

**DESIGN MANUAL**  
**ROADS AND STORM DRAINS**



**Book No:** \_\_\_\_\_

**CARROLL COUNTY, MARYLAND**  
**DEPARTMENT OF PUBLIC WORKS**

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**NOTE:** Since the adoption of the 1994 Manual, there have been various design and procedural revisions. Many of the revisions are included under the Revisions link. Engineers and surveyors are encouraged to call the Bureau of Engineering to obtain the latest design criteria and procedures.

**Definition of Terms**

- A.A.S.H.T.O.** - American Association of State Highway and Transportation Officials
- Administrator** - The Director of Public Works for the County Government of Carroll County, Maryland or designated representative.
- Arterials** - Roads which provide the high speed, high volume network for travel between major points in both rural and urban areas. Consequently, higher speeds may be typical. Arterial roads are classified as principal, intermediate or minor.
- Auxiliary Lanes** - The portion of the roadway adjoining the traveled way for parking, speed change, turning, weaving, truck climbing, and other purposes supplementary to through-traffic movement.
- Average Daily Traffic (ADT)** - This is an average 24-hour volume at a given location for some time period less than a year.
- Background Traffic** - Non-site traffic consisting of two components: through (regional) traffic consisting of all movements through the study area, without origin or destination in the study area; and traffic generated by all other developments in the study area, with origin or destination in the study area.
- Bid or Proposal** - Written proposal of the Bidder, for the work contemplated, on Proposal Form.
- Bidder** - Individual, firm or corporation submitting formally a proposal for the work contemplated, or any portion thereof, acting directly or through an authorized representative.
- Built-out Year** - The year that the proposed project will be completely built, projected ending date of the project.
- Calendar Day** - Every day shown on the calendar including Saturdays, Sundays, and Holidays.

- Change Order** - A written order to the Contractor, signed by the Engineer, ordering a change in the work from that originally shown by the plans and specifications. If the work is of a nature involving an adjustment of the unit price, a supplemental agreement shall be executed by the Contractor which, when approved, shall constitute authorized modifications of the contract.
  
- Collectors** - Roads which serve primarily intracounty travel and constitute those roads on which (regardless of traffic volume) the traffic flow is facilitated between local roads and arterial highways. Consequently, more moderate speeds may be typical. Collector roads are classified as major or minor.
  
- Commission** - Means the Carroll County Planning and Zoning Commission.
  
- Concept Plan** - A professionally prepared drawing of a proposed development which is not a preliminary plan but which contains information as specified by the current concept plan checklist. This plan enables the staff of the Carroll County Planning and Zoning Commission and other reviewing agencies to give assistance and/or comments on the project before the submission of a preliminary plan.
  
- Contract and Included Documents** - Agreement covering the performance of the work as indicated and specified. The Contract includes the advertisement, instructions to bidders, specifications, and accompanying drawings, Proposals, Addendum, Contract, and Contract Bonds, all supplemental agreements entered into, and all General or Special Provisions pertaining to the work.
  
- Contract Documents** - The various documents which comprise the contract as listed above under Contract and other included documents.
  
- Contract Items** - The obligation of the Contractor including the performance of all work and the furnishing of all labor and materials described in the respective articles or sections of the Specifications and Contract or in the Special Provisions which are made a part thereof.

- Contract Time** - The number of working days or calendar days shown in the special conditions (proposal) indicating the time allowed for the completion of the work.
  
- Contractor** - Individual, firm or corporation acting for or in behalf of the Contractor in the execution of all or any part of the Contract.
  
- Construction** - The creation of a new road, driveway, or drainage structure, or reconstruction of an existing road by proper grading, draining, and application of road material.
  
- County** - Means the County Commissioners of Carroll County, Maryland, a body corporate and politic.
  
- Critical Movement Summation** - This method simply sums the "critical lane volume movements" at an intersection to obtain a value (service volume) which is the critical lane summation. This value is compared to tabular values (See Table 2, under Chapter 5, Page 5-6 and Chapter 5, Appendix-II) to determine the level of service. The "critical lane volume movement" is the highest total of the through plus opposing lefts in one direction on an hourly per lane basis (See Appendix II). This technique is also commonly called "Critical Lane Analysis", "Critical Lane Summation" or "Critical Lane Volume".
  
- Developer** - Means any person, firm, association, syndicate, co-partnership, corporation, trust, or any other legal entity beginning proceedings under this handbook to bring about development for the individual or another.
  
- Development** - Means the subdivision of land; construction, reconstruction, conversion, structural alteration, relocation or enlargement of any structure, road, driveways or appurtenance; installation of a sign; and any mining, excavation, grading, landfill or land disturbance.
  
- Directional Distribution** - An estimation of trip origin and destination for trips produced by a proposed land use.
  
- Director** - Means the Director of the Department of Public Works.

- Drainage Structure** - Any facility such as a bridge, culvert, storm drain, catch basin, inlet, ditch or other similar facilities designed to carry off surface or other water.
  
- Driveway** - Any entrance from adjacent land onto a County maintained road or onto a road to be accepted into the County system.
  
- Easement** - The area secured beyond the right-of-way limits for the purpose of flattening or constructing slopes, side ditches, stream changes, etc. and also means a grant by a property owner of the use of land for a specific purpose or purposes by the public, or a corporation, or a certain person or persons. The various types of easements are described on page 2-53.
  
- Engineer** - The Director of Public Works for Carroll County or designated representative.
  
- Engineering** - The surveying, designing, and drafting of plats or plans to be used in the construction of a road, driveway, or drainage structure.
  
- Forecast Year** - Time period for which study results are characterized. Usually influenced by or directly related to the opening date or date of reaching build-out of project and full occupancy.
  
- Frontage** - That portion of a lot or parcel of land which adjoins the publicly maintained road surface or existing right-of-way line.
  
- Functional Classification** - The process by which streets and highways are grouped into classes, or systems, according to the type of service the roads are intended to provide. For more information on Carroll County's Functional Classification Criteria and Assignment contact the Department of Planning at 876-6547.
  
- Holidays** - As designated by the County Commissioners of Carroll County.
  
- Homeowner's Association** - Means a community association, other than a condominium association, organized in a development in which individual owners share common interest in open space or facilities.

- Inspector** - Authorized representative of the Engineer assigned to make detailed inspection of the work or materials used therein.
- Instruction Bidders** - All instructions issued for the information of Bidders pertaining to the requirements governing the submission of proposals, the quantities and qualities of materials, the performance of the work and the payments therefore.
- Laboratory** - Official testing laboratory or chemist as designated by the Engineer.
- Land Use Code** - Numerical code number assigned to types of land use by the 4th edition of the book Trip Generation, by the Institute of Transportation Engineers, 1991 (or later edition).
- Lane Use Configuration** - The number and type of lanes on each approach to an intersection that accommodates turning and through movements.
- Lane Use (Utilization) Factors** - Factors used to reflect lane utilization.
- Level of Service (LOS)** - A qualitative measure describing the operating conditions within a traffic stream. It is usually expressed in a one-letter designation. The one-letter designations range from A to F, with A representing the optimum operation of a roadway or an intersection and F representing the breakdown of traffic flow along a roadway or through an intersection (See Level of Service Descriptions, page 5-12).
- Linear Trend Analysis** - Method of forecasting traffic volumes based on the assumption that recent (3 years) growth rates in traffic volumes will continue through the study target year, or will change predictably. A review of trends over longer periods is desirable, as a general rule the historic time period should at least equal the future projection time period.
- Lot** - Shall mean a portion of a subdivision or a parcel of land intended for building development, immediate or future.

- Maintenance** - The care and protection afforded roads or their associated facilities such as grading, draining, patching, or addition of surface materials.
  
- Major Subdivision** - Means a division of a tract or parcel of land into 4 or more lots or a division of property which creates, involves, touches, or is in the path of an officially planned new road, street, or highway.
  
- Maximum Buildout** - The most intense use of property allowed under the land use designations in the Carroll County Zoning Ordinance Number 1E.
  
- Minor Subdivision** - A subdivision of no more than 3 lots and which does not create, involve or is not contiguous to or in the path of an officially planned new road, street or highway.
  
- Pass-By Trip** - A trip which enters directly from the traffic stream passing the facility on the adjacent street system, returns thereto, and which did not require a diversion from another roadway.
  
- Passenger Car Equivalency (PCE)** - The number of Passenger Cars that are displaced by a single heavy vehicle or a particular type under prevailing roadway, traffic and control conditions.
  
- Pavement** - That portion of the roadbed designed and constructed to serve the bulk of vehicular traffic and that portion on which a sub-base, base, and/or surfacing materials are provided for such traffic excluding shoulders, curbs, and/or gutters.
  
- Peak Period (Hour)** - The time period during which the highest traffic flow occur (i.e., morning, evening, weekday, weekend, etc.) and the highest one hour of traffic flow within that period.
  
- Performance Bond** - The instrument entitled "Performance Bond" furnished by the Contractor and his or her Surety in connection with this project and which bond forms a part of the contract documents.
  
- Person** - Any individual, firm, association, partnership, or corporation.

- Planned Unit Development** - Means a development scheme to provide suitable sites for relatively higher density types of residential structures in areas zoned "R-10,000" and "R-7,500" Districts and to permit the optimum amount of freedom and variety in the design and management of such varying types of residential structures, including one and two-family units, townhouses, and garden apartments within the areas designated.
- Plans** - All drawings or reproduction thereof, pertaining to the construction of the improvement and its appurtenances.
- Pre-application Conference** - Open agency-developer discussions regarding all aspects of land development and during which the specific requirements of the traffic study are assigned. This meeting is mandatory prior to an official plan submittal.
- Preliminary Plan** - Means a professionally prepared drawing of a proposed development which is not a final plat but which contains information as specified by the current preliminary plan checklist concerning the proposed development sufficient to enable the Commission to approve the proposal, subject to latter submission of a final plan and to the actual construction of the development conforming with the approved plat.
- Proposal Guaranty** - Security to be furnished by the Bidder as a guaranty of good faith to enter into a contract for the work contemplated if it be awarded to him or her.
- Public Works Agreement** - Means a legal agreement between the county and the owner and developer for the construction of water and sewer facilities, storm drains, streets, bridges, culverts and other public improvements as well as Use-in-Common driveways.
- Purchasing Agent** - Head of the Purchasing Department of Carroll County.
- Right-of-Way** - A strip of land appropriated for placement, maintenance and for use as a street, highway, alley, or walkway, or for a drainage or public utility purpose or other similar use.

- Road** - Any road, street, highway, boulevard, way, circle, court, alley, avenue, lane or any part of the length thereof, whose purpose is to provide access for vehicular traffic to abutting properties.
- Roadbed** - That portion of road right-of-way graded and used for the accommodation of vehicle traffic.
- S.C.D.** - Soil Conservation District
- S.C.S.** - Soil Conservation Service, Dept. of Agriculture
- Service Volume** - The maximum hourly rate of traffic that can reasonably be expected to traverse a point or uniform section of a lane or roadway during a given time period under prevailing roadway, traffic, and control conditions while maintaining a designated level of service.
- S.H.A.** - Maryland State Highway Administration
- Site Plan (Site Development Plan)** - Means a plan for an industrial, commercial, multi-family residential activity, or other development which contains information as specified by the current site development plan checklist and zoning ordinance to enable the Carroll County Planning & Zoning Commissioner to act on the proposal.
- Special Provisions** - Clauses contained under the heading "Special Provisions" setting forth requirements peculiar to the specific work included in the contract.
- Specifications** - All provisions and requirements contained herein, together with all written or printed agreements of instructions, made or to be made pertaining to the methods and manner of performing the work.
- State** - State of Maryland
- State Specifications** - Refers to the "Standard Specification for Construction and Materials - Maryland Department of Transportation State Highway Administration (latest edition)"

- Storm Drain Systems** - Storm Drain Systems as used in this manual shall consist of inlets, manholes, pipes, channels, waterways, swales, ditches, streams, and any other or related method of collecting and conveying storm water runoff on or beneath the ground or finished surface.
- Study Area** - The amount of area to be studied which is determined by an appropriate analysis which is based upon local or site specific issues, development size and reviewing agency policy. The area is established during the pre-application conference by representatives from the Departments of Planning and Public Works.
- Subbase** - The layer or layers of specific select material of designated thickness placed on a subgrade to support a base course.
- Sub-Contractor** - Individual, firm or corporation acting for or in behalf of the Contractor in the execution of all or any part of the Contract.
- Subdivision** - Means the division of any tract or parcel of land into three (3) or more lots or parcels for immediate or future sale or lease or building development. Any division of land involving a new street or involving property identified by Carroll County as all or part of a planned public project shall be a "subdivision".
- Subgrade** - The material in excavation (cuts) and embankments (fills) immediately below any subbase, base, pavement, shoulder or other improvement course.
- Supplemental Specifications (Addendums)** - Certain directions, provisions and requirements adopted as supplemental specifications and made a part of the Contract, with the express purpose of superseding the specifications and drawings issued previously in whole or in part.
- Surety** - The corporate body that is bound with and for the Contractor who is primarily liable and which engages to be responsible for the Contractor for his or her acceptable performance of the work for which he has contracted.

- Through Lane** - A lane in the configuration of an intersection that may be used either partially or exclusively to facilitate traffic traveling through an intersection (without turning left or right).
- Trip** - A single or one-direction vehicle movement with either the origin or destination (existing or entering) inside the study area.
- Trip Assignment** - The process by which trips generated by a development are assigned to the road network. This process assigns trips to the most obvious routes. When there is a question as to which route would be the preferred route of travel additional analyses are performed to determine the projected route of choice.
- Trip Generation** - Projected number of trips produced by a type of land use or building. Based upon statistical analysis of existing land uses and building types.
- Turning Movement Count** - Data collection technique whereby the observer records the number of vehicles that utilize each approach lane of an intersection, usually recorded for a standard time periods of two to three hours in increments of 15 minutes.
- Use-in- Common Driveway** - Means a private roadway serving two or more properties and which provides vehicular access to a public street. A Declaration of Maintenance Obligations and a Public Works Agreement are required for all Use-in-Common driveways.
- Work** - Work shall be understood to mean the furnishing of all labor, materials, equipment and other incidentals necessary for the proper and successful completion of the project or portion of the project involved and the carrying out of all duties and obligations imposed by the Contract.
- Working Days** - A calendar day, except Saturday, Sundays, and Holidays, unless used as a working day, which weather and working conditions permit the Contractor to make effective use of not less than fifty percent (50%) of the usual daily man hours during regular working hours.

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## CHAPTER 1

# INTRODUCTION AND GENERAL INFORMATION

**CHAPTER 1: INTRODUCTION AND GENERAL INFORMATION**

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## **CHAPTER 1: INTRODUCTION AND GENERAL INFORMATION**

### **1.1 Introduction**

Carroll County Government adopted its last design manual for roads and storm drains in March of 1977. Since that time, much has taken place in the way of revisions to road standards, storm water management, and storm drain design standards in general.

Carroll County has adjusted to these changes by supplementing the Design Manual information with various updates that were sent to holders of the manual but not in such a fashion that the supplements could be inserted into the manual in an orderly and systematic fashion. The format of this manual will allow for insertion of supplemental or revised criteria as it becomes adopted from time to time by the Commissioners of Carroll County.

The County, although having its own road design policy, did not have its own storm drain policy included in the 1977 manual. Instead, it utilized the State of Maryland's Hydraulic Criteria for Design of Highways. This updated manual now includes a storm drain design section along with revised standards and text for road construction. It also includes information on Road Functional Classification Criteria, Traffic Impact Study Guidelines and Capital Project Engineering directives.

### **1.2 Purpose of Design Manual**

The purpose of this manual is to provide a thorough set of directives for anyone designing or constructing storm drains and roads under the purview of Carroll County but excluding the individual incorporated towns within the County.

These directives shall be considered the minimum which will be accepted by Carroll County and there is nothing to preclude them from being exceeded in an effort to obtain an even safer design.

The criteria contained in the manual are generally compatible with that of the American Association of State Highway and Transportation Offices (AASHTO) and the Maryland State Highway Administration. References are made to documents published by these and other agencies where appropriate.

### **1.3 Waivers**

It is understood there may be occasions when requests for deviations from the standard design manual may be warranted. In these cases, a request must be sent to the

Director of Public Works and Chief of the Bureau of Engineering explaining the nature of such request. After reviewing requests, the director and/or bureau chief or designated representative will respond to the person making such request. Under normal procedure, a meeting will be scheduled between the parties involved and the director shall make his or her decision.

#### **1.4 Construction Standards and Specifications**

It is recognized that in most cases uniform high quality construction is best achieved through the use of standards. However, there may be times when deviation from adopted standards are necessary because of unusual circumstances. Where proposed work is not covered by construction standards or where the Engineer feels certain deviations are necessary, a design shall be developed in accordance with the principles of this manual and submitted to the bureau chief, or representative, for review and approval.

#### **1.5 Scope of Design Manual**

This manual contains requirements, guidelines and standards for the design of roadways and storm drain systems constructed within the county. Persons desiring to develop land in Carroll County are urged to obtain a copy of Carroll County's Development Handbook from the Bureau of Development Review at the Carroll County Office Building, 225 North Center Street, Westminster, Maryland. The Development Handbook contains directives and general information on how to subdivide land, the process for submitting plans, attending review meetings, general design standards, legal matters, subdivision regulations, a copy of Article 66B, Annotated Code of Maryland Zoning and Planning plus additional information pertaining to the subdivision process.

## **CHAPTER 2**

# **DESIGN SPECIFICATIONS FOR COUNTY ROADS**

**NOTE:** Since the adoption of the 1994 Manual, there have been various design and procedural revisions. Many of the revisions are included under the Revisions link. Engineers and surveyors are encouraged to call the Bureau of Engineering to obtain the latest design criteria and procedures.

## CHAPTER 2: DESIGN SPECIFICATIONS FOR COUNTY ROADS

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## **CHAPTER 2: DESIGN SPECIFICATIONS FOR COUNTY ROADS**

### **2.1 Introduction**

The following chapter contains guidelines, procedures and technical design information for anyone who is required to construct roads and storm drains in Carroll County as a result of the desire to develop land.

The enforcement of the criteria comes under the purview of the Department of Public Works Bureau of Engineering. Engineers and Developers, should they feel it necessary, are encouraged to contact the Bureau of Engineering for any interpretation of this chapter's contents.

### **2.2 Overview**

Any person or person contemplating the construction of a road to be accepted into the county road system, the updating of an existing county road, or the construction of a road which is shown on a final subdivision plat duly recorded in the plat records of the Circuit Court of Carroll County shall provide engineering for said road in accordance with the regulations set forth in the "Design Specifications for County Roads".

This resolution shall apply only to roads maintained by Carroll County. It does not apply to (a) roads within incorporated municipalities, (b) State roads, (c) roads maintained by the Federal Government.

### **2.3 Classification of Roads**

All existing county roads and all new roads proposed for acceptance as county roads shall be classified by the Engineer according to their importance within the road system. The engineering standards for construction or improvement of any such roads shall then be determined on the basis of their classifications. (See Chapter 4 of this manual)

The Engineer shall maintain a record of the classifications assigned to the above mentioned roads, along with the criteria used in determining those classification assignments.

### **2.4 Procedures**

#### **2.4.1 Construction Plan**

The Developer shall file with the Engineer a road, storm drain and driveway construction plan which, if approved by the engineer, will be used as a basis for construction. Said plan shall include the profile of the proposed finished grade in relation to the existing centerline grade, the typical road section, and details of required drainage facilities. Existing and proposed cross sections of the road area shall accompany the construction plans. Plans, profiles, and cross sections shall be submitted at scales shown in the "Checklist for Contract Drawings" at the end of this chapter. Details and particular information can be obtained by contacting the Engineering Review Division. Storm drain design shall be in accordance with Chapter 6 of this manual.

#### **2.4.2 Public Works Agreements and Contribution of Funds**

When required, the Developer shall file with the County a Public Works Agreement or shall post funds as described under Section 2.5 for the construction of any new road, updating of any existing county roads, the construction of use-in-common driveways, the construction of storm drain facilities, and the construction of other related road items that may be considered pertinent to the protection of the health, safety and welfare of the general public. Where a portion or all of a subdivision changes ownership during the time that a Public Works Agreement is in force, the new Owner or Owners will be obligated to negotiate a new Public Works Agreement, which may be updated to current requirements. In the event the Public Works Agreement has expired, the new Owner is required to abide by the latest requirements in effect by the various governmental agencies involved. Prior to the submission of the Public Works Agreement the Developer shall furnish to the Department of Public Works a construction estimate for bonding purposes.

#### **2.4.3 Private Street Ordinance**

Carroll County Ordinance No. 2-A provides for the upgrading of existing private roads to county standards for the purpose of acceptance into the county's system for maintenance.

The typical section for the road shall be determined by the Department of Public Works' Bureau of Engineering.

The Ordinance outlines the procedures for submitting an application and describes, in detail, the various steps necessary to bring a project to completion, once an application is approved.

Copies of the Ordinance can be obtained from the Bureau of Engineering or the County Attorney's Office.

## **2.5 Owner/Developer Responsibilities**

### **2.5.1 Responsibility For Road Construction**

It shall be the responsibility of the property owner to construct or provide for the construction of all county roads within the subdivision or fronting on the subdivision including required connections to adjacent properties except to properties precluded from development by law or agreement.

Where land along an existing county road is being subdivided into three (3) or more new lots and a subdivision plat is required in accordance with County Subdivision Regulations, the Developer shall be responsible for upgrading the road frontage to current standards except as otherwise described under this chapter, or, at the County's sole option, to contribute to the County the funds that would be required to bring the road to current standards. The Developer is also responsible for dedicating as much of the right-of-way and additional easement as is necessary for said construction.

**NOTE:** If a parcel of land being subdivided contains an existing dwelling, the resulting lot created by the subdivision and containing the existing dwelling will not be counted as a new lot when determining the total lot count if it had occupancy either prior to or at the time the land was being divided.

1. Where lots or parcels shown on a one (1) or two (2) lot minor subdivision plat can not be further divided to the extent that three (3) or more lots could ultimately be created within the land division, road improvements will not be required unless the subdivision creates a sight distance problem or a traffic problem generated by other than an increase in traffic flow. An example of a traffic problem is when land is being developed at the end of an existing dead end road that lacks an acceptable turn around area. In this instance, the Owner or Developer may be required to construct a permanent turnaround in accordance with Section 2.7.18 of this manual regardless of the number of lots being developed.
2. Where lots or parcels shown on a one (1) or two (2) lot minor subdivision plat can be further divided to the extent that three (3) or more lots could ultimately be created within the land division, road improvements will be required and be subject to the provisions outlined under this chapter.

Upgrading to current standards may include but is not necessarily limited to, widening of existing paving to required width as determined by the Department of Public Works through the County's "Functional Classification Criteria and Assignment" for roadways and/or overlay of part or all of existing roadway frontage depending on condition

of surfacing. Improvements may also include level and wedge operations to bring the existing road to proper cross section elements. See Plate 7 for method of improvement. The Department of Public Works will determine the type of improvement method at the time of preliminary review.

The extent of Owner's Responsibilities is as follows:

(a) **Owner Owns Land on One (1) Side of Road Only.**

Where the property owner owns land on only one (1) side of the road, the property owner will be required to construct or (at the County's sole option) to contribute to the County the funds necessary to construct one (1) side or up to 1/2 of the designated pavement width.

(b) **Owner Owns Land on Both Sides of Road**

Where the property owner owns land on both sides of the road, the Owner will be required to construct or (at the County's sole option) to contribute to the County the funds necessary to construct the entire length of all such roads within the subdivision to the full designated pavement width.

(c) **Continuation to Nearest Public Road Intersection**

When a Developer makes road improvements pursuant to these regulations, the Department of Public Works may require the Developer to continue the improvement or (at the County's sole option) contribute the cost of constructing the continuance of the improvement to the nearest public road intersection; if:

- (1) The necessary right (s)-of-way exist or have been acquired by the Developer or the County; and
- (2) The continuation of the improvements is necessary to make the required improvements functional or to provide for safe traffic movements; and
- (3) The Director of Public Works has determined that the nearest public road is in close proximity to the proposed subdivision.

Generally, these off-site improvements will be required when the road is substandard. Substandard roads are roads which have any or all of the following conditions:

- (1) Lack paving or surface treatment.
- (2) Have a pavement width of less than 16 feet.
- (3) Involve a substantial or dangerous horizontal and/or vertical alignment or similar problems.

## ~~2.5.2~~ Exemptions

Road improvements, as described in Section 2.5.1, will not be required by the Department of Public Works if any of the following conditions are met.

1. Each and every lot comprising the subdivision is a minimum of five (5) acres in size and has a minimum width of three hundred (300) feet at the building set back line. The three hundred (300) feet requirement may be waived by the Bureau of Engineering where lots front on Cul-de-sacs, or
2. The lots are located in the Agricultural District and created in accordance with Section 6.6 (a) of the Carroll County Zoning Ordinance.

**NOTE:** It is called to the Developers attention that although the Department of Public Works may not require improvements under these exemptions the Carroll County Planning and Zoning Commission has the authority to do so when the Commission finds the particular circumstances involved warrant improvements pursuant to Adequate Public Facilities Law.

In approving preliminary subdivision plans, the Developer shall be advised of the need for any Public Works Agreement or contribution of funds to the County as may be required. The Developer shall furnish said Public Works Agreement and any guarantees, bonds, or participating costs prior to recordation of the final subdivision plat. Such agreement shall set forth those requirements of the Developer and the County in modifying the existing county road.

## 2.6 Roadway Design

### 2.6.1 Standards

The Engineering standards within this section shall be considered minimum

requirements for road design. The use of superior values should be considered whenever economically feasible. For additional guidance, refer to the latest publication of "A Policy on Geometric Design of Highways and Streets" (AASHTO).

## **2.6.2 Controls for Determining Typical Section**

The Developer and or consultant doing the design work shall meet with a representative of the Department of Public Works' Engineering Review Division prior to the submittal of preliminary plans to determine the typical section to be used for the project. In general, the section will be determined by it's functional classification as outlined in Chapter 4 of this manual and as explained in Chapter 2, Section 2.3. There may be times when an independent traffic study will be required to determine a road section if it is felt a typical design would not be sufficient in meeting traffic demands. Chapter 5 of this manual stipulates the requirements for when a study is required.

The standard plates shown in this manual will be used for the majority of roads being constructed in the county. Any deviation from these standards must be approved by the Department of Public Works.

**NOTE: Sections 2.6.3 through 2.6.6 have been updated. Refer to the Revisions link.**

## ~~2.6.3 Sight Distance~~

Sight distance criteria used in this manual are adopted from the A.A.S.H.T.O publication of 1990. A.A.S.H.T.O defines sight distance as the length of roadway ahead visible to the driver. It should be long enough to enable a vehicle traveling at or near the design speed to be able to stop before reaching a stationary object in its path.

## ~~2.6.4 Stopping Sight Distance~~

Stopping sight distance is the sum of:

1. The distance traversed by the vehicle from the time the driver sights an object necessitating a stop to the time the brakes are applied and
2. The distance required to stop the vehicle from the time brake application begins

The criteria used by A.A.S.H.T.O. and adopted by Carroll County for computing stopping sight distance is as follows:

Height of Driver's eye = 3.50 feet

Height of Object = 0.50 feet (6 inches)

The equation for stopping sight distance is:

$$SSD = 3.675 V + \frac{V^2}{30 (f+g)}$$

Where V = initial speed (mph)

f = coefficient of friction between tires and roadway

g = percent of algebraic grade divided by 100 (g is positive for upgrade and negative for downgrade)

(A) Sag Vertical Curves

Headlight sight distance is the main criteria for determining sight distance length. The portion of roadway lighted by a vehicle's headlights at night is dependent on the headlight position and the direction of light beam. The general height of headlights used for determining proper sight distance is 2.0 feet with a 1° upward divergence of the light beam from a longitudinal axis.

The formulas used to determine the minimum length of sag vertical curves are as follows:

When  $S < L$ ;

$$L = \frac{AS^2}{400 + 3.5 S}$$

When  $S > L$ ;

$$L = 2S - \frac{400 + 3.5 S}{A}$$

Where:

L = Length of sag vertical curve, ft;

S = light beam distance, ft; and

A = algebraic difference in grades, in percent

B) Crest Vertical Curves

Crest curves must be long enough to provide for the required stopping sight distance. Again, the height of drivers eye and the height of object are 3.50 feet and 0.50 feet respectively.

The formulas used to determine the minimum length of crest vertical curves are as follows:

When  $S < L$ ;

$$L = \frac{AS^2}{1,329}$$

When  $S > L$ ;

$$L = 2S - \frac{1329}{A}$$

Where: L = Length of crest vertical curve, ft;  
S = stopping sight distance, ft; and  
A = algebraic difference in grades, in percent

To simplify determination of stopping sight distance, the designer may use Table 2.00 which shows the minimum lengths of stopping sight distance for the most commonly used designed speeds in Carroll County. The table also shows a "K" value for both crest and sag vertical curves which can be used to determine the length of vertical curve which will provide minimum stopping sight distance.

### 2.6.5 Sight Distance for Passing

A driver of a vehicle should be able to see a sufficient distance ahead, clear of traffic, to complete a passing maneuver without cutting off the passed vehicle in advance of meeting an opposing vehicle during the maneuver. It is measured based on a height of eye of 3.5 feet and a height of object of 4.5 feet. Ordinarily, passing sight distance is provided only at places where combinations of alignment and profile do not require the use of crest vertical curves and is applicable only to two lane rural major collectors and minor arterial type roadways. These types of roadways will be determined by the Carroll County Functional Classifications and Criteria documents contained in Chapter 4 of this manual.

Table 2.01 shows the minimum passing sight distances for various design speeds.

### 2.6.6 Sight Distance at Intersections

Intersections should be carefully situated to avoid steep profile grades and to ensure adequate approach sight distance. An intersection should not be situated on a short-crest vertical curve, just beyond a short-crest vertical curve, or on a sharp horizontal curve. When there is no practical alternate to such a location, the approach sight distance on each leg should be checked carefully. Where necessary, backslopes should be flattened and horizontal or vertical curves lengthened to provide additional sight distance. Sight distance should be sufficient to permit a vehicle on the minor leg of the intersection to cross the

traveled way without requiring the approaching through traffic to slow down. As a general rule, there should be a minimum of seven (7) seconds available to the driver of a passenger vehicle crossing the through lanes.

Table 2.02, as adopted from A.A.S.H.T.O. is to be used for the design of intersecting roads in Carroll County.

There may be times, because of terrain characteristics, that the sight distances required in Table 2.02 are very difficult to obtain for intersecting roadways and in cases where proposed single and use-in-common driveways are designed to intersect with roadways. In such cases, the Developer, or his or her engineer, must request a waiver of the requirements by contacting the Bureau of Engineering' Review Division. The Bureau will conduct a field investigation and submit the results to the Director of Public Works for a waiver recommendation, a recommendation with conditions or a refusal of recommendations.

A sample Analyses Form is shown on page 2-12.

**TABLE 2.00**

**STOPPING SIGHT DISTANCE**

Design Speed, MPH	25	30	35	40	45	50	55
Stopping Sight distance: in feet	150	200	225	275	325	400	450
K value for: * Crest vertical curve	20	30	40	60	80	110	150
Sag Vertical curve	30	40	50	60	70	90	100

**NOTE:**

\*"K" value is a coefficient by which the algebraic difference in grade may be multiplied to determine the length, in feet, of the vertical curve which will provide minimum stopping sight distance.

**TABLE 2.01**

**PASSING SIGHT DISTANCE**

Design Speed, MPH	25	30	35	40	45	50	55
Minimum passing sight distance in feet	95	1,100	1,300	1,500	1,650	1,800	1,950

Source: A Policy on Geometric Design of Highways and Streets; 1990

**TABLE 2.02**

**INTERSECTION SIGHT DISTANCE**

<b>Design Speed (mph)</b>	<b>Corner Intersection Sight Distance (ft)<sup>a</sup></b>
60	650 <sup>b</sup>
50	515
40	415
30	310
20	210

<sup>a</sup>Corner sight distance measured from a point on the minor road at least 15 ft from the edge of the major road pavement and measured from a height of eye at 3.50 ft. on the minor road to a height of object at 4.25 ft. on the major road.

<sup>b</sup>At 60 mph stopping distance governs.

# INTERSECTION SIGHT DISTANCE ANALYSIS

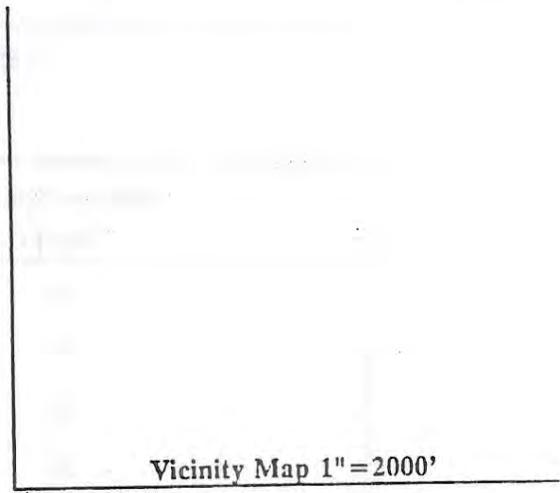
Carroll County Department of Public Works - Bureau of Engineering - Engineering Review Division

Road Name \_\_\_\_\_  
 (County or Preference Road) (Route No.)

Property/Project \_\_\_\_\_

County File# \_\_\_\_\_

Inspected by \_\_\_\_\_ Date \_\_\_\_\_



Existing surface: width: \_\_\_\_\_ Type: \_\_\_\_\_ Condition: \_\_\_\_\_

Existing shoulder/adjacent: width: \_\_\_\_\_ Type: \_\_\_\_\_ Condition: \_\_\_\_\_

Existing shoulder/opposite: width: \_\_\_\_\_ Type: \_\_\_\_\_ Condition: \_\_\_\_\_

Posted speed: \_\_\_\_\_ Minimum Required Sight Distance: \_\_\_\_\_

Actual Sight Distance, Left: \_\_\_\_\_ Actual Sight Distance, Right: \_\_\_\_\_

Notes/Conditions: \_\_\_\_\_

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Based on conditions cited above, a waiver of minimum sight distance requirements:  is recommended;  is recommended with conditions;  is not recommended. By: \_\_\_\_\_ Date: \_\_\_\_\_

Request for waiver of minimum sight distance:  granted;  granted with above-listed conditions;  not granted.

Minimum Required Sight Distance <sup>1</sup>	
Posted Speed M.P.H.	Minimum Distance Feet
20	210
25	240
30	310
35	365
40	415
45	465
50	515

Keith R. Kirachnick, Director  
 Department of Public Works

Date: \_\_\_\_\_

1. Reference Table V-11 of A Policy on Geometric Design of Highways and Streets. (A.A.S.H.T.O.) 1990 Edition.

2. Actual sight distances are measured from vehicle sitting in minor road or driveway, with driver positioned at 15 feet from the edge of County road, to a point in centerline of lane. Use height of eye = 3.5 feet and height of object = 4.25 feet.

## **2.6.7 Horizontal Alignment**

Alignment between control points should be to as high a standard as is commensurate with the topography terrain and design traffic. Sudden changes between curves of widely different radii or between long tangents and sharp curves should be avoided. Where crest vertical curves and horizontal curves occur at the same location, there should be above-minimum sight distance design to assure that the horizontal curve is visible as drivers approach.

Horizontal curves are required whenever the roadway centerline changes direction, regardless of how slight that direction change might be.

Minimum lengths of horizontal curves shall be as follows:

### **SYSTEM ROADS**

Local Roads = 150'

Collector Roads = 300'

Arterial Roads = 500'

### **SUBDIVISION ROADS**

Loop Roads and Cul-de-Sac Roads = 100'

Residential Streets = 150'

Subcollector Roads = 150'

In no case shall the length of curve be less than the superelevation runoff.

- a. Where reversed curves are used in superelevated roadways, a length of tangent sufficient for superelevation runoff, but in no case less than 100', shall be provided between the curves.
- b. Broken back curves, that is, two curves, in the same direction separated by a short tangent, should be avoided. Such an arrangement can usually be replaced by a series of compound curves.
- c. Sharp curvature shall be avoided on long, high fills. The absence of reference items such as cut slopes, trees, and buildings makes it difficult for the driver to judge horizontal curvature.
- d. In compound circular curves, the radius of the flatter curve should not be more than 1.5 times greater than the radius of the sharper curve.

### **2.6.7-1 Curvature**

Requirements for superelevated roadways are specified under Section 2.6.8 of this manual.

The minimum centerline radius required for Subcollector and Residential roads is 275' (See Table 2.08).

Loop roads and Cul-de-Sac roads may be constructed with radii as minimal as 100' (125' desirable) providing the centerline deflection angle is greater than 60°.

If the centerline deflection angle of Loop and Cul-de-Sac roads is greater than 40° but less than 60°, a 200' minimum radius may be used to connect the centerlines.

Subcollector, Residential, Loop and Cul-de-Sac roads do not require superelevation.

### **2.6.8 Superelevation Criteria**

Superelevation of roadways will only be required for Collector and Arterial type roadways requiring design speeds of 40 mph or greater. It will not be required for other road classifications unless otherwise directed by the Director of Public Works or Chief, Bureau of Engineering.

Superelevation is the raising of the outside edge of roadway and rotation of the roadway surface to offset the effect of centrifugal force which is produced when entering a horizontal curve. Superelevation generally consists of four (4) parts; full super, superelevation runoff, tangent runout, and transition or spiral curvature. Superelevation on undivided highways shall be accomplished by rotation of road surface about the centerline, see Plates 39 and 40. Divided highways and other special cases shall be designed as directed by the Department of Public Works.

Rate of superelevation (e) shall vary in accordance with radius of curve. Maximum (e) shall be 0.06 feet per foot unless approved otherwise by the Department of Public Works (1). This rate shall apply to a minimum centerline radius of 510 feet (2). Rate of superelevation shall decrease as centerline radius increases in accordance with Table 2.03.

In instances where collector roads and arterial roads intersect, neither road may be in superelevation or transition. In instances where local roads intersect collector or arterial roads, the intersection shall be located in the tangent if at all possible. When it becomes necessary to locate an intersection in superelevation or transition areas, particular attention must be paid to drainage and sight distance concerns.

The following information is extracted from the A.A.S.H.T.O. 1990 Edition of A Policy on Geometric Design of Highways and Streets.

### **2.6.8-1      Superelevation Transitions**

Superelevation transitions are the total lengths of highway necessary to achieve full superelevation from a normal crowned roadway. Total transition length is the sum of superelevation runoff length and tangent runoff length, as discussed below. Shoulder transitions shall also occur simultaneously with roadway transitions as discussed in "Shoulders". Transitions are based on the Point of Curvature (P.C.) and Point of Tangency (P.T.) of horizontal curves.

### **2.6.8-2      Superelevation Runoff**

Superelevation runoff is the general term denoting the length of highway needed to accomplish the change in cross-slope from a section with adverse crown removed to a fully superelevated section, or vice-versa. Approximately two-thirds of the runoff shall be placed on the tangent approach and one-third on the curve, see Plate 39.

### **2.6.8-3      Tangent Runout**

Tangent runout is the length of highway needed to remove the adverse crown and raise outside edge to same elevation as centerline. Length of tangent runout shall be equal to one-third of the length of runoff (L). Tangent runout shall be in addition to superelevation runoff and shall apply only to the outside lane.

### **2.6.8-4      Transition (Spiral) Curves**

Spiral curves are curves of varying radii used to lessen the effect of horizontal curvature in the vicinity of the P.C. and P.T. On highways where design speed is 40 m.p.h. or greater, spiral curves shall be used in accordance with AASHTO requirements if and when required by the Bureau of Engineering.

### **2.6.8-5      Shoulders**

Shoulder slope on inside of curve shall remain constant 6% down from edge of road. Shoulder slope on outside of curve shall transition smoothly from 6% down to 2% down.

Shoulder transition shall begin 100' ahead of P.C. so that 2% down is effective from P.C. to P.T. See Plate 40.

## 2.6.8-6 Length of Tangent Between Curves

In instances where horizontal curves of opposite direction must be placed closely together the minimum length of tangent between P.T. of one curve and P.C. of next curve shall be 300'. Closely spaced horizontal curves to the same direction sometimes called "broken-back" or "flat-back" curves shall not be permitted. Spiral transitions or a compound curve alignment, wherein there is some degree of continuous superelevation, shall be used for such conditions.

**TABLE 2.03**

D	R (ft)	e	V = 40 mph		e	V = 50 mph		e	V = 55 mph	
			L(ft)			L(ft)			L(ft)	
			Two Lanes	Four Lanes		Two Lanes	Four Lanes		Two Lanes	Four Lanes
0°15'	22,918	NC	0	0	NC	0	0	NC	0	0
0°30'	11,459	NC	0	0	NC	0	0	NC	0	0
0°45'	7,639	NC	0	0	RC	0	0	RC	160	160
1°00'	5,730	NC	0	0	.020	150	150	.023	160	160
1°30'	3,820	.020	125	125	.028	150	150	.032	160	160
2°00'	2,865	.025	125	125	.035	150	150	.040	160	160
2°30'	2,292	.030	125	125	.040	150	150	.045	160	160
3°00'	1,910	.034	125	125	.045	150	160	.050	160	160
3°30'	1,637	.038	125	125	.048	150	170	.054	160	210
4°00'	1,432	.041	125	130	.052	150	180	.057	160	220
5°00'	1,146	.046	125	140	.056	150	200	.060	160	230
6°00'	955	.050	125	160	.059	150	210	D max = 5° 15'		
7°00'	819	.053	125	170	D Max = 6° 45'					
8°00'	716	.056	125	180						
9°00'	637	.058	125	180						
10°00'	573	.059	125	190						
11°00'	521	.060	130	190						
12°00'	477	D max = 11°15'								
13°00'	441									
14°00'	409									
16°00'	358									
18°00'	318									
20°00'	286									
21°00'	273									

e max = 0.06

D = degree of curve

R = radius of curve

V = assumed design speed

e = rate of superelevation

L = minimum length of runoff (does not include tangent runout)

NC = normal crown section

RC = remove adverse crown, superelevate at normal crown slope

**NOTE:** Lengths rounded in multiples of 25 or 50 ft permit simpler calculations

**VALUES FOR DESIGN ELEMENTS RELATED TO DESIGN SPEED AND HORIZONTAL CURVATURE**

SOURCE: A POLICY ON GEOMETRIC DESIGN OF RURAL HIGHWAYS - 1990 (AASHTO) P.167

**TRANSITION DATA TABLE**

CONTROL DATA	STATION	DISTANCE FROM BEGINNING	Left Side		CENTERLINE ELEVATION	Right Side		REMARKS
			EDGE SHOULDER	EDGE SHOULDER		Edge Road	Edge Shoulder	
<u>Curve #4</u>	10+00.00	0	99.16	99.76	100.00	99.76	99.16	NC/Begin Trans.
<u>Left</u>	10+45.00	45.00	100.06	100.66	100.90	100.90	100.48	Half Level
D = 11°14'04"	10+50	50.00	100.16	100.76	101.00	101.03	100.63	
e max = 0.06 1/14	10+90.00	90.00	100.96	101.56	101.80	102.01	101.80	Plane Incline
R = 510.00	11+00	100.00	101.11	101.71	102.00	102.29	102.09	
T.L. = 180.00'	11+35.00	35.00	101.62	102.22	102.70	103.18	102.98	P.C.
P.C. = 11+35.00	11+50	150.00	101.84	102.44	103.00	103.56	103.36	
P.T. = 15+65.00	11+80.00	180.00	102.28	102.88	103.60	104.32	104.12	End Trans/F.S.
	15+20.00	0	109.08	109.68	110.40	111.12	110.92	F.S./Begins Trans
	15+50	30.00	109.84	110.44	111.00	111.56	111.36	
	15+65.00	45.00	110.22	110.82	111.30	111.78	111.58	P.T.
	16+00	80.00	111.11	111.71	112.00	112.29	112.09	
	16+10.00	90.00	111.36	111.96	112.20	112.44	112.26	Plane Incline
	16+50	130.00	112.16	112.76	113.00	113.03	112.93	
	16+55.00	135.00	112.26	112.86	113.10	113.10	113.01	Half Level
	17+00	180.00	113.16	113.76	114.00	114.00	113.76	End Trans/N.C.

