The City of Bristol, Tennessee

Infrastructure Design Standards

October 2017

GENERAL PROVISIONS

Adoption

These Infrastructure Design Standards (the "Standards") are adopted pursuant to Section 62-8 of the City's Code of Ordinances relating to ensuring the proper installation of public improvements, and under the authority conferred by Tennessee Code Title 68, Chapter 221, Part 1 and Part 11, and other applicable sections of the Tennessee Code. The Standards were adopted by Resolution No. 17-115, adopted on October 3rd, 2017 by the City Council of the City of Bristol, Tennessee.

Amendment and Revisions

The Standards may be amended from time to time as new technology is developed or the experience gained in the use of these Standards indicates a need for revision. Technical modifications to these Standards shall be approved by the City Manager. Policy changes within these Standards shall be approved by the City Council, following the recommendation of the City Manager. The Director of Public Works shall monitor the performance and effectiveness of the Standards and will recommend changes, amendments or revisions, as needed, to the City Manager.

Definitions

Throughout this document, the following definitions shall apply:

"City" shall mean the City of Bristol, Tennessee.

"TDEC" shall mean the Tennessee Department of Environment and Conservation.

"TDOT" shall mean the Tennessee Department of Transportation.

"VDOT" shall mean the Virginia Department of Transportation.

Conflicting Standards

In the event that these standards reference more than one document, and the applicable provisions of those documents conflict, then the City Engineer will determine the appropriate standard to follow.

STREET DESIGN STANDARDS

General Information

1. Streets shall be provided to give access to properties as set forth in the City Subdivision Regulations.

2. All rights-of-way shall conform to the standards as set forth in the City Subdivision Regulations.

3. Dedication of streets shall be required as set forth in the City Subdivision Regulations.

4. Street Construction shall conform to the latest revision of the TDOT *Standard Specifications for Road and Bridge Construction*.

5. The intent of the City is that all street design meets or exceeds the requirements of *A Policy on Geometric Design of Highways and Streets*, latest revision, published by the American Association of State Highway Transportation Officials (AASHTO).

6. The finished elevation of proposed public ways subject to flooding shall be no less than one foot above the regulatory flood protection elevation (the 100-Year Flood Elevation). Where fill is used to bring the finished elevation of any public way to the required elevation, such fill shall not encroach upon a floodway and the fill shall be protected against erosion by appropriate ground cover or other methods deemed acceptable by the City Engineer.

Street Plan and Profile Requirements

1. Traffic control signage and pavement markings shall be shown on the drawings and meet the requirements of the latest revision of the *Manual on Uniform Traffic Control Devices* and the City.

2. Design of traffic signals shall be per the requirements of the latest revision of the *Manual on Uniform Traffic Control Devices*, Bristol Tennessee Essential Services and the City.

3. Sidewalks shall be designed per the requirements of TDOT. Sidewalks shall be a minimum of 5-feet in width and must have curb-cut ramps designed and located to conform with the Americans With Disabilities Act and TDOT.

4. Guardrails should be provided where warranted by the AASHTO *Roadside Design Guide* and the City. The locations and design of guardrails shall be shown on the plans.

5. Streets shall intersect as nearly as possible to a 90 degree angle for a minimum of fifty (50) feet from the intersection. A proposed intersection of two (2) public ways at an angle of less than seventy-five (75) degrees shall not be permitted. No more than two (2) public ways shall intersect at any one point.

6. Centerline offsets of less than one hundred fifty (150) feet between T-type intersections shall not be permitted except where the intersected public ways have separated dual travel ways without median openings at either intersection. Where public ways intersect arterial or collector routes, their alignment shall be continuous. Intersections of arterial or collector streets shall be at least eight hundred (800) feet apart.

7. Minimum curb or edge of pavement radius at intersections shall be 25-feet for residential streets and 40-feet for non-residential local and collector streets. The intersection radius for higher order streets shall be as determined by the City Engineer. When streets of different classifications intersect, the return radius shall be determined by the value for the higher classification street. A

radius larger than shown may be required by the City Engineer based on a traffic analysis and/or the anticipated vehicular turning movements.

8. Whenever a proposed street intersects an existing or proposed street of higher classification, the street of higher classification shall be designated as the through street.

9. When designing turn lanes, the lane width shall be the same as the required width of the street through lanes. The minimum lane width shall be maintained throughout the storage length of the turn lane. The storage lane shall be a minimum of 100 feet in length. The City may require a storage lane length in excess of 100 feet based on a traffic impact study. Any deceleration taper shall be of sufficient length to meet the requirements of *A Policy on Geometric Design of Highways and Streets*, latest revision, published by AASHTO. When providing the turn lane and associated deceleration lane on a state highway, the design shall also meet the requirements of TDOT.

10. Bridge design shall meet the requirements of TDOT and the City. Bridges shall be designed so that the bottom of any part of the bridge (excluding abutments and piers) is a minimum of one foot above the regulatory flood elevation.

11. Design of street lighting shall meet the requirements of the Illuminating Engineering Society, *Roadway Lighting* and the Bristol Tennessee Essential Services.

12. Some of the minimum geometric design standards are as shown in the following tables:

Street Classification	**NUMBER OF DWELLING UNITS**					
	1 – 10		**11 – 30**		**> 30**	
	Travel Way Width (ft)	**R.O.W. Width (ft)**	**Travel Way Width (ft.)**	**R.O.W. Width (ft)**	**Travel Way Width (ft.)**	**R.O.W. Width (ft)**
Alley	12	20	12	20	12	20
Residential	22	40	24	40	28	50
Split	12	20	12	20	12	20
Loop	12	20	12	20	N/A	N/A
Non-Residential Local	28	50	28	50	28	50
Collector	40	70	40	70	40	70
Frontage	24	50	24	50	24	50

DESIGN FEATURE	MINIUMUM DESIGN REQUIREMENT	
Design Speed		
Alley	20 mph	
Residential	25 mph	
Non-Residential Local	25 mph	
Collector	35 mph	
Arterial	40 mph – subject to approval	
Maximum Grade		
Alley	12 %	
Residential	12 %	
Non-Residential Local	10 %	
Collector	8 %	
Minimum Grade		
All Streets	1 %	
Horizontal Curvature To be designed as per applicable AASHTO standards. Minimum 25 mph design speed = 198 feet.		
Maximum Superelevation To be designed as per applicable AASHTO standards. Maximum superelevation = .04 ft/ft.		
Minimum Tangent Between Reverse Curves To be designed as per applicable AASHTO standards. A minimum tangent of 50 feet must be provided on residential streets. A minimum tangent of 100 feet must be provided on non-residential local and higher classification streets.		
Minimum Vertical Geometry Sight Distance To be designed as per applicable AASHTO standards. For 25 mph: Crest K = 12, Sag K = 26		
Minimum Radius of Return at Intersection		
	Residential	Non-Residential
At edge of pavement/face of curb	25 ft.	40 ft.
Minimum Intersection Sight Distance To be designed as per applicable AASHTO standards.		
Maximum Grade at Intersections		
Alley	5 % (within 50 feet)	
Residential	5 % (within 50 feet)	
Non-Residential Local	3 % (within 50 feet)	
Collector	3 % (within 100 feet)	
Pavement Crown The pavement crown shall slope downward from the centerline of the street to the edge of the paved surface at ¼ inch per foot, except in those locations with superelevation.		
Turnaround Standards for Dead End Street (Permanent and Temporary)		
	Residential	Non-Residential
Pavement/ Face of Curb Radius	45 feet	50 feet

Difficult Terrain

When designing streets in difficult terrain developments the following standards can be utilized:

1. The maximum grade on residential shall be 15 percent. When unusual topographic or other conditions exist, portions of the street may be approved which exceed 15 percent but may be no more than 18 percent.

2. Streets can be designed with a 20 mph design speed allowing the following geometric design standards:

    a. Minimum Horizontal Curvature: Centerline Radius = 107-feet

    b. Minimum Vertical Geometry for Sight Distance for Crest Curve: K = 7

    c. Minimum Vertical Geometry for Sight Distance for Sag Curve: K = 17

3. Alternative designs such as switchbacks may be permitted in unique conditions where the standard horizontal geometry requirements cannot be met if approved by the City Engineer. Such alternative design shall meet standards of safety and shall allow for safe passing of vehicles on all two-way streets and allow for the passage of emergency vehicles

4. Street travel way widths are shown in the following table:

Street Classification	NUMBER OF DWELLING UNITS							
	1 – 10		11 – 30		31 – 50		> 50	
	Travel Way Width (ft)	R.O.W. Width (ft)	Travel Way Width (ft.)	R.O.W. Width (ft)	Travel Way Width (ft.)	R.O.W. Width (ft)	Travel Way Width (ft.)	R.O.W. Width (ft)
Residential	20	36	22	38	24	40	24	40
Split	12	50	12	50	N/A	N/A	N/A	N/A
Loop	12	20	12	20	N/A	N/A	N/A	N/A
Cul-de-Sac	18	36	22	38	N/A	N/A	N/A	N/A

Proposed Street Construction Plan and Profile Preparation

1. Stations shall be indicated on the plan view at the following locations:

    a. Every 100 feet on centerline.

    b. Points of Curvature.

    c. Points of Tangency.

    d. Street centerline intersections.

    e. Subdivision limits or construction phase limits.

    f. Turnaround radius points.

2. Existing and proposed topography at a minimum of 2-foot contour interval shall be shown in the plan view.

3. Erosion and sediment control plan and narrative shall be provided.

4. The limits of construction shall be shown on the plan view. In order to minimize the disturbance of the existing terrain, the construction limits shall be no further than 20-feet from any proposed grading shown on the plan view.

5. Existing street centerline profiles for a 250 feet minimum distance shall be shown to insure a proper grade tie when a proposed street is an extension of an existing street.

6. When a proposed street intersects with an existing street the centerline profile of the existing street shall be shown for a 250 feet minimum distance to the right and left of the proposed intersection.

7. A profile centerline grade line of all proposed street construction shall include:

    a. Percent of grade of tangent lines. The minimum grade for streets shall be one (1) percent. The maximum grade of street construction shall be 12 percent for residential streets, 10 percent for non-residential local streets and 8 percent for collector streets.

    b. Elevations and stations at the beginning and the end of all vertical curves.

    c. The length of vertical curves.

    d. The elevations computed every 100 feet on all tangent sections, and elevations computed every 25 feet in all vertical curves.

    e. Elevations and stations at all:

        (1) Centerline intersections of streets.

        (2) Street centerline intersections with the boundaries of a subdivision or phase of construction.

        (3) Curb inlets.

8. All proposed and existing culverts, storm sewer crossings, sanitary sewer crossings, water line crossings and other utility crossings shall be shown on the street profiles at the proper location and grade when known.

9. Grade profiles of proposed curb and gutter construction in cul-de-sacs are to be computed along the face of the curb starting at the beginning of the curb return, following counter clockwise the face of curb around the cul-de-sac thence to the end of the return opposite the point of beginning.

10. If a temporary cul-de-sac is to be constructed at the end of a street which is intended to be extended with the development of the abutting property, the proposed grade and centerline profile shall be carried through to provide for the future extension of the proposed street for a distance of 300 feet beyond the subdivision boundary.

11. Street construction shall be provided along the full frontage of all lots.

12. All street improvements must be constructed within the dedicated street right-of-way.

13. The maximum centerline grade of permanent cul-de-sacs may not exceed five (5) percent.

14. If a difference exists in elevations on proposed curb grades on opposite sides of the street, curb elevations showing top of right curb and top of left curb shall be shown on the plans.

15. A profile of all curb returns at street intersections must be shown on the plans.

16. Street landings shall be provided at all intersections. A minimum 50-foot landing with a maximum grade of five (5) percent must be provided for residential streets. Non-residential local streets require a minimum 50-foot landing with a maximum grade of three (3) percent. Collector streets require a minimum 100-foot landing with a maximum grade of three (3) percent.

17. The minimum intersection sight distance for all streets shall be as required by *A Policy on Geometric Design of Highways and Streets*, latest revision, published by AASHTO. When connecting to a State Highway, the sight distance shall also meet the requirements of TDOT. The City may require more stringent sight distance requirements than previously stated in the interest of motorist and pedestrian safety. Commercial entrances are considered street intersections for the purpose of sight distance calculations. The City Engineer may require the plans to show a profile of the sight distance line to determine if adequate distance is available at the proposed intersection location.

STORM DRAINAGE DESIGN STANDARDS

General

Drainage Systems

1. The overall drainage system is divided into two parts, the minor system and the major system.

a. The minor drainage system (normally designed for the 10-year storm) consists of storm sewer appurtenances and conduits such as inlets, manholes, street gutters, roadside ditches, swales, small underground pipes and small channels which collect the storm water runoff and transport it to the major drainage system.

b. The major system (designed for the less frequent storm up to the 100-year event) consists of natural waterways, large man-made conduits, and large water impoundments. In addition, the major system includes some less obvious drainage ways such as overland relief swales and infrequent temporary ponding at storm sewer appurtenances. The major system includes not only the trunk line system, which receives the water from the minor system, but also the natural backup system which functions in case of overflow from or failure of the minor system. Overland relief must not flood or damage houses, buildings or other property.

2. The intent of these regulations is to require that public facilities meet or exceed applicable drainage laws.

3. Special attention is invited to:

    a. The most current version of the TDEC *Tennessee Erosion and Sediment Control Handbook*.

    b. The most current version of the VDOT *Drainage Manual*.

    c. The most current version of the VDOT *Road and Bridge Standards.*

    d. The most current version of the TDOT *Drainage Manual*.

    e. The most current version of the TDOT *Standard Roadway Drawings* and *Standard Structure Drawings*.

Remarks

1. Designers and reviewers are encouraged continually to seek better solutions to the design of drainage systems.

2. These storm drainage policies, guidelines, criteria and standards will continually be re-evaluated as additional research and basic information becomes available.

Policy And Requirements For Adequate Drainage

Minimum Requirements

1. The drainage system must have the hydraulic characteristics to accommodate the maximum expected flow of surface waters for a given watershed, or portion thereof, for the duration and intensity of rainfall as specified in this Section.

2. Determination of the size and capacity of the drainage system shall be based on the planned development, existing zoning or existing development, whichever is greater, within the watershed.

3. The drainage system shall be designed:

    a. To honor natural drainage divides,

    b. To account for both off-site and on-site surface waters,

    c. To convey such waters to a natural watercourse or an existing storm drainage facility,

    d. To discharge the surface waters into a natural watercourse at the natural elevation, or into an existing facility of adequate capacity.

4. The drainage system shall be designed such that the properties, over which the surface waters are conveyed, from the development site to the discharge point(s), are not adversely affected.

5. Concentrated surface waters shall not be discharged on adjoining property, unless an easement expressly authorizing such discharge has been granted by the owner of the affected land or unless the discharge is into a natural watercourse, or other appropriate discharge point as set forth above.

6. The owner or developer may continue to discharge storm water which has not been concentrated into a lower lying property if:

    a. The peak rate after development does not exceed the predevelopment peak rate,

    b. The increase in volume caused by the development will not have an adverse impact on the lower lying property, and

    c. There is no existing drainage problem on the downstream property.

7. If the discharge conditions are not met and the discharge may aggravate an existing drainage problem or cause a drainage problem, the developer must provide a drainage system satisfactory to the City Engineer, to preclude an adverse impact upon the adjacent or downstream property.

8. Drainage structures shall be constructed in such a manner that they may be maintained at a reasonable cost. To facilitate design, construction, and maintenance, drainage facilities shall meet and conform, insofar as practical, to City, TDOT standards or VDOT standards.

