The City of Florence follows the Boone County Subdivision Regulations as they pertain to Storm Water Regulations. The following are the regulations from the Boone County Subdivision Regulations book.

SECTION 325
Storm Water Management, Drainage and Residential Lot Grading

Storm sewer systems are designed to collect and convey storm water runoff from street inlets, runoff control structures, and other locations where the accumulation of storm water is unsafe. No storm sewer shall be permitted to run into a sanitary sewer system within a proposed subdivision. In general, the cumulative amount of storm water runoff discharged from the boundary of the subdivision should be equal in terms of pre-development and post-development. Storm water runoff from a site or subdivision shall not adversely impact natural drainage from an uphill drainage basin or to a downhill drainage basin or adjacent properties. The property owner shall be responsible for storm water drainage facilities located on private property where runoff will be principally collected within that property and be minimally discharged over a larger area before the storm water naturally drains on adjacent properties. For isolated areas of the subdivision, where increased runoff may leave the boundary, downstream conditions must be considered to ensure that the increased runoff will not adversely impact existing drainage patterns.

The impact of development changes both the storm water quantity and quality over the watershed that drains to a stream, river, lake or reservoir and directly impacts the condition of that water body and downstream waters. To help minimize this adverse effect, runoff generated from the first 0.8 inches of rain shall pass through a water quality Best Management Practice (BMP).

The post-construction controls chosen shall be designed to minimize the impact of stormwater discharges on channel stability (hydromodification) and environmental integrity of local receiving streams. The design of post-construction controls shall attempt to maintain the natural flow regime such that erosive flows (volume and duration) more closely resemble pre-development hydrology, or be equally protective.

For technical guidance and information on the preparation of storm water site plans, the use of better site design techniques, hydrological techniques, selection and design of appropriate structural storm water control, and drainage (hydraulic) design, please refer to the *Storm Water Best Management Practices Manual* by Sanitation District No. 1 of Northern Kentucky and the City of Florence.

Storm Water and Erosion Control rules and regulations in Boone County is broken into regions. These regions are the Storm Water District of the Sanitation District No. 1; the City of Florence; and Unincorporated Boone County including the City of Walton. All subdivision development within Boone County must be designed and constructed per the Boone County Subdivision Regulations. Any subdivision development within one of the above regions, must also comply with the rules and regulations of the governing body responsible for that region. When an individual rule or regulation is in conflict, the most restrictive rule shall apply. The developer must determine which region the proposed development is a part, and design and construct the storm sewer system per the applicable regulations. Both the volume based storm water management requirements and the water quality requirements outlined in this Section, and the requirements in Section 330 "Soil Erosion and Slope Control," apply to development proposals that are subject to the Major Site Plan procedure as outlined in Article 30 of the Boone County Zoning Regulations, and/or those subject to the Major Division of Land procedure outlined in Article 2 of this document. For additions or modifications to previously developed sites, including building additions and site improvements or alterations, only the new improvements are required to conform to the current requirements of this Section.

All publicly maintained storm sewer systems shall be designed for peak flows calculated on the ten year (10 yr.) storm frequency. Overflows shall be designed on the one hundred year (100 yr.) storm frequency. No living area shall be affected by the one hundred year (100 yr.) storm. Safety swales shall be designed to carry all runoff away from any residential structure.

Basic Design Criteria for a Storm Drainage System

A) Degree of Protection Required- The storm drainage system shall be adequate to handle the runoff from storms having various frequencies of occurrence for various degrees of site development, in accord with the following general categories:

1.	Conservation, agricultural and low density residential (2 acre lots or larger)	10 year frequency
2.	All other residential and commercial	10 year frequency
3.	Industrial areas	10 year frequency
4.	For concentrated high value areas	10 year frequency
5.	For flood control facilities	100 year frequency

The runoff computed from these storm frequencies shall be from the area within the subdivision and all other areas draining thereto.

B) Determination of Quantity of Runoff for Design of Storm Water Collection System- Each portion of the storm water drainage collection system shall be capable of handling the peak flow of runoff. For drainage areas less than one hundred (100) acres, either the "Rational Method" or Soil Conservation Service (SCS) Method may be used. For areas greater than one hundred (100) acres, either the "Soil Conservation Service (SCS) Method" or the "Regional Method" of the Kentucky Transportation Cabinet, Bureau of Highways shall be used:

1. "Rational Method" where Q = CiA
   - Q = peak runoff quantity in cubic feet per second;
   - C = runoff coefficient varying with perviousness and other characteristics of the drainage area;
   - I = average intensity of precipitation in inches per hour, varying with frequency of storm occurrence, duration or concentration time, and area of the tributary watershed;
   - A = area in acres of the tributary watershed.

A. Runoff Coefficients: The runoff coefficient is the portion of the precipitation, expressed as a decimal, that will reach a given storm water facility. Each lot within a subdivision contributes runoff from the roof, driveway, sidewalk and street. Generally, the smaller the lot width, the less impervious area. As the lot increases in width so does the impervious area. Weighted coefficients shall be used with the impervious areas C = 0.95 and all other areas C = 0.40

Table 2 - Rational Method Runoff Coefficients for Composite Analysis

Land Use Description	**Average Percent Imperviousness**	**Runoff Coefficient (C)**
Natural and Undisturbed Areas	Varies	0.40
Single Family Residential Average Lot Size/Width	Varies (See Below for Value)	0.43 - 0.76 (See Below for Value)
3 acres/300 feet	6	0.43
2 acres/200 feet	7	0.44
1 acre/100 feet	12	0.47
½ acre/100 feet	23	0.53
12,500 sq. ft./80 feet	34	0.59
9,000 sq. ft./70 feet	42	0.63
7,500 sq. ft./60 feet	44	0.64
6,000 sq. ft./50 feet	48	0.66
<6,000 sq. ft./<50 feet	65	0.76

Industrial	72	0.80
Multi-Family Residential	75	0.81
Commercial/Office	85	0.87
Impervious Areas Including; Pavement, Roofs, Drives, Sidewalks, etc.	100	0.95

B. Intensity of Precipitation: The "point" values of average precipitation intensity in inches per hour, for Northern Kentucky can be determined from Exhibit No. 4-904 Kentucky Bureau of Highways "Rainfall Intensity-Duration-Frequency Curves." For any given storm duration (concentration time of runoff) the curves show the average precipitation intensity of storms having 2, 5, 10, 25, 50, and 100 year frequencies or the precipitation intensity can be calculated by using the following formula and constants developed by the Kentucky Transportation Cabinet:

$$I_{RI} = B/(Tc+D)^{E}$$

Return Interval (RI)	B	D	E
2	34.5848	6.9000	0.7899
5	54.0284	9.5000	0.8211
10	65.6903	10.6000	0.8262
25	87.9368	12.4000	0.8499
50	100.0737	13.0000	0.8553
100	114.6446	13.8000	0.8614

C. The time of concentration is the time associated with the travel of runoff from an outer point that best represents the shape of the contributing areas. Runoff from a drainage area usually reached a peak at the time when the entire area is contributing, in which case the time of concentration is the time for a drop of water to flow from the most remote point in the watershed to the point of interest. Runoff may reach a peak prior to the time the entire drainage area is contributing. Sound engineering judgement should be used to determine the time of concentration. The time of concentration to any point in a storm drainage system is a combination of the sheet flow (overland), the shallow concentrated flow and the

channel flow, which includes storm sewers. The minimum time of concentration for any area shall be 6 minutes.

The Soil Conservation Service TR-55 method for calculating the time of concentration shall be used.

At no time shall the Time of Concentration be greater than 30 minutes for design of storm inlets.

2. The Soil Conservation Service (SCS) Method may be used to calculate the peak discharge rates; develop runoff hydrographs for basins and subbasins; determine runoff volumes; and provide inflow information to determine the required storage volume for detention and retention basins. The SCS Method is the preferred method for performing hydrologic analysis. The SCS Method will utilize the formulas, constants and data in the current manual from the U.S. Natural Resources Conservation Service. The Soil Conservation Service utilizes a 24-hour storm duration, which is considered to be acceptable for Northern Kentucky. When the Soil Conservation Service methods are used, the Type II rainfall distribution shall be used.

   For detailed information, the user is referred to the following Soil Conservation Service publications:

   1. NEH-4: "Hydrology," Section 4, National Engineering Handbook;

   2. TR-20: Computer Program for Project Formulation, Hydrology;

   3. TR-55: Urban Hydrology for Small Watersheds;

   4. TP-149: A Method for Estimating Volume and Rate of Runoff in Small Watersheds.

3. The Regional Method of the Kentucky Transportation Cabinet, Bureau of Highways (Regional Method) may be used to calculate the peak discharge rates when required by regulatory agencies such as the Kentucky Division of Water. The Regional Method will utilize the formulas, constants and data from the current Manual of Instruction of Drainage and Design, Kentucky Transportation Cabinet, Bureau of Highways.

C) Storm Water System Facilities-

1. Flow times in sewers or conduits to the point of design may be determined from the hydraulic properties of the sewers upstream of that point, assuming average flow-full velocity at the proposed sewer slopes.

2. Pipe Capacities- Public storm sewer pipes shall be designed to carry peak flows as determined by the methods previously described. At the design storm the drainage system shall be designed as open channel (non-surcharged) flow. Sizes shall be determined by Manning's formula using a range of roughness coefficients (n=0.009-0.024). For roughness

coefficients see Street, Storm, and Sidewalk Specifications.

3. Minimum Pipe Size- The minimum diameter for public storm sewer pipe shall be fifteen inches (15") for inlet headwalls and twelve inches (12") for systems with a catchbasin at the initial point.

4. Minimum and Maximum Velocities- Velocities in public storm sewer pipes, when flowing full at average peak flows, shall not be less than two feet (2.0') per second and not greater than twenty five (25') per second.

5. Pipe Grades - The sewer pipe shall be laid on gradients so that the velocity (flowing full) shall be kept within the foregoing stated minimum and maximum unless other special provisions are made. Storm sewer pipe shall be laid on gradients so that the velocity (flowing full) shall be kept within the foregoing stated minimum and maximum, unless other special provisions are made. Sewers on twenty percent (20%) slopes or greater shall be anchored securely with concrete anchors or equal, spaced as follows:

   A. Not over thirty six feet (36') center to center on grades twenty percent(20%) and up to thirty five percent (35%);

   B. Not over twenty four feet (24') center to center on grades thirty five percent (35%) and up to fifty percent (50%); and

   C. Not over sixteen feet (16') center to center on grades fifty percent (50%) and over.

6. Hydraulic Grades- To ensure against surface ponding or street flooding due to surcharging, the hydraulic grade line (HGL) of the design storm in any pipe may not be higher than the top of pipe for the ten year (10 yr.) design storm; and one foot (1') below the inlet or manhole for the twenty five year (25 yr.) check storm.

   Design of all public storm sewer appurtenances shall consider the balance of energy plus the loss due to entrance in all structures having a critical change in horizontal or vertical alignment. In no case shall the difference in invert elevations be less than the result of equal crowns when a smaller pipe empties into a larger one. In no case shall storm sewer pipe sizes be reduced unless the upstream pipe is an approved underground detention structure.

7. Manholes (Junction Boxes)- Manholes shall be constructed in accord with Standard Construction Drawings as shown in the current city/county street specifications. Drop manholes may be required to reduce the slope of any sewer line. Pipes shall not extend more than two inches (2") into the side of the manhole, and the invert of the outlet pipe shall be at the bottom.

8. Inlets (Catch Basins)-
   Capacity: The capacity of the grate on the inlet should not be less than the quantity of flow tributary to the inlet. Inlets at low points or sags should have extra capacity as a safeguard

for street flooding from flows overtopping the street curb. A safety swale designed for the 100 year storm shall be placed at all low points or sags. Curb openings on combination inlets should be used for overflows in the event that the grate is clogged. Special inlets may be required for streets with steep gradients to provide the extra capacity such situations require. Pipes shall not extend more than two inches (2") into the side of the manhole, and the invert of the outlet pipe shall be at the bottom.

Type: Combination type inlets (single or double) shall be used and installed in accord with "Standard Construction Drawings" as shown in the current city/county street specifications. Any catch basin not placed on a lot line or within three feet of a driveway shall use a roll type grate as shown in the Street Specifications, and capacity calculations must be based on the type of inlet. Curb inlets and gutters shall accommodate the flow from a storm with an intensity of four (4) inches per hour.

Location: Inlet spacing shall be based upon gutter and inlet capacity, street slope and contributing drainage area. The spacing of inlets should ensure that street drainage generated along continuous grades or in sags will not damage and flood private properties or residential basements. For the design storm, no more than 5 cfs shall enter any grade inlet; no more than 8 cfs shall enter any sump inlet; and no more than 2.5 cfs is permitted to flow in side yards between houses.

A. Along continuous grades (less than 2 percent) - 400 feet maximum;

B. Along continuous grades (2 percent and over) - 600 feet maximum;

C. At sag locations (draining less than 2 percent grades) - 400 feet maximum between inlets or from a high point;

D. At sag locations (draining 2 percent and over grades) -600 feet maximum between inlets or from a high point.

Special consideration should be given to storm drainage entering cul-de-sacs. Additional inlets shall be required when drainage areas and/or street slopes are excessive. In addition to an inlet provided at the low point within the cul-de-sac two (2) additional inlets shall be required along each curb prior to the entrance of the cul-de-sac in accord with the following criteria:

A. For street slopes less than eight (8) percent and draining more than 400 feet of pavement; and

B. For all street slopes more than eight (8) percent and draining more than 300 feet of pavement.

9. Intersections - Storm water runoff crossing the intersection of a street shall be kept to a minimum.

10. Outfalls - When a storm sewer system outfalls into a flood plain of any major water course, the outfall must not be subject to frequent floods or backwaters. Standard headwalls and/or headwalls with wingwalls shall be constructed for all outfalls. To minimize adverse impacts on receiving channels one of the following conditions must be met: (1) the outlet velocity at a headwall or outfall of a paved channel shall be less than or equal to the natural velocity of the receiving channel or stream for the design storm but shall not be more than ten (10') feet per second; (2) structurally lined aprons or other acceptable flow spreading or energy dissipating devices shall be installed at the outlet to reduce the velocity; (3) the receiving channel shall be lined as per Article 3, Section 325 - Basic Design Criteria for Storm Water Drainage Channels, Water Courses, and Erosion Control, of these regulations for a sufficient distance to protect against erosion.

    When a storm sewer or paved channel outlets onto a slope without a defined drainage channel, either a channel shall be graded and properly protected down to its convergance with the natural channel, or the outlet flow shall be dispersed on the slope using acceptable flow spreading or energy dissipating devices. Storm sewers or paved channels that outlet at or near defined drainage channels, shall be designed to outlet at as near to parallel to the channel as practical.

    The outlet velocities of all headwalls shall be included in the drainage calculations. The invert of the first storm sewer appurtenance upstream of the outfall structure shall be above the elevation of the calculated one hundred (100) year flood plain. The calculated one hundred 100 year flood plain for all channels with a drainage area of more than fifty (50) acres within the project shall be shown on the Improvement Plan.

11. Culverts and Bridges - Culverts and bridges shall be designed in accordance with the methods given in the "Manual of Location and Design" published by the Kentucky Department of Highways; except that storm water quantities to be handled by the culverts and bridges shall be determined on the basis described in these standards. The allowable headwater (AHW) shall not be greater than $^{HW}/_{D} = 2.0$.

12. Headwalls - Standard headwalls for pipe sizes twelve (12) thru twenty-four (24) inch and headwalls including wingwalls and aprons for pipes larger than twenty-four (24) inch, shall be constructed at the outfall of all storm sewers in accord with "Standard Construction Drawings" as shown in the current city/county specifications. No grate shall be placed on any headwalls.

    Safety guards and railings: Safety guards and railings shall be provided along the top and sloped/winged sidewalls on all headwall inlet and outlet structures having a vertical drop of 4'-0" or greater. Such guards or railings shall be at least 42-inches in height measured vertically above the wall. Guards or railings shall not have an ornamental pattern that would provide a ladder effect. Vinyl coated chain link fencing is an acceptable guard type.

13. Other Drainage Improvement Measures - Other drainage improvement measures may be required to provide the necessary hydraulic characteristics required for adequate drainage. These other measures include stream bed clearing, removal or obstructions, stabilization

of banks or areas to eliminate erosion, widening, deepening or realignment of streams, construction of ponds behind dams, or other measures for adequate drainage.

14. Sub-Surface Springs - While constructing developments, sub-surface springs may be disturbed. In these cases, it is the responsibility of the developer to adequately address the removal of the water from the surface. This would include installing a pipe network to transfer water to a storm water structure or natural stream. Discharge of this type of water shall not be onto the lot directed toward the street, or on any part of the lot that will pond water. It is the responsibility of the builder/developer to correct any problems with sub-surface springs until a Certificate of Occupancy has been issued for the construction of a building on the affected lot.

15. Specifications for Construction and Materials - See *Street and Storm Drainage Construction Specifications*.

Basic Design Criteria for Storm Water Drainage Channels, Water Courses, and Erosion Control

Open channels provide many advantages in the management and control of storm water runoff. Such channels provide for natural infiltration of storm water into ground water supply and extend the Time of Concentration (T_c) helping to maintain the runoff rate nearer to that which existed prior to development. The objective of open channel flow design is: (a) to determine a channel slope and size that will have sufficient capacity to prevent undue flooding damage during the anticipated peak runoff period; and (b) to determine the degree of protection based on stream velocity to prevent erosion in the drainage channel. Existing drainage channels, which will remain undisturbed, shall not be required to be reconstructed unless additional capacity and erosion control is required.

A) Degree of Protection - Storm water drainage channels and water courses shall be adequate to handle runoff from storms of the frequencies of occurrence shown for the degrees of site development as follows:

1. For all subdivisions and developments twenty five year (25 yr.) frequency.

2. For main flood control channels - one hundred year (100 yr.) frequency. The runoff computed from these storms shall be that from the area within the subdivision and from all other areas considered as fully developed in accord with development planned in the County's Comprehensive Plan.

B) Determination of Quantity of Runoff - Each portion of the storm water system of drainage channels and water courses shall be capable of handling the peak flows as determined by the proper method previously described in Section 1.

C) Drainage Channel -Capacities- Drainage channels shall be designed to carry peak flows as determined by the methods previously described. Channel cross-section areas shall be determined by Manning's formula, using a value of n from the following chart.

Drainage Channel Manning's n Values	
Concrete	0.013
Earth (non-vegetated)	0.022
Rip-Rap	0.035
Rock Cuts	0.035
Grass-mowed short	0.05
Grass-tall stand	0.10
Natural Channel:	
-Clean and Straight	0.030
-Stones and Some Weeds*	0.035
-Gravel and Rock	0.040
-Weedy and Winding	0.06
-Dense Weeds & Brush	0.10

*this is typical for a natural intermittent stream

When open drainage channels require various lining types to attain ultimate design capacity, the earth sections of the drainage channel and its structure shall be designed and constructed to the ultimate design required. The design engineer shall provide swale sizing calculations for any proposed swale that drains more than one (1) acre of area. The Planning Commission's staff may require sizing calculations for swales draining less than one (1) acre of area, where said swale may have an adverse impact on the development or downstream properties.

D) Erosion Control for Drainage Channels - Runoff flows in open channels may cause accelerated erosion. Such erosion can be controlled by limiting velocities, changing the channel lining, and reshaping the channel to spread the flow of runoff. Methods of controlling erosion in open channels include the following:

1. Sown grass covers, seeded degradable turf reinforcing mats;
2. sod
3. permanent turf reinforcing mats;
4. aggregate channel lining (minimum KDOT Type II channel lining, underlain with filter fabric)
5. aggregate filled gabion baskets or mattresses (underlain with filter fabric);
6. interlocking concrete blocks or cabled mattress (underlain with filter fabric;
7. reinforced concrete or precast paving (of at least 4" thickness);
8. energy dissipators.

Any placement of erosion control materials in a channel could require a permit from the Kentucky Division of Water (KDOW) and the US Army Corps of Engineers.

*Alternate methods of channel erosion control will be considered on an individual case basis. Note that the methods above are generally listed (and numbered) in order of increasing erosion protection ability. The design requirements below indicate the minimum level of protection. Any method listed above with a higher erosion protection ability than the minimums stated below will be acceptable.