Road Grade = +2.00%

N.C. = Normal Crown      Road Width = 24'  
 F.S. = Full Super        Shoulder Width = 10'

TABLE 2.04

**TRANSITION DATA TABLE**

CONTROL DATA	STATION	DISTANCE FROM BEGINNING	Left Side		CENTERLINE ELEVATION	Right Side		REMARKS
			EDGE SHOULDER	EDGE SHOULDER		Edge Road	Edge Shoulder	
<u>Curve #4</u>								
<u>Left</u>								
D =								
e max =								
R =								
T.L. =								
P.C. =								
P.T. =								

**NOTE:** Length of Table as necessary to include all transitions.  
 Size of table may not be smaller than shown here.

- D = Degree of curve
- e max. = Maximum rate of superelevation
- R = Centerline Radius
- T.L. = Transition Length (incl. Tangent Runout)
- P.G. = Point of Curvature
- P.T. = Point of Tangency
- Curve # as assigned
- \_\_\_\_\_ = Direction: Right or Left

### **2.6.8-7 Information To Be Shown**

In addition to items shown on the standard checklist, the plan sheet shall contain a transition data table which gives the following information: centerline station, stations and elevations of; left edge shoulder, left edge road, centerline, right edge road, right edge shoulder, and remarks; see Table 2.05. Data shall be given at normal 25 foot increments as well as for the following specific sections; begin transition, half-level (crown removed), 2% plane (plane incline), 4% plane, and full super. Table 2.04 is a sample of the transition data table. Each transition must be separately listed.

A schematic transition diagram shall be shown on the same sheet with the Transition Data Chart, see Plate 39.

### **2.6.8-8 Capital Improvements Projects**

In establishing a criteria for design of superelevated roads, it must be recognized that there will be instances when, due to specific site conditions, those criteria may not be practical. These instances will most likely occur on Capital Improvements Projects (C.I.P.'s) which involve modifications and/or improvements to existing roads. The criteria for superelevation shall apply generally to C.I.P.'s as well as to new roads; however, the Department of Public Works reserves the right to modify, adjust or waive the criteria as may be necessary to suit specific conditions.

### **2.6.9 Design Speeds**

The minimum design speeds to be used for the various classifications of roads are as shown in Tables 2.08 and 2.09.

### **2.6.10 Vertical Alignment**

Minimum grades should be established for roadway construction to assure adequate drainage for the integrity of the road. Maximum grades should be established to facilitate smooth operational characteristics of vehicles using the road.

Vertical curve design is required whenever grades change direction regardless of how slight that change might be. Lengths of such curves must be at least long enough to provide the required stopping sight distance outlined in Section 2.6.4 and shown in Table 2.00.

Vertical alignment is controlled by a Profile Grade Line (PGL) shown on the construction drawings and shall coincide with the following criteria:

A. Closed Section

1. Normal Crown - Undivided Roadway

Concrete Curb                      Street Centerline or Top of Curb

Normal Crown - Divided Roadway

Concrete Curb                      Top of Median Curb

2. Superelevated

Undivided Roadway              Street Centerline  
Divided Roadway                  Median Edge

**2.6.11              Grades**

The minimum grade allowed for new county roads shall be 1.0% unless otherwise approved by the Director of Public Works or Chief of the Bureau of Engineering.

The maximum grade allowed for all but Major Collector and Arterial Type roadways shall be 10%.

The maximum desirable grade for Major Collectors and Arterial type roadways shall be 6%. However, in no case will a grade in excess of 8% be allowed for these types roadways without prior approval from the Director of Public Works or Chief, Bureau of Engineering.

Although the maximum allowable grade for cul-de-sac roads is 10%, the grade along the centerline of the bulb shall be limited to a maximum grade of 8%. The maximum pavement cross slope through the bulb shall be limited to 6%. The minimum preferred grade for the linear profile shall be 2%.

**TABLE 2.06**

<b>ROAD TYPE</b>	<b>MINIMUM GRADE</b>	<b>MAXIMUM GRADE</b>
<b>Loop and Cul-de-Sac</b>	<b>1.0%</b>	<b>10%</b>
<b>Residential</b>	<b>1.0%</b>	<b>10%</b>
<b>Subcollector</b>	<b>1.0%</b>	<b>10%</b>
<b>Local</b>	<b>1.0%</b>	<b>10%</b>
<b>Minor Collector</b>	<b>1.0%</b>	<b>10%</b>
<b>Major Collector</b>	<b>1.0%</b>	<b>6% (desirable) 8% (absolute)</b>
<b>Arterial</b>	<b>1.0%</b>	<b>6% (desirable) 8% (absolute)</b>

In rehabilitating existing roadways; such as when roads are improved under the Capital Improvement Program, the maximum 10% criterion may be waived if the grade of the existing road already exceeds 10% and reducing the grade to 10% would cause grading related problems such as encroachment upon existing well, septic and dwelling areas, major reconstruction of driveways, and other modifications to existing facilities. Generally, the existing grade is allowed to be the final grade in these cases.

**A) Intersection Grades**

At an intersection of two traffic ways, the normal typical section of the priority traffic way shall continue through the intersection without break. The crown of the other traffic way shall be warped from its normal section to connect to the edge of the priority traffic way. In general, the road with the higher functional classification will be considered the priority road. If the roads are of the same classification, the Department of Public Works Bureau of Engineering will make the determination.

The maximum allowable tie in grades for the various types of roads shall be as shown in Table 2.07. When the grade of a non priority road exceeds these limits, the grade shall be broken in advance of the tie in point in order to satisfy the following criteria shown in Table 2.07.

**TABLE 2.07**

<b>Functional Classification of Non Priority Roads</b>	<b>Maximum Grade At Intersection</b>	<b>*Landing Grade Distance From Intersection</b>
<b>Loop and Cul-de-sac</b>	<b>6%</b>	<b>**50'</b>
<b>Residential</b>	<b>6%</b>	<b>**50'</b>
<b>Subcollector</b>	<b>6%</b>	<b>**50'</b>
<b>Local</b>	<b>6%</b>	<b>**50'</b>
<b>Minor Collector</b>	<b>4%</b>	<b>175'</b>
<b>Major Collector</b>	<b>4%</b>	<b>175'</b>
<b>Arterials</b>	<b>4%</b>	<b>200'</b>

\*Distance measured from pavement edge of priority road to the PVC of the vertical curve. Vertical curve design to be in accordance with Section 2.6.4 and Table 2.00.

**NOTE:**

\*\*Landing grades will not be required providing the tangent grades are 4% or less.

**2.7 Roadway Elements**

**2.7.1 Typical Sections**

Typical sections for the various functional classifications shall be as follows:

<b>Loop Road &amp; Cul-de-sac</b>	<b>Plates 20 and 21</b>
<b>Residential Street</b>	<b>Plates 18 and 19</b>
<b>Subcollector Road</b>	<b>Plates 16 and 17</b>
<b>Local Road</b>	<b>Plates 23 and 24</b>
<b>Collector Road</b>	<b>Plates 25, 25-A, and 26</b>

Typical sections for Arterial type roadways shall be developed specifically for each project and submitted to the Department of Public Works, Bureau of Engineering for review and approval.

## **2.7.2 Widths and Cross Slopes**

**Roadway widths shall be as shown on typical sections.**

**All cross slopes shall be as shown on the typical sections except in such cases where overlays to existing roads are required. In such cases the Department of Public Works may allow a steeper cross slope if it conforms more naturally to the slope of the road to be overlaid and lessens the requirements for significant wedge and level operations that might otherwise be required to meet the standard cross slope criteria.**

**The construction drawings submitted by the Developer's Engineer must clearly show the existing and proposed cross sectional elements for these areas to be overlaid along with all pertinent design data for handling drainage; including new routing, if necessary, and raising or revising location of existing inlets and manholes plus modification of any affected curbing.**

**The Bureau of Engineering will address such issues on a case by case basis.**

TABLE 2.08

CLASSIFICATION	ZONING	PAVEMENT WIDTH & SECTION TYPE	R/W WIDTH	MINIMUM DESIGN SPEED (M.P.H.)	MINIMUM CENTERLINE RADIUS	ADT & LENGTH CRITERIA	PLATE NO.
Subcollector	R-20 R-10 R-7.5	38' C & G	60'	30	275'	Over 1000 ADT	17
	R-40 Agric. Conserv.	22' Open	60'	30	275'	Over 1000 ADT	16
	R-20 R-10 R-7.5	30' C & G	50'	30	275'	Max. = 1000 ADT	19
Residential	R-40 Agric. Conserv.	20' Open	50'	30	275'	Max. = 1000 ADT	18
	R-20 R-10 R-7.5	22' Closed	40'	25	(See Note No. 1 Below)	Max. = 250 ADT Length = 1500' Max.	21
Loop & Cul-de-sac	R-40 Agric. Conserv.	18' Open	44'	25	(See Note No. 1 Below)	Max. = 250 ADT Length = 1500' Max.	20

S U B D I V I S I O N R O A D S

**NOTE:**

1. If the centerline deflection angle on loop and cul-de-sac streets is greater than 40°, but less than 60°, a 200' minimum radius may be used to connect the centerlines.  
If the centerline deflection angle is greater than 60°, a 100' minimum (125' desirable) radius may be used to connect the centerlines.  
Minimum lengths of horizontal curves must be in accordance with Section 2.6.5 under Horizontal Alignment.
2. Superelevation not required for roads listed in the above Table.

**TABLE 2.02**

		S Y S T E M						R O A D S	
CLASSIFICATION	ZONING	PAVEMENT WIDTH & SECTION TYPE	R/W WIDTH	MINIMUM DESIGN SPEED (M.P.H.)	MINIMUM CENTERLINE RADIUS	ADT & LENGTH CRITERIA	PLATE NO.		
Collector	N/A	38' C & G	60'	40	See Note No. 1 Below	Over 1000 ADT	25		
		26' C & G	50'	40	670'	Over 1000 ADT	25-A		
	N/A	22' Open	60'	40	See Note No. 2 Below	Over 1000 ADT	26		
Local	N/A	30' C & G	50'	30	275'	Max. = 1000 ADT	23		
	N/A	20' Open	50'	30	275'	Max. = 1000 ADT	24		

**NOTE:**

1. Superelevation not required for curb and gutter section; however, minimum radius as shown in Table Above, for normal crown, must be used.
2. Superelevation will be required for open section Collector roads. See Table 2.03 for values.

### **2.7.3 Sidewalks**

The requirement for sidewalk construction is the responsibility of the Bureau of Development Review and is normally determined at the time of preliminary plan submittal. Establishing design parameters, however, is a function of the Department of Public Works. Details for construction are shown in this manual on Plate 15 and shall be constructed to the widths, depths, and locations shown on these plates.

Sidewalks may be constructed adjacent to the curb or a minimum 2' from the right-of-way line as shown on the Typical Sections. Location normally depends on requirement for landscaping. Passing spaces at least 5' x 5' in dimension shall be constructed at intervals not exceeding 200' in length to accommodate wheel chairs along the 4' wide sidewalk.

### **2.7.4 Side Slopes**

It is called to the designer's attention that the 2:1 ratio backslope shown on the road plates is the maximum allowed. The designer is encouraged to design for a flatter slope where practical. A flatter slope allows for easier grass mowing operations for both the County maintenance personnel and the property owner.

### **2.7.5 Ditch Design**

Ditches will be required for open section roadways and shall be constructed in accordance with the typical plates for such roadways. Exceptions might be allowed for some open section loop roads and cul-de-sac roads whereby a modified swale design as shown on Plate 27 may be utilized providing the computed flow for the ten (10) year design storm does not spread onto the edge of roadway paving.

Approval for this design will be on a case by case basis and must be obtained from the Bureau of Engineering prior to the submission of any final review plans.

### **2.7.6 Guardrail**

Other than as stated below, "W Beam" guardrail is the preferred type to be used for roadside protection in Carroll County.

Guardrail will be required as shown in Plate 42. In addition, guardrail may also be required by the Bureau of Engineering in situations where roadside obstacles may pose a danger to vehicles. Pedestrians may also warrant protection from traffic and guardrail may be required in particular cases where that would be a concern.

It is recommended that, although a maximum 2:1 ratio is allowed for road backslope construction, the Engineer investigate the feasibility of constructing a 3:1 or flatter slope so guardrail would not be required in most fill situations.

Guardrail shall conform to standard Plate Numbers 48 thru 53 except that along use-in-common driveways, loop roads and cul-de-sac roads wooden guardrail may be used if approved by the Director of Public Works or the Chief, Bureau of Engineering.

See Plate 55 for detail of wooden post and chain installation.

### **2.7.7 Shoulder Bypass Lanes**

Shoulder bypass lanes shall generally be required by the Bureau of Engineering on roadways carrying a minimum ADT count of 2000. The requirement for these lanes may also be dependent on the availability of right-of-way and topographical conditions.

Plate 38 shows a general plan view for layout of the approach and taper lanes in constructing a shoulder bypass.

No specific signing is needed for shoulder bypass lanes. Pavement edge lines should be painted with a four (4) inch solid white line throughout the length of the approach and taper lanes.

Refer to Section 2.7.10 for information concerning road striping.

### **2.7.8 Auxiliary Lanes**

The width of an auxiliary lane should equal that of the through lanes. An auxiliary lane may be provided to comply with the concept of lane balance or to comply with capacity requirements in the case of adverse grades or to accommodate speed changes, weaving, and maneuvering of entering and leaving traffic. Where auxiliary lanes are provided along freeway main lanes, the adjacent shoulder would desirably be eight (8) to twelve (12) feet in width, with a minimum 6-ft-wide shoulder considered.

The Bureau of Engineering may require an auxiliary lane or lanes for any project when such a requirement would be deemed necessary to improve safety. Design of auxiliary lanes shall be in conformance to A.A.S.H.T.O.'s 1990 A Policy on Geometric Design of Highways and Streets.

### **2.7.9 Median Islands, Lanes and Openings**

Medians are normally not used except in the design of Arterial type roadways. The maximum width of medians, when allowed, shall not exceed 14' in width and shall have a cross slope of 1" per 1' starting at the mid-point of median and sloping towards the curb in both directions. Minimum widths shall be 4'.

Since median design is done on a special case basis, guidance on design will be given by the Bureau of Engineering on a case by case basis.

Median widths shall be as shown in Plate 41.

Plate 41 also shows the lengths of median openings as well as the radii to be used at the island ends. In addition, the plate also shows a 50' and a 75' radius to be designed tangent to the median edge and the cross road centerline.

Normally, a 50' radius is allowed if the traffic consists primarily of passenger and non commercial type vehicles.

If the traffic using the crossroad will also consist of a large number of trucks such as in commercial and industrial areas, a radius of 75' is preferred.

A semicircular end shall be used in all 4' and 6' wide medians. All other size medians shown in the table shall have a bullet nose shape.

The ends of median islands may be depressed to 2 inches above the pavement if approved by the Bureau of Engineering.

Turning lanes at medians should be a minimum 10' wide with 12' being the preferred width. Specifics for design should be as shown in A.A.S.H.T.O.'s A Policy on Geometric Design of Highways and Streets, 1990.

### **2.7.10 Road Striping**

Carroll County's Bureau of Highway Maintenance should be notified at least three (3) days in advance of any striping work.

The costs associated with painting of lane markings or re-markings of new and existing roadways because of road improvement requirements placed on a Developer shall be the responsibility of that Developer.

The work, however, shall normally be performed by the County's own crews.

**TABLE 2.10**

**INTERSECTION SPACING**

<u>Classification of Through Road</u>	<u>Minimum Spacing Between Intersecting Roadways (Centerline to Centerline)</u>
Principal Arterial	1 mile (Interchange)
Intermediate Arterial	
Divided	Median Crossover: 1600'
Undivided	750'
Minor Arterial	750'
Major Collector	500'
Minor Collector	275'
Local	275'
Subcollector	275'
Residential	275'
Loop Road	N/A
Cul-de-Sac	N/A

Costs will be determined by the Carroll County Bureau of Roads Operations prior to submission of any Public Works Agreement or posting of funds.

### **2.7.11 Handicap Ramps**

Handicap ramps shall be installed whenever sidewalks installation is required for the project. There may be other areas where ramps will be required to facilitate special conditions or when access areas for maintenance equipment are necessary. See Plate 15 for detail of construction.

### **2.7.12 Utility Locations**

Plates 57 and 58 show the normal location for installation of various utilities within the County's right-of-way.

Any deviations from the locations shown must be approved by the Bureau of Engineering and the Bureau of Roads Operations before any construction work can begin.

Utility installation plans must be submitted to the Bureau of Engineering for approval.

Any requests for the installation of utilities within existing county roads, either by tunneling or open cut method, must first be approved by the Bureau of Roads Operations by submitting an application.

Utility owners are directed to file for a permit with the Bureau of Roads Operations and should contact that Bureau for guidance in submitting the application.

### **2.7.13 Intersection Design and Spacing**

Table 2.10 shows the minimum distances allowed between intersecting roadways. Any deviation from these limits must be approved by the Director of Public Works or the Chief of the Bureau of Engineering.

Intersecting roads should meet at a 90 degree angle whenever possible, but in no case shall they meet at an angle less than 60 degrees.

Where the radius of the horizontal curve of a street approaching an intersection is less than or equal to three hundred (300) feet, a tangent at least fifty (50) feet long shall be placed between the flowline of the intersecting street and the P.C. of the curve.

#### **2.7.14 Right-of-Way at Intersections**

The right-of-way lines at intersections shall be adequate to accommodate all required design features. Unless otherwise permitted by the Bureau of Engineering, right-of-way at intersections shall be established by the truncation method.

The Bureau of Engineering's Review Division should be contacted for any questions concerning this item.

#### **2.7.15 Turning Radius**

Unless otherwise approved by the Bureau of Engineering, a minimum thirty foot (30') radius shall be used for all road fillets of intersecting streets. This applies to both curb section and open section roadways.

#### **2.7.16 Driveways**

Plates 8 thru 12 show layout for design and construction of both single and use-in-common driveways.

Requirements for the necessity of use-in-common driveways as well as general guidelines concerning widths, construction materials, in-fee strips, etc., are contained in Carroll County's Development Handbook which can be obtained from the Bureau of Development Review. Driveways, both single and use-in-common, shall be located so that safe corner sight distance can be obtained as shown in Table 2.02 and explained in Section 2.6.6.

Paved aprons shall be constructed to the limits shown on the plates and shall generally terminate at the right-of-way line. In the event the distance between the edge of road and the right-of-way line is less than 10 feet the apron shall be extended beyond the right-of-way line so that the 10 foot criterion is met.

#### **2.7.17 Street, Driveway and Stop Signs**

Plate 56 shows details for placement of street name, driveway name and stop signs. Costs for material and labor, unless otherwise determined by the Bureau of Engineering, shall be the responsibility of the Developer.

The Bureau of Roads Operations must approve all sign installations and the Developer is urged to contact that department for any particular questions or information.

**2.7.18 Dead-End Roads In Developments Other Than Multi-Family**

**A. Permanent**

Permanent dead end streets over 300 feet in length, as measured from the flow line of the primary street to the end of paving, must terminate in a circular turn-around. Permanent dead end streets less than 300 feet in length can be terminated by a "T" shaped turnaround.

The length of a permanent cul-de-sac shall be determined by the amount of ADT (Average Daily Traffic) generated by the lots fronting on the cul-de-sac; however, in no case shall 250 ADT be exceeded at any time without prior approval from the Bureau of Engineering. In addition, the maximum length of a permanent cul-de-sac shall not exceed 1500 feet.

**B. Temporary**

When a road is not initially constructed for its full planned length or when it stops adjacent to an adjoining property, the Bureau of Engineering may permit a temporary "T" Shaped turn-around providing the street does not exceed a length of 300 feet as measured from the flow line of the primary road to the end of paving of the "T" Turnaround. Also, temporary turnarounds of "T" construction or circular construction can be eliminated providing the length does not exceed 100 feet as measured from the flow line of the primary road to the end of paving. Any temporary road exceeding 300 feet in length must terminate via cul-de-sac construction. If the property adjacent to the portion currently being subdivided is owned by the same person or persons, the temporary cul-de-sac or "T" turnaround shall be constructed on that adjacent portion so as to eliminate future problems that often arise when removing existing paving in front of homes such as; conflicts with driveways, landscaping, drainage ditches, culverts, etc.

Criteria for temporary road construction is as follows:

0 feet to 100 feet - no turnaround required
101 feet to 300 feet - "T" turnaround required
301 feet and over - Circular turnaround required

**C.** All turn-arounds, including "T" turnarounds and cul-de-sacs, shall be constructed in accordance with Plates 28 thru 32 and shall be engineered and constructed using the same grading, base, and surfacing specifications as the roadway.

Carroll County Department of Public Works  
Bureau of Engineering

**NOTE: The “Checklist for Preliminary and Contract Drawings for New Roads and Improvements to Existing Roads” on pages 2-34 through 2-46 has been updated. Please refer to the Revisions link.**

## STANDARD PROCEDURE FOR FIELD CHANGES

### **1. Introduction**

A field change is a change to an approved set of construction drawings, which becomes necessary during the course of construction under the terms of a fully executed Public Works Agreement.

It can occur as a result of the Developer's wish to make slight alterations to construction, or when there is a discrepancy between the construction drawings and field conditions to such as extent that items cannot be constructed as designed.

A. When an Engineer or Developer proposes a field change, the following procedure applies:

- 1) Engineer is to submit blueprints to Engineering Review, marked in red, to show the proposed changes. Each specific item of change is to be numbered and a triangle containing the respective number placed where the change is shown in plan and profile.

The triangle shall be sized as shown here  . Each numbered item is to be completely described in a dated list on the title sheet. The dated list of changes is to appear in close proximity to the field approval block.

- 3) When the change is approved, Developer/Engineer is responsible for payment of reproduction costs, contact the Bureau of Development Review for the amount.
- 3) It is the Developer/Engineer's responsibility to communicate with any agency which may be affected by the field change and to obtain their approval prior to submission of the change package.
- 4) Upon approval by all concerned agencies, the Engineer is to submit revised mylars and three prints of all affected sheets. The revised drawings are to be clearly labeled, specifying exactly what changes have been made and the date of the changes. If the approved construction set included a title sheet, a new title sheet, specifying the field changes and the sheets affected, must be provided. In either case, the top sheet of the field change set must provide a signature block posted in a conspicuous location. The signature block shall read as follows:

**Revisions Approved for  
Field Changes dated: \_\_\_\_\_**

**Engineer is to fill in the date to correspond with the dated list required in Paragraph 1.**

- 5) The field change submittal is to be accompanied by a check made payable to the Commissioners of Carroll County, to cover the cost of printing.**
- 6) Mylars and fees for the field change set are to be submitted to the Bureau of Development Review for logging and signature circulations.**
- 7) The three sets of prints are to be submitted directly to Engineering Review. Engineering Review Division will initial and forward the three sets to the Bureau of Engineering for their use in inspection. One of the three copies is given to the contractor, one to the inspector and one is retained in the Bureau of Engineering files.**
- 8) The mylars, once signed, are printed by the Department of General Services and distributed to all agencies who received the original set.**

## RIGHT-OF-WAY STANDARDS

Carroll County Department of Public Works  
Bureau of Engineering  
Survey Division

1. Right-of-way Plats and Base Maps

A. Standard right-of-way plats will be prepared in accordance with the Department's standards, as follows:

- 1) The right-of-way plats will be prepared for the ultimate future road improvements on the same scale as used for the construction plan sheets for the project, utilizing the same base survey line as used on said plans, which will be a line actually run and established in the field, and not a theoretical or paper line. All right-of-way lines will be referenced to the aforesaid base survey line and all dimensions necessary to stake out or establish said right-of-way lines will be measured from or to said base survey line. Stations on the base line and dimensions to the new right-of-way line will be shown at all breaks in the base line, including all P.C.'s, and P.T.'s, and at all breaks or offsets in the new right-of-way lines.
- 2) The base survey line will be labeled as the "BASE LINE OF RIGHT-OF-WAY." The bearing of all tangents on this line will be shown, as well as all curve data (circular or spiral) relating thereto. The right-of-way line radii at all street and road intersections will be shown, as well as any other right-of-way radii, not concentric with the base line of right-of-way.
- 3) Each right-of-way plat will show a meridian arrow along with its origin in relation to the bearings shown on the plat.
- 4) At both ends of each plat, a direction arrow to the nearest town will be shown for orientation.
- 5) Each right-of-way plat will show all existing culture and topography, such as buildings, structures, property markers, pipes or monuments, fences, hedges, major trees and shrubbery, pavements, curbs, islands, walks, steps, entrances, and signs of any nature located within the right-of-way taking or in close proximity thereto, together with all road and street right-of-way or dedication lines, route numbers and names of streets.

- 6) Each right-of-way plat will show all existing utilities that are located above or below the ground (with identifying number and name of owners), such as poles, transmission towers, water, oil, electric, gas, sanitary or storm sewers, pipe lines or conduits, meters, fire hydrants, manholes, valves and all other appurtenances connected therewith.
- 7) Each right-of-way plat will show all existing rights-of-way and easements. The width of the existing right-of-way and easements must be shown along with a deed reference or recorded plat number where they are recorded.
- 8) Each plat will show the fee simple taking and all needed easement in accordance with samples and instructions provided by the County Surveyor.
- 9) The various legends -- Such as drainage, access control and title block information and right-of-way line designations, will be shown on all plats, in accordance with the samples and instructions provided by the County Surveyor.
- 10) All property lines must be shown on right-of-way plats, along with owners' name, deed reference number and parcel number. All adjoining property owners should also be listed. This information must be accurate as of the date of the plat.
- 11) Bearings and distances on property lines, centerlines, and baselines must be shown, and at least two grid tick marks should be shown on the plat.
- 12) The entire outlines of all recorded subdivisions lots affected by, which lie adjacent to, or abut the new right-of-way line, will be shown on the right-of-way plats, with the appropriate subdivision name, lot, and block numbers.
- 13) Right-of-way plats are to be continuous without any overlapping of taking on adjoining plats, and when match marks are required, they will be shown in accordance with instructions furnished by the County Surveyor.
- 14) A metes and bounds plat is required and must be signed and stamped by a Professional Land Surveyor, or Property Line Surveyor registered in the State of Maryland.

- 15) **The original mylars and second original mylars (one of which will be retained by the County) must be submitted to the County Surveyor for his signature and approval.**

## DEFINITIONS

### Right-of-Way:

A strip of land to be acquired by the County for roadway, utilities or other public use.

### Existing Right-of-Way:

An existing strip of ground for a roadway, utility or other use which is owned by or has been dedicated to the County, State or Local jurisdiction.

### Slope Easements:

These easements cover the laying back of side slopes in cut conditions or constructing the side slopes in fill conditions.

### Construction Easement or Right for Special Purpose as Indicated by Notation on This Plat

This easement covers construction beyond the limits of the right-of-way and the slope easement. Items which may be covered under this easement may include sediment control devices, scarifying existing pavement, driveway construction, adjustments, tie-ins, day lighting of slopes and other.

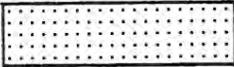
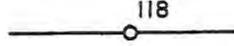
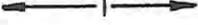
### Perpetual Easements for Special Purposes, as Indicated by Notation on This Plat:

A special easement or right of a permanent nature to be used for other than a drainage facility.

### Perpetual Easement for Drainage Facility, as Indicated by Notation on This Plat:

This easement is of a permanent nature used for construction of and future maintenance of all drainage facilities, such as pipes, culverts, bridges, ditches, swales, etc. The easement extends from the right-of-way line to the required limits.

**LEGEND**

<b>Proposed Right-of-Way</b> _____	
<b>Existing Right-of-Way</b> _____	
<b>Slope Easement</b> _____	
<b>Construction Easement or Right for Special Purpose, as Indicated by Notation on This Plat</b> _____	
<b>Perpetual Easement for Special Purpose, as Indicated by Notation on This Plat</b> _____	
<b>Perpetual Easement for Drainage Facility, as Indicated by Notation on This Plat</b> _____	
<b>Property Line</b> _____	
<b>Right-of-Way Line</b> _____	
<b>Centerline or Baseline</b> _____	
<b>Pipe Culvert</b> _____	
<b>Discharge Flow of Water Into Existing Waterway or Natural Drainage Course</b> _____	
<b>Discharge Flow of Water Upon Existing Ground</b> _____	
<b>Approximate General Drainage Flow Pattern</b> _____	
<b>Fence Line</b> _____	

**Property Corners**

<b>A Corner, not found or set</b>	
<b>A Pipe, Pin and Cap, or Rebar, found or set</b>	 Rebar Found
<b>A Monument, found or set</b>	 Monument Found
<b>A Stone, found</b>	 Stone Found
<b>A Tree, found</b>	 24" Oak Fnd.



## **CHAPTER 3**

# **CAPITAL PROJECTS**

**NOTE:** Since the adoption of the 1994 Manual, there have been various design and procedural revisions. Many of the revisions are included under the Revisions link. Engineers and surveyors are encouraged to call the Bureau of Engineering to obtain the latest design criteria and procedures.



## CHAPTER 3: CAPITAL PROJECTS

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## **CHAPTER 3: CAPITAL PROJECTS**

### **3.1 General**

The Department of Public Works has the responsibility for Capital Projects involving road and storm drain construction.

All administrative matters, technical reviews and coordination of the Contract documents and general liaison will be handled through the appropriate divisions of the Department of Public Works. Current information pertaining to the requirements for project reviews, the number of copies required for review submissions, standards, format, documentation, etc. shall be obtained from the Department of Public Works, Bureau of Engineering.

The intent is to prescribe a complete work or improvement which the Contractor undertakes to do in full compliance with the Plans, Specifications, Proposal, and Contract, together with any Special Provisions, authorized alterations, and supplemental agreements. The Contractor shall perform all items of work covered and stipulated in the Specifications, Proposal and Contract, together with any Special Provisions, authorized alterations, extra work and supplemental agreements, all in accordance with the lines, grades, cross sections and dimensions shown on the plans. The Contractor shall furnish, unless otherwise provided in these Specifications and Special Provisions, all materials, implements, machinery, equipment, tools, supplies, transportation and labor necessary to the prosecution and completion of the work.

The following agencies may review the construction Contract documents for road projects, depending on the location, funding program and characteristics of the project:

- Department of Public Works (various divisions)
- Carroll Soil Conservation District
- Office of Environmental Services
- Maryland Department of Transportation, State Highway Administration (SHA) (for construction with SHA right-of-way or State and Federally funded projects)
- Maryland Department of Natural Resources
- Maryland Department of the Environment
- Federal Highway Administration (FHWA) in Federally funded projects
- Federal Environmental Protection Agency (EPA) in Federally funded projects.

- Maryland State Department of Health and Mental Hygiene
- U.S. Army Corps of Engineers

## **3.2 Phase I - Preliminary Engineering Report**

### **3.2.1 Purpose of Report**

All capital improvement projects which will involve any significant expenditure of construction funds will require the preparation of a preliminary engineering report. The purpose of the report is to consider the feasibility of the various alternatives for solving a given problem and establishing the basis for selecting the most feasible solution to the problem and the recommended course of action to effect the solution.

### **3.2.2 Content of Report**

Engineering reports vary in their complexity and subject matter based on the type and the particular circumstances of the project being studied. However, all reports shall contain at least the following information:

- Purpose and scope of the study performed
- Description of existing conditions and problems and project history in general
- Establishment of appropriate design criteria on which the study is based
- Description of all feasible alternatives studied
- Comparison of alternatives including cost estimates (construction, right-of-way, utility relocation, etc.), environmental effects, design characteristics, serviceability, disruption of existing traffic and utilities during construction and other pertinent features.
- Conclusions
- Recommendations
- Appropriate exhibits such as vicinity and location maps, sketch plan layout of the alternative design, profiles, typical sections or details and tables shall be included to support and depict the written material in the report.

### **3.2.3 Submission for Review**

All reports shall be type written and reproduced on 8-1/2 inch by 11 inch pages and bound in a booklet with a suitable cover.

Maps, plans, profiles, tables, etc. shall be either 8-1/2 inch by 11 inch or folded to that size for binding in the report booklet unless otherwise approved by the Department of Public Works.

Copies of the preliminary draft of the report shall be submitted to the Department of Public Works for review.

After incorporating any modifications or revisions made during the review, the final report shall be signed by a Professional Engineer and submitted to the Department of Public Works.

### **3.2.4 Public Meetings**

The Department of Public Works shall schedule all public meetings concerning proposed projects and will coordinate the preparation of exhibits, scripts and brochures and conduct the public meeting presentation. The Engineer shall assist in the preparation of the public meeting information and the presentation as requested by the Department of Public Works.

### **3.3 Phase 2 Field Surveys, Preliminary Construction Plans and Estimate of Construction Cost**

Upon approval of the Preliminary Engineering Report and the receipt of a Notice to Proceed with Phase 2 Activities, the Engineer shall proceed with the field surveys and plotting of topography and cross sections as required for preparation of preliminary construction plans. Field surveys shall be in accordance with Chapter 3.6 herein. The plans shall be developed to the 30% stage at this time and shall be prepared as concept plans on a graphical basis to scale and shall clearly set forth the preliminary design details proposed for the project. The intent of the 30% plans is to establish a basis for approval of the design details which will be included in the final plans for the project.

A definitive preliminary estimate of quantities and construction cost shall be submitted with the Preliminary Construction Plans.

If requested, the field survey notes and the plotted topography, cross sections and profiles shall be submitted to the Department of Public Works for review at this stage.

Preliminary design computations shall be submitted with the Preliminary Construction plans, if requested by the Department of Public Works.

### **3.4 Phase 3 - Final Plans, Specifications, Bidding**

Upon approval of the preliminary plans and the receipt of a Notice to Proceed with Phase 3, the Engineer shall prepare final plans, bidding documents and final right-of-way plats based on the approved design concepts established in Phase 2. The intent of the final plans and bidding documents is to present clearly the construction details of the proposed work which is to be performed in a manner that will allow efficient construction procedures and the taking of competitive bids for the work in accordance with the County's standard bidding procedures. The intent of the right-of-way plat preparation is to establish the limits of the areas of fee taking and easements which are required for the construction of the project. A definitive construction cost estimate shall be prepared based on the actual quantities of each item of work required in the Bid Proposal.

In order that right-of-way acquisition procedures may proceed concurrent to the preparation of the final design plans, the plats shall be completed at the earliest possible time that the construction requirements can be determined. Usually this is possible by the 70%-80% stage of construction plan preparation. Right-of-way plats shall be prepared in accordance with the Right-of-Way Standards included at the end of Chapter 2.7 of this manual. Any final right-of-way plats shall be submitted at the 75% completion plan for review.

The draft of the final plans, specifications and bidding documents shall be submitted to the Department of Public Works for review when they are completed to the 95% stage. After approval, final modifications requested by the Department of Public Works shall be made and the originals of all final documents shall be prepared ready for the reproduction of copies as requested for the Contract bidding process.

Final design computations for the project shall be neatly and clearly prepared and bound in booklet form suitable for filing. If requested by the Department of Public Works, copies of the final design computations shall be submitted for review and inclusion in the County's record files.

If requested, the Engineer shall attend Pre-Bidding Conferences.

Phase 3 ends with the taking of Contract bids for the project.

### **3.5 Phase 4 - Post Award Activities**

The following activities are included in Phase 4 and may be performed "in-house"

by the Department of Public Works or by the Engineer assigned to the project, as directed by the Department of Public Works:

- Pre-construction conferences
- Resident supervision of construction
- General supervision of construction
- Construction stakeout
- Review of shop drawings
- Monthly estimate for payment
- Preparation of as-built drawings

### **3.6 Surveys for Capital Projects**

#### **3.6.1 General Requirements**

All field surveys performed for Capital Projects in Carroll County shall be done in accordance with Carroll County Manual titled, "Survey Procedures Manual".

#### **3.6.2 Survey Notes**

##### **A. Survey Books**

Unless otherwise approved for a specific project, survey books shall be standard, bound hard cover field books made of 50% high grade rag stock with a water resisting surface sizing.

##### **B. Organization of Notes**

Field notes shall be placed in the survey book or books in an organized manner with notes for the control surveys, Bench Mark leveling, profiles, topography, cross sections and property surveys kept separately.

If the size of the project warrants, separate field books shall be used for each element or group of elements of the survey. The first half page of each book shall be used as a title page and the next two pages shall be kept for an index with the remaining pages numbered with one number assigned to each two facing pages. The index shall be complete and up to date and shall reflect the stations or areas of work and a description of notes contained on subject pages.

### **C. Legibility**

Field notes shall be recorded in the field book at the time the work is being done, using a well pointed 4H or 3H pencil. Sketches shall be used for clarification and crowding of data shall be avoided. In general, tabulated numerical values shall be written on the left hand page and sketches and notes shall be written on the right hand page. Numerical data shall not be erased. Erroneous data shall be lined out and correct data entered above.

#### **3.6.3 Survey Baseline**

The survey baseline may be established as a preliminary traverseline for the purpose of obtaining preliminary information or as a baseline of construction if its location can be determined in advance of the survey (say by the use of photogrammetry or an actual field selection). In any event, the baseline of survey shall run generally parallel to the proposed work. Angle points in the baseline shall be marked by cross cuts in concrete, except bridge decks, spikes in pavement or iron rods in earth. Base control points shall be spaced not more than 1000 feet apart and shall be accurately referenced to nearby prominent objects by recorded swing ties. Usually the survey baseline will be part of the traverse control network, but in any event, it shall be tied into the control traverse.

Spur lines shall be run on all intersecting roads, railroads, streams and natural drainage courses and shall be tied into the main baseline.

After the baseline control point have been accurately set, the baseline shall be stationed at fifty (50) foot intervals or as directed by the Engineer in the field. In general, stationing of baseline shall increase from south to north and from west to east.

The survey baseline shall extend for the full length of the project and approximately two hundred (200) feet beyond the anticipated limit of work.

All property corners shall be set in accordance with Section 8 of the Carroll County Survey Procedures Manual.

#### **3.6.4 Stakes, Hubs and Monuments**

Hubs shall be 2 inch x 2 inch hardwood, at least nine (9) inches in length, with points marked in the top by standard survey tacks.

Stakes shall be 1 inch x 2 inch hardwood, at least twenty-four (24) inches in length.

Monuments shall be set flush with the ground and shall be made of concrete with a four (4) inch square top with center cross and a six (6) inch square bottom. They shall be three (3) feet long and strengthened by a 3/8 inch diameter steel reinforcing rod at least thirty (30) inches long placed in the center of the concrete and unbroken.

### **3.6.5 Control Stations to be Disturbed by Proposed Construction**

All control stations of Carroll County, U.S.C & G.S., State of Maryland and other agencies falling within the limits of a proposed project shall be accurately located and plotted on the topographic map prepared for the project area. If it is determined that a control station monument will be disturbed by the proposed work, the County Surveyor shall be notified in writing of the proposed action and arrangement shall be made for the relocation of the monument. The monument shall be noted on the Contract plans along with appropriate advisement concerning its disposition and protection during construction.

### **3.6.6 Plotting of Survey Notes**

#### **A. Profiles**

Profiles shall be plotted on a continuous roll at a minimum scale of 1" = 50' horizontal to 1" = 5' vertical unless otherwise directed by the Department of Public Works. See Checklist on Page 2-45 of this manual for method of showing information.

#### **B. Cross Sections**

Cross sections shall be plotted on standard cross section sheets at a scale of 1" = 10' horizontal to 1" = 10' vertical or as directed by the department of Public Works

#### **C. Submission of Plotted Survey Data**

Upon completion of the project, all survey field books, computation, and other pertinent information shall be submitted to and become the property of the Department of Public Works.

### **3.6.7 Survey for Subdivisions and Site Development Projects**

Field surveys for subdivision and site development projects shall be performed in accordance with the Carroll County Manual titled " Survey Procedures Manual".

### **3.7 Conditions Applicable to Capital Projects**

#### **3.7.1 Qualification of Bidders**

The Director will require the Bidder to present satisfactory evidence that he or she is fully prepared with the necessary capital, materials, machinery and skilled workpersons to carry out the Contract. This evidence must be on forms furnished by the Administrator and must be received by the Administrator prior to the date of opening bids.

Prior to the Award of Contract, the successful Bidder may be required to complete forms entitled "Experience and Equipment Certification." Failure by Bidder to promptly complete these forms may result in rejection of his or her bid. In addition, a form entitled "Bid Letter" will be included in all Contracts, and this form must be completed and submitted with all bids.

#### **3.7.2 Contents of Proposal Forms**

The Bureau of Engineering will furnish the Bidders Proposal Forms which will state the location and description of the improvement and its appurtenances to be constructed; approximate estimates for the various quantities of work to be performed and materials to be furnished, and, if any, the number of working or calendar days to complete the work; the date, place, and time of opening of Proposals; the amount of Proposal Guaranty which must accompany the Proposal, and Special Provisions, if any. All papers bound with or attached to the Proposal Forms shall be considered a part thereof and must not be detached or altered.

#### **3.7.3 Preparation of Proposals**

Proposals must be made on the blank form provided by the Bureau of Engineering. The blank spaces in the Proposal, except as otherwise noted, must be filled in, and no change shall be made either in the phraseology of, or in the items mentioned in the Proposal form.

Proposals must be signed in ink by the Bidder with the signature in full. When a firm is a Bidder, the agent who signs the firm name to the Proposal shall state, in addition, the names and addresses of the individuals composing the firm. When a Corporation is a Bidder, the person signing shall state under the laws of what State the Corporation was chartered and the names and title of the officer having authority under the by-laws to sign Contracts. The Proposal shall also bear the seal of the Corporation, attested by its secretary. Any one signing the Proposal as agent must file with it legal evidence of his or her authority to do so. Post Office address, County and State, must be given after the signature.

Each Proposal shall specify a unit price, written with ink in both words and figures, for each of the separate items as called for. In case of discrepancy between the written words and the figures, the written words shall govern.

#### **3.7.4 Public Opening of Bids**

Bids will be opened publicly and read at the hour and on the date set in the "Notice to Contractors" in the Office of the County Commissioners of Carroll County, Room 300, Westminster, Maryland 21157.

#### **3.7.5 Consideration of Proposals**

After the Proposals have been publicly opened and read, the bid prices will be compared by the Department of Public Works and the results of such comparisons will be available to the public. The right is reserved by the County to reject any or all bids; to advertise for new Proposals, to proceed to do the work otherwise, or to abandon the work, if in the judgement of the County the best interest of the County will be promoted thereby. No bids may be withdrawn for period of sixty (60) days after the opening of Proposals. Award of a Contract after sixty (60) days will be made only with the Contractor's concurrence.

#### **3.7.6 Obtaining Specifications, Drawings, Etc.**

The proposed Contract documents may be examined without charge, at the Carroll County Department of Public Works, Bureau of Engineering and necessary copies thereof may be obtained on payment of the amount specified for each copy.

#### **3.7.7 Examination of Site and Data**

Before submitting Proposals, prospective Bidders should carefully examine the Proposed Contract Documents, inspect the site of the proposed project, acquaint themselves with all governing laws, ordinances, etc., and otherwise thoroughly familiarize themselves with all matters which may affect the performance of the work. The act of submitting a Proposal shall be considered as meaning that the Bidder has so familiarized himself or herself and, therefore, no concession will be granted by the County because of any claim of misunderstanding or lack of information. Bidders are expected to read and study the drawings and specification with special care and to observe all their requirements. Discrepancies, ambiguities, errors, or omissions noted by Bidders should be reported promptly to the Engineer for correction or interpretation before the date of the opening of bids.