9. If off-site downstream construction and easements are necessary to obtain an adequate outfall, no plans shall be approved until such storm drainage easements, extending to the nearest natural and well-defined, adequate, stabilized watercourse, or adequate man-made drainage channel or pipe, have been obtained and recorded.

10. Storm sewers shall be discharged into the area least likely to erode.

    a. Generally, discharging at the floodplain limit into an adequate watercourse channel leading to the main streambed is better than disturbing the floodplain by extending the storm sewer.

    b. If an adequate watercourse channel does not exist the only alternative is to discharge into the main streambed.

    c. In either case, energy dissipation devices are required.

11. The requirements of the City set forth in this Section relating to erosion and sedimentation control, and the further requirements for protection of stream-beds by the detention or retention of surface waters must be satisfied.

12. All drainage ways, including overland relief pathways, must be separated from buildings.

13. Consideration must be given in the preparation of the plans to preclude adverse impacts due to higher rates and volumes of flow that will occur during construction.

14. In those cases in which the drainage plans of a proposed development do no satisfy these minimum requirements because the necessary off-site facilities or improvements are lacking, the developer shall delay development until the necessary off-site facilities or improvements are constructed or other arrangements suitable to the City are made.

    a. In such event, the plat or plans, if otherwise satisfactory, will be approved when the requirements of this Article are satisfied.

    b. Alternatively, the developer may choose to supply the off-site facilities that are necessary for adequate drainage.

Submission of Narrative Description

1. In addition to plats, plans, and other documents that may be required, a description of the outfall of the storm drainage system and of non-concentrated discharge(s) of surface waters from the development site shall be submitted as part of the relevant subdivision construction plan or site plan unless the provisions of paragraph 8 of this section apply.

    a. The additional submission shall include a narrative, computations and sketches describing the major elements (pipe, channel, natural watercourse stream, etc.) of the outfall drainage system(s), including discharges of non-concentrated surface waters from the development site.

    b. The downstream review, divided into reaches, shall note the existing surrounding topography, soil types, embankments, vegetation, structures, abutting properties, etc., which may be impacted by drainage and shall conclude with a written opinion, signed and sealed by the designer as to the adequacy of the downstream system(s) for the critical storm return period.

2. Where erosion is an issue, the critical storm return period referred to in the preceding paragraph normally would be the two-year storm.

3. Where an existing facility is at issue (such as a storm sewer system, highway culvert, etc.), the return period would be that storm return frequency which begins to exceed the capacity of the existing facility up through the normal design standard for that type of facility.

4. Where house flooding is involved, the critical storm return period normally would be the storm that begins to flood the structure up through the 100-year flooding event.

5. Where open streams are involved, the designer must assess the stream adequacy to receive the two-year run-off without causing erosion or over-bank flooding.

6. The downstream extent of this review shall be:

    a. To the point at which an adequate channel is found; or

    b. To the point at which the total drainage area is at least 100 times greater than the area of the development site in question; or

c. To the limit of the nearest 100-year floodplain.

7. The City Engineer shall have the right to require further downstream analysis, where the submitted narrative and all related plats and plans are insufficient to show the true impact of the development on the surrounding and other lower lying properties.

8. The narrative description may be omitted when the storm sewer discharge is into a pipe or other drainage system meeting current design standards and the peak rates of non-concentrated flows onto adjoining properties are not increased by the development.

Policy On Detention Of Storm Waters

General

1. The intent of this policy is to encourage the design of developments to minimize the adverse effects of increased storm water runoff on all downstream drainage ways.

2. The intent of this policy is to encourage a regional approach in the implementation of storm water detention, rather than numerous small, marginally effective individual on-site ponds.

3. Detention facilities must be provided in all storm drainage plans proposed for development in the City unless waived by the City Engineer.

4. The developer, property owner, homeowners association and/or other private entity shall be responsible for maintenance of detention facilities unless otherwise approved by the City.

Detention Measures

1. Except where otherwise prohibited, detention, either alone or in a combination with other measures, is an acceptable option for meeting the City and State requirements for protecting receiving waterways from erosion and flooding resulting from development run-off.

2. Detention of storm water is desirable in many cases to alleviate existing downstream drainage problems and to preclude the development of new ones.

    a. Detention is mandatory where the existing downstream drainage system is clearly inadequate and its expansion or improvement is either financially prohibitive or unacceptable for aesthetic or other compelling reasons.

    b. In some areas of a watershed, detention may cause increased peak flows to occur on the major streams and tributaries. Therefore, the downstream impact must be carefully investigated.

    c. The City reserves the right to prohibit detention of storm water where and when detention of the storm water is not in the best interest of the City as determined by the City Engineer in his or her sole discretion.

3. The release rate from ponding areas shall approximate that of the site prior to the proposed development for the design storm, but adequate alternate drainage must be provided to accommodate major storm flows.

4. Detention ponds should be designed to reduce peak runoffs downstream by providing adequate storage.

a. Care must be taken to ensure that such ponds do not become nuisances or health hazards.

b. The licensed design professional should strive to design detention facilities that require minimal maintenance. The maintenance responsibility shall be clearly stated on the plans.

c. Where dual-purpose facilities are provided, flat grades encountered, or poor draining soils found, provisions for adequate low flow drainage may be required.

Location of Detention Facilities

1. All detention facilities that receive storm runoffs from public infrastructure shall be within a storm drainage easement.

2. Although this policy is primarily concerned with maintaining post-development peak outflow at the level of the pre-development condition, this policy may be applied under certain conditions for the purpose of correcting an existing inadequate outfall. When used in this fashion, such a facility also may aid in meeting the requirement for adequate detention.

3. Wherever storm water management facilities are planned in areas within 300 feet of a residence or active recreational area, special design attention shall be directed toward the safety aspects of the facility including such factors as mild bottom slopes along the periphery of a detention pond extending out to a point where the depth exceeds two feet, flat lateral and longitudinal slopes where concrete low flow channels are used, outlet structures with properly fastened trash racks which will inhibit unauthorized entrance, and posted warning signs.

4. In addition, credit for recreational open space shall not be allowed in those areas where detention facilities are located unless the area can reasonably be used for recreational purposes. For example, some detention ponds could be used for active recreational use if the low flows are totally separated from the play areas by a piping system.

5. Underground detention facilities may not be used in residential developments, including townhouses, condominiums and apartments. Underground detention facilities may be used in other commercial and industrial developments where private maintenance agreements are executed and are not located in a City storm drainage easement.

Policy On Off-Site Drainage Improvements

Purpose and Intent

In the interest of the health, safety and welfare when the appropriate land use has been determined for any area to be developed, the City reserves the right to require the developer to show that off-site downstream drainage can be accommodated (considering the planned development of the contributing watershed) without damage to existing facilities or properties before such development is approved for construction.

Policy On Development In Floodplains

Purpose and Intent

The purpose of floodplain management is to promote the public health, safety and general welfare, and to minimize public and private losses due to flood conditions in specific areas. Floodplain management is designed to:

1. Restrict or prohibit uses that are vulnerable to water or erosion hazards, or which cause damaging increases in erosion, flood heights, or velocities.

2. Require that uses vulnerable to floods, including community facilities, be protected against flood damage.

3. Control the alteration of natural floodplains, stream channels, and natural protective barriers that accommodate floodwaters.

4. Control filling, grading, dredging and other development that may increase erosion or flood damage.

5. Prevent or regulate the construction of flood barriers that will unnaturally divert floodwaters that may increase flood hazards.

General

Development in the floodplains of the City must be per the requirements of the Floodplain Management Ordinance found in Chapter 7 of the City Planning and Zoning Ordinance.

Hydrologic Design

Acceptable Hydrologies

1. All retention and detention facilities must be designed utilizing the Soil Conservation Service (SCS) Technical Release Number 20 and Technical Release Number 55 methodology.

2. Storm drainage systems can be designed utilizing the Rational Formula or the SCS TR-55 methodology. The Rational Formula can only be used when the contributing drainage area to a storm drainage system is less than 100 acres.

Soil Conservation Service Hydrology

The Soil Conservation Service (SCS) Hydrology consists of *Technical Release Number 20* (TR-20) and *Technical Release Number 55* (TR-55). This hydrology is preferred and acceptable for all applications

Rational Formula

The Rational Formula, Q = CIA, is acceptable for design of drainage systems where the contributing drainage area is less than 100 acres, except the rational method is not authorized for designing detention/retention facilities.

Q = Rate of run-off in cubic feet per second
C = Run-off coefficient (ratio of run-off to rainfall)
I = Rainfall intensity in inches per hour
A = Area of drainage basin in acres

1. Run-off Coefficient (C): The run-off coefficient used to compute flow to the point of interest shall be the composite of the “C” factors for all the areas tributary to the point of interest. Table B-1 at the end of this section provides examples of run-off coefficient values.

2. Rainfall Intensity (I): The rainfall intensity shall be determined from the rainfall frequency curve provided in the Figure at the end of this section. The 10-year frequency shall be used to design storm drains of minor drainage systems; the 100-year frequency curve shall be used to design drainage ways of major drainage systems.

3. Time of Concentration (tc): The time of concentration is the time required for water to flow from the hydraulically most remote point of the drainage area to the point under investigation. Flow time in conduits may be estimated by the hydraulic properties of the conduit. Inlet time is the time required for the run-off to reach the inlet of the storm sewer and includes overland flow time and flow time through established surface drainage channels such as swales, ditches and street gutters.

    a. The recommended minimum inlet time is five (5) minutes.

    b. When estimating inlet times the following suggestions are made to assist the designer:

        1. Estimate the overland time, time for run-off to reach established surface drainage channels such as street gutters and ditches.

        2. Estimate the time of flow through the established surface drainage channels from the channel's hydraulic properties.

    c. Judgment should be used in estimating the time of concentration or any portion of the time of concentration. Often the initial time may be based on the first few inlet areas.

        1. If the uppermost area has a low runoff rate with long times of concentration, and major portions of the lower area have high runoff rates with short times of concentration, then the first inlet time may not necessarily be based solely on its own land use.

        2. The above statements also would be true of the converse case; that is, the uppermost area producing high runoff rates with short times of concentration and the lower areas producing low runoff rates with long times of concentration.

4. Area (A): Areas shall be determined from field run topography, current U.S. Geological Survey quadrangle sheets, or City Topographical Maps. Watershed maps showing applicable divides, contributing areas and adopted Comprehensive Plan recommendation or existing zoning, whichever is greater, must accompany all computations.

Other Hydrologies

The City recognizes that many hydrologies are available, especially in the form of computer software. The City Engineer may approve other hydrologies for specific applications provided that the alternatives are demonstrated to be appropriate for the purpose intended.

Closed Conduit System

Design Flow

The closed conduit system shall be designed for a 10-year rainfall frequency when the intended use is to function as the minor drainage system. Design flows shall be determined by the methods previously discussed and pipes will be sized by the amount of run-off actually entering the system.

Storm Sewer Pipe

1. The size of the storm sewer pipe may be determined utilizing the Manning Formula.

2. Adjustments of pipe sizes as determined by the Manning Formula may be necessary due to hydraulic gradient considerations. Other guidelines related to size and configuration of storm sewer pipe are as follows:

a. The Minimum size of pipe will be 15 inches in diameter.

b. Pipes shall be designed for flows intercepted by the inlets.

c. Pipes 18 inches in diameter and larger may be constructed on horizontal curves. The maximum allowable curvature will be based on the manufacturer's recommended maximum curvature.

d. The maximum length between access openings shall not exceed 400 feet for pipes less than 36 inches in diameter or 800 feet for pipes 36 inches in diameter or greater. Access openings may be in the form of an inlet, manhole, junction box or other approved appurtenance.

e. Prefabricated tee sections, wye sections and bends are not permitted.

f. Any changes in horizontal and vertical alignment shall require and access opening. An exception to this is the horizontal curvature allowed in 18 inch and larger pipe.

g. In general, there may not be a reduction in pipe size greater than one increment along the direction of flow.

h. Minimum cover for storm sewer pipe shall be three (3) feet from finished grade to the outside top of pipe, except where approved structural correction is provided when cover requirements cannot be met.

i. Minimum easement widths shall be 20 feet for pipe sizes less than 36 inches in diameter and 30 feet for pipe sizes from 36 inches to 72 inches in diameter. Where multiple pipes are installed, the edge of the easement shall be ten (10) feet clear of the outside wall of the pipe. No storm drainage pipe shall be installed within five feet of a building foundation loading plane, or closer than 15 feet to the building foundation, whichever is greater. Storm sewers to be maintained by the City shall be within dedicated storm drainage easements.

j. Storm sewers shall be designed to provide an average velocity when running full of not less than two and one half feet per second.

k. The need for concrete anchors must be investigated on storm sewer lines with slopes of 20 percent or greater. If anchors are required, the design professional shall show a detail on the plans of the spacing requirements and anchor geometry.

l. All storm sewer pipes shall be Class III or higher, Reinforced Concrete Pipe (RCP) or High Density Polyethylene Pipe (HDPE).

m. When storm sewers are provided, they shall not outfall in the front yard of a lot, but shall be extended at least to within 20 feet of the rear property line in lots up to one half acre in size and at least 50 feet to the rear of the house on larger size lots. If the storm sewer outfalls on a lot or adjacent to a lot on which a building exists that will remain, the building must be shown with topography of the area between the building and the outfall. Finished floor elevations of the building shall also be provided.

n. In general, drainage facilities may not be terminated short of the subdivision boundary unless an adequate outfall exists at this point.

Pipe and Culvert Materials

Pipe and culvert materials acceptable for storm drain construction with the accompanying roughness coefficients are shown below:

Material	Manning "n"
Reinforced Concrete Pipe, Class III or higher	0.013
HDPE Pipe	0.013

Energy and Hydraulic Gradients

The hydraulic grade line (HGL) for pressure flow is the piezometric surface, i.e. the height to which water will rise in a piezometer. The HGL for open channel flow is equal to the water surface elevation. The energy grade line (EGL) is the line showing the total energy of the flow above some arbitrary horizontal datum. The vertical distance between the HGL and EGL is the velocity head.

1. At storm sewer junctions the total energy loss at the junction is the difference in elevation between the energy grade lines of the upstream and downstream pipes. To establish these gradients for a system requires starting at a point where the hydraulic and energy gradients are known or can readily be determined.

2. Generally, when the energy and hydraulic gradients must be determined, the pipes are assumed to have uniform flow.

3. The total energy loss at a junction is assumed to be made up of one or more of the following losses:

    a. Expansion loss when storm water enters the junction.

    b. Contraction loss when storm water leaves the junction.

    c. Bend loss due to the change in horizontal direction of storm water velocity.

4. Storm sewer systems generally shall be designed as non-pressure systems. In general, if a drop in the structure between the inverts of the incoming and outgoing pipes is approximated by a value equal to or greater than the junction energy loss, the system can be assumed to be non-pressure flow.

5. Storm sewer systems may be designed for pressure flow if approved by the City Engineer in the preliminary design stage. The hydraulic gradient for the design flows shall not be above the elevation of one foot below the established ground elevation nor more than five feet above the crown of the pipe. For curb opening inlets the gutter flow line is considered the established ground elevation.

6. If possible the energy losses through a junction should be accounted for by a drop across the junction equal or greater than the junction energy loss.

Closed Conduit Design Calculations

In general, design calculations required for submittal to the City are as follows:

1. A copy of the drainage plan showing drainage divides, contributing areas and the adopted Comprehensive Plan or existing zoning, whichever allows the densest development.

