hydraulic losses encountered at inlets, outlets, drain inlets, junctions, manholes, bends and other system components by the use of standard loss coefficients. See USDOT FHWA *Urban Drainage Design Manual (HEC 22)* available online at http://isddc.dot.gov/OLPFiles/FHWA/010593.pdf. A loss coefficient of 1.0 is recommended at the outlets of such systems that discharge under pressure or full flow conditions.

TABLE 4.11
TYPICAL MANNING'S ROUGHNESS COEFFICIENTS (*n*)

DESCRIPTION	MANNING'S *n*
Reinforced concrete pipe	0.013
Corrugated metal pipe	0.024 - 0.027
Cast or ductile iron pipe	0.014
Concrete-lined channels	0.015
Earthen channel	0.025 - 0.050
Grass-lined channel	0.030 - 0.045
Gabion-lined channel	0.025 - 0.035
Riprap-lined channel	0.030 - 0.040

Maximum side slopes on trapezoidal-shaped channels shall not exceed a ratio of 2:1 (horizontal to vertical) unless site conditions mandate the use of steeper slopes. In such cases, prior approval of the final design side slope must be obtained from the County Engineer.

In the design of a stormwater conveyance system, special consideration shall be given to those reaches in which a supercritical flow may exist. This shall include the potential for hydraulic jumps and negative pressures.

4.12 General Standards for Structural Stormwater Management Measures

Although the use of nonstructural measures is to be used where possible, the County recognizes that they are not always applicable or possible. Consequently, the County has prepared construction details for a number of structural measures. Applicants shall use these details where possible. The use of these details (modified as necessary) will facilitate the review process and provide sound and tested structural stormwater management facilities. The details are available online at the County website http://www.co.somerset.nj.us/engineering.

Structural stormwater management measures shall be designed to take into account the existing site conditions, including, for example, environmentally critical areas; wetlands; flood-prone areas; slopes; depth to seasonal high water table; soil type; permeability and texture; drainage area and drainage patterns; and the presence of solution-prone carbonate rocks (limestone).

Structural stormwater management measures shall be designed to minimize maintenance, facilitate maintenance and repairs, and ensure proper functioning.

Structural stormwater management measures shall be designed, constructed, and installed to be strong, durable, and corrosion resistant.

Onsite measures such as depressed curbs, swales and diversion berms are to be incorporated into the site design to ensure that all runoff for the 100-year storm event will be conveyed to the stormwater management facility.

All stormwater management measures shall be designed to drain within 72 hours.

A subsurface soil analysis is required at the exact location of proposed stormwater management facilities in order to confirm its ability to function properly without failure. Such tests should include a determination of the textural classification, seasonal high ground water and permeability of the subgrade soil at and below the bottom of the stormwater management facilities. For an infiltration basin, the recommended minimum depth for subgrade soil analysis is 5 feet below the bottom of the basin or to the groundwater table. A proposed drainage map shall indicate soil test pit location(s).

4.13 Above Ground Stormwater Management Facilities

1. Outlet structures are to be designed to meet the hydraulic requirements of the stormwater management plan and to inconspicuously fit into the slope of the detention facility. An outlet structure configuration consistent with the typical County outlet structure, which incorporates sloping concrete walls conforming to the slope of the basin to support the low-flow trash rack, is one example of how this can be achieved.

2. All outlet structures shall be constructed of reinforced concrete and all exposed edges on the outlet structures shall have a 1", 45° chamfer. Plan and elevation drawings shall show the reinforcement steel, bar sizes, spacing and related information. The minimum wall thickness for a cast-in-place outlet structure shall be 12" to facilitate the placement of concrete. All construction joints are to be watertight. All pipes, stubs, and/or fittings are to be cast monolithically in the structure. Trash racks are to be removable, fastened to the outlet structure with non-corrodible stainless steel bolts.

3. Structural drawings, shop drawings and details shall be drawn to scale on 24"x36" plan sheets signed and sealed by a professional engineer licensed in the State of New Jersey. Minimum wall thickness for pre-cast structures shall be 9" and the inside dimension of the structure shall be a minimum 4'x 4'.

4. The minimum outlet structure orifice size shall be two and one-half inches in diameter.

5. Corrosion resistant ladder rungs are to be provided on the inside wall of the outlet structure under the access point.

6. A durable, waterproof, colored, architectural coating shall be used on all exposed surfaces of the outlet structure as defined in the Somerset County supplemental specifications as Class 6, Special Finish. All exposed surfaces shall first be given a Class 2 finish. Coating shall then be applied in two coats in accordance with the manufacturer's specifications. Coating shall be a colored, acrylic-based stain specially intended for sealing and protecting concrete. Coating shall be Sto Concrete Stain, product CR648, manufactured by the Sto Corp., or approved equal. Prior to coating all specified surfaces, the area to be coated shall be cleaned of all laitance by a 2000 psi minimum power wash rotating-nozzle water jet.

7. Outfall pipes from outlet structure shall be reinforced concrete pipe with rubber gaskets.

8. A separate emergency spillway that is not incorporated into the outlet structure is required for all above-ground stormwater detention basins and ponds. Grading plans must clearly depict the proposed contours of the emergency spillway.

9. Emergency spillways are to be located to minimize and/or eliminate the need for stabilization. If an emergency spillway is to be located in a fill area, stabilization is required and the spillway shall be gabion lined. The gabions shall have a minimum thickness of 12 inches and shall extend a minimum distance of 10 feet downslope from the toe of the proposed embankment. Discharge from emergency spillways shall not be directed toward private property.

10. The emergency spillway is defined as "a spillway capable of passing the spillway design storm with the principle spillway blocked." Since the principle spillway is the outlet structure, the design engineer shall assume that the outlet structure is blocked when designing the emergency spillway and top of berm.

11. The emergency spillway crest and the top of berm elevations for above-ground stormwater basins and ponds, regardless of dam classification, are to be set in accordance with the following:

    a. Establish the water surface elevation in the detention facility for the 100 year storm.
    b. Determine the depth of flow at the crest of the emergency spillway and add one foot to establish the top of berm elevation.
    c. If this does not yield a spillway depth of 1.5 feet, set the top of berm elevation to provide a minimum spillway depth of 1.5 feet.

12. The top of berm shall be a minimum of 10’ wide. Refer to *Embankment and Detention Basin Clay Core detail*, for top of berm requirements related to higher berms, available on the County website.

13. For extended detention basins with grass bottoms, the proposed contours must reflect a minimum slope for the grass portion of the bottom of the basin to be 2%. The 2% slope shall be calculated from the edge of the concrete low-flow channel to account for its 6" depth. The low flow channel shall have a minimum 1% slope. The side slope of the basin shall have a maximum slope of 3:1.

14. The low flow channel shall be reinforced concrete. The concrete low-flow channel shall be a minimum thickness of 6" with 6" of 3/4" broken stone with a 4" diameter perforated underdrain. The reinforcing shall consist of 4"x 4", four gauge welded steel wire fabric. Expansion joints shall be provided every 20' and the edges of the channel shall have a 1" chamfer on the top edges.

15. No portion of any stormwater basin or pond shall be located within 10 feet of any existing or proposed County Right-of-Way. For basins in fill areas, the outside toe of slope must be located 10 feet outside the County Right-of-Way. If the detention basin is in a cut area, there must be a 10’ wide “top of basin” around the entire basin located outside the County Right-of-way line. That is, if in a cut area, a minimum distance of 10 feet shall be provided from the top of the detention basin slope to the County right-of-way line.

16. If a portion of the basin or pond is located in a fill area, an impervious clay core will be required. The limits of the clay core shall be identified on the plans. To help clarify the limits, the clay core shall be highlighted on the plan with shading.

17. If topsoil and seeding are required, the plans shall clearly note that the basins are to be topsoiled with a minimum depth of 4 inches and seeded. The plan shall specify that the topsoil will meet the standard for “Topsoil” as defined in the NJDOT standard specifications for Road and Bridge Construction. The seeding shall conform to type “A” Grass Seed Mixture as defined in said specifications.

4.14 Underground Stormwater Management Facilities

1. All subsurface facilities must have a positive hydraulic outlet such as an orifice or weir that discharges to an adequate discharge point.

2. Due to the greater difficulty in removing silt, sediment, and debris, all runoff to a subsurface infiltration stormwater management facility must be pretreated. This pretreatment must remove 80 percent of the TSS in the runoff from the basin's maximum design storm.

3. Where pipes are used to provide storage volume the minimum pipe size allowable shall be 36 inches.

4. Access must be provided at all ends of the facility. Minimum diameter for manhole access points is 36 inches.

5. For closed systems that do not allow infiltration, minimum slope of storage chambers is 1%. The invert of the facility outlet pipe must be set below the bottom of the end chamber so that all runoff will flow out, leaving the structure dry between storm events.

6. For subsurface infiltration systems, the perforated pipe shall be level to assure even water distribution; the excavation/trench shall be backfilled with 2 ½ " clean broken stone. Piping shall lay on a minimum 12" stone bedding; adequate soil cover (a minimum of 12 inches) shall be maintained above the basin to allow for a healthy vegetative cover; non-woven filter fabric shall completely enclose the substructure including the stone aggregate; the filter fabric shall overlap six inches in "shingle" fashion when one or more sections is required to enclose the aggregate. For additional infiltration requirements see Section 4.16 Infiltration.

7. Non-corrodible ladder rungs shall be provided at all access manholes and subsurface structures.

8. To ensure proper compaction under and between storage pipes, the outside edges of the pipes shall be spaced no closer than 2 feet from adjacent pipe(s).

9. Backfilling around storage and end chambers and pipes shall be consistent with NJDOT specifications and loading calculations and supporting strengths.

10. All pipes within County Right of Way shall be reinforced concrete pipes.

4.15 Conduit Outlet Protection

Conduit outlet protection shall be provided where outlet velocity will cause erosion. Conduit outlet protection shall be designed in accordance with the Standards for Soil Erosion and Sediment Control in New Jersey.

Where velocities exceed 15 feet per second or where conduit outlet protection requirements result in an excessively large riprap pad, an energy dissipater may be used. Energy dissipators shall be designed in accordance with the Federal Highway Administration's HEC-14: Hydraulic Design of Energy Dissipators for Culverts and Channels available online at http://www.fhwa.dot.gov/engineering/hydraulics/pubs/06086/.

If possible, storm sewer systems shall be designed so that the final most downstream segment shall not exceed a 2% pipe slope. Use of upstream drop manholes is encouraged where necessary to meet this goal so that outlet velocities are minimized.

4.16 Infiltration

The NJ Best Management Practices (BMP) notes that the use of infiltration basins is recommended only for the stormwater quality design storm or smaller storm events. Infiltration basins must not be used where their installation would cause surficial flooding of groundwater.

Since permeability rates may vary from test results and may also decrease over time, due to soil bed consolidation or the accumulations of sediments removed from the treated stormwater, a factor of safety of two must be applied to the tested permeability rate to determine the design permeability rate. Therefore, if the tested permeability rate is 4 inches/hour, the design rate would be 2 inches/hour (i.e., 4 inches per hour/2). This rate would be used to compute the basin's maximum design storm drain time. The minimum allowable permeability rate is 1 inch/ hour (i.e., 2 inches per hour/2). The maximum allowable permeability rate to determine drain time is 10 inches/hour. In addition, the design permeability rate of the soil must be sufficient to fully drain the infiltration's maximum storm runoff volume within 72 hours.