### **3.7.8 Special Provisions**

In all cases the Special Provisions shall be considered a part of the Contract Documents. In case of conflict between the Special Provisions and any other provision or provisions of the Contract documents, the Special Provisions shall govern.

### **3.7.9 Approximate Quantities**

The Bidders attention is called to the fact that the quantities given are estimate quantities and are intended as a guide to the Bidder, but in no way bind or limit the County to the actual amount of work to be performed or the quantity of material to be furnished. Any estimates of quantities herein furnished by the Engineer are approximate only, have been used by the Engineer as a basis for estimating the cost of work, and will also be used for the purpose of tabulating and comparing the bids and awarding the Contract. The Engineer has endeavored to estimate these quantities correctly according to his or her knowledge and the information as shown on the plans; but it is not guaranteed that these estimated quantities are accurate and if the Contractor, in making up and/or submitting his or her bid or bids relies upon the accuracy of said estimated quantities he or she does so at his or her own risk.

### **3.7.10 Contents of Proposal Forms**

The County will furnish the Bidder with Proposal Forms, which will state the general location and description of the work to be done, and which will also show the approximate estimate of the various quantities of work to be performed and materials to be furnished. All papers bound with or attached to the Proposal Forms are a necessary part thereof and shall not be detached. Proposals made on any other than the Proposal Form contained in the Contract documents will not be considered. Changes in phraseology of the Proposal, additions, or limiting provisions, will render the Proposal informal and may be cause for its rejection.

### **3.7.11 Preparation of Bids**

Bids shall be submitted on the Proposal Form furnished by the Engineer. Each Bidder must make his or her own estimate of the quantities of materials and amount of work involved and of the facilities and difficulties attending the performance of the proposed Contract, including local conditions, uncertainty of the weather, and all other contingencies. All designations, and prices shall be clearly set forth in words and numerals for each item and written in ink; in case of discrepancy the words shall govern.

### **3.7.12 Proposal Guaranty**

- A. No bid will be considered for any Contract in excess of twenty-five thousand dollars (\$25,000) unless accompanied by a Guaranty in an amount not less than five (5) percent of the amount bid, and made payable to the County.**
- B. Acceptable security for bids shall be as follows:**
  - (1) A bond in a form satisfactory to the County underwritten by a company licensed to issue bonds in this state;**
  - (2) A bank certified check, bank cashier's check, bank treasurer's check, or cash; or**
  - (3) Pledge of securities backed by the full faith and credit of the United State Government or bonds issued by the County.**

The Proposal Guaranty of the Bidder to whom the Contract is awarded will be forfeited to the said County Government as liquidated damages in case the Contract and Bond are not executed within ten (10) days after receiving Award of the Contract in writing. Proposal Guaranties of unsuccessful Bidders will be returned within three (3) days after the Contract has been signed and satisfactory Surety Bonds provided.

### **3.7.13 Signatures of Bids**

Each bid must given the full business address of the Bidder and be signed by him or her with his or her usual signature. The full name of all partners must be given to bids by partnerships and the bid must be signed with the partnership name by one of the partners or by an authorized representative. All un-incorporated entities must submit social security number of all involve individuals. Bids by Corporations must be signed with the legal name of the Corporation, followed by the name of the State of incorporation and by the signature and designation of the president, secretary, or other authorized persons, the corporate seal shall be affixed. The name of each person signing shall be typed or printed below the signature. When requested, satisfactory evidence of the authority of the officer signing in behalf of a Partnership or Corporation shall be furnished.

### **3.7.14 Withdrawal of Bids**

Bids may be withdrawn only on written request received from Bidders prior to the time set for opening.

**3.7.15 Opening of Bids**

Bidders may attend or be represented at the opening of bids.

**3.7.16 Changes in Costs**

Changes in costs of labor, materials, or equipment, whether the result of regulatory action by the Government or otherwise, will not be considered a basis for any change and/or adjustment in Contract price.

**3.7.17 Labor and Material not to be Furnished by the County**

The County will not furnish any labor, material, or supplies unless specifically provided for in the Contract.

**3.7.18 Laws to be Observed**

The Contractor is presumed to be familiar with all laws, ordinances, and regulations which may in any manner affect the equipment or materials used in the proposed construction, and those persons engaged on the work, or the conduct of the work, and shall save the County and its representatives harmless against any claim arising from violation thereof.

**3.7.19 Permits and Licenses**

The Contractor shall procure all permits and licenses, pay all charges and fees, and give all notices necessary and incident to the due and lawful prosecution of the work.

**3.7.20 Non-Discrimination in Employment**

In connection with the performance of work under all County Contracts, the Contractor agrees that he or she shall not discriminate in employment because of religion, race, color, or national origin.

**3.7.21 O.S.H.A. Requirements**

The Contractor is advised that all equipment, machinery, and work shall conform to all requirements of the Occupational Safety and Health Act of 1970 and amendments thereto, as well as all Occupational Safety regulations promulgated by the Maryland

Division of Labor and Industry pursuant to Article 89, Annotated Code of Maryland.

### **3.7.22 Award of Contract**

The County may reject any or/all bids for such reason as it may deem proper. In acceptance of bids, the County will be guided by consideration of the interest of the public and the County shall be under no obligation to accept the lowest bid. Proposals may be rejected if they show any omissions, alternate bids, or irregularities of any kind. To insure fair competition, and to permit a determination of the lowest Bidder, unresponsive bids or bids obviously unbalanced may be rejected. The County also reserves the right to negotiate further with one or more of the Bidders as to any features of their bids and to accept modifications of the work and bid price when such action will be to the best interest of the County and is desirable. A Letter of Intent or Notice of Award will be issued promptly after the choice of a Contractor and the Contract documents executed within ten (10) days of date of receipt of such notice.

### **3.7.23 Interpretation of Plans**

On all plans the figured dimensions shall govern in case of discrepancy between the scales and figures. The Contractor shall not take advantage of any error or omission in the plans or of any discrepancy between the plans and specifications, and the Engineer shall make such corrections and interpretations as may be deemed necessary for the fulfillment of the intent of the specifications and of the plans as construed by him or her. In all cases of doubt as to the true meaning of the drawings and/or specifications, the decision of the Engineer will be final and conclusive. If the Contractor in the course of the work, discovers any discrepancies between the drawings and the conditions of the ground, or any errors or omissions in the drawings, or in the layout given by stakes, points, or instructions, it shall be his or her duty to inform the Engineer immediately in writing and the Engineer shall promptly verify the same. Any work done after such discovery, until authorized, will be done at the Contractor's risk.

### **3.7.24 Drawings**

Drawings show the intent, extent, and class of work included under the Contract. Any deviation from the drawings must be approved by the Engineer in writing. The Contractor is required to furnish working drawings such as shop, erection, and bending diagrams for re-enforcing steel and where necessary he or she shall furnish plans for cribs, falsework and formwork, the costs of which shall be included in the costs of the work to be done and shall not be paid for separately. Any drawings submitted by the Contractor shall be in triplicate and shall be approved by the Engineer prior to the starting of the respective work. Approval of Contractors working drawings or details shall be expressly understood

to relate only to the requirements for strength and detail and such approval will not relieve the Contractor of responsibility for errors in dimensions.

### **3.7.25 Authority of County**

The County shall decide all questions as to the quality and acceptability of material furnished and work performed as to the manner of performance and rate of progress of the work; he or she shall decide all questions as to the interpretation of the drawings and specifications and as to the acceptable fulfillment of the terms of the Contract. The decision shall be final and the County shall have authority to enforce and make effective such decisions and orders which the Contractor fails to carry out promptly.

### **3.7.26 Inspection**

The Engineer will appoint such persons as may be deemed necessary to properly inspect the materials furnished or to be furnished, and the work done under this Contract, and to see that the same strictly corresponds with the drawings and specifications; such materials and workmanship shall be always subject to the approval of the Engineer, but no inspection, approval or acceptance at any part of the work herein contracted for, or of the materials used therein or any payment on account thereof, shall prevent the rejection of said work or materials found to be defective, or not in accordance with the requirements of the Contract. Work and materials will be inspected promptly, but if, for any reason, delay should occur, the Contractor shall have thereby no claim for damages or extra compensation.

### **3.7.27 Contract Information**

All information concerning the actual terms and requirements will be contained in the Contract. Items such as bonding, liquidated damages, process and materials, subletting of Contract, completion times, and other specific information pertinent to the requirements of the Contract will be specifically outlined for each particular project. The Bidder should contact the Bureau of Engineering at 857-2173 for any information regarding the submission of Contracts for road and storm drain work under the County's capital improvement program.

## **CHAPTER 4**

# **CARROLL COUNTY FUNCTIONAL CLASSIFICATION CRITERIA AND ASSIGNMENT**

**NOTE: Chapter 4 has been updated in its' entirety. Please refer to the Revisions link.**

## **CHAPTER 5**

# **TRAFFIC IMPACT STUDY GUIDELINES**

**NOTE:** Since the adoption of the 1994 Manual, there have been various design and procedural revisions. Many of the revisions are included under the Revisions link. Engineers and surveyors are encouraged to call the Bureau of Engineering to obtain the latest design criteria and procedures.



## CHAPTER 5: TRAFFIC IMPACT STUDY GUIDELINES

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## **CHAPTER 5: TRAFFIC IMPACT STUDY GUIDELINES**

### **5.1 Introduction**

In accordance with Article 66B of the Annotated Code of Maryland, the Carroll County Planning Commission and municipal planning commissions may consider the adequacy of adjoining public facilities in the subdivision and site plan approval process. These guidelines are intended to provide the planning commissions located within Carroll County the information necessary to make informed decisions regarding planned development impacts to traffic on Carroll County's roads.

By adopting these guidelines the Carroll County Commissioners seek to insure that:

- a) Traffic Impact Study requirements are administered equitably,
- b) Traffic Impact Studies are uniform and reviewed in a timely and efficient manner, and
- c) All decisions regarding traffic impacts due to development are based upon empirical study.

The Carroll County Departments of Planning and Public Works review all proposed development plans for traffic impacts. These agencies are considered staff to the Carroll County Planning Commission and to those municipal planning commissions that request their assistance. The Carroll County Planning Commission and those municipal planning commissions that request staff assistance have the ultimate responsibility for resolving questions concerning traffic impact studies.

To facilitate the determination of adequacy of adjoining public transportation facilities these agencies may require that a Traffic Impact Study be performed for any residential, commercial, industrial or institutional subdivision. The Maryland State Highway Administration and the incorporated municipalities of Carroll County may or may not require a Traffic Impact Study depending on their particular criteria.

It is recommended that before anyone performs a Traffic Impact Study in Carroll County and/or the incorporated municipalities therein, that they request a multi-agency meeting in a pre-study conference to address the traffic concerns of each agency and/or jurisdiction. These guidelines are intended to define study limits and analysis procedures acceptable to Carroll County. The need for additional analyses will be determined at the pre-study conference or by the mitigation plan (see Sections 5.1.18 and 5.1.19).

These guidelines are intended to provide structure for the pre-study conference, where study requirements will be determined on a case by case basis. If the Traffic Impact Study submitted does not adhere to the established guidelines, a revised study, shall be

required based on suggestions by County transportation officials and shall be prepared by the applicant for submission.

All Traffic Impact Studies shall conform to sound engineering principles and are subject to review and approval by the Carroll County Departments of General Services, Planning and Public Works. Three copies of the study shall be sent to the Bureau of Development Review who will, upon receipt, distribute one copy each to the Departments of Planning and Public Works. When other jurisdictions are within the study area, additional copies of the study may be required by the municipality (see item 5.1.3) and/or Maryland State Highway Administration (see item 5.1.4).

All methods used for analysis other than those mentioned in this guideline must be explained, (include references), and their limitations described in an appendix to the Traffic Impact Study.

#### **5.1.1 When is Traffic Impact Study Needed?**

A Traffic Impact Study may be required during the pre-study conference according to either of the following:

- a) Any proposed development, or petitioned rezoning, that will generate 25 to 50 peak hour trips (see appendix IV for examples), and is located within a community planning area, or
- b) Proposed developments in the vicinity of areas previously identified as having levels of service "E" or "F", hazardous locations or other adequacy concerns (as determined by State, County, or Town agencies).

A Traffic Impact Study shall be required for any proposed development that will generate 50 or more peak hour trips.

A Traffic Impact Study shall not be required of any proposed development that will generate less than 25 peak hour trips.

#### **5.1.2 When in the Land Planning and Development Process Shall Such a Study be Required, Performed and/or Updated?**

A pre-study conference will address the need for and scope of the proposed study, (to be held after pre-application conference with the Bureau of Development Review). The pre-study conference shall provide a means to discuss the traffic concerns expressed by the developer, reviewing agencies and jurisdictions responsible for traffic operations in the

vicinity of the proposed project site.

The Traffic Impact Study shall be performed and completed before the first Subdivision Advisory Committee meeting for both site plans and preliminary plans.

In those instances where a subdivision project has been approved by the Carroll County Planning Commission and that project has not been completed, (as depicted in the Traffic Impact Study) or been recorded six (6) years after the date of approval, an updated traffic study may be required.

In those instances where a site plan project has been approved by the Carroll County Planning Commission and that project has not been completed 18 months after the date of approval, an updated Traffic Impact Study may be required.

**5.1.3 When Performing a Traffic Impact Study in an Incorporated Municipality of Carroll County, What Considerations Must be Given to that Municipality?**

Incorporated municipality planning commissions have the authority to approve or disapprove proposed developments within their jurisdictions. The Carroll County Department of Planning recommends that the pre-study conference for proposed developments within an incorporated municipality include a representative from that town who is familiar with traffic issues concerning the town (see Appendix III for Planning Commission meeting times, locations and phone numbers for each municipality's contact person).

Agencies of the Carroll County Government may be requested by the municipality to review Traffic Impact Studies required by that municipality. When reviewing a Traffic Impact Study in this capacity, agencies of the Carroll County Government are to be considered as staff subordinate to the town planning commissions.

**5.1.4 When Performing a Traffic Impact Study that will Have in its Study Area a Roadway Under the Jurisdiction of the Maryland State Highway Administration, What Considerations Must be Given to the Maryland State Highway Administration?**

To eliminate any duplication of study requirements, arrangements will be made by the County to have a representative from the Engineering Access Permits Division of the Maryland State Highway Administration present at the pre-study conference. This representative will indicate State Highway Administration requirements for a Traffic Impact Study. Carroll County (District 7) representative's telephone number is (410) 333-1350.

**5.1.5 What Areas of Investigation will Generally be Included in a Traffic Impact Study? (The exact parameters will be defined at the pre-study conference.)**

- a) A determination of existing traffic conditions by securing actual traffic counts in the study area.
- b) A determination of projected traffic flows, exclusive of the site being studied, defined as "background traffic".
- c) A determination of projected traffic flows when site traffic is added, defined as "total traffic".
- d) A discussion of mitigation measures (if such measures are required).

**5.1.6 How shall existing traffic be determined?**

- a) From data collected by other persons or agencies within the defined study area which is no more than two (2) years old at the time of the pre-study conference.
- b) From traffic counts undertaken by the applicant based on the specifications established at the pre-study conference.

**5.1.7 What Study Area Shall be Evaluated?**

As a minimum standard, the study area shall include each intersection with an arterial highway which can be considered as a logical travel path between the site and the arterial highway network. Arterial highways are so designated by the Carroll County Functional Classification and Criteria (See Chapter 4 of this manual).

Additional intersections between the site and the arterial intersection(s) as well as those intersections that are rationally identified as being impacted by a development shall be included in the study area.

**5.1.8 What Design Hours Shall be Analyzed?**

The design hour shall be determined by:

- a) The period for the proposed development which will generate/attract the highest traffic volumes, and/or

- b) The period of highest traffic volumes on the traffic facilities within the study area.

**5.1.9 What shall be the Forecast Year?**

The forecast year shall be determined at the pre-study conference according to some or all of following criteria:

- a) A scheduled phase or the completion of the project (for this and other projects),
- b) Community Planning Area Comprehensive Plan,
- c) State, County, or Municipal capital improvement program schedule,
- d) Major transportation system changes.

**5.1.10 What Technical Procedures and Guidelines Shall be Used?**

Roadways shall be analyzed using the appropriate analysis method as depicted in the Highway Capacity Manual, Transportation Research Board, 1985.

All intersections shall be analyzed using the Critical Lane Summation (Critical Lane Analysis) technique (per McInerney/Petersen article, Appendix II). The following specific treatments (per the Maryland State Highway Administration) shall be applied to this method:

The following lane use factors (LUF) will be used:

Table 1

NUMBER OF APPROACH LANES	LANE USE FACTOR
1	1.00
2	0.55
3	0.40
≥4	0.30
double left-turn	0.60

The following Level of Service (LOS) criteria shall be used:

Table 2

CRITICAL LANE VOLUME	LOS GRADES
≤ 1000	A
1001-1150	B
1151-1300	C
1301-1450	D
1451-1600	E
≥ 1601	F

Additional analyses may or may not be required depending on the traffic concerns expressed at the pre-study conference.

**5.1.11 What is the Minimum Standard for Traffic Operations in Carroll County?**

Level of service "D" is the lowest level of service that shall be considered adequate for intersections and roadways in Carroll County.

**5.1.12 How Shall Background Traffic be Determined?**

Background traffic on roads in the study area shall be determined by functional classification, (as per the Carroll County Functional Classification and Criteria document):

- a) By historic and/or projected traffic increase rates on roads classified as being arterial or major collectors, and
- b) By developments/trips that have been approved (recorded) on roads classified as minor collectors or local roads.

ADT information is available at the Carroll County Department of Planning, 876-6547. Development activity information is available at the Carroll County Bureau of Development Review, 857-2674.

**5.1.13 How Shall Trip Generation, Distribution and Assignment be Determined?**

Trip generation shall be determined:

- a) By using the latest edition of the Trip Generation Manual, Institute of Transportation Engineers, (cite land use code and page number), or
- b) By using documented local trip generation rates, (as determined through previous or current studies).

Trip distribution shall be determined by using any of the following:

- a) Gravity model,
- b) Trip assignment of the County's traffic demand forecasting model,
- c) Utilization of demographic data leading to trip purpose and trip tables,
- d) Current directional distribution only if no future changes to land use and improvements to transportation facilities are expected until the design year.

Trips shall be assigned to the study area network during the study's design hour.

**5.1.14 How Shall Pass-by Trips be Determined in Carroll County?**

Pass-by trips shall be determined by using either of the following:

- a) The Institute of Transportation Engineers pass-by trip rates, or
- b) Documented local pass-by trip rates, (as determined through previous or current studies).

**5.1.15 How Shall Traffic be Apportioned to the Proposed Project?**

First, the projected level of service for the study area is forecast without the proposed project.

Second, the projected level of service is forecast with the addition of the proposed project.

Then the two forecasts are evaluated to determine whether the traffic projected to be generated by the proposed development will lower the projected levels of service within the study area to below level of service "D".

**5.1.16 What Happens When a Traffic Impact Study Projects that the Intersection(s) or Roadway(s) in the Study Area will be Adequate?**

Once a plan has met the level of service standard, no further approval for traffic impact is required.

**5.1.17 What Happens When a Traffic Impact Study Projects that the Intersection(s) or Roadway(s) in the Study Area will be Inadequate?**

The following alternatives may be considered by the Carroll County Planning Commission:

- a) The project is deferred or reduced in scope so that the level of service standard is not exceeded.
- b) A mitigation plan is submitted for review by the Departments of Planning and Public Works. The mitigation plan together with the recommendations of the departments are presented to the Planning Commission.
- c) The improvements recommended by the mitigation plan are required of the Developer unless 100% of construction costs for the projected improvements are in the subject budget year of the County's six year Capital Improvements Program.
- d) The Developer is allowed to deposit funds into Carroll County's Capital Improvements Program to fund the necessary improvements.
- e) If the existing level of service is inadequate (i.e., "E" or "F"), or the existing plus the background growth (not including the site) causes an inadequate level of service, then the Developer will be required to mitigate only the traffic to be generated by the proposed project.
- f) If the proposed development is of significant economic importance an exception and/or waiver may be granted where improvements are scheduled or included in the six (6) year Capital Improvements Plan.

### **5.1.18 What is a Mitigation Plan?**

A mitigation plan is:

- a) An addition to a Traffic Impact Study, (the need for which is identified by preliminary study results),
- b) Intended to identify specific causes of lowered levels of service (traffic impacts), and
- c) A plan that recommends improvements that will moderate the effects of projected traffic impacts.

Examples of possible mitigation plan improvements; construction of new roads, road improvements, traffic signals, ridesharing programs, off-site parking facilities and para-transit, signal timing/phasing changes, channelization modifications, changes in ingress/egress points, reducing the number of entrances, widening, etc.

### **5.1.19 How Shall Suggested Mitigation Plan Improvements be Phased?**

Recommendations for the improvements of conditions shall be sensitive to the following:

- a) Timing of short-term and long-term network improvements that are already planned, scheduled and/or funded,
- b) Time schedules of adjacent developments,
- c) Size and timing of individual phases of development,
- d) Right-of-way needs and availability of additional right-of-way within appropriate time frames,
- e) Local priorities for transportation improvements and funding,
- f) Local priorities for transportation demand management strategies,
- g) Necessary lead time for additional design and construction,
- h) That the sum of improvements are proportional to the projected impact.

Analysis of traffic needs by development phase should provide the information

needed to determine the appropriate sequence of improvements.

**5.1.20 What Type of Additional Analyses, with References, may be Required?**

Typical examples with references are as follows:

**Sight Distance Analysis, Improvement Plan for Geometric Conditions, - A Policy on Geometric Design of Highways and Streets, American Association of State Highway Transportation Officials, 1990.**

**Signal Warrant Analysis, Traffic Control Plan During Construction - Manual of Uniform Traffic Control Devices, Federal Highway Administration, 1988.**

**Traffic Signal Progression Analysis - any recognized software application (i.e., PASSER II, 1990 or TRANSYT 7F).**

**Local Trip Generation Study, Pass-By and Diverted Linked Trip Analysis - Trip Generation, 5th Edition, 1991.**

**Accident Analysis, Transit Analysis, Pedestrian Analysis, Parking Analysis - Transportation and Traffic Engineering Handbook, Institute of Transportation Engineers, 1982.**

**Environmental Analysis - For specific treatments contact the Carroll County Office of Environmental Services at 857-8123.**

**5.1.21 How Shall the Findings, Conclusions and Recommendations of the Study be Presented and Documented?**

The format (as depicted on page 5-11) is to be used as a guide for the presentation of those items as required in the pre-study conference:

- Chap. I Executive Summary**
- A) Development description
  - B) Pre-study conference work scope, site location & study area (w/map)
  - C) Principal findings with LOS Map (see Appendix I for an example)
  - D) Conclusions
  - E)\* Mitigation Plan Summary
- Chap. II Description of All Proposed Developments in Study Area**
- A) Off-site approved future developments in the area (w/map)
  - B) On-site developments & phasing to include build-out year (w/map)
- Chap. III Existing Conditions**
- A) Site accessibility
  - B) Traffic Volumes Map & LOS Map
  - C) Illustration of existing road & intersection lane use configurations
- Chap. IV Projected Conditions without Proposed Development During Build-out Year**
- A) Site accessibility
  - B) Projected Background and Regional Traffic Volumes Map & LOS Map
  - C) Illustration of projected road and intersection lane use configurations
- Chap. V Projected Conditions with Proposed Development at Projected Completion**
- A) Site accessibility
  - B) Projected Traffic Volumes Map & LOS Map
  - C) Illustration of projected road & intersection lane use configurations (if different than Chap. IV, part C).
- Chap. VI\* Mitigation Plan/or Additional Analysis Requested**
- Appendix**
- A)\* Description of analysis method(s)
  - B)\* Statement of method(s) limitations
  - C) Count Data
  - D) Critical Lane Analysis Work Sheets

**\*Optional items that are required during the pre-study conference or included by the person(s) performing the Traffic Impact Study.**

## 5.1.22 Level of Service Descriptions

- Los A** Free flow. Individual users are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to maneuver within the traffic stream is extremely high. The general level of comfort and convenience provided to the motorist, passenger, or pedestrian is excellent. Turning movements are easily made.
- Los B** Upper range of stable operation, but the presence of other users in the traffic stream begins to be noticeable. Freedom to select desired speeds is relatively unaffected, but there is a slight decline in the freedom to maneuver within the traffic stream from LOS A. The level of comfort and convenience provided is somewhat less than at LOS A, because the presence of others in the traffic stream begins to affect individual behavior.
- Los C** Mid range of stable flow, but is the beginning of the range of flow in which the operation of individual users becomes significantly affected by interactions with others in the traffic stream, but not objectionably so. The selection of speed is now affected by the presence of others, and maneuvering within the traffic stream requires substantial vigilance on the part of the user. Back-ups may develop behind turning vehicles. The general level of comfort and convenience declines noticeably at this level.
- Los D** High density, but stable flow. Speed and freedom to maneuver are severely restricted, and the driver or pedestrian experiences a generally poor level of comfort and convenience. Small increases in traffic flow will generally cause operational problems at this level. Delays to vehicles approaching signalized intersections may be substantial peak hours.<sup>1</sup>
- Los E** Unacceptable, operations near capacity. All speeds are reduced to a low, but relatively uniform value. Freedom to maneuver within the traffic stream is extremely difficult, and it is generally accomplished by forcing a vehicle or pedestrian to "give way" to accommodate such maneuvers. Comfort and convenience levels are extremely poor, and driver or pedestrian

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<sup>1</sup> This LOS is considered to be the minimum acceptable LOS by 5 of the 7 jurisdictions in the B.R.C.O.G.. Traffic Impact Studies: A Review of Current Procedures in the Baltimore Region, July 1990, City of Annapolis Department of Planning.

frustration is generally high: Operations at this level are usually unstable, because small increases in flow or minor perturbations within the traffic stream will cause breakdowns.

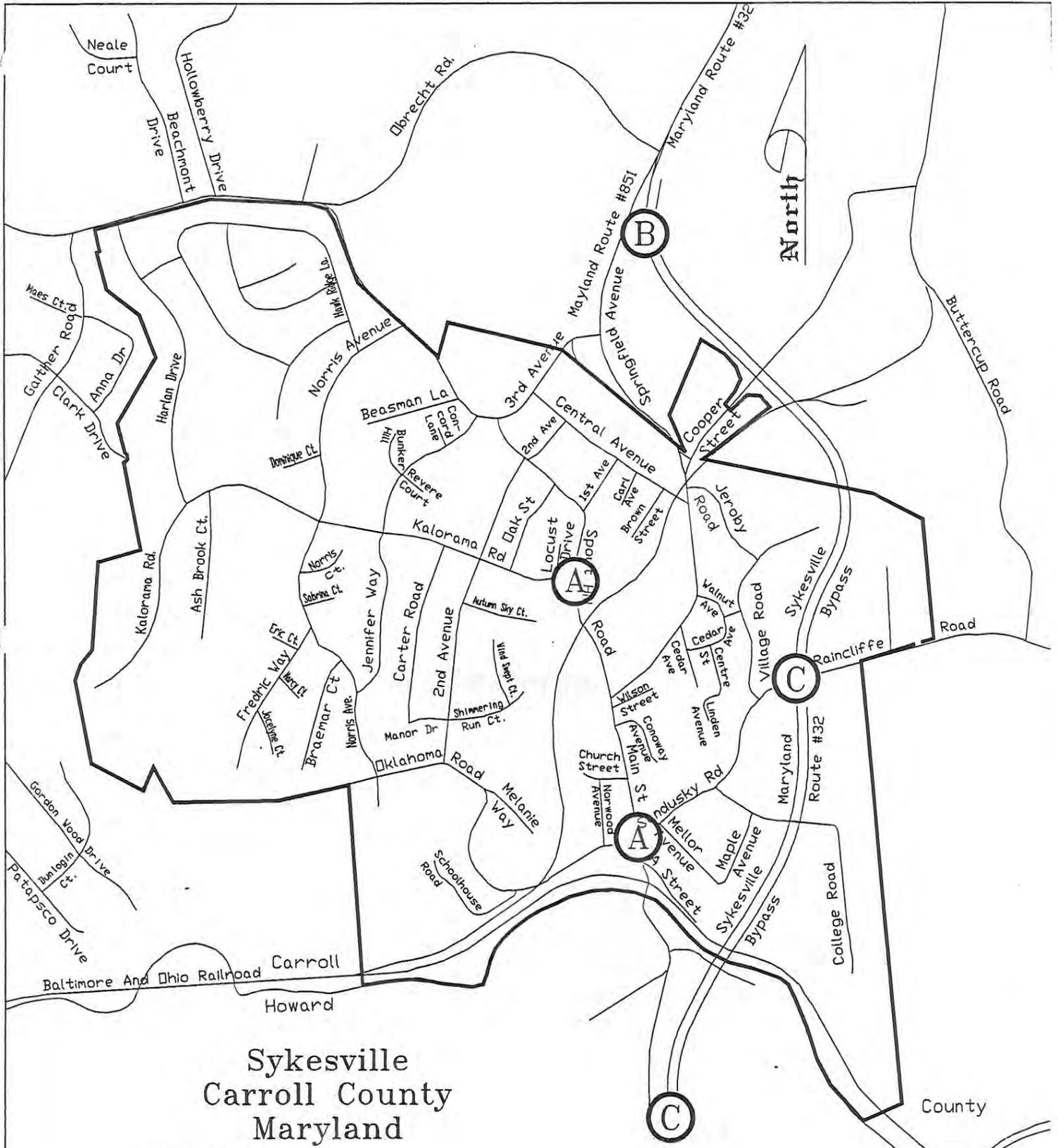
Los F

Unacceptable, forced or breakdown flow, representing jammed conditions. The amount of traffic approaching an intersection cannot be accommodated adequately.

Investment is generally high. Operations at the level are usually unprofitable because of the high level of investment in plant and equipment. The price of the product is low and the cost of production is high.

The amount of capital required is large. The amount of capital required is large. The amount of capital required is large.

## APPENDIX I



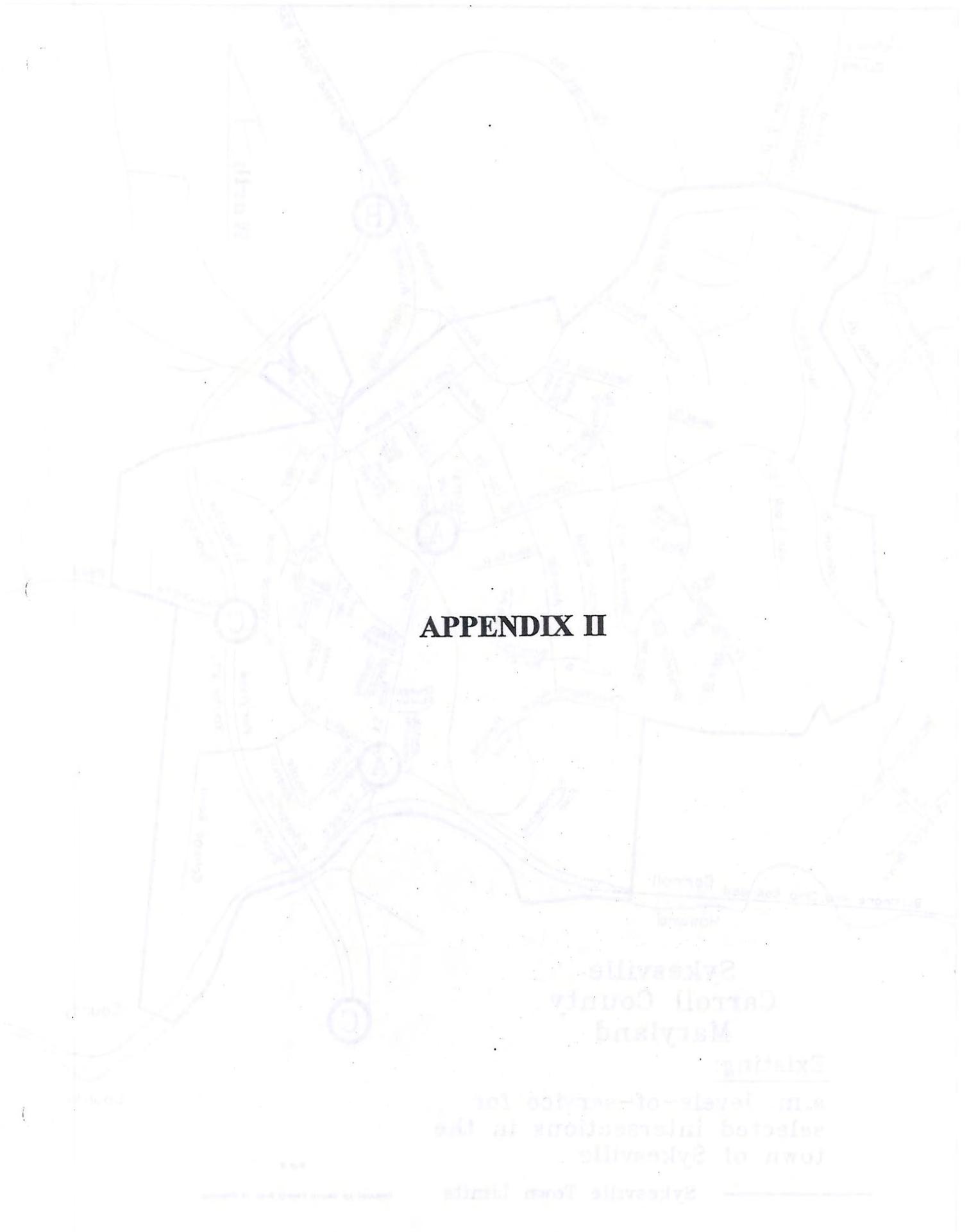
**Sykesville**  
**Carroll County**  
**Maryland**

Existing:

a.m. levels-of-service for  
 selected intersections in the  
 town of Sykesville

———— Sykesville Town Limits

**APPENDIX II**



# Intersection Capacity Measurement Through Critical Movement Summations: A Planning Tool

by Henry B. McInerney and Stephen G. Petersen

The critical movement technique discussed in this article, was improvised not to replace the analysis techniques in the *Highway Capacity Manual*, but to meet the need for presenting a picture to the layman of how an intersection operates without losing him in a discussion of peak-hour factors and G/C ratios. The method was valuable in examining a group of intersections to determine those most able to absorb the load from a new employment center. The evaluation of the most favorable routes from a capacity standpoint led, in turn, to the provision of routing maps to employees based on the parking lot to which they were assigned. Because the technique dissects the various turns and through movements, it is possible to quickly determine which intersection improvement will do the most for improving capacity.

Another use of the technique is to determine the increment of development which can be added as a result of each change in intersection configuration. Caution has to be exercised in this application because one is dealing in differences rather than comparing totals against a standard.

Use of the technique to date has been related principally to site planning, but two other diverse applications have been suggested. One is as an algorithm for capacity restraint traffic assignments. In a network for an urbanized area, intersections are much more likely to determine capacity than links, yet present programs state capacity as a function of link volume.

At the opposite end of the spectrum, the technique can be useful as a quick check on the level of service at the intersections in a street network and possibly even as a rough warrant for signalization. It could be applied in reverse to a congested intersection to determine if it is operating as efficiently as possible. In a large traffic operations study, early identification of potential problem areas can be done with limited data through use of this tool. This makes the data collection effort a more productive process.

The traffic engineer engaged in planning frequently must evaluate the impact on traffic of proposed changes in land use. Estimates of generated traffic distributed over a new or expanded street system often must be made without the refinements available when an existing condition is being observed. Capacities must be determined, and this generally concerns intersection capacity since, at least in urban considerations, intersection conditions usually fix the capacity of the street system. By means of what can be called a critical movement method, intersection capacities can be developed easily.

While the *Highway Capacity Manual* (1965) and *Public Roads*<sup>1</sup> (Nos. 9 and 10, Vol. 34, 1967) cover the procedure for making



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**STEPHEN G. PETERSEN** (Member, ITE) is an Associate with Alan M. Voorhees & Associates, Inc., transportation consulting firm of McLean, Virginia where he has recently been concentrating his efforts on site development studies. Prior to joining Voorhees & Associates, Mr. Petersen was with the Institute of Traffic Engineers, first as Staff Engineer and later as Executive Secretary. He holds a B.C.E. degree from Rensselaer Polytechnic Institute, a Certificate in Traffic Engineering from the Yale Bureau of Highway Traffic, and an M.C.E. degree from the Catholic University of America. He is a registered Professional Engineer and a member of the American Society of Civil Engineers.

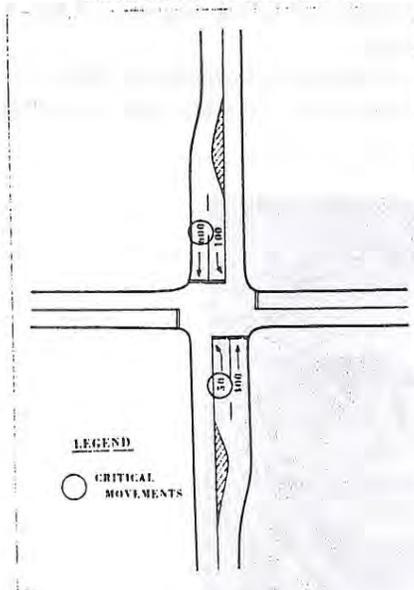
capacity determinations of at-grade intersections, when dealing with future conditions overly conscientious involvement with estimates of street widths, G/C ratios, peak-hour factor adjustments, and percentages of turns and trucks is often beyond the accuracy of the base data. The critical movement method, on the other hand, provides results which are reasonably consistent with those which could be obtained through conventional capacity analysis if it were possible to count the traffic which will be using an intersection in some future year.

**the technique**

Basically, the critical movement method applies a technique similar to that used in the analysis of diamond interchanges to a simple intersection. Early works<sup>2,3</sup> on capacity analysis of diamond interchanges define a "critical volume" above which a diamond interchange will fail unless additional lanes are added. This "critical volume" was determined by field work to be the sum of the volumes on a per lane basis of the four extreme approaches to the two at-grade intersections, taken as a system, created by a diamond interchange.

This same technique can be used on a simple intersection. At a simple intersection, the "critical movements" are the highest total of the through plus its opposing left in one direction on an hourly per lane basis (Figure 1). This total determines the green time requirement for that direction. For example, in Figure 1, 600 + 50 is greater than 400 + 100—assuming single lane flows—and therefore establishes the portion of an hour required for the N-S movement. Similarly, in Figure 2, the total of E-W critical movements is 450.

FIGURE 1  
NORTH-SOUTH CRITICAL MOVEMENTS



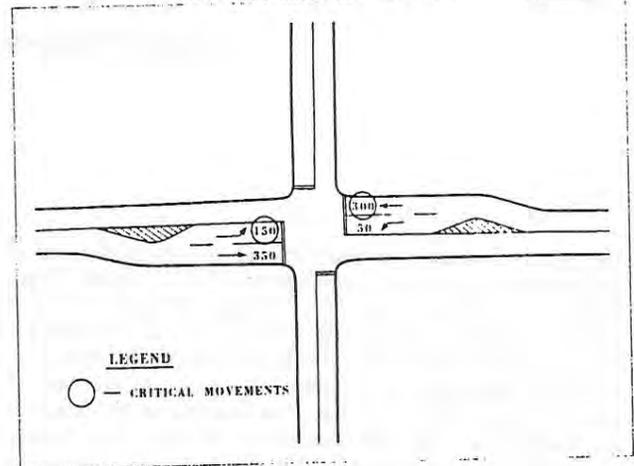
If the two directions are superimposed at an intersection, the total of the critical movements is 1,100.

The next problem is what to measure this number against. Several possibilities exist. A theoretical analysis in Matson, Smith & Hurd<sup>4</sup> set the maximum value of vehicles per hour passing over a given conflict point at 1,500, with 1,200 vehicles per hour set as the limit to avoid excessive cycle lengths.

A second possibility can be derived from a statement on page 126 of the Highway Capacity Manual: "Rarely can traffic move away (from a stop) at a rate greater than 1,500 vehicles per

hour of green." If 50 percent of the traffic approaching a signal is stopped and has a departure capacity of 1,500 vehicles/hour/lane, and 50 percent is free flow at 2,000 vehicles/hour/lane, it is possible to cross 1,470 vehicles per hour over a given conflict point using a 50/50 split on the signal cycle and allocating 15 percent of the cycle to clearance intervals.

FIGURE 2  
EAST-WEST CRITICAL MOVEMENTS



In addition to these, there are "rules of thumb" derived from experience. In one it is assumed each vehicle takes three seconds to clear the intersection—thus arriving at a capacity of 1,200 vehicles per hour. In another, through movements are estimated at 2.4 seconds per vehicle and turns at 3.6 seconds per vehicle. By multiplying vehicle volumes by these clearance values and comparing the total with 3,600, a measure is obtained.

The problem with these techniques is that they provide no measure against the Highway Capacity Manual and its "levels of service." The critical movement method, however, does.

**correlating data**

Data for this method were gathered at four heavily traveled intersections in the Virginia suburbs of Washington, D.C. Critical movement totals were developed for each intersection for levels of service "C" and "E" as shown below:

Intersection	Level of Service C (VPH)	Level of Service E (VPH)
I	1,225	1,475
II	1,205	1,445
III	1,185	1,455
IV	1,215	1,465

The average values for each condition are about 1,200 for level of service "C" and about 1,460 for level "E." In other words, if the volumes at an intersection are tabulated according to the rules set forth below, and the total of conflicting movements is around 1,200, it is reasonably safe to assume that the operation is at a "C" level of service or "design" capacity as defined by the American Association of State Highway Officials. If the total is in the 1,450 to 1,500 range, "E" level of service or "possible" capacity conditions can be expected. Between these two points, a value of 1,350 is a good indication of a "D" level of service. Over 1,500 there is little question of severe congestion and breakdown conditions.

Exclusive pedestrian phases, though, are one area for caution. These values are based on a full hour of movement through the

intersection, assuming ambers are part of green time. A pedestrian phase reduces movement time available for vehicles, and the standard values should be reduced by an amount equal to the percentage the pedestrian phase is of the total cycle. The same is true for an all red phase in the signal cycle.

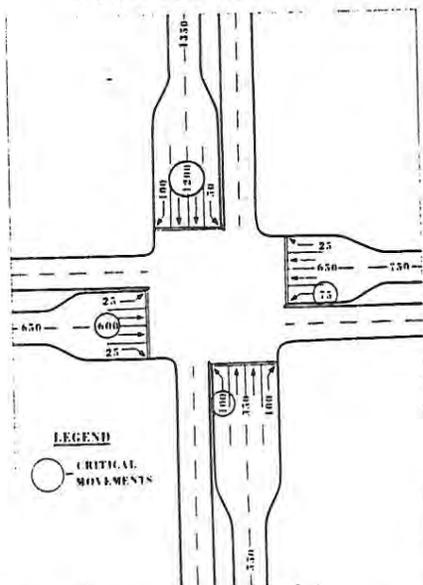
**general rules of procedure**

The engineer must know two things in order to proceed with a capacity analysis using this method: Turning volumes at the intersection under study and the number of lanes on each approach. Most important are the values for each critical movement, since these will give a good approximation of the level of service which can be expected with the given volumes and intersection configuration, assuming the signal controller and phasing will be efficient and result in minimum delay to all movements. It is best, in fact, not to think in terms of a specific signal phasing during the critical movement analysis, because it tends to restrict thinking about all the combinations of possible movements which will lead to a critical movement total. There is also no need to consider amber time since it is usually used to clear left turns. General rules for selecting conflicts, based on the sample volumes and intersection configurations in Figure 3, follow:

For north-south flow, (1) determine the volumes of through traffic (1,200 and 350 in this case); (2) compute the volume per lane for the through movement (600 and 175 for the two lane approaches shown); (3) determine opposite direction left turn volumes (100 and 50); and (4) add the through volume per lane and its opposing left turn (600 + 100 = 700, 175 + 50 = 225). The critical movements are the two which produce the largest sum—in this case, the southbound through and northbound left.