2. Storm water run-off quantities, drainage areas and runoff coefficients.

3. Pipe design calculations:

    a. For storm sewer systems or portions of systems designed for pressure flow, a storm sewer profile with energy and hydraulic gradients drawn on the profile shall be submitted.

    b. Energy and Hydraulic gradients do not need to be submitted for non-pressure systems.

4. Energy loss calculations at storm sewer junctions.

Open Channels

Design Criteria

1. In general, roadside and median ditches shall be designed with sufficient capacity to contain the runoff for a 10-year storm. For determining whether or not special linings will be required to prevent erosion and the lining dimensions, the 2-year storm shall be used.

    a. All special channels shall be designed for storm frequencies in accordance with the importance of the road and its vulnerability to inundation, should the capacity be exceeded.

    b. Where the velocity exceeds the allowable velocity as determined from the type of soil the channel is constructed from, the ditch shall be lined.

    c. If the newly constructed channel alongside, or leading from, any street providing access to lots to be occupied, or through, or alongside any such lots, is not well stabilized within 120 days after initial attempts to stabilize, or 120 days after issuance of any residential or nonresidential occupancy permit for such lots, whichever occurs first, the channel must be lined with concrete.

    d. In the event that the channel is constructed during winter months the 120 days shall run from March 15 the following spring.

    e. Well stabilized shall mean a good stand of grass must be growing and not showing any visible evidence of erosive forces. Sod shall be growing well and knitted into the underlying soil.

Channel Size and Shape

1. The size of a channel shall primarily be established by the Manning Formula.

2. General guidelines related to the size and shape of channels are:

    a. Low flow sections should be considered in the design of channels with large cross-sections.

    b. Channel bottom widths greater than 10 feet shall be built with a minimum cross slope of two percent (2%).

    c. The side slopes of a channel shall be a function of the channel material. The side slopes throughout the entire length of a channel shall be stable.

    d. Channels to be constructed on horizontal curves should be investigated to see if the channel section must be modified due to superelevation of the water.

e. A minimum 20-foot drainage easement shall be provided for all channels with a top width up to 10 feet. The easement width for channels with a top width of greater than 10 feet is 15 feet plus the channel top width with a minimum of 5 feet on one side.

f. All channels to be maintained by the City shall be within dedicated Storm Drainage Easements.

Channel Design Calculations

In general the following design calculations shall be required for submission of plans to the City:

1. Design flows shall be determined by use of the Manning Equation.

2. Contributing drainage area including a drainage divide map and runoff coefficients.

3. Channel capacity calculations shall be shown for each section of the channel with similar properties. The calculations shall include flow for the 2-year, 10-year and 100-year storm events. The velocity and depth of flow for these events must also be provided.

4. A note shall be place on the plans stating “All grass-lined channels must be in a well stabilized condition and show no signs of erosion at the time of final acceptance by the maintaining authority”.

5. Typical channel cross-section and slope shall be shown.

6. The plans shall show the channel lining or ground cover that will be utilized to prevent erosion.

Storm Sewer Appurtenances

General

1. Wherever possible storm sewer appurtenances should conform to the current version of TDOT *Standard Roadway Drawings*, TDOT *Standard Structure Drawings* or the VDOT *Road and Bridge Standards*. Special designs are subject to the approval of the City Engineer.

2. Storm sewer appurtenances shall be designed for the run-off generated by the 10-year frequency storm.

Curb Inlets

The length of the curb inlet opening is dependent on the inlet location, pavement, geometry, and the amount of flow approaching the inlet. General guidelines pertaining to design of curb inlets in streets are as follows:

1. Water shall be picked up on continuous grades of residential streets before the spread into the street exceeds one-half the travel way in each direction or 10 feet from the face of the curb, whichever is less, for a rainfall intensity of 4 inches per hour.

2. Storm water shall be picked up on continuous grades of non-residential local and collector streets before the spread into the street exceeds one-half the travel way in each direction or 8 feet from the face of the curb, whichever is less, for a rainfall intensity of 4 inches per hour.

3. In general inlets on continuous grades should be designed to intercept 100 percent of the flow for a rainfall intensity of 4 inches per hour. Inlets on continuous grade can be designed with a

percentage of the 10-year storm flow bypassing the inlet. Any bypass flow must be accounted for at the next downstream inlet.

4. The spacing of inlets on continuous grades is governed by the spread of flow in the street.

5. Inlets in sumps must be designed to take flow from the inlets drainage area land any bypass flow that may occur from upstream inlets.

6. Sump inlets located in streets shall be designed with the same spread criteria as stated previously for inlets on continuous grades.

    a. The spread requirements must be met at the point above the sump location where the street grade is 0.2 percent. The design flow to a sump inlet from each direction must be calculated.

    b. Adherence to the spread requirements is not necessary at the 0.2 percent street grade for inlets at sump locations within the turnaround of a cul-de-sac. However, flow depth, flow direction and grading must be checked and the turnaround designed to prevent local flooding of adjacent property.

    c. The amount of flow to the sump inlet must be checked to see that the flow is not directed at driveway entrances where the storm water could “jump” the curb.

    d. Appropriate overland relief must be provided in sump areas for storm events that exceed the 10-year intensity.

    e. The minimum length of inlet throat at sump locations shall not be less than six (6) feet.

7. All inlets must be designed to intercept the 10-year storm flows without the flow topping the curb.

8. When street grades are less than two (2) percent, a maximum of two (2) cubic feet per second may be allowed to cross the intersections of residential streets. Flows in excess of two (2) cubic feet per second but no more than four (4) cubic feet per second will be allowed to cross intersections of residential streets when the grade across the intersection is two (2) percent or greater.

9. No flows shall be allowed to cross non-residential local, collector or higher category streets.

10. The length of curb inlet throats shall not be less than two and one half (2.5) feet.

    a. Curb inlets in streets can easily be designed in accordance with the above guidelines by use of the Charts in the VDOT *Drainage Manual*.

11. Curb inlets shall not be built within curb returns.

12. The most common type of inlet to be utilized in design is the TDOT Number 10 series, VDOT DI-3B series for inlets on grade and the VDOT DI-3C series for inlets in sump locations.

Yard Inlets

1. Yard inlets should be designed to intercept the 10-year storm flows.

2. Yard inlets should be positioned in such a way that they intercept all the design flow approaching the inlet.

3. Any area that is inundated by water ponding at a yard inlet for the 10-year storm flows shall be within a storm drainage easement.

Grate Inlets

When grate inlets are utilized in sumps and on grades in conjunction with throat inlets, the additional interception capacity of the grate shall not be utilized in calculating the inlet interception capacity of the inlet.

Open Top Structures

Open top structures are not permitted.

Energy Dissipation Devices

1. The terminal ends of all pipes and paved channel storm sewer systems shall be evaluated to be sure that the receiving surface will experience no erosion due to the design discharge.

2. Where the design discharges have velocities greater than the erosive velocity of the receiving surface, an energy dissipation device shall be designed or a standard energy dissipation device shall be specified.

3. When riprap is used for erosion control, the riprap shall be sized according to the velocities at the receiving surface and in accordance with the Tennessee *Erosion and Sediment Control Handbook.*

Drainage in Residential Areas

The intent of the section is to utilize closed conduit systems for residential subdivisions that utilize curbed roads.

1. General guidelines to be observed in drainage design in residential subdivisions developments in which curbed roads are required:

    a. No quantity of design surface runoff across lots shall be erosive.

    b. Quantities of surface runoff greater than two (2) cubic feet per second that flow through lots shall be picked up and conveyed in a closed storm drainage system except the City Engineer may approve an open channel where the preservation of a natural drainage way is desirable or the use of an open channel will not interfere with use of the property.

    c. Lots generally shall be graded in such a manner that surface runoff does not cross more than three lots before being collected in a storm sewer system. This system may be open channel, closed conduit, or a combination of both.

2. The following general guidelines are to be observed in drainage design in residential subdivisions in which ditch section streets may be utilized:

    a. No quantity of design surface runoff across lots shall be erosive.

    b. Drainage from rights-of-way should flow in an easement along lot lines whenever possible.

    c. Once drainage is concentrated in rights-of way, the storm water shall be transferred to a logical point of discharge, preferably a storm sewer system, either open channel, closed conduit, or a combination of both.

    d. In fill sections, a ditch at the toe of a fill may be necessary. If the toe of the fill area is outside of the right-of-way, the drainage ditch must be in an easement.

3. If, at the time of design plan submission, the developer has not established how drainage concentrated in the rights-of-way ultimately will be handled, the affected lots shall be restricted until such time as a grading plan showing ultimate drainage disposition has been submitted and approved.

Inlet Design Calculations

In general, design calculations required for submission to the City are as follows:

1. A calculation showing the spread of gutter flow in the street is within the allowable range.

2. Calculations showing the percent of interception of gutter flow.

3. Capacity calculations for all inlets.

4. Evaluation of the terminal ends of piped and paved ditch systems for the possible need of energy dissipation devices.

5. A drainage divide plan that clearly shows all the on-site and any off-site acreage and the runoff coefficient for each inlet.

6. Calculations should be provided for both the 4 inch per hour intensity storm and the 10-year storm event.

Culverts

Design Flow

1. Culverts shall generally be designed for the 25-year rainfall frequency when crossing under non-residential local roads or higher classification.

2. Culverts under residential roads shall be designed for the 10-year rainfall frequency.

3. Culverts shall be checked for the effects of the 100-year storm. No flooding of building structures shall result from the 100-year design flow.

Size

1. In general, culverts shall be hydraulically designed in accordance with the latest version of the Federal Highway Administrations *Hydraulic Design of Highway Culverts*.

2. General guidelines in selection of culvert size are as follows:

    a. Headwater depth for design discharge shall not exceed a height greater than one and one-half (1.5) feet below the edge of the shoulder of a road

    b. In general the maximum allowable headwater above the crown of a culvert shall not be greater than five (5) feet.

    c. Headwater depth for the design discharge shall not cause water to rise above the top of approach channels that are adjacent to improved land or above the established floodplain easements.

d. Headwater depth at design discharge shall cause no flooding of existing or proposed building structures.

e. Outlet velocities shall be calculated. If outlet velocities equal or exceed erosive velocities of channel linings, then riprap or some other form of energy dissipation device shall be placed at the culvert outlet.

Culvert Materials

Unless otherwise approved by the City Engineer, all culverts shall be reinforced concrete pipe, minimum Class III.

Retention And Detention Facilities

General Requirements

1. Storm water retention and detention facilities are incorporated in the design of storm drainage systems to reduce the peak rate of discharge of the drainage system, reduce downstream erosion problems, possibly reduce the capital cost of the drainage system and help eliminate the environmental problems normally associated with the increased runoff of storm waters from new developments.

2. Detention measures are extremely helpful for development in areas where downstream storm drainage systems are not adequate to receive the increased run-off being generated by the upstream development. These detention measures may be an adequate manner for meeting offsite drainage requirements.

3. Some methods for achieving storm water detention are as follows:

   a. Parking lot storage.

   b. Retention and detention ponds.

   c. Recreation area storage.

   d. Road embankment storage.

   e. Street and secondary drainage system storage during extreme intensity storms.

4. The 2-year, 24-hour and the 10-year, 24-hour storms shall be used for the design of retention and detention facilities.

5. Emergency spillways in ponds shall be designed to discharge the 100-year, 24-hour storm.

6. Design of retention and detention facilities require the determination of actual volumes of rainfall occurring in a specific time and the actual volume of storm runoff in the same specified time. Routing of these volumes shall be incorporated into the design calculations.

7. Other design parameters include the maximum allowable rate of runoff, characteristics of the developed area, and limitations of the developed area such as the maximum size of storage basin that can be incorporated in the topography.

Retention and Detention Ponds

1. Small ponds created by constructing low earth dams across natural drainage courses or by excavating and regrading of a development site to provide capacity for storm water runoff detention.

    a. Storm water permanently retained in these ponds may be considered a potential resource suitable for a variety of uses, including fire fighting, irrigation supplies and recreational sources.

    b. In addition to providing storm water discharge reduction capabilities, detention ponds provide storage for sediment and pollution control in runoff, especially during the construction phase of development.

    c. If embankments are used to dam natural drainage courses, they must be designed according to accepted practices, both engineering and environmental.

2. Detention ponds and their primary outlet or spillway shall be designed to detain the increased runoff generated by development of a site based on the 2-year and the 10-year frequency storms. Emergency or secondary spillways for detention ponds shall be designed using the 100-year frequency storm, and the storm runoff hydrograph shall be routed through the detention facility to determine the spillway design capacity to carry this event.

3. Outlets and emergency spillways shall be placed on either undisturbed ground or on a stabilized foundation and not in fill areas.

4. Design calculations for detention ponds shall be submitted with the site drainage plan and shall generally include the following:

    a. Hydrographs of the 2-year, 10-year and 100-year storm inflow to the facility.

    b. Volume of storage vs. depth of storage curve.

    c. Outlet design calculations.

    d. Head discharge curve for the selected outlet size.

    e. The routed discharge hydrograph from the facility for the 2-year, 10-year and 100-year inflows.

    f. Emergency spillway design calculations for ponds with storage in excess of two acre-feet shall include a freeboard safety factor such that the top of the dam is a minimum of two feet above the crest elevation of the emergency spillway and a minimum of one foot above the maximum design stage of the 100-year frequency emergency spillway design storm.

    g. Calculations or effects (if any) on established floodplain boundaries.

5. Other items that shall be included with or on the plans are:

    a. When possible, the shape of the pond should conform to the natural topography.

    b. Identification of required easements.

    c. Landscaping and fencing around detention ponds when access exposes the public to unusual risk.

d. Properly executed maintenance agreements when required.

Maintenance Design Considerations

1. The maintenance of storm water management facilities is considered to be a primary concern to the City and to the future operations of these facilities.

2. Design Professionals in the preparation of plans for construction are urged to include maintenance and operation of these facilities as one of the primary design considerations.

3. The following shall be included in design considerations:

    a. All access ways shall be designated on plans and cleared, graded, or constructed with the facility construction.

    b. Proximity of facilities to the public right-of-way shall be considered in order to minimize the length of access-way.

    c. Multiple accesses should be provided to major facilities.

    d. Ingress/egress easements must be established for access-ways.

    e. Grading of the access to and around facilities shall not create steep slopes (maximum 4:1), in order to accommodate easy maintenance-vehicle access.

    f. To be considered accessible, major facilities including wet ponds, underground chambers, etc., shall have accessibility with at least one all weather access roadway to include a minimum of ten foot wide surface to the satisfaction of the City Engineer.

    g. As these facilities are generally in close proximity to dwellings and may be subject to vandalism, principal spillways and other devices shall be designed to minimize tampering.

    h. The design of dry pond bottoms shall include a concrete trickle ditch from the principal inlets to the outlets. The minimum pond floor slope shall be 2% into the trickle ditch.

    i. Where trash racks are provided, they shall be removable as a unit by unbolting, without destroying the structure.