According to the NJ Best Management Practices (BMP), the bottom of an infiltration basin must be at least two (2) feet above seasonal high water table or bedrock. For surface basins, this distance must be measured from the bottom of the sand layer. Also, to help ensure maintenance of the design permeability rate over time, a 6 inch layer of sand must be placed on the bottom of an infiltration basin. The sand layer must meet the specifications of a K5 soil with a minimum permeability rate of 20 inches per hour. A subsurface soil analysis is required to confirm the proposed basin's ability to function properly without failure. Such tests should include a permeability of the subgrade soil at and below the bottom of the basin. For an infiltration basin, the recommended minimum depth for subgrade soil analysis is 5 feet below the bottom of the basin or to the groundwater table. Please note that Somerset County highly discourages the use of infiltration basins. The County has noticed a high failure rate in previously constructed infiltration basins located in Somerset County.

If the applicant proposes an infiltration basin and provides documentation that the basin is designed in accordance with all NJ BMP requirements, then all stormwater management measures affiliated with discharge shall be designed anticipating infiltration failure and with the ability to be easily redesigned as a traditional extended detention basin with an alternate water quality treatment.

4.17 Bioretention

Bioretention systems shall be designed in accordance with the latest design standards in the NJ Stormwater Best Management Practices Manual available online at http://www.njstormwater.org/bmp_manual2.htm.

4.18 Stormwater Maintenance Manual Requirements

A Drainage Facilities Operations and Maintenance Manual shall be provided to insure the proper maintenance of all proposed drainage features. This must consist of a concise document that provides a clear understanding of the land owner's responsibility for each component of the stormwater management system. The location and maintenance limits of each component must be defined within the body of the manual as well as on legible maps. Specific instructions for maintenance for each component together with a timetable for each task must be presented within the manual. The manual must provide information on the type of action that will be taken in the event that the facility fails to function as anticipated, for example, if the basin does not drain completely within 72 hours of a storm event.

The name, address, and telephone number of the person or persons responsible for the preventative and corrective maintenance of the stormwater management measure shall be identified in the maintenance plan. If the plan identifies a party other than the owner or developer as having responsibility for maintenance, i.e., a public entity or homeowners' association, the plan must include a copy of the other party's written agreement to assume this responsibility. This agreement must include a copy of any ordinance or regulation that requires the owner or developer to dedicate the stormwater management measure and/or its maintenance to the other party.

Specific preventative and corrective maintenance tasks such as removal of sediment, trash, and debris; mowing, pruning, and restoration of vegetation; restoration of eroded areas; elimination of mosquito breeding habitats; control of aquatic vegetation; and repair or replacement of damaged or deteriorated components must be included in the plan. Detailed maintenance information for specific structural stormwater management measures is presented in Chapter 9 of the New Jersey BMP Manual.

A schedule of regular inspections and tasks shall be included in the maintenance manual. Detailed inspection tasks and schedules for specific structural stormwater management measures are presented in Chapter 9 of the New Jersey BMP Manual.

Detailed logs of all preventative and corrective maintenance performed at the stormwater management measure, including all maintenance-related work orders shall be included in the maintenance manual.

The location, grading, vegetation and maintenance limits of each component of the stormwater maintenance measures must be defined on legible maps and included in the maintenance manual.

4.19 Owner's Stormwater Management Maintenance Requirements

Since the maintenance of the stormwater management facility is an obligation that runs with the ownership of the land, unless a homeowner's association is being created with provisions for maintaining the stormwater management facility; a new deed for the property is to be recorded in the County Clerk's office for the purpose of outlining the owner's maintenance requirements and making them a matter of public record.

BRIDGES AND CULVERTS

5.1 General

These guidelines are intended for all consultants and their subconsultants who provide engineering-design services related to any County bridge. They may be directly retained by the County or indirectly when retained by a developer whose site development includes a bridge.

When a consultant is retained by a developer to include the design of a County bridge, the consultant should contact the Bridge Section and request a meeting to discuss the bridge's configuration, design procedures and minimum requirements. This meeting should take place at the conception of the project and before any permit applications are made to NJDEP.

5.2 Definition of a Bridge

For a structure to be accepted as a "bridge" for maintenance by the County, the following definition applies:

> *A bridge is any structure carrying vehicular traffic that typically crosses over a waterway and has a clear span of 5 feet or more, measured normal face-to-face of supports. For circular or elliptical pipes, the span is the inside horizontal dimension.*

Based on this definition of a bridge, the County is responsible for the maintenance of all bridges on both County and Township roads with the exception of Delaware and Raritan Canal bridges and most bridges over railroads.

5.3 Types of Bridge Structures

A bridge can be of any configuration; typically, however, new bridge construction in Somerset County consists of the following three categories:

CATEGORY 1

Span bridges consist of a separate substructure (abutments, wingwalls, piers) that support the superstructure (steel beams, precast concrete beams, timber components, etc.) with either an integral or nonstructural deck.

CATEGORY 2

Culvert bridges consist of cast-in-place concrete or precast concrete "box" sections or of round or elliptical concrete pipes.

CATEGORY 3

Arch/rigid frame bridges consist of either cast-in-place or precast concrete segments in the configuration of an arch or a rigid frame.

5.4 Structural Design Criteria

The design and construction of bridges in Somerset County is governed by the following:

1. *AASHTO LRFD Bridge Design Specifications, 2007 edition,* including all amendments adopted by AASHTO.

2. NJDOT's *Design Manual for Bridges and Structures*, current edition, including all revisions except as modified by this handbook.

3. NJDOT's *Standard Specifications for Road and Bridge Construction* latest edition, including all revisions except as modified by the County's master *Supplementary Specifications*.

4. Applicable provisions of the latest ACI (American Concrete Institute) code and/or the CRSI (Concrete Reinforcing Steel Institute) code as they pertain to placing and detailing reinforcement steel.

The above publications are to be used in conjunction with this handbook. They provide general requirements consistent with County practice, but may require modifications to suit local conditions based on judgment, experience and basic engineering principles. Before any bridge design is started, the County's Bridge Section shall be contacted for mutual agreement on the interpretation, applicable sections, details and procedures to be used for design.

5.5 Geometric Parameters

The roadway profile shall be designed to avoid a low point on the bridge, which would require inlets or scuppers. The longitudinal slope of the profile across the bridge shall be 1 percent minimum on a tangent. If profile constraints require a vertical curve to fall within the limits of the bridge, the slopes between the PVC/PVI and PVI/PVT shall be increased to provide adequate drainage.

For these bridges, it is desirable to develop a horizontal alignment that locates the bridge within a tangent portion so as to avoid curved walls, decks, railings, etc. If a curved alignment is unavoidable, consider using a series of chord segments that approximate the curve.

For Category 2 and 3 (culvert- and arch-type) bridges, the desirable minimum vertical clearance between the streambed invert and the underside of the structure is 6'-0" to facilitate maintenance and cleaning. If less than 6 feet of clear opening is necessary due to

the roadway profile and/or streambed profile, prior approval must be obtained from the County Engineering Division.

5.6 Loadings

1. For vehicular live loads, use AASHTO LRFD HL-93 Vehicular Live Load, rRefer to *Design Manual for Bridges and Structures,* Section 3.

2. The superstructure design shall include a 25 PSF additional dead load for a future 2-inch-thick overlay wearing course.

3. Designs of concrete decks shall assume that stay-in-place (SIP) metal forms shall be used. The superstructure design shall include the additional dead load of the SIP forms and additional concrete.

4. All other applicable loads (impact, wind, pedestrian, earth, etc.) shall be in accordance with AASHTO.

5. The AASHTO LRFD design method shall be used for the design of all structures.

6. A base map will be prepared by the consultant indicating the proposed location of soil borings for County review and approval.

7. Soil parameters shall be in accordance with Section 10 of the AASHTO LRFD Bridge Design Specifications as modified by the latest NJDOT Design Manual for Bridges and Structures.

5.7 General Design Criteria

The following criteria should be considered during the preliminary design of a bridge.

1. Whenever possible, the structure length should be extended to eliminate the need for guiderail.

2. Proper drainage easements, temporary construction easements and right-of-ways shall be provided to facilitate site access for proper construction and future maintenance requirements. Insure that the design of easements and right-of-ways encompasses the entire length of the beam guiderail, including guiderail end terminals, minimum 15-foot distance from wingwall and headwall footings, and minimum 15-foot distance from the limits of gabion/riprap slope protection.

3. A walk area of ample width shall be provided across the bridge structure that is consistent with the type of structure being designed. In addition, a walk area (either grass for a future sidewalk or a permanent sidewalk) shall be provided for culverts and pipes.

4. A minimum underclearance of 6'-0" is preferred by the County for maintenance purposes. An underclearance of less than 6'-0" must be justified in regard to site conditions and approved by the County Engineering Division.

5. Oversized structures—such as long wingwalls—along roadways will not be permitted to mitigate environmental concerns (i.e., wetlands).

5.8 Wall and Abutment Design

Design shall be in accordance with Section 11 of the *AASHTO LRFD Bridge Design Specifications* as modified by Section 17 of the latest *NJDOT Design Manual for Bridges and Structures*.

1. For the design of footings for retaining walls, the resultant must fall in the middle-third of the footing width so as to avoid negative pressure (uplift) on the heel. For calculating the factor of safety for sliding, the passive pressure in front of the wall shall be ignored (assume erosion).

2. The depth of footings at bridges, including culvert headwalls, shall comply with NJDEP's *Technical Manual for Stream Encroachment*, Sections 3.2-5(a)1 and 3.2-6(a)1. Contact the Bridge Section for guidance in establishing the bottom of footings based on geotechnical conditions.

3. NJDOT Class B air-entrained concrete shall be used on substructures. Superstructure elements such as concrete deck, sidewalk and parapets shall be NJDOT Class A HPC.

4. The footing heel shall be designed to support soil on top of the heel without soil support below the heel.

5. The footing toe shall be designed to accommodate upward soil pressure without soil on top of the toe.

6. The minimum footing thickness at the heel shall be 1'-6".

7. The minimum wall thickness shall be 1'-6".

8. Compacted porous fill shall be No. 8 broken stone. Compacted porous fill shall be placed behind all abutments, headwalls and wingwalls; the limits are 6" from the back edges of all footings along the entire length and height of the walls to the bottom of the subgrade.

9. All reinforcement steel shall be galvanized.

10. All faces of the wall shall have reinforcement steel. A minimum cover of 2" of concrete shall be provided for the steel for cast-in-place wall structures.

11. All pipes shall be cast monolithically within wall sections.

12. Vertical contraction joints shall be provided in the wingwalls, 1'-0" from the corner of wingwall/headwall near-face intersections and 2'-0" from the corner of abutment/wingwall near-face intersections. Such joints shall also be provided in wingwalls, headwalls and abutments as required, with a maximum spacing of 30'-0". Vertical expansion joints shall be provided in the walls, with contraction joints in the footing underneath at a maximum spacing of 90'-0". All required horizontal keys shall be raised and both horizontal and vertical keys shall be 3" x 5½" for walls 1'-6" thick. All vertical keys and joints are to stop 6" below the top of walls.