1. Design velocity should generally be greater than 1.5fps to avoid excessive deposition of sediments. When flattened slopes are unavoidable, method (7) should be used to accelerate runoff.

2. Design velocity between one and one-half (1.5) and five (5) feet per second: Method (1) shall be used. The bottom and sides of the earth channel shall be seeded, mulched and fertilized to an elevation of three (3) feet above the design water surface, or three (3) feet beyond the top of the channel bank. Seeding shall be a perennial or annual mixture of grass seeds applied at a rate of 75 pounds per acre. Acceptable whole fertilizer shall be applied at a rate of 75 pounds per one thousand square feet. Where seeding is required and the soil is not capable of supporting vegetation (such as sandy soil or clay types), appropriate action shall be taken to bring the soil to an acceptable condition which will support the growth of seed. A degradable turf reinforcing mat is recommended to help stabilize the soil until the grass has become fully established.

3. Design velocity between one and one-half (1.5) and five (5) feet per second: Method (2) or (3) shall be used. The bottom and sides of the earth channel shall be sodded and pegged to remain in place, or a permanent turf reinforcing mat shall be installed and seeded. Where seeding or sodding is required and the soil is not capable of supporting vegetation (such as sandy soil or clay types), appropriate action shall be taken to bring the soil to an acceptable condition which will support the growth of seed or sod.

4. Design velocity between nine (9) and fourteen (14) feet per second: Method (3) or (4) shall be used.

5. Design velocity between fourteen (14) and twenty (20) feet per second: Method (4) or (5) shall be used.

6. Design velocity greater than twenty (20) feet per second: Method (5) or greater shall be used.

A method greater than the required minimum may also be necessary at bends, changes in alignment, junctions with other ditches, and at other locations where erosion is more likely to occur. Design velocity at the downstream end of a protected channel shall be equal to or less than the natural velocity in the receiving channel. Energy dissipation may be necessary to reduce the velocity prior to reintroduction into a receiving channel.

E) Drainage Channel or Water Course Relocations- In order to minimize hillside slippage near relocated drainage channels or water courses due to drainage channel depth or character of the earth in the drainage channel fill and side slopes, precautions shall be taken to compact the fill and side slopes, provision of under drainage, bank protection or reinforcing or other measures. Additional easement width shall be provided at such possible slide areas.

F) Erosion Control - All subdivision developments shall have a Best Management Practices (BMP) document prepared and submitted with the Improvement Plan. This document shall meet the minimum requirements as stated in the current "Kentucky Best Management Practices For Construction Activities" prepared by The Kentucky Division of Water (KDOW). A copy shall be on site at all times. Permit applications with the KDOW and US Army Corps of Engineers shall be submitted with the Improvement Plan. All graded areas are to be maintained at all times to prevent erosion and excessive runoff. Several methods used to prevent soil erosion during development are included in the current city/county street specifications. Drainage swales, silt checks, temporary sedimentation basins, rock check dams, etc., are to be used and maintained during the grading operation. All collected sedimentation shall be removed from the detention site. All slopes and graded areas are to be seeded after the grading of that area has been completed.

Additional erosion control measures to prevent erosion and excessive runoff may be required if necessary.

G) Mud and Debris - Until all lot and street improvements in the subdivision have been completed, the subdivider shall take such measures as are necessary to prevent erosion of graded surfaces, and to prevent the deposit of soil and debris from graded surfaces onto public streets, into drainage channels or sewers, or onto adjoining land. All public streets shall be kept clear of mud and debris per local ordinances.

H) Specifications for Construction and Materials - In all other respects, the design, materials, and construction shall be as specified in Sections 206, 212, 601, 610, 703, 710 of the current State of Kentucky Standard Specifications for Road and Bridge Construction and in accord with "Standard Construction Drawings" shown in the current city/county street specifications.

I) Equipment on Streets - Any equipment on any existing pavements shall be per local ordinances.

Basic Design Criteria for Stormwater Runoff Control Facilities

These regulations affect all subdivision and developments:

A) General- In order to minimize runoff damage to downstream properties, sediment pollution of public and private waters and hydraulic overloading of existing drainage facilities, the storm water runoff from a subdivision after development shall not exceed the pre-

development discharge from that subdivision calculated by using a undeveloped runoff coefficient c= 0.40. Detention shall be provided for all subdivisions and developments. The detention facility may be designed for each individual lot in commercial or industrial zones, but regional basins are encouraged to be provided throughout the subdivision or development. All basins within residential zones must be regional. Such facilities shall be designed so that no standing water will remain in detention basins during dry weather, or the design of retention ponds that will not allow standing water to stagnate and present health hazards. In certain cases, other non-basin detention/retention techniques such as underground vault storage and ponding water on parking lots may be utilized when approved by the commission. Individual site storm water management shall be reviewed under the current Boone County Zoning Regulations. The amount of water to be detained shall be determined by the method described in the following paragraphs using the design criteria as referenced in Table 1 and Figures 3, 4, and 5.

Storm Water Control Facility Volume Calculations
Estimated Runoff by:

An accepted method that generates an inflow/outflow hydrograph such as the Soil Conservation Service (SCS) method or Modified Rational Method (MRM) as detailed in the Street and Storm Drainage Specifications. It is recommended that these methods are used through a computer program. All documentation shall be submitted for review by the Planning Commission Staff.

B) Pre-Development - Calculations - Calculate the subdivision or development site runoff based on a 2, 10, 25 and 50 year storm frequency. The entire acreage contributing to the runoff, shall be included in the calculations.

C) Post-Development Runoff Calculations - Calculate the proposed ultimate development runoff based on a 2, 10, 25, 50 and 100 year storm frequency curve. The entire acreage contributing to the runoff shall be included in the calculations.

D) Storage Requirement - The amount of detention/retention required for a subdivision or development shall be the amount determined from the inflow/outflow hydrograph as previously outlined based on the fifty year (50 yr.) storm frequency. If the Modified Rational Method is used, the storm duration used shall be the one that produces the maximum storage.

E) Discharge from Detention Basin - The discharge from the detention/retention basin shall be controlled by a multi-stage release outlet structure and not be greater than a pre-developed runoff rate based on a 2, 10, 25 and 50 year storm frequency at that particular point where the discharge occurs. Alternative methods using water quality volume design may be used upon approval. The routing of an emergency spillway shall be shown based on the one hundred year (100 yr.) storm frequency. Trash racks may be required to be installed on the low flow outlet in detention basins to prevent clogging.

Detention Basins/Retention Ponds - Standards and Specifications

A) Definition and Scope- These standards apply to permanent and temporary storm water runoff, sediment and debris basins formed by an embankment, or excavation. These standards are limited to the installation of basins on sites where:

1. Failure of the structure will not result in loss of life, damage to homes, or interruption of use or service of public utilities.

2. Drainage area does not exceed two hundred acres (200).

3. The water surface at the crest of the emergency spillway does not exceed five (5) acres.

4. All detention basins that shall be designed and built with side-slopes no greater than 3:1 (three feet horizontal per one foot vertical), and proper outlet structures to insure no standing water during dry periods.

5. All retention ponds shall have dams that conform to the current Design Criteria For Dams and Associated Structures, Kentucky Division of Water. In cases when the top of the dam is also a publicly dedicated street right-of-way, the developer shall have a geotechnical report prepared with recommendation on the design and construction of the dam.

NOTES:

a. All computations to be prepared by a Kentucky Licensed Professional Engineer.

b. All detention areas and methods to be approved by the engineer for the city or county. In the event the city or county does not have an engineer, the approval will be by the engineer for the Planning Commission.

c. Fencing may be required when the location of the detention area is not easily observed or in the opinion of the inspector a safety problem would exist.

d. All sedimentation must be removed from all detention basins/ retention ponds prior to acceptance by proper legislative body.

Residential Lot Grading and Drainage

A) Lot Grading - Lot grading shall be accomplished as follows: Within the limits of the public right-of-way adjacent to street pavements, all final grading for grass strip, sidewalk, and yards to the building structure, shall comply with minimum and maximum grades in accord with typical sections for streets as shown in the current city/county street specifications. For lots that drain toward the street, the areas between the right-of-way line and the curb shall

be graded so that water drains to the street at a minimum grade of 1 inch per foot (approximately 8 percent) except where sidewalks are required (see Typical Sections). All grading behind the street shall be done in a fashion that does not allow ponding of water adjacent to the paved street. For lots that drain away from the street, the area between the right-of-way line and the curb shall be graded so that water drains away from the street at a minimum grade of ½ inch per foot (approximately 4 percent) except where sidewalks are required (see Typical Sections). Grading and surface drainage at the building shall conform to the current edition of the Kentucky Residential Code. Lot areas outside of the limits of the building structure shall be graded per the detail in the current Boone County Street, Storm, and Sidewalk Specifications.

Building Elevation: All Zoning Permit applications shall be consistent with the subdivision Improvement Plan in relation to the lot grading. The Zoning Permit application requires the difference in elevations between the street curb at the center of the driveway and the basement floor, first floor, and lowest opening (if applicable.) The difference in the elevations shall be consistent with the elevations of the grading on the Improvement Plan.

Temporary Driveway: All residential lots shall have a single point access and a temporary driveway of crushed stone with fabric placed in the location of the permanent driveway. The temporary driveway shall be constructed after completion of foundation. It shall be a minimum of three inches (3") in depth with a separation fabric and a minimum of ten feet (10') in width. All construction traffic to the site must utilize the temporary driveway and shall not drive on any other portion of the lot without prior approval of the city/county inspector.

Slope for Permanent Driveway: Driveways within RSE, RS, SR-1, SR-2, SR-3, and R1F zones shall not exceed fifteen (15) percent slope within the front yard area unless approved by the Zoning Administrator. Relief from this requirement shall be granted only when a steeper grade is unavoidable due to on-site conditions and will not have a detrimental impact on the subject lot or adjoining lots.

Top Soil: If grading results in the stripping of top soil, top soil shall be uniformly spread over the lots as grading is finished. Temporary silt barriers should be installed around stock-piled top soil for erosion and sediment control.

Trees: As many trees as can be reasonably utilized in the final development plan shall be retained and the grading adjusted to the existing grade of the trees where practicable.

B) Swales - Swales carry surface runoff from roofs, yards, and other areas to the rear of lots or along common property lines to streets or other drainage areas to prevent ponding of water near building structures or other portions of the lot. Surface drainage swales shall have a minimum grade of two (2) percent and shall be constructed so that the surface water will drain onto a street, storm inlet, or natural drainage area. Swales for handling lot drainage shall be constructed as a part of final lot grading and be seeded and mulched or sodded as soon as possible to prevent erosion.

C) Roof and Subsurface Drains - Roof downspouts, footing or foundation drains shall be discharged onto the same parcel of land from which the water is generated. Roof downspouts shall terminate onto a splash block or if a private, on-site sidewalk is blocking the flow, within two feet (2') of the lower edge of the walk. All subsurface drains including sump pumps shall outlet toward the rear of the lot unless infeasible based on site conditions, and the water from such drains shall be dispersed on the subject lot. No subsurface drain shall outlet nearer than ten feet (10') to a property line and twenty feet (20') to the right-of-way line. If a collection system was approved, then sump pump drains may be connected to the system.

D) Buffer Zone - To help protect natural channels and streams within a development, there shall be Buffer zones placed over these areas. These Buffer Zones shall coincide with the Buffer Zones as defined in the Kentucky Division of Water Permit KYR10. A copy of the application for this permit with the SWPPP shall be submitted to the Planning Commission. Upon approval of the application, a copy of the approval shall also be submitted. The location of these zones shall be shown on the Improvement Plan. The location of the zone shall be field staked prior to any clearing or grading in the vicinity of the zone.

Maintenance of Retention/Detention Areas

In all developments the owner of each lot and/or the developer shall be responsible for properly maintaining each retention/ detention areas in order for such facility to function according its design and purpose. Maintenance for the detention/retention areas shall be noted on the Improvement Plan, including access roads. For all basins, only the appropriate easements around inlets structures and outlet structures, and a retention easement over the area of the fifty year (50 yr.) storm event shall be dedicated to the appropriate legislative body or utility. The area of the pond or lake shall be owned and maintained by the adjoining residents or Home Owners Association (HOA). This shall include maintaining the shoreline and removing sedimentation, and shall be included in the Subdivision's Restricted Covenants

Storm Water Quality BMP Sizing Requirements

In accordance with the Kentucky Pollutant Discharge Elimination System (KPDES) permit for Small Municipal Separate Storm Sewer Systems (Phase II MS4 General Permit: SD1 KPDES No. KYG200007 and City of Florence KPDES No. KYG200013), for new development and redevelopment projects, runoff generated from the first 0.8" of rainfall must pass through a water quality BMP. This runoff treatment standard is based on the 80th percentile precipitation event.

These BMP sizing standards are volume-based standards and are appropriate for sizing BMPs that provide their primary treatment function by storing the water quality design volume (Vwq). As such, volume-based BMPs are designed to treat a volume of runoff, which is detained for a certain period of time to allow for settling of solids and associated pollutants, as well as any biochemical treatment processes that may be provided for dissolved pollutants such as adsorption, precipitation, biodegradation, and plant uptake. Example volume-based BMPs include extended detention basins, retention basins, media bed filters, and rain gardens.

Flow based sizing standards are needed for structural BMPs that have minimal storage where their performance is related more to the peak flow rate that they are designed to treat rather than the storage capacity. As such, flow-based BMPs treat water on a continuous flow basis. Examples of flowbased BMPs include vegetated swales, filter strips, and many proprietary hydrodynamic treatment devices. These types of BMPs are more appropriately sized using a water quality design flow rate (Qwq).

While the distinction between volume-based and flow-based controls is not always clear, especially in a sequence of BMPs or BMPs that include multiple storage and flow-through treatment components, this manual differentiates these BMP types for the purposes of providing simple sizing guidelines for each type of control. Continuous hydrologic simulation modeling may be used to demonstrate an equivalent level of treatment in lieu of the simple sizing methods presented below.

Simple Sizing Method for Volume Based Controls

The water quality design volume used for sizing volume-based treatment BMPs may be computed using the Simple Method (Schueler, 1987). This method uses a volumetric runoff coefficient:

$$Rv = 0.009 \times \%IMP + 0.05 \quad (3\text{-}1)$$

Where:

Rv = the volumetric runoff coefficient (unit-less)

%IMP = the percent imperviousness of the drainage area (%)

Using the design storm volume summarized above, the water quality design volume may be computed using a modified form of the rational formula:

$$Vwg = 3630 \times Rv \times P \times A \quad (3\text{-}2)$$

Where:

Vwq = the water quality design volume (ft3)

Rv = the mean volumetric runoff coefficient, a unit-less value that is a function of the imperviousness of the drainage area (see Equation 3-1 above).

P = the rainfall depth of the storm (in) [For SD1: use 0.8 for new development in the separate system, 0.4 for redevelopment in the separate system, or use 0.8 for new development and redevelopment in the combined system; for City of Florence use 0.8 for both new development and redevelopment]

A = the BMP drainage area (acres)

The water quality design volume should be used to initially size the BMP using the design criteria provided in the individual BMP fact sheets. Additional storage capacity must be provided if the BMP is designed to attenuate peak flows.

Note about Drawdown Time

Drawdown time is the time required to drain a volume-based BMP that has reached its design capacity, usually expressed in hours. Drawdown time is important because it is the time required to fully replenish the storage capacity, which affects the capture efficiency of the next storm, and is a surrogate for residence time, which affects treatment. Estimates for design drawdown time vary, and ideally would be determined based on site-specific information on the size, shape, and density or settling velocity of suspended particulates in the runoff. This information is generally not available and estimates of appropriate ranges for settling time have relied on settling column test information reported in literature.

An important source of drawdown time information is settling column tests conducted by Grizzard et. al. (1986) as part of the Nationwide Urban Runoff Program (NURP). Grizzard found that settling times of 48 hours resulted in removals of 80% to 90% of total suspended solids (TSS). Rapid initial removal was also observed in storm water samples with medium (100 to 215 mg/L) and high (721 mg/L) initial TSS concentrations. For example, at settling times of 24 hours, the 80% to 90% removals were already achieved in samples with medium and high initial TSS, whereas only 50% to 60% removal was achieved in those with low initial TSS.

Given the data provided above, a drawdown time of 36 to 48 hours is recommended for sizing outlet structures for volume-based BMPs that depend on settling as the primary treatment. For volume-based BMPs, such as bioretention and media filters, which depend on filtration as the primary treatment mechanism, the drawdown time for the entire system (ponded water plus the filtration media pore water) should be less than 48 hours (i.e., there is no minimum drawdown time for volume-based BMPs that include filtration as the primary treatment mechanism). The upper limit of the drawdown time is consistent with the recommendation of various vector control agencies that structures be designed to drain in less than 72 hours to minimize mosquito breeding opportunities.

Simple Sizing Method for Flow-Based Controls

The water quality design flow rate for a flow-based BMP may be selected such that it treats an equivalent proportion of the long-term runoff volume as a volume-based BMP would. In order to use this approach, continuous runoff modeling techniques must be performed. A spreadsheet can be used to statistically analyze the long time series of runoff predicted by the continuous model for a project site to determine the flow rate associated with treating the volume of runoff determined using the volumetric sizing criteria discussed above.

An alternative simple approach is to select a design storm intensity and use the rational formula to compute the design flow rate. The design storm intensity may be based on the 80th percentile rainfall intensity. However, if hourly rainfall data are used to compute this value, the design intensity will be an under-prediction of the 80th percentile computed from shorter duration intensities. For example, during a one hour period peak rainfall, intensities may only occur for a few minutes and these peaks would be smoothed by the hourly averaging period. Therefore, a conservative

approach for selecting a design storm intensity is to use twice the 80th percentile rainfall intensity from hourly historical rainfall data.

The 80th percentile hourly rainfall intensity measured at the Cincinnati-Northern Kentucky Airport is approximately 0.08 in/hr (Strecker and Rathfelder, 2008). Therefore, doubling this intensity gives a 0.16 in/hr design storm intensity, which can be converted to a design flow rate using the rational formula:

Qwg = Rv x i x A

Where:

Qwq = the water quality design flow rate (cfs)

Rv = the mean volumetric runoff coefficient, a unit-less value that is a function of the imperviousness of the drainage area

i = rainfall intensity (in/hr) [use 0.16 in/hr]

A = the BMP drainage area (acres)

Note that 1 acre-in/hr = 1.0083 cfs; this conversion factor can be used with Equation 3- 3, but is not necessary as the uncertainty for the other parameters is generally well above 0.8%.