Recommended Coefficient Of Runoff Values For Various Selected Land Uses

Description of Area	Runoff Coefficients
Business: Downtown Areas	0.70 - 0.95
Neighborhood Areas	0.50 - 0.70
Residential: Single-Family Areas	0.30 - 0.50
Multi Units-Detached	0.40 - 0.60
Multi Units-Attached	0.60 - 0.75
Suburban	0.25 - 0.40
Residential (1/2 Acre Lots or Larger)	0.30 - 0.45
Apartment Dwelling Areas	0.50 - 0.70
Industrial: Light Areas	0.50 - 0.80
Heavy Areas	0.60 - 0.90
Parks, Cemeteries	0.10 - 0.25
Playgrounds	0.20 - 0.40
Railroad Yard Areas	0.20 - 0.40
Unimproved Areas	0.10 - 0.30

WATER LINE DESIGN STANDARDS

General Information

1. All newly constructed subdivisions within the corporate limits of the City shall provide a public water supply approved by the water authority of jurisdiction, the City and the TDEC.

2. All water systems located in a flood prone area shall be floodproofed to the regulatory flood protection elevation. All water supply facilities located below the regulatory flood protection elevation shall be designed to prevent the infiltration of floodwaters into the water supply system.

3. All water systems shall be constructed utilizing materials that comply with all federal, state and local materials specifications.

General Requirements

1. All water mains, their sizes, valves, fire hydrants, etc. and their relationship to other utilities shall be shown on design plans as indicated below:

    a. Wherever practical, water lines and the associated appurtenances shall be placed outside of paved areas. In general, water lines shall be placed a minimum of 5 feet behind the curb line on curb and gutter streets and in the shoulder on ditch section streets. Placement of water lines under sidewalks should also be avoided where practical.

    b. Water lines should be placed in public rights-of-way where possible. A minimum 20-foot utility easement is required for all water lines placed outside of public rights-of-way. The City Engineer may require a larger easement based on site conditions, size of water line, water line depth or other unusual conditions.

2. Design Criteria:

    a. All water main construction shall comply with the requirements of the public water authority of jurisdiction, the American Water Works Association, the City and TDEC.

    b. All water mains shall have a minimum cover of three (3) feet unless otherwise approved by the City Engineer.

    c. No other underground utilities may be place in the same trench as the water line.

    d. All water mains shall be a minimum of Pressure Class 350, Ductile Iron Pipe unless otherwise approved by the City Engineer.

    e. Swivel fittings must be provided for all fire hydrant lines. Swivel fittings must be used to connect the valve to the water main and the fire hydrant to the valve. Rods may be used in lieu of swivel fittings where approved by the City Engineer.

    f. All water mains shall be capable of supplying an instantaneous peak demand of 2 gpm per connection. Water mains must also maintain a minimum pressure of 20 psi at ground level at all points in the distribution system under all conditions of flow.

    g. Wide variations in pressure above the minimum requirement of 20 psi may be inherent in the design of a distribution system but pressures no greater than 100 psi should be delivered to the customer (unless higher pressures are requested). The 100 psi maximum pressure requirement can be met by pressure reducing valves in vicinity of each customer's source line, or by designing the distribution system to limit the maximum pressure.

h. All assumptions and any flow data used must be clearly documented and submitted with the hydraulic calculations. If actual flow data is not available theoretical calculations shall be based on all storage facilities half-full and the Hazen-Williams friction factor appropriate for the type of pipe being used but in no case greater than 130.

i. Where feasible, all water lines shall be looped. Dead end water lines do not provide optimal water circulation through the system, and thus are discouraged.

j. Air release valves shall be installed at high points in the water line. Blow offs shall be installed at low points in the water line. Blow offs shall also be installed at the end or terminal water lines. Hydrants should be utilized for these purposes where feasible.

k. Where utilized, blow-offs shall be a minimum of 2-inch and provide a minimum flushing velocity of two (2) feet per second. No flushing device shall be directly connected to any sanitary or storm sewer or be subject to flooding or plugging.

l. Criteria for fire hydrants are as follows:

    1. Fire hydrants in residential areas shall be located no more than 900 feet apart as measured along the servicing street and be within 450 foot of any residential lot. Fire hydrants in commercial and industrial areas shall be located no more than 500 feet apart as measured along the servicing street and be within 250 foot of any commercial or industrial lot. The City Engineer and Fire Chief may require a closer spacing based on physical site conditions, city fire codes, types of structures, spacing of structures, etc.

    2. A minimum of 750 gpm flow with a minimum residual pressure of 20 psi shall be provided for all fire hydrants unless lower flow requirements are approved by the Fire Chief and City Engineer. The Fire Chief and City Engineer may require flow capabilities in excess of this requirement based on the type of development.

    3. Fire hydrants shall not be connected to water mains that are not capable of providing a flow of 500 gpm at a residual pressure of 20 psi.

    4. In general fire hydrants should be located at street intersections, commercial/industrial entrances, ends of water lines in cul-de-sacs and the middle of long blocks. Fire hydrants should be placed on property lines.

    5. When placed at intersections fire hydrants should be placed five (5) feet from the point of curvature of the curb return.

    6. Fire hydrants shall meet the latest revision of the American Water Works Association Standard C502.

m. A minimum of six (6) inch diameter water lines are required in all residential developments. A minimum of eight (8) inch diameter water lines are required in all commercial and industrial developments. The City Engineer and Fire Chief may require larger diameter water lines in developments based on fire flow requirements or estimated usage.

n. Water Main Separation:

    Water main separation from sanitary sewer and storm sewer systems shall meet the requirements of TDEC. In general the requirements are as follows:

    1. The following factors should be considered in providing adequate separation:

a. Materials and type of joints for water and sewer pipes.

b. Soil conditions.

c. Service and branch connections into the water main and sewer line.

d. Compensating variations in the horizontal and vertical separations.

e. Space for repair and alterations of water and sewer pipes.

f. Offsetting of pipes around manholes.

g. Water mains and sanitary or storm sewers shall not be laid in the same trench.

h. Parallel Installation

1. Normal conditions – Water mains shall be laid at least 10 feet horizontally from any sanitary sewer, storm sewer or sewer manhole, whenever possible. The distance shall be measured edge to edge.

2. Unusual conditions – When local conditions prevent a horizontal separation of 10 feet, a water main may be laid closer to a storm or sanitary sewer provided that:

a. The bottom of the water main is at least 18 inches above the top of the sewer.

b. Where this vertical separation cannot be obtained, the sewer shall be constructed of materials and with joints that are equivalent to water main standards of construction and shall be pressure tested to assure water-tightness prior to backfilling.

2. Crossings

a. Normal conditions – Water mains crossing house sewers, storm sewers or sanitary sewers shall be laid to provide a separation of at least 18-inches between the bottom of the water main and the top of the sewer, whenever possible.

b. Unusual conditions – When local conditions prevent a vertical separation of 18-inches, the following construction shall be used;

1. Sewers passing over or under water mains should be constructed of materials and with joints that are equivalent to water main standards of construction and shall be pressure tested to assure water-tightness prior to backfilling.

2. Water mains passing under sewers shall, in addition, be protected by providing:

- A vertical separation of at least 18 inches between the bottom of the sewer and the top of the water main.

- Adequate structural support for the sewers to prevent excessive deflection of joints and settling on and breaking the water main.

- The length of water pipe to be centered at the point of crossing so that the joints will be equidistant and as far as possible from the sewer.

- Both the sewer and the water main shall be constructed of materials and with joints that are equivalent to water main standards of construction and shall be pressure tested to assure water-tightness prior to backfilling.

c. Sewer manholes – No water pipe shall pass through or come into contact with any part of a sewer or sewer manhole.

o. Surface Water Crossings

Surface water crossings, both over and under water, present a special problem that should be discussed with the City Engineer before final plans are prepared.

1. Above-water crossings – The pipe shall be:

a. Adequately supported.

b. Protected from damage and freezing.

c. Accessible for repair or replacement.

2. When crossing water courses which are greater than 15 feet in width:

a. The pipe shall be restrained joint ductile iron pipe.

b. Valves shall be provided at both ends of the water crossing so that the section can be isolated for test or repair. The valves shall be easily accessible and not subject to flooding.

c. Sampling taps should be available at each end of the crossing.

d. Permanent taps should be made for testing and locating leaks.

p. Cross Connections

1. There shall be no physical connection between the distribution system and any pipes, pumps, hydrants or tanks whereby unsafe water or other contaminating materials may be discharged or drawn into the system.

2. The approval of the City and TDEC shall be obtained for interconnections between potable water supplies.

3. Neither steam condensate nor cooling water from engine jackets or other heat exchange devices shall be returned to the potable water supply.

q. Chambers or pits containing valves, blow offs, meters or other such appurtenances to a distribution system, shall not be connected directly to any storm drain or sanitary sewer, nor shall blow offs or air-relief valves be connected directly to any sewer. Such chambers or pits shall be drained to the surface of the ground where they are not subject to flooding by surface water, or to absorption pits underground.

r. Valves are to be placed at all intersections of water mains on each branch but at no time greater than 4000 feet apart.

3. Plans Requirements

a. All water line plans submitted for review by the City shall show the following information:

1. Date, scale, location map and north arrow.

2. Plan view of the water line showing:

    a. All existing and proposed utilities, streets, buildings, structures, sidewalks, streams, drainage swales, trails, and other features of the proposed project area.

    b. Existing and proposed topography at a two (2) foot contour interval.

    c. Existing and proposed property boundary information including property lines, easements, rights-of-way, floodway boundary, 100-year flood fringe boundary, etc.

    d. Size and location of all proposed water lines, location, fire hydrants, valves, blow offs, air releases, water meters, service lines, fire lines, detector check vaults, etc.

    e. Stationing of the proposed water line at a maximum of 100-foot intervals.

3. Profile of the water line showing:

    a. Scale.

    b. Stationing of the proposed water line at a maximum of 100-foot intervals.

    c. Location and stationing of all intersecting water lines, fire hydrants, blow offs, air releases, highway crossings, pipe types different than standard push-on joint, pressure class 350 ductile iron pipe.

    d. Existing and proposed ground elevation lines.

    e. Existing and proposed street centerlines when crossing.

    f. Existing and proposed utility crossings.

4. Seal, signature and date of the Engineer who prepared the drawing. The Engineer must be licensed by the State of Tennessee.

5. A sheet showing details such as blocking dimensions, trench bedding and backfill, fire hydrant installation, service connection installation including meter setting and box, valve installation, highway crossing installation, stream crossing installation, air release detail, blow off detail, etc.

b. The City Engineer may require additional information to be shown on the water line design documents other than the items listed above.

SANITARY SEWER DESIGN STANDARDS

Applicability

1. All newly constructed subdivisions within the corporate limits of the City shall provide public sanitary sewer facilities approved by the City and the TDEC.

2. All newly constructed public sanitary sewer systems shall be constructed utilizing materials that comply with all federal, state and local specifications.

General and Hydraulic

1. Type of Sewers

   The City sanitary sewer system is designed to provide total containment of sanitary wastes and maximum exclusion of infiltration and inflow. Systems that do not meet these criteria shall not be approved.

2. Compliance with Design Criteria

   These criteria establish the minimum requirements for the design of sanitary sewer systems. The design must be in accordance with these requirements and the requirements of TDEC.

3. Tributary Population

   a. Sewerage facilities shall be designed for the estimated ultimate tributary population.

   b. Consideration shall be given to the adopted Comprehensive Plan and Zoning, and to the maximum anticipated capacity of uses such as, but not limited to, institutions, industrial parks and apartment developments.

   c. Trunk and sub-trunk sewers shall be designed normally on the basis of the adopted Comprehensive Plan densities and/or Zoning, whichever is greater, unless the City Engineer approves otherwise.

   d. Design analysis shall be provided for all trunk, subtrunk and collecting sewers.

4. Sewage Flow:

   a. The design basis for wastewater flow and loadings should be per TDEC requirements.

   b. Sewers shall be designed to carry a peak flow when full as determined from applying the appropriate peak flow factor to the average flow.

      1. Lateral and Submains: Minimum peak flow should be not less than 400 percent of the average design flow. Lateral is defined as a sewer that has no other common sewers discharging into it. Submain is defined as a sewer that receives flow from one or more lateral sewers.

      2. Main, Trunk and Interceptor Sewers: Minimum peak design flow should not be less than 250 percent of the average design flow. Main or trunk is defined as a sewer that receives flow from one or more submains. Interceptor is defined as a sewer that receives flow from a number of main or trunk sewers, force mains, etc.

5. Location of Sewers and Manholes

a. In general, sewers shall be located on legally established street rights-of-way. The City prefers the sewer to be located outside of the paved street area.

1. When the sewer must be located in the paved area of streets the manholes shall be located as to fall on the centerline of the street or in the middle of the travel lane. Placement of manholes in the common vehicular wheel paths in streets should be avoided.

2. Manholes placed in streets must also be placed outside of the spread of storm water gutter flow.

3. The horizontal and vertical separation between sewers and waterlines shall be in accordance with requirements of TDEC and the City. In general the requirements are as follows:

   a. Horizontal Separation: Whenever practical, sewers should be laid at least 10 feet horizontally from any existing or proposed water main. The distance should be measured edge to edge. Should local conditions prevent a lateral separation of 10 feet, a sewer may be laid closer than 10 feet to a water main if the sewer is laid in a separate trench and if the elevation of the top (crown) of the sewer is at least 18 inches below the bottom (invert) of the water main.

   b. Vertical Separation: Whenever sewers must cross under water mains, the sewer shall be laid at such elevation that the top of the sewer is at least 18 inches below the bottom of the water main. When the elevation of the sewer cannot be varied to meet the above requirement, the water main shall be relocated to provide this separation or reconstructed with mechanical-joint pipe for a distance of 10 feet on each side of the sewer. One full length of water main should be centered over the sewer so that both joints will be as far from the sewer as possible.

   c. When impractical to obtain proper horizontal and vertical separation as stipulated above, the sewer shall be designed and constructed equal to the water main pipe and shall be pressure-tested to assure water-tightness (see Appendix C). Such arrangements are discouraged and adequate reason shall be provided to justify the design. Any variations from this standard must be approved by TDEC and the.

4. Sanitary sewer service shall be provided to each lot in a subdivision such that the main shall be extended to the nearest property line of the lot to be served.

5 Generally, proposed sanitary sewers shall not be located closer than 15 feet from existing or proposed buildings or structures.

6. Manholes for access to sewers shall be provided:

   a. At all intersections of sewers that are 8-inches in diameter or larger.

   b. At all points of change in horizontal and vertical alignment.

   c. At the terminal end of lines 8-inch diameter or larger.

   d. At intervals not exceeding 400-feet on all sewers 15-inches in diameter and less and not exceeding 500-feet on all sewers for sewers 18-inches to 30-inches. Greater spacing may be permitted in larger sewers and in those carrying settled effluent.

7. When necessary to drop the elevation of the sewer at a manhole 2-feet or greater, a drop connection shall be provided for the sewer.

8. Flow channels in manholes shall be of such shape and slope as to provide smooth transition between inlet and outlet sewers and to minimize turbulence. A minimum of 0.1-feet of drop must be provided through all manholes. Channeling height shall be to the crowns of the sewers. Benches shall be sloped from the manhole wall toward the channel to prevent accumulation of solids.

9. Manholes for sewers up to 21-inches shall have a minimum of 4-feet inside diameter. Manholes for sewers 24-inches up to 36-inches shall have a minimum 5-feet inside diameter.

10. Line connections to existing manholes shall be made by coring the manhole wall and installation of a flexible boot.

11. When designing a new sewer to tie into existing manholes, the bench elevation at the inside manhole wall shall be shown on the plans. The invert of the new tie-in should not be lower than the existing bench unless approved by the City Engineer. When the existing sewer line is larger than the new connection, the crown of the new pipe shall be no lower than the highest crown of any existing lines within the manhole.