13. All exposed concrete edges shall have a ¾", 45-degree chamfer unless otherwise noted.

14. All exposed concrete surfaces shall receive a Class 6 special concrete finish as per section 504 of NJDOT's *Standard Specifications for Road and Bridge Construction*, 2007 edition and as amended.

15. All reinforcement steel splices shall be a minimum of 40 bar diameters for galvanized rebar.

16. The coarse aggregate layer under concrete structures should not be incorporated in the original design. All concrete structures shall be placed on undisturbed soil or rock.

17. A freeboard of 6" shall be held (soil line to top of wall) for all headwalls and wingwalls to the end of the wingwalls.

5.9 Bridge Approaches

A minimum 4" curb reveal shall be provided across the bridge.

Beam guiderails shall be provided when required in accordance with NJDOT Design Manual, latest edition. The guiderail shall be installed and conform to *Standard Specifications for Road and Bridge Construction*, latest edition, and as shown on the state's standard beam guiderail sheets.

5.10 Specific Design Criteria

CATEGORY 1 BRIDGES

The following provisions are an abbreviated version of the County's *Supplementary Specifications* for the design and construction of Category 1 (span-type) bridges. Before starting a design, contact the Bridge Section for additional design criteria, specifications and details.

Galvanized steel stringers with a concrete deck is the preferred structure type. The face of the fascia stringers shall be painted. The concrete deck shall incorporate a "wrap-around deck" detail over the abutments to eliminate the need for deck joints. Once cured, the concrete deck must receive an approved waterproof or water resistant coating.

Other superstructure materials for span-type bridges include glu-lam timber, prestressed concrete I-beams and spread prestressed concrete box-beams. Adjacent box-beams shall not be used unless previously approved by the Bridge Section.

Experience has shown that the inadequate stiffness of reinforced concrete decks contributes to cracking and accelerated deterioration. To provide adequate stiffness, the effective span of the slab shall be limited to 6 feet (nominal) with a 9" minimum slab and No. 6 reinforcement steel top and bottom at 6". All reinforcement in the slab, parapets, sidewalks, pylons, etc. shall be galvanized.

CATEGORIES 2 AND 3

Category 2 and Category 3 bridges shall be designed so that the ends of the structure are 90 degrees to the centerline of the structure and not parallel to the road.

Single-span units are preferred by the County. Culvert-type bridges comprised of a single-cell opening can be either cast-in-place or precast concrete box structures or rigid frame.

Precast units are recommended for use when an existing structure is being replaced and an existing road is to be detoured. Either precast or cast-in-place structures are acceptable for any new structure (i.e., where a structure did not previously exist).

Headwalls shall be provided for all structures. Headwalls and wingwalls shall be on spread footings. All footings for headwalls/wingwalls are to be poured on undisturbed soil. Stone bedding is not permitted under footings to prevent the stream from flowing under the culvert through the stone bed. If the excavation at the bottom of footing is wet due to the infiltration of water, a bedding of Class C concrete (3,200 psi) may be used to provide a working surface to place footing reinforcement.

The reinforcement steel in the structure is to be protected against the infiltration of roadway deicing salts by the combination of the following methods:

1. Coat the outside surfaces with an approved epoxy waterproofing sealant.

2. Use galvanized reinforcement steel

3. Use Waterproofing Membrane.

The top slab of the structure is not to be used as a riding surface. Waterproofing membrane shall be installed over the width of the structure and of the road (overlapping a minimum of 1'-0" over the sidewalls) to ensure the proper watertight integrity of the structure.

Epoxy waterproofing shall be applied to all outer surfaces of the structure (top, side walls and bottom) of the structure for the entire length of the structure.

Filter fabric shall be installed along the entire length of the box culvert or rigid frame for the full height of the structure, and shall overlap to provide cover over the entire top of the structure to separate the porous fill from adjacent soil.

Compacted porous fill shall be No. 8 broken stone and shall be placed 1'-0" thick along the entire height of each sidewall and along the entire length of the box culvert section.

Drainage pipes shall not penetrate the sidewalls of box culverts and rigid frame structures, unless approved by the County.

PRECAST CONCRETE STRUCTURES

When precast concrete is utilized, the manufacturing plant shall be certified by either the National Precast Concrete Association or by the Precast/Prestressed Concrete Institute Plant Certification Program. Certifications shall list the proper product group and category for each product being supplied. Written plant certifications shall be submitted to the County prior to final approval.

Precast concrete headwalls and wingwalls will be considered if:

1. The system is preapproved,

2. The site conditions do not require unusual grading, and

3. The interface details between the bridge and the headwall/wingwall are adequately designed and detailed.

Class P air-entrained concrete shall be used. A minimum concrete cover of 2" shall be provided for galvanized reinforcement steel. The minimum slab thickness for precast concrete culverts is 12" and the minimum wall thickness is 10".

A comprehensive culvert installation procedure shall be provided on the construction plans.

5.11 Utilities

Utilities should be installed within the streambed and outside of the bridge footprint, wherever possible. The design engineer is responsible for contacting and coordinating the installation/relocation and protection of existing and future utilities with the respective utility companies as related to the bridge's design.

5.12 Aesthetics

The use of aesthetic treatments (tinted concrete, concrete form liners, stone facing, landscaping) shall be considered in the design of bridges.

5.13 Hydrologic and Hydraulic Design Criteria

Recommended guidelines for performing the hydrologic and hydraulic (H&H) design of new or replacement bridges and culverts on waterways in Somerset County are presented below. These guidelines address general aspects of the required H&H design process; however, the exact steps to be followed for a specific design depend upon several factors. These include the availability, accuracy and suitability of existing data, the severity and causes of existing flooding, the desired level of flow capacity and flood protection, potential impacts to upstream and downstream properties, and any constraints imposed by structural or traffic requirements. Therefore, design engineers are encouraged to review the exact scope of all bridge and culvert H&H designs with the County Engineering Division prior to proceeding.

5.14 General Procedure

The general procedure to be followed in conducting H&H designs for bridge and culvert projects is as follows:

1. Obtain and review existing project data
2. Perform a site reconnaissance
3. Obtain and/or develop additional project data
4. Establish and analyze existing conditions
5. Determine the required level of flood protection
6. Develop a preliminary hydraulic design
7. Evaluate upstream and downstream impacts
8. Finalize the hydraulic design

9. Prepare the necessary reports and plans

A description of each step in this procedure is presented below.

Step 1—Obtain and Review Existing Project Data

Determining the availability, accuracy and suitability of existing project data for a bridge and culvert project is one of the most important steps in performing a comprehensive and efficient H&H design, since it will determine both the required extent of all subsequent steps and the techniques to be used in performing them. Sources of existing hydrologic and hydraulic data include the Somerset County Engineering Division, the NJ Department of Environmental Protection (NJDEP), the Federal Emergency Management Agency (FEMA), the US Army Corps of Engineers (ACOE), the US Geological Survey (USGS), and the engineering and/or planning department of the municipality in which the bridge or culvert is located. This data may range from topographic maps of the stream corridor and project site to detailed computer models of the watershed and/or waterway.

After obtaining the existing project data, it is then important to determine both its accuracy and applicability to the project design. Problems with accuracy may arise particularly with older data such as topographic maps, field surveys, and peak discharge estimates, all of which may be obsolete due to changes in ground or watershed conditions. Waterway computer models used to develop Flood Insurance Zones for FEMA Flood Insurance Studies may not contain the level of information necessary for the detailed hydraulic design of a new bridge or culvert and, therefore, may not be directly applicable to the project without some modification. In addition, the computer model may have been based upon a technique or standard that has since become obsolete or which may, in fact, contain data or modeling errors that have managed to survive the technical review process.

With regard to applicability, it is also important to note that a deficiency in accuracy or detail in one portion of a data source does not necessarily render it completely inapplicable. In many instances, the source can be updated and/or supplemented with new or additional data or reconfigured to employ a more appropriate technique.

During the search for existing project data, the applicant should also review pertinent design standards and requirements with the appropriate review agencies, including the County Engineering Division, the NJDEP, and the Somerset-Union Soil Conservation District (SCD). Topics to be discussed may include the range of flood frequencies to be analyzed; the techniques, equations, and/or models to be utilized to estimate design discharges, water surface profiles, and peak flow velocities; typical watershed runoff and waterway roughness and loss coefficients; and the number and location of watershed subareas and waterway cross sections. Minimum, maximum, and optimum coefficient values should also be reviewed and agreed upon. If computer modeling techniques are to be utilized, the overall modeling strategy should also be discussed. Finally, the basis for establishing starting elevations for all water surface profile computations should be selected.

Step 2—Perform a Site Reconnaissance

Having obtained all existing project data, a field reconnaissance of the project site should then be performed. The knowledge gained from this can then be used to help evaluate the existing project data collected under Step 1 as well as to determine what new information will be required for the H&H design. This is particularly important if computer modeling techniques are to be utilized, since many input parameters required by these models can only be determined through the visual observation of project-site features. As such, the site reconnaissance may not be limited to the immediate bridge or culvert site, but may extend upstream and downstream along the waterway and even throughout the entire watershed.

During the site reconnaissance, color photographs of the project site and waterway should also be taken. The photographs can be used during later design stages to determine or verify required data and coefficients without returning to the field. The photographs may also be used as part of an application to the NJDEP for a Stream Encroachment or Freshwater Wetland Permit as well as during design review meetings with the County Engineering Division.

Step 3—Obtain and/or Develop Additional Project Data

Based upon the review of existing project data and the site reconnaissance, all additional data required to perform the H&H design should be obtained. This may range from additional channel cross sections and spot elevations to supplement an existing computer model of the waterway to new topographic mapping and location surveys of the entire project site.

Step 4—Establish and Analyze Existing Conditions

Prior to developing the design of the new or replacement bridge or culvert, it is vital to establish the existing hydrologic and hydraulic conditions at the project site. This should include existing peak discharges, water surfaces and velocities for a range of flood events not only at the project site, but upstream and downstream as well. There are several reasons for doing this. First, it must be remembered that the new or replacement structure will not function separately from but, rather, in conjunction with the upstream and downstream waterway. As a result, the design of the structure must also include and reflect this existing interaction. Of particular interest will be downstream tailwater levels and the extent and cause of existing flooding problems at the site. By determining these factors, the designer will be able to more readily identify what site improvements are feasible and what must be done to accomplish them.

In addition, the existing conditions established during this step of the H&H design process will also serve as a baseline to be used to determine the extent and acceptability of any changes caused by the new bridge or culvert. It is imperative that the new or replacement structure not create any new problems or aggravate any existing flooding or erosion problems. However, such a determination cannot be made unless the existence and

severity of these existing problems has been quantified.