For east-west flow, the same procedure is followed. For Figure 3, volumes of through traffic are 600 and 650; volume per lane for through movement of the two approaches shown is 300 and 325; opposite direction left turn volumes are 75 and 25. The sum of the through volume per lane and its opposing left turn are 300 + 75 = 375 and 325 + 25 = 350. Therefore, the critical movements are the eastbound through and westbound left.

FIGURE 3  
EXAMPLE OF CRITICAL MOVEMENTS



For the intersection, add the north-south and east-west critical movements (700 + 375 = 1,075), and compare with the stand-

ards for level of service. Since 1,075 is less than 1,200, the intersection in Figure 3 is operating at approximately level of service "B."

**rules of procedure: other configurations**

Intersections with turn lanes are the easiest to analyze by the critical movement technique, but other configurations also can be evaluated. Where the turn volumes are as light as those shown in Figure 3, and there are no turn lanes, the total approach volume is used. For example, if Figure 3 were a simple intersection of two 4-lane roads, the analysis would be as follows:

	N-S Flow		E-W Flow	
(1) Approach Volumes .....	1350	550	650	750
(2) Divide by Number of Lanes (2) .....	675	275	325	375
(3) Opposing Lefts .....	100	50	75	25
(4) Totals (2 + 3) .....	775	325	400	400
(5) Critical Movements				
(Larger value on line 4) .....	775		400	
(6) Intersection Total (sum of 5) .....			1175	
Level of Service .....	1175 < 1200; approximately "C"			

Another complication occurs when there are heavy left turns on multi-lane approaches without turn lanes. If one left is heavy enough to be considered a lane by itself, while the opposing left is light, the sum of critical movements is computed as described under the general rules except the approach with the heavy left is considered on a lane basis rather than dividing the total approach volume by the number of lanes. For example:

	East (2 lanes)	West (2 lanes)
L— .....	230	35
T— .....	365	235
R— .....	20	40
Total .....	615	310

Even though the left turn volume on the east approach is less than the through plus right, it is assumed that only lefts use the left lane because of the heavy through from the opposite direction. Thus, we compare

$$(365 + 20) + (35) = 420 \text{ with } \frac{310 + 230}{2} = 385, \text{ and}$$

select 420 as the sum of critical movements as shown.

However, if both left turns are heavy, the best method is to divide by the number of lanes and select the most critical combination:

	East (3 lanes)	West (2 lanes)
L— .....	200	230
R— .....	180	190
T— .....	430	360
Total .....	810	780

$$\text{Since } \frac{810}{3} + 230 = 500 \text{ is less than } \frac{780}{2} + 200 = 590,$$

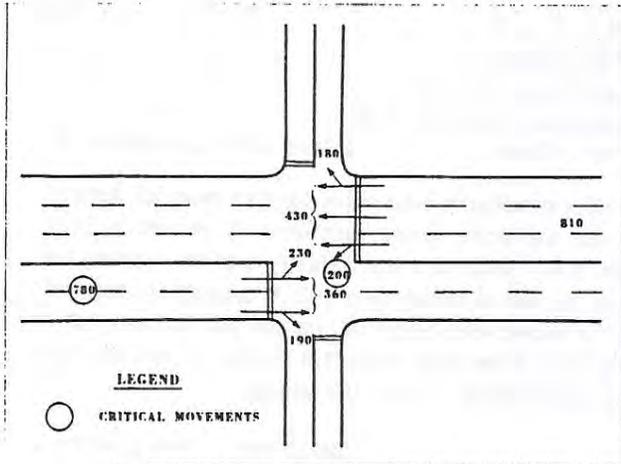
the latter is the critical movement total (see Figure 4).

For situations where a double turn lane is needed, the 80 percent efficiency factor in the Highway Capacity Manual is applied. A turn volume of 360 vehicles in two lanes is divided by 1.8 and the heaviest lane volume of 200 is used in the critical movement analysis.

### rules of procedure: one lane approaches

One lane approaches are the hardest to evaluate because the intersection operation becomes a function of whether or not through and right turn vehicles can "squeeze" by the left turner. On roads without curbs, the shoulder, whether paved or not, often becomes a lane. When curbs are present and only center line markings are used, streets less than 36 feet in width will usually not allow more than a single lane to pass. For planning purposes, it is rare that a single lane approach would be recommended for anything but a minor street, but there are occasions when such approaches must be evaluated and the following rules apply: For streets where the left can be bypassed, evaluate (through plus right)

FIGURE 4  
EXAMPLE OF HEAVY OPPOSING LEFT TURN FLOWS



+ (opposing left) and select the pair of flows which give the highest total as the critical movement.

For streets where lefts cannot be bypassed, evaluate (through plus right plus left) + (opposing through plus right). Critical movements are the two flows with the highest total.

In addition, this technique can be applied to multi-legged intersections. In the case of a 3-legged intersection, right and left turns can often be phased together for more efficient utilization of the intersection and therefore a lower critical movement total. For more than 3 legs, a third set of critical movements is added to the total.

The critical movement method can be a useful tool in the traffic engineer's planning kit—one which provides results reasonably consistent with those that could be obtained through conventional capacity analysis if it were possible to measure the traffic that will be using an intersection at some future date.

A brief technical supplement describing the details of the field work used to develop the standards of comparison is available from the authors.

The authors acknowledge with appreciation the guidance provided by their AMV staff associates, particularly Dan Hoyt, a pioneer user of the critical movement technique for capacity analysis, and Steven Provost, for his review of several early drafts.

### References:

<sup>1</sup>Journal of Highway Research, published by the U.S. Bureau of Public Roads.

<sup>2</sup>FREWAY DESIGN AND OPERATIONS, HRB Bulletin 291 "Capacity Study of Signalized Diamond Interchanges," Capelle, D.G. and Pinnell, C. Highway Research Board, Washington, D.C. 1961 Pp. 1-25.

<sup>3</sup>FREWAY OPERATIONS, HRB Bulletin 324, "Operational Study of Signalized Diamond Interchanges," Capelle, D.G., and Pinnell, C. Highway Research Board, Washington, D.C. 1963. Pp. 38-72.

<sup>4</sup>Traffic Engineering, McGraw-Hill, 1966. Pp. 336, 342.

PLANNING AND ZONING COMMISSIONS  
CONTACTS

City/Town	Address	Meeting Date	Meeting Time
Altoona	Mr. James Schumacher Town of Altoona 127 Main Street Altoona, Maryland 21784	Meeting held first Monday of month	7:00 p.m. (752-8222)
Beltsville	Mr. James Smith Code Enforcement Officer City of Beltsville 17 East Beltsville Street Beltsville, Maryland 21751	Meeting held last Monday of month	7:30 p.m. (754-1100)
Blacksburg	Mr. William Johnson Town of Blacksburg 1200 York Street Blacksburg, MD 21761	Meeting held third Monday of month	7:30 p.m. (752-1200)
Brookline	Mr. Robert Johnson Town of Brookline P.O. Box 88 1 Park Avenue Brookline, Maryland 21771	Meeting held last Monday of month	7:30 p.m. (752-1211)
Chesapeake	Mr. John Baker City of Chesapeake P.O. Box 811 City Hall Chesapeake, Maryland 21762	Meeting held second Thursday of month	7:30 p.m. (754-8000)
Chesapeake	Mr. John Baker Town of Chesapeake 111 Main Street Chesapeake, Maryland 21762	Meeting held as regular	(752-8772)
Chesapeake	Mr. William Johnson Town of Chesapeake 1200 York Street Blacksburg, MD 21761	Meeting held last Monday of month	7:30 p.m. (752-1200)
Chesapeake	Mr. William Johnson Town of Chesapeake 1200 York Street Blacksburg, MD 21761	Meeting held last Monday of month	7:30 p.m. (752-1200)
Chesapeake	Mr. William Johnson Town of Chesapeake 1200 York Street Blacksburg, MD 21761	Meeting held last Monday of month	7:30 p.m. (752-1200)

APPENDIX III

PLANNING AND ZONING COMMISSION  
CONTACTS

Hampstead

Ms. Debbie Spadaro  
Town of Hampstead  
1034 South Carroll Street  
Hampstead, MD 21074

Meeting held last Monday of month  
7:00 p.m. (374-2761)

Manchester

Ms. Miriam DePalmer  
Town of Manchester  
3208 York Street  
Manchester, MD 21102

Meeting held third Monday of month  
7:30 p.m. (239-3200)

Mount Airy

Ms. Barbara Jean Dixon  
Town of Mount Airy  
P. O. Box 48  
2 Park Avenue  
Mount Airy, Maryland 21771

Meeting held last Monday of month  
7:30 p.m. (829-1424)

New Windsor

Mr. John Keck  
Town of New Windsor  
211 High Street  
New Windsor, Maryland 21776

Meeting held as needed.  
(635-6575)

Sykesville

Mr. James Schumacher  
Town of Sykesville  
7547 Main Street  
Sykesville, Maryland 21784

Meeting held first Monday of month  
7:00 p.m. (795-8959)

Taneytown

Mr. Laverne Smith  
Code Enforcement Officer  
City of Taneytown  
17 East Baltimore Street  
Taneytown, Maryland 21787

Meeting held last Monday of month  
7:30 p.m. (751-1100)

Union Bridge

Ms. Kathy Kreimer  
Town of Union Bridge  
1 West Broadway Street  
Union Bridge, Maryland 21791

Meeting held first Tuesday of month  
7:00 p.m. (775-2711)

Westminster

Mr. John Dutterer  
City of Westminster  
P. O. Box 010  
City Hall  
Westminster, Maryland 21157

Meeting held second Thursday of  
month - 7:30 p.m. (848-9000)

DAILY AND PEAK HOUR TRIP GENERATION BY LAND USE SOURCE - THE DEVELOPER'S MANUAL TO CHOOSE THE APPROPRIATE

LAND USE	TRIP RATE	TRIP RATE	TRIP RATE
	PER HOUR	PER HOUR	PER HOUR
MULTI-FAMILY DETACHED	1.00	1.00	1.00
APARTMENT	1.00	1.00	1.00
RESIDENTIAL CONDO/ROW	1.00	1.00	1.00
MULTI-FAMILY ATTACHED	1.00	1.00	1.00
OFFICE	1.00	1.00	1.00
GENERAL OFFICE BUILDING	1.00	1.00	1.00
MEDICAL OFFICE BUILDING	1.00	1.00	1.00
OFFICE PARK	1.00	1.00	1.00
RESEARCH CENTER	1.00	1.00	1.00
BUSINESS PARK	1.00	1.00	1.00
COMMERCE	1.00	1.00	1.00
SHOPPING CENTER - FULL ANCHOR	1.00	1.00	1.00
SHOPPING CENTER - PARTIAL ANCHOR	1.00	1.00	1.00
QUALITY RESTAURANT	1.00	1.00	1.00
RESTAURANT	1.00	1.00	1.00
CONVENIENCE STORE	1.00	1.00	1.00
WALK-IN BAKERY	1.00	1.00	1.00
NEW CAR SALES	1.00	1.00	1.00
INDUSTRIAL	1.00	1.00	1.00
INDUSTRIAL PARK	1.00	1.00	1.00
MANUFACTURING	1.00	1.00	1.00
MOTEL	1.00	1.00	1.00
HOTEL	1.00	1.00	1.00

**APPENDIX IV**

TRIP RATE ADJUSTMENT FACTOR IS 0.50 FOR TRIP GENERATION FROM BUSSES

DEVELOPMENT SIZES THAT MAY HAVE TO PERFORM A TRAFFIC IMPACT STUDY

DAILY AND PEAK HOUR TRIP GENERATION BY LAND USE  
 SOURCE: ITE TRIP GENERATION MANUAL, 5TH EDITION

		ADT	AM PEAK	PM PEAK
<b>RESIDENTIAL</b>				
SINGLE FAMILY DETACHED	20 DWELLING UNITS	234	20	25
APARTMENT	37 DWELLING UNITS	223	22	25
RESIDENTIAL CONDOMINIUM	30 DWELLING UNITS	234	19	25
MOBILE HOME PARK	1.60 ACRES	72	25	20
<b>OFFICE</b>				
GENERAL OFFICE BUILDING	6.50 THOUSAND SQUARE FEET (GFA)	178	23	25
MEDICAL OFFICE BUILDING	6.50 THOUSAND SQUARE FEET (GFA)	146	25	24
OFFICE PARK	6.50 THOUSAND SQUARE FEET (GFA)	148	25	19
	0.22 ACRES	64	24	25
RESEARCH CENTER	13.00 THOUSAND SQUARE FEET (GFA)	198	23	25
	0.28 ACRES	214	25	24
BUSINESS PARK	1.10 ACRES	257	25	19
<b>COMMERICAL</b>				
SHOPPING CENTER <570K SQ.FT.	0.60 THOUSAND SQUARE FEET (GLA)	289	8	25
SHOPPING CENTER ON SAT.	0.35 THOUSAND SQUARE FEET (GLA)	262 PK HR =		25
QUALITY RESTAURANT*	3.70 THOUSAND SQUARE FEET (GFA)	382	6	25
SUPERMARKET*	2.80 THOUSAND SQUARE FEET (GFA)	351	2	25
CONVENIENCE MARKET*	0.35 THOUSAND SQUARE FEET (GFA)	310	24	25
WALK-IN BANK*	1 THOUSAND SQUARE FEET (GFA)	204	17	25
NEW CAR SALES	7.00 THOUSAND SQUARE FEET (GFA)	333	14	25
<b>INDUSTRIAL</b>				
INDUSTRIAL PARK	17.00 THOUSAND SQUARE FEET (GFA)	850	25	16
	1.00 ACRES	646	19	25
MANUFACTURING	33.00 THOUSAND SQUARE FEET (GFA)	115	*	25
	0.30 ACRES	103	22	25
<b>INSTITUTIONAL</b>				
MOTEL	4 EMPLOYEES	139	15	27
HOSPITAL	46 BEDS	1159	14	25

\*Fitted curve question not given in the 5th Edition, therefore used equations from 4th Edition

DEVELOPMENT SIZES THAT SHALL PERFORM A TRAFFIC IMPACT STUDY

DAILY AND PEAK HOUR TRIP GENERATION BY LAND USE  
SOURCE: ITE TRIP GENERATION MANUAL, 5TH EDITION

		ADT	AM PEAK	PM PEAK
<b>RESIDENTIAL</b>				
SINGLE FAMILY DETACHED	43 DWELLING UNITS	474	39	50
APARTMENT	75 DWELLING UNITS	460	43	50
RESIDENTIAL CONDOMINIUM	72 DWELLING UNITS	493	39	50
MOBILE HOME PARK	6.90 ACRES	308	47	50
<b>OFFICE</b>				
GENERAL OFFICE BUILDING	17.00 THOUSAND SQUARE FEET (GFA)	368	48	50
MEDICAL OFFICE BUILDING	12.50 THOUSAND SQUARE FEET (GFA)	321	47	50
OFFICE PARK	15.50 THOUSAND SQUARE FEET (GFA)	306	50	40
	0.58 ACRES	160	48	50
RESEARCH CENTER	30.00 THOUSAND SQUARE FEET (GFA)	386	48	50
	0.90 ACRES	376	50	47
BUSINESS PARK	2.25 ACRES	481	50	39
<b>COMMERICAL</b>				
SHOPPING CENTER <570K SQ.FT.	1.75 THOUSAND SQUARE FEET (GLA)	564	15	50
SHOPPING CENTER ON SAT.	1.09 THOUSAND SQUARE FEET (GLA)	535	PK HR =	50
QUALITY RESTAURANT*	7.50 THOUSAND SQUARE FEET (GFA)	711	8	50
SUPERMARKET*	5.70 THOUSAND SQUARE FEET (GFA)	715	3	50
CONVENIENCE MARKET*	0.70 THOUSAND SQUARE FEET (GFA)	621	47	50
WALK-IN BANK*	1.40 THOUSAND SQUARE FEET (GFA)	385	22	50
NEW CAR SALES	17.40 THOUSAND SQUARE FEET (GFA)	827	34	50
<b>INDUSTRIAL</b>				
INDUSTRIAL PARK	39.00 THOUSAND SQUARE FEET (GFA)	959	50	37
	2.55 ACRES	720	41	50
MANUFACTURING	67.00 THOUSAND SQUARE FEET (GFA)	247	*	50
	1.40 ACRES	213	44	50
<b>INSTITUTIONAL</b>				
MOTEL	16 EMPLOYEES	373	37	50
HOSPITAL	79 BEDS	1633	31	50

\*Fitted curve question not given in the 5th Edition, therefore used equations from 4th Edition



## **CHAPTER 6**

# **STORM DRAINAGE CRITERIA**

**NOTE:** Since the adoption of the 1994 Manual, there have been various design and procedural revisions. Many of the revisions are included under the Revisions link. Engineers and surveyors are encouraged to call the Bureau of Engineering to obtain the latest design criteria and procedures.



## CHAPTER 6: STORM DRAINAGE CRITERIA

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- A. Design Data Charts
- B. Standard Design Forms

## CHAPTER 6: STORM DRAINAGE CRITERIA

### 6.1 Introduction

Storm drain systems shall consist of inlets, manholes, pipes, channels, waterways, swales, ditches, streams and any other or related method of collecting and conveying storm water runoff on or beneath the ground or finished surface. Information presented herein constitutes policies, criteria and procedures to be used in design of storm drain systems. In establishing this policy it is presumed that the user is familiar with storm drainage design and has some degree of experience and knowledge of the subject. Therefore, detailed explanations of the more basic aspects of design and computations are not included.

Nothing in this policy may be construed to supersede, nullify or overrule the requirements of any Federal, State, County or Local agency. It shall be the responsibility of the Surveyor or Engineer to ascertain whether or not a project is under the jurisdiction of other agencies and to satisfy requirements of those agencies prior to submittal of plans for final approval. In the event of conflict with requirements of other agencies, the Surveyor or Engineer shall contact the Engineering Review Division prior to submitting plans for review.

Criteria for the design of storm drain systems in Carroll County shall be, except as noted herein, that of the Maryland Department of Transportation, State Highway Administration contained in the Highway Drainage Manual, dated December 1981 and any addenda or corrigenda thereto, hereafter referred to as the Manual. The Carroll County Department of Public Works, hereafter referred to as Department, reserves the right to interpret and rule on the applicability of any information or practice presented in the Manual, and to decide the method to be used in the event of conflict between this criteria and the Manual, and between sections of this criteria. In instances where the policy of the Department, as presented herein, varies from the Manual, the policy of the Department shall govern.

### 6.2 Methodology

- A. The Rational formula shall be used to determine quantity of flow (Q) for the design of storm drainage systems. It is given as follows:

$$Q = CiA \tag{1}$$

Where: Q = Quantity of flow in cubic feet per second (C.F.S.)

C = Coefficient of runoff

i = Rainfall intensity, in inches per hour

A = Contributory drainage area, in acres

The manual also uses an intensity coefficient ( $i_r$ ) which is a percentage of intensity ( $i$ ). For Carroll County the values of  $i_r$  range from 0.96 to 0.99. The volume of runoff calculated when using the coefficient, compared to not using it, has been determined to be insignificant. Therefore, to simplify computations, the intensity coefficient may be disregarded.

Values of C based on soil type are given in Appendix A pages A-1a through A-1d.

Intensity ( $i$ ) is based on time of concentration ( $t_c$ ). Information for computation of  $t_c$  is given in Appendix A, pages A-2a through A-2g.

- B. The Manning Formula shall be used for the design of storm drain systems where pressure operation is not encountered. It is given as follows:

$$V = \frac{1.486}{n} r^{2/3} s^{1/2} \quad (2)$$

where: V = instantaneous velocity, in feet per second (f.p.s.).

r = hydraulic radius = area of flow, in square feet, divided by wetted perimeter, in feet.

s = slope, in feet per foot.

n = roughness coefficient.

Values of n are given in Appendix A pages A-4a and A-4b

## 6.3 Design Criteria

### 6.3.1 Computations

**6.3.1-1 Design Frequencies**

- a. 2-year: Inlet design and determinations of spread in roadways.
- b. 10-year: Pipes, ditches, and open channels.
- c. 25-year: Cross-culverts and hydraulic gradients.
- d. 100-year: Flood Plains
- e. Driveway Cross-Culverts: 10-year, except where base flow is present, in which case, 25-year.

**6.3.1-2 Coefficient of Runoff**

May be obtained from appropriate chart in Appendix A. Designer is cautioned against the use of blanket C values on any given design. Reasonable and prudent engineering judgement must be exercised in determination of C values. The Department reserves the right to require detailed calculations in any case it deems necessary.

Soil permeability is sensitive to disturbance and compaction. Therefore, development of commercial, institutional, industrial and Planned Unit Developments and projects within the R-7,500, R-10,000 and R-20,000 zoning districts shall be done with soil classification adjusted as follows:

Pre-development Soil Group	Design Soil Group
A	B
B	C
C	C
D	D

**6.3.1-3 Time of Concentration**

In performance of  $t_c$  calculation for storm drainage systems, overland or sheet flow may not exceed 400 feet in length. Particular attention must be given to overland flow since it may be significantly less than 400 feet due to site grading, house construction, swales or other features. The designer must exercise proper judgement when determining the  $t_c$  flowpath so as not to diminish the volume of runoff by a disproportionately long  $t_c$ .

Except where  $t_c$  is 5.0 minutes or less, flowpath used for determination of  $t_c$  must be accurately shown on Drainage Area Map. Each reach of the  $t_c$  flowpath is clearly shown and represented in the total.

- a. Minimum inlet time shall be 5.0 minutes regardless of zoning.
- b. Maximum permissible inlet times are based on zoning and are as follows:

For commercial, industrial, institutional and Planned Unit Developments.....8 mins.

For R-7500 and R-10000.....12 mins.

For R-20000 and R-40000.....15 mins.

- c. Charts for computation of  $t_c$  are given in Appendix A and are as follows:

Overland Sheet Flow: S.H.A. - 61.1 - 402.1

Swale Flow: S.H.A. - 61.1 - 402.3 or 402.4

Ditch Flow: S.H.A. - 61-1 - 402.5 or 402.6

Gutter Flow: S.H.A. - 61.1 - 402.7

Stream Velocities: Table 1, pg. II-2-B-3

#### 6.3.1-4 Inlet Capacities

- a. Sump Inlets: Must be designed on a two-year frequency storm with 100% pickup and limiting spread of eight feet (8') unless otherwise approved by the Department of Public Works. If additional inlet(s) are required they may be no closer than ten feet (10') measured center to center of structures. Designer should use charts for the specific type of inlet when available. When charts are not available inlet grates may be evaluated using the following formula.

$$Q = 3.0 P h^{3/2} \quad (3)$$

**NOTE:** Section 6.3.1-4 has been supplemented. Please refer to the Revisions link.

Where:  $Q$  = Capacity, in cubic feet per second

$P$  = Perimeter grate opening, ignoring bars, in feet. ( $P = 2W + L$ )

$h$  = head over grate in feet.

Grate-only inlets shall not be permitted in sumps. Combination inlets (i.e. curb opening and grate) shall be designed using three sides. The curb opening will be considered as a factor of safety against clogging.

- b. **Inlets on grade:** Shall be spaced to pick up at least 85% of the total gutter flow and the maximum allowable spread of flow in the curb and gutter section shall be eight feet (8'). Capture shall be computed based on chart for type of inlet being used. Capacity charts for Single and Standard W R inlets are given in Appendix A. Where flow is 2.25 c.f.s. or less, use values obtained by reading chart (S.H.A. - 61.1 - 433.2 - 2.08, and 433.3 - 2.08) directly where  $Q$  and slope lines intersect. Where flow is greater than 2.25 c.f.s., use 2.25 c.f.s. and applicable slope line. Flow above 2.25 c.f.s. shall be considered as flow-by.

Example:  $Q_c = 3.1$  c.f.s. and slope = 5.0%, read intercepted  $Q_i = 1.7$  c.f.s.

Therefore, capacity - 1.7 c.f.s. and flow-by = (3.1 minus 1.7) or 1.4 c.f.s. In this instance another inlet would be required because  $Q$  intercepted ( $Q_i$ ) is less than the required 85%.  $Q_i (1.7) \div Q (3.1) = 0.55$  or 55%.

- c. **C.O.G. Inlets:** Capacity of C.O.G. inlets shall be computed by the following method:

1. Use chart A-5a with  $Q_2$ , roadgrade and  $\frac{2}{n}$  ratio = 3333 to determine depth of flow at curb ( $y$ ).
2. Use chart A-6c, enter with depth of flow ( $y$ ), read down to 1½" then right to  $Q_2/L_a$  ratio.
3. Calculate length ( $L$ ) by dividing  $Q_2$  by  $Q_2/L_a$  ratio.
4. Select a trial length of opening ( $L_a$ ) 5', 10', 15' or 20'.
5. Calculate  $a/y$  ratio where  $a = 1\frac{1}{2}$ " and  $y =$  depth at curb.

6. Calculate  $L/L_a$  ratio, enter bottom of chart at  $L/L_a$  ratio and read up to  $a/y$  ratio then right to  $Q/Q_a$  ratio.
7. Calculate  $Q$  captured by multiplying  $(Q/Q_a)$  times  $Q_2$ .
8. Capture must be a minimum of 85% of gutter flow.

### **6.3.1-5 Hydraulic Gradient**

Drainage systems shall be based on the post-development twenty-five (25) year frequency. Hydraulic gradient elevation for all structures must be below rim or grate elevation. Charts for computation of hydraulic gradient are as follows:

S.H.A. - 61.1 - 408.1.....see pg. A-7a

S.H.A. - 61.1 - 408.2.....see pg. A-7b

S.H.A. - 61.1 - 408.3.....see pg. A-7c

In instances where the storm drain system discharges into an approved storm water management facility, starting elevation for hydraulic gradient computations shall be either crown of outfall pipe or twenty-five (25) year water level in facility, whichever is higher.

### **6.3.1-6 Headwater for Cross-Culverts**

Shall be determined using the twenty-five (25) year storm and the chart appropriate to the particular type of pipe and entrance condition being proposed. Charts for the three (3) most commonly used types of pipe; concrete, corrugated metal and corrugated metal pipe arch are given in Appendix A, for other types of pipes refer to the Manual.

## **6.4 Information and Design Parameters**

### **6.4.1 Information to be Presented for Review**

#### **6.4.1-1 Drainage Area Map**

A drainage area map shall be shown on a drawing which shall be included as a part of the construction plans. The drainage area map must be at a scale of 1" = 100' or larger and must show the following:

- a. **Tract Boundary**
- b. **Existing Contours:** Two-foot (2') intervals unless natural grade exceeds 25% in which cases, ten-foot (10') intervals will be acceptable.
- c. **Existing Features:** Such as culverts, swales, streams, roads, driveways and woods lines. All must be accurately labeled for identification.
- d. **Soil Types:** Based on A, B, C, and D designations as established by the Soil Conservation Service.
- e. **Proposed Development:** Such as lot numbers, houses, Use-In-Common Driveways, road rights-of-way, road paving, road centerline with stationing, wetlands delineation and 100-year floodplain.
- f. **Proposed Drainage System:** Structure locations with number designations (use ½" diameter circle), locations and sizes of pipes, outfall treatment, ditches, waterways and diversions.

The drainage area map shall be for the sole purpose of determining drainage area for permanent storm drainage systems. The use of drainage area maps for presentation of actual construction information such as sediment control, traffic control, wells, septic areas, etc. will not be allowed.

#### **6.4.1-2 Computations**

Copies of computation sheets are given in Appendix B. Copies of completed computation sheets and other information relative to design shall be sequentially numbered and stapled or bound in booklet form. Computation booklet must be submitted for review along with construction plans.

- a. **First page of computation booklet must show:**
  - (1) **Name of project**
  - (2) **Phase or section number**
  - (3) **County file number**
  - (4) **Name and address of Surveying or Engineering firm**
  - (5) **Seal and signature of Registered Professional Engineer or Land Surveyor.**

- (6) Date of computations and revision dates
- b. Computations must include breakdown sheets for each drainage area and must show the following:
- (1) Drainage Area; by letter designation
  - (2) Area; in acres
  - (3) Structure number to which area contributes
  - (4) Soil type; A, B, C or D
  - (5) Computation of weighted "C" value.
  - (6) Computation of time of concentration ( $t_c$ ).
  - (7) Intensity ( $i$ ); based on computed  $t_c$ .
  - (8) Computation of Q and,
  - (9) any other pertinent information
- c. Computations should generally be arranged as follows:
- (1) Title page
  - (2) Drainage area breakdown sheets
  - (3) Inlet spacing sheets
  - (4) Storm sewer design sheet
  - (5) Culvert analysis sheets
  - (6) Spread checks or other miscellaneous
  - (7) Hydraulic Gradient Computation

Actual computations will begin at page two of the booklet.

For purposes of storm sewer and hydraulic computation, time in pipe shall be considered instantaneous where there is no new incoming flow. Where new incoming flow is encountered, time for this new flow will be compared to time for flow already in system,

longer of the two shall govern.

Wherever velocity in pipe or open channel is to be calculated, or used in other calculations, actual velocity ( $V_o$ ) shall be used in all cases.

#### **6.4.1-3 Spread Checks**

May be required if it is possible that the eight foot (8') limitation is being exceeded. When required, these checks shall consist of a drainage area map, runoff calculation and a copy of spread chart or graph showing the result. Spread checks must be site-specific and must reflect completely developed condition of area in question. These computations shall be included as a part of the storm drain computation booklet.

#### **6.4.2 Easements**

All permanent storm drainage facilities, where not within public rights-of-way, shall be placed, and preferably centered, within permanent easements of sufficient width to contain the facility and allow for access and maintenance. These shall be labeled "Drainage and Utilities Easements" and shall be a minimum of twenty feet (20') in width. Easements shall be deeded to the County Commissioners and recorded among the County's Land Records.

#### **6.4.3 Inlet Types**

Carroll County does not permit the use of depressed inlets. The following types of inlets shall be permitted for use in roadways.

##### **6.4.3-1 On Grade**

###### **Double Grate**

- a. Carroll County Standard Type "S", Double Grate Tandem, Plate Number 65 (reinforced concrete).
- b. Carroll County Precast Standard Type "S" Double Grate Tandem, Plate Number 66, (precast concrete).

###### **Single Grate**

- c. Carroll County Single "WR" Inlet, Plate Number 67 (reinforced

concrete).

- d. Carroll County Precast Single "WR" Inlet, Plate Number 68 (precast concrete).

or

- e. Maryland State Highway Administration Standard Plate Number MD-374.62 Curb Opening on Grade Circular type (C.O.G.) inlets.
- f. Maryland State Highway Administration Standard Plate Number MD-374.51, Curb Opening on Grade type (C.O.G.) Square and Rectangular inlets.

#### **6.4.3-2 In Sump**

##### **Double Grate**

- a. Carroll County Standard "WR" Inlet, Plate Number 69 (reinforced concrete).
- b. Carroll County Standard Precast "WR" Combination Inlet, Plate number 70.

or

- c. Maryland State Highway Administration Standard Plate Number MD-374.63, Curb Opening in Sump Circular (C.O.S.) type inlets.
- d. Maryland State Highway Administration Standard Plate Number MD-374.61, Square and Rectangular (C.O.S.) type inlets.

#### **6.4.3-3 Inlets in Non-Traffic/Traffic Areas**

Inlets in non-traffic areas such as ditches, swales, and parks or open spaces shall generally be one of the following types:

- a. Maryland State Highway Administration Type "J", Standard Plate Number MD-377.01.
- b. Carroll County Modified Standard Yard Inlet, Plate Number 59.

- c. Carroll County Modified "J" Inlet, Plate Number 60.
- d. Carroll County "K" Inlet, Plate Number 61.

Inlets in traffic areas shall generally be one the following types:

- a. Maryland State Highway Administration Type "K", Standard Plate Number MD-378.11.
- b. Carroll County Standard Type "K", Single Grate, Plate Number 62.
- c. Carroll County Standard Type "K" Inlet Double Grate Tandem, Plate Number 63.

#### **6.4.3-4 Curb Transitions**

Wherever curb opening inlets are used, curb transitions twenty feet (20') in length are required where curbs are Carroll County mountable type. In permanent cul-de-sacs, curb transitions lengths of ten feet (10') will be permitted. Transition lengths shall be the same on both sides of the inlet.

#### **6.4.3-5 Curb Openings**

Curb openings are not permitted on new permanent street construction. However, two-foot (2') wide curb openings will be permitted in temporary cul-de-sacs, provided area receiving flow is stabilized.

#### **6.4.3-6 Inlet Placement**

Storm drain inlets shall be required on the upgrade sides of all intersections, and at all pedestrian cross-walks or sidewalk ramps. Inlets shall also be placed along the road as necessary to limit spread to eight feet (8').

It shall be permissible on the beginning (upgrade) ends of drainage systems to combine a maximum of three (3) inlets before going to a manhole system, provided the pipe is less than twenty-four (24") in diameter. Manhole systems shall be used wherever pipes are twenty-four inches (24") or greater in diameter.

#### **6.4.4 Manholes**

Must be provided wherever storm drain pipes join, where the drain pipe changes direction or grade, or where drain pipe is twenty-four inch (24") in diameter or larger. Manholes shall generally be positioned in center of roadway except that frame and cover of large manholes may be offset slightly so that physical center of structure is at center of road.

Manholes can be constructed of either brick, reinforced concrete or precast concrete in accordance with Plates 90 thru 104.

##### **6.4.4-1 Manhole Placement**

Where cover over pipe (rim to top of highest pipe) is five feet (5') or less, a shallow manhole is required. Minimum cover for a shallow manhole shall be 2.75 feet.

Incoming pipes shall be placed at an elevation so that crowns of inflow pipes are not lower than crown of outflow pipe.

Manholes shall be placed as necessary so that no continuous pipe run exceeds four hundred (400) feet in length.

In remote areas such as through woods or where manholes may become covered by overgrowth, or where directed by Department of Public Works, manhole covers shall be raised 9 inches (0.75') above existing ground.

#### **6.4.5 Cut-Ins**

Cut-Ins or field connections will be permitted only in concrete pipe and only where main pipe is existing, and is at least twice the diameter of incoming pipe. In addition, the minimum inside diameter of the main pipe line must be at least 33". Prefabricated tee or wye fittings may be used for inlet connection in lieu of manholes, provided main drain does not change direction or grade. Where both main drain and inlet connection are new, fitting must be prefabricated.

See Plate 105 for detail.

#### **6.4.6 Pipe Systems**

Pipe type, once selected, must be consistent throughout the system. Mixing of pipe types will not be permitted.

Pipe runs must be straight in line and grade between structures. Horizontal or vertical curves on pipe runs will not be permitted.

Storm drain pipes should not be designed to run with and beneath curb lines.

Minimum size of pipe shall be fifteen inches (15") in diameter between first two (2) structures, then eighteen inches (18") in diameter. Pipes crossing beneath driveway aprons must also be fifteen inches (15") in diameter, headwater for 10-year frequency storm event may not overtop driveway.

All drain pipes except driveway pipes shall be designed with a minimum of 1.0 foot of earth cover above top of pipe. Driveway pipe shall have a minimum of six inch (6") of earth cover above top of pipe. Polyethylene pipe shall not be used for driveways.

Drain pipes shall be circular in cross-section. Elliptical Reinforced Concrete Pipe (E.R.C.P.) and Corrugated Metal Pipe Arch (C.M.P.A.) may be allowed only where necessary due to cover limitations and must be approved in advance by the Department.

Storm drain pipe systems shall be of sufficient length to reach a suitable point of discharge. Suitable points of discharge include an existing stream, ditch, or other stabilized water course, existing pipe drainage system, and a storm water management facility. Where a drainage system outfall pipe is to discharge along lot lines in residential development, pipe shall be carried to a point at or near rear lot line unless dictated otherwise by Local, State or Federal law or regulation.

Minimum velocity of flow in pipe shall be 3.0 feet per second.

All storm drainage discharge pipes shall have appropriate end treatment on each end, and outfall protection at the point of discharge. End treatment shall be concrete endwall if pipe is subject to rising and falling tailwater such as into a stormwater management facility, otherwise prefabricated end sections are permissible.

In cases where a pipe system discharges into a stormwater management facility, elevation of outfall point must be at or near bottom of stormwater management facility.

The following pipe types are allowed for storm drain construction:

#### **6.4.6-1 Reinforced Concrete Pipe (R.C.P.)**

Concrete pipe shall be a minimum of Class IV under roadways and adjoining slopes but may be Class III in open space or where not under roadways. A structure must be provided where pipes change class. Pipe shall meet the requirements of AASHTO M170.

#### **6.4.6-2 Corrugated Metal Pipe (C.M.P.)**

Shall be a (minimum) of fourteen (14) gauge thickness and of the following types.

- a) Aluminum - alloy coated metal pipe to meet AASHTO Specification M-274.
- b) Aluminum - alloy metal pipe to conform to AASHTO Specification M-196 for conduit and M-197 for material.

Galvanized metal pipe, except as an option for driveway apron culverts, will not be allowed for storm drainage construction unless given approval by the Director of Public Works or the Chief of the Bureau of Engineering. Any allowed usage of galvanized pipe will be on a very limited case by case basis.

#### **6.4.6-3 Polyvinyl Chloride Pipe (P.V.C.)**

Shall meet the requirements of ASTM F-758 type PS-28.

#### **6.4.6-4 Polyethylene Smooth Interior Pipe (PeP)**

Shall meet the requirements of AASHTO M 252 (4" - 10") and M 294 (12" and larger). See Section 8.1.2-4 on page 8-3 for further information.

#### **6.4.7 Outfall Protection**

Shall be required at every new discharge point regardless of quantity or velocity of flow or pipe size. Types of outfall protection include paving (with velocity breakers), stone gabion mattress or concrete blocks. Concrete block type can be either interlocking blocks or open type which permits grass to grow through.

In instances where Water Resources Administration, Department of Natural Resources or other State or Federal agency require the use of stone rip-rap for outfall protection, the requirements and procedures of that agency shall govern.

The general standard for outfall protection, where not otherwise controlled by State or Federal agencies, shall be stone filled wire gabion mattresses. Consideration will also be given to grid type pavers in outfall areas providing the design velocity of storm water does not exceed eleven (11) feet per second. In areas subject to frequent inundation of water, the pavers shall be filled with gravel instead of the usual gravel, sand, topsoil and seed combination. In certain cases where point of discharge is a remote location, surrounded by

woods or heavy growth and will not become a nuisance to homeowners or require an unusual degree of maintenance, loosely laid rip-rap aprons may be considered on a case-by-case basis. Loose rip-rap will not normally be permitted for use as ditch or channel lining.

#### **6.4.7-1 Gabion Mattress Protection**

Gabion mattress protection shall be placed on filter fabric and shall be flush against the end section or concrete endwall. Minimum length and width of protection shall be determined using USDA-SCS Charts 38.10 or 38.11 depending on tailwater condition. Since stone will be held in place by gabion baskets, the lower portion of each chart is not applicable and may be disregarded.

To determine length enter bottom of chart with discharge quantity in c.f.s. Read up to pipe diameter, then left to obtain length. In instances where Q and pipe diameter lines do not intersect, read upward on Q line to the base line then read left from base line to obtain length. Length of apron may not be less than the base line reading but may be greater for smaller diameter pipes. Following are two examples using chart 38.11 for minimum tailwater:

Q = 25 c.f.s. d = 30": Enter at Q = 25 c.f.s. then up to base line (between 24" and 27" diameter) then left to L = 15'.

Q = 25 c.f.s. d = 18": Enter at Q = 25 c.f.s. then up to 18" pipe then left to L = 19'.

Designer must note that lengths obtained accordingly are minimums, and must be lengthened as necessary to obtain a layout which conforms to mattress dimensions.

Construction plans, at each point of discharge, must shown an enlarged diagram giving specific size and placement of each basket.

#### **6.4.7-2 Other Types**

Outfall protection other than gabion mattress must be approved in advance by the Department and shall be individually designed on a case by case basis.

#### **6.4.8 Open Channels**

Include ditches, swales, channels or other waterways and shall be either "V" shape or trapezoidal (flat bottom)

#### 6.4.8-1 Limiting Velocities

Limiting velocities for type of stabilization:

Type of Stabilization	Maximum Velocity (Feet per second)
Seed and Mulch (n = 0.030)	2.5
Solid sodding (n=0.030)	4.0
Jute, excelsior or coconut shell matting (n=0.030)	4.5
Synthetic Fiber matting* (See note below)	7.5
Concrete lined, concrete block or gabions	no max.

\*NOTE: Where normal depth  $\leq 0.5'$ ,  $n=0.024$   
Where normal depth  $> 0.5'$ ,  $n=0.020$

TABLE 6.00

#### 6.4.8-2 Stabilization

Stabilization shall extend across bottom of waterway and up both sides to an elevation 0.5' higher than normal depth ( $d_n$ ).

#### 6.4.8-3 Detailed Plan

A detailed plan, cross-section, and instructions for installation of lining material must be included on construction plans.

#### 6.4.8-4 Side Slopes

Except for roadside "V" ditches (which have 3:1 and 2:1 slopes) side slopes of open channels shall generally not be steeper than 4:1.

#### **6.4.8-5 Freeboard**

Minimum freeboard shall be 0.75 feet (9").

#### **6.4.8-6 Depth of Open Channels**

Maximum depth of open channels shall be five feet (5'), including allowance for freeboard.

#### **6.4.8-7 Plans and Profiles**

Plans and profiles for open channels and roadside ditches must contain, at a minimum, the following:

- a. Limits of construction; given by note and station value or dimensions.
- b. Type of stabilization and limits of each type by station or dimension. Refer to Table 6.00 of this section for limiting velocities.
- c. Typical cross-section; indicating width, side slope ration, constructed depth and type and thickness of surface material.
- d. In cases of open channels (other than roadside ditches), a profile view shall be required. In addition, plan must show complete existing and proposed grade contours along with such notes and dimensions as may be necessary to permit accurate construction. Open channels which are designed to cross a property (not with the common property line) must provide a flat enough side slope (4:1 or flatter) to allow safe access for the operation of ground maintenance equipment (e.g. riding mowers) to both sides of the waterway.
- e. In cases of roadside ditches, a dimension from centerline of road to centerline of ditch along with elevation of ditch, shall be given on plan view at fifty-foot (50') intervals, corresponding to centerline stationing of road. Arrows indicating direction of flow shall be drawn at centerline of ditch. Though not a general requirement for roadside ditches, existing and proposed grade contours shall be shown where requested or where necessary to clearly convey intent of plan. Invert elevations of roadside ditches shall also be shown on road cross-sections.
- f. A tabulation of Hydraulic Data must be shown on plans along with typical cross-section. Hydraulic Data shall include:  $Q$ , slope,  $n$ ,

waterway area (A), wetted perimeter (W.P.), hydraulic radius (r), normal depth ( $d_n$ ), and velocity (V).

## **6.4.9 Drainage Plans**

### **6.4.9-1 Information Required**

Plan views of storm drainage systems shall be shown on road construction plans. Plans shall be arranged so that entire drainage system is shown. If necessary, match lines will be permitted, but broken views which do not represent true length of system will not be permitted.

Both plan and profile views shall be provided for all drainage systems, including open channels. Limits of work by station or other clear reference must be given on both views. Profile views of pipe systems shall indicate diameter and type of pipe, slope (in percent). Quantity of flow (in cubic feet per second, c.f.s.), and actual velocity ( $V_o$ ) in feet per second (f.p.s.).

Proposed grading shall be shown where changes of existing drainage patterns are planned and for all new open channels.

Grading contours for roadside ditches along open section roadways will not generally be required. They may be required in instances where abnormal drainage patterns, heavy cuts, or fill, or other unusual circumstances are encountered.

### **6.4.10 Cross-Culverts**

Cross-culverts are storm drainage systems placed for conveying drainage previously collected in an open channel, existing or manmade, from one side of the road to the other. In instances where Water Resources Administration, Department of Natural Resources or other State or Federal Agency requirements differ from this criteria, the requirements and procedures of that agency shall govern.