12. In general where different size pipes enter and exit a manhole, the crowns of the pipes should match.

13. All sanitary sewer manholes or appurtenances subject to infiltration of surface water shall be provided with a watertight manhole frame/cover and be indicated as such on the plans.

14. Ventilation of gravity sewers shall be provided where there are continuous watertight sections greater than 1,000-feet in length.

15. Sewers adjacent to or crossing streams shall be designed per the requirements of TDEC and the City. In general the requirements are as follows:

    a. The top of all sewers entering or crossing streams shall be at a sufficient depth below the natural bottom of the streambed to protect the sewer line. In general, the following cover requirements must be met:

        1. One (1) foot of cover (poured in place concrete) is required where the sewer is located in rock.

        2. Three (3) feet of cover is required in stabilized stream channels.

        3. Seven (7) feet of cover or more is required in shifting stream channels.

    b. Sewers located along streams shall be located outside of the streambed and sufficiently removed therefrom to minimize disturbance or root damage to streamside trees and vegetation.

    c. Sewer outfalls, headwalls, manholes, gateboxes or other structures shall be located so they do not interfere with the free discharge of flow of the stream.

    d. Sewers crossing streams shall be designed to cross the stream as nearly perpendicular to the stream flow as possible and shall be free from change in grade. To prevent the french drain effect of the sewer crossing the stream, check dams must be installed on both sides of the stream in the pipe conduit trench. This must be separate from any concrete encasement.

e. Sewers entering or crossing streams shall be constructed of ductile iron pipe with mechanical joints, concrete encased, or shall be so otherwise constructed that they will remain watertight and free from changes in alignment or grade. Sewer systems shall be designed to minimize the number of stream crossings.

f. Manholes must be placed on each side of a stream crossing unless otherwise approved by the City Engineer.

16. Sewer lines should not be located underneath detention/retention facilities, ponds, lakes or other bodies of water unless specifically approved by the City Engineer.

17. Ductile iron pipe must be used for sewer lines constructed in fill areas.

18. Check dams shall be installed in the bedding and backfill of all new or replaced sewer lines to limit the drainage area subject to the french drain effect of gravel bedding. Major rehabilitation projects should also include check dams in the design. Dams shall consist of compacted clay bedding and backfill at least three (3) feet thick to the top of the trench and cut into the walls of the trench two (2) feet. Alternatively, concrete may be used, keyed into the trench walls. Dams shall be placed no more than 500 feet apart. The required location is upstream of each manhole. All stream crossings will include check dams on both sides of the crossing.

6. Minimum Sewer Size

The minimum pipe diameter for sanitary sewers shall be eight (8) inches.

7. Hydraulic Design Criteria

The hydraulic design and determination of sewer size shall be based on the following conditions:

a. Sewers shall have a uniform slope and straight alignment between manholes.

b. Unless otherwise approved, the minimum slope of a sewer line should be a minimum of 0.5 percent or the slope required to produce an average velocity of not less than 2.0 feet per second during design average flows, whichever is greater. Terminal lines should have a minimum slope of at least 0.8 percent or the slope required to produce an average velocity of not less than 2.0 feet per second during design average flows, whichever is greater.

c. Sewers shall be designed to be free flowing with the hydraulic grade below the pipe crown and with hydraulic slopes sufficient to provide an average velocity of not less than 2.0 feet per second during design average flows. Computations of velocity of flow shall be based on a coefficient of roughness “n” in the Manning formula of 0.013.

d. The maximum permissible velocity at average flow (before applying the peak factor) shall not exceed 15 feet per second. The City Engineer may allow for design of flow in excess of 15 feet per second where special provision is made in the design to protect against internal erosion or displacement by shock.

e. Suitable drop manholes shall be provided to break steep slopes to limit the velocities in the connecting sewer pipes between manholes. Where drop manholes are impractical for reduction of velocity, the sewer shall be of abrasion resistant materials.

f. Invert channels in terminal manholes shall be built at a slope of not less than one inch per one foot.

g. The deflection angle between entering and exiting pipes should not be less than 90 degrees.

Structural

1. Pipe Materials

   The City will allow the use of Polyvinyl Chloride (SDR 35 and SDR 26), and Ductile Iron (Pressure Class 350) pipe in construction of public sanitary sewer extensions. Only one type of pipe material can be placed between manholes.

2. Minimum Cover

   All sewer lines shall have a minimum of three (3) feet of cover over the top of the pipe.

3. Maximum Permissible Depth

   The maximum permissible depth of cover for sewer pipes is as follows:

Pipe Material	Maximum Depth
PVC – SDR 35	Up to12-feet
PVC – SDR 26	Up to18-feet
DIP – Pressure Class 350	18-feet and greater

4. Trench Width

   The width of trench at or below the top of the pipe shall not exceed 24-inches plus the diameter of the pipe. The trench must be no closer than 6-inches and no further than 18-inches from the side of the pipe.

5. Slope Anchorage

   Sewers on 18 percent slope or greater shall be anchored securely with concrete anchors or equal. Suggested minimum anchorage spacing is as follows:

   a. Not over 36 feet center to center on grades 18 percent and up to 25 percent.

   b. Not over 24 feet center to center on grades 25 percent and up to 35 percent.

   c. Not over 16 feet center to center on grades 35 percent and over.

Preparation of Plans

1. Construction Drawings

   An engineer registered in the State of Tennessee must prepare the plans and design analysis for all proposed public sewer extensions. The design must meet the requirements of TDEC and the City. Such plans shall be in conformance with the foregoing design criteria and show the following information:

   a. Plans shall be drawn on sheets measuring 24-inches wide by 36-inches long. The upper half of the drawing shall show the sewer location in plan and the lower half, the profile of the sewer and ground surface.

   b. A general layout sheet shall be provided showing but not limited to the following:

1. Existing and proposed streets, curbs, entrances, parking areas, access roads, railroads, bridges, guardrails, travel ways, sidewalks and trails.

2. Existing and proposed lots, rights-of-way, easements, floodways, 100-year flood fringes and other boundary information.

3. Existing sanitary sewer facilities including location, stationing, sizes, manhole top elevations, manhole invert elevations, manhole stations, watertight castings, vented manholes, service line location and size, cleanouts and other appurtenances.

4. Existing and proposed underground and overhead utilities including location, type, size, poles, guy wires, etc.

5. Proposed sanitary sewer facilities including location, sizes, manholes, service line location and size, cleanouts and other appurtenances.

6. Existing and proposed structures, buildings, houses, signs, recreation areas, fences, gates, etc.

7. Existing and proposed topography with a maximum contour interval of two (2) feet. Topography should show streams, drainage ways, water bodies, wooded areas, rock outcrops, swamps, wetlands and other important topographic features.

8. If the project is in a regulatory flood area then the floodway location and elevation, and the 100-year flood fringe location and elevation must be shown.

c. The layout sheet shall be the same scale as that used for the plan, but in no case be smaller than 100 feet per inch.

d. The profile shall show but not be limited to the following information:

1. Proposed pipe grade, length, size, stationing and type.

2. Manhole invert elevations of all incoming and exiting pipes, top elevations of castings, drop connections and numbering.

3. Pipe cradles, anchors, and encasements and check dams.

4. Existing and proposed utility crossings including type and size of the crossing.

5. Existing and proposed street centerlines.

6. Connections to existing manholes including inverts of entering and exiting pipes, top elevation of casting and bench elevations.

7. Existing and proposed grades.

8. Bored and tunneled crossings including casing pipe size and length, beginning and ending stations, carrier pipe type and size.

9. Stream crossings.

e. The horizontal scale for profiles shall be the same as that used for the plan, but in no case be smaller than 100 feet per inch. The vertical scale shall in no case be smaller than ten feet per inch.

2. Easements

   Before approval of construction drawings can be made, all offsite easements shall be obtained and recorded.

3. Service Lines

   When sewer systems are being installed for a subdivision, the developer shall install service lines from the sanitary sewer main to the property or easement line where sidewalks are not to be constructed. Where sidewalks are proposed for construction, the service line shall be constructed to five (5) feet beyond the back of the sidewalk. The following criteria apply to the service lines:

   a. The service lines shall be shown on the sewer construction drawings.

   b. The service line size shall not be less than 4-inches.

   c. In general the service line shall be constructed out of the same material as the main where the service line connects.

   d. Only one lot can be connected to a service line.

   e. The service lines shall be designed to meet the requirements of the City Plumbing Code.

   f. The service line shall enter the sanitary sewer through a manufactured wye, tee or approved sewer saddle.

   g. In general, the service line slope should be a minimum of 1/4 inch fall per foot or run (2.08% slope). Service line slopes down to 1/8 inch fall per foot of run (1.04% slope) may be used when approved by the City Engineer and the Department of Codes Enforcement.

   h. Connections of the service line to the manholes are allowed. When connecting the service line to a manhole, the crown of the service line should match the crown of the exiting line. The invert of the manhole must also be formed to accommodate the service line.

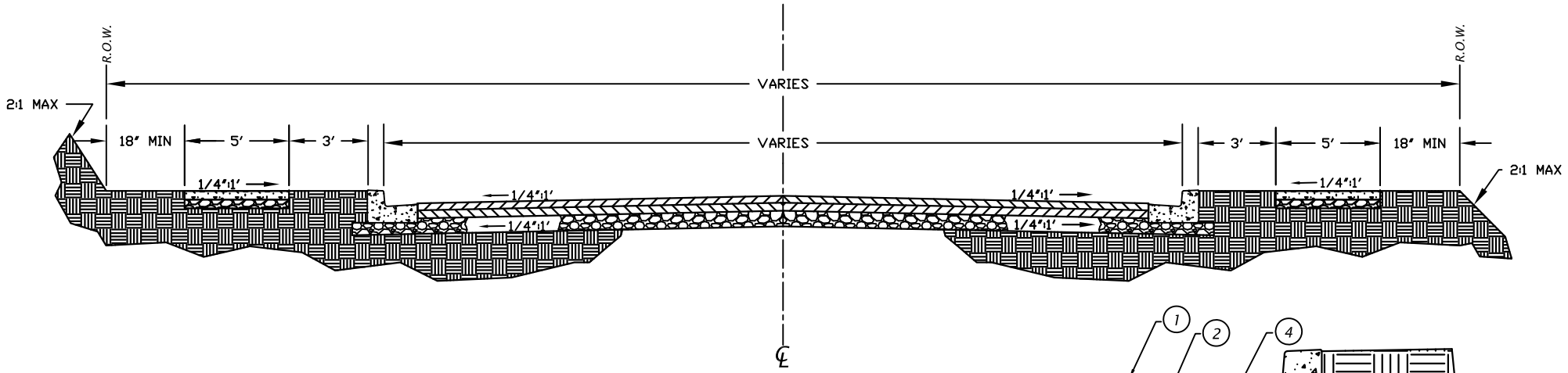
   i. The deflection angle between the service line pipe and the exiting main shall not be less than 90 degrees.

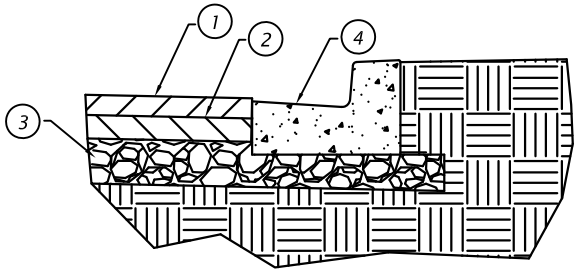
   j. The minimum cover allowed over service lines is three (3) feet.

   k. A cleanout shall be placed on all service lines at the property line, right-of-way line or easement line.