Finally, the existing hydrologic and hydraulic conditions established at the project site will also serve as the baseline for determining the required level of flood protection and flow capacity at the new bridge or culvert. See Step 5 for further details.
In general, existing conditions at, upstream and downstream of the project site should be established for 1-through-100-year flood events based upon present land development levels in the upstream watershed. Typical parameters to be developed include peak discharge rates, water surface levels, and flow velocities. In addition, the development of complete runoff hydrographs may also be required in order to determine upstream and downstream conditions and impacts. It may also be necessary, in certain instances, to estimate these parameters under future or ultimate development conditions in the watershed. Finally, if the new or replacement structure will affect the flood storage characteristics of the waterway on which it will be located, it will be necessary to determine existing storage capacity and resultant flow attenuation characteristics.

In view of the wide range of existing conditions that may be present, applicants are advised to confer with the County Engineering Division regarding the specific flood events and watershed conditions to be analyzed prior to undertaking any specific computations or modeling efforts.

Step 5—Determine a New Level of Flood Protection

Due to wide variations in existing capacities, upstream and downstream conditions, environmental concerns and regulatory constraints, the County Engineering Division has not established a uniform flood protection or flow capacity level for all bridges and culverts. Instead, the protection level and capacity of the new structure is to be determined on a case-by-case basis. This determination is to be based, in part, upon the extent, severity and cause of existing flooding and erosion problems at the project site along with the cost, feasibility and environmental impacts of addressing these problems.

As noted in Step 4, it is imperative that the new or replacement structure not create new problems or worsen existing flooding or erosion problems. This structure should improve such conditions and remain flood-free itself to the greatest practicable extent. In general, the 100-year flood event will be the highest level of flood protection sought for replacement and, in particular, new structures, while the 10-year event will, in most instances, be the greatest event used to evaluate erosion impacts. However, as noted above, the exact levels to be used for a specific bridge or culvert design will be determined on a case-by-case basis. As such, all applicants are encouraged to confer with the County Engineering Division upon completion of the existing conditions analysis described in Step 4 when selecting the protection levels and flow capacity of any new or replacement bridge or culvert.

Step 6—Develop a Preliminary Hydraulic Design

Upon selection of the flood protection and flow capacity levels for the bridge or culvert, a preliminary hydraulic design should be developed to achieve them. This design should be based upon reasonable estimates of the size, shape, slope, elevation and roughness of the bridge or culvert as well as the alignment, width and profile of the roadway above. The estimates should be sufficiently precise to allow for the computation of accurate hydrograph routings through the bridge or culvert and of water surface profiles for the resultant peak discharges upstream and downstream. To do so, invert, underside and roadway elevations will typically need to be estimated to the nearest 0.1 foot, while spans, rises, and lengths will, in general, need to be estimated to the nearest foot.

The preliminary hydraulic design should also reflect estimated roadway and right-of-way widths, the type of end treatments to be provided for the bridge or culvert, the location of local storm sewer and drainage swale outlets, and the approximate length and configuration of linings and other erosion control measures. However, detailed structural designs and final construction details should not be developed until the upstream and downstream impacts of the bridge or culvert are evaluated in Step 7.

Step 7—Evaluate Upstream and Downstream Impacts

Upon completion of the preliminary hydraulic design, the impacts of the new or replacement bridge or culvert on existing peak discharges, water surface profiles and velocities should be determined to insure that all design goals have been met. In most instances, this determination begins with a routing analysis of the new structure to estimate the effects of any flood storage and stage changes on peak discharges downstream. Next, water surface profiles are developed downstream, through and upstream of the structure utilizing these new discharges and hydraulic characteristics to determine resultant changes in the water surface profile and velocity. These new values should then be compared with both existing conditions and design goals to determine the adequacy of the new structure. Based upon this comparison, necessary changes in the preliminary hydraulic design should be made until satisfactory results are achieved.

Step 8—Finalize the Hydraulic Design

When satisfactory results are achieved from the preliminary design, the design of the new or replacement bridge or culvert should then be finalized. This normally includes the selection of all final dimensions, elevations and slopes, as well as the detailed design of end treatments, erosion control measures, and roadway dimensions, elevations and drainage systems. All computer models used in the analysis of the preliminary design should be updated to reflect the final design values, and then final model runs should be made. The results of the final runs should be checked once again to insure that satisfactory results are still achieved, and should then be stored for further use with permit applications and at design review meetings.

The degree of detail achieved during this step will depend upon the next project phase. For example, if NJDEP Stream Encroachment and/or Freshwater Wetland Permits must be obtained, it is advisable to delay the final structural design until these permits have been issued.

Step 9—Prepare the Necessary Reports and Plans

When the final hydraulic design of the new or replacement bridge or culvert is completed, the necessary plans and design reports should be prepared for submittal to the Somerset County Planning Board. In preparing these plans and reports, it should be remembered that the project may also require submittals to additional agencies, such as the County Engineering Division, the NJDEP, the ACOE, the Somerset-Union SCD and the municipal engineering department.

5.15 Equations, Analytic Techniques and Computer Models

In general, the following equations and analytic techniques are recommended for use in the H&H design of new or replacement bridges and culverts. However, all technically sound and applicable methods are acceptable, provided that suitable documentation regarding this soundness and applicability is provided.

1. Hydrologic Design

Reliable historic flow records should be used to the greatest practical extent in the development of design discharges. This may range from the exclusive use of such records to directly develop design discharges via statistical techniques to the more limited use of selected records to calibrate or verify deterministic models. When utilizing such records, it is important to assess the impacts that upstream urbanization may have had on their suitability.

When utilizing a deterministic model, the rainfall-runoff methodology of the Soil Conservation Service (SCS), including the SCS Dimensionless Unit Hydrograph and Runoff Equation, is recommended since it is the basis for most County Engineering Division studies, plans and designs. When utilizing the SCS method, either the 24-Hour Somerset County Design Storm or the SCS 24-hour Type III Storm should be used. Additional requirements for using the SCS method are in Section 3.11.b, including recommended design rainfalls, Runoff Curve Numbers, and techniques for estimating watershed Times of Concentration.

If a computerized version of a deterministic model is to be utilized, the ACOE's *HEC-1 Flood Hydrograph Package* is preferred since it is the basis for most of the rainfall-runoff models developed by the County Engineering Division.

2. Hydraulic Design

The preferred equation for performing hydraulic computations for both open channels and closed conduits is the Manning Equation which utilizes generally accepted roughness coefficients. Typical roughness coefficients for channels and conduits are shown in Table 4.11. Additional roughness coefficients for natural channels and floodplains can be found in *Open-Channel Hydraulics* by Ven Te Chow.

The preferred technique for determining water surface profiles is the Standard Step Method, including the use of appropriate coefficients to estimate form losses between cross sections. Typical form loss coefficients for open channels and waterways are shown in Table 5.15. When required, the computation of hydraulic jump characteristics must be based upon an analysis of flow momentum. In doing so, the techniques presented in *Open-Channel Hydraulics* are prepared.

If a computerized water surface profile model is to be utilized, the ACOE's *HEC-2 Water Surface Profiles* is preferred since it is the basis for most of the water surface profile models developed by the County Engineering Division.

TABLE 5.15
RECOMMENDED FORM LOSS COEFFICIENTS

Description	Type of Form Loss	Loss Coefficient
Mild	Contraction	0.1
Mild	Expansion	0.3
Moderate	Contraction	0.3
Moderate	Expansion	0.5
Severe	Contraction	0.5
Severe	Expansion	1.0

5.16 Quality Assurance

The terms "Quality Assurance" and "Quality Control" are often erroneously used interchangeably. *Quality Assurance* can be defined as a management program whereby various Quality Control methods and procedures are implemented to assure that the project's objectives can be achieved. *Quality Control* is an aggregate of activities to obtain the desired quality of the finished product.

In the case of an engineering firm providing design services to a client, a Quality Assurance program may include, but is not limited to, such measures as assigning knowledgeable and experienced staff to a project, coordinating the various design disciplines, having the senior staff monitor/review the project for code compliance, constructability and economy, and requiring that all calculations and plans are checked, not only for accuracy, but for completeness and for the applicability of loads/details.

The purpose of a Quality Assurance program from the design consultant is to provide a package of construction documents (plans, specifications and cost estimates) that are complete and ready for construction. Errors in dimensions, elevations and details are to be resolved during the design process, not during construction.

The County Engineering Division reviews the construction documents for compliance with County Standards, applicable codes, and design specifications, and to confirm that proper design parameters are used. The County's review is not intended to be a substitute for adequate Quality Control procedures that are required by the design consultant.

The consultant must provide a statement of compliance that a QA/QC review has been performed by a New Jersey Licensed Engineer, signed and sealed by the engineer, with all submissions to the County.

5.17 Calculations

Design calculations shall be submitted on 8-1/2" x 11" sheets with a heading that identifies both the project and the design element. All sheets are to be dated and consecutively numbered, and are to contain the bridge number in the headings.

Each sheet shall be initialed by the designer and the checker. The cover sheet is to be signed and sealed by a Professional Engineer licensed by the State of New Jersey. **Either the designer or the checker must be the professional engineer to sign and seal the cover sheet.**

The calculations should clearly identify the design parameters used (loads, allowables, etc.) and should reference specific sections of applicable design codes, such as AASHTO. If a computer is used for analysis, a text description of the computer program explaining the analysis method must be included with each set of calculations. All input data should be provided. The design parameters used by the program are to be explicitly identified. A copy of the relevant computer print-out sheets is to be enclosed and the controlling values used for design are to be identified.

Computations that are incomplete or unchecked will not be reviewed by the County Engineering Division, and will delay the review and approval of the construction plans.

5.18 Construction Plans and Specifications

Plans should be 22" x 36" (with oversized binding margin to allow true half-scale reproduction of the full drawing area on all 11" X 17" sheets), with a title block that identifies the project and which has the bridge number (to be assigned by the County), and which includes a signature block on each sheet for signing and sealing by a Professional Engineer licensed by the State of New Jersey. A sample set of plans from similar projects can be provided to the design consultant upon request.

All plans submitted for review are required to be checked for accuracy by the consultant. The final set of plans must be checked, and should include a box in the lower-left corner of each sheet that provides for the names of the designer, drafter and checker. All final plans are to be checked for the accuracy of dimensions, elevations and details.

For any bridge to be accepted for maintenance by the County, the construction will be monitored by an inspector from the County Engineering Division. An error or missing detail on the plans can cause the construction to be delayed if the inspector deems it necessary to issue a stop-work order until the error is resolved by the design consultant.

The construction plans should contain general notes that identify the live loads used for design, the soil-bearing capacity used in design and boring logs, the design strengths of materials used, and any miscellaneous notes that pertain to special provisions, utilities, etc. The general notes should also state that the construction is to be in conformance with NJDOT's *Standard Specifications for Road and Bridge Construction*, 2007 edition, as amended. A copy of the project's supplementary specifications related to bridge construction shall be submitted for review by the Engineering Division.

ROAD DESIGN ELEMENTS

6.1 Design Criteria

AASHTO's *A Policy on Geometric Design of Highways and Streets*, latest edition, provides guidelines for the operational comfort, safety, efficiency and convenience of the motorist. However, AASHTO's policies on highway design represent nationwide standards that do not satisfy New Jersey's conditions. As such, NJDOT's *Roadway Design Manual* (http://www.state.nj.us/transportation/eng/documents/RDME/), latest edition, will be used to supplement the national standards. The design engineer might encounter situations that require sound judgment and that require deviations from the above standards. These changes are to be approved by the County Engineering Division.