#### **6.4.10-1 General**

Cross-culverts may be single or multi-cell pipes or box culverts, and shall be placed so as to have the least possible effect on existing waterways.

Where multi-cell installations are necessary, sufficient separation must be provided to allow proper compaction. Minimum requirement is three feet (3') or one-half ( $\frac{1}{2}$ ) the

pipe diameter, whichever is greater.

#### 6.4.10-2 Design

- a. Twenty-five (25) year post-development storm.
- b. End treatment is required. Preferred method is concrete endwalls. Prefabricated end sections may be used provided there is no live or base flow. Where base flow exists, even if only seasonal, concrete endwalls are required.
- c. In cases where base flow exists or where pipe diameter is thirty inches (30") or larger, cross-culvert must be reinforced concrete pipe, Class IV.
- d. A completed Culvert Analysis Form must be provided for each culvert and must contain computations for both inlet and outlet control conditions.
- e. Maximum headwater elevation (freeboard) shall be 0.75 feet (9") below outside edge of shoulder at lowest point in profile.
- f. Headwater pool and elevation must be shown on plans and must be completely enclosed in a drainage and utilities easement.

**NOTE:** Section 6.4.11 has been deleted in its' entirety. Please refer to the Carroll County Floodplain Management Manual.

#### ~~6.4.11 Flood Plains~~

When a proposed development, site plan, or subdivision contains, or may be affected by, an existing watercourse which has live or base flow, even if only seasonal, or the watercourse has a contributory area of seventy-five (75) acres or more, determination of the 100-year floodplain shall be required. When determination of 100-year floodplain is to be made, the following information is required to be submitted for review and approval:

#### 6.4.11-1 Information and Methodology Required

1. Stream cross-sections, taken at locations along the watercourse where flow is most constricted, or at intervals of approximately three hundred feet (300'). Cross-sections shall be plotted on a scale not smaller than 1" = 20' horizontal and 1" = 5' vertical. Sections must be accurately cross referenced on drainage area map.

2. The following methods shall be acceptable for determination of the volume of runoff: TR-55 TR-20, or the rational method. The following method shall be acceptable for determination of water surface elevation: reservoir routing/TR-20 (where applicable) or HEC-II. Other methodology may be acceptable with prior approval from the Carroll County Department of Public Works.
3. The following information must be submitted for review as a part of construction plan package: drainage area map, computation sheets or computer printout, and cross sections showing 100-year elevation.
4. Final floodplain elevation plus allowance for freeboard shall be established by metes and bounds description, and shall be identified on the record plat and the road construction plan or site plan as "100-year Floodplain and Drainage and Utilities Easement."

#### **6.4.11-2 Freeboard**

Where flood plain elevations are based on field data and where computations have been approved by the Department, a minimum one foot (1.0') of freeboard shall be required. Where flood plain elevation is based on Flood Insurance Maps or other recognized source, the Department may waive requirement for field run data and computations, in which case three feet (3.0') of freeboard is required above elevation given on map.

#### **6.4.12 Subsurface Drainage**

##### **6.4.12-1 Underdrains**

Underdrains are perforated pipe drains placed in an envelope of stone and are for the purpose of draining subsurface water from beneath roadways. It is the responsibility of the Surveyor or Engineer to be familiar with hydrogeologic conditions at construction sites and to incorporate underdrains under roadways wherever there may be potential for subgrade saturation. Refer to S.H.A. Standard No. MD-387.01 and MD-387.11, or latest addenda thereof, for details of installation and materials.

#### 6.4.12-2 Subgrade Drains

Subgrade Drains (See Plate 43-A) unless otherwise directed, shall consist of a one foot wide by one foot deep stone filled trench containing a 4" diameter perforated pipe. Subgrade drains shall be installed as a standard item on open section roadways. Subgrade drains shall be placed directly beneath outer edges of the Graded Aggregate Base of roadway and shall run continuously with the road base. In cases of Collector Roads, edge of road shall be edge of paved shoulder. For closed section roads, Standard Underdrains (Plate 44) will be used only if, and where, directed by the county inspector, or as shown on approved construction plans.

Pipe shall be 4" diameter perforated, and may be either Schedule 40 PVC or HDPE (type SP). Stone shall be clean #57 aggregate. Permeable filter cloth shall be placed on top of trench separating trench stone from road base stone. Standard prefabricated fittings, installed in accordance with manufacturers recommendations, shall be used for abrupt changes in direction or when joining pipe systems. Fittings will not be required for normal undulations in road profile.

Subgrade Drains shall have a positive outfall (daylight). Whenever possible, outfall shall be into an existing ditch, constructed roadside ditch or other waterway. When possible, subgrade drain outfall pipes should be set above the flowing depth or headwater pool of the receiving watercourse. Where outfall will be placed in upland areas, a standard 5" Concrete Gutter will be used (see Plate 44). Final 10' section of pipe (at outfall) shall be non-perforated, trench for final 10' section shall be backfilled with earth.

Where a cross culvert will conflict with installation of subgrade drain, subgrade drain will terminate near the culvert and discharge into the roadside ditch. Where road improvements are being made along an existing county road which include the addition of a paved widening such as a turn lane, by-pass lane or auxiliary lane, subgrade drains shall be installed.

There might be times when an optional type of Subgrade Drain installation is allowed. If approved by the Bureau of Engineering, the installation shall be in accordance with Plate 43, and consist of 2' wide channels filled with No. 57 aggregate and are for the purpose of acting as a relief outlet for any subsurface water under the roadway paving. These drains, if allowed, are to be constructed on a regular basis in open section roadway, and on a case by case basis in closed section roadways, regardless of whether water is evident or not.

##### A. Open Section Roads

Optional subgrade drains, as shown on Plate 43, shall be installed on all open section roads. Installation shall be at low point in road, and at 25-foot intervals each direction for 125 feet, then at 100-foot intervals thereafter to within 125 feet of crest of vertical curve. Where road is on continual up or down grade and has no low point, subgrade drains shall be installed on 100-foot intervals. Where roadways are in superelevation, subgrade drains must be installed as noted above, except beginning at half level section, continuing through curve to ending half level sections, drains shall be only on low side of superelevation.

These drains shall begin at edge of paving and shall extend both right and left to roadside ditch.

**B. Closed Section Roads**

In general, optional subgrade drains shall be designed and constructed on a case-by-case basis. Engineer or Surveyor shall inform the Department of any areas which are or may become saturated. Department will work with Engineer or Surveyor to develop a layout for subgrade drains.

**6.4.12-3 Information Required**

Subgrade drains must be shown, along with all appropriate construction information, on construction plans when first submitted for review.

Plans must include a typical section of subgrade drains and a tabular chart giving centerline station, length left, length right, and total length.

**6.4.13 Protection of Downstream Properties**

Development of property generally involves changing of existing flow patterns, and concentration of runoff. These often result in increased quantities and velocities of site discharge even though drainage areas may not change. If 10-year discharge is increased because of development, Developer shall be responsible to construct new facilities, or upgrade existing facilities, as necessary, to handle flow. Engineer shall provide a detailed analysis of existing culverts which are subject to flows from a development site, and must present detailed information pertaining to receiving ditch, or waterway, into which pipe discharges. Analysis must contain, at a minimum, the following:

- a. Pre and post-development areas,
- b. Pre and post-development runoff calculations based on 10 year frequency storm.
- c. Plan showing location and dimensions of receiving ditch or waterway. Plan must extend to the length necessary to insure drainage is conveyed to an existing stabilized watercourse. Plan must show existing houses, garages, buildings or other surface features, with elevations, which may be subject to flooding.
- d. Cross-section of receiving ditch, or waterway, at intervals necessary to insure adequate capacity to handle anticipated flows. Sections should be on a scale of 1" = 20' horizontal and 1" = 5' vertical and must show 10-year pre and post-development water levels.

Developer of a project shall be responsible to acquire any drainage or construction easements necessary for, and shall improve or construct or improve existing drainage facilities of adequate capacity to handle the 10-year post-development storm. Approval of construction plans by the Department of Public Works shall not relieve the Engineer and Developer of their responsibility to protect downgrade properties from drainage caused by changed or increased flows, or insufficient sediment control measures.



**APPENDIX A**

**DESIGN DATA CHARTS**

## APPENDICES

### APPENDIX A - DESIGN DATA

#### C VALUES

Rural Land Uses	A - 1a
Agricultural Land Uses	A - 1b
Agricultural Land Uses	A - 1c
Urban Land Uses	A - 1d

#### TIME OF CONCENTRATION

Overland Sheet Flow	A - 2a
Swale Flow Velocity (n=0.06)	A - 2b
Swale Flow Velocity (n=0.015)	A - 2c
Ditch Flow Velocity (n=0.04)	A - 2d
Ditch Flow Velocity (n=0.015)	A - 2e
Gutter Flow Velocity	A - 2f
Stream Velocities	A - 2g

#### RAINFALL INTENSITY CHARTS

5.0 mins. to 10.0 mins.	A - 3a
10.0 mins. to 14.9 mins.	A - 3b
15.0 mins. to 19.9 mins.	A - 3c

#### MANNING ROUGHNESS COEFFICIENTS

Culverts	A - 4a
Gutter Ditches and Channels	A - 4c

#### GUTTER FLOW\SPREAD

Nomograph	A - 5a
Flow Characteristic Curves	A - 5b

#### INLET CAPACITY CHARTS

Single WR	A - 6a
Standard WR	A - 6b
Capacity of Curb Opening Inlet on Continuous Grade	A - 6c

## HYDRAULIC GRADIENT

Head Losses in Inlets	A - 7a
Head Losses in Manholes	A - 7b
Head Losses in Bends	A - 7c

## PIPE CULVERTS

Headwater Depth for Concrete Pipe with Inlet Control	A - 8a
Headwater Depth for Corrugated Metal Pipe with Inlet Control	A - 8b
Headwater Depth for Corrugated Metal Pipe Arch with Inlet Control	A - 8c
Critical Depth - Circular Pipe	A - 8d
Critical Depth - Corrugated Metal Pipe Arch	A - 8e
Head for Concrete Pipe	A - 8f
Head for Corrugated Metal Pipe	A - 8g
Head for Corrugated Metal Pipe Arch	A - 8h

## OUTFALL PROTECTION

Maximum Tailwater Condition	A - 9a
Minimum Tailwater Condition	A - 9b

Part 1 Rational Formula Coefficients SCS Hydrologic Soil Groups (A,B,C,D)

Rural Land Uses

- 1) Storm Frequencies of Less Than 25 Years
- 2) Storm Frequencies of 25 Years or Greater

Land Use	Treatment/ Practice	Hydrologic Condition	A			B			C			D		
			0-2%	2-6%	6%+	0-2%	2-6%	6%+	0-2%	2-6%	6%+	0-2%	2-6%	6%+
Pasture or range	poor	poor	0.23	0.25	0.26	0.31	0.33	0.34	0.37	0.38	0.39	0.40	0.41	0.42
			0.27	0.29	0.31	0.36	0.37	0.39	0.42	0.43	0.44	0.45	0.46	0.47
	fair	fair	0.12	0.13	0.15	0.24	0.25	0.27	0.31	0.33	0.34	0.36	0.37	0.38
0.15			0.17	0.19	0.26	0.30	0.32	0.36	0.37	0.39	0.40	0.41	0.43	
	Contoured	good	0.07	0.09	0.10	0.16	0.20	0.22	0.27	0.29	0.31	0.32	0.34	0.35
			0.09	0.11	0.13	0.22	0.24	0.26	0.32	0.33	0.35	0.37	0.38	0.40
			0.11	0.12	0.14	0.22	0.24	0.26	0.33	0.34	0.36	0.39	0.40	0.41
	Meadow	fair	0.06	0.07	0.08	0.17	0.19	0.21	0.26	0.30	0.31	0.35	0.36	0.37
			0.07	0.08	0.10	0.21	0.23	0.25	0.32	0.34	0.36	0.39	0.40	0.45
			0.03	0.04	0.06	0.11	0.12	0.14	0.24	0.26	0.28	0.31	0.33	0.34
	Wooded	poor	0.06	0.08	0.10	0.10	0.14	0.19	0.12	0.17	0.22	0.15	0.20	0.25
			0.08	0.11	0.14	0.13	0.18	0.22	0.16	0.20	0.26	0.21	0.25	0.32
			0.10	0.12	0.13	0.13	0.15	0.20	0.16	0.19	0.23	0.16	0.22	0.27
		good	0.06	0.08	0.09	0.10	0.13	0.18	0.11	0.15	0.20	0.13	0.18	0.23
			0.08	0.10	0.12	0.13	0.17	0.21	0.15	0.18	0.24	0.16	0.22	0.29
			0.05	0.07	0.08	0.08	0.11	0.15	0.10	0.13	0.17	0.12	0.15	0.21
			0.06	0.09	0.11	0.11	0.15	0.18	0.13	0.17	0.15	0.19	0.25	

PART 2A Rational Formula Coefficients SCS Hydrologic Soil Groups (A,B,C,D)

Agricultural Land Uses

- 1) Storm Frequencies of Less Than 25 Years
- 2) Storm Frequencies of 25 Years or Greater

Land Use	Treatment/ Practice	Hydrologic Condition	A			B			C			D		
			0-2%	2-6%	6%+	0-2%	2-6%	6%+	0-2%	2-6%	6%+	0-2%	2-6%	6%+
Fallow	Straight row		0.41	0.48	0.53	0.60	0.66	0.71	0.72	0.78	0.82	0.84	0.88	0.91
			0.57	0.64	0.69	0.70	0.76	0.80	0.83	0.88	0.91	0.95	0.97	0.98
Row Crops	Straight row	poor	0.31	0.36	0.39	0.54	0.58	0.62	0.70	0.74	0.77	0.75	0.78	0.80
		good	0.45	0.50	0.54	0.65	0.70	0.73	0.82	0.86	0.88	0.86	0.88	0.89
	Contoured	poor	0.24	0.30	0.35	0.43	0.46	0.52	0.61	0.65	0.68	0.73	0.76	0.78
		good	0.38	0.44	0.49	0.60	0.64	0.67	0.75	0.77	0.79	0.83	0.85	0.86
	Contoured and terraced	poor	0.28	0.34	0.39	0.51	0.55	0.59	0.61	0.65	0.68	0.70	0.74	0.77
		good	0.43	0.48	0.52	0.84	0.68	0.71	0.73	0.76	0.78	0.84	0.86	0.88
		poor	0.21	0.26	0.30	0.41	0.45	0.49	0.55	0.59	0.63	0.63	0.66	0.68
		good	0.33	0.38	0.42	0.56	0.60	0.64	0.69	0.72	0.74	0.74	0.76	0.77
	Straight row	poor	0.26	0.30	0.34	0.38	0.42	0.46	0.50	0.54	0.57	0.56	0.59	0.61
		good	0.38	0.42	0.46	0.52	0.57	0.62	0.66	0.70	0.74	0.69	0.72	0.74
Small Grain	Straight row	poor	0.20	0.24	0.27	0.31	0.35	0.39	0.45	0.48	0.51	0.55	0.58	0.60
		good	0.34	0.37	0.40	0.45	0.49	0.53	0.61	0.64	0.67	0.68	0.70	0.72
		poor	0.42	0.28	0.32	0.43	0.47	0.51	0.62	0.65	0.68	0.72	0.74	0.78
		good	0.37	0.40	0.43	0.59	0.63	0.66	0.73	0.76	0.78	0.84	0.86	0.87
		poor	0.23	0.26	0.29	0.42	0.45	0.48	0.57	0.60	0.62	0.71	0.73	0.75
		good	0.35	0.38	0.41	0.57	0.60	0.63	0.70	0.73	0.75	0.83	0.85	0.86

PART 2B Rational Formula Coefficients SCS Hydrologic Soil Groups (A,B,C,D)

Agricultural Land Uses

- 1) Storm Frequencies of Less Than 25 Years
- 2) Storm Frequencies of 25 Years or Greater

Land Use	Treatment/ Practice	Hydrologic Condition	A			B			C			D		
			0-2%	2-6%	6%+	0-2%	2-6%	6%+	0-2%	2-6%	6%+	0-2%	2-6%	6%+
Small Grain	Contoured	poor	0.21	0.26	0.30	0.38	0.42	0.46	0.55	0.59	0.62	0.63	0.65	0.67
			0.33	0.38	0.42	0.53	0.57	0.61	0.69	0.72	0.75	0.75	0.77	0.78
		good	0.17	0.22	0.27	0.33	0.38	0.42	0.54	0.58	0.61	0.62	0.65	0.67
			0.29	0.34	0.38	0.50	0.54	0.58	0.67	0.70	0.73	0.74	0.76	0.77
	Contoured and terraced	poor	0.18	0.22	0.26	0.32	0.36	0.40	0.52	0.55	0.58	0.56	0.59	0.61
			0.30	0.34	0.37	0.46	0.50	0.53	0.65	0.68	0.71	0.70	0.72	0.73
		good	0.16	0.20	0.24	0.31	0.35	0.38	0.45	0.48	0.50	0.55	0.58	0.60
			0.28	0.32	0.35	0.44	0.48	0.51	0.62	0.64	0.66	0.68	0.70	0.71
Closed-seeded legumes or rotation meadow	Straight row	poor	0.25	0.30	0.35	0.44	0.48	0.52	0.62	0.65	0.68	0.73	0.76	0.78
			0.37	0.42	0.46	0.60	0.64	0.67	0.74	0.77	0.80	0.83	0.85	0.86
		good	0.15	0.19	0.23	0.31	0.35	0.38	0.55	0.58	0.60	0.63	0.65	0.66
			0.20	0.24	0.28	0.47	0.50	0.53	0.67	0.70	0.72	0.75	0.77	0.78
	Contoured	poor	0.23	0.28	0.32	0.41	0.45	0.49	0.57	0.60	0.63	0.62	0.65	0.67
			0.35	0.40	0.44	0.56	0.60	0.63	0.70	0.73	0.76	0.74	0.77	0.79
		good	0.14	0.18	0.21	0.30	0.34	0.37	0.45	0.48	0.51	0.58	0.60	0.61
			0.24	0.28	0.31	0.42	0.46	0.49	0.61	0.64	0.66	0.71	0.73	0.74
	Contoured and terraced	poor	0.21	0.26	0.30	0.34	0.38	0.42	0.51	0.54	0.57	0.58	0.60	0.61
			0.33	0.38	0.42	0.50	0.54	0.57	0.67	0.70	0.72	0.71	0.73	0.74
		good	0.07	0.10	0.13	0.28	0.32	0.35	0.44	0.47	0.49	0.52	0.54	0.58
			0.20	0.24	0.28	0.40	0.44	0.61	0.61	0.63	0.65	0.68	0.70	0.71

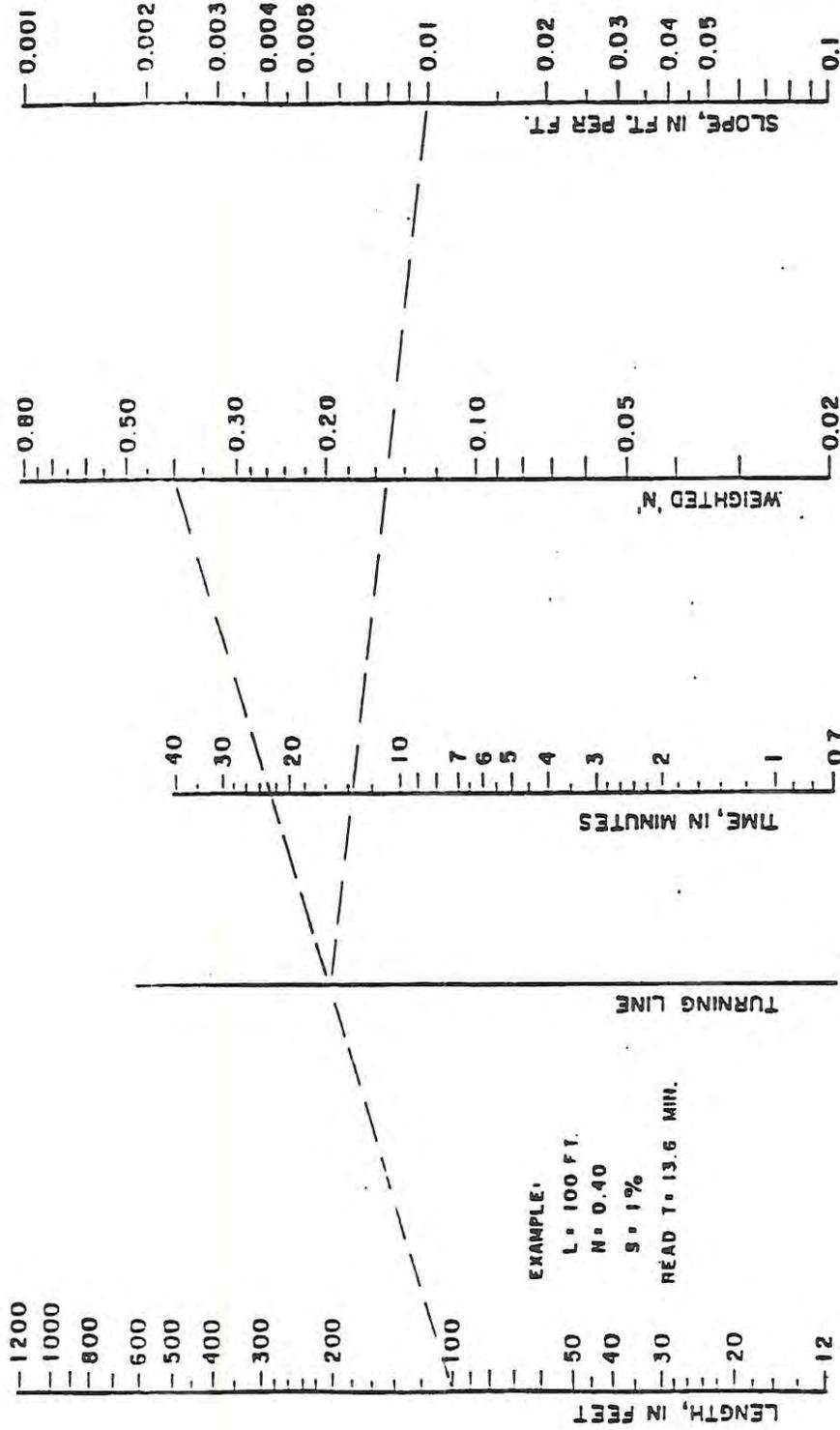
PART 3 National Formula Coefficients SCS Hydrologic Soil Groups (A,B,C,D)

Urban Land Uses

- 1) Storm Frequencies of Less Than 25 Years
- 2) Storm Frequencies of 25 Years or Greater

Land Use	Treatment/ Practice	Hydrologic Condition	A				B				C				D			
			0-2%	2-6%	6%+	6%+	0-2%	2-6%	6%+	6%+	0-2%	2-6%	6%+	6%+	0-2%	2-6%	6%+	6%+
Paved Areas & Impervious surfaces			0.85	0.86	0.87	0.87	0.85	0.86	0.87	0.87	0.85	0.86	0.87	0.87	0.85	0.86	0.87	0.87
			0.95	0.96	0.97	0.97	0.95	0.96	0.97	0.97	0.95	0.96	0.97	0.97	0.95	0.96	0.97	0.97
Open Space - lawns etc.			0.08	0.12	0.15	0.15	0.11	0.16	0.21	0.21	0.14	0.19	0.24	0.24	0.20	0.24	0.29	0.29
			0.11	0.15	0.19	0.19	0.15	0.20	0.26	0.26	0.19	0.24	0.32	0.32	0.25	0.29	0.37	0.37
Industrial			0.67	0.68	0.68	0.68	0.68	0.68	0.69	0.69	0.68	0.69	0.69	0.69	0.69	0.69	0.69	0.69
			0.85	0.85	0.86	0.86	0.85	0.86	0.86	0.86	0.86	0.86	0.87	0.87	0.86	0.86	0.86	0.86
Commercial			0.71	0.71	0.72	0.72	0.71	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
			0.88	0.88	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.90	0.90	0.89	0.89	0.89	0.89
Residential Lot Size 1/8 acre			0.25	0.26	0.31	0.31	0.27	0.30	0.35	0.35	0.30	0.33	0.36	0.36	0.33	0.36	0.42	0.42
			0.33	0.37	0.40	0.40	0.35	0.39	0.44	0.44	0.38	0.42	0.49	0.49	0.41	0.45	0.54	0.54
Lot Size 1/4 acre			0.22	0.26	0.29	0.29	0.24	0.29	0.33	0.33	0.27	0.31	0.36	0.36	0.30	0.34	0.40	0.40
			0.30	0.34	0.37	0.37	0.33	0.37	0.42	0.42	0.36	0.40	0.47	0.47	0.38	0.42	0.52	0.52
Lot Size 1/3 acre			0.19	0.23	0.26	0.26	0.22	0.26	0.30	0.30	0.25	0.29	0.34	0.34	0.28	0.32	0.39	0.39
			0.28	0.32	0.35	0.35	0.30	0.35	0.39	0.39	0.33	0.38	0.45	0.45	0.36	0.40	0.50	0.50
Lot Size 1/2 acre			0.16	0.20	0.24	0.24	0.19	0.23	0.28	0.28	0.22	0.27	0.32	0.32	0.26	0.30	0.37	0.37
			0.25	0.29	0.32	0.32	0.28	0.32	0.36	0.36	0.31	0.35	0.42	0.42	0.34	0.38	0.48	0.48
Lot Size 1 acre			0.14	0.19	0.22	0.22	0.17	0.21	0.26	0.26	0.20	0.25	0.31	0.31	0.24	0.29	0.35	0.35
			0.22	0.26	0.29	0.29	0.24	0.28	0.34	0.34	0.28	0.32	0.40	0.40	0.31	0.35	0.46	0.46

FOR RECOMMENDED VALUES OF 'N' AND 'L' SEE TABLE SIA-61.1-402.0



EXAMPLE:

L = 100 FT.

N = 0.40

S = 1%

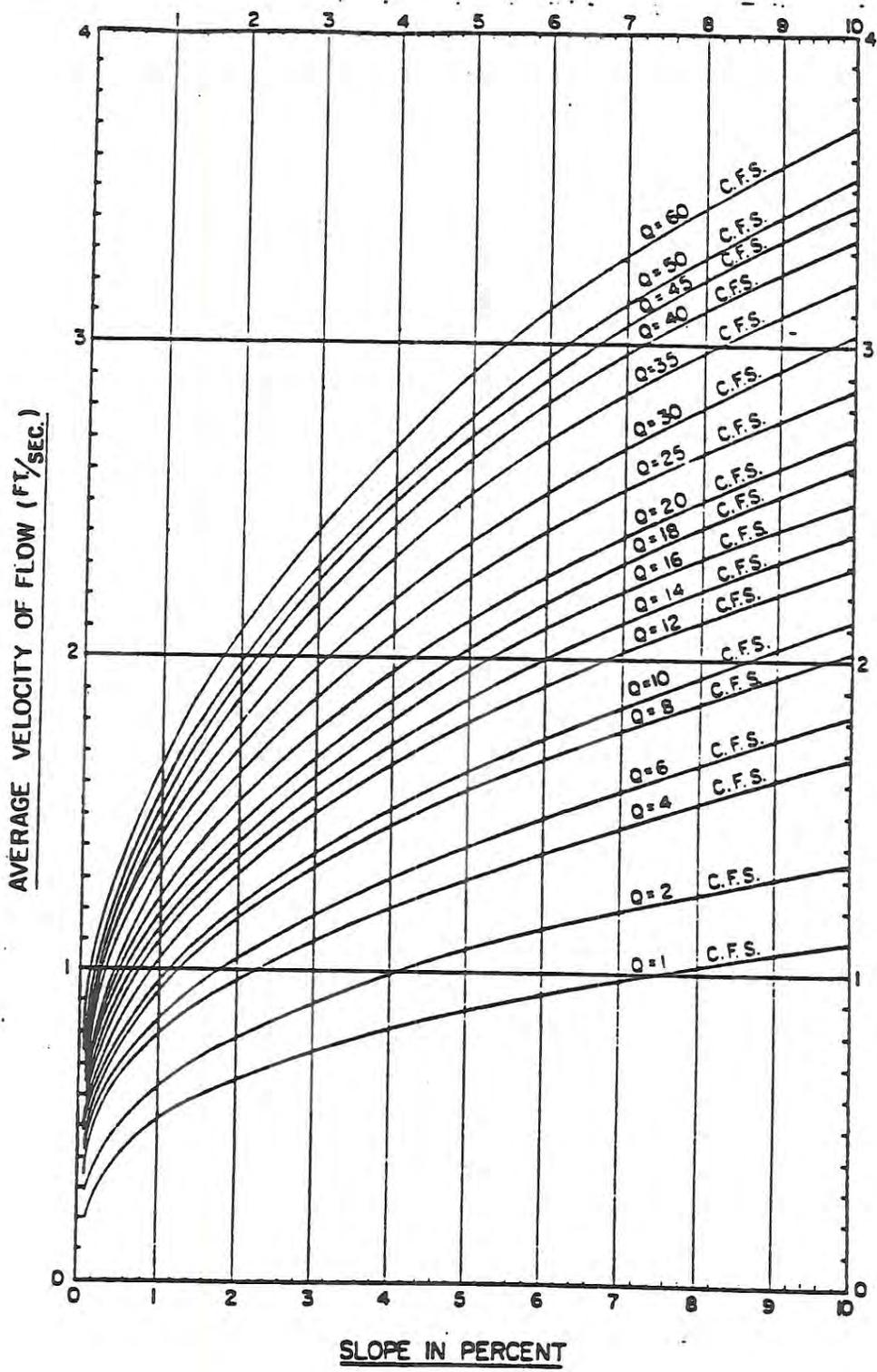
READ T = 13.6 MIN.

## OVERLAND SHEET FLOW

MARYLAND STATE HIGHWAY ADMINISTRATION

SOURCE ARTICLE BY W.S. KERBY  
MARCH 1959 ISSUE  
'CIVIL ENGINEERING'

SIA-61.1-402.1  
REVISED 1-1-77



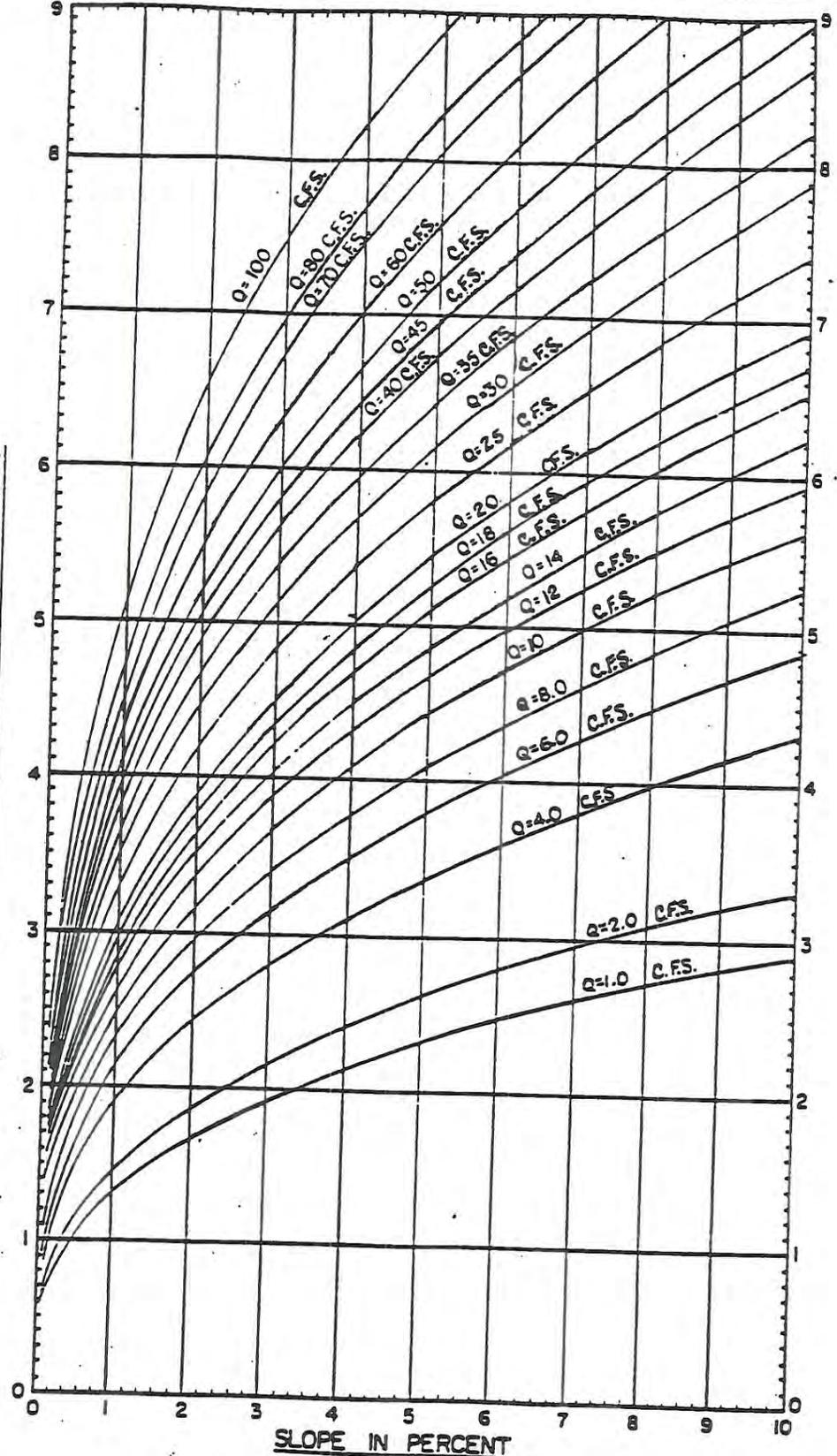
SWALE FLOW VELOCITY

(N=0.06)

MARYLAND STATE HIGHWAY ADMINISTRATION

8/5/80  
SHA-61.1-4C2.3

AVERAGE VELOCITY OF FLOW (FT./SEC.)

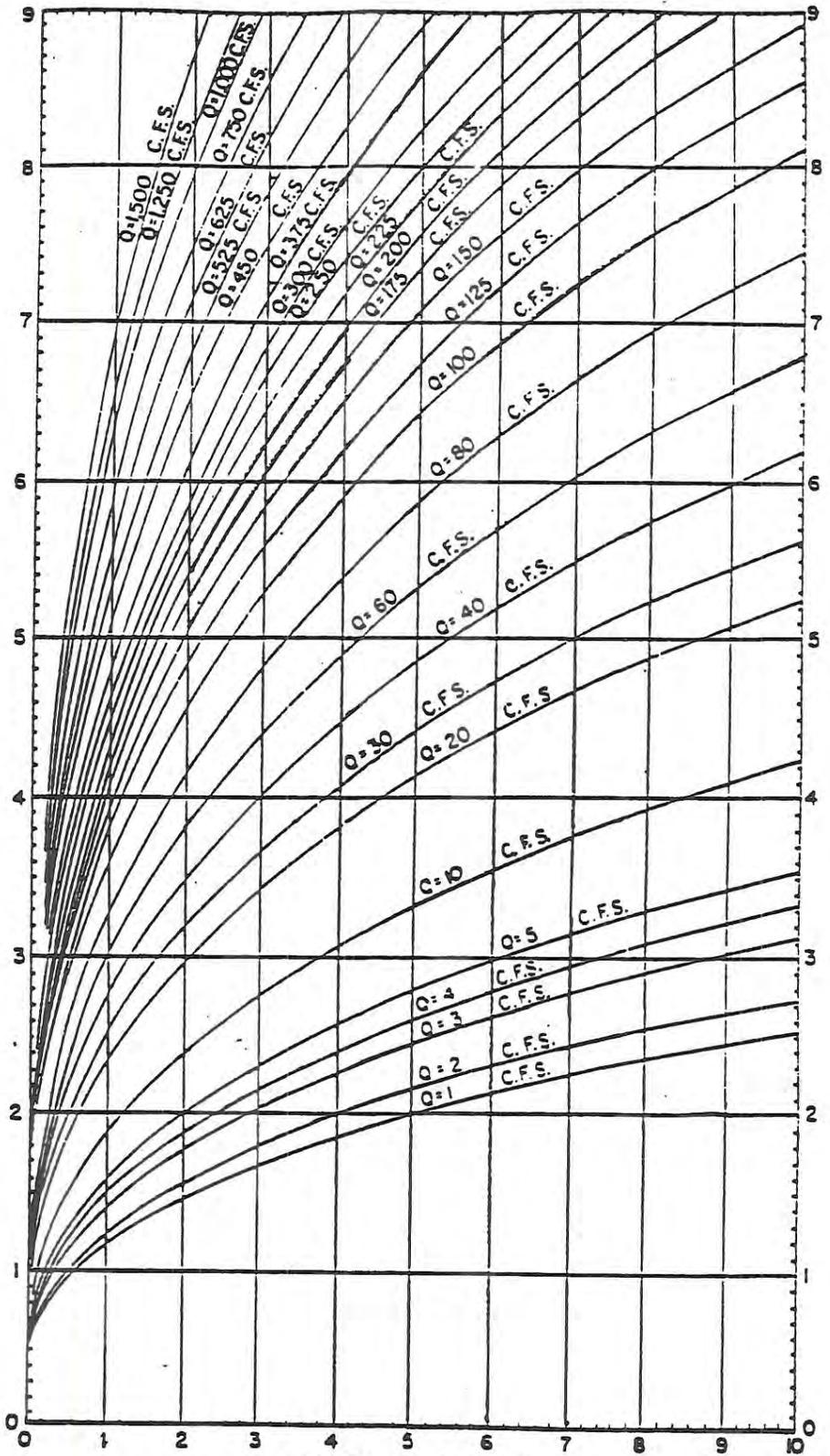


SWALE FLOW VELOCITY  
(N = 0.015)

MARYLAND STATE HIGHWAY ADMINISTRATION

8/5/80  
SHA.-61.1-402.4

AVERAGE VELOCITY OF FLOW (FT./SEC.)



SLOPE IN PERCENT

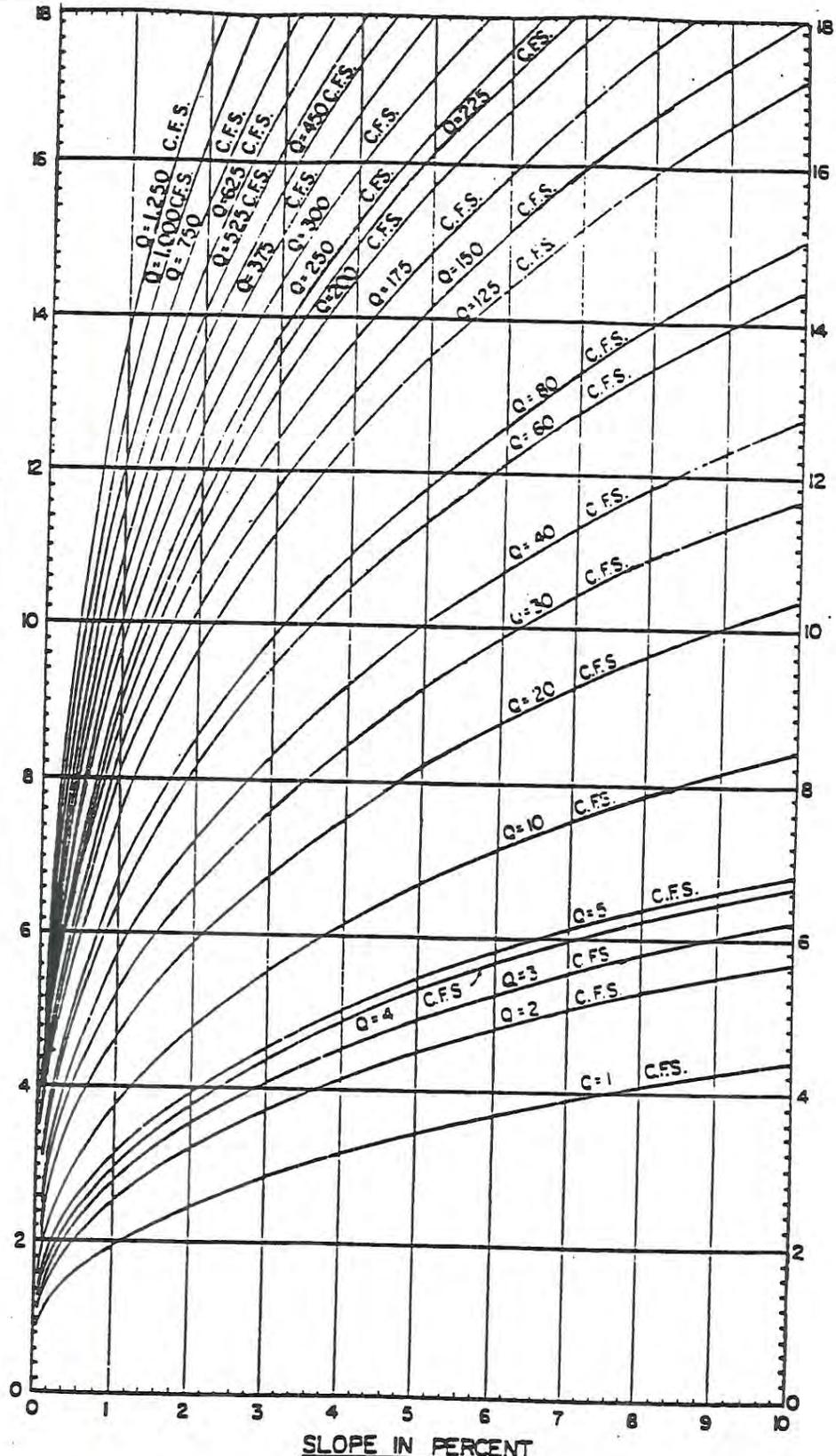
DITCH FLOW VELOCITY

(N=0.04)

MARYLAND STATE HIGHWAY ADMINISTRATION

8/5/80  
SHA-61.1-402.5

AVERAGE VELOCITY OF FLOW (FT./SEC.)



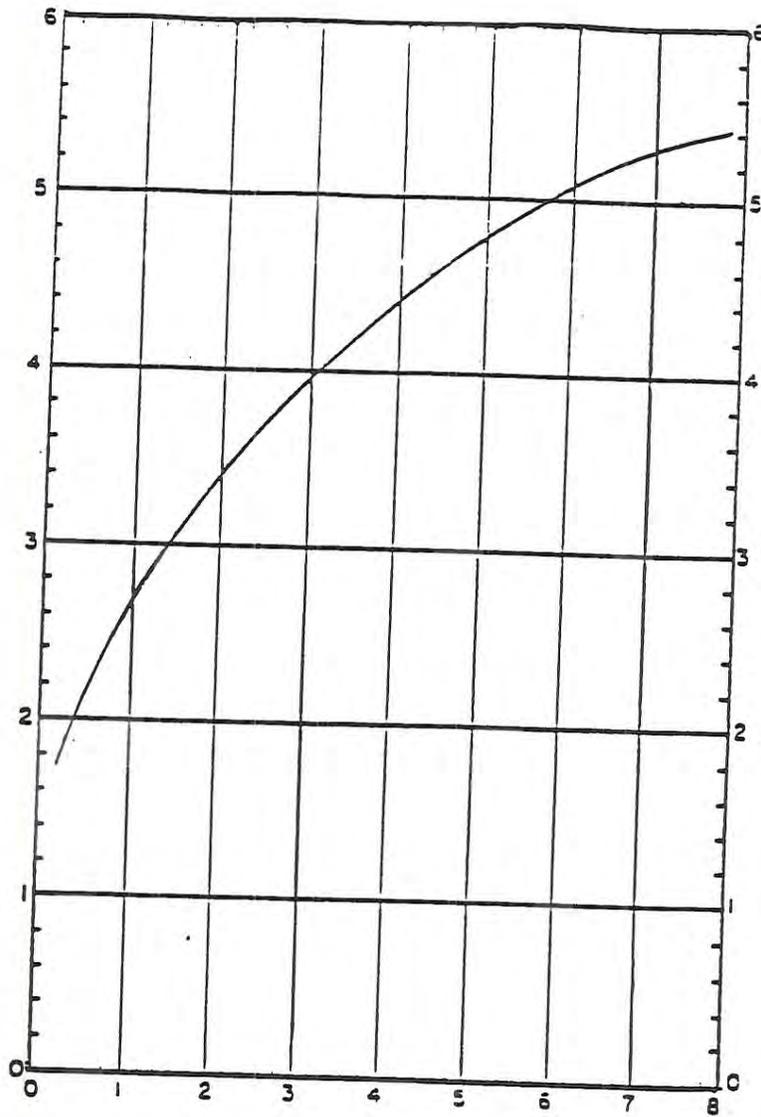
SLOPE IN PERCENT

DITCH FLOW VELOCITY  
(N=0.015)

MARYLAND STATE HIGHWAY ADMINISTRATION

8/5/88  
SHA-61.1-402.6

AVERAGE VELOCITY OF FLOW (FT./SEC.)