Appendix A

Design Details





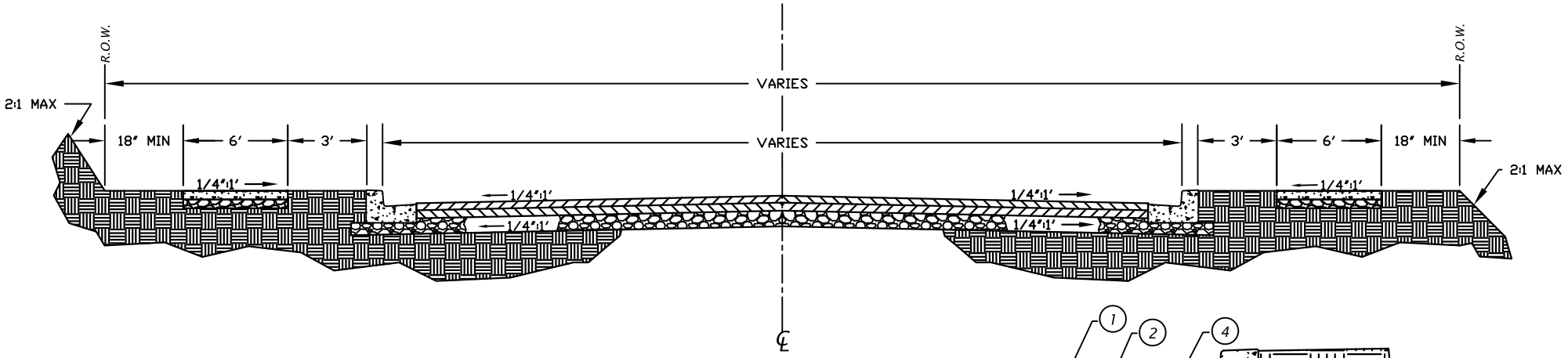
PAVEMENT COURSES
NTS

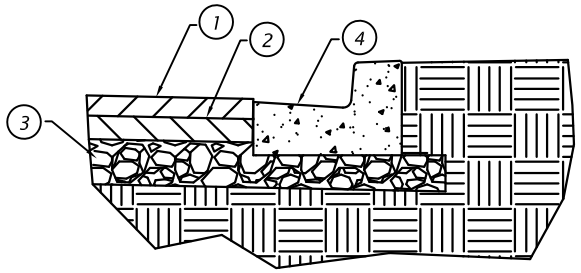
PAVING SCHEDULE

1. 1" BITUMINOUS SURFACE
2. 3" BITUMINOUS BASE
3. 6" BASE AGGREGATE
4. TDOT 6-30 CURB AND GUTTER

TYPICAL SECTION
CURB AND GUTTER STREET
RESIDENTIAL & NON-RESIDENTIAL LOCAL STREETS

FIGURE A-1





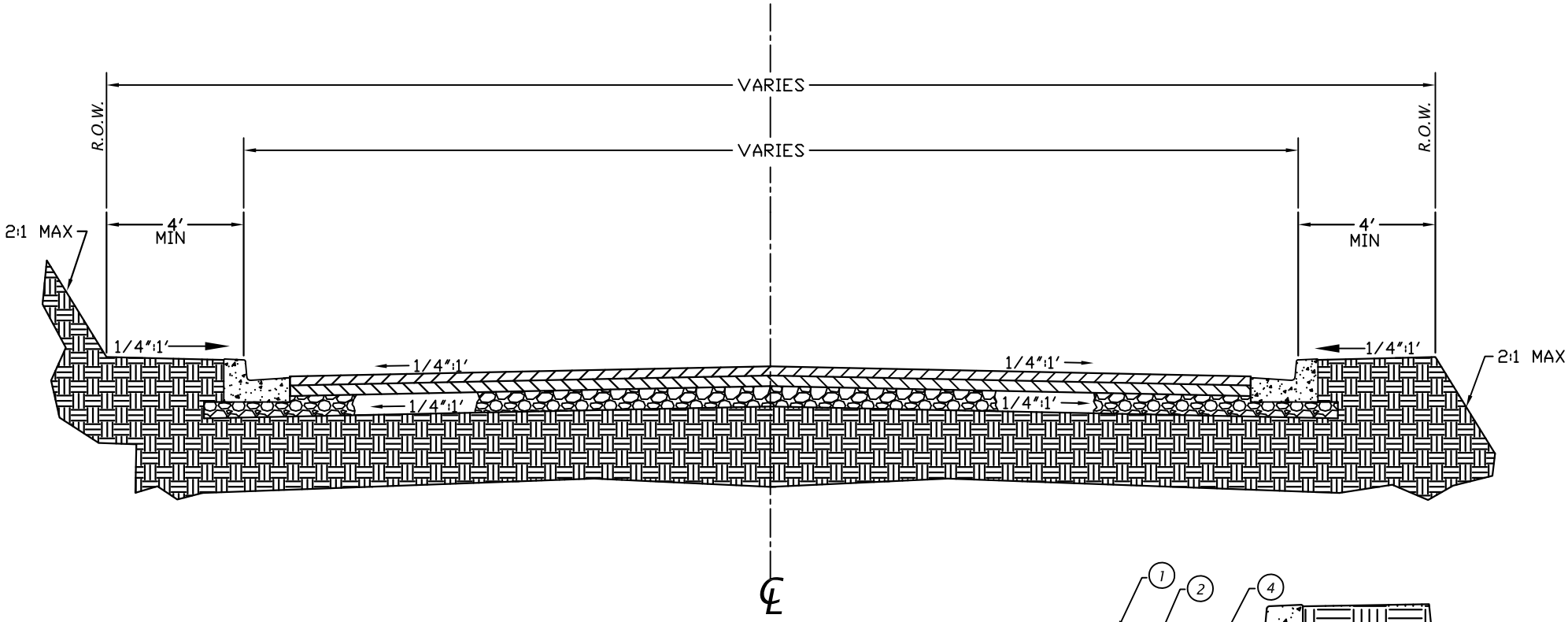
PAVEMENT COURSES
NTS

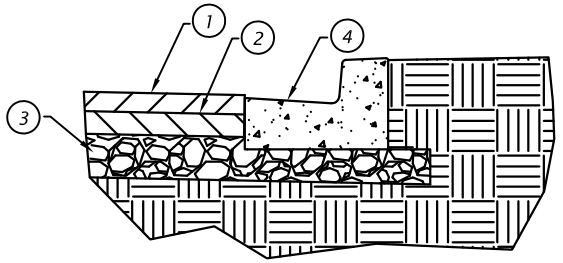
PAVING SCHEDULE

1. *2" BITUMINOUS SURFACE*
2. *3" BITUMINOUS BASE*
3. *8" BASE AGGREGATE*
4. *TDOT 6-30 CURB AND GUTTER*

TYPICAL SECTION
CURB AND GUTTER STREET
COLLECTOR STREETS

FIGURE A-2





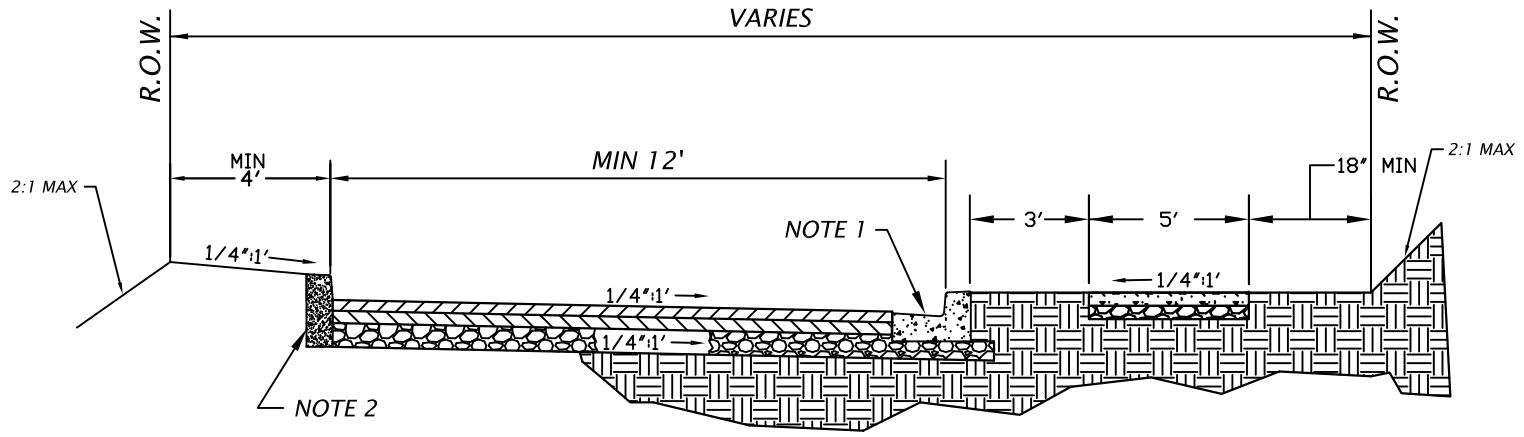
PAVEMENT COURSES
NTS

PAVING SCHEDULE

RESIDENTIAL & NON-RESIDENTIAL LOCAL	COLLECTOR
(1) 1" BITUMINOUS SURFACE	(1) 2" BITUMINOUS SURFACE
(2) 3" BITUMINOUS BASE	(2) 3" BITUMINOUS BASE
(3) 6" BASE AGGREGATE	(3) 8" BASE AGGREGATE
(4) TDOT 6-30 CURB AND GUTTER	(4) TDOT 6-30 CURB AND GUTTER

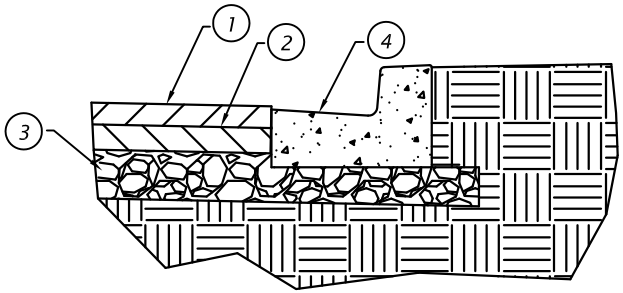
TYPICAL SECTION
CURB AND GUTTER STREET
NO SIDEWALKS

FIGURE A-3



NOTES:

1. TDOT 6-30 CONCRETE CURB AND GUTTER
2. TDOT TYPE "A" 6" DETACHED CONCRETE CURB



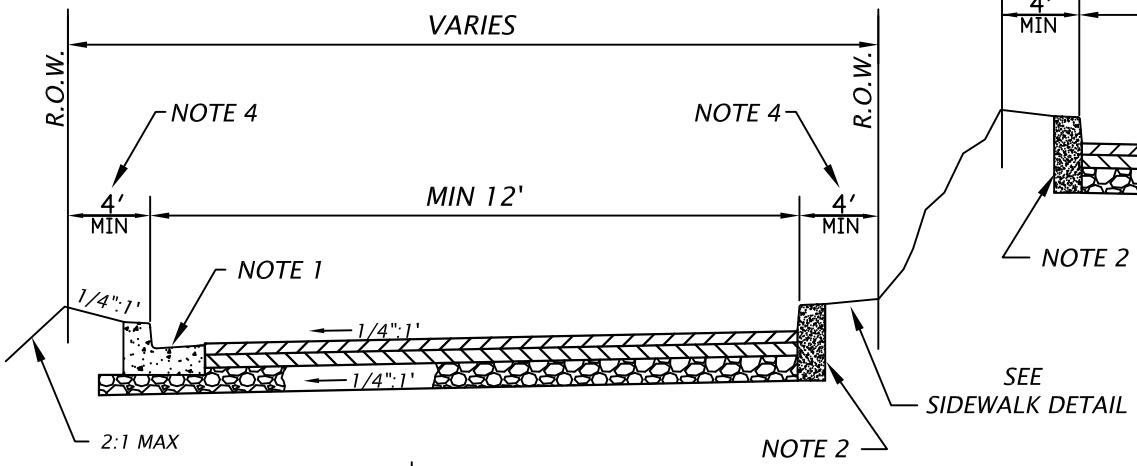
PAVEMENT COURSES
NTS

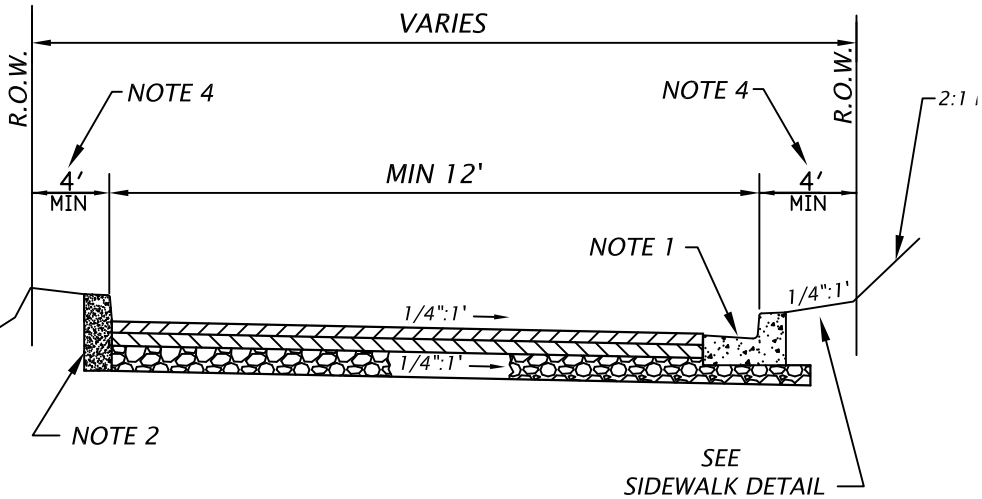
PAVING SCHEDULE

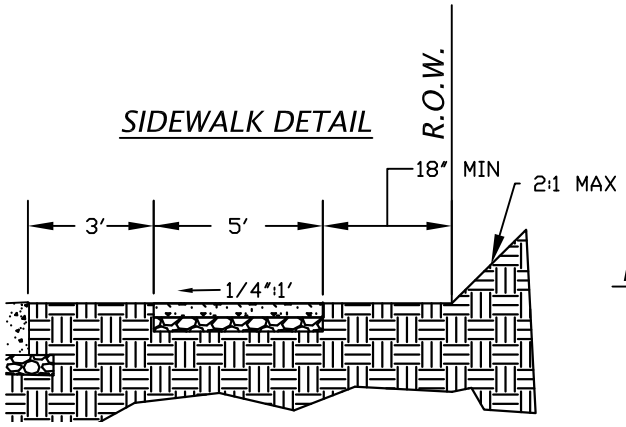
1. 1" BITUMINOUS SURFACE
2. 3" BITUMINOUS BASE
3. 6" BASE AGGREGATE
4. TDOT 6-30 CURB AND GUTTER

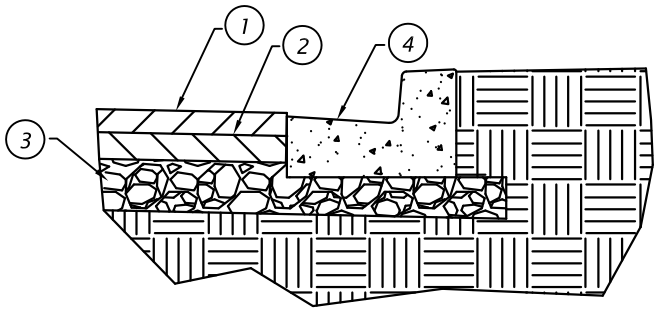
TYPICAL SECTION
RESIDENTIAL LOOP STREET

FIGURE A-4









PAVEMENT COURSES
NTS

PAVING SCHEDULE

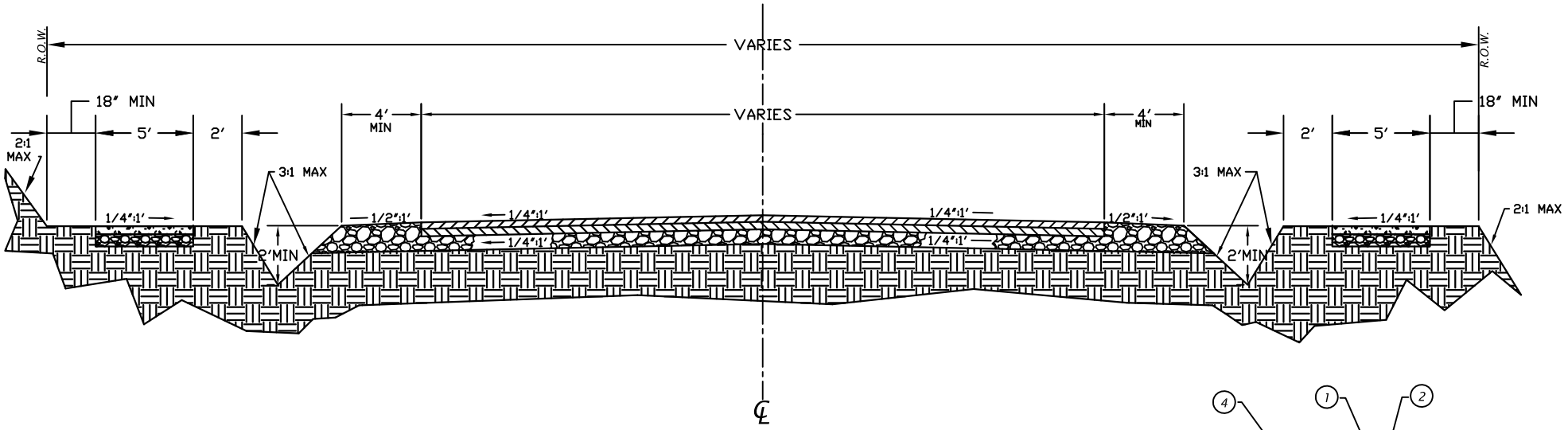
1. 1" BITUMINOUS SURFACE
2. 3" BITUMINOUS BASE
3. 6" BASE AGGREGATE
4. TDOT 6-30 CURB AND GUTTER

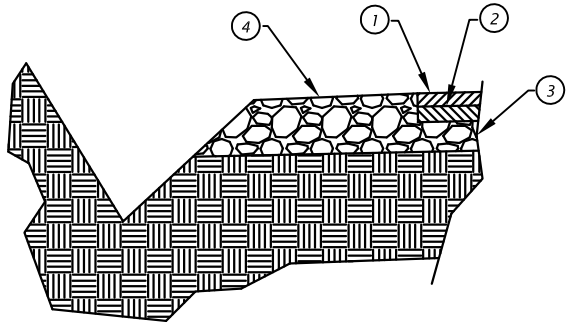
NOTES:

1. TDOT 6-30 CONCRETE CURB AND GUTTER
2. TDOT TYPE "A" 6" DETACHED CONCRETE CURB
3. THE MAXIMUM DISTANCE BETWEEN CROSSOVERS IS 500 FEET
4. SEE SIDEWALK DETAIL WHEN REQUIRED