6.2 Typical Sections

A typical road section is to be provided for each proposed condition (e.g., full-depth pavement, overlay, superelevation,) and must be based on the following criteria.

1. All sections are to be drawn to a scale large enough to clearly show pavement specifications, all pertinent dimensions, and necessary information.

2. Pavement specifications must be in conformance with County standards:

    a. Dense graded aggregate base course, 6" thick

    b. Superpave HMA 19M64 base course, 6" thick

    c. Superpave HMA 9.5M64 surface course, 2" thick

3. The roadway's cross-slope is be approximately 2 percent, but may vary between 1 and 4 percent for road widenings to match existing conditions.

4. The area behind the curb is to be graded at a 2 percent slope for a distance of 10 feet or to the proposed right-of-way line, and then at a maximum slope of 3 horizontal to 1 vertical to meet the existing ground surface.

5. Existing and proposed centerlines and right-of-way lines are to be shown and clearly dimensioned.

6. Station limits must be given for the section for each roadway condition proposed for the project.

7. Typical sections must be in conformance with the cross sections provided.

6.3 Horizontal and Vertical Alignment

The horizontal and vertical alignments of a roadway must be designed in accordance with the latest editions of *A Policy on Geometric Design of Highways and Streets* and the *Roadway Design Manual*. In designing horizontal curves, it is necessary to establish the proper relationship between design speed and curvature, and also their joint relationship with superelevation. Horizontal alignment must afford at least the minimum stopping sight distance for the design speed at all points on the roadway. The vertical profile line is a reference line by which the elevation of the pavement and other features of the roadway are established. The major considerations in horizontal and vertical alignment design are safety, grade, type of facility, design speed, topography, existing structures, sight distance, economics, drainage, cultural aspects and construction cost. In design, safety is always considered, either directly or indirectly. Topography controls both the curve radius and design speed to a large extent. The design speed, in turn, controls sight distance, but sight distance must be considered concurrently with topography because it often demands a larger radius than does the design speed. All of these factors must be balanced to produce an alignment that is safe, economical, in harmony with the natural contour of the land and, at the same time, adequate for the design classification of the roadway.

6.4 Design Speed

The design speed is determined for the design and correlation of the physical features of a highway that influence vehicle operations. It is the maximum safe speed maintainable over a specified section of highway when conditions permit design features to govern.

Some features (e.g., curvature, superelevation, sight distance, gradient) are directly related to and vary appreciably with the design speed. Pavement and shoulder widths and clearances to walls and rails are less directly related to the design speed, but because they can affect vehicle speeds, higher standards should be used for them on roadways with higher design speeds. Thus, nearly all geometric highway-design elements are affected by the selected design speed. The design of any roadway must provide sufficient sight distance for the driver to perceive potential conflicts and to carry out actions needed to safely negotiate the road.

The selection of a design speed is influenced by the terrain's character, the density and character of the land use, the classification and function of the highway, the traffic volumes expected for the roadway, and by economic and environmental considerations. Usually, a roadway in level terrain warrants a higher design speed than one in mountainous terrain; one in a rural area warrants a higher design speed than one in an urban area; an arterial roadway warrants a higher design speed than a local road.

6.5 Superelevation

When a vehicle travels on a circular curve, it is forced radially outward by centrifugal force. This effect becomes more pronounced as the radius of the curve is shortened. This is counter-balanced by providing roadway superelevation and by the side friction between the vehicle's tires and the road surface. Safe travel at different speeds depends upon the radius of curvature, the side friction and the rate of superelevation.

The maximum rate of superelevation shall be 6 percent (the exception is a maximum of 4 percent for rural roads and urban roads without access control).

6.6 Rollback

A rollback is the reverse cross pitch of the road on the high side of the superelevated curve. The rollback will be at a 3 percent slope and will be designed not to be in the vehicle's wheel- path area. The rollback helps to maintain water runoff out of the vehicle's path.

6.7 Transitions

The superelevation transition generally consists of the superelevation runoff (the length of roadway needed to accomplish the change in cross slope from a normal crown section to a fully superelevated section, or vice versa).

The superelevation transition should be designed to satisfy the requirements of safety and comfort and should have a pleasing appearance. The length of this transition should be based on a desirable distribution rate of 2 percent per second of the design speed. With respect to the beginning or ending of a curve, two-thirds of the superelevation runoff is on the tangent approach and one-third is within the curve. This results in two-thirds of the full superelevation rate at the beginning or ending of a curve. This may be altered as required to adjust for flat spots or undesirable sags and humps when the alignment is tight.

6.8 Traffic Control Devices

All traffic control devices are to conform with the requirements of the *Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD)*, latest edition available at http://www.mutcd.fhwa.dot.gov/. Material specifications for traffic control devices are to be in accordance with NJDOT's *Standard Specifications for Road and Bridge Construction*, latest edition (http://www.state.nj.us/transportation/eng/specs/), and Somerset County's *Supplementary Specifications*.

Note the following County standards:

1. Pavement markings are to be thermoplastic unless otherwise directed; thermoplastic symbols are to be properly spaced.

2. Double yellow centerlines are to be 4" wide and separated by a 6" clear space.

3. White edge lines are to be 6" wide.

Within or outside of a construction work zone, the County Engineer may require the use of solar-powered advance warning arrow panels and, in areas of deep excavation, Jersey barrier curb.

6.9 Jughandles

The construction of a jughandle to accommodate left-turning vehicles may be desirable where the inclusion of a left-turn slot would create an unsafe horizontal or vertical alignment condition, or where a highway capacity analysis of the intersection indicates that a significant improvement in Level of Service will result with the inclusion of a jughandle. No entrance or exit driveway shall be located on a jughandle, unless otherwise approved by the County Engineer.

6.10 Channelization (Islands/Medians)

At intersections where the proper course of travel is not immediately obvious, it may be advantageous to separate turning movements with channelization. Channelization may be required for one or more of the following purposes:

1. Separation of conflicts

2. Control of angle of conflict

3. Reduction of excessive pavement areas

4. Regulation of traffic and indication of proper use of intersection

5. Protection of pedestrians

6. Protection and storage of turning and crossing vehicles

7. Location of traffic control devices

Channelization shall be designed in accordance with the *Manual on Uniform Traffic Control Devices*, latest edition. All pavement markings are to be thermoplastic.

The use of curbed islands may be desirable, particularly in the case of items 5 and 7 above. Where curbed islands are used, the intersection should have fixed-source lighting or appropriate pavement markings and signing delineations. The design of curbed islands (size, designation, etc.) is to be in accordance with AASHTO's specifications.

6.11 Ramps for the Physically Disabled

At curbed intersections, depressed curbs and ramps shall be provided within the sidewalk or pedestrian island.

6.12 Signalized Intersections

The installation of a traffic signal may be required at the intersection of a County road by the County Planning Board in conjunction with either an access or off-tract improvement. All traffic signals shall be designed in accordance with the *MUTCD*, latest edition.

NJDOT's *Roadway Design Manual*, Section 12, "Traffic Signal Systems," is to be used as a guide in the planning and design of all traffic signal systems; however, the following guidelines for the design and construction of traffic signals supersede any conflicting information found in Section 12 of the manual.

6.13 Analysis

The methodology used to analyze the capacity of a signalized intersection shall be in accordance with that outlined in of the latest edition of the *Highway Capacity Manual* by the Transportation Research Board, National Research Council. Preferably, the analysis shall be performed using the latest version of the Highway Capacity Software developed by the US Department of Transportation, Federal Highway Administration, or similar software based on the same methodology. The analysis is to be submitted to the County Engineering Division.

The following conditions are to be utilized in the analysis:

1. A saturation flow rate of no more than 1,900 vehicles per hour.

2. Clearance intervals of no less than 3 seconds "yellow" and no less than 1 second "all red." (Timings will depend on the speed of approach and the distance required to "clear" conflicting movements.)

6.14 Geometry (see also Section 2.18)

Storage bays shall be of a sufficient length to accommodate 150 percent of the turning vehicles. Eight-inch solid white lines shall be used to separate approach lanes at an intersection. The length of such lines shall be 66 percent of the length of the corresponding bay.

6.15 Indications

There shall be a minimum of three vehicular indications per approach. Preferably two (as a minimum, one) of the indications are to be located within the "cone of vision" as per the *MUTCD*.

Independent traffic signal assemblies for the same approach are to be utilized where possible so that one indication will be visible in the event that any one traffic signal assembly is "knocked down" by an errant vehicle.

Five-section heads shall be used for protected/permitted indications (fiberoptic lenses are not allowed).

All signal indications shall have L.E.D. lamps and are to be wired separately back to the controller.

Crosswalks and pedestrian indications are to be provided unless extenuating circumstances preclude their installation. Pedestrian indications are to be the "countdown" type.

6.16 Traffic Signal Requirements

Span wire-mounted indications shall be used for temporary installations only.

Aluminum poles (TSS Type "K" or "T") shall be located a minimum of 5 feet behind the curbline.

Mast arms greater than 25 feet in length will require a steel pole (TSS Type "S"). Steel poles are to be located at least 10 feet from the face of curb.

Curbs are to be provided at all intersection legs for a minimum distance of 100 feet beyond the point of curvature of the curb radii.

Controllers are to be located within the intersection so as not to interfere with the sight distance of right-turning vehicles on the minor street approach.

All centerlines (double yellow lines) are to be spaced so that there is a clear 6" space between the 4" lines.

Underground conduits are to be a minimum of 4" in diameter. Conduits installed under existing concrete sidewalks or bituminous concrete shall be classified as Type CUR. All conduit shall be rigid nonmetallic, schedule 80, and separate conduit runs shall be either Type CUR or CUG. Conduits under the road are to be installed by the open cut method.

6.17 Vehicle Detection

Vehicle detection shall be accomplished with the use of a video tracking unit (VTU). The VTU shall be the shelf-mounted Econolite Autoscope 704120 or an approved equal. The following guidelines are to be used in designing areas of presence detection on the approaches to a signalized intersection.

1. Delay-call detection is to be provided on right-turn lanes where a "right turn on red" is permitted and where permitted left-turn lanes exist.

2. The vehicle-extension interval is to be two seconds.

3. The front edge of the area of detection must be no more than 10 feet from the curbline of the intersecting roadway projected across the approach being detected.

4. In no case shall any portion of the detection extend beyond the projection of the curbline into the intersection area.

5. The front edge of the detection immediately behind the stop line shall be no more than 3.5 feet from the stop bar.

6. Lateral spacing shall be 3 feet from a curb or pavement edge and 3 feet from a painted line.

6.18 Guiderail

These guidelines are based on AASHTO's *Roadway Design Guide* and will assist the designer in determining conditions that warrant the installation of guiderail as well as its dimensional characteristics. It is important that application of these guidelines be made in conjunction with sound engineering judgment and a thorough evaluation of site conditions so that a proper solution is derived.

Guiderail is a longitudinal barrier whose primary functions are to prevent vehicular penetration and to safely redirect an errant vehicle away from a roadside or median hazard.

A warranting condition is defined as a fixed object or nontraversable hazard whose physical characteristics are such that injuries resulting from an impact with it would probably be more severe than injuries resulting from an impact with guiderail. The physical characteristics of an obstruction and its distance from the edge of the travelled way are the basic factors to be considered in determining if guiderail is warranted.