SLOPE IN PERCENT

GUTTER FLOW VELOCITY

MARYLAND STATE HIGHWAY ADMINISTRATION

8/5/80  
SHA-61.1-402.7

TABLE I	
STREAM VELOCITIES FOR VARIOUS SLOPES TO BE USED FOR COMPUTING TIME OF CONCENTRATION	
Slopes %	Velocity ft./sec.
0.10	1.7
0.15	1.9
0.20	2.2
0.30	2.5
0.40	2.7
0.50	3.1
0.60	3.4
0.70	4.0
0.75	4.3
0.833	4.5
1.00	4.8
1.25	5.1
1.50	5.5
1.75	6.1
2.00	6.7
2.25	7.3
2.50	7.8
2.75	8.3
3.00	8.7
3.25	9.0

Source: Highway Drainage Manual, Maryland State Highway Administration, 1981

RAINFALL, INTENSITY - FREQUENCY - DURATION  
(INCHES PER HOUR)

MIN.	RETURN PERIOD (YEARS)						
	1	2	5	10	25	50	100
5.00	4.40	5.38	6.39	7.00	8.00	8.70	9.50
5.10	4.38	5.36	6.37	6.98	7.97	8.68	9.48
5.20	4.36	5.33	6.34	6.95	7.94	8.66	9.46
5.30	4.34	5.31	6.32	6.93	7.91	8.64	9.44
5.40	4.32	5.28	6.29	6.91	7.88	8.62	9.42
5.50	4.30	5.26	6.27	6.89	7.85	8.60	9.40
5.60	4.28	5.23	6.25	6.86	7.82	8.58	9.38
5.70	4.26	5.21	6.22	6.84	7.79	8.56	9.36
5.80	4.24	5.18	6.20	6.81	7.76	8.54	9.34
5.90	4.22	5.16	6.17	6.79	7.73	8.52	9.32
6.00	4.20	5.13	6.15	6.77	7.70	8.50	9.30
6.10	4.18	5.10	6.12	6.75	7.68	8.48	9.27
6.20	4.16	5.06	6.10	6.72	7.67	8.46	9.24
6.30	4.14	5.03	6.07	6.70	7.66	8.44	9.21
6.40	4.12	5.00	6.04	6.68	7.64	8.42	9.18
6.50	4.10	4.97	6.02	6.66	7.63	8.40	9.15
6.60	4.08	4.93	5.99	6.63	7.61	8.38	9.12
6.70	4.06	4.90	5.96	6.61	7.60	8.36	9.09
6.80	4.04	4.87	5.93	6.59	7.58	8.34	9.06
6.90	4.02	4.83	5.91	6.56	7.57	8.32	9.03
7.00	4.00	4.80	5.88	6.54	7.55	8.30	9.00
7.10	3.99	4.80	5.86	6.52	7.53	8.28	8.98
7.20	3.97	4.79	6.49	6.49	7.50	8.25	8.96
7.30	3.96	4.79	5.83	6.47	7.48	8.23	8.94
7.40	3.94	4.78	5.81	6.45	7.45	8.20	8.92
7.50	3.93	4.78	5.80	6.43	7.45	8.18	8.90
7.60	3.91	4.77	5.78	6.40	7.40	8.15	8.88
7.70	3.90	4.77	5.76	6.38	7.38	8.13	8.86
7.80	3.88	4.76	5.74	6.36	7.35	8.10	8.84
7.90	3.87	4.76	5.73	6.33	7.33	8.08	8.82
8.00	3.85	4.75	5.71	6.31	7.30	8.05	8.80
8.10	3.83	4.73	5.68	6.30	7.27	8.03	8.78
8.20	3.81	4.70	5.66	6.28	7.24	8.00	8.76
8.30	3.79	4.68	5.63	6.27	7.21	7.98	8.74
8.40	3.77	4.65	5.61	6.25	7.18	7.95	8.72
8.50	3.75	4.63	5.58	6.24	7.15	7.93	8.70
8.60	3.73	4.60	5.55	6.23	7.12	7.90	8.68
8.70	3.71	4.58	5.53	6.21	7.09	7.88	8.66
8.80	3.69	4.55	5.50	6.20	7.06	7.85	8.64
8.90	3.67	4.53	5.48	6.18	7.03	7.83	8.62
9.00	3.65	4.50	5.45	6.17	7.00	7.80	8.60
9.10	3.64	4.48	5.43	6.14	6.98	7.78	8.57
9.20	3.62	4.47	5.40	6.11	6.95	7.76	8.54
9.30	3.61	4.45	5.38	6.08	6.93	7.74	8.51
9.40	3.59	4.43	5.35	6.05	6.91	7.72	8.48
9.50	3.58	4.42	5.33	6.02	6.89	7.70	8.45
9.60	3.56	4.40	5.30	5.98	6.86	7.68	8.42
9.70	3.55	4.38	5.28	5.95	6.84	7.66	8.39
9.80	3.53	4.36	5.25	5.92	6.82	7.64	8.36
9.90	3.52	4.35	5.23	5.89	6.79	7.62	8.33
10.00	3.50	4.33	5.20	5.86	6.77	7.60	8.30

USE S.H.A. - 61.1 - 403.1 FOR RAINFALL INTENSITY FACTORS

RAINFALL, INTENSITY - FREQUENCY - DURATION  
(INCHES PER HOUR)

MIN.	RETURN PERIOD (YEARS)						
	1	2	5	10	25	50	100
10.10	3.49	4.32	5.19	5.84	6.75	7.58	8.28
10.20	3.48	4.30	5.17	5.83	6.73	7.56	8.26
10.30	3.46	4.29	5.16	5.81	6.72	7.54	8.24
10.40	3.45	4.28	5.14	5.80	6.70	7.52	8.22
10.50	3.44	4.27	5.13	5.78	6.68	7.50	8.20
10.60	3.43	4.25	5.12	5.76	6.66	7.48	8.18
10.70	3.42	4.24	5.10	5.75	6.64	7.46	8.16
10.80	3.40	4.23	5.09	5.73	6.63	7.44	8.14
10.90	3.39	4.21	5.07	5.72	6.61	7.42	8.12
11.00	3.38	4.20	5.06	5.70	6.59	7.40	8.10
11.10	3.37	4.19	5.05	5.68	6.57	7.38	8.08
11.20	3.36	4.18	5.03	5.67	6.55	7.36	8.06
11.30	3.34	4.16	5.02	5.65	6.54	7.34	8.04
11.40	3.33	4.15	5.00	5.64	6.52	7.32	8.02
11.50	3.32	4.14	4.99	5.62	6.50	7.31	8.00
11.60	3.31	4.13	4.98	5.60	6.48	7.29	7.98
11.70	3.30	4.12	4.96	5.59	6.46	7.27	7.96
11.80	3.28	4.10	4.95	5.57	6.45	7.25	7.94
11.90	3.27	4.09	4.93	5.56	6.43	7.23	7.92
12.00	3.26	4.08	4.92	5.54	6.41	7.21	7.90
12.10	3.25	4.07	4.91	5.52	6.39	7.19	7.88
12.20	3.24	4.05	4.89	5.51	6.37	7.17	7.86
12.30	3.22	4.04	4.88	5.49	6.35	7.15	7.84
12.40	3.21	4.03	4.86	5.47	6.33	7.13	7.82
12.50	3.20	4.02	4.85	5.46	6.32	7.11	7.80
12.60	3.19	4.00	4.84	5.44	6.30	7.09	7.78
12.70	3.18	3.99	4.82	5.42	6.28	7.07	7.76
12.80	3.16	3.98	4.81	5.40	6.26	7.05	7.74
12.90	3.15	3.96	4.79	5.39	6.24	7.03	7.72
13.00	3.14	3.95	4.78	5.37	6.22	7.01	7.70
13.10	3.13	3.94	4.77	5.35	6.20	6.99	7.68
13.20	3.12	3.93	4.75	5.34	6.18	6.97	7.66
13.30	3.10	3.91	4.74	5.32	6.17	6.95	7.64
13.40	3.09	3.90	4.72	5.31	6.15	6.93	7.62
13.50	3.08	3.89	4.71	5.29	6.13	6.92	7.60
13.60	3.07	3.88	4.70	5.27	6.11	6.90	7.58
13.70	3.06	3.87	4.68	5.26	6.09	6.88	7.56
13.80	3.04	3.85	4.67	5.24	6.08	6.86	7.54
13.90	3.03	3.84	4.65	5.23	6.06	6.84	7.52
14.00	3.02	3.83	4.64	5.21	6.04	6.82	7.50
14.10	3.01	3.82	4.63	5.19	6.02	6.80	7.48
14.20	3.00	3.80	4.61	5.18	6.00	6.78	7.46
14.30	2.98	3.79	4.60	5.16	5.99	6.76	7.44
14.40	2.97	3.78	4.58	5.15	5.97	6.74	7.42
14.50	2.96	3.77	4.57	5.13	5.95	6.72	7.40
14.60	2.95	3.75	4.56	5.11	5.93	6.70	7.38
14.70	2.94	3.74	4.54	5.10	5.91	6.68	7.36
14.80	2.92	3.73	4.53	5.08	5.90	6.66	7.34
14.90	2.91	3.71	4.51	5.07	5.88	6.64	7.32

USE S.H.A. - 61.1 - 403.2 FOR RAINFALL INTENSITY FACTORS

RAINFALL, INTENSITY - FREQUENCY - DURATION  
(INCHES PER HOUR)

Tc MIN	RETURN PERIOD (YEARS)						
	1	2	5	10	25	50	100
15.00	2.90	3.70	4.50	5.05	5.86	6.62	7.30
15.10	2.89	3.69	4.49	5.04	5.85	6.60	7.28
15.20	2.89	3.68	4.48	5.02	5.83	6.59	7.26
15.30	2.88	3.67	4.46	5.01	5.82	6.57	7.25
15.40	2.87	3.66	4.45	5.00	5.81	6.55	7.23
15.50	2.86	3.65	4.44	4.99	5.80	6.54	7.21
15.60	2.85	3.64	4.43	4.97	5.78	6.52	7.19
15.70	2.85	3.63	4.42	4.96	5.77	6.50	7.17
15.80	2.84	3.62	4.40	4.95	5.76	6.48	7.16
15.90	2.84	3.61	4.39	4.93	5.74	6.47	7.14
16.00	2.83	3.60	4.38	4.92	5.73	6.45	7.12
16.10	2.82	3.59	4.37	4.91	5.72	6.43	7.10
16.20	2.82	3.58	4.35	4.89	5.70	6.42	7.08
16.30	2.81	3.57	4.34	4.88	5.69	6.40	7.06
16.40	2.81	3.56	4.33	4.87	5.67	6.39	7.04
16.50	2.80	3.55	4.32	4.86	5.66	6.37	7.03
16.60	2.79	3.54	4.30	4.84	5.65	6.35	7.01
16.70	2.79	3.53	4.29	4.83	5.63	6.34	6.99
16.80	2.78	3.52	4.28	4.82	5.62	6.32	6.97
16.90	2.78	3.51	4.26	4.80	5.60	6.31	6.95
17.00	2.77	3.50	4.25	4.79	5.59	6.29	6.93
17.10	2.76	3.49	4.24	4.78	5.58	6.27	6.91
17.20	2.76	3.48	4.23	4.76	5.56	6.26	6.89
17.30	2.75	3.47	4.21	4.75	5.55	6.24	6.88
17.40	2.74	3.46	4.20	4.74	5.54	6.22	6.86
17.50	2.74	3.45	4.19	4.73	5.53	6.21	6.84
17.60	2.73	3.44	4.18	4.71	5.51	6.19	6.82
17.70	2.72	3.43	4.17	4.70	5.50	6.17	6.80
17.80	2.71	3.42	4.15	4.69	5.49	6.15	6.79
17.90	2.71	3.41	4.14	4.67	5.47	6.14	6.77
18.00	2.70	3.40	4.13	4.66	5.46	6.12	6.75
18.10	2.69	3.39	4.12	4.65	5.45	6.10	6.73
18.20	2.69	3.38	4.10	4.63	5.43	6.09	6.71
18.30	2.68	3.37	4.09	4.62	5.42	6.07	6.69
18.40	2.68	3.36	4.08	4.61	5.40	6.06	6.67
18.50	2.67	3.35	4.07	4.60	5.39	6.04	6.66
18.60	2.66	3.34	4.05	4.58	5.38	6.02	6.64
18.70	2.66	3.33	4.04	4.57	5.36	6.01	6.62
18.80	2.65	3.32	4.03	4.56	5.35	5.99	6.60
18.90	2.65	3.31	4.01	4.54	5.33	5.98	6.58
19.00	2.64	3.30	4.00	4.53	5.32	5.96	6.56
19.10	2.63	3.29	3.99	4.52	5.31	5.94	6.54
19.20	2.63	3.28	3.98	4.50	5.29	5.93	6.52
19.30	2.62	3.27	3.96	4.49	5.28	5.91	6.51
19.40	2.61	3.26	3.95	4.48	5.27	5.89	6.49
19.50	2.61	3.25	3.94	4.47	5.26	5.88	6.47
19.60	2.60	3.24	3.93	4.45	5.24	5.86	6.45
19.70	2.59	3.23	3.92	4.44	5.23	5.84	6.43
19.80	2.58	3.22	3.90	4.43	5.21	5.82	6.42
19.90	2.58	3.21	3.89	4.41	5.20	5.81	6.40

USE S.H.A. - 61.1 - 403.2 FOR RAINFALL INTENSITY FACTORS

**MANNING'S ROUGHNESS COEFFICIENT 'n'**

<b><u>Pipe Material</u></b>	<b><u>Value of "n"</u></b>
Concrete pipe, vitrified clay pipe & cast iron pipe	0.013
Corrugated Exterior and Interior Polyethylene Pipe (PeP)	
3" - 6" Diameter	0.015
8" Diameter	0.016
10" Diameter	0.017
12" - 15" Diameter	0.018
18" - 36" Diameter	0.020
Corrugated Exterior and Smooth Interior Polyethylene Pipe (All Sizes)	0.012
Corrugated Exterior and Smooth Interior Polyvinylchloride Pipe (P.V.C.) All Sizes	0.012
Corrugated Steel/Aluminum Alloy Pipe 2 2/3 x 1/2 helical corrugations	
12" - 36" diameter	0.019
42" - 96" diameter	0.014
Corrugated Steel/Aluminum Alloy Pipe 3 x 1 helical corrugations	
36" - 84" diameter	0.021
96" - 144" diameter	0.024
Corrugated Steel/Aluminum Alloy Pipe 2 2/3 x 1/2 annular corrugations	0.024
Corrugated Steel/Aluminum Alloy Pipe 3 x 1 annular corrugations	0.028
Structural Plate 6 x 2 corrugations	0.034

## MANNING'S ROUGHNESS COEFFICIENT 'n'

<u>Pipe Material</u>	<u>Value of "n"</u>
Corrugated Steel/Aluminum Alloy Pipe Arch	0.024
Corrugated Steel/Aluminum Alloy Pipe 25% paved invert full flow	0.021
Corrugated Steel/Aluminum Alloy Pipe Arch 40% paved invert full flow	0.020
Corrugated Steel/Aluminum Alloy Pipe 100% paved	0.013
Tunnel Liner Plate	0.04 - 0.045
Monolithic Concrete box culverts	0.015

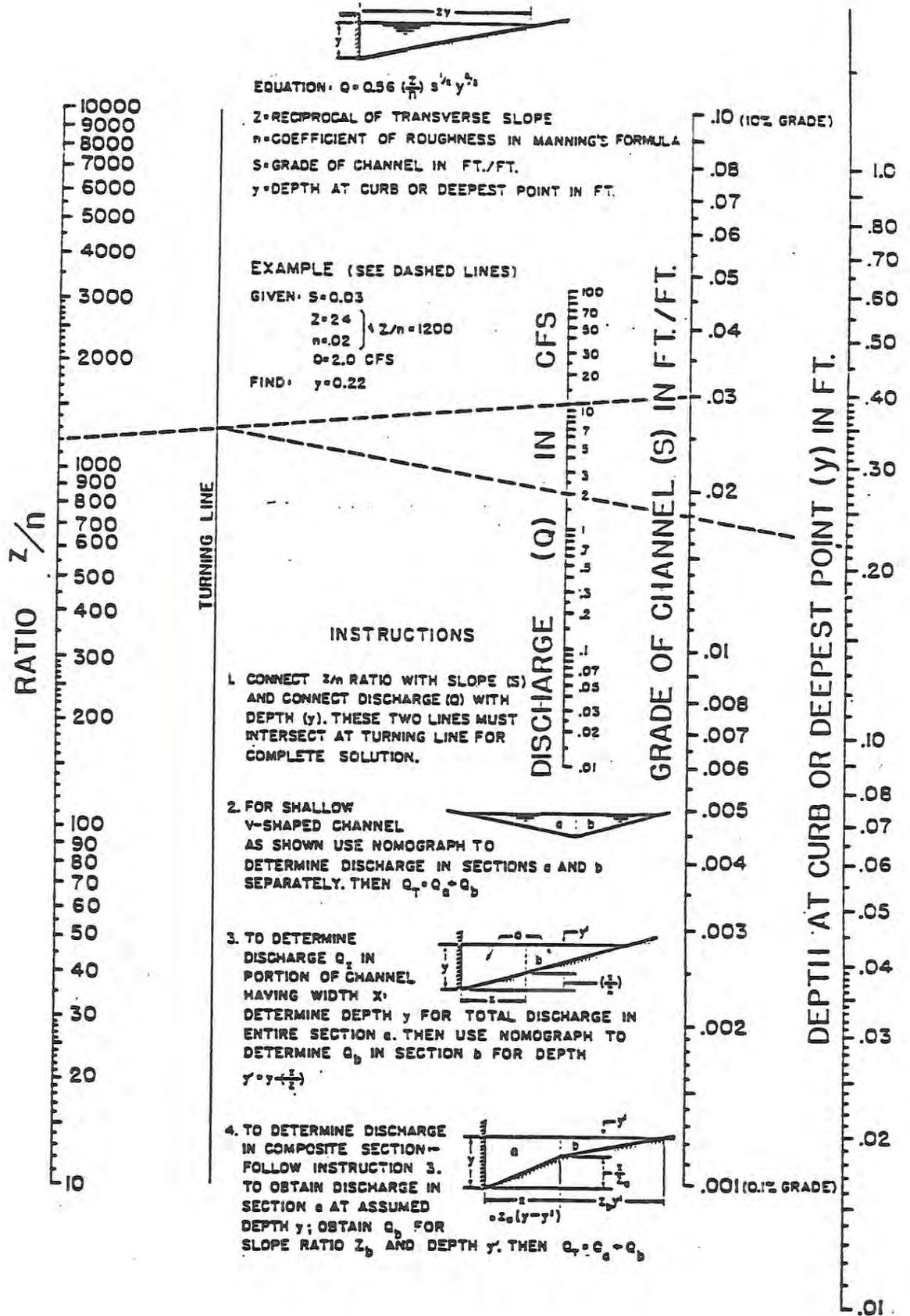
**Limitations -** While it is true that helical corrugated metal pipe may have a lower 'n' value than annular corrugated metal pipe, care should be exercised in the use of the reduced values. Since the low values depend upon the development of spiral flow across the entire cross section of pipe, the designer must assure himself that fully developed spiral flow can occur in his design situations. It is recommended that the 'n' values for annular pipe be used under the following conditions:

1. Partly full flow in the pipe
2. Extremely high sediment load
3. Short Culverts less than 20 diameters
4. Non-Circular pipes
5. Partially paved pipes

**Source:** (For All but PeP and P.V.C. Pipe)  
Highway Drainage Manual  
Maryland State Highway Administration

MANNING'S ROUGHNESS COEFFICIENT 'n'

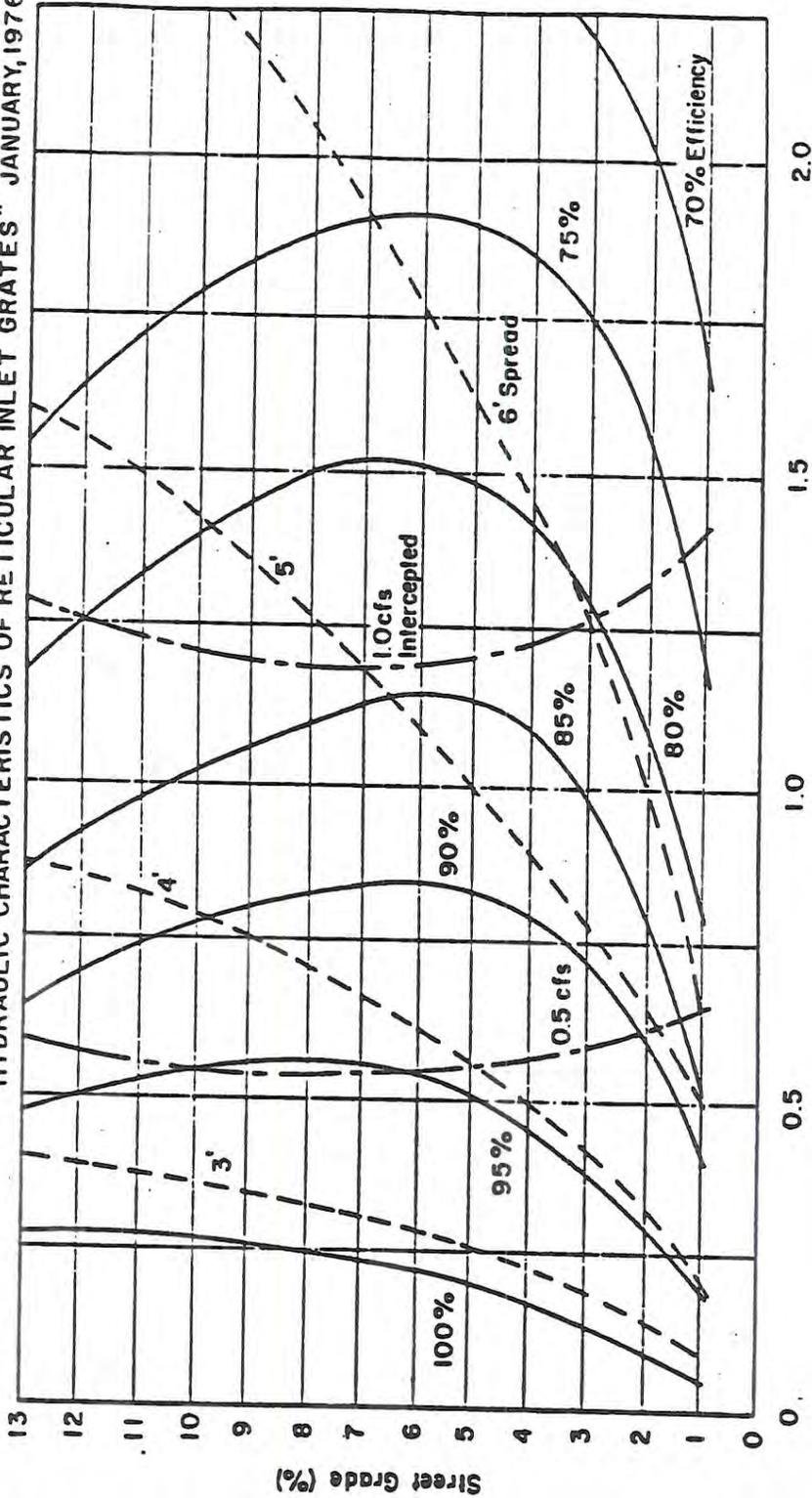
<u>Gutters, Ditches and Channels</u>	<u>Value of "n"</u>
Concrete or bituminous lined channels	0.013
Bituminous concrete paving with concrete gutters	0.015
Grass gutters & ditches, flow greater than 6"	0.040
Grass gutters & ditches, flow less than 6"	0.060
Gabions	0.030
Rip-Rap	Ref. to Chart SHA-61.1-405.1
Channels not maintained, uncut weeds & brush	0.08 - 0.12
Earth gutters and ditches	0.025
Ditches in rock	0.037
Seed and Mulch	0.030
Soil Stabilization Matting	0.030
Natural Stream channels	0.035 - 0.150



NOMOGRAPH FOR FLOW IN TRIANGULAR CHANNELS  
 Source: AASTHO, Highway Drainage Guidelines, 1990



NOTE: FROM THE UNIVERSITY OF MARYLAND REPORT -  
 "HYDRAULIC CHARACTERISTICS OF RETICULAR INLET GRATES" JANUARY, 1976



Gutter Flow, C.F.S.

Inlet Capacity Curves - Undeformed - Cross Slope 2.08 %  
 Single WR

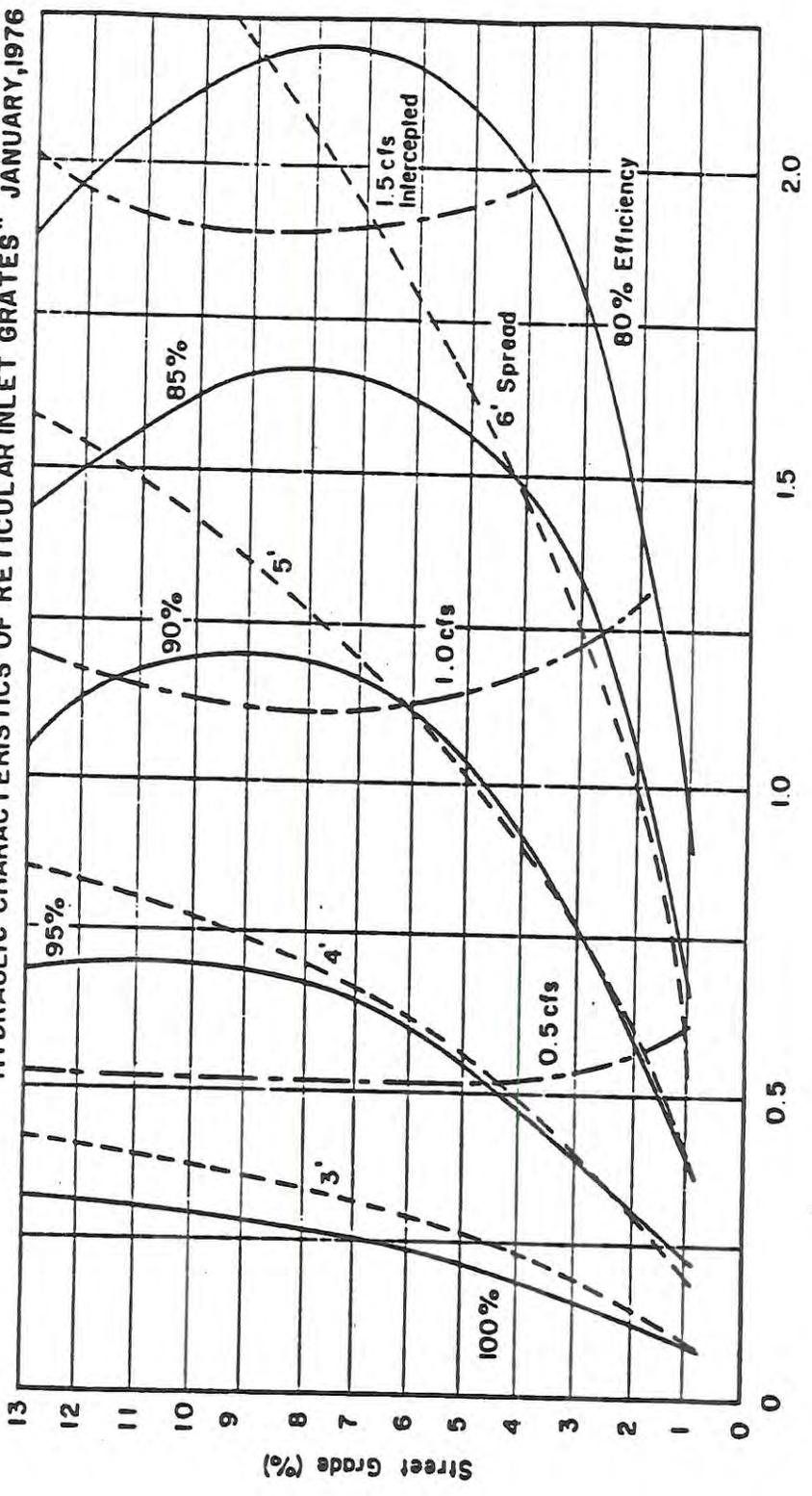
MARYLAND STATE HIGHWAY ADMINISTRATION

BUREAU OF HIGHWAY DESIGN

10/76

SHA-61.1-433.2-2.08

NOTE: FROM THE UNIVERSITY OF MARYLAND REPORT -  
 "HYDRAULIC CHARACTERISTICS OF RETICULAR INLET GRATES" JANUARY, 1976



Gutter Flow, C.F.S.

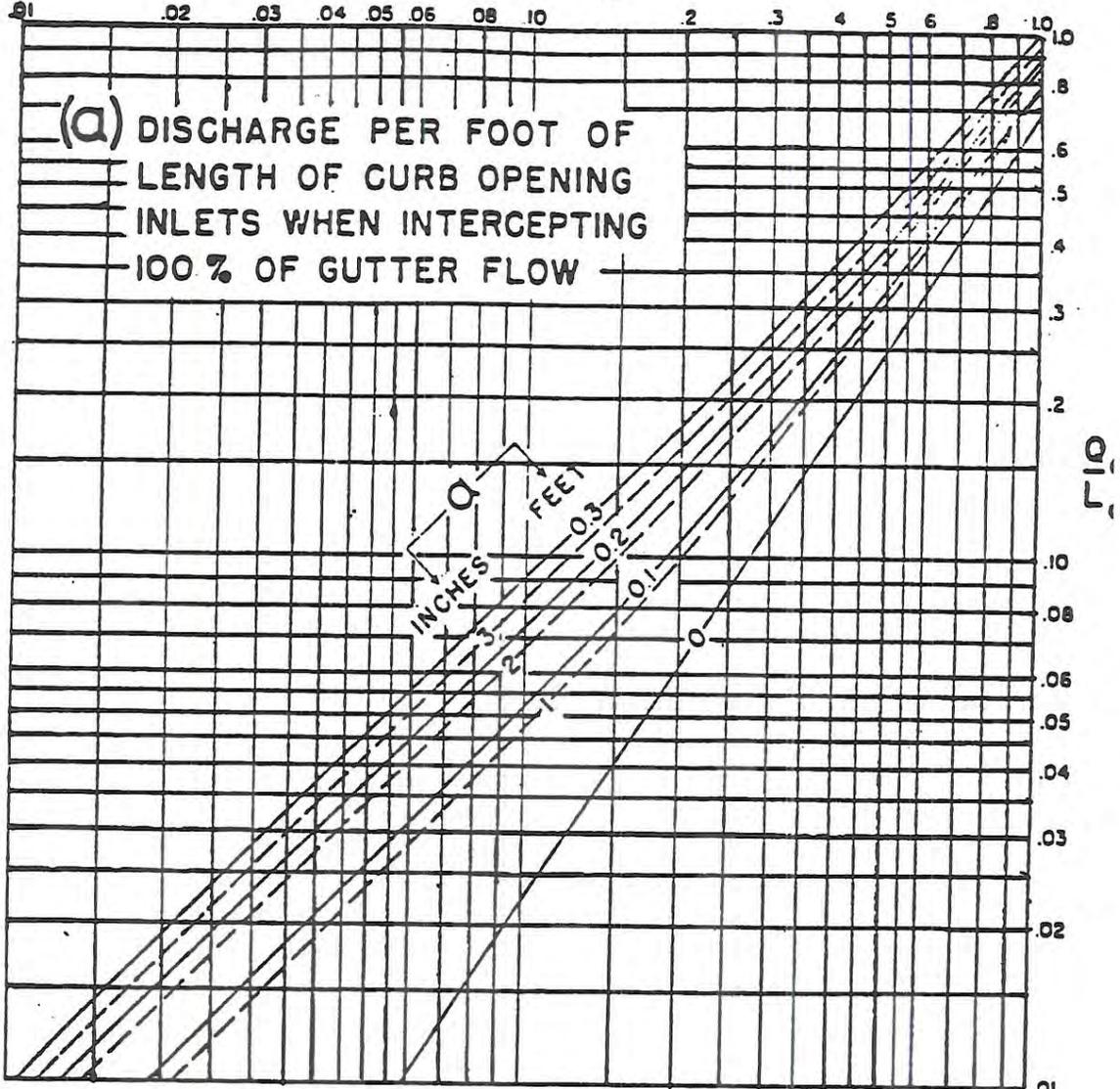
Inlet Capacity Curves - Undepressed - Cross Slope 2.08 %  
 Standard WR

MARYLAND STATE HIGHWAY ADMINISTRATION

BUREAU OF HIGHWAY DESIGN

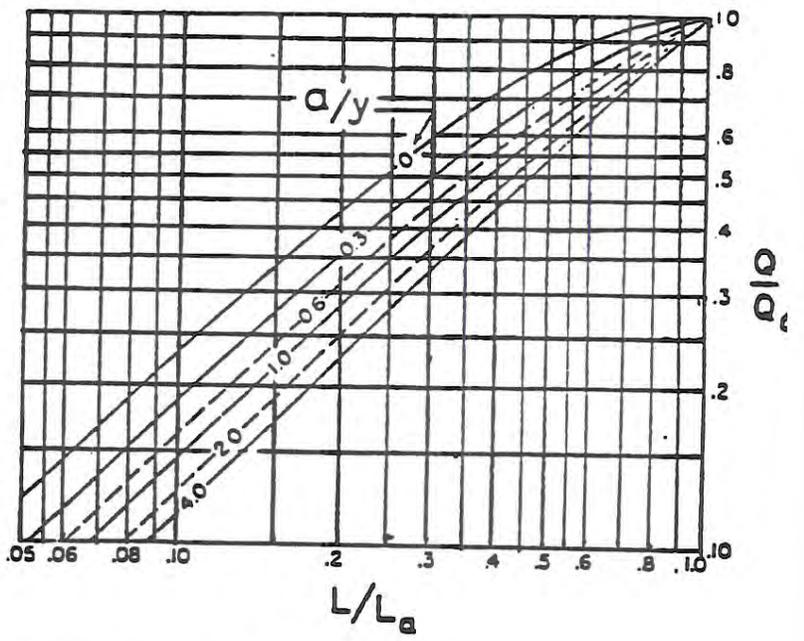
10/76

SHA-61.1-433.3-2.08



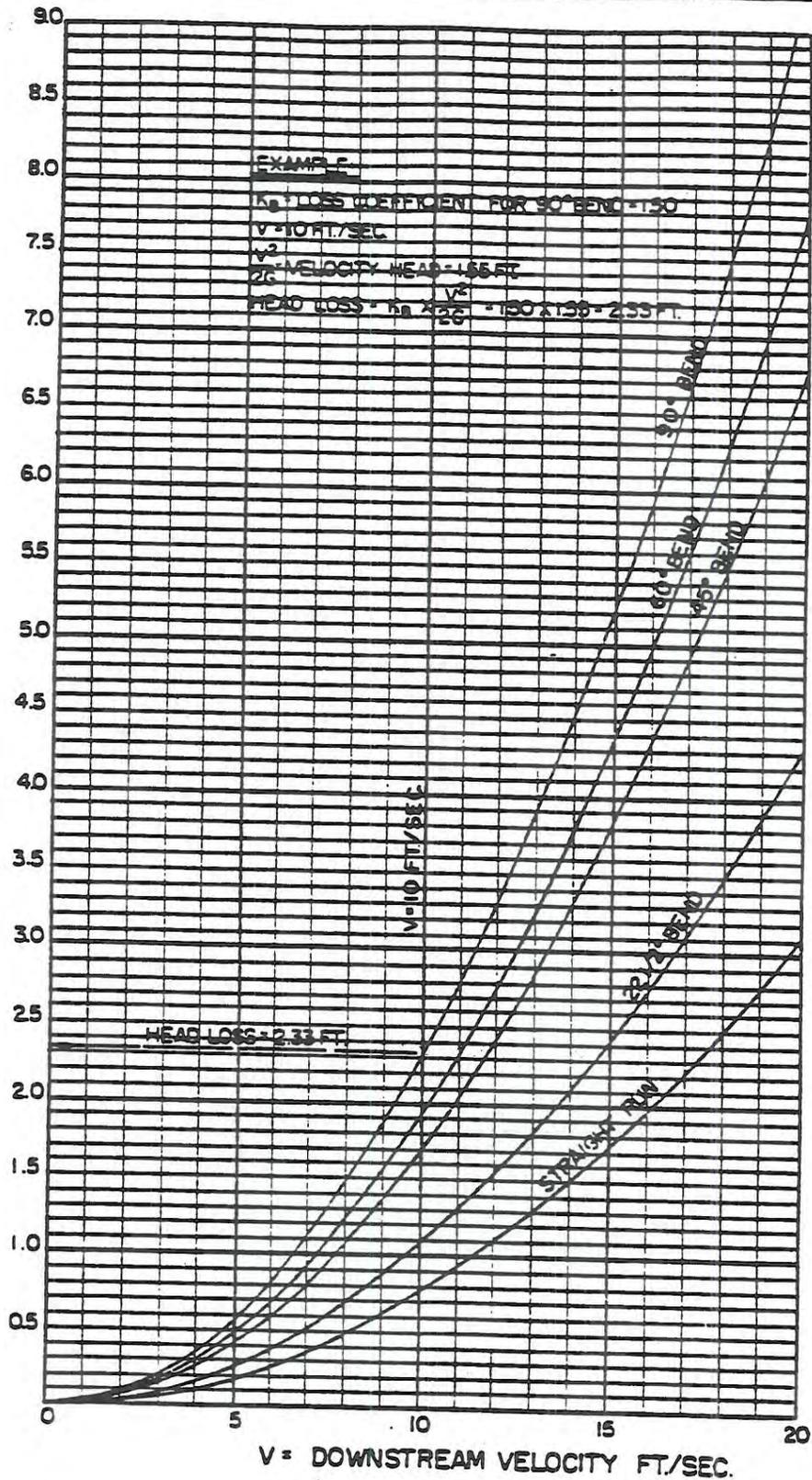
JULY 1950

(b) PARTIAL INTERCEPTION RATIO FOR INLETS OF LENGTH LESS THAN  $L_a$



CAPACITY OF CURB OPENING INLETS ON CONTINUOUS GRADE  
 Source: Bureau of Public Roads, Division Two Washington D.C.2

HEAD LOSS IN FEET.