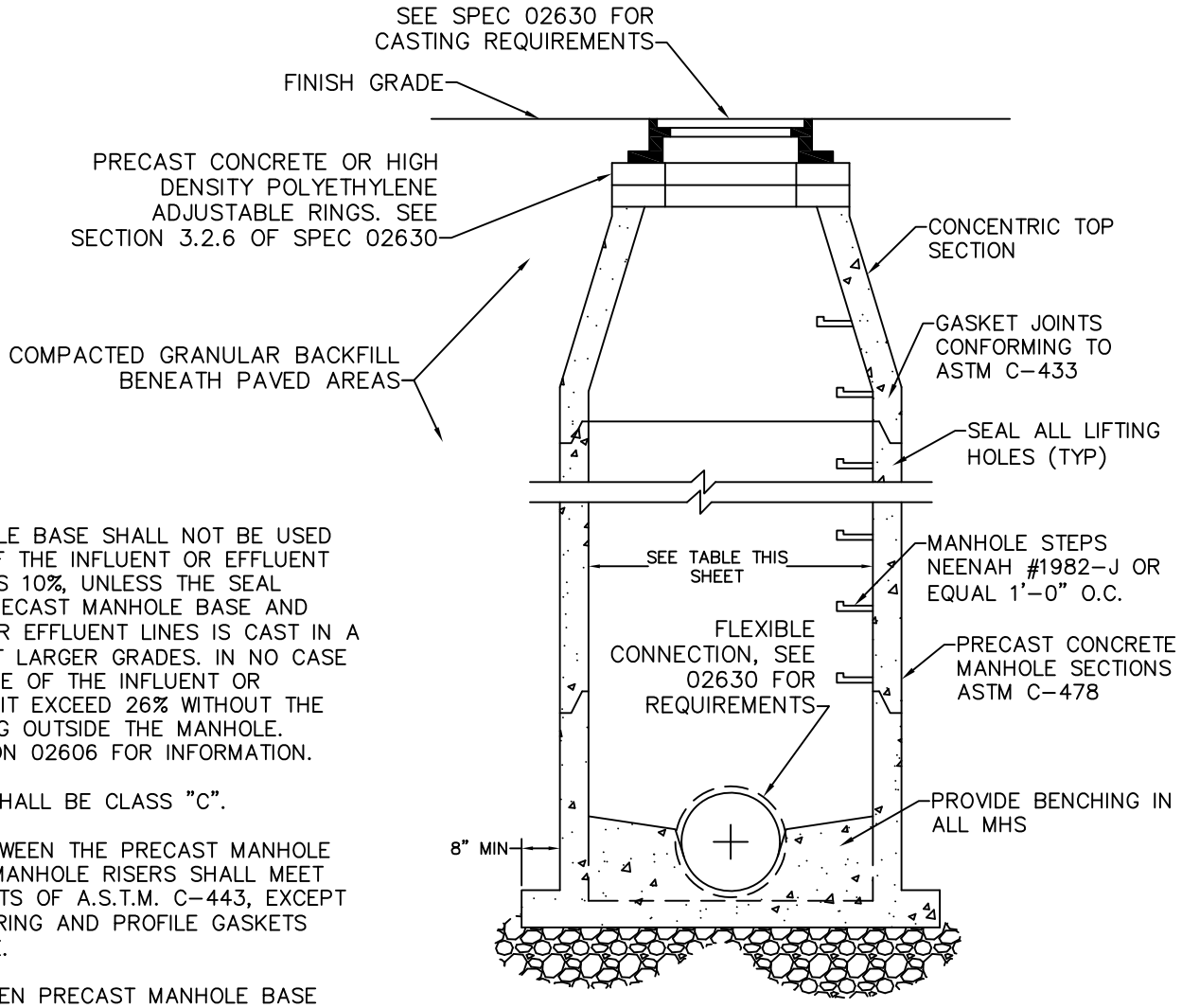
SECTION 330
Soil Erosion and Slope Control

The developer of a proposed subdivision or development shall be required to submit to the Commission a detailed plan for erosion and/or sedimentation control. The plan shall contain proposed methods for slope stabilization, erosion control and water pollution abatement and shall be reviewed by the Commission. The Commission shall require that such a plan or part thereof be submitted with the Improvement Plan and Grading Plan.

A) Prior Grading or Disturbed Site - No Improvement Plan and/or Grading Plan may be approved where the site has been graded, stripped, excavated, devegetated or otherwise disturbed so that slipping, erosion and/or water pollution has or may reasonably be expected to occur until such conditions are corrected to the satisfaction of the Commission.

B) Soil Survey - The current "Soil Survey of Boone, Campbell and Kenton Counties, Kentucky" issued by the United States Department of Agriculture, Soil Conservation Service in cooperation with the Kentucky Agricultural Experiment Station is hereby made a part of these regulations and will be used for informational and reference purposes.

C) Erosion Control Measures - Must be per the current *Kentucky Best Management Practices For Construction Activities*.



NOTES:

1. PRECAST MANHOLE BASE SHALL NOT BE USED IF THE GRADE OF THE INFLUENT OR EFFLUENT CONDUIT EXCEEDS 10%, UNLESS THE SEAL BETWEEN THE PRECAST MANHOLE BASE AND INFLUENT AND/OR EFFLUENT LINES IS CAST IN A SKEW TO ACCEPT LARGER GRADES. IN NO CASE SHALL THE GRADE OF THE INFLUENT OR EFFLUENT CONDUIT EXCEED 26% WITHOUT THE USE OF A FITTING OUTSIDE THE MANHOLE. SEE SPECIFICATION 02606 FOR INFORMATION.

2. ALL CONCRETE SHALL BE CLASS "C".

3. THE GASKET BETWEEN THE PRECAST MANHOLE BASE AND THE MANHOLE RISERS SHALL MEET THE REQUIREMENTS OF A.S.T.M. C-443, EXCEPT THAT ONLY "O" RING AND PROFILE GASKETS ARE ACCEPTABLE.

4. THE SEAL BETWEEN PRECAST MANHOLE BASE AND INFLUENT AND/OR EFFLUENT CONDUITS SHALL BE A FLEXIBLE CONNECTION, "A-LOK", "KOR-N-SEAL", "DURA'SEAL" OR AN APPROVED EQUAL FOR PIPES LESS THAN OR EQUAL TO 48 INCHES IN DIAMETER.

5. THE PRECAST BASE SHALL HAVE THE FLOOR AND SIDE WALL CAST AS ONE UNIT; IF THE FLOW LINE (CHANNEL) AND BENCHES ARE NOT CAST AS A PART OF FLOOR AND SIDE WALL, THEY SHALL BE CAST AT THE PLACE OF MANUFACTURE.

6. LIFT HOLES IN PRECAST MANHOLE BASE TO BE SEALED WITH HYDRAULIC CEMENT AND THE EXTERIOR COATED WITH A BITUMINOUS PAINT.

7. PRECAST MANHOLES SHALL BE INSTALLED PER SECTION 02606.

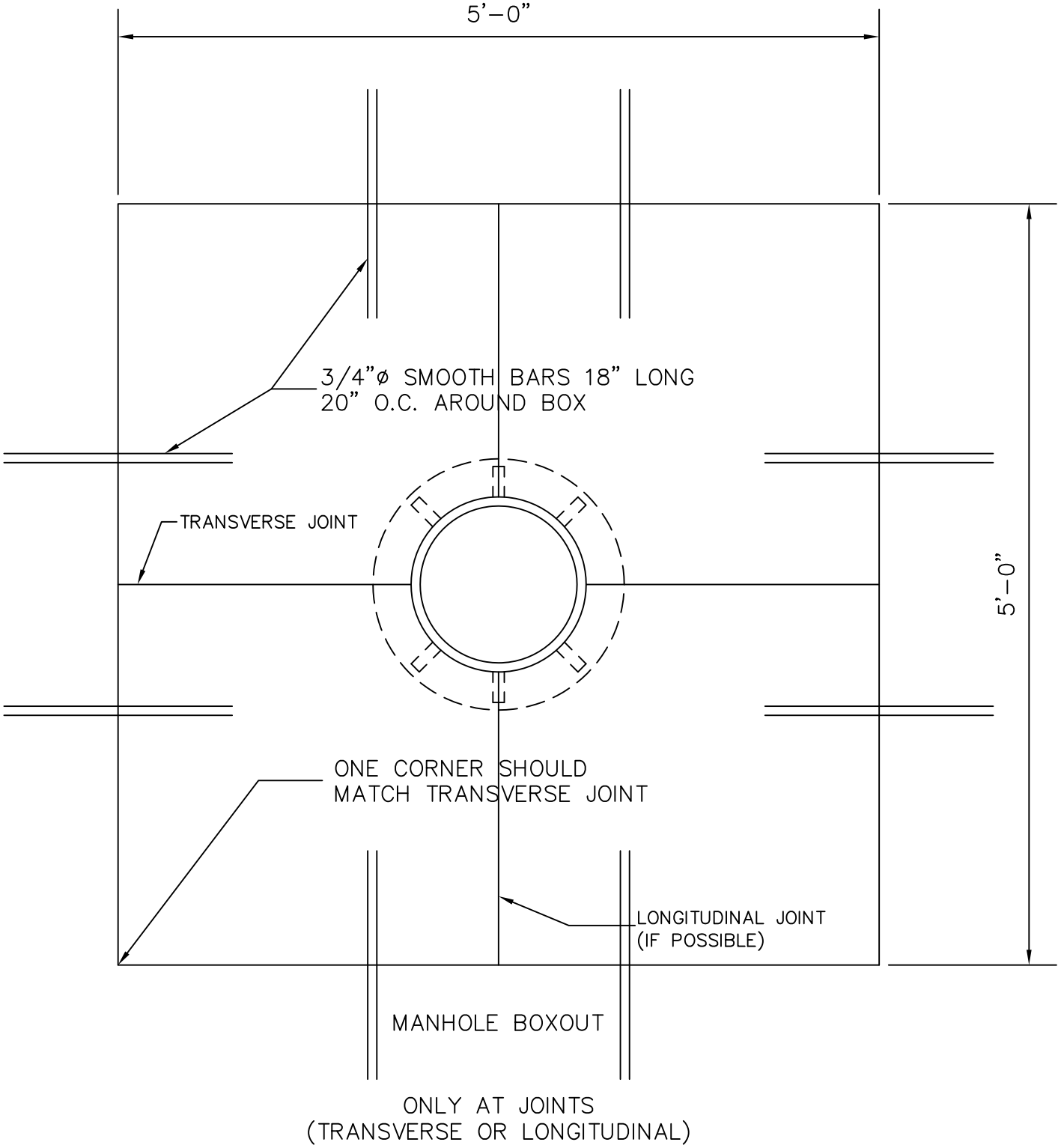
8. BENCHING SHALL BE SHAPED TO MAINTAIN A SMOOTH TRANSITION OF FLOW FOR PIPE ANGLES BETWEEN 90 AND 180 DEGREES, AS REFERENCED TO THE DOWNSTREAM FLOWLINE. NO ANGLES LESS THAN 90 DEGREES WILL BE ALLOWED BETWEEN INCOMING AND OUTGOING PIPES IN MHS.

9. ALL MANHOLES SHALL FOLLOW THE REQUIREMENTS OF SECTION 02630 OF SD1'S TECHNICAL SPECIFICATIONS.

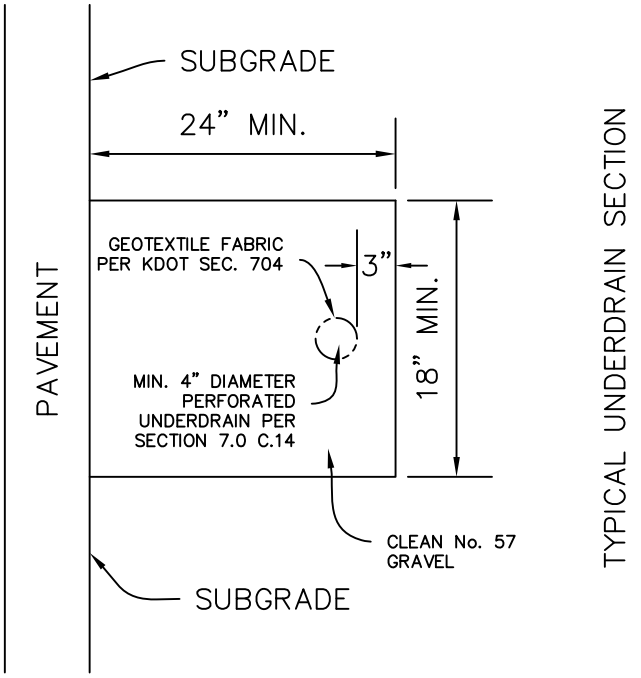
PIPE DIAMETER	MH BASE ID
8" THRU 21"	48"
24" THRU 36"	60"
42" & 48"	72"
60"	90"
72"	108"

STANDARD MANHOLE

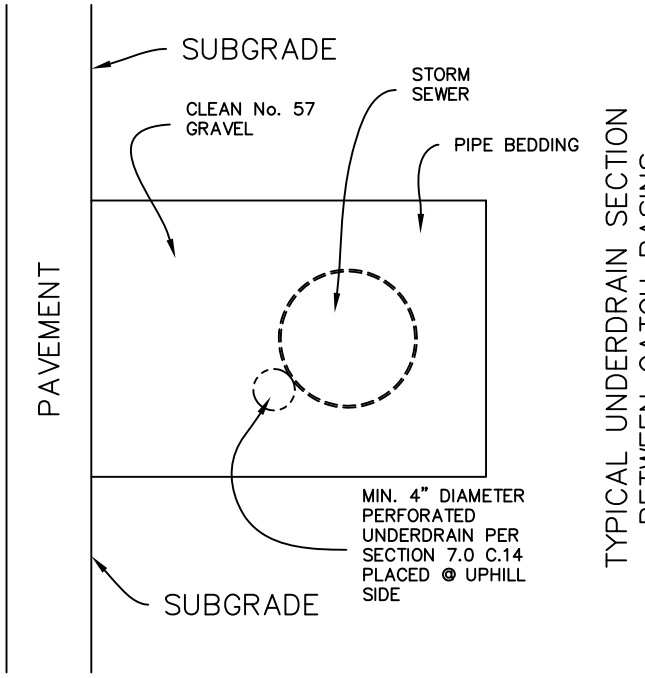
MANHOLE DETAIL
IN CONCRETE PAVEMENT



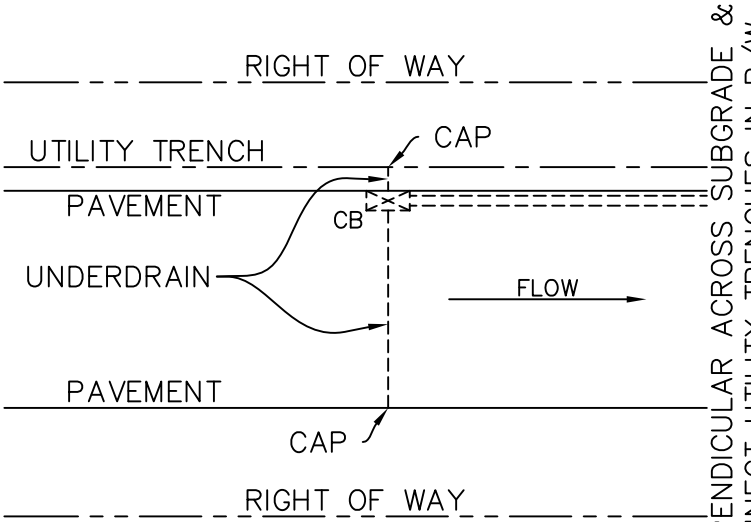
ONLY AT JOINTS
(TRANSVERSE OR LONGITUDINAL)



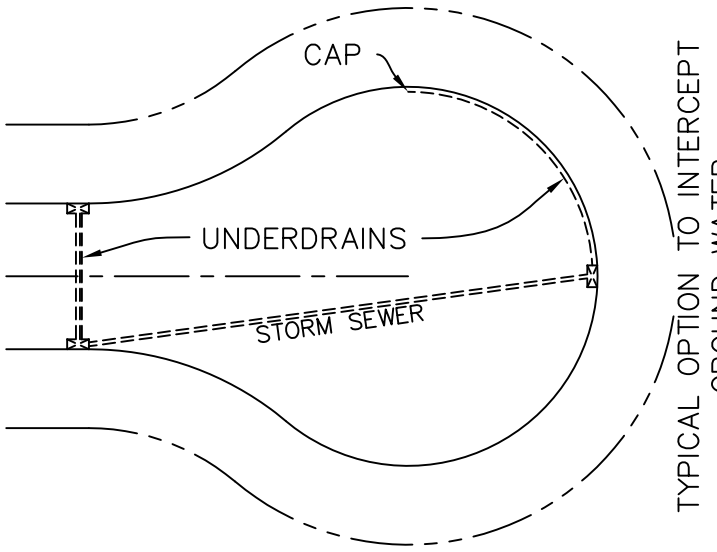
TYPICAL UNDERDRAIN SECTION



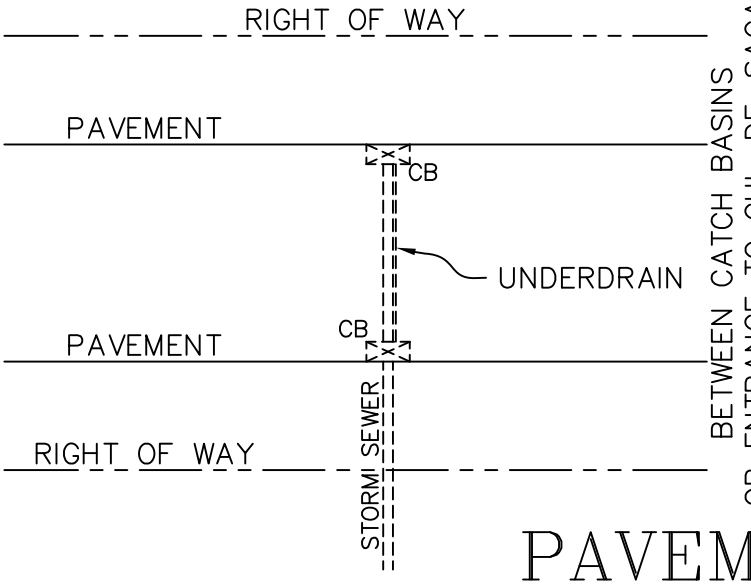
TYPICAL UNDERDRAIN SECTION BETWEEN CATCH BASINS



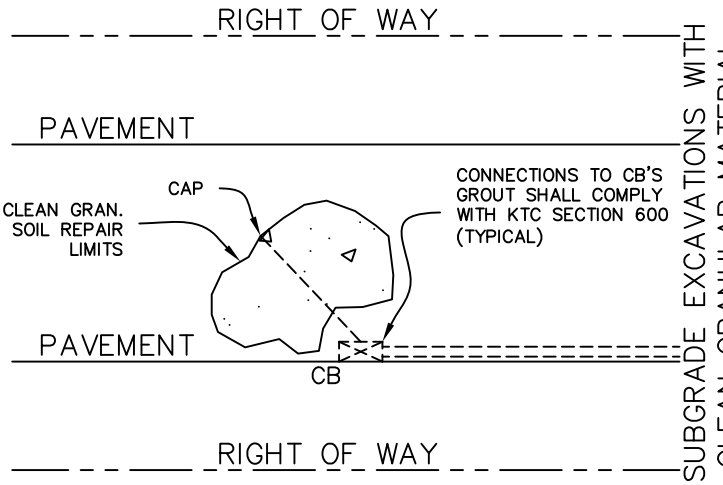
PERPENDICULAR ACROSS SUBGRADE & CONNECT UTILITY TRENCHES IN R/W