Although various roadside conditions are covered below, special cases will arise for which there is no clear choice as to whether or not guiderail is warranted. Such cases must be evaluated on an individual basis and, in the final analysis, must usually be resolved by sound engineering judgment. The NJDOT's *Roadway Design Manual*, available online at http://www.state.nj.us/transportation/eng/documents/RDME/, is to be used for more detailed criteria of the placement of guiderail.

1. Clear zone is defined as the roadside or border area that starts at the edge of the travelled way and which is available for safe use by errant vehicles. The width of the clear zone varies with the posted speed and roadside slope. Desirably, the design speed should be used when determining the clear zone on either new or existing roadways. As a minimum, the posted speed plus 5 mph may be used when determining the clear zone width on existing roadways.

2. The design engineer is to investigate alternatives to alleviate and/or eliminate the need for guiderail. Safety and the costs of design alternatives will be reviewed by the County Engineer.

   It is emphasized that guiderail should not be installed indiscriminately. Every effort should first be made to eliminate the obstruction. In some cases, another type of traffic barrier might be a better choice than guiderail; for example, obstructions in gores can often be more effectively shielded with a crash cushion. The designer should consider such alternatives and choose the most suitable solution based on safety requirements, economic limitations, maintenance and aesthetic considerations.

3. The length of "approach" guiderail shall be determined by the *Roadway Design Manual* and the site conditions. These parameters will be reviewed by the County Engineer.

4. The guiderail termination points will be constructed with a beam guiderail anchorage or breakaway cable terminal consistent with the *Roadway Design Manual*.

5. A highly desirable characteristic of any road is uniform clearance from the travelled way to the guiderail. If possible, guiderail should be placed at a distance beyond which it will not be perceived as a threat by the driver. In general, guiderail should be located as far as possible from the travelled way, and on land service roads, the front face of the guiderail should be a minimum of 7 feet from the outside edge of the shoulder.

6. Where guiderail is used to shield an isolated obstruction, it is more important that the guiderail be located as far from the travelled way as possible so as to minimize the probability of impact. The distance from the face of the rail element to the face of the obstruction should desirably be a minimum of 4 feet, unless otherwise indicated in the Roadway Design Manual.

7. On existing road structures with safety walks equal to or greater than 1'-6" where it is not feasible to remove and provide a concrete barrier-shaped parapet, guiderail should be carried through the structure. The guiderail shall be installed on both sides, and all four ends shall be provided with breakaway cable terminals.

   When the roadway approaching a structure is curbed or bermed, the guiderail mounting height on the structure should be measured from the top of the curb. On long structures, however, the mounting height may be measured from the gutterline provided the face of the guiderail is flush with the curb face. In this latter case, a rub rail may be omitted.

When there is a difference in the offset to the approach guiderail and the offset to the bridge parapet, a transition flare of 15:1 should be used.

The attachment of guiderail to bridges and structures shall be in accordance with NJDOT's standard details.

6.19 Maintenance and Protection of Traffic and Detours

1. Before construction can commence on a County road, a road opening permit must be obtained. A written application for such shall be made to the Somerset County Department of Public Works (see Section 2.3). Traffic control in the work area and the detour route shall be established in conformance with the *Manual on Uniform Traffic Control Devices*, latest edition.

2. The design engineer is to meet with representatives of the County Engineer's construction division prior to designing the traffic control plan to discuss construction methods and traffic control. Unless extenuating circumstances require a lane to be closed overnight, lane closures will only be allowed between the hours of 9:00 AM and 3:00 PM during weekdays and a uniformed police officer must be present to direct traffic. Two-way traffic is to be maintained at all times by providing flagmen at both ends of the work zone (a typical one-lane-closure operation available on the County website at http://www.co.somerset.nj.us/division/engineering.html. If the work zone is within the confines of a signalized intersection, a uniformed police officer must be present to direct traffic.

3. Any project which requires a County road to be closed is to include a detour plan as part of the construction plans for that project. The detour plan must be approved by the Office of the County Engineer and all applicable local agencies. During the times that the detour is not in effect, the signing must either be removed or "bagged" so that it is not visible to the motorist.

   An approval for a detour plan may take several weeks depending on its complexity, the detour route selected, and the workload of the County Engineer's Office. Before the plan is designed, a meeting is to be scheduled with representatives of the construction division of the Engineer's Office to discuss such particulars of the detour as:

   a. The adequacy of the proposed detour route to accommodate an increase in traffic.

   b. The expected duration of the detour.

   c. The proposed date at which the detour will become effective.

   d. Working hours.

   e. The proper authorities to be notified.

f. Bridge weight limits on selected detour routes.

In addition, conflicts with other detours or proposed construction in the vicinity of the detour route might restrict or postpone the proposed detour.

Once reviewed and found acceptable by the County Engineer's Office, the County will, in turn, forward the detour plan to the affected municipalities for review by their mayor, police department, and administrator. Detours that involve state highways must also be submitted by the County to NJDOT for concurring approval. All detour plans are to comply with the requirements of Section 6.1.6 of this handbook.

After receiving approval of the detour plan, the applicant must notify the County Engineer's Office at least 48 hours in advance of exposing the detour signs so that they can be inspected.

6.20 Off-Street Parking and Loading

Each land development project which is subject to County site plan approval shall provide, on its lot, the number of off-street parking spaces and loading or unloading spaces required by any zoning, subdivision, site plan or other ordinance of the municipality in which the development is to be located. In addition to local requirements, the following criteria are to be accounted for in the design of off-street parking and loading facilities for developments along County roads:

1. Entrance and exit lanes shall be clearly signed in order to prevent driver confusion.

2. Sufficient reservoir space shall be provided at the lot entrance to prevent queued entering vehicles from spilling back across the existing or proposed right-of-way of the County road, including the sidewalk area.

3. Off-street parking areas shall be designed to prevent the storage of vehicles within any portion of an entrance driveway or driveway lane that is within 20 feet of the right-of-way of the County road. Parking areas shall be designed to permit all vehicles to turn around on the site so as to prevent the necessity of any vehicle having to back onto the County road from the site.

4. For larger lots, parking aisles shall be arranged perpendicularly to the building face or pedestrian destination. This enables pedestrians to use driving aisles or parallel sidewalks to move between parking spaces and the building entrance. The parallel arrangement is considered acceptable on narrow sites where parking stalls are arranged at 90-degree angles and where pedestrians are not forced to cross more than two parking module widths.

5. No part of any off-street parking area or loading or unloading space shall be located within the right-of-way of the County road, including the sidewalk area. Off-street truck loading and unloading spaces shall be located and designed to permit any truck to

maneuver from a driveway into and out of such a space without encroaching upon any portion of a County road's existing or proposed right-of-way, including the sidewalk area.

6. The truck-circulation system shall be designed to avoid interference with automobile and pedestrian movements or with high-turnover parking. Truck-loading docks shall be located away from areas of pedestrian movement and screened from view of parking areas, adjacent properties or adjacent streets.

6.21 Landscaping

Landscaping along County roads must be mutually agreed upon by the County Engineer, the local tree commission and/or the local shade tree commission. When a road-widening project creates a steep slope condition along the County road, a slope stabilization plan is to be submitted for review and acceptance.

CONSTRUCTION PLAN REQUIREMENTS

Engineering acceptance of all construction documents expires two (2) years from the date of acceptance. If an acceptance expires, the plans must be resubmitted and reviewed for conformance to current requirements. After any necessary revisions are made to bring the construction plans up to current standards, the two-year acceptance period will once again commence.

Although the acceptance of the construction plans will expire every two years, this does not affect the acceptance status with the County Planning Board or other review agencies.

The following items must be included on all construction plans. For further information, visit http://www.co.somerset.nj.us/division/engineering.html

7.1 Title Sheet

Requirements for title sheets are as follows:

1. The sheet size is to be either 22" x 36" or 24" x 36".

2. Plans are to be signed and sealed by a Professional Engineer and Licensed Land Surveyor.

3. A key map is to be provided that shows the tract to be developed and its relation to the surrounding area, including any major highways in the vicinity, at a scale of 1" = 2,000'. If a bridge is involved, include the County's number of the bridge.

4. Project title and an Index of Sheets that corresponds respectively to each sheet in the plan set must be shown.

5. The Somerset County Engineering Acceptance block is required for land development projects that affect County facilities. The acceptance block is available at http://www.co.somerset.nj.us/division/engineering.html, with the following note under the block:

   "These plans are NOT ACCEPTED FOR CONSTRUCTION unless this block has an acceptance stamp and is initialed by a staff member of the County Engineering Division. The acceptance of these plans expires two (2) years from the date of acceptance."

6. A list of the present County Freeholders (for projects to be bid by the County).

7. Signature lines for approvals.

8. A utility block with the correct addresses and phone numbers of all applicable utility companies.

9. The station limits and length of the project where County road improvements are required.

7.2 Estimate of Quantities Sheet

An *estimate of quantities* sheet minimally includes the following:

1. A list of all items called for in the construction plans.

2. A list of all items generally used in construction.

3. The units given for each item must be in conformance with the specifications.

4. Calculations are to be submitted for all items listed.

7.3 Alignment Map

An *alignment map* minimally includes the following:

1. A key map.

2. A list of property owners within 200' of the project with block and lot designations.

3. A depiction of the existing and proposed centerlines along the County road that shows bearings, distances, and curve data. The bearing system is to be the New Jersey State Plane Coordinate System.

4. A depiction of the existing and proposed right-of-way and/or easement lines with bearings, distances and curve data.

5. The approximate location of all property lines.

6. Stationing along the proposed centerline with points of curvature and points of tangency stations, offsets to the proposed/future curbline, and offsets to right-of-way and/or easement lines.

7. The proposed centerline ties.

8. A signature block for County and pertinent review agencies.

9. A location for the County's acceptance stamp with the nullifying clause.

10. A County-approved title block.

11. The alignment map shall be drawn at a scale of 1" = 30' unless otherwise approved by the County Engineer.

12. In addition to the alignment map, a property parcel map is to be prepared for each parcel to be acquired.

7.4 Utilities

All existing and proposed utilities must be shown on the construction plan. When conflicts between existing utilities and proposed improvements are possible, test borings or test holes are to be performed as directed by the County Engineer. Every effort is to be made to avoid conflicts. When conflicts cannot be avoided, the construction plan must clearly indicate which utilities are to be relocated.

7.5 Traffic Control Plan

A traffic control plan is to be included in the construction documents for any project which involves the closure of any lane of traffic. This drawing is to outline a sequence of construction, in phases, for the purpose of minimizing disruption to the flow of traffic. Part VI of the *Manual on Uniform Traffic Control Devices* (http://www.mutcd.fhwa.dot.gov/) is to be utilized in designing the plan. Where appropriate, the plan is to include the following elements:

1. Signs with fluorescent orange wide angle prismatic retroreflective sheeting for visual impact performance that conforms to NJDOT's *Standard Specifications for Road and Bridge Construction* (http://www.state.nj.us/transportation/eng/specs/), latest edition.