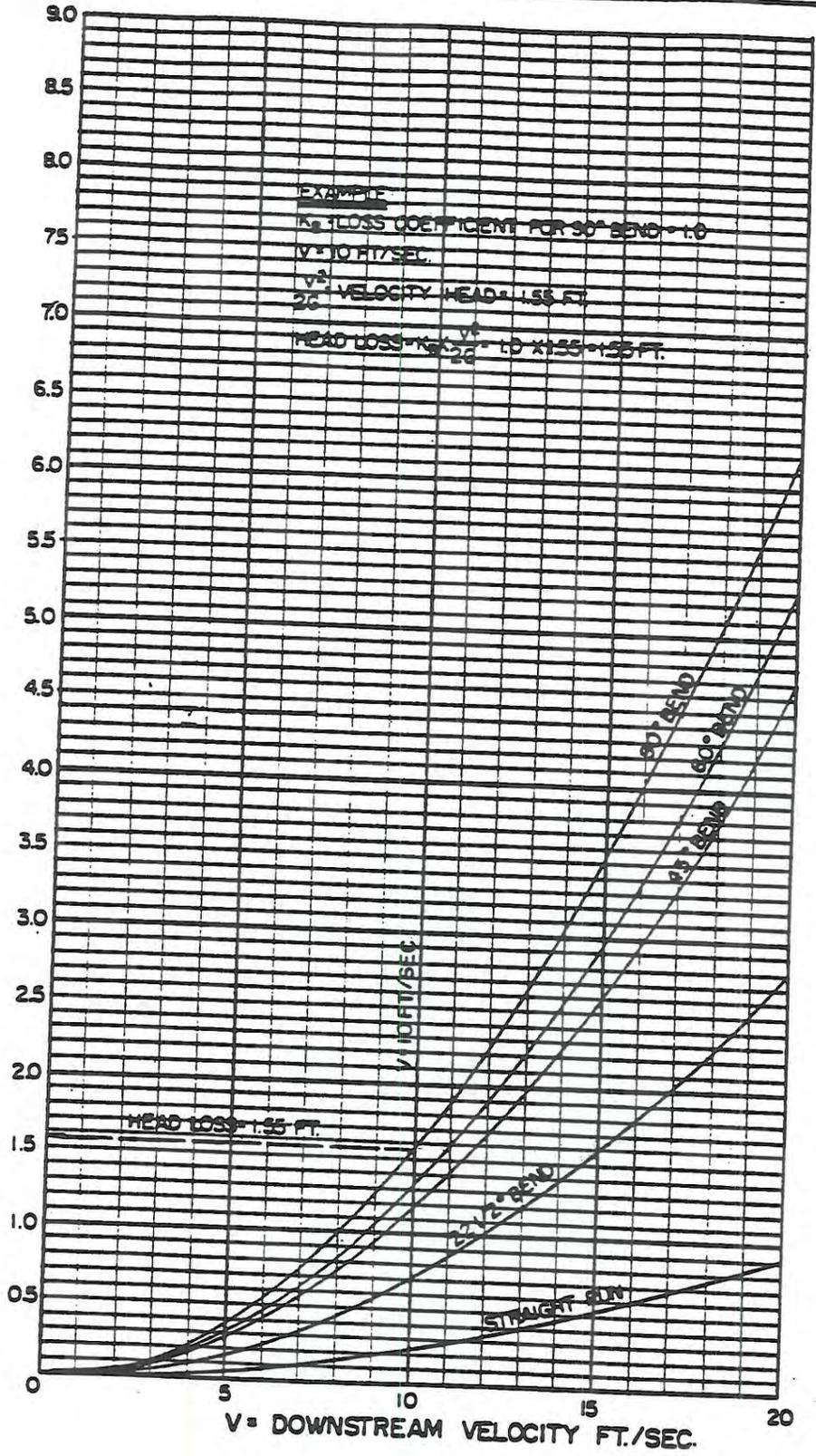
HEAD LOSSES IN INLETS

MARYLAND STATE HIGHWAY ADMINISTRATION

10/5/64

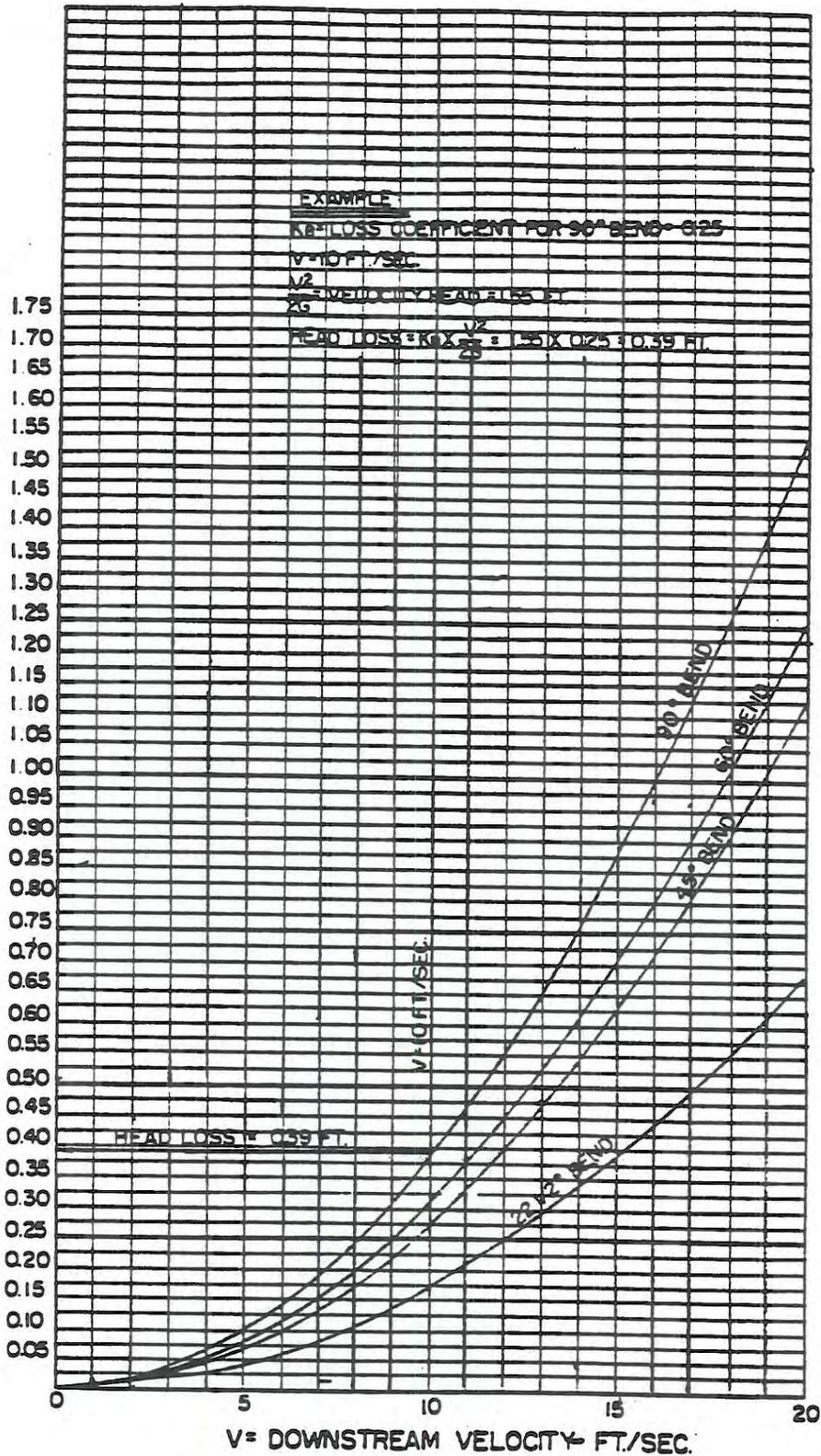
SHA-61.1-408.1

HEAD LOSS IN FEET



HEAD LOSSES IN MANHOLES  
 MARYLAND STATE HIGHWAY ADMINISTRATION 10/5/64 SHA-6LI-408.2

HEAD LOSS IN FEET



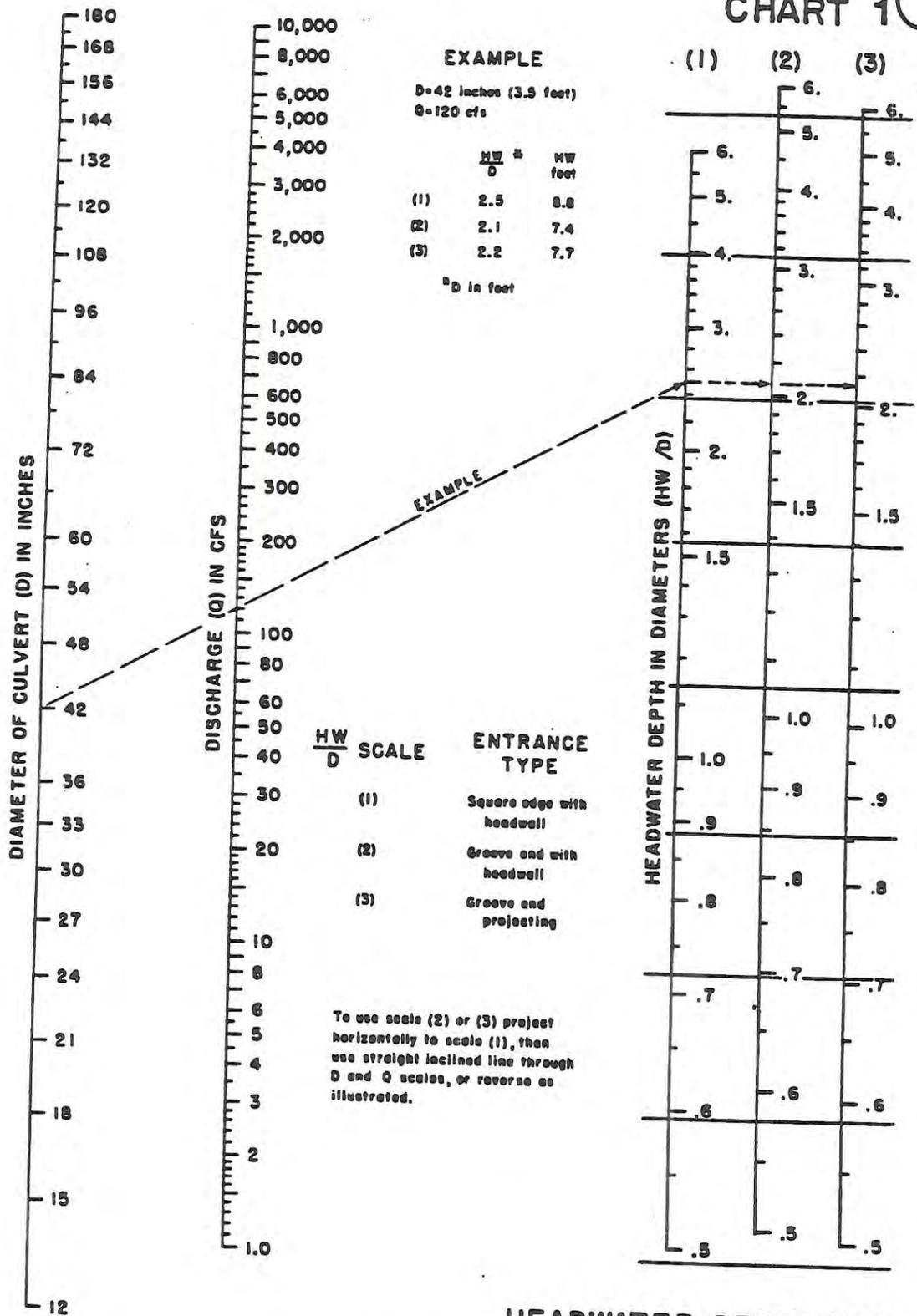
HEAD LOSSES IN BENDS (R = 2 1/2 X PIPE DIA.)

MARYLAND STATE HIGHWAY ADMINISTRATION

10/5/64

SHA-611-408.3

# CHART 1



**EXAMPLE**  
 D=42 inches (3.5 feet)  
 Q=120 cfs

	$\frac{HW}{D}$	HW feet
(1)	2.5	8.8
(2)	2.1	7.4
(3)	2.2	7.7

<sup>a</sup>D in feet

$\frac{HW}{D}$ SCALE	ENTRANCE TYPE
(1)	Square edge with headwall
(2)	Groove end with headwall
(3)	Groove end projecting

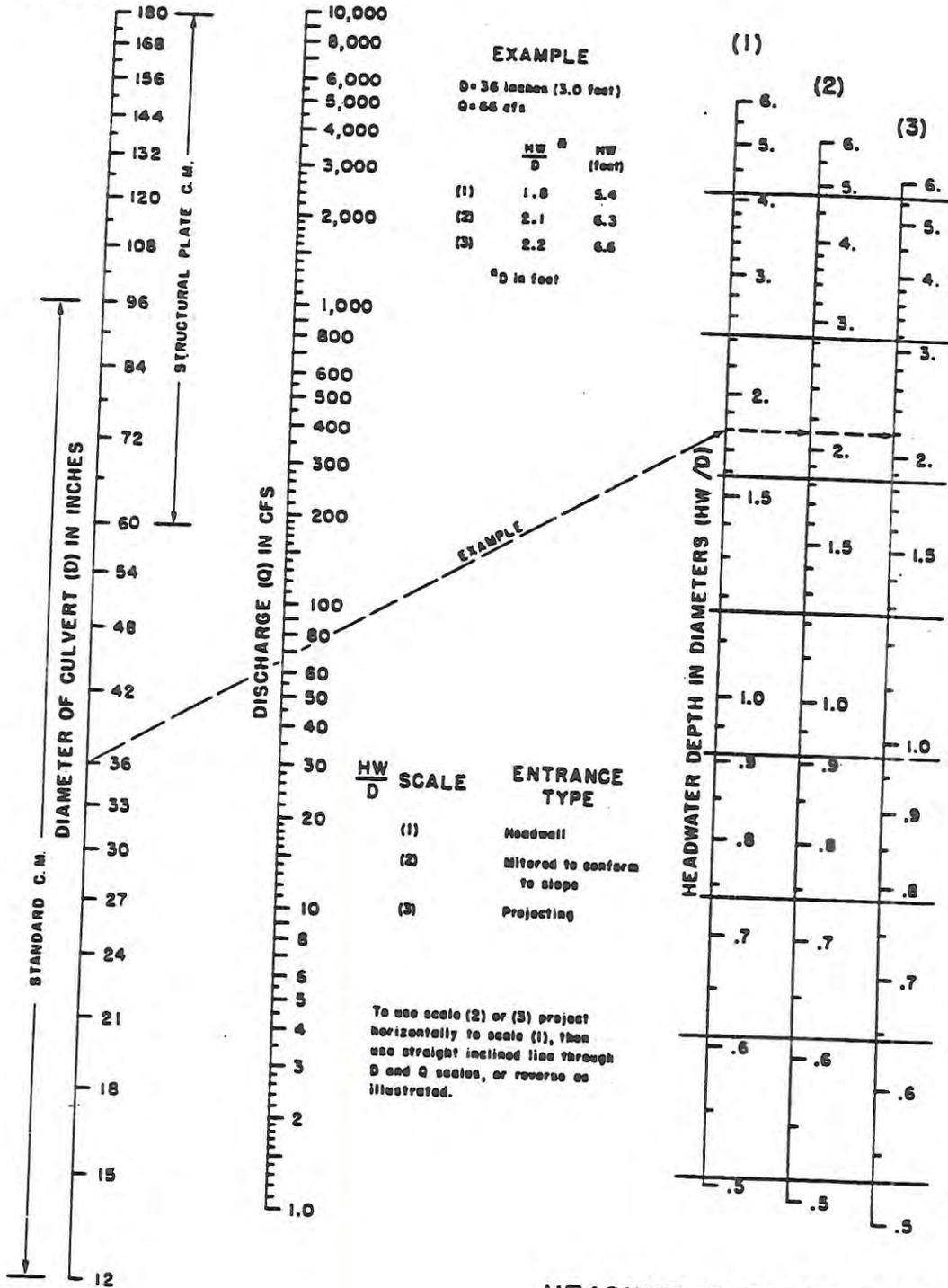
To use scale (2) or (3) project horizontally to scale (1), then use straight inclined line through D and Q scales, or reverse as illustrated.

## HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

HEADWATER SCALES 2 & 3  
 REVISED MAY 1964  
 BUREAU OF PUBLIC ROADS JAN. 1963



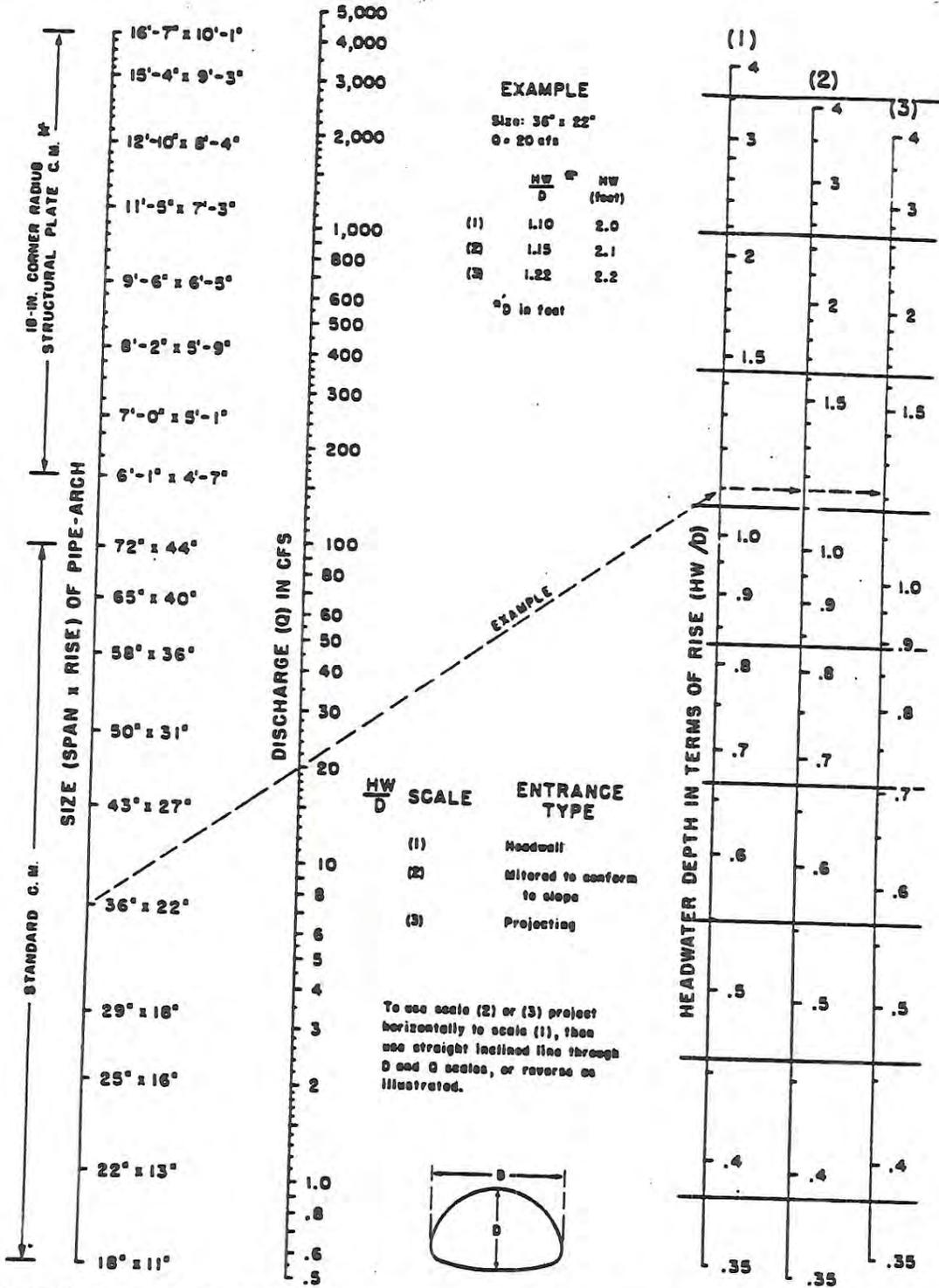
# CHART 2



BUREAU OF PUBLIC ROADS JAN. 1963

## HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

# CHART 34



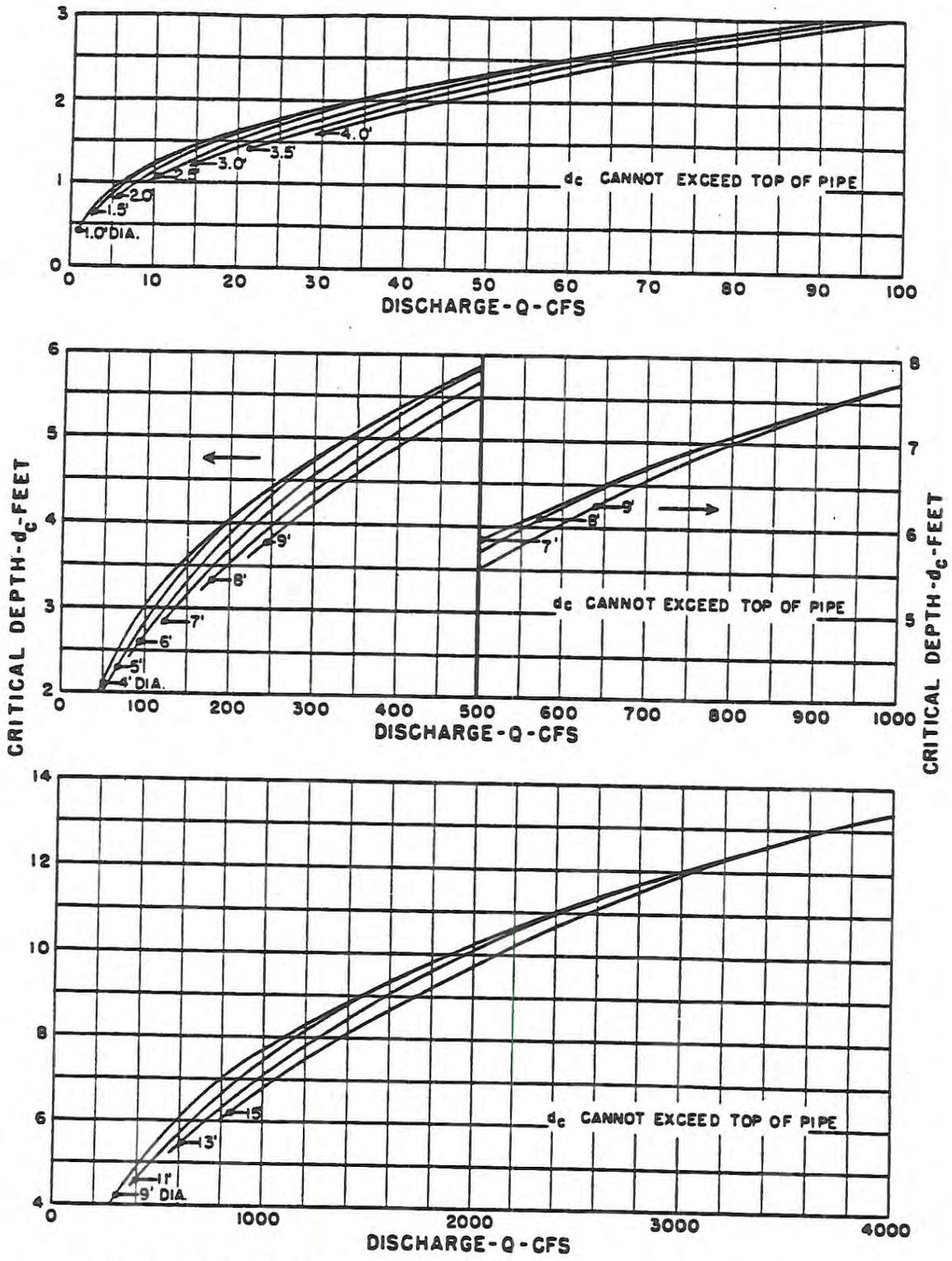
\* ADDITIONAL SIZES NOT DIMENSIONED ARE LISTED IN FABRICATOR'S CATALOG

BUREAU OF PUBLIC ROADS JAN. 1963

**HEADWATER DEPTH FOR C. M. PIPE-ARCH CULVERTS WITH INLET CONTROL**



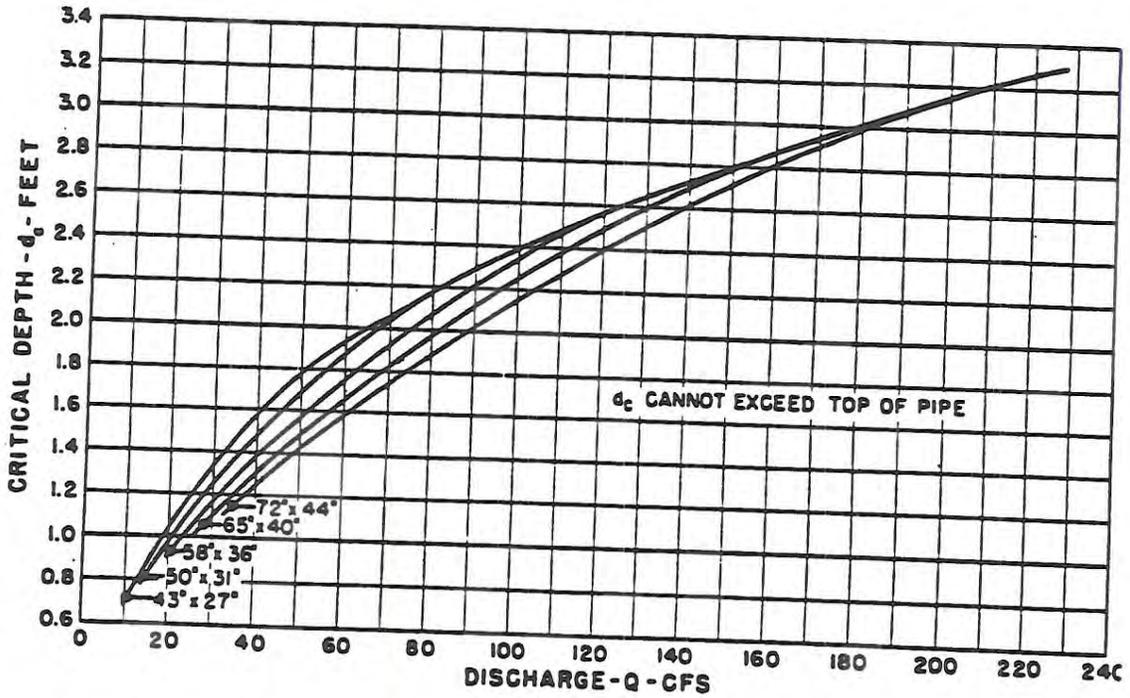
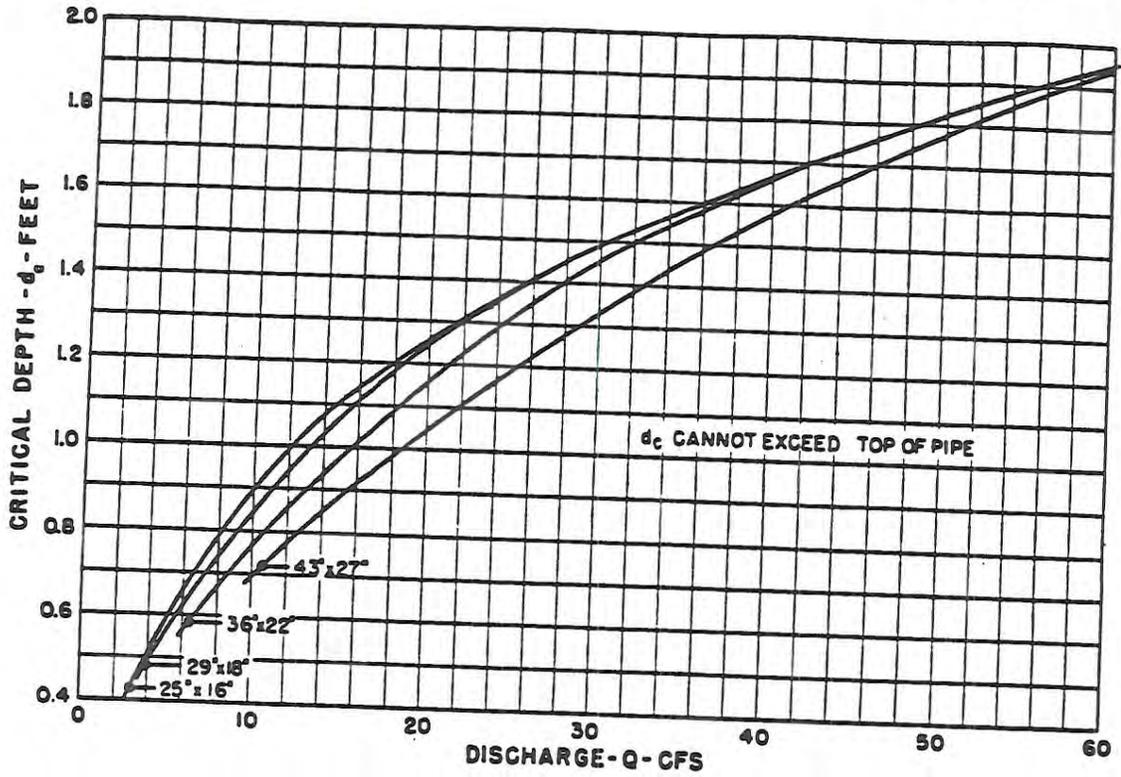
# CHART 4



BUREAU OF PUBLIC ROADS  
JAN. 1964

## CRITICAL DEPTH CIRCULAR PIPE

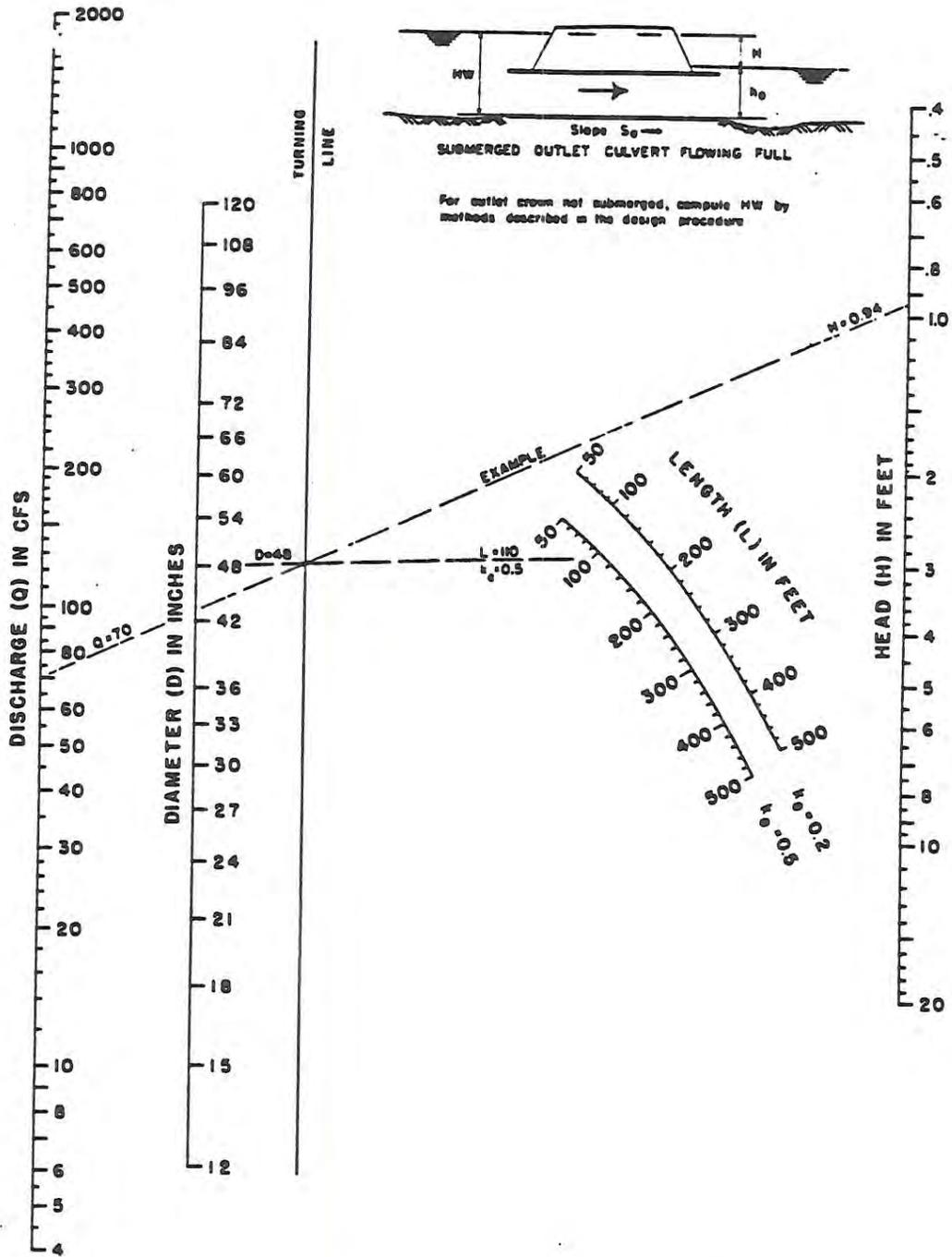
# CHART 37



BUREAU OF PUBLIC ROADS  
 JAN 1964

## CRITICAL DEPTH STANDARD C.M. PIPE-ARCH

# CHART 5

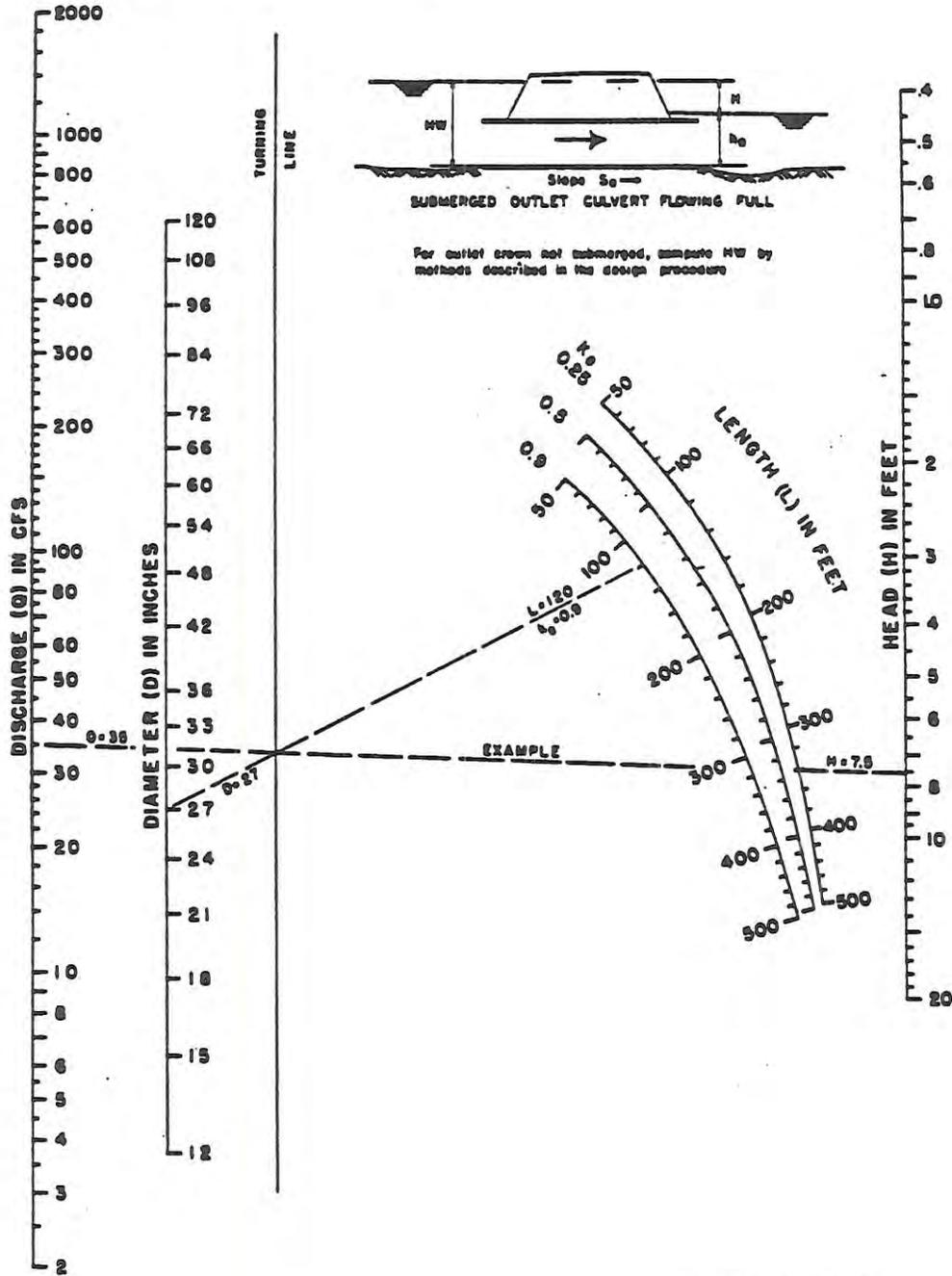


**HEAD FOR  
CONCRETE PIPE CULVERTS  
FLOWING FULL  
 $n = 0.012$**

BUREAU OF PUBLIC ROADS JAN. 1963

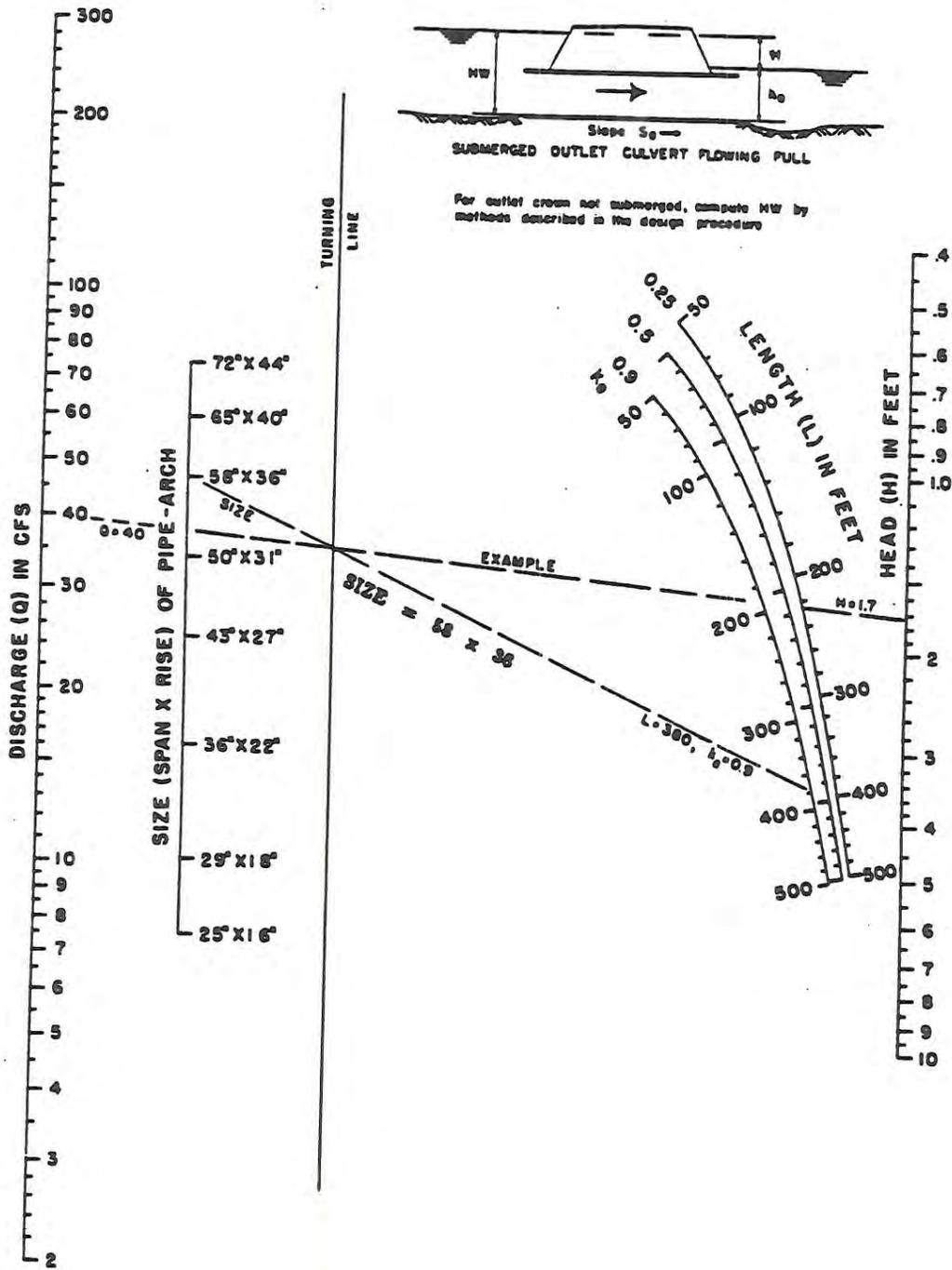


# CHART 6



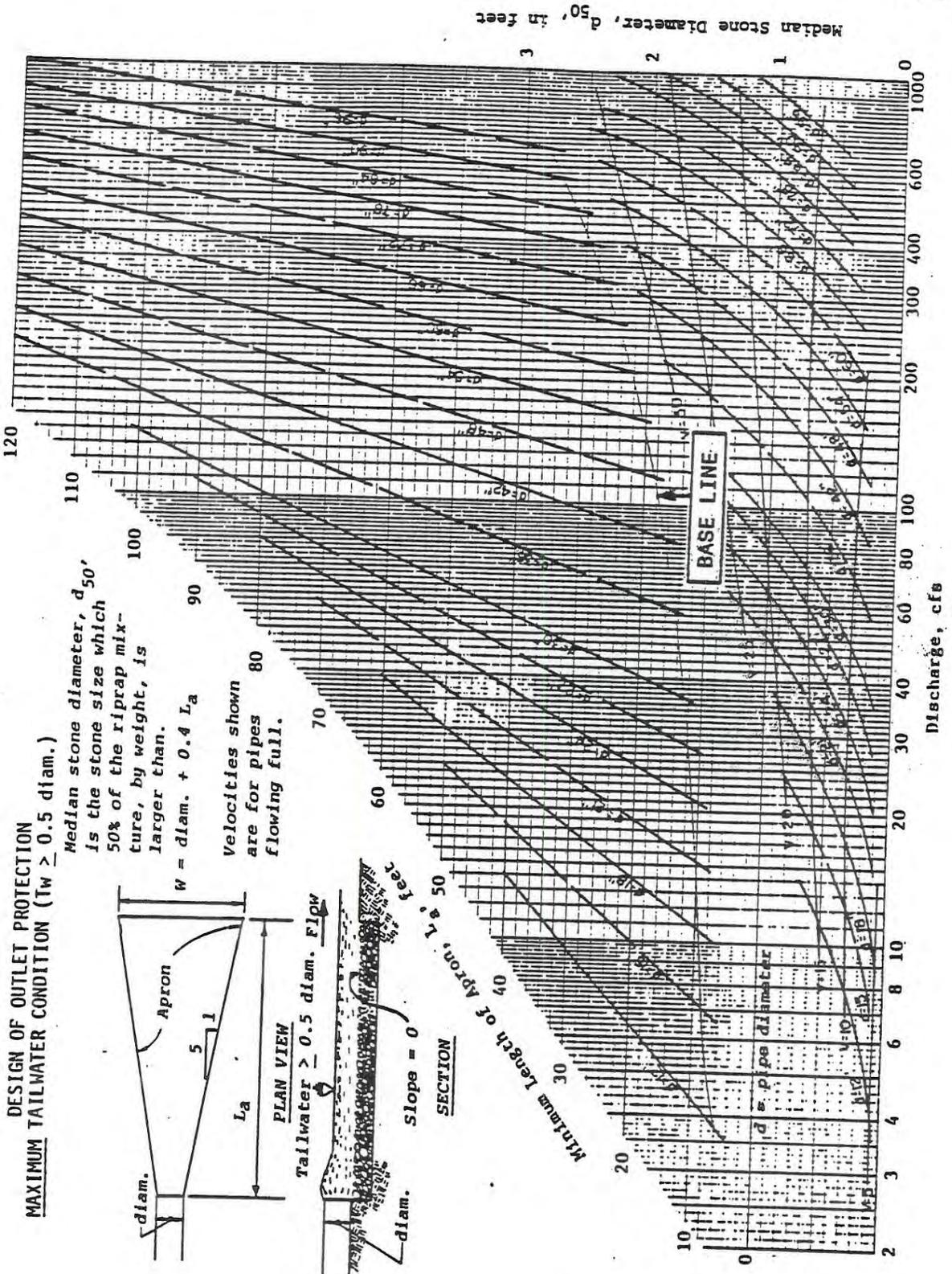
**HEAD FOR  
STANDARD  
C. M. PIPE CULVERTS  
FLOWING FULL  
 $n = 0.024$**

# CHART 39



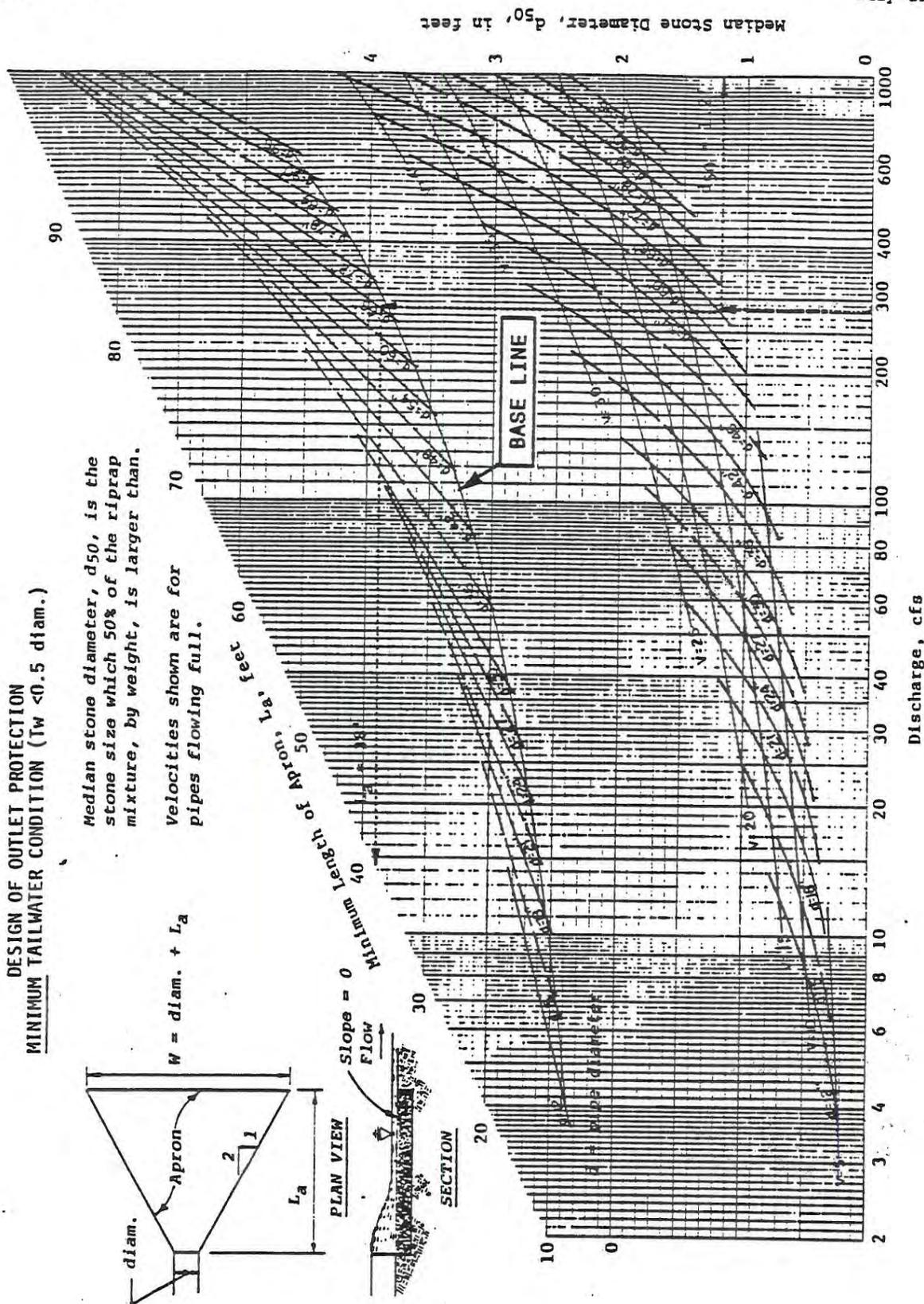
HEAD FOR  
STANDARD C. M. PIPE-ARCH CULVERTS  
FLOWING FULL  
 $n = 0.024$

BUREAU OF PUBLIC ROADS JAN. 1963



A-38.08

**NOTE: This chart is no longer applicable. Refer to the Stilling Basin Detail in the Stormwater Management Design Manual Volumes I and II.**



A-38.09

**NOTE: This chart is no longer applicable. Refer to the Stilling Basin Detail in the Stormwater Management Design Manual Volumes I and II.**

**APPENDIX B**

**STANDARD DESIGN FORMS**

APPENDICES

APPENDIX B - STANDARD DESIGN FORMS

Inlet Spacing	B - 1
Storm Sewer Design	B - 2
Culvert Analysis	B - 3
Hydraulic Gradient	B - 4







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**GENERAL INFORMATION AND CRITERIA FOR ROAD CONSTRUCTION PROCEDURES**

CHAPTER 7: GENERAL INFORMATION AND CRITERIA FOR ROAD  
CONSTRUCTION PROCEDURES

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## **CHAPTER 7: GENERAL INFORMATION AND CRITERIA FOR ROAD CONSTRUCTION PROCEDURES**

### **7.1 Introduction**

This Chapter outlines the general procedures for roadway construction and inspection on County sponsored capital projects as well as private developments. Certain sections apply to capital projects only and are noted as such.