TYPICAL OPTION TO INTERCEPT GROUND WATER

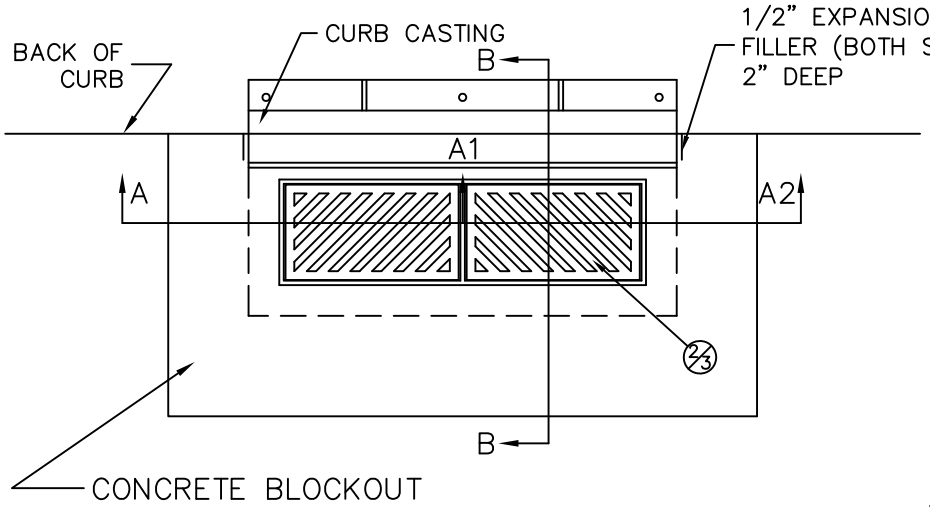


BETWEEN CATCH BASINS OR ENTRANCE TO CUL-DE-SACA

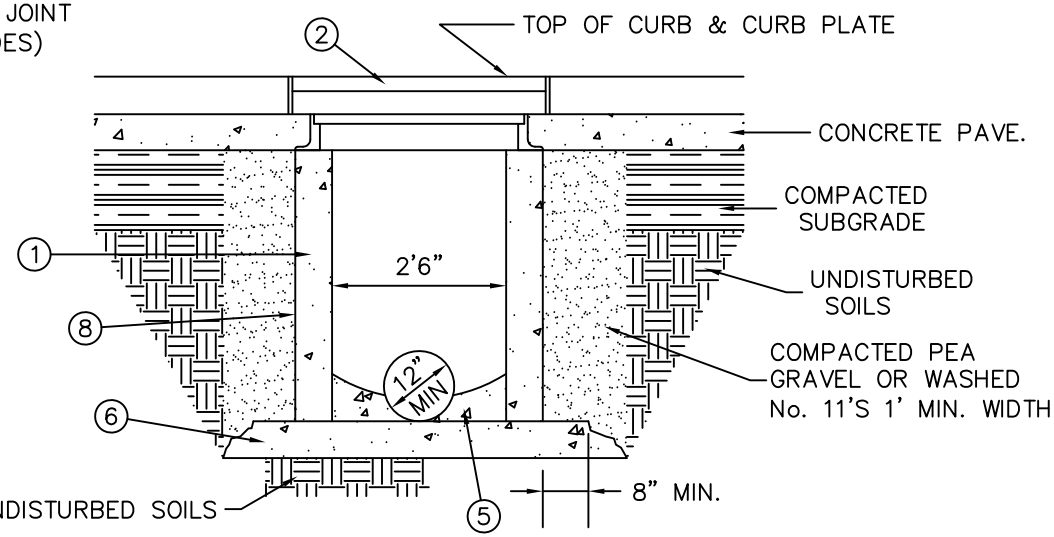


SUBGRADE EXCAVATIONS WITH CLEAN GRANULAR MATERIAL

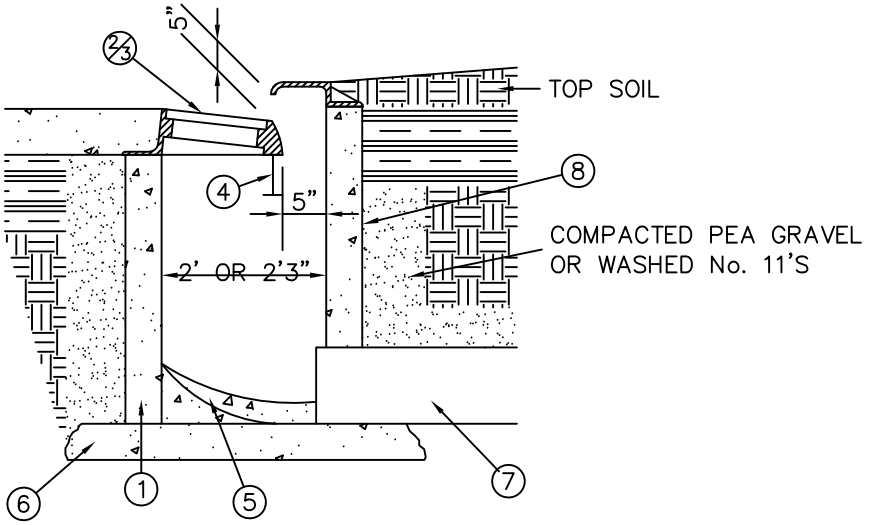
PAVEMENT UNDERDRAINS



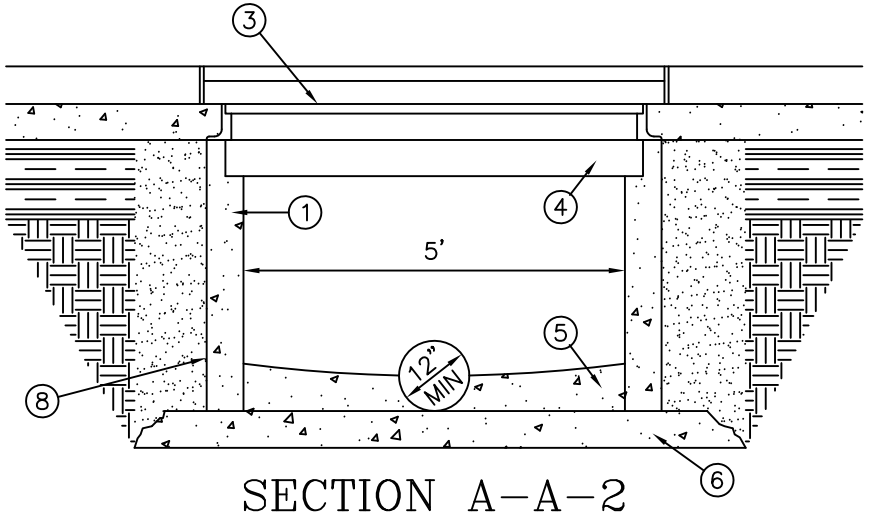
PLAN OF CATCH BASIN



SECTION A–A–1



SECTION B–B



SECTION A–A–2

(1) CONCRETE BRICK OR SLAB BLOCK MAY BE USED IN PLACE OF PRECAST OR CAST IN PLACE CONCRETE. SIDEWALLS SHALL BE 6" NOMINAL THICKNESS W/HORIZONTAL REINFORCEMENT EVERY 16 INCHES.

(2) SINGLE INLET: FRAME, GRATE AND CURB PLATE – NEENAH R–3289–C OR APPROVED EQUAL.

(3) DOUBLE INLET: FRAME, GRATE AND CURB PLATE – NEENAH R–3288–E2 OR APPROVED EQUAL.

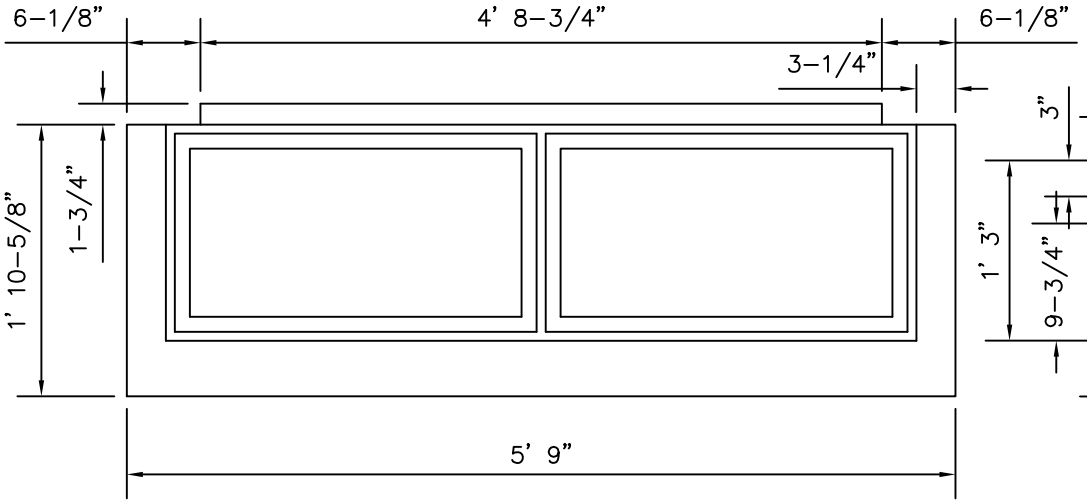
(4) 5–6 X 12.5 X 6' STEEL BEAM (USE WITH SEPARATE OR BOLTED INLETS).

(5) 4" MIN. DEPTH 4000 PSI AE CONCRETE WITH SCRIBED INVERT.

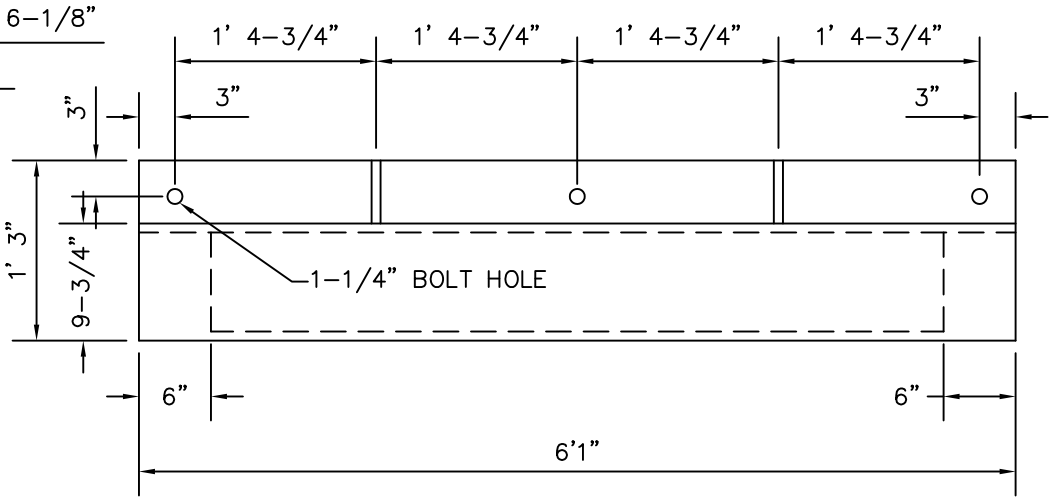
(6) 6" MIN. DEPTH 4000 PSI AE CONCRETE EXTENDED MIN. 8" BEYOND EXTERIOR OF BOX.

(7) 12" MIN. DIA. PIPE (FOR ALL PIPE TYPES AND SIZES SEE SECTION 7.0)

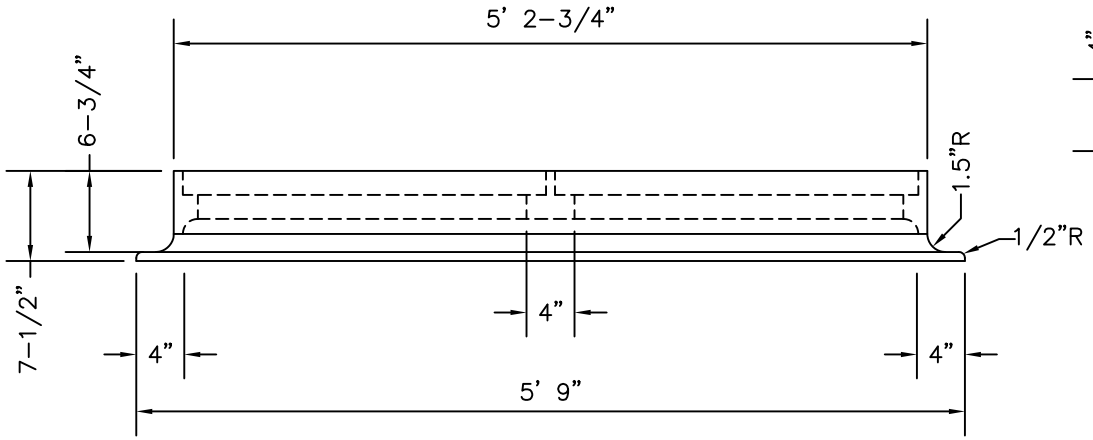
(8) UFT HOLES AND JOINTS SHALL NOT YIELD AN OPENING GREATER THAN THE SIZE OF AGGREGATE BACKFILL.



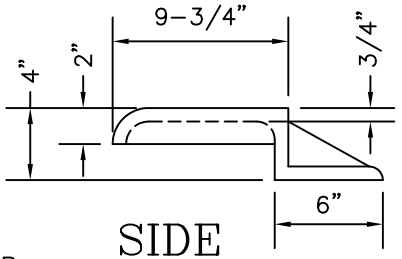
PLAN – DOUBLE



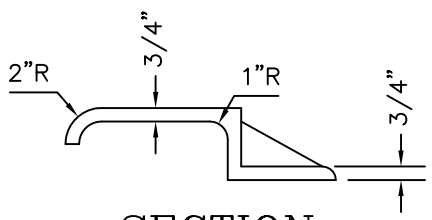
PLAN



FRAME (FRONT VIEW)

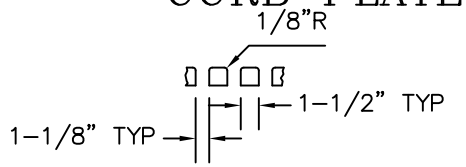


SIDE

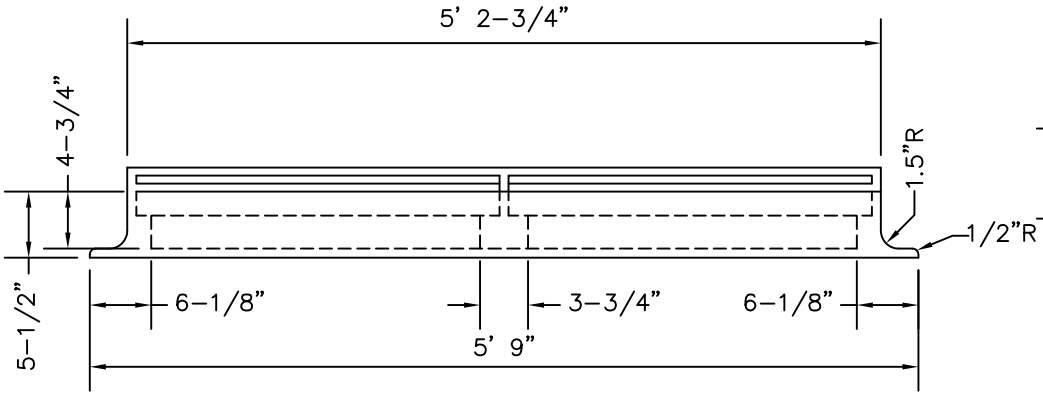


SECTION

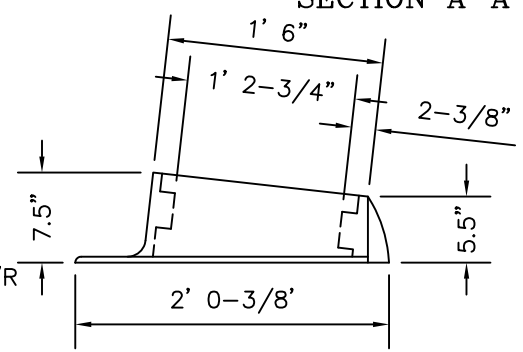
CURB PLATE

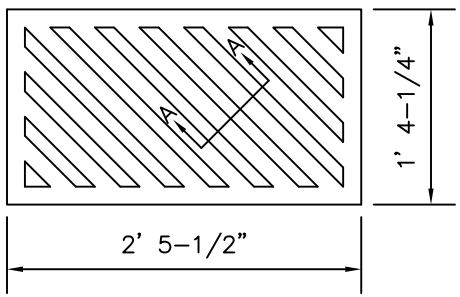


SECTION A-A



FRAME (BACK VIEW)

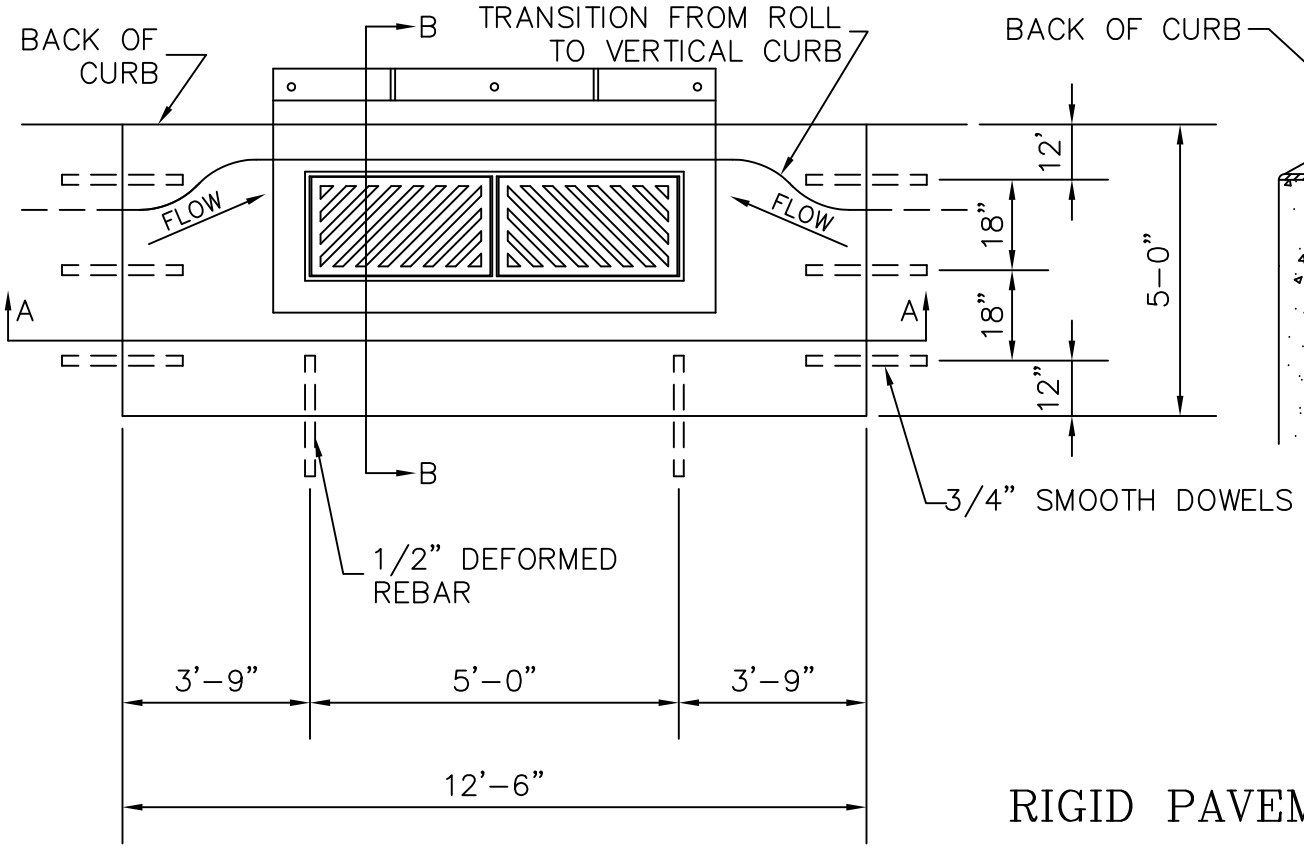




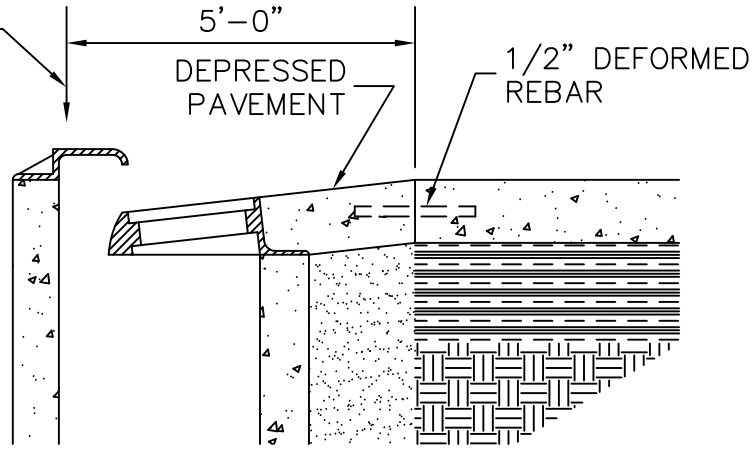
GRATE PLAN

CB CASTING DETAILS – DOUBLE

NOTE: SPECIFICATIONS PER NEENAH R-3288-E OR EQUIVALENT



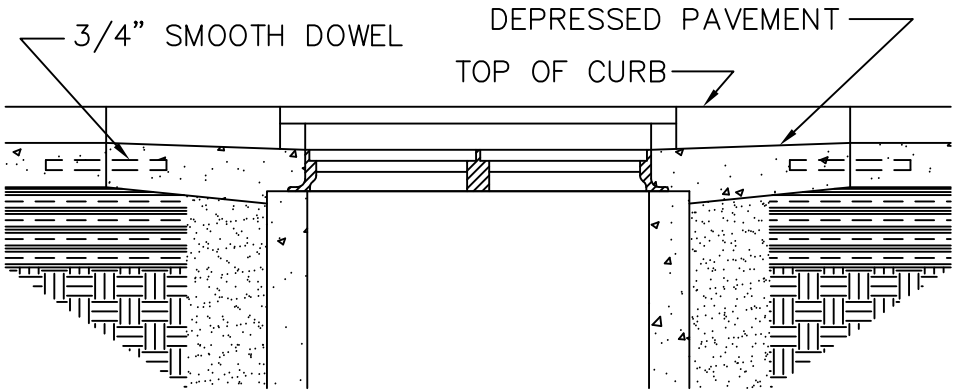
PLAN VIEW



SECTION B-B

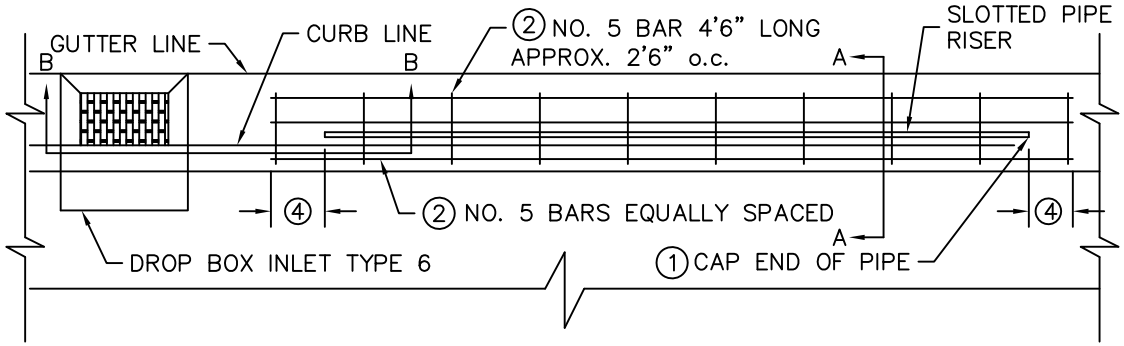
RIGID PAVEMENT BLOCKOUT DETAIL

C.20



SECTION A-A

- BLOCKOUTS SHALL BE PAVED WITH 4000 PSI AIR ENTRAINED PORTLAND CEMENT CONCRETE
- BLOCKOUTS FOR SINGLE INLET CATCH BASINS SHALL BEAR THE SAME DIMENSIONS AS THE DOUBLE INLET CATCH BASIN
- 3/4"X18" DOWELS ARE REQUIRED FOR CONCRETE PAVEMENT OR GUTTER BLOCKOUT – SEE SHEET C-10 FOR DOWEL DETAILS
- TWO 1/2"X18" PIECES OF DEFORMED REBAR ARE REQUIRED ALONG BUTT JOINT OF ISOLATION AREA



PLAN VIEW

① THE CAP SHALL BE A STANDARD MANUFACTURED ITEM FURNISHED BY THE PIPE SUPPLIER.