TYPICAL RESIDENTIAL SPLIT STREET

FIGURE A-5





PAVEMENT COURSES
NTS

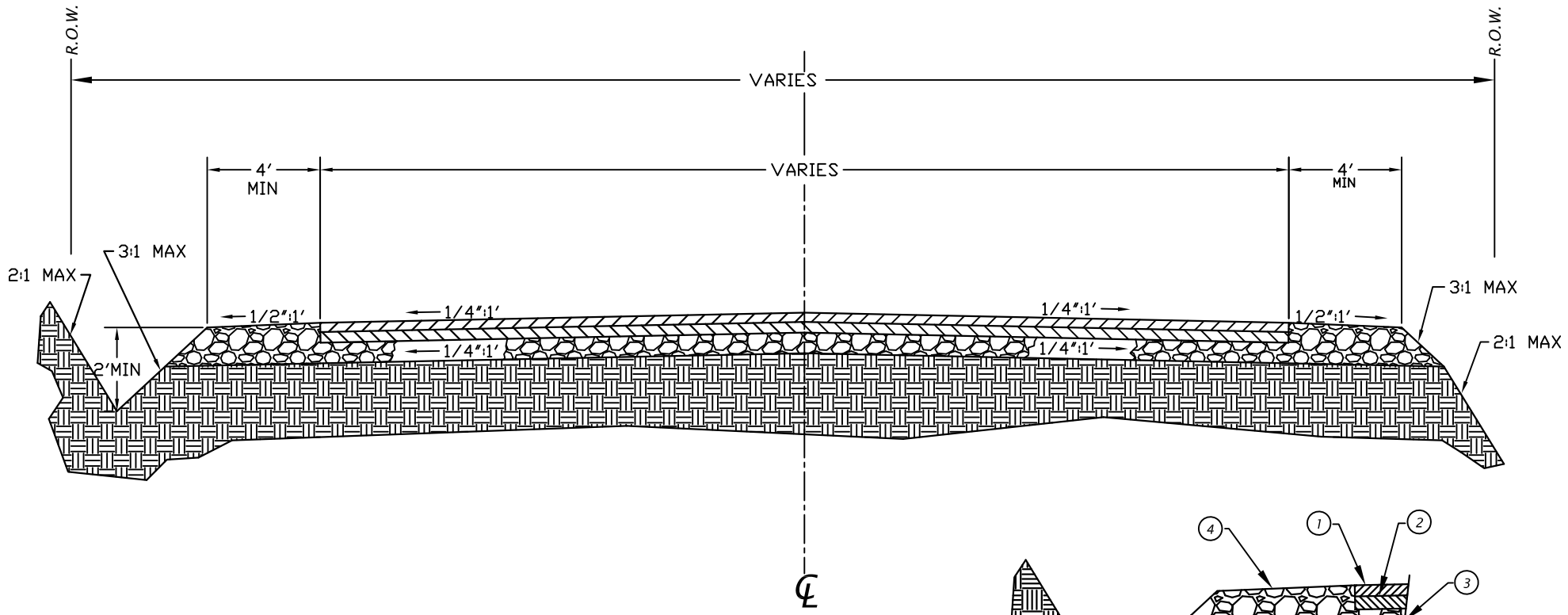
GREATER THAN 4' SHOULDER MAY BE REQUIRED IN AREAS WHERE GUARDRAIL IS REQUIRED.

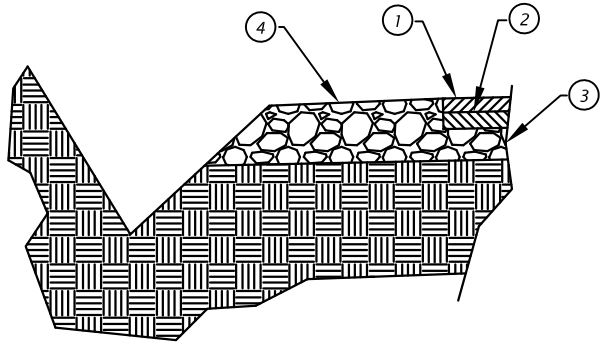
PAVING SCHEDULE

RESIDENTIAL & NON-RESIDENTIAL LOCAL	*COLLECTOR*
(1) *1" BITUMINOUS SURFACE*	(1) *2" BITUMINOUS SURFACE*
(2) *3" BITUMINOUS BASE*	(2) *3" BITUMINOUS BASE*
(3) *6" BASE AGGREGATE*	(3) *8" BASE AGGREGATE*
(4) *BASE AGGREGATE SHOULDER*	(4) *BASE AGGREGATE SHOULDER*

TYPICAL SECTION DITCH SECTION STREET WITH SIDEWALK

FIGURE A-6





GREATER THAN 4' SHOULDER MAY BE REQUIRED IN AREAS WHERE GUARDRAIL IS REQUIRED.

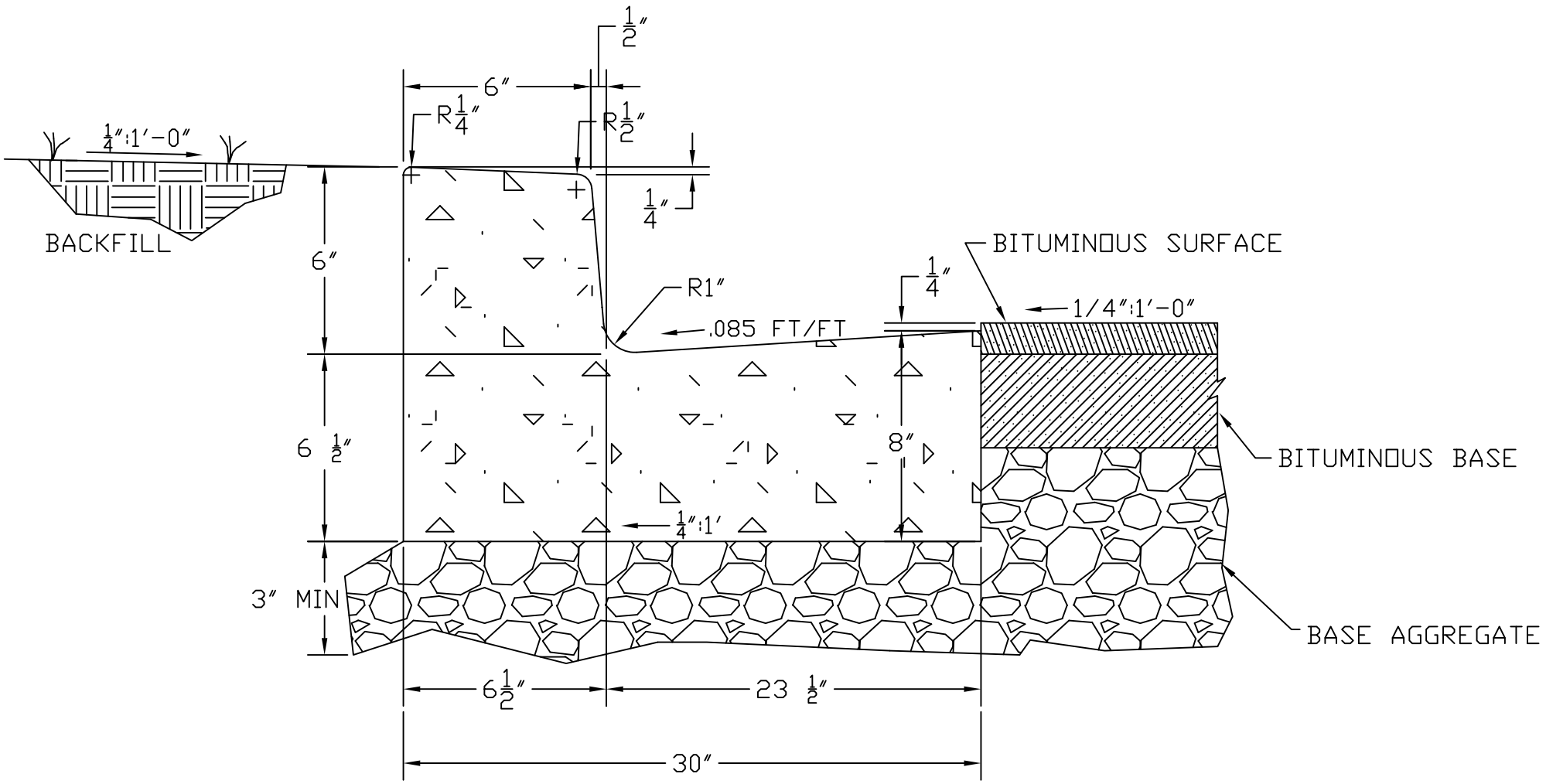
PAVEMENT COURSES
NTS

PAVING SCHEDULE

RESIDENTIAL & NON-RESIDENTIAL LOCAL	*COLLECTOR*
(1) *1" BITUMINOUS SURFACE*	(1) *2" BITUMINOUS SURFACE*
(2) *3" BITUMINOUS BASE*	(2) *3" BITUMINOUS BASE*
(3) *6" BASE AGGREGATE*	(3) *8" BASE AGGREGATE*
(4) *BASE AGGREGATE SHOULDER*	(4) *BASE AGGREGATE SHOULDER*

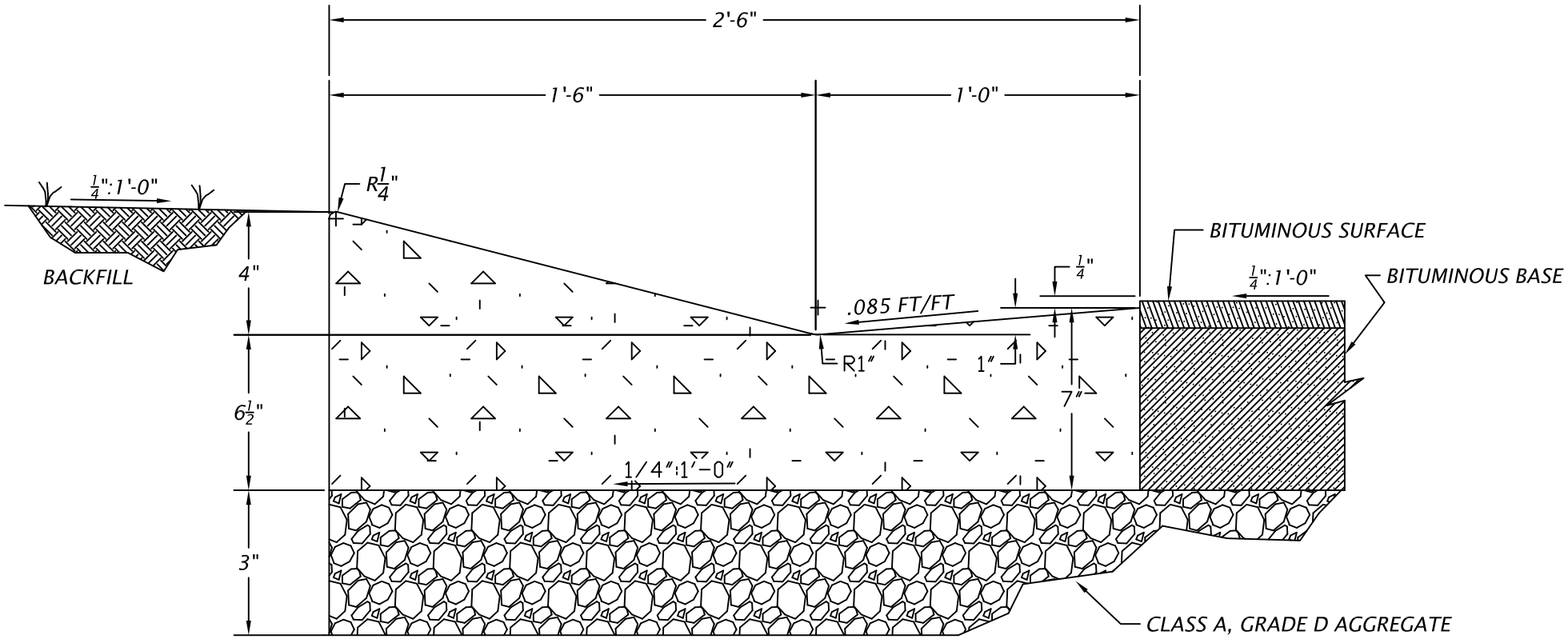
TYPICAL SECTION DITCH SECTION STREET NO SIDEWALKS