### **7.2 Inspection Procedures and Notifications**

- (a) The Developer and/or his or her Contractor shall notify the Engineer of his or her intent at least seventy-two (72) hours in advance of construction, so that inspection can be scheduled.
- (b) The Engineer shall and upon notification by the Developer and/or his or her Contractor inspect the subgrade and grading operations prior to the application of any base material.
- (c) The Engineer shall and upon notification by the Developer and/or his or her Contractor inspect the base materials prior to the application of any surfacing materials.
- (d) During such inspections as noted above in (b) and (c) the Engineer shall indicate to the Developer approval or disapproval of the project.
- (e) The Developer and/or his or her Contractor shall in no instance proceed with any stage of construction until the Engineer indicates approval of all previous stages.

### **7.3 Inspection Costs**

The Developer will be required to reimburse the County for all inspection costs incurred by reason of said Developer constructing subdivision streets updating sub-standard county roads where required and installing sediment control measures associated thereto. Prior to the approval of any subdivision plat, a fee in the amount of four percent (4%) of the construction cost of the project as determined by the County will be forwarded to the County Commissioners of Carroll County by either a Cashier Check, Certified Check, or Money Order. Should the prosecution of the work for any reason be discontinued, the Contractor shall notify the Engineer of his or her intention to stop and shall also notify the

Engineer at least 24 hours in advance of resuming operations. An Inspector will be assigned to the project for the term that the project is under construction.

#### **7.4 Contractor's Legal Responsibility**

Prior to the start of construction on any subdivision street, or other work associated therewith, it will be incumbent upon the Contractor to ascertain that an approved Public Works Agreement, if required, is on file. Pursuant with Chapter 8-40, Sub-section C, Laws of Maryland - 1963, a Contractor failing to comply with the above requirement will be subject to the revocation of his or her Prequalification Certificate and/or other fines or penalties levied.

**NOTE: Section 7.5 has been updated. Please refer to the Revisions link.**

#### **7.5 Prequalification of Contractors**

~~Each year beginning April 1st and ending March 31st prospective Contractors shall qualify prior to bidding on County Capital Projects or engaging in any work involving the construction of subdivision streets and associated utilities. Applications shall be filed along with the submission of Contractors Financial Statement under oath and an Experience Questionnaire all of which shall be on forms furnished by Carroll County. Such qualification information shall be filed not less than fifteen (15) days prior to the anticipated start of construction of any street or the opening of any Bid Proposal thereon. Only Contractors who have been given Prequalification approval will be permitted to engage in the construction of subdivision streets and associated utilities and such approval shall be evidenced by a Certificate of Prequalification signed by the Director of Public Works. Contractors will be required to perform a minimum of fifty-one percent (51%) of the contract work on Capital Projects with their own forces. This fifty-one percent (51%) rule does not apply for private development.~~

#### **7.6 Control During Construction and Responsibility to the Public**

##### **7.6.1 Erosion Control During Construction**

One of the most detrimental effects on a drainage system, improved, or unimproved, results from the deposition of large quantities of eroded soils during average storms. All Developers, Builders, Contractors, etc., who are undertaking grading operations, are to control this problem. They shall submit, at the time they secure permits, plans, and any and all other supportive data as may be required by Soil Conservation Service in accordance with the Carroll County Grading and Sediment Control Ordinance (No. 100)

and any supplementary addenda to the Ordinance. These facilities are to be considered as temporary only, and must be cleaned of deposited material and removed at the completion of construction. All disturbed areas are to be stabilized. Sediment Control facilities can not be removed without approval from the Carroll County Office of Environmental Services.

#### **7.6.2 Responsibility to the General Public**

The Developer shall take whatever measures are required to insure that a public nuisance is not created as a result of his or her construction operations. The preceding paragraph indicates the prime sources of damage to the general public, but shall not be construed to indicate the only preventive measures that may be required as construction proceeds.

#### **7.6.3 Maintenance of Traffic**

The developer is responsible for the costs of material and labor necessary for the posting of temporary traffic control signs such as detour and road closing signs and any other traffic control devices that may be required by the county during construction of a project. Standards for these signs and devices shall be in accordance with the latest edition of the Manual On Uniform Traffic Control Devices for Streets and Highways published by the United States Department of Transportation Federal Highway Administration. The Bureau of Engineering may require a Maintenance of Traffic Plan to be incorporated into the set of construction drawings for a project if it is felt necessary. Said plan shall show all required information such as; types of signs, wording, locations, road names and any and all information required by the County. The Developer should also contact the Bureau of Roads Operations, prior to preparation of the engineering drawings, for guidance.

#### **7.7 Modifications**

Any modifications or deviations from these regulations other than what has been established by the work "as directed" or "under the discretion" of the Engineer in preceding sections, shall be recommended by the Engineer, or representative, in writing to the Board of County Commissioners of Carroll County. If such recommendation is accepted, such modifications or deviations shall be recorded in the minutes of the County Commissioners along with the reasons for such action.

**7.8**

**Violations**

**Any person, Firm or Corporation violating any rules or regulations set forth herein shall be guilty of a misdemeanor and upon conviction thereof shall be fined a sum not to exceed twenty-five dollars (\$25.00) exclusive of costs. Likewise, any violations shall be the basis for disapproval on any project or road proposed for acceptance by the County.**

## **CHAPTER 8**

# **SPECIFICATIONS FOR CONSTRUCTION AND MATERIALS**

**NOTE:** Since the adoption of the 1994 Manual, there have been various design and procedural revisions. Many of the revisions are included under the Revisions link. Engineers and surveyors are encouraged to call the Bureau of Engineering to obtain the latest design criteria and procedures.

## CHAPTER 8: SPECIFICATIONS FOR CONSTRUCTION AND MATERIALS

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## **CHAPTER 8: SPECIFICATIONS FOR CONSTRUCTION AND MATERIALS**

### **8.1 Introduction**

With the exception of Chapter 8, "Specifications for Construction and Materials", of this manual Carroll County refers to the latest Edition (1993) entitled "Maryland Department of Transportation State Highway Administration Standard Specifications for Construction and Materials" for the construction of roadways, storm drains and related structures.

If any question arises concerning the interpretation of these specifications, that question must be resolved before commencing work so that a failure to raise a question concerning an erroneous interpretation of the Specifications shall result in no loss to the County and shall be the sole responsibility of the Developer, Contractor, or Engineer.

It is suggested that Developers and Contractors become familiar, with all sections of the State Specifications plus any and all supplements to the Specifications that are issued from time to time, by the State, to holders of the Specifications. Any questions regarding interpretation of the Specifications should be directed to the Bureau of Engineering's Construction Inspection Division at 410-386-2157.

#### **8.1.1 Construction Stakeout**

In addition to Section 107 of the State Specifications, the Contractor shall supply the Construction Inspection Division with cut sheets before the following work phases are initiated.

1. Initial Roadway Excavation - Maximum station distance at fifty (50) foot intervals.
2. Utility Installation - Maximum station distance at fifty (50) foot intervals.
3. Open Section Roadway - Maximum station distance at twenty-five (25) foot intervals.
4. Subgrade-Paving - Maximum station distance at twenty-five (25) foot intervals.

If a discrepancy between the cut sheets and construction drawings is discovered by either the County, the Contractor or the Engineer prior to or during construction, work

shall immediately stop until the discrepancy is resolved.

After the discrepancy is satisfactorily resolved, work may proceed.

### **8.1.2 Curb, Combination Curb and Gutter and Monolithic Median**

No curb and gutter shall be placed until all utility lines and all house connections or crossings have been completed, and all grading operations that may affect the improvements have been completed.

**Note:** The following items are extrapolations from, and modifications to, the State's Specifications and are to be used when constructing these particular items on Carroll County projects.

#### **8.1.2-1 Excavation**

All necessary roadway excavation shall be completed before curb or combination curb and gutter forms are placed or poured by Slip Form method. When curb and gutter is constructed on a fill, the fill must be completed as far as possible. The area behind the curb must be graded and compacted to within four (4) inches of finish grade before curb is poured by either Fixed Form or Slip Form.

The base upon which the curb or combination curb and gutter is to be poured shall be compacted to a firm unyielding even surface with mechanical tampers. All soft and unsuitable material shall be removed and replaced with suitable materials.

#### **8.1.2-2 Contraction Joints**

Contraction joints to be spaced at ten (10) foot intervals. No section shall be less than five (5) feet in length.

If spreader plates are used with the Fixed Form method they shall be designed to allow the concrete to be poured monolithically. The depth of embedment into the concrete shall be two (2) inches.

Contraction joints shall be sawed with a power saw capable of cutting a depth of two (2) inches and shall be perpendicular to the face of curb. Joints to be cut a minimum of four (4) hours after placement, but before random cracking occurs.

Joints to be filled full depth with sealer meeting the requirements of Sections 911.01 and 911.01.01 of S.H.A. Standard Specifications for Construction and Materials.

Expansion material 1/2" thick conforming to Section 911.02 shall be placed full depth at intervals not to exceed two hundred (200) feet, at storm drain structures as indicated on pertinent standards, points of curvature (P.C.), points of tangent (P.T.) and points of reverse curvature (P.R.C.).

#### **8.1.2-3 Curing**

Immediately upon completion of the finishing operations a uniform and ample application of liquid curing compound conforming to A.A.S.H.T.O. Specifications M-148 shall be applied.

Cold weather placement and protection shall conform to the requirements of S.H.A. Sections 520.03.02 and 520.03.12.

#### **8.1.2-4 Installation Procedures for Polyvinyl Chloride and Polyethylene Storm Drain Pipe**

Contractors should obtain a copy of (ASTM Designation D 2321-89) which outlines procedures for installing thermoplastic pipe for storm drain installations.

Particular attention should be paid to Section 5 of Designation D 2321-89 which deals with materials and also to the related Subsections for guidance on acceptable backfill materials.

Final selection of backfill material will primarily depend on what is available locally in order to minimize costs. Crushed stone and other Class 1 materials can be dumped around the pipe, taking care to ensure voids are eliminated. Noncohesive sand, sand/gravel mixes, and other Class II or III materials must be compacted to a minimum of 85% or 90% standard Proctor density, respectively. Class IVA material is acceptable provided it is compacted at optimum moisture to an appropriate density. Guidance from a soils engineer in the behavior of IVA material may be required, especially in areas involving substantial loads.

Native soil should be used as backfill material if it meets the requirements of a soil class shown in Table 1 of Designation D 2321-89 and if it is suitable for the load conditions. Soil not meeting the requirements in Table 1 may be unacceptable backfill material. In these situations, suitable material should be imported.

**8.1.2-5 Backfilling of Trenches for Utility Installation**

Plate 47 shows the three (3) approved options for backfilling utility trenches. The particular option should be noted on the construction plans and/or on the approved Utility Permit.

In most cases, flowable backfill placed in accordance with State Highway Administration's Standard Specifications for Construction and Materials, Section 314, shall be used except that fly ash will not be used in the flowable cement mix for Carroll County.

## **CHAPTER 9**

# **TREES AND LANDSCAPING WITHIN COUNTY ROADWAYS**

**NOTE: Chapter 9 has been deleted in its' entirety. Please refer to the Carroll County Landscape Manual.**

# **CHAPTER 10**

## **BOX CULVERTS AND BRIDGE STRUCTURES**

Approved by the County Commissioners  
of Carroll County - December 23, 2008

## **CHAPTER 10: BOX CULVERTS AND BRIDGE STRUCTURES**

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## CHAPTER 10: BOX CULVERTS AND BRIDGE STRUCTURES

### 10.1 Introduction

The object of this chapter is to offer guidance on the design and construction of structures that are part of a roadway network needed as a result of land development. Only general methods are offered to assist in establishing proper criteria and methodology. They are not intended to restrict the engineer in exercising proper engineering judgment.

### 10.2 General

A box culvert, rectangular or square, is a structure built to allow water to pass underneath a road, railroad, or embankment. Box culverts may be completely enclosed (four sided) or bottomless (three sided).

A bridge is a structure built to span a valley, road, railroad, river or stream, floodplain or floodway, body of water, or any other physical obstacle. Designs of bridges will vary depending on the function of the bridge and the nature of the terrain where the bridge is to be constructed.

Any proposed crossings requiring an opening greater than fifty (50) square feet shall be designed as a structure. Box culverts and bridges shall be designed as single opening or single span structures. Multiple span or multiple opening structures may only be designed with prior approval from the Carroll County Department of Public Works (Department). The latest Federal Highway Administration manuals and guidance, AASHTO specifications and State Highway Administration policies and specifications shall be used when designing structures. Structural designs and construction documents shall be sealed by a professional engineer licensed in the State of Maryland.

During the initial evaluation, the following structure types shall be evaluated in order of preference:

1. concrete box culvert (cast-in-place)
2. concrete box culvert (precast with cast-in-place headwalls and wingwalls)
3. precast concrete slabs on concrete abutments
4. precast concrete girders on concrete abutments
5. structural steel beams on concrete abutments.

The use of other structure types must be approved by the Department before proceeding with design. Aesthetics should be considered. Use of form liners and other aesthetic treatments is encouraged if compatible with the area and the expense can be justified.

The use of mechanically stabilized earth (MSE) retaining walls in lieu of cast in place concrete abutments will not be allowed.

All structures must have a Federal Highway Administration crash-tested traffic barrier system in accordance with NCHRP Report 350 guidelines.

Utilities may not be supported by or attached to any box culvert or bridge structure without prior approval by the Department.

Structure design shall meet the requirements of all other governing agencies, such as the MD Department of the Environment, MD Department of Natural Resources, US Army Corps of Engineers, and the Carroll County Bureau of Resource Management.

### **10.3 Design**

#### **10.3.1 Geotechnical Investigation and Foundation Design**

A minimum of two borings for each bridge support is required. For culverts, a minimum of two borings are required, one at each end, diagonal of each other. Borings shall be strategically located to evaluate both foundation requirements and scour potential. Borings shall be taken after approval of the Type, Size and Location (TS&L) submission. Boring logs shall be included on the plans, identifying type of material and the proposed minimum bottom of footing elevation. A foundation report shall be prepared, and shall contain the following: approved TS&L plan and elevation with plotted boring locations; written report containing an interpretation and analysis of the proposed structure and boring data; recommendations for foundation design; construction considerations; and any other pertinent information relating to the site, soil/rock data, and the foundation recommendations.

#### **10.3.2 Clear Roadway Width**

The minimum clear roadway width for box culverts is dependant on the depth of fill over the box culvert. For culverts with 5'-0" or less of fill, the length of the culvert shall be determined by placing the concrete headwall in alignment with the approach traffic barrier. The location of traffic barrier shall follow the specifications in the Design Manual. For culverts carrying more than 5'-0" of fill, the typical section shall be carried across the culvert. The depth of fill will be measured from the profile grade line to the top of the box culvert.

The minimum clear roadway width for bridges shall be 28-feet. Additional travel lane and shoulder width may be required, based on the approach lane widths, paved shoulder widths, prevailing speed, sidewalk requirements, etc.

#### **10.3.3 Design Specifications**

An HS25 design loading will be used for all bridge spans 35-feet and greater, and all other structures. For all bridge simple spans less than 35-feet, an HS27 design loading shall be used. Design loading should also include a provision for future 2-inch hot mix asphalt wearing course.

The design specifications include the following:

Bridge Design: AASHTO LRFD Specifications, latest edition, including all interim specifications

Concrete Design: Service Load Design Method,  $f_c = 1,200$  psi

Reinforcing Steel Design:  $f_s = 24,000$  psi

#### **10.3.4 Scour Analysis and Design**

Scour is the result of the erosive action of flowing water. All bottomless structures shall be evaluated for scour potential and designed to resist scour. Scour evaluations shall be performed by an interdisciplinary team of engineers with requisite knowledge in structural, hydraulic, river mechanics and geotechnical engineering. A scour evaluation report shall be prepared, and shall contain the following: introduction and background; study scope; summary and recommendations; hydrology study; site investigation; stream classification, geomorphology and stability study; TS&L plan and elevation; line, grade and typical section of approach roadways; hydraulic study; scour evaluation and development of scour cross-section under the structure; significance of scour evaluation; structural and geotechnical design considerations; scour countermeasures; and appendices and documentation.

Foundations, either spread footings or deep (pile supported), shall be designed to withstand the conditions of scour for the design flood (the more severe of the 100 year storm or the overtopping flood) and the check flood (500-year flood).

#### **10.4 Submissions**

Reviews shall be submitted based on the following schedule. Each submission must be approved before proceeding with additional work.

##### **10.4.1 Type, Size and Location (TS&L)**

This submission shall include a general plan and elevation showing pertinent dimensions and clearances, general notes, typical section, and preliminary hydrologic and hydraulic calculations, if applicable. The TS&L documents are due as part of the preliminary plan stage process.

##### **10.4.2 Foundation and Scour**

This submission shall include the same information as the TS&L, except that soil boring data and foundation recommendations shall be incorporated. Any changes to the approved TS&L shall be identified at this time. Soil borings shall be coordinated with other on-site geotechnical work for pavement design and stormwater management design. The foundation report, scour evaluation report, and plans shall be submitted and approved with the preliminary plan phase.

##### **10.4.3 Structural**

The structural submission builds on the previously approved submissions, and includes details, sections, and special features of the structure.

#### **10.4.4 Final**

The final submission shall consist of a complete set of plans, incorporating all revisions from the structural review. The final documents shall be submitted and approved with the final road plans. Structure plans shall be submitted as a subset of plans within the road plans. Submit all design calculations and load rating calculations for H15, HS20 and Type 3 loadings (inventory and operating) using the load factor method, or load and resistance factor rating method (LRFR) HL-93, at this time. A bound hard copy of calculations shall be submitted, as well as an electronic version (PDF).

#### **10.4.5 Structure Inventory and Appraisal (SIA) Forms**

Initial inspection, completion of SIA forms, and submission to the MD State Highway Administration is required within ninety (90) days of the completion of the structure. Acceptance of structures and roadways will be simultaneous.

The Department must approve the load rating calculations and SIA forms before acceptance of the structure and roadways.

#### **10.5 Construction**

Approved shop drawings and an approved material list must be submitted to the Department before ordering any materials and before any construction commences.

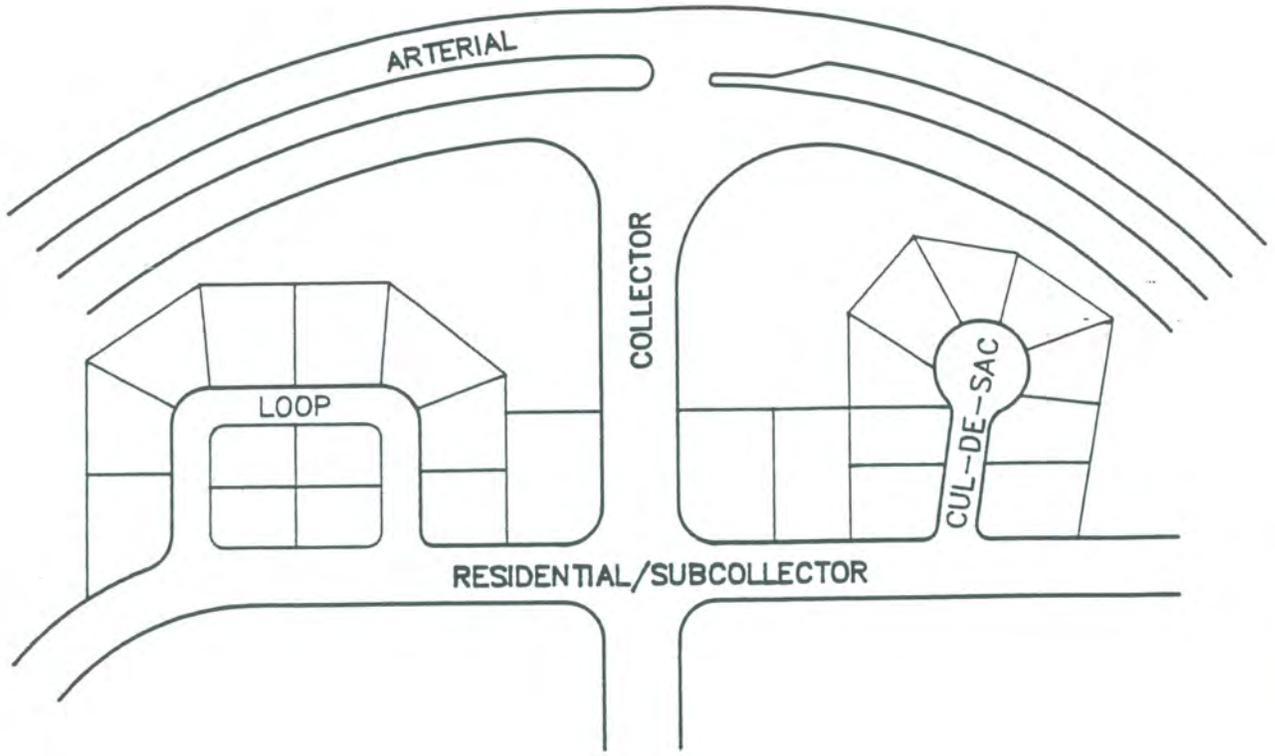
Contractors performing this work must be pre-qualified in the structures categories. Construction of all structures shall be in accordance with the MD State Highway Administration Standard Specifications for Construction and Materials, latest edition.

#### **10.6 References**

- Federal Highway Administration (FHWA) HEC-18, Evaluating Scour at Bridges
- FHWA HY-9, Scour at Bridges
- MD State Highway Administration (SHA) Structural Standards Manual
- MD SHA Standard Specifications for Construction and Materials, latest edition, including all interim specifications
- AASHTO LRFD Bridge Design Specifications, latest edition, including all interim specifications
- MD SHA Guide for Completing Structure Inventory and Appraisal Input Forms
- MD SHA Office of Bridge Development Manual of Hydrologic and Hydraulic Design

## PLATES

**NOTE:** Since the adoption of the 1994 Manual, there have been various design and procedural revisions. Many of the revisions are included under the Revisions link. Engineers and surveyors are encouraged to call the Bureau of Engineering to obtain the latest design criteria and procedures.



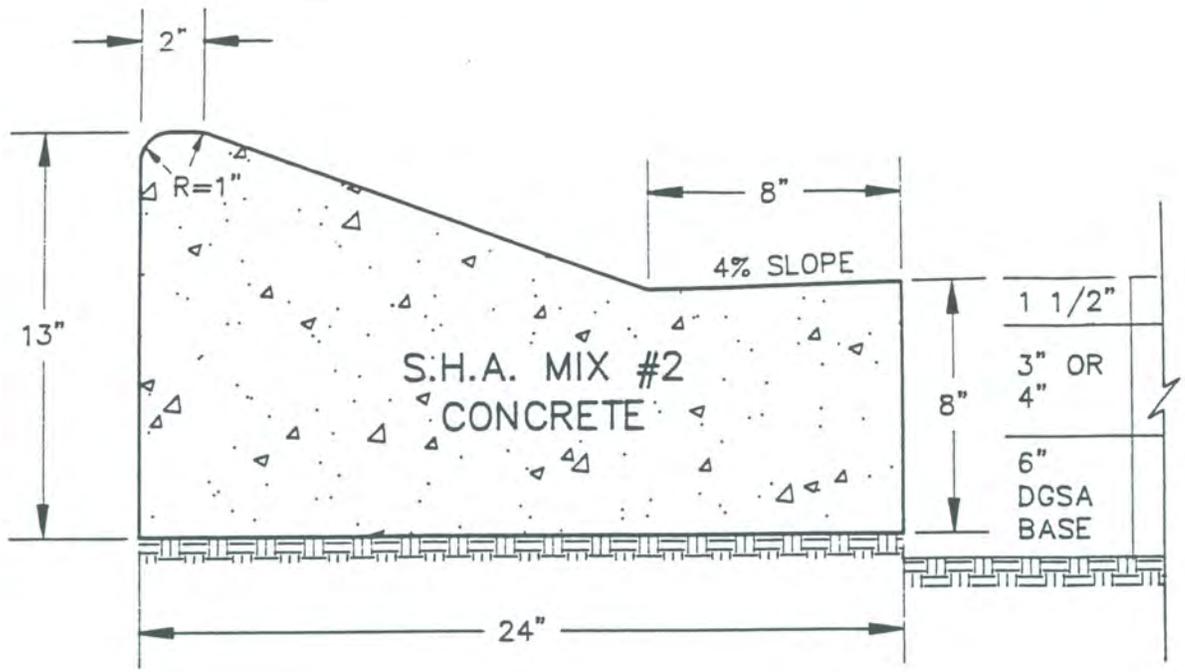
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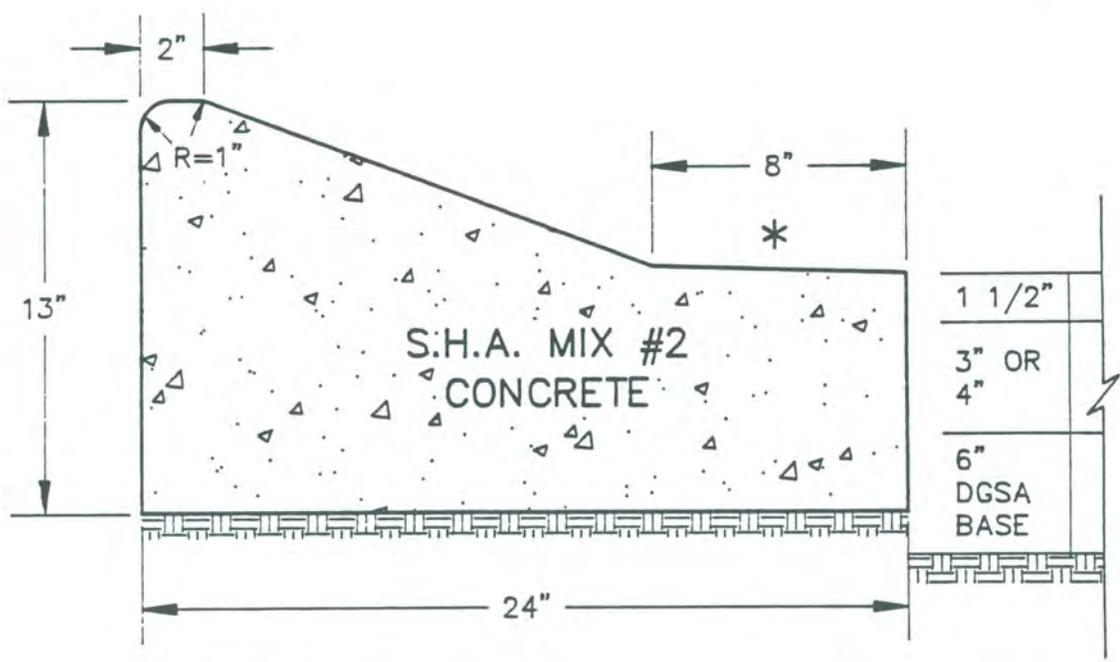
*Eric S. Cleveland* 4-12-94  
 DIRECTOR DATE

HIERARCHY OF STREETS  
 SCHEMATIC

PLATE  
 1



A = NORMAL SLOPE



\* SLOPE OF GUTTER  
AS SHOWN ON PLANS

B = REVERSE SLOPE

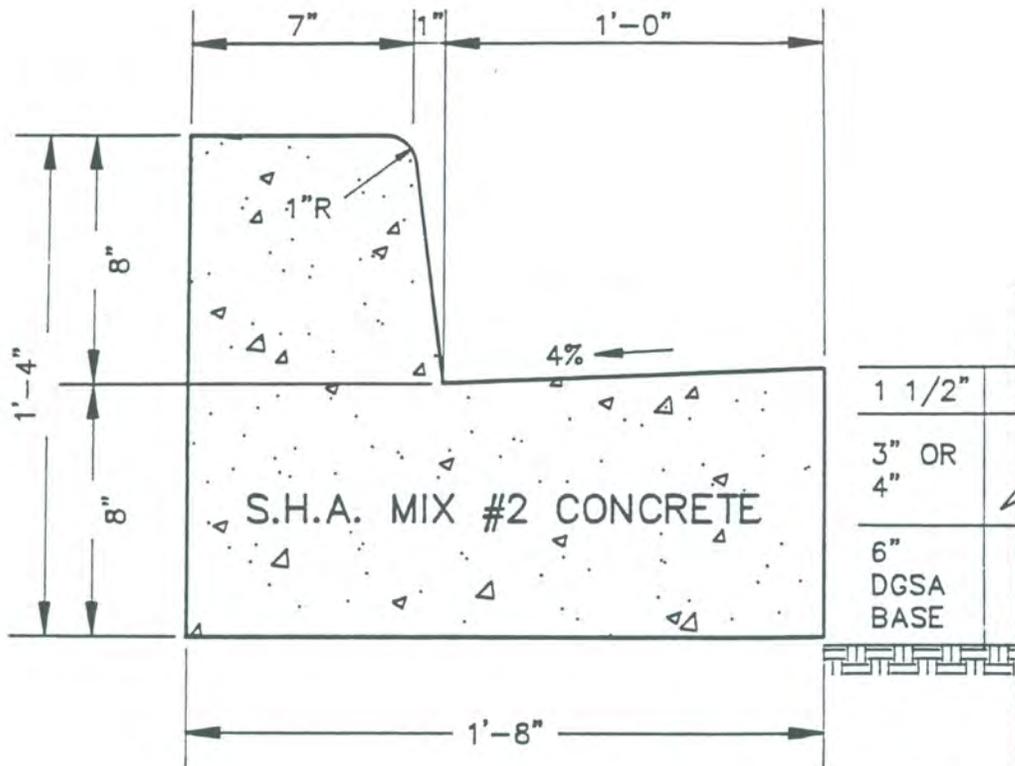
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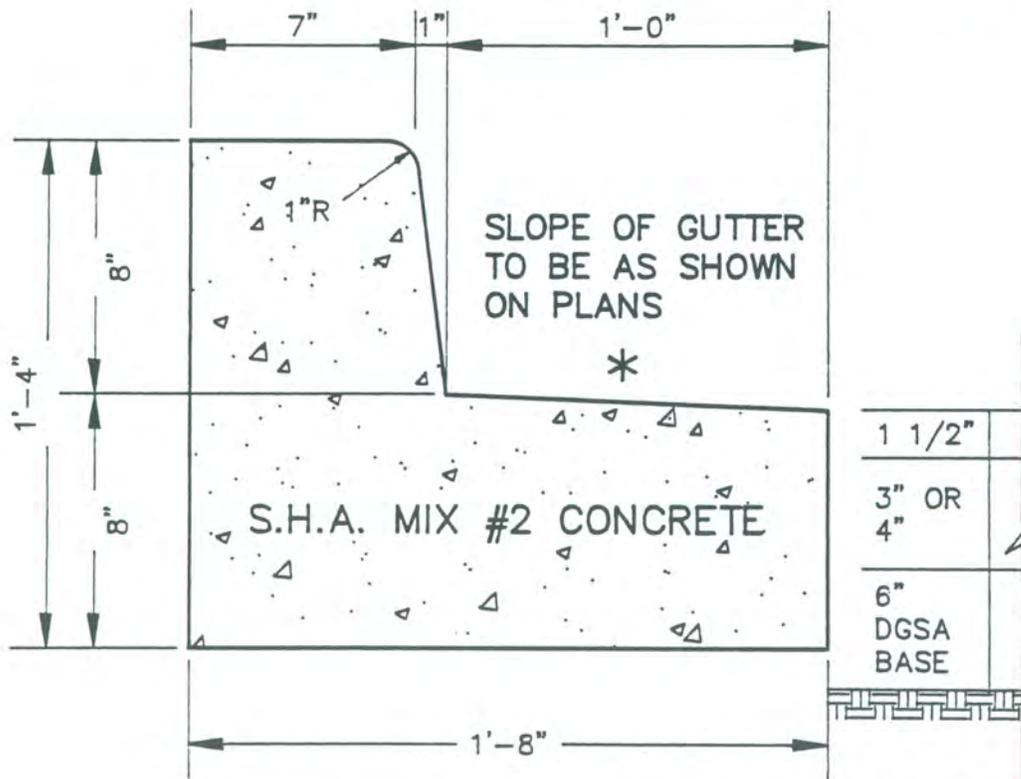
MOUNTABLE CURB  
AND GUTTER

PLATE

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DIRECTOR DATE



A: NORMAL SLOPE



B: REVERSE SLOPE

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DEPARTMENT OF PUBLIC WORKS

*Kevin St...* 4-12-94  
DIRECTOR DATE

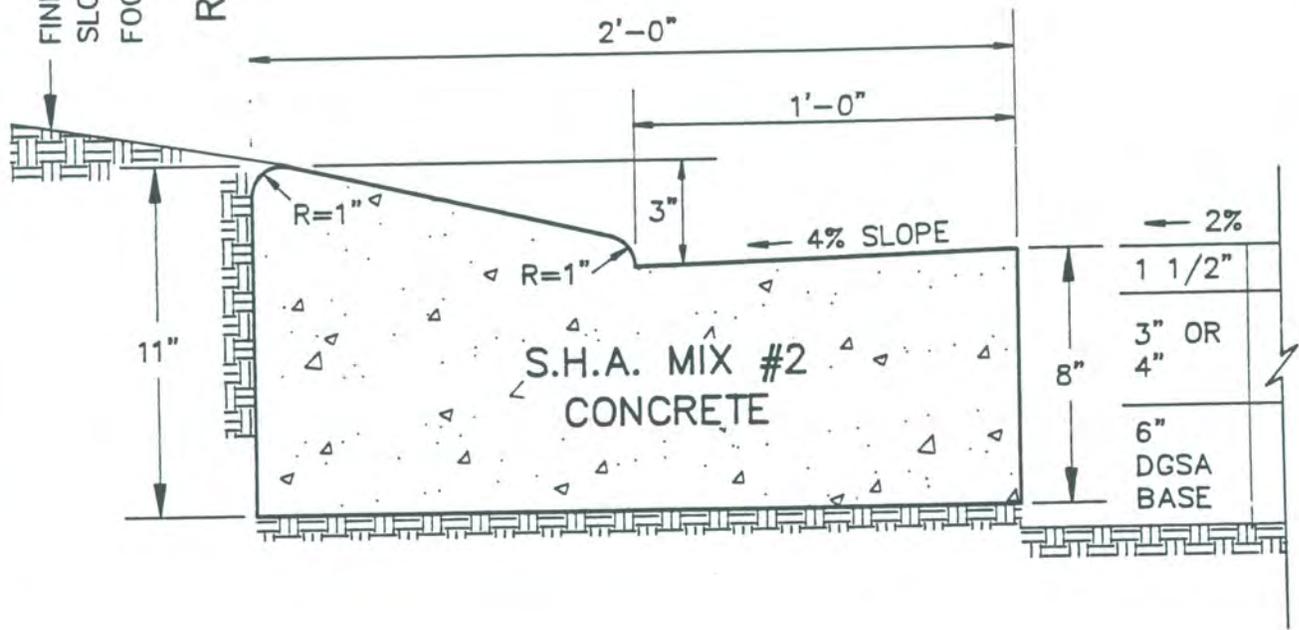
8" COMBINATION  
CURB AND GUTTER

PLATE

3

FINISHED GRADE BEHIND CURB TO  
SLOPE UP FROM BACK OF CURB AT 1" PER  
FOOT FOR 2' MIN.

RIGHT OF WAY LINE



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DEPARTMENT OF PUBLIC WORKS

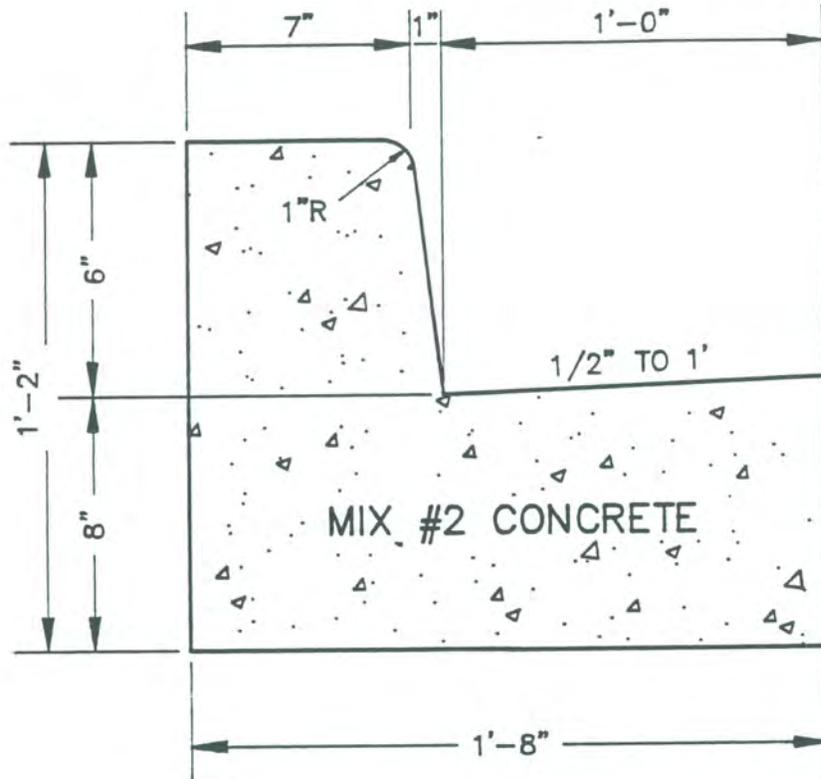
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DIRECTOR DATE

MULTI-FAMILY DEVELOPEMENT

MODIFIED MOUNTABLE  
CURB AND GUTTER

PLATE

4



**NOTE:**  
 GUTTER PAN SLOPE TO BE REVERSED TO MATCH ADJACENT  
 PAVING SLOPE WHERE NOTED ON PLANS.

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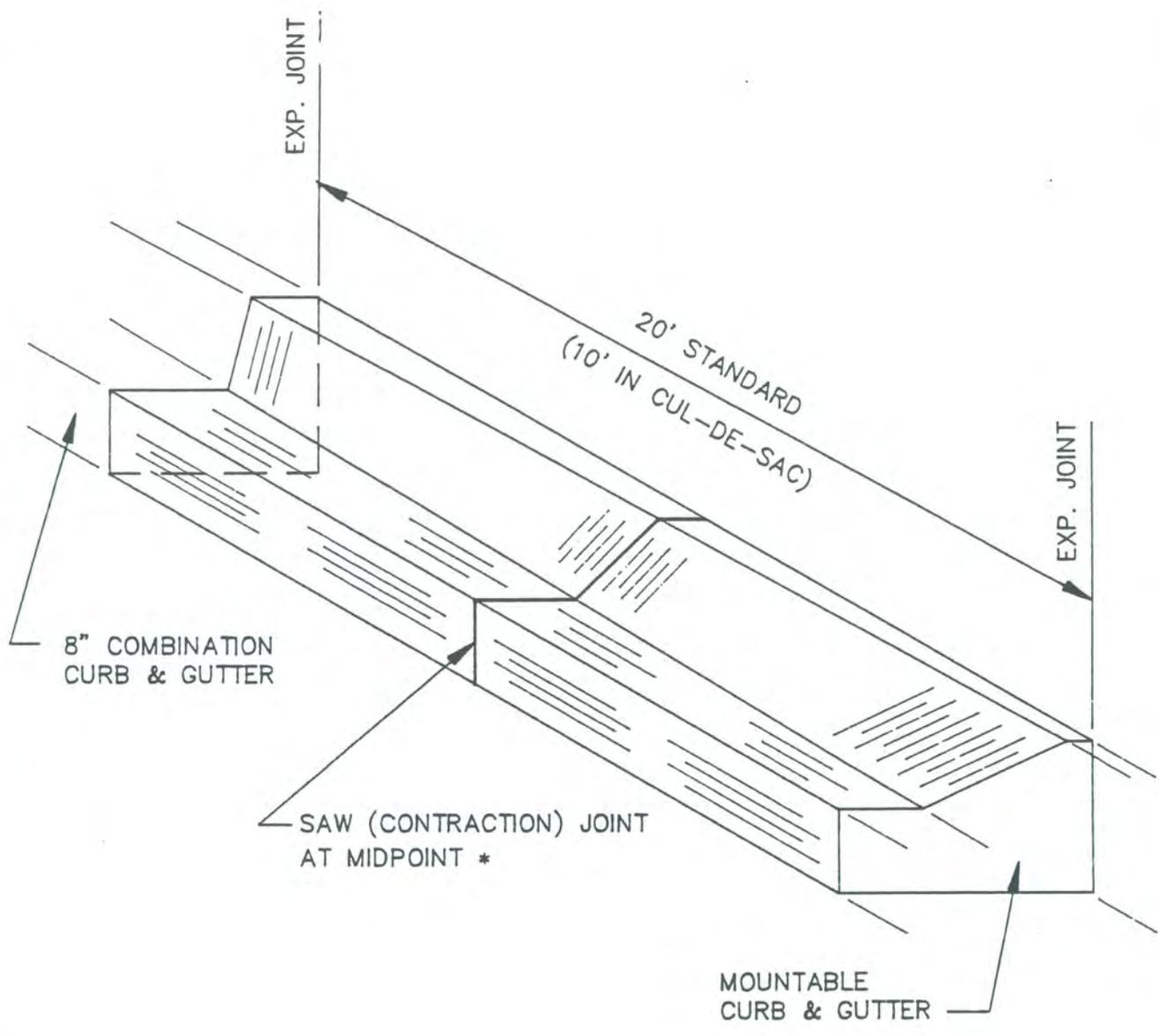
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MULTI-FAMILY DEVELOPMENT  
 6" COMBINATION  
 CURB AND GUTTER  
 PARKING BAY LOCATION

PLATE

5



\* CONTRACTION JOINT NOT NECESSARY IN 10' TRANSITIONS