② ALL REINFORCING STEEL SHALL BE INCLUDED IN THE CONTRACT UNIT PRICE PER LINEAR FOOT OF SLOTTED DRAIN PIPE.

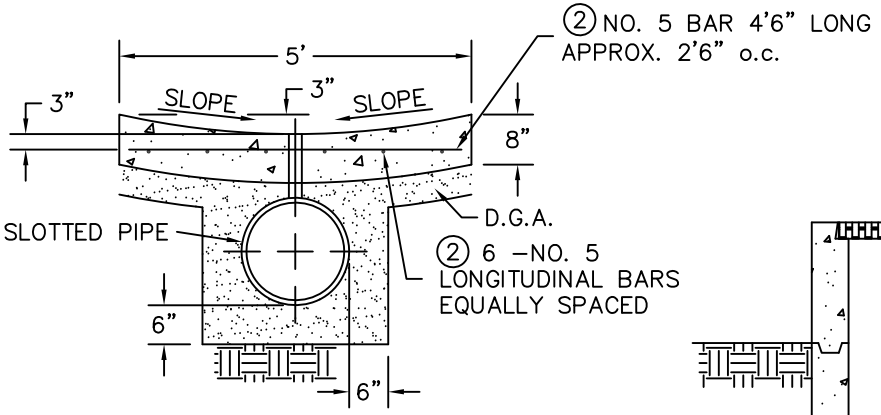
③ USE DROP BOX INLET TYPE 10 WITH VALLEY GUTTER (LIMITED TO 24" METAL PIPE SIZE), OR EQUAL.

④ EXTEND LONGITUDINAL BAR APPROXIMATELY 1'–6" PAST END OF SLOTTED DRAIN PIPE.

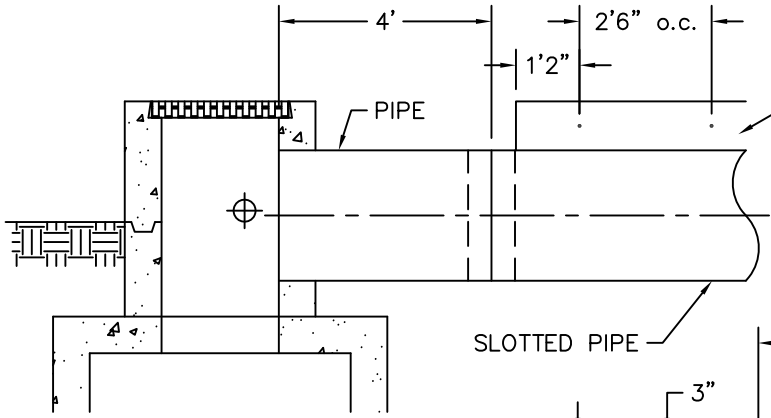
⑤ MINIMUM THROAT DEPTH FOR SLOTTED DRAIN PIPE SHALL BE 10".

⑥ CONTROLLED–LOW–STRENGTH–MATERIAL OR FLOWABLE FILL MAY BE USED FOR BACKFILL.

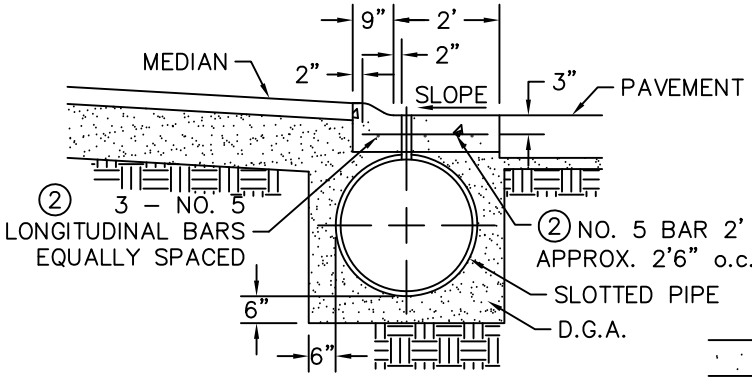
⑦ 12" MINIMUM DIA., 20' MAXIMUM LENGTH.



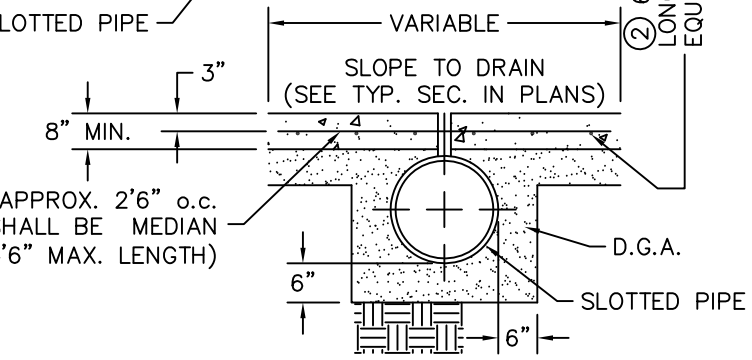
VALLEY GUTTER SECTION ③



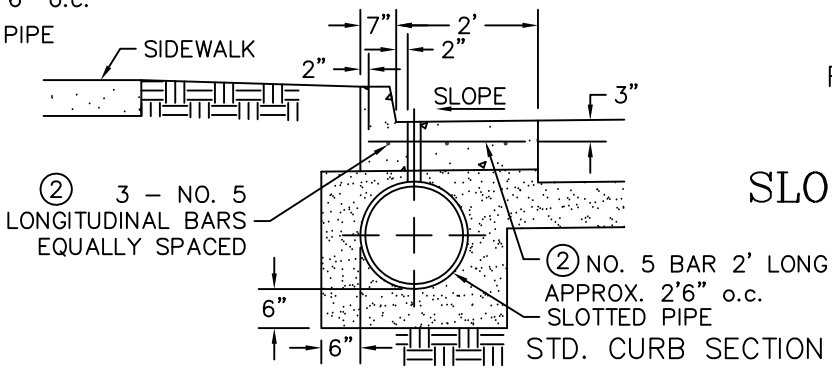
SECTION B–B



SECTION A–A
LIP CURB SECTION

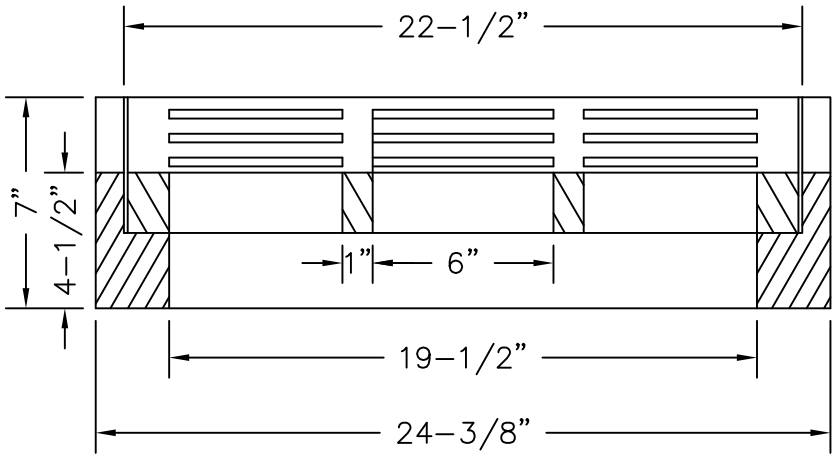


FLUSH MEDIAN SECTION

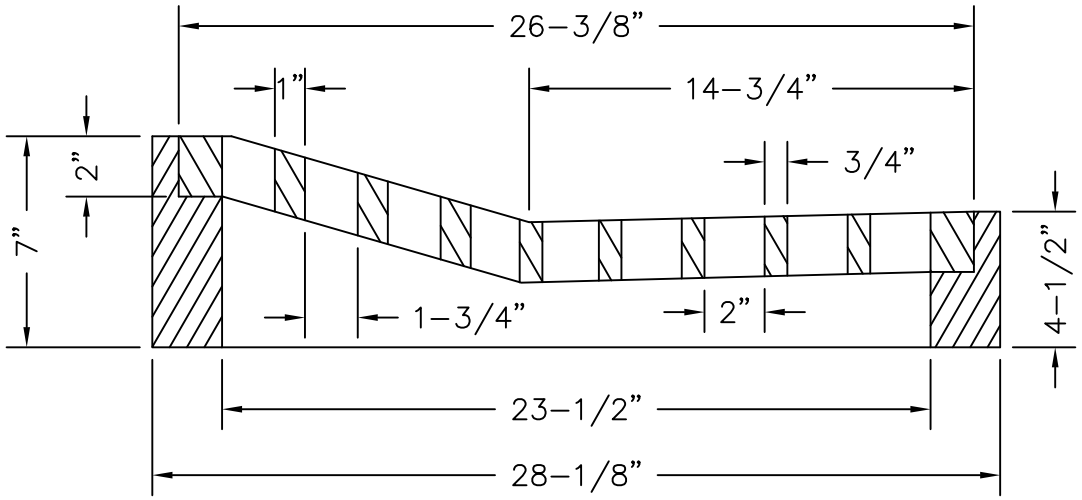


STD. CURB SECTION

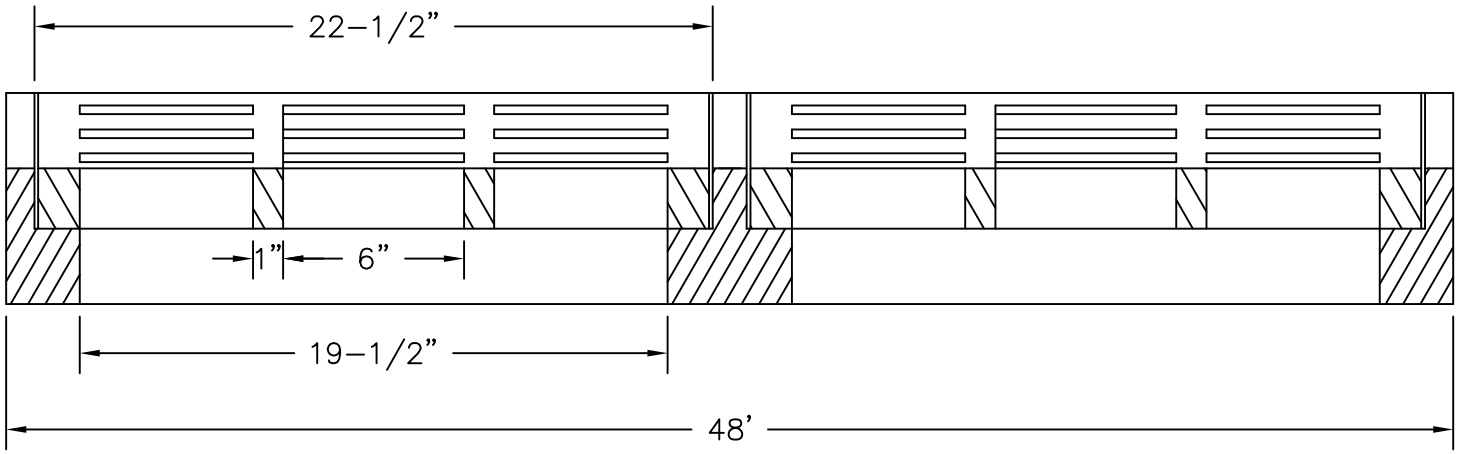
SLOTTED DRAIN PIPE



FRONT SECTION OF R-3516-1
SINGLE UNIT

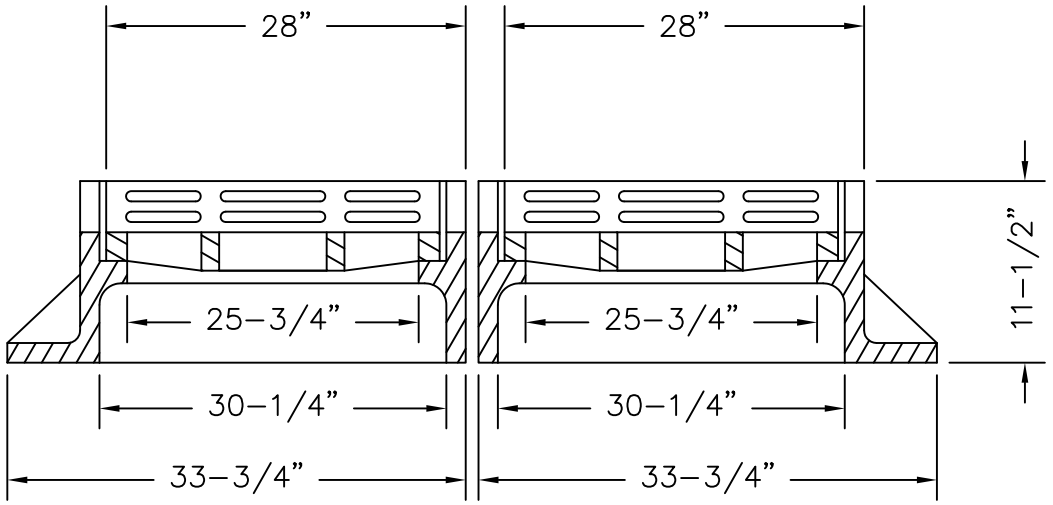


SIDE SECTION R-3516
AND R-3516-1

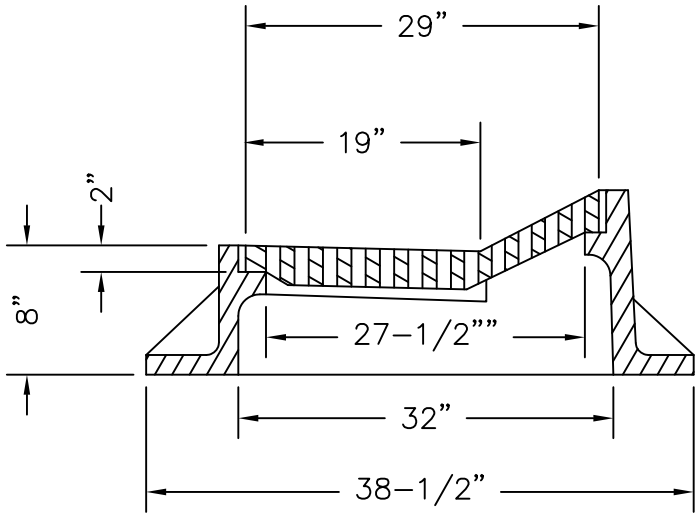


FRONT SECTION OF R-3516
DOUBLE UNIT

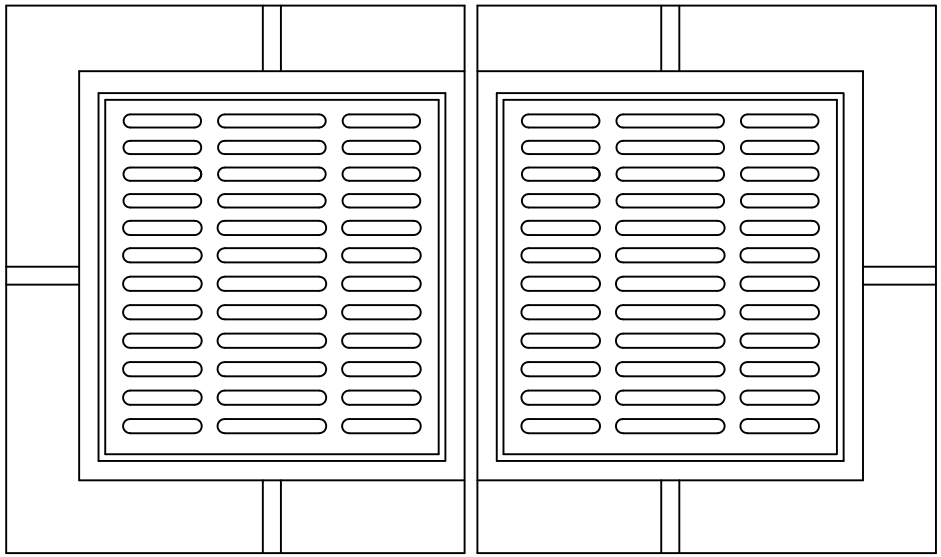
R-3516 INLET FRAME AND DOUBLE GRATE FOR DRIVEWAY AND MOUNTABLE CURB