FIGURE A-7



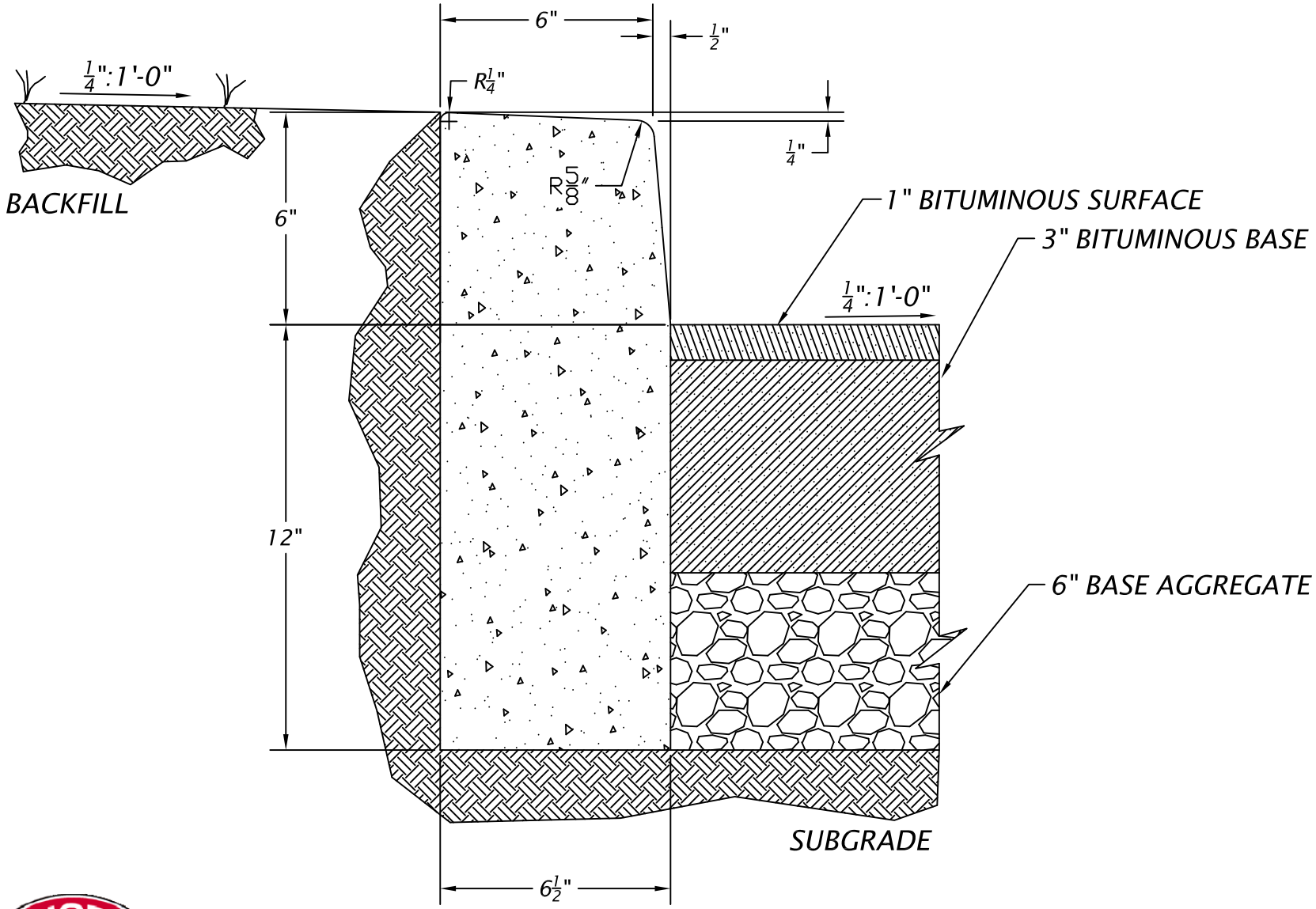
TDOT 6-30 CURB & GUTTER

FIGURE A-8



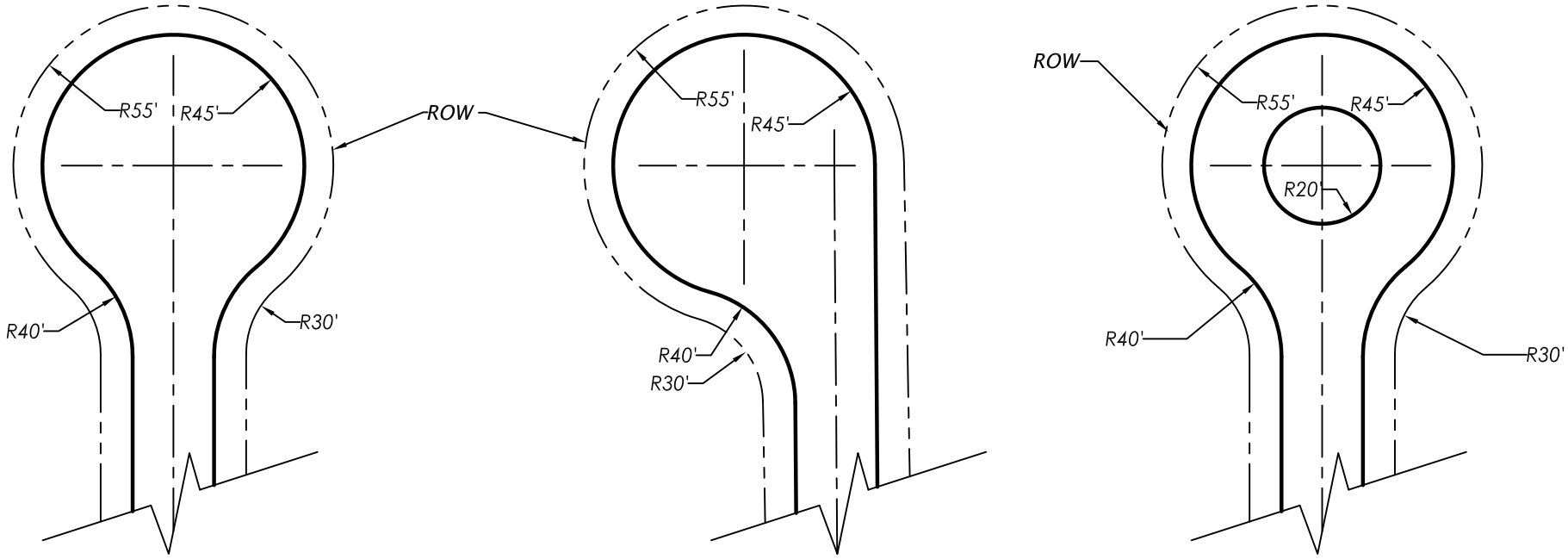
CONCRETE ROLLED CURB

FIGURE A-9



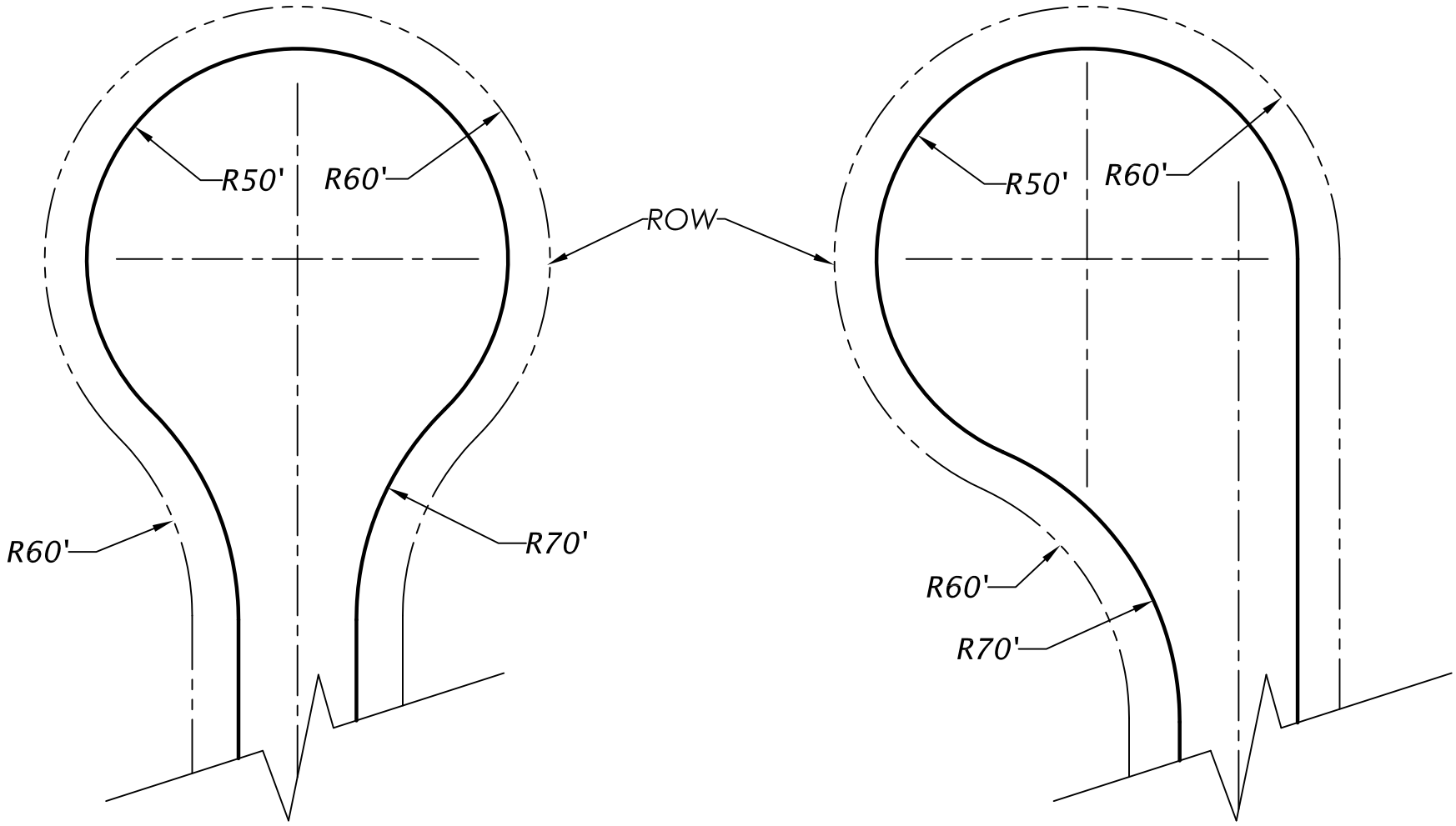
TYPE "A"
6" DETACHED CONCRETE CURB

FIGURE A-10



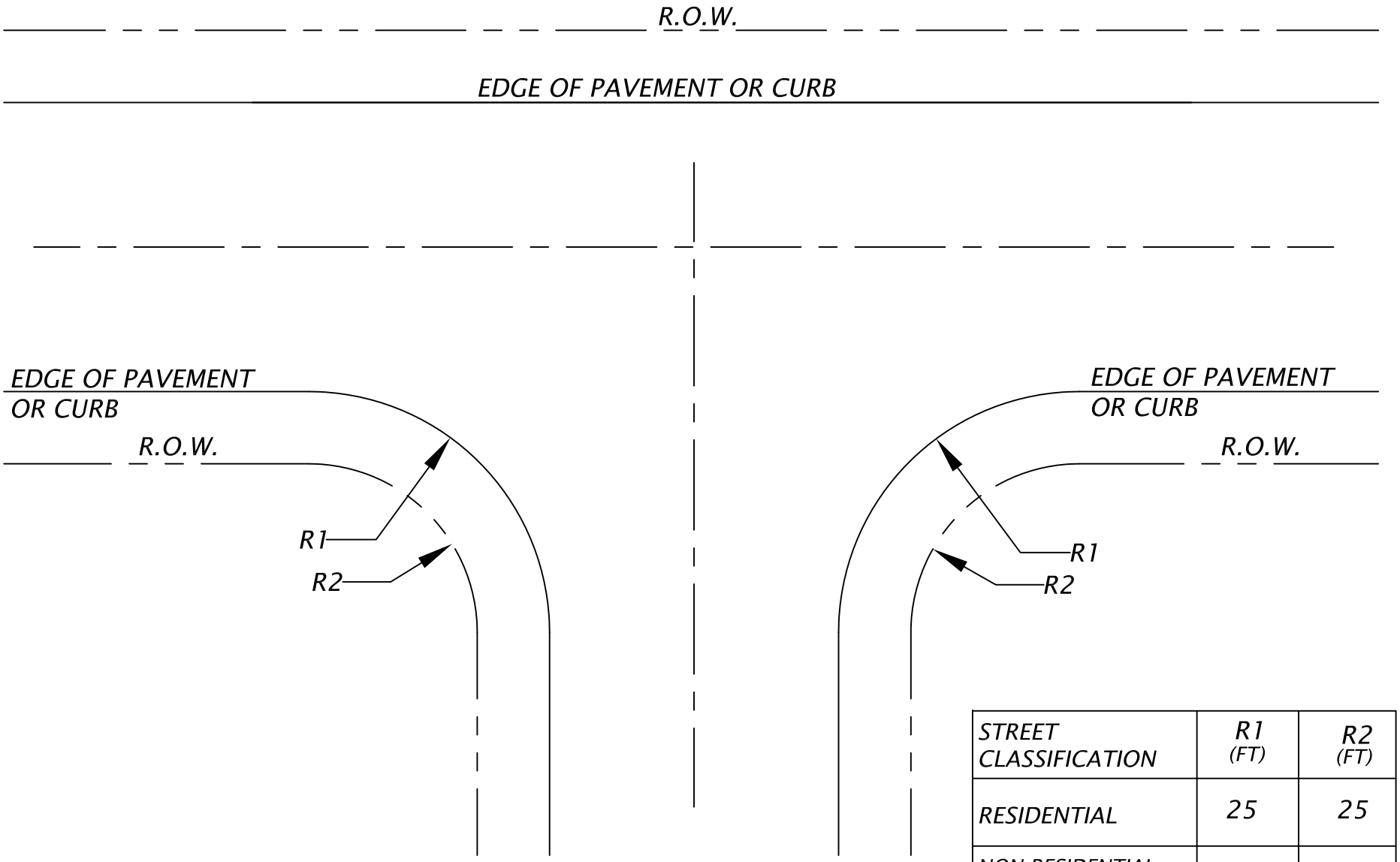
RESIDENTIAL STREETS
CUL-DE-SAC

FIGURE A-11



NON-RESIDENTIAL LOCAL STREETS
CUL-DE-SAC

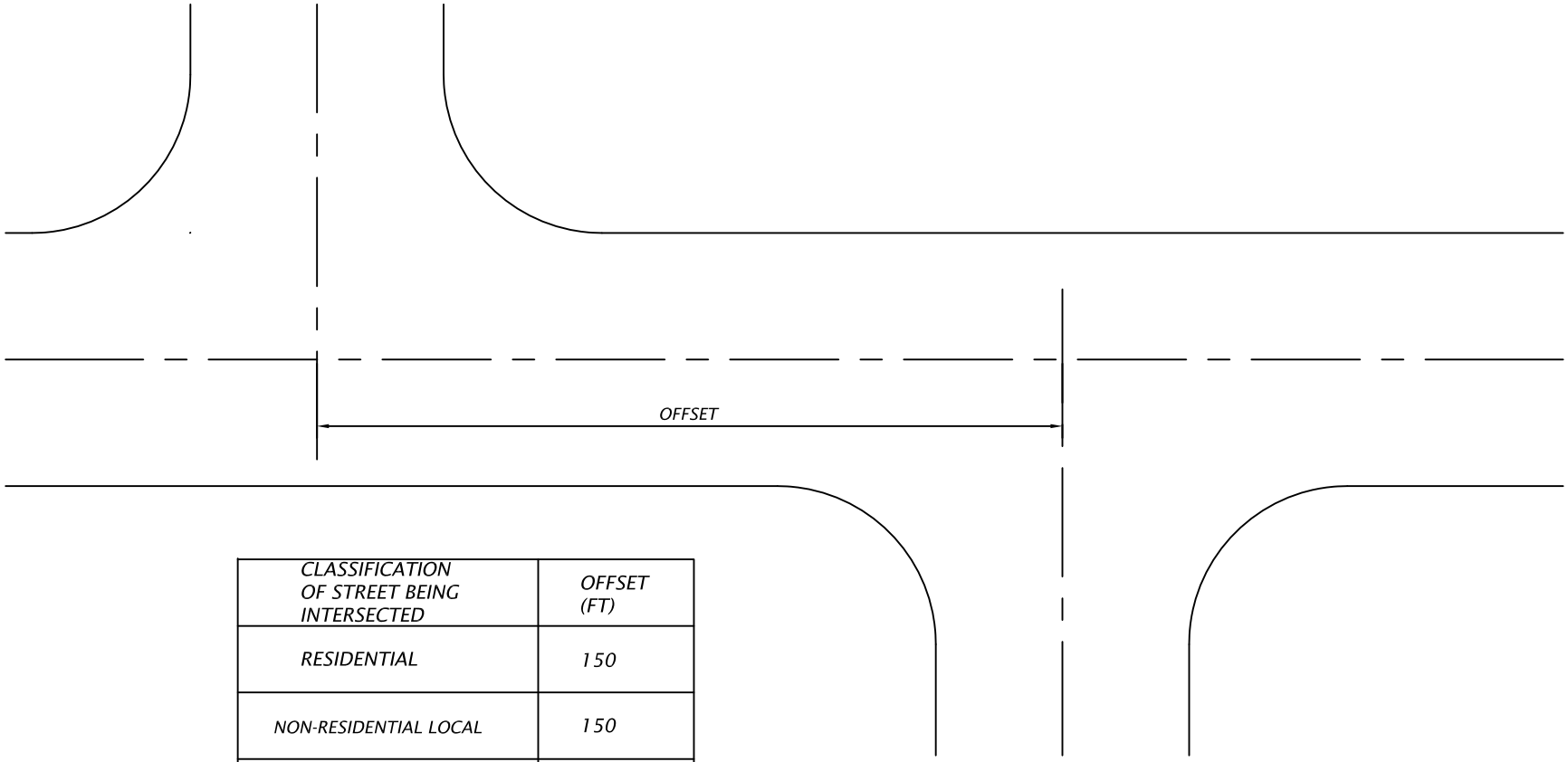
FIGURE A-12



STREET CLASSIFICATION	R1 (FT)	R2 (FT)
RESIDENTIAL	25	25
NON-RESIDENTIAL LOCAL	40	30
COLLECTOR	40	30

STREET INTERSECTION GEOMETRY

FIGURE A-13



CLASSIFICATION OF STREET BEING INTERSECTED	OFFSET (FT)
RESIDENTIAL	150
NON-RESIDENTIAL LOCAL	150
COLLECTOR	800
ARTERIAL	800

STREET INTERSECTION OFFSET REQUIREMENTS

FIGURE A-14