2. Arrow boards.

3. Drums for channelizing traffic.

4. Barricades (Type III wooden barricades are not permitted).

5. The location of flagmen.

6. A large-scale detail of the construction area that shows barricades, signing, and Jersey barrier curb if appropriate.

7. Notes that indicate the hours of operation and references to the Federal Highway Administration's Standard Alphabets for Highway Signs and Pavement Markings and the Manual on Uniform Traffic Control Devices.

8. Details for sign supports, drums and barricades which will be provided by the County upon request.

7.6 Detour Plan

A detour plan is to be included in the construction documents if it is demonstrated by the design engineer that the closure of a County road will become unavoidable at some time during the construction of the road improvement. All efforts are to be made to minimize the duration of the detour. Refer to Section 6.8.2 for the process required to implement a detour.

The detour plan is to be designed in accordance with the *Manual on Uniform Traffic Control Devices*, latest edition. The County Engineer will provide the applicant with examples of approved detours upon request.

The following elements, in addition to those listed in Section 6.19, are to be included in the plan:

1. The detour route, with all roads and major intersecting streets identified.

2. Advance-notice signing which is to be posted two weeks prior to the effective date of the detour to warn motorists of the impending detour.

3. Detour signing per the MUTCD, along with a sign legend.

7.7 Roadway Construction Plans

1. Before any highway design is started, the County's Highway Section shall be contacted for mutual agreement on the interpretation, applicable sections, details and procedures to be used for design.

2. Roadway construction plans must be designed in accordance with this handbook, *A Policy on Geometric Design of Highways and Streets*, and *Transportation and Traffic Engineering Handbook*, latest editions.

3. The plan is drawn to a scale of 1" = 30" unless otherwise directed by the County Engineer.

4. The plan shall include the road/stream centerline and stations, edges of roadway pavement, curb, beam guiderail, utilities, easements and right-of-way.

5. The locations of proposed structures such as drainage structures, culverts, bridges, headwalls and wingwalls are shown and are labeled as to size and type.

6. Any problems that arise from changes in the alignment, road-widening, new driveway cuts, etc. must be properly addressed by the design engineer.

7.8 Road/Stream Profile Sheets

1. The scale of the profile shall correspond with the scale of the plan view.

2. Road profiles shall show the existing and proposed road/ground, proposed structures with appropriate stationing, existing and proposed elevations, vertical curve data, existing and proposed utilities and drainage systems with the pipe sizes, slopes, inverts, and conduit outlet protection.

3. Stream profile shall show the existing and proposed streambed with appropriate stationing, proposed structures, existing and proposed elevations, proposed channel slopes, proposed riprap or gabion details, utilities, and existing and proposed drainage with pipe sizes, slopes and inverts.

4. Proposed structures, drainage pipes, encasements and clearances between utilities are shown.

7.9 Horizontal Alignment Plan

1. The horizontal alignment plan must be at a scale of 1" = 20' or 1" = 30'.

2. The existing and proposed centerlines are to be shown with bearings, curve data and centerline stationing every 50 feet.

3. All points of curvature, points of tangency, angle points, etc. in the centerline are to be clearly shown and defined with centerline stations.

4. All centerline radii must be greater than 800 feet and, where possible, the centerline should be designed to AASHTO standards.

5. Curve data for the proposed curbing must be shown.

6. The location and length of superelevations and superelevation runouts are to be in accordance with AASHTO standards.

7. Horizontal sight distances across embankments or cut areas must meet the standards outlined in the Somerset County Land Development Review Resolution and this handbook.

8. The horizontal alignment must be in general conformance with County standards.

9. The baseline and construction line are to be shown along with centerline tie sheet and benchmark locations.

7.10 Intersection Grading Plans

1. An intersection grading plan is to be provided for all intersections at a scale of 1" = 10' or 1" = 20'. The plan must show the proposed bottom and top of curb elevations at the point of curvature, point of tangency and midpoints of all curb returns and be free of superfluous information. Spot pavement elevations are to be shown throughout the intersection area as needed to ensure proper drainage.

2. All necessary information to ensure smooth curb profiles and proper drainage must be shown on the plans (e.g., bottom and top of curb elevations, spot elevations, etc.).

3. Any safety-related improvements deemed necessary by the County Engineer shall be installed at all intersections.

7.11 Baseline Tie Sheet

A baseline or construction line tie sheet must be provided that shows tie distances to key control points on the baseline/construction line. The ties must be established from permanent structures or objects that will not be disturbed during construction. The tie distances must be adequate for re-establishing the control point during construction.

7.12 Typical Sections

A typical roadway section is to be provided for each proposed condition (e.g., full-depth pavement, mill/overly, normal crown, superelevation). All typical sections are to be drawn to a scale large enough to clearly show pavement specifications, all pertinent dimensions, and necessary information. Pavement specifications must be in conformance with County standards. All station limits, roadway widths, cross slopes, sidewalk locations, curbs, beam guiderail locations, top/top of slopes and right-of-way lines shall be shown.

7.13 Striping and Signing Plan

1. The plan shall be drawn to a scale of 1" = 20' or 1" = 30'.

2. A north arrow shall be shown.

3. White or yellow edge lines shall be 6" wide unless otherwise specified.

4. Broken white or yellow lines shall be 10 feet long and separated by 30-foot spaces.

5. Double yellow lines shall be 4" wide and separated by a 6" space.

6. Existing and proposed edges of pavement shall be shown.

7. Stop bars shall be white and 24" wide.

8. Crosswalks shall be designed in accordance with the Crosswalk Striping detail found on the County website.

9. All proposed lane widths shall be shown.

10. All striping and arrow and ONLY symbols shall be alkyd-type thermoplastic unless otherwise specified.

11. Plowable reflective pavement markers shall be identified as being either monodirectional or bidirectional.

12. Proposed centerlines and stationing shall be shown.

13. The radius and length of each curved section of striping shall be shown, and all points of curvature, points of tangency and points of compound curvature shall be identified by stations and offsets from the centerline.

14. If the plan appears on two or more sheets, a "TO BE CONSTRUCTED" box on each sheet shall show the quantities for that sheet.

15. All proposed signs shall be shown and identified by their MUTCD designations and sizes. The location of each proposed sign shall be shown on the plan. Existing signs shall be identified as such.

16. All striping and signs shall conform to the current MUTCD.

7.14 Cross Sections

Cross sections are to be included in the construction plans for all roadway improvement projects. The following criteria must be followed in the preparation of cross sections:

1. The cross sections shall be prepared at a scale of 1" = 5' in the horizontal and vertical planes.

2. Centerline stations and all elevations shown for each section must be consistent with the plans and profile.

3. Existing pavement elevations are to be shown for the centerline and edge of pavement.

4. Proposed elevations are to be shown for the centerline, edge of proposed pavement or bottom and top of the proposed curb.

5. The limits of the full-depth pavement area must be boxed out and the overlay and milling areas must be clearly defined.

6. Cross slopes and elevations are to be shown in conformance with the typical section,

plans and profile, and are to be consistent with County standards.

7. The cross section must continue far enough beyond the proposed curbline to clearly show that existing conditions will be met in accordance with the standards listed for typical sections.

8. Sections are to be provided at all driveways and side streets to show how proposed conditions meet existing conditions.

9. Areas to be topsoiled, strip cut, and strip filled are to be clearly indicated on the cross sections along with the quantities for cut, fill, topsoiling, stripping cut and stripping fill.

10. The locations of the existing and proposed right-of-way lines are to be shown.

11. The cross sections must clearly depict areas of widening, with boxed-out sections representing the limits of full-depth pavement to be constructed. The cross sections must also show boxed-out sections along with the limits and depths of milling. The proposed pavement depth in overlay areas shall be a minimum of 3" in the County road.

12. In pavement-widening areas, the cross sections must clearly show the proposed cross slope between the edge of the existing pavement and the proposed bottom of curb. Whenever possible, a 2 percent cross slope is to be maintained (see road widening detail on the County website). However, the cross slope may vary between 1 and 4 percent as needed to achieve a smooth top-of-curb profile.

7.15 Details

All necessary construction details, which must be in conformance with County standards, are to be shown on the plans.

The standard County construction notes are to be shown on the plans.

7.16 Traffic Signal Plan

Plans that pertain to the construction of traffic signals are to be prepared in accordance with the guidelines in NJDOT's *Roadway Design Manual*, and "Traffic Signal Systems." The following supersedes any conflicting information contained in that manual.

An example traffic signal plan will be provided by the County Engineering Division on request. The traffic signal plan (LTS) shall be at a scale of 1" = 20' or, as a minimum, 1" = 30', and must indicate the following elements:

1. The edge of pavement or curbline.

2. Existing and proposed right-of-way lines.

3. Sidewalks.

4. Existing and proposed manholes and inlets.

5. Sight distance restrictions (see Section 2.10).

6. The intersection's geometry.

7. Lane widths and striping within lanes.

8. Pavement transitions.

9. The locations of traffic signal poles and pedestals.

10. Vehicle and pedestrian indications and where they are located.

11. Indications other than standard three-section signal heads are to be illustrated in detail.

12. Any special-signal visibility-limiting device (type, location, and back plate if any).

13. Vehicle indications shall be labeled numerically clockwise and sequentially by phase, starting with one approach and continuing similarly with other approaches on the same phase.

14. Pedestrian indications shall be labeled numerically with a “P” prefix (P-1, P-2, etc.).

15. The lengths of mast arms.

16. Proposed pavement markings and channelization.

17. All signs which pertain to the signalized operation.

18. The location of the controller.

19. The timing schedule, which indicates vehicle intervals, hours of operation, and the flashing operation.

20. A phasing diagram.

21. The locations of detection.

22. Proposed curbing and radii.

23. Construction notes.

24. Driveway and street intersections within 250 feet of the intersection.

25. Railroad grade crossings within 250 feet of the intersection.

26. Emergency centers within 250 feet of the intersection.

27. Traffic regulations, including parking and stopping and standing restrictions.

28. Bus stops, loading zones and applicable regulations.

29. Turn restrictions and one-way streets.

7.17 Electrical Underground Plan

The following elements must be located on this drawing:

1. All wiring identified by type.

2. Traffic signal foundations identified by type.

3. The controller foundation.

4. Junction boxes identified by type.

5. The locations of all conduits. Conduit is to be installed by the open cut method.

6. Service-wire connections.

7. Existing and proposed underground facilities.

8. Existing and proposed curbing.

7.18 Traffic Signal Standard Details

1. Construction documents for traffic signal installations shall reference the appropriate standard detail sheets which have been prepared by NJDOT's Bureau of Electrical Engineering. These sheets have drawing numbers prefixed by the letter "T" or "L".

2. Attention is directed to the following items which are specific requirements of Somerset County and which are not included in NJDOT's *Standard Specifications for Road and Bridge Construction*, latest edition.

3. The controller shall be either an Eight Phase PEEK Model 3000 with Internal Time Base Coordination or an Econolite model ASC/2S with Internal Time Base Coordination. The controller and cabinet supplied shall be fully equipped for immediate operation as an isolated intersection with PEEK Corp. Closed Loop System software or Econolite Zone Monitor IV software. The Econolite shall be capable of using Aries Closed Loop

software when used in a closed loop system. This shall include a modem interface panel mounted within the cabinet and the supply of a modem authorized for use in the manufacturer's Closed Loop System. All required telephone interface equipment shall be supplied within the cabinet to allow immediate connection via twisted pair cable to the telephone network.