FRONT SECTION



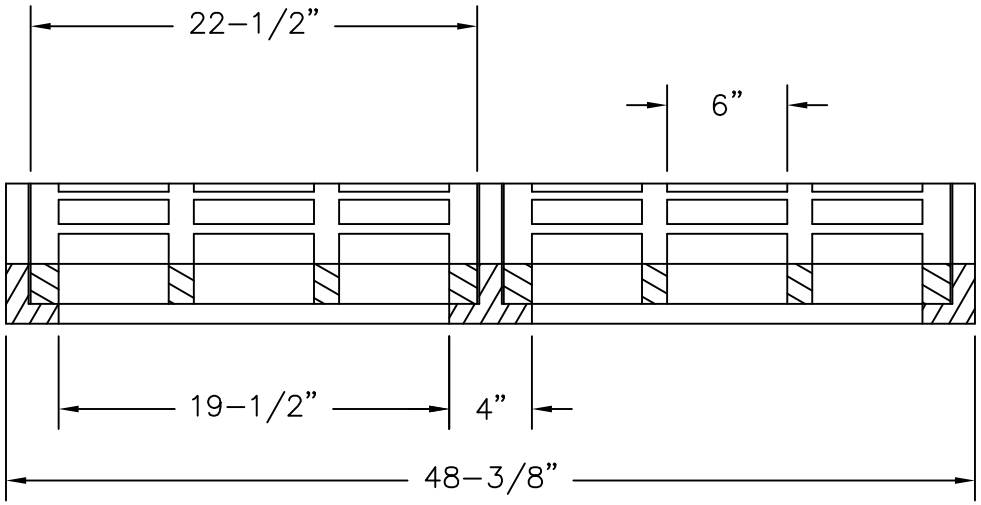
SIDE SECTION



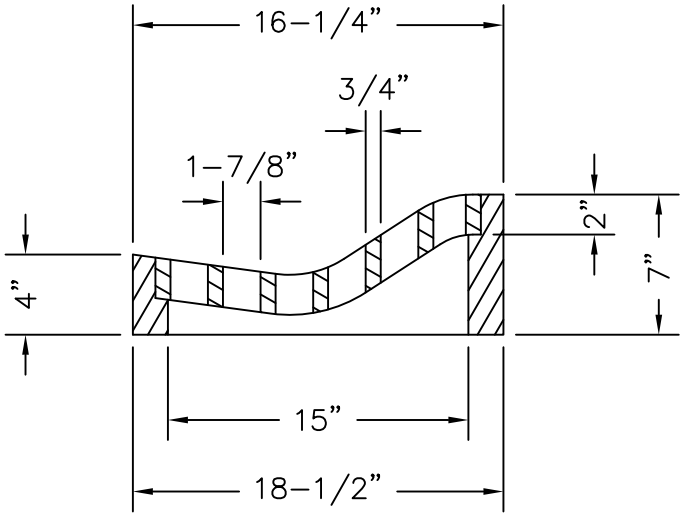
PLAN – DOUBLE SECTION

NOTE: SPECIFICATIONS PER EAST JORDAN IRON WORKS 7391 OR EQUIVALENT

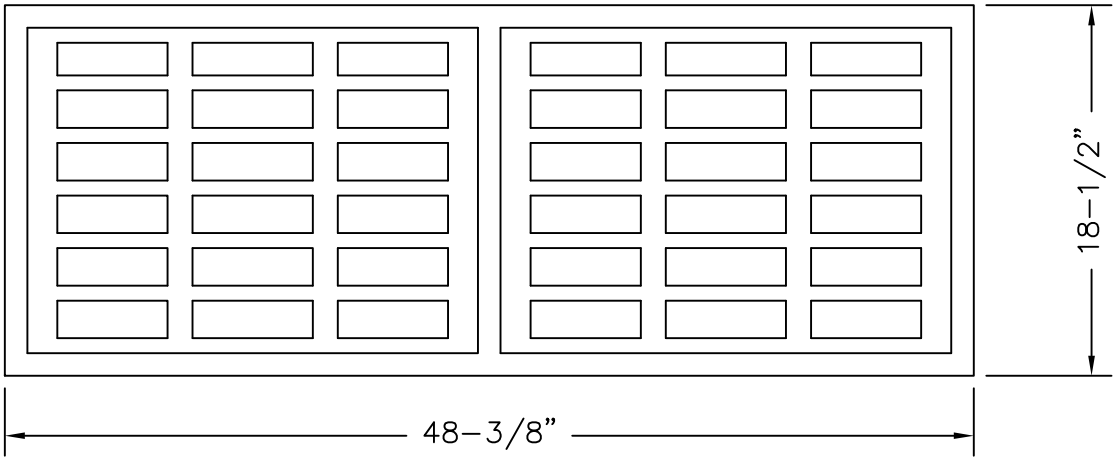
7391 CATCH BASIN CURB INLET



FRONT SECTION – DOUBLE SECTION



SIDE SECTION



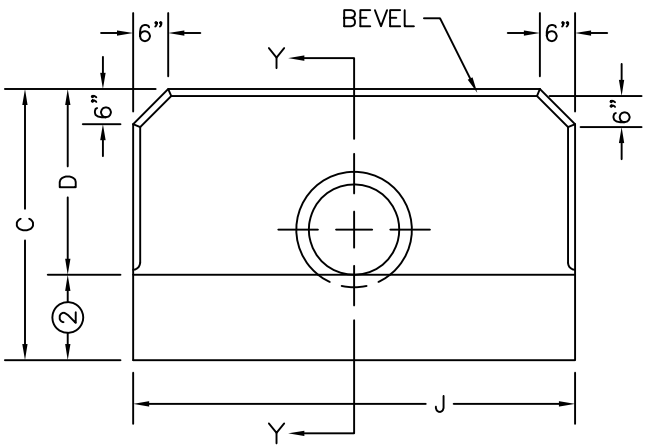
PLAN – DOUBLE SECTION

NOTE: SPECIFICATIONS PER NEENAH R-3504-F OR EQUIVALENT

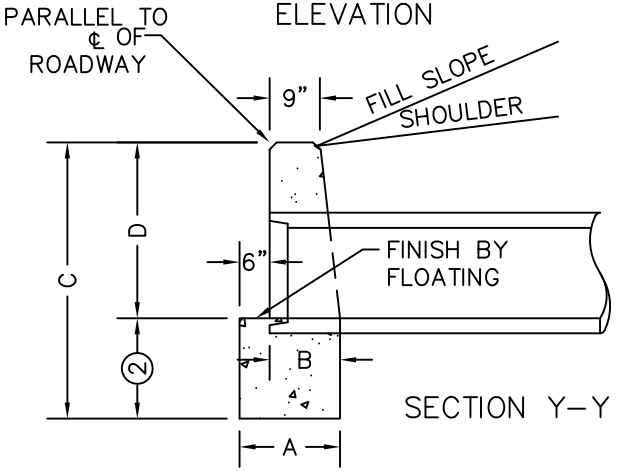
R-3504-F INLET FRAME AND DOUBLE GRATE FOR DRIVEWAY AND MOUNTABLE CURB

CONCRETE HEADWALL

HEADWALL TYPE	DIAMETER OF PIPE	HEADWALL DIMENSIONS									CUBIC YARDS CONCRETE FOR ② ONE HEADWALL	
		A	B	C	D	E	F	G	H①	J	EARTH	ROCK
STANDARD	12"	1'–8"	1'–2"	4'–0"	2'6"	–	–	–	–	6'–0"	1.05	0.87
	15"	1'–8.5"	1'–2.5"	4'–3"	2'–9"	–	–	–	–	6'–9"	1.25	1.03
	18"	1'–9"	1'–3"	4'–6"	3'–0"	–	–	–	–	7'–6"	1.48	1.23
	21"	1'–9.5"	1'–3.5"	4'–9"	3'–3"	–	–	–	–	8'–3"	1.73	1.46
	24"	1'–10"	1'–4"	5'–0"	3'–6"	–	–	–	–	9'–0"	1.99	1.69
RAISED	12"	1'–8"	1'–2"	4'–6"	3'–0"	–	–	–	–	7'–6"	1.45	1.23
	15"	1'–8.5"	1'–2.5"	4'–9"	3'–3"	–	–	–	–	8'–3"	1.69	1.43
	18"	1'–9"	1'–3"	5'–0"	3'–6"	–	–	–	–	9'–0"	1.96	1.67
	21"	1'–9.5"	1'–3.5"	5'–3"	3'–9"	–	–	–	–	9'–9"	2.25	1.93
	24"	1'–10"	1'–4"	5'–6"	4'–0"	–	–	–	–	10'–6"	2.54	2.19
STANDARD ELL	12"	1'–8"	1'–2"	4'–0"	2'–6"	2'–0"	3'–8"	3'–0"	2'–6"	4'–8"	1.19	0.99
	15"	1'–8.5"	1'–2.5"	4'–3"	2'–9"	2'–3"	3'–11.5"	3'–6"	2'–9"	5'–2.5"	1.42	1.19
	18"	1'–9"	1'–3"	4'–6"	3'–0"	2'–6"	4'–3"	4'–0"	3'–0"	5'–9"	1.67	1.41
	21"	1'–9.5"	1'–3.5"	4'–9"	3'–3"	2'–9"	4'–6.5"	4'–6"	3'–3"	6'–3.5"	1.93	1.63
	24"	1'–10"	1'–4"	5'–0"	3'–6"	3'–0"	4'–10"	5'–0"	3'–6"	6'–10"	2.22	1.89
RAISED ELL	12"	1'–8"	1'–2"	4'–6"	3'–0"	2'–9"	4'–5"	3'–9"	3'–3"	5'–5"	1.62	1.37
	15"	1'–8.5"	1'–2.5"	4'–9"	3'–3"	3'–0"	4'–8.5"	4'–3"	3'–6"	5'–11.5"	1.88	1.59
	18"	1'–9"	1'–3"	5'–0"	3'–6"	3'–3"	5'–0"	4'–9"	3'–9"	6'–6"	2.16	1.85
	21"	1'–9.5"	1'–3.5"	5'–3"	3'–9"	3'–6"	5'–3.5"	5'–3"	4'–0"	7'–0.5"	2.47	2.12
	24"	1'–10"	1'–4"	5'–6"	4'–0"	3'–9"	5'–7"	5'–9"	4'–3"	7'–7"	2.79	2.41

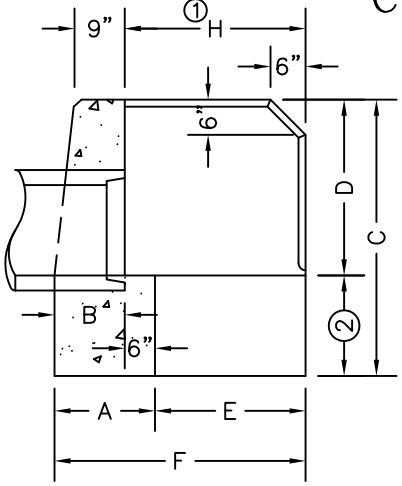


ELEVATION

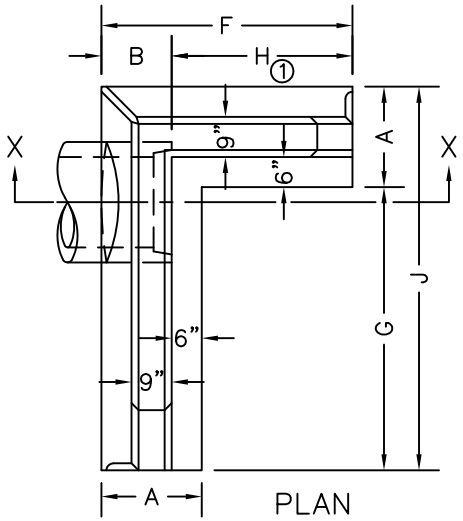


SECTION Y–Y

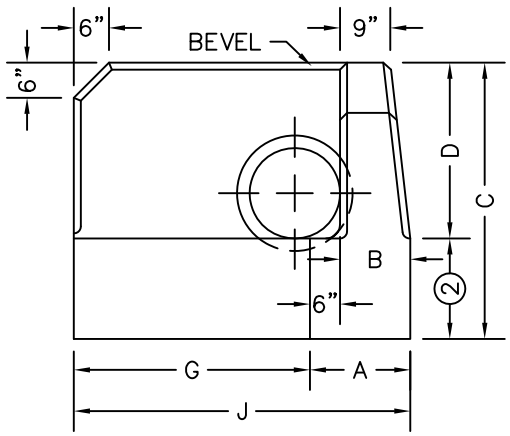
CONCRETE ELL HEADWALL



SECTION X–X



PLAN



ELEVATION

NOTES

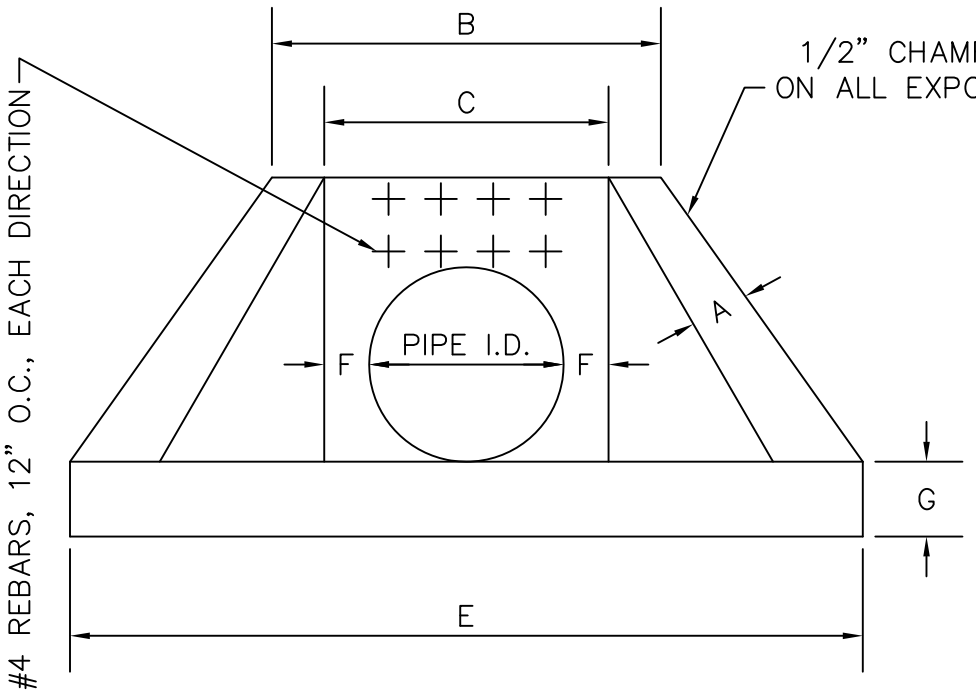
CIRCULAR PIPE INCLUDES SLIGHTLY ELLIPTICAL CONCRETE PIPE WITH CIRCULAR REINFORCMENT.

VOLUME DISPLACED BY BARREL OF PIPE HAS BEEN COMPUTED USING INSIDE DIMENSION OF PIPE.

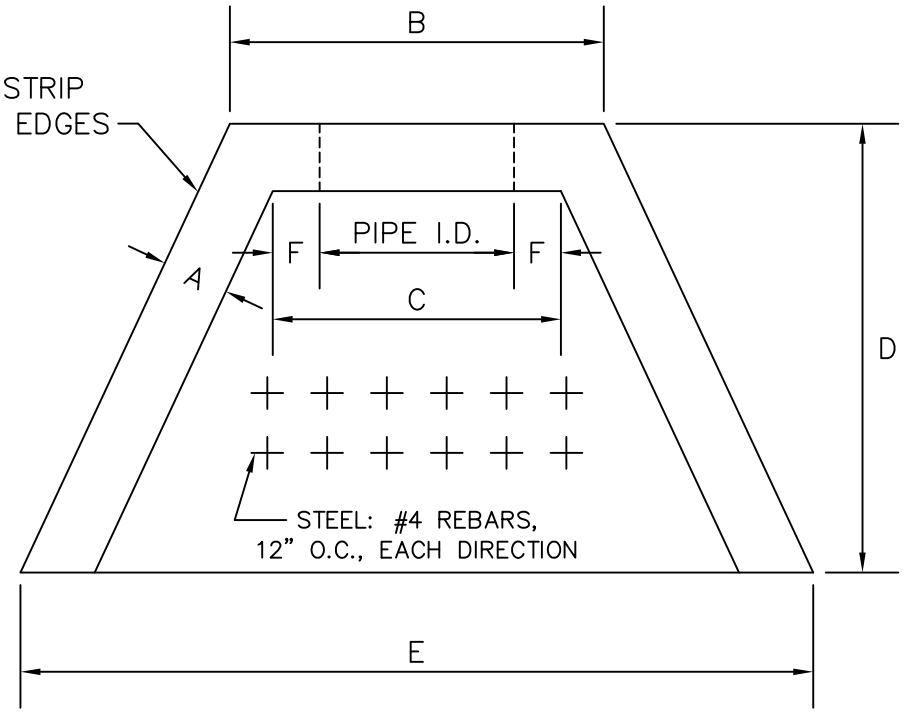
① THE DIMENSION AND/OR THE ANGLE OF INTERSECTION BETWEEN THE WALLS MAY BE VARIED ON CONSTRUCTION.

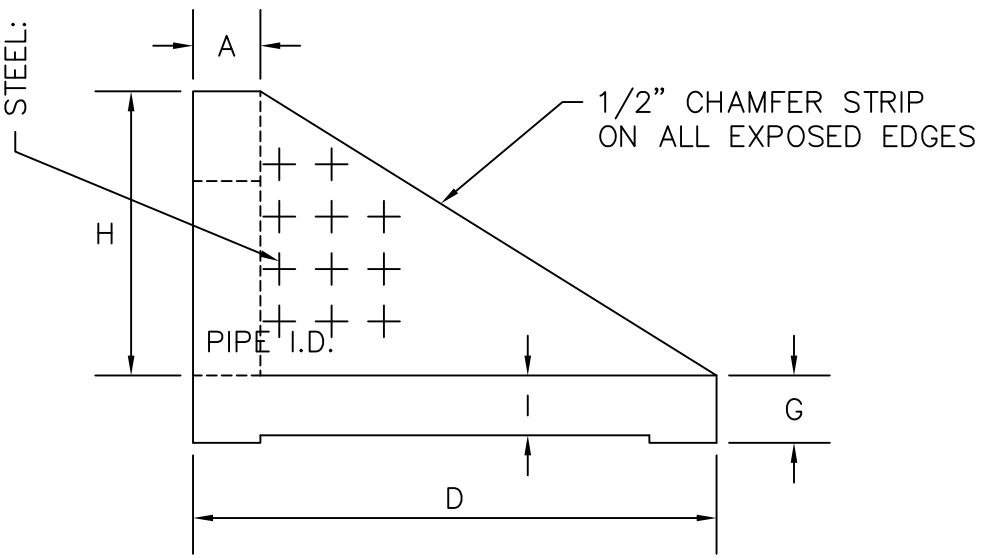
② VOLUME BASED ON VALUES OF 18" FOR EARTH, 12" FOR ROCK.

FRONT VIEW



TOP VIEW





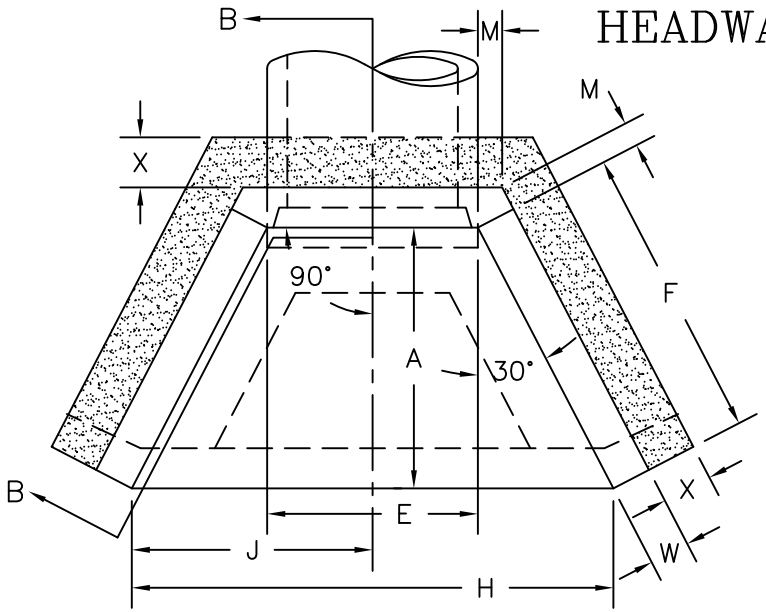
SIDE VIEW

MINIMUM DIMESIONS

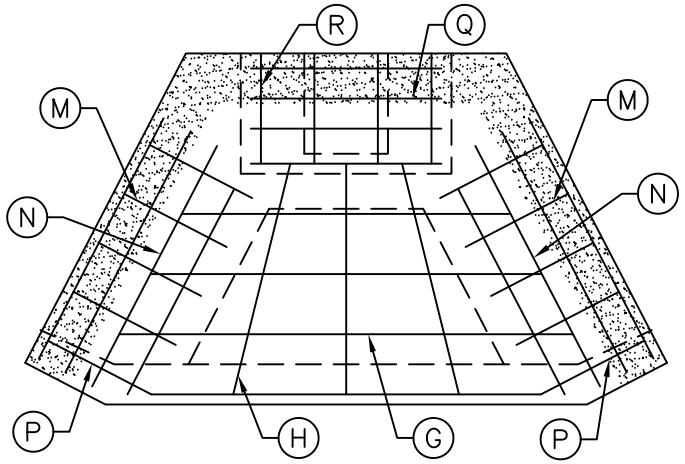
A: 7"
B: PIPE I.D. + 14"
C: PIPE I.D. + 6"
D: 4' OR 2 X PIPE I.D. WHICHEVER IS GREATER
E: 5' OR 2.5 X PIPE I.D. WHICHEVER IS GREATER
F: 3"
G: 8"
H: PIPE I.D. + 12"
I: 6"

HEADWALL DETAIL FOR 12" THRU 36" I.D. PIPE

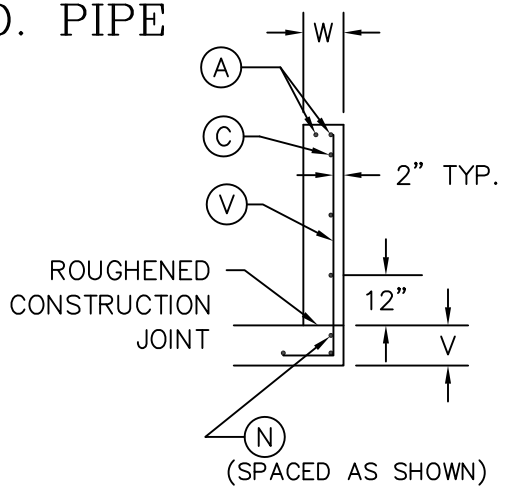
HEADWALL DETAIL 42" THRU 108" I.D. PIPE



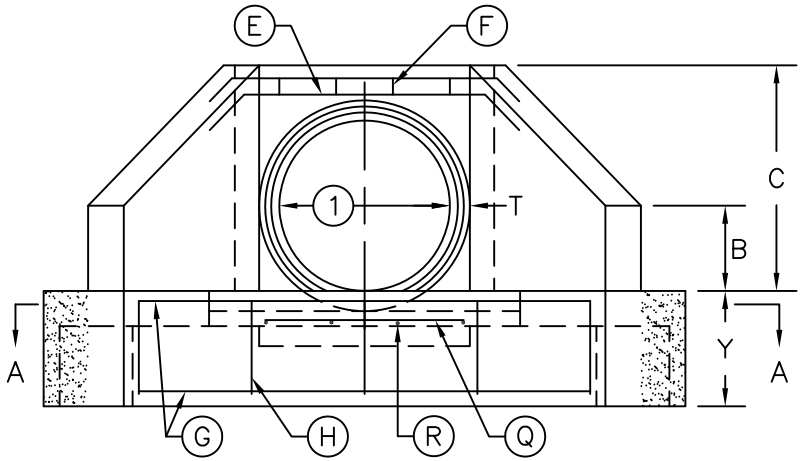
PLAN VIEW



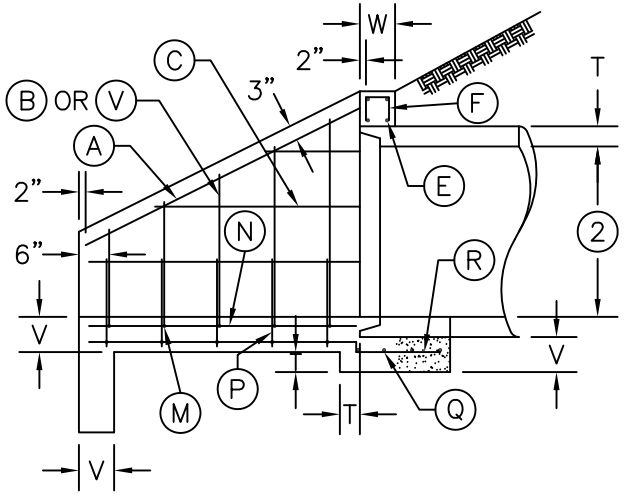
SECTION A–A



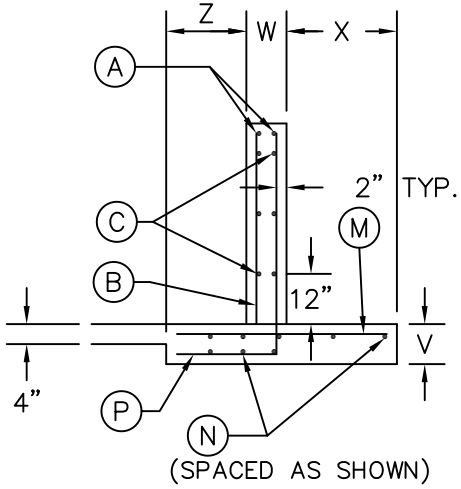
WING SECTION
42" TO 60" CIRCULAR PIPE
42" TO 72" NON–CIRCULAR PIPE



FRONT ELEVATION



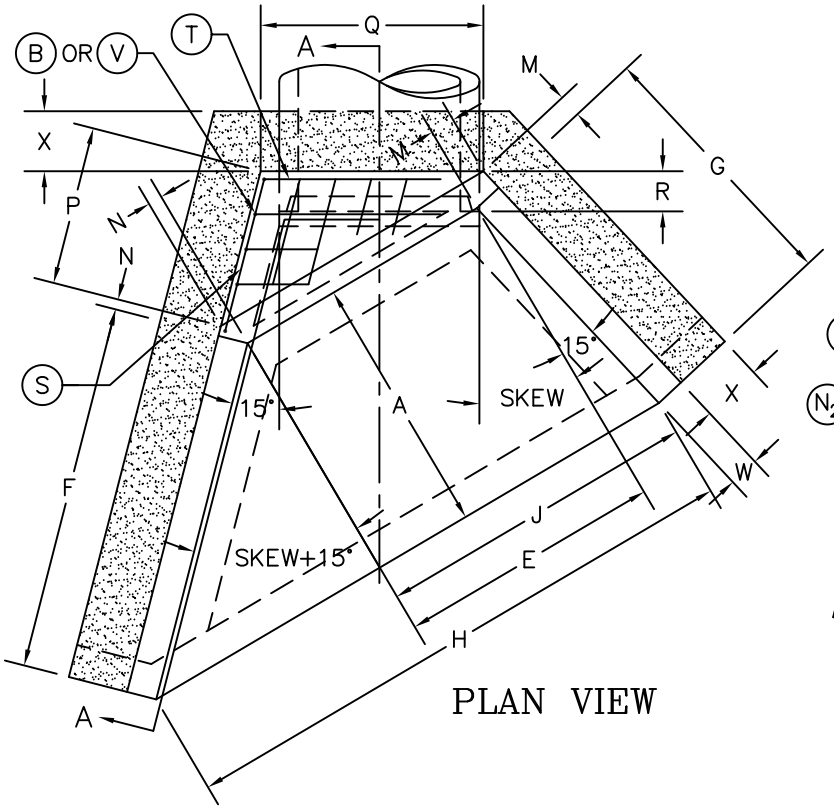
SECTION B–B



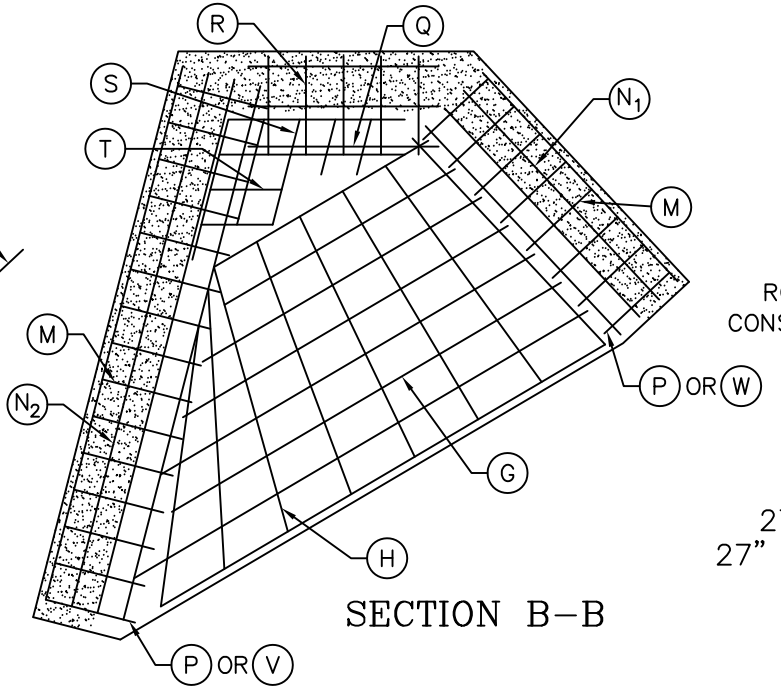
WING SECTION
66" TO 108" CIRCULAR PIPE

C.27

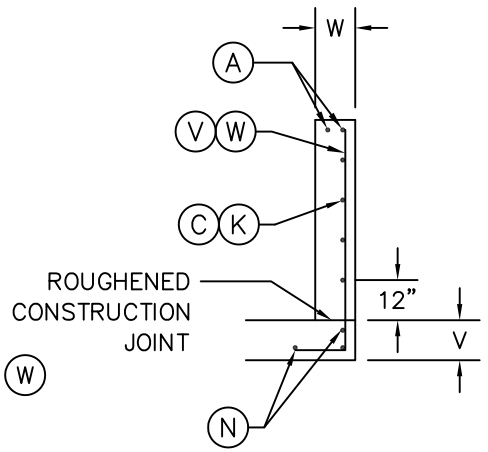
① DIAMETER OF CIRCULAR PIPE OR SPAN OF NON–CIRCULAR PIPE.
② DIAMETER OF CIRCULAR PIPE OR RISE OF NON–CIRCULAR PIPE.
3. [ ] APPLIES TO 66" DIAMETER AND GREATER (CIRCULAR PIPE).
4. SEE CURRENT STANDARD DRAWINGS RDH–200 AND 300 SERIES FOR DIMENSIONS,QUANTITIES, AND BILL OF REINFORCEMENT.
5. DIMENSIONS FROM FACE OF CONCRETE TO STEEL SHALL BE 2" CLEAR DISTANCE.
6. ENCIRCLED LETTERS, Ⓐ, INDICATE STEEL BAR LOCATIONS.
7. BARS Ⓑ, Ⓒ, Ⓖ, Ⓟ, Ⓜ, Ⓥ ARE SPACED 1'–0" O.C. ALL OTHER BARS SHALL BE EVENLY SPACED.
8. BARS Ⓑ AND Ⓥ ARE PLACED IN ORDER OF INCREASING LENGTHS, BEGINNING AT THE TOP OF EACH WING.
9. BARS Ⓒ ARE PLACED IN ORDER OF INCREASING LENGTHS, BEGINNING AT THE TOP OF EACH WING.
10. HEADWALLS LOCATED AT EDGE OF SHOULDER SHALL BE PARALLEL TO CENTERLINE OF THE ROAD.
11. APRON BETWEEN WINGS SHALL BE SLOPED IN DIRECTION OF FLOW EQUAL TO SLOPE OF PIPE. FRONT FACE OF HEADWALL AND ENDS OF WINGS SHALL REMAIN VERTICAL.



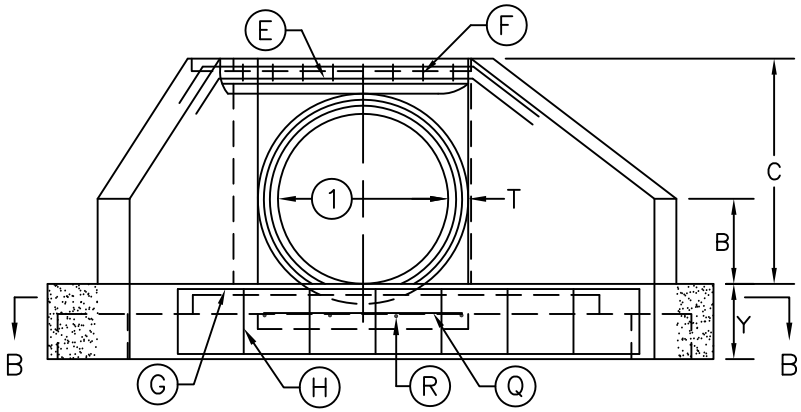
PLAN VIEW



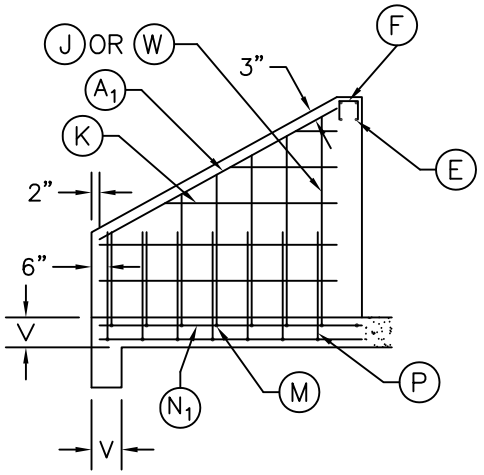
SECTION B–B



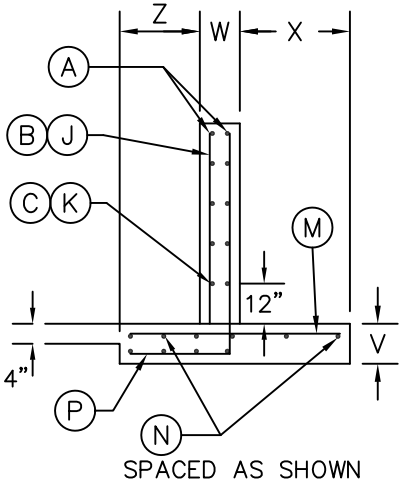
WING SECTION
27" TO 60" CIRCULAR PIPE
27" TO 72" NON–CIRCULAR PIPE



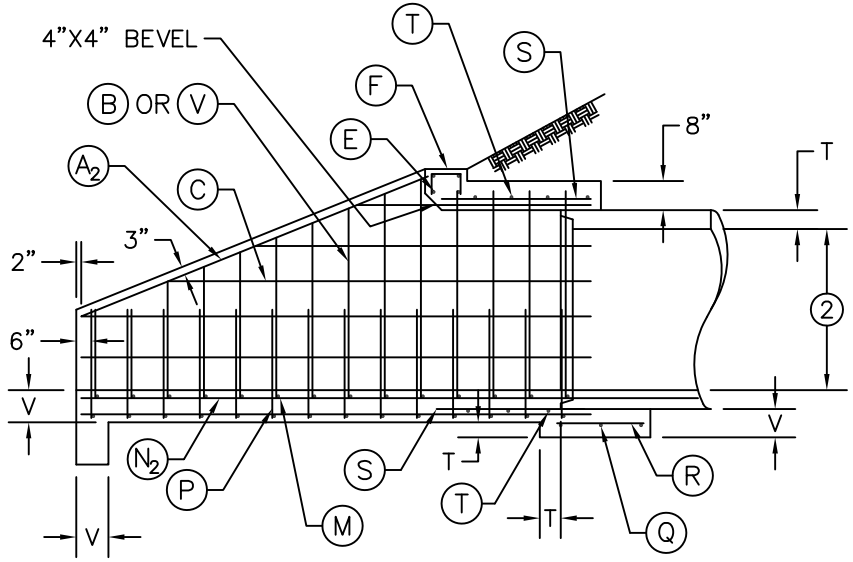
FRONT ELEVATION



SHORT WING SECTION



WING SECTION
66" TO 108" CIRCULAR PIPE



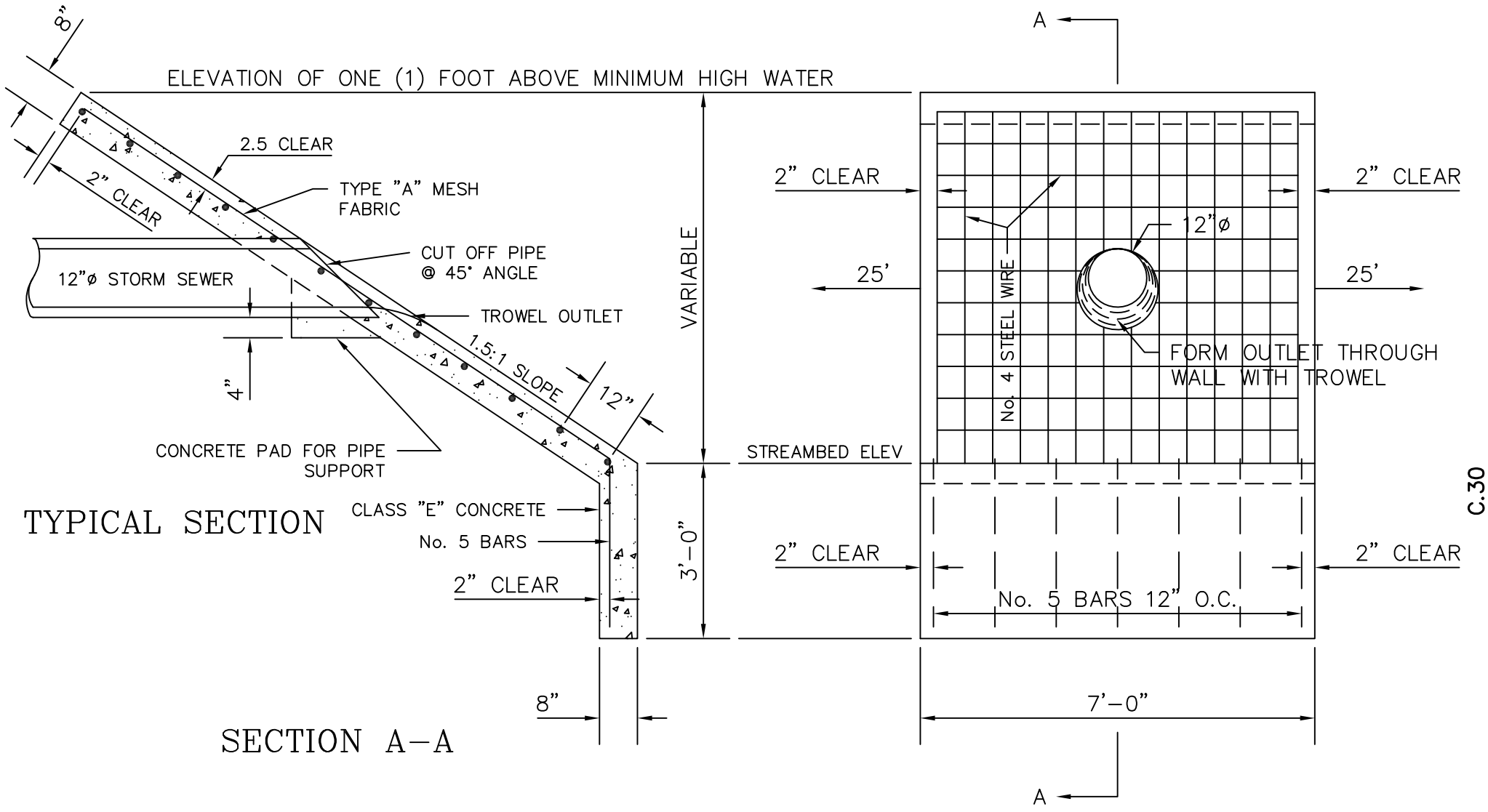
SECTION A–A

C.29

NOTES

① DIAMETER OF CIRCULAR PIPE OR SPAN OF NON–CIRCULAR PIPE.
② DIAMETER OF CIRCULAR PIPE OR RISE OF NON–CIRCULAR PIPE.
3. [shaded] APPLIES TO 66" DIAMETER AND GREATER. (CIRCULAR PIPE)
4. SEE CURRENT STANDARD DRAWINGS RDH–200 AND 300 SERIES FOR DIMENSIONS, QUANTITIES, AND BILL OF REINFORCEMENT.
5. DIMENSIONS FROM FACE OF CONCRETE TO STEEL SHALL BE 2" CLEAR DISTANCE.
6. ENCIRCLED LETTERS, ◯, INDICATE STEEL BAR LOCATIONS.
7. BARS Ⓑ , Ⓒ , Ⓖ , Ⓟ , Ⓜ , Ⓥ ARE SPACED 1'–0" O.C. ALL OTHER BARS SHALL BE EVENLY SPACED.
8. BARS Ⓑ AND Ⓥ ARE PLACED IN ORDER OF INCREASING LENGTHS, BEGINNING AT THE TOP OF EACH WING.
9. BARS Ⓒ ARE PLACED IN ORDER OF INCREASING LENGTHS, BEGINNING AT THE TOP OF EACH WING.
10. HEADWALLS LOCATED AT EDGE OF SHOULDER SHALL BE PARALLEL TO CENTERLINE OF THE ROAD.
11. APRON BETWEEN WINGS SHALL BE SLOPED IN DIRECTION OF FLOW EQUAL TO SLOPE OF PIPE. FRONT FACE OF HEADWALL AND ENDS OF WINGS SHALL REMAIN VERTICAL.