4. The conflict monitor shall be a 12-channel unit conforming to specification EB-TSC-ITB-8 Section VII. In addition, the monitor shall be a logging and reporting type unit capable of storing event time and date. The most recent 100 events must be stored and a record of those events must be able to be retrieved by a front panel menu driven display and may be accessed via software through an RS-232 serial port connected to the controller, computer, or portable printer.

5. The controller assembly, 8-phase shall also include an uninterruptible power source (UPS) unit in the controller cabinet.

6. Traffic signal pedestal poles are to have a TBJ-6 cast aluminum base and an SPF foundation.

7. Specifications are to be in accordance with *Standard Specifications for Road and Bridge Construction* and Somerset County's Supplementary Specifications.

8. All improvements to be constructed under County jurisdiction must be in conformance with *Standard Specifications for Road and Bridge Construction,* current edition, and the County's Supplementary Specifications will be required for all County Capital Improvement Projects.

CONSTRUCTION REQUIREMENTS

8.1 Preconstruction Requirements

It is unlawful for any person, partnership, association or corporation to make excavation in any right-of-way under the jurisdiction of the Somerset County Board of Chosen Freeholders for any purpose without first satisfying all relevant requirements presented in this handbook and/or the resolution for Specifications and Fee Schedules for Road Openings.

Any person, partnership, association, or corporation violating this provision shall be subject to the fines and penalties presented in the above-referenced resolution.

No construction is to commence on improvements under County jurisdiction until the following items have been satisfied:

1. For land development projects, County Planning Board approval of the application, which includes submittal of all applicable cash contributions, performance guarantees, inspection fees and all other Planning Board requirements.

2. Final construction plans, stamped "Accepted as Submitted" by the County Engineering Division, have been provided to the contractor. (Note: The acceptance of construction plans does not constitute Planning Board approval.)

3. Acceptance has been received from the County Engineer on all relevant engineering reports, supporting information, and shop drawings as deemed necessary by the County Engineer.

4. All necessary permits from other review agencies have been acquired and are "in effect."

5. A detour/traffic control plan has been reviewed by all necessary County, municipal and police offices (for projects that propose construction in the County's right-of-way).

6. Construction permits and road opening permits have been issued by the County Engineer's Office to the contractor(s) performing the work.

7. Written notification has been received by the County Engineering Division from the contractor(s) performing the work.

8. A preconstruction meeting has been held with the County Engineering Division, the contractor, utility companies, township officials, local police, etc.

8.2 Preconstruction Meeting

A preconstruction meeting must be held prior to the commencement of any construction on projects under County jurisdiction. The following are elements of this meeting:

1. It is the contractor's responsibility to regularly inspect and maintain the traffic control plan and/or detour route. All signs, temporary striping, safety-related devices, etc. must be continuously maintained throughout the duration of the project.

2. It is the contractor's responsibility to have representatives from each applicable utility company present at the meeting. If a representative is unable to attend, it is the contractor's responsibility to contact the absent utility company and to coordinate all necessary aspects of the project.

3. Cut sheets are to be prepared in a format agreeable to the County Engineering Division. Cut sheets are to be provided by the contractor to the County Engineer as directed by the County Engineer.

4. A progress schedule is to be presented by the contractor. The schedule is to clearly show the anticipated time frame for each phase of construction.

5. The contractor is to provide all necessary information for each subcontractor, including emergency phone numbers and a list of major material suppliers contractor.

8.3 Acceptance/Inspection

The following conditions must be met before the County will accept any of the various improvement projects into its maintenance system.

8.4 Traffic Signals

The following requirements must be satisfied:

1. Somerset County has inspected and certified that the signal has been constructed in accordance with the approved plan, and has found that all materials, equipment and methods of construction conform to the requirements set forth in this document.

2. The signal has been in trouble-free operation for at least one week. This will be preceded by a period of one week in which the signal will operate in the emergency flashing mode.

3. All appropriate technical manuals, box diagrams and part-replacement number lists have been received by the County.

4. An “as-built” aboveground signal plan and electrical underground plan are received by the County.

8.5 As-Builts

As-built drawings of all construction plans for improvements under County jurisdiction must be submitted to the County. An electronic version of the as-built plans are to be submitted as directed by the County Engineering Division.

8.6 As-Built Road Construction Plans

1. With a bold black marker or red ink, write or stamp "As-Built Plans" and the date the as-builts were developed on the cover (key) sheet of the construction plans.

2. Enter all as-built quantities in the appropriate spaces on the Estimate of Quantities sheet and on individual sheets as required.

3. Revise all callouts and notes appropriately so as to reflect the "as-built" condition of the road and associated structure(s). Here are a few typical examples:

    a. The proposed centerline should read "CENTERLINE" and the word "PROPOSED" should be circled and crosshatched.

    b. "TO BE" in "TO BE CONSTRUCTED" should be circled and crosshatched.

    c. The word "CONSTRUCT" should have an "ED" added so as to read "CONSTRUCTED."

    d. The word "REMOVE" should have a "D" added so as to read "REMOVED."

    If an item included in the original contract was eliminated from the project, then all callouts, details and appropriate notes require revisions. If an item was omitted from the original contract but was still constructed, then callouts, details and appropriate notes are to be added that reflect its proper location, dimensions and configuration.

    All sheets that pertain to the construction of the road—including, but not limited to, the road plans, road profiles/cross sections, drainage structures and associated details—should be revised as required.

4. All road cross sections are to be "as-built" at every 50-foot station on the straight portions of the project and at every 25-foot station on curves. All such sections should extend 10 feet past the appropriate right-of-way lines.

5. All intersection grading plans are to reflect the as-built grades.

6. All as-built grades are to be shown on the plans for the tops of manholes, catch basin grates, and catch basin and pipe inverts (in and out).

7. All as-built pipe lengths, sizes and materials are to be shown on the plans.

8. All as-built driveway profiles, dimensions and locations are to be shown.

9. All as-built pavement limits, dimensions and elevations are to be shown.

10. All as-built headwall dimensions and elevations are to be shown.

11. Any road details that were added or revised are to be shown in the as-built configuration.

12. Any and all plan revisions that pertain to any portion of the project should be incorporated in the final set of as-built plans.

13. The as-built plans are to be signed and sealed by a licensed New Jersey Professional Engineer and/or a licensed New Jersey Land Surveyor, as required, certifying that all construction was executed in accordance with the approved design calculations, approved plans, and *Standard Specifications for Road and Bridge Construction* and all supplements thereto.

14. As-built drawings of all construction plans for improvements under County jurisdiction must be submitted to the County. An electronic version of the as-built plans are to be submitted as directed by the County Engineering Division.

8.7 As-Built Bridge Construction Plans

1. With a bold black marker or red ink, write or stamp "As-Built Plans" and the date the as-builts were developed on the cover (key) sheet of the construction plans.

2. Enter all as-built quantities in the appropriate spaces on the Estimate of Quantities sheet and on individual sheets as required.

3. Revise all callouts and notes appropriately so as to reflect the "as-built" condition of the structure(s). Here are a few typical examples:

   a. The proposed centerline should read "CENTERLINE" and the word "PROPOSED" should be circled and crosshatched.

   b. "TO BE" in "TO BE CONSTRUCTED" should be circled and crosshatched.

   c. The word "CONSTRUCT" should have an "ED" added so as to read "CONSTRUCTED."

   d. The word REMOVE" should have a "D" added so as to read "REMOVED."

   If an item included in the original contract was eliminated from the project, then all callouts, details and appropriate notes require revisions. If an item was omitted from

the original contract but was still constructed, then callouts, details and appropriate notes are to be added that reflect its proper location, dimensions and configuration.

All sheets that pertain to the construction of the bridge—including, but not limited to, the road plan, road and stream profiles/cross sections and bridge construction plans—should be revised as required.

4. Each dimension and elevation for an abutment, wingwall, deck, parapet and pylon, as constructed, is to be circled and crosshatched and the as-built dimension or elevation is to be entered alongside it.

5. Any details (joints, corners, rebars, etc.) that were added or revised are to be shown in the as-built configuration.

6. Any and all plan revisions that pertain to any portion of the project should be incorporated in the final set of as-built plans.

7. The structural as-built plans are to be signed and sealed by a licensed New Jersey Professional Engineer certifying that all construction was executed in accordance with the approved design calculations, approved plans, and *Standard Specifications for Road and Bridge Construction* and all supplements thereto. An electronic version of the as-built plans are to be submitted as directed by the County Engineering Division

Appendix of Publications Referenced in This Handbook

Somerset County Department of Public Works, P.O. Box 3000, 20 Grove St., Somerville, NJ 08876-1262

Supplementary Specifications
Specifications and Fee Schedules for Road Openings and Access To or Alterations Within County Right-of-Way

Somerset County Planning Board, P.O. Box 3000, 20 Grove St., Somerville, NJ 08876-1262

Somerset County Land Development Review Resolution

Somerset-Union Soil Conservation District, 308 Milltown Road, Bridgewater, NJ 08807

Soil Survey of Somerset County, New Jersey
Technical Release 55—Urban Hydrology for Small Watersheds, June, 1986

American Association of State Highway and Transportation Officials
444 North Capitol St., N.W., Suite 225, Washington, D.C. 20001

Roadway Design Guide
Standard Specifications for Highway Bridges
A Policy on Geometric Design of Highways and Streets

Chow, Ven Te (published by McGraw-Hill Book Company, 1959)

Open-Channel Hydraulics

Federal Highway Administration (FHWA), Office of Traffic Operations (HTO-20)
400 7th St., S.W., Washington, D.C. 20590

Standard Alphabets for Highway Signs and Pavement Markings
Manual on Uniform Traffic Control Devices for Streets and Highways

Harmelink, M.D., "Volume Warrants for Left-Turn Storage Lanes at Unsignalized Grade Intersections"

Highway Research Record, No. 211, 1967

Institute of Transportation Engineers, 525 School St., S.W., Suite 410, Washington, D.C. 20024

Trip Generation manual
Trip Generation Handbook
Transportation and Traffic Engineering Handbook

NJ Department of Environmental Protection, Maps and Publications
Bureau of Revenues, CN417, Trenton, NJ 08625

Technical Manual for Stream Encroachment

NJ Department of Transportation, 1035 Parkway Avenue, CN600, Trenton, NJ 08625

Roadway Design Manual
Design Manual for Bridges and Structures
Standard Specifications for Road and Bridge Construction

Manual for the Preparation of Right of Way Maps and Agreements

NJ State Soil Conservation Committee, NJ Department of Agriculture, CN330, Trenton, NJ 08625-0330
Standards for Soil Erosion and Sediment Control in New Jersey

Transportation Research Board, National Research Council, 2101 Constitution Avenue, N.W. Washington, D.C. 20418
Highway Capacity Manual

US Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161
National Engineering Handbook, Section 4, "Hydrology," August, 1972 (PB 86-180494)

US Department of Commerce, National Oceanic and Atmospheric Administration
National Oceanic Survey, Rockville, MD 20852
Input Formats and Specifications of the National Geodetic Survey Data Base