SLOPED HEADWALL

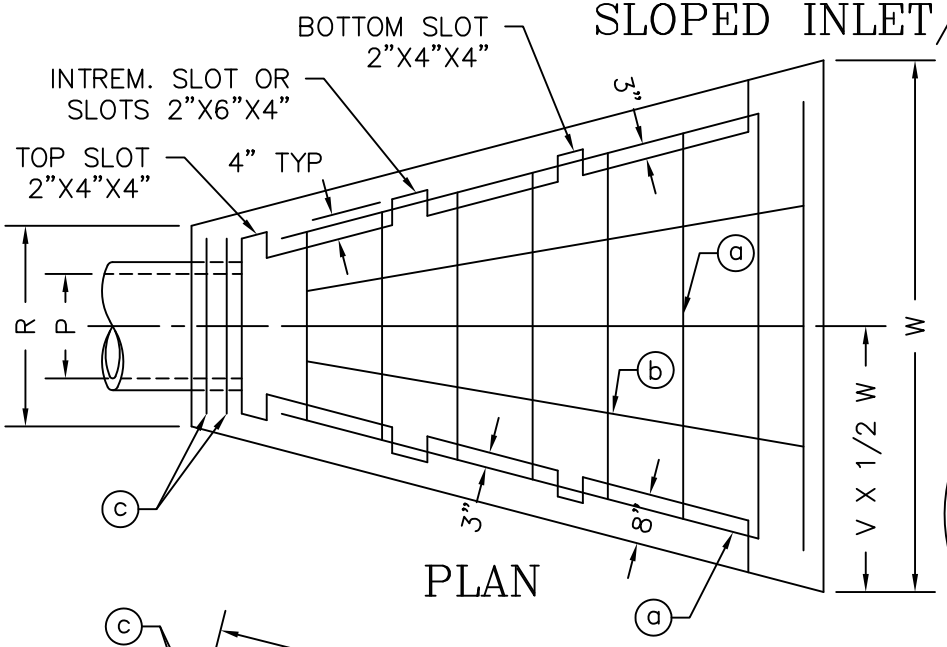


C.30

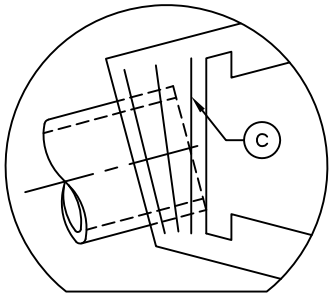
NOTE:

INCREASE WIDTH OF WALL SIX (6) INCHES FOR EACH THREE (3) INCH INCREASE IN DIAMETER OF OUTFALL PIPE.
ALL MESH FABRIC SHALL BE FURNISHED IN FLAT SHEETS.
EDGE TOOL ALL EXPOSED CONCRETE EDGES IN SLOPE WALLS.
GRADE BANK OF STREAM FROM THE HEADWALL SLOPE TO A WARPED SURFACE TO MEET THE EXISTING BANK SLOPE IN TWENTY-FIVE (25) FEET EACH WAY.

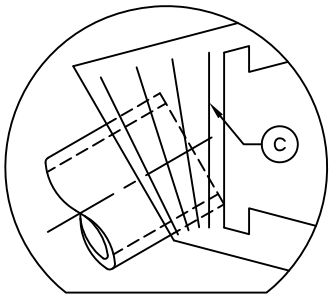
SLOPED INLET/OUTLET



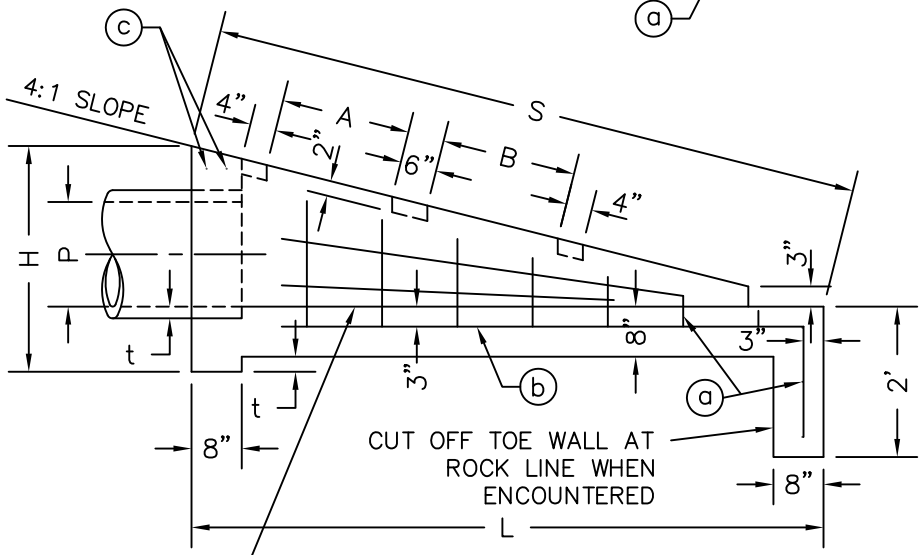
PLAN



15° SKEW

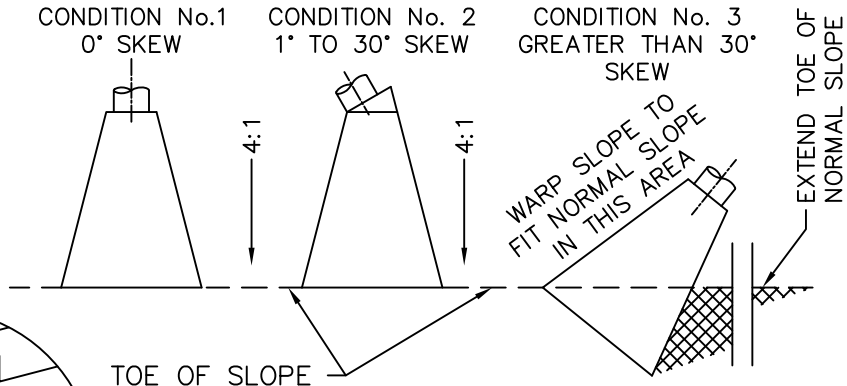


30° SKEW



ELEVATION

PLAN VIEW OF STRUCTURE LOCATIONS



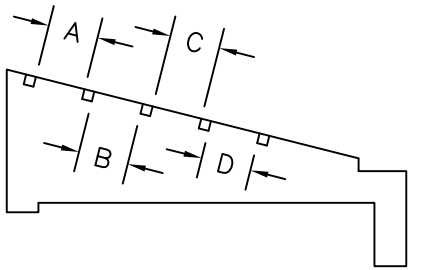
NOTES

THE MINIMUM REQUIREMENT FOR REINFORCING STEEL SHALL BE GRADE 40. FIELD BENDING WILL BE PERMITTED.

(1) ONE ADDITIONAL C BAR WILL BE REQUIRED FOR EACH 15° SKEW.

SEE CURRENT EDITION OF RDB–106.

DETAIL SHOWING LOCATION OF SLOTS FOR GRATES

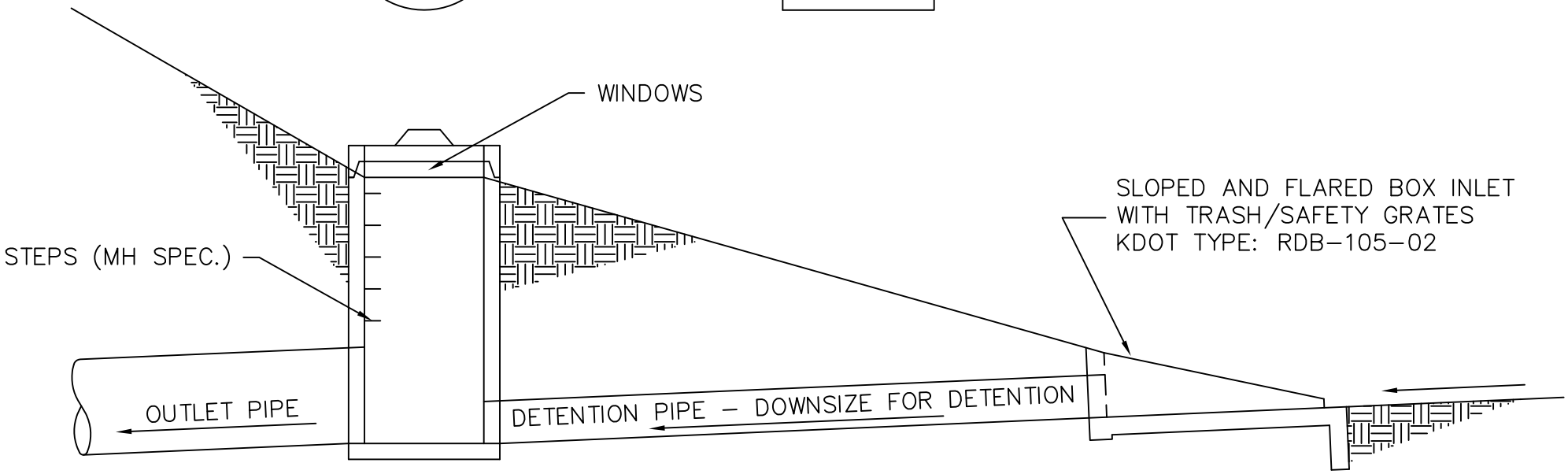


A,B FOR 2 GRATES
A,B,C FOR 3 GRATES
A,B,C,D FOR 4 GRATES

DIMENSIONS											No. OF GRATES REQ'D.		No. 4 REINFORCEMENT BARS NUMBER – LENGTH AND WEIGHT				CLASS A CONC.
P	H	L	S	R	V	W	A	B	C	D	2'	3'	ⓐ	ⓑ	① ⓒ	LBS.	CU. YD.
18"	3'–0"	8'–6"	8'–9.5"	2'–6.5"	3'–5"	6'–10"	1'–9"	1'–9"	–	–	2	–	14 @ 6'–0"	3 @ 8'–6"	2 @ 2'–3"	76	1.7
24"	3'–7"	10'–8"	11'–0"	3'–0.5"	4'–2.5"	8'–5"	2'–9"	2'–9"	–	–	–	2	16 @ 7'–6"	3 @ 10'–6"	2 @ 2'–9"	105	2.5
30"	4'–2"	12'–10"	13'–2.75"	3'–6.5"	5'–0"	10'–0	2'–9"	2'–9"	1'–9"	–	1	2	18 @ 9'–0"	3 @ 12'–9"	2 @ 3'–3"	137	3.6
36"	4'–9"	15'–0"	15'–5.5"	4'–0.5"	5'–9.5"	11'–7"	2'–9"	2'–9"	1'–9"	1'–9"	2	2	20 @ 10'–8"	3 @ 15'–0"	2 @ 3'–9"	177	4.8

DETENTION OVERFLOW BOX
4' X 4' CONC. BOX W/ SLAB TOP
OR 4' DIA. MANHOLE WITH SLAB TOP

BEEHIVE CASTING ON TOP SLAB
NEENAH FOUNDRY CO.
FRAME AND CASTING R-4346 OR
APPROVED EQUAL



C.32

SAMPLE
DETENTION OVERFLOW BOX WITH SLOPED AND FLARED BOX INLET AND TRASH/SAFETY GRATES

APPENDIX "D"

STORM DRAINAGE SYSTEMS, EROSION CONTROL

STORM SEWERS
SCOPE OF WORK

ITEM 1.0 WORK INCLUDED

1.1 The contractor shall furnish all material, equipment, tools, and labor necessary to do the work as shown on the contract drawings, and unload, haul and distribute all pipe, and accessories. The contractor shall excavate the trenches and pits to the required dimensions; sheet, brace, and support the adjoining ground or structures where necessary; handle all drainage or ground water; provide barricades, guards, and warning lights, lay the pipe; backfill and consolidate the trenches and pits; remove surplus excavated material; clean the site work, and maintain other surfaces over the trenches as specified.

ITEM 2.0 MATERIALS

2.1 Pipe

A. Reinforced Concrete Pipe (RCP AASTO M 170, ASTM C76 and AAASHTO M 198)
KYTC Type 1 installation
(1) 12"-18"; Class V Max. Cover 57+ feet
(2) 21"-24"; Class IV Max. Cover 36 feet
(3) 27" & Larger; Class III Max Cover 25 feet

B. Aluminized Type 2 Corrugated (2-2/3" X ½") Pipe (AASHTO M36 Type 1, AASHTO M274)
(1) 12" - 36" 16 Gauge
(2) 42" - 54" 14 Gauge
(3) 60" - 12 Gauge
(4) 66" - 72" 10 Gauge

C. Aluminized type 2 Spiral Rib (3/4" X 3/4" X 7- ½") Pipe (AASHTO M36 Type 1, AASHTO M274)
(1) 18" - 36" 16 Gauge
(2) 42" - 54" 14 Gauge
(3) 60" - 72" 12 Gauge

D. Aluminum Spiral Rib (3/4" X 3/4" X 7-1/2") Pipe (AASHTO M196 and M197)
(1) 18" 30" Gauge 14 Max. Cover 30 feet
(2) 36" - 48" Gauge 12 Max. Cover 30 feet
(3) 54" - 66" Gauge 10 Max. Cover 30 feet

E. Polyvinyl Chloride (PVC) Pipe

(1) Smooth Wall:

(a) Pipe/Fittings: ASTM D 3034; ASTM F679; AASHTO M 278
Material: ASTM D 1784
Joint: ASTM D 3212
Sizes 12" - 27" or other size available
Minimum Pipe Stiffness: 46 @ 5% deflection
Installation: ASTM D 2321.

(2) Ribbed:

(a) Pipe/Fittings: ASTM F794; ASTM F949; AASHTO M304
Material: ASTM D 1784
Joint: ASTM D 3212
Sizes: 12" - 48" or other size available
Minimum Pip Stiffness: 46 @ 5% deflection
Installation: ASTM D 2321
(b) Pipe/Fittings: AASHTO M 304
Material: ASTM D 1784
Joint: ASTM D 3212
Sizes: 18" - 48" or other size available
Installation: ASTM D 2321.

F. Polyethylene (HDPE) Pipe

(1) Corrugated:

(A) Pipe/Fittings: AASHTO M294 Type S
Material: ASTM D 3350
Joint: Minimum silt tight including: (a) thermally molded; (b) integral bell; or (c) bell and spigot with built-in gasket coupler assemblies only.
Sizes: 12" - 36" only
Minimum Pipe Stiffness: Variable @ 5% deflection
Installation: ASTM D 2321.

2.2 Bedding: Pipe bedding shall be clean natural or washed sand and gravel, crushed gravel or crushed stone, free from cementitious substances and flat or flaky particles in an amount to cause caking, packing, yielding or uneven support for the pipe. All material shall be of such sized that one-hundred percent (100%) passes the one and one half (1 1/2) inch screen, 40% or less passes the No. 40 sieve, and ten (10) percent or less passes the No. 200 sieve. Bedding material shall not consist of any organic soil or stone larger than 1 1/2-inch in any dimension.

2.3 Select Fill: Select fill shall be well graded sand and gravel, free from organic matter. Not more than 70 percent by weight shall pass through a No 40 sieve; not more than 10 percent by weight shall pass through a No. 200 sieve; and 100 percent shall pass through a 3-inch square sieve. See SD1 technical specification 02220 for further requirements of Select Fill.

2.4 General Backfill: General backfill shall be soil materials that are free of rock thicker than 6 inches or larger than 24 inches maximum in any dimension, debris, waste, frozen materials, vegetation and other organic matter and other deleterious materials. Previously excavated materials meeting these requirements may be used for backfill. All rock shall be excluded from fill within 24 inches of the pipe. If the excavated trench material does not meet these

requirements, this material shall be wasted and suitable imported material shall be used for backfill.

ITEM 3.0 CONSTRUCTION

3.1 No pipe shall be laid until the location has been staked by the engineer.

3.2 A trench shall be excavated and shall be equal to the outside width of the pipe plus 3/10 of the outside width of the pipe on each side or 12 inches on each side, whichever is greater. The wall of the trench shall be as nearly vertical as possible In case unstable foundation is encountered at the established grade, the unstable material shall be removed and replaced with a suitable material to a width and depth and in a manner that will provide a uniform and firm foundation. Storm sewers shall not be less than the diameter specified in Article 3 of the Subdivision Regulations. Manholes or junction boxes may be precast concrete or masonry. Boxes shall be sized to provide the space of a standard precast manhole and on concrete footing slab 6 inches thick and walls shall not be less than 6 inches thick.

3.3 In all operations such as placing the pipe, jointing, bedding, and backfilling, care shall be exercised and in shall be the contractor's responsibility to see that the pipes are not damaged during the unloading or placement on the bed, or during compaction of the backfill. Any pipe culvert which is not in true alignment and grade or which shows undue settlement after laying or is otherwise damaged, shall be taken up and replaced .

3.4 Storm sewer clean-outs shall be provided at a maximum of 500 foot intervals for pipes which have less than a thirty (30) inch diameter, and at a maximum of 600 foot intervals for pipes having a larger diameter. Clean-outs may be catch basins, junction boxes or headwalls.

3.5 Curb drainage inlets and/or catch basins shall be provided at intervals along roadways. Maximum intervals shall meet the existing Design Standards in the current Subdivision Regulations.

ITEM 4.0 BACKFILL AND COMPACTION

4.1 Backfill Placement: Backfill shall be placed in horizontal loose lifts not exceeding 8-12 inches in thickness and shall be mixed and spread in a manner assuring uniform lift thickness.

4.2 Compaction requirements are as follows:

A. Select Fill and Pipe Bedding: For fill and bedding beneath structures and foundations, compact granular materials that exhibit a well-defined moisture density curve to at least 98 percent of the standard proctor maximum dry density (ASTM D698). For all other fill and bedding, compact granular materials that exhibit a well-defined moisture-density curve to at least 95 percent (ASTM D698). Moisture-condition fill materials to within a range of two (2) percent below to three (3) percent above optimum moisture content (ASTM D698). Compact granular materials that do not exhibit a well-defined moisture-density curve to at least 85 percent relative density (ASTM D4253 and D4254) beneath structures and foundations, and to at least

75 percent relative density (ASTM D4253 and D4254) for all other areas.

B. General Backfill: Compact materials that exhibit a well-defined moisture density curve to at least 98 percent of the standard proctor maximum dry density (ASTM D698) beneath structures, foundations and the top one (1) foot below pavements, and at least 95 percent (ASTM D698) in all other areas. Moisture-condition fill materials to within a range of two (2) percent below to three (3) percent above optimum moisture content (ASTM D698). Compact granular or rock materials that do not exhibit a well-defined moisture-density curve to at least 85 percent relative density (ASTM D4253 and D4254) beneath structures and foundations, and to at least 75 percent relative density (ASTM D4253 and D4254) for all other areas.

(1) After the pipe sections have been embedded up to a point 12-inches or more above the top of the pipe, the pipe sections have been encased in concrete, or the structures or appurtenances have been constructed, as specified on the drawings, in non-ROW areas, the remainder of the trench or excavated area shall be back-filled using trench or structure excavated material if it meets the requirements as previously described. If the material does not meet these requirements, the trench or structure excavated material shall be wasted and suitable imported material shall be used for backfill.

(2) Backfill shall be placed in horizontal loose lifts not exceeding 8-12 inches in thickness and shall be mixed and spread in a manner assuring uniform lift thickness after placing. Backfill shall then be compacted as previously described to existing ground level or finished grade level if same has been established.

4.3 All trenches within the Public Right of Way shall be, backfilled with controlled low strength material (CLSM)(flowable fill).

4.4 Copies of all testing reports shall be submitted to the appropriate accepting agency.

CATCH BASINS, HEADWALLS & JUNCTION BOX

1.0 SCOPE OF WORK

1.1 The contractor shall furnish all materials, equipment and labor necessary to construct or install all drainage structures as shown on the attached detailed drawings.

2.0 MATERIALS

2.1 Concrete shall comply with the Street Paving Specifications. Precast or cast in place structures shall be a minimum of five (5) days old, prior to paving operation.

CITY OF FLORENCE STORMWATER PROGRAM

1.0 FLORENCE STORMWATER PROGRAM

1.1 The City of Florence has a comprehensive storm water program for properties within the City limits. In order to meet applicable storm water requirements, each applicant is advised to contact the Florence Public Services Department.

SANITATION DISTRICT NO. 1 STORMWATER PROGRAM

1.0 SANITATION DISTRICT NO. 1 STORMWATER PROGRAM

1.1 Sanitation District No. 1 has a comprehensive storm water program for properties within its' jurisdictional boundary. In order to meet applicable storm water requirements, each applicant is advised to contact the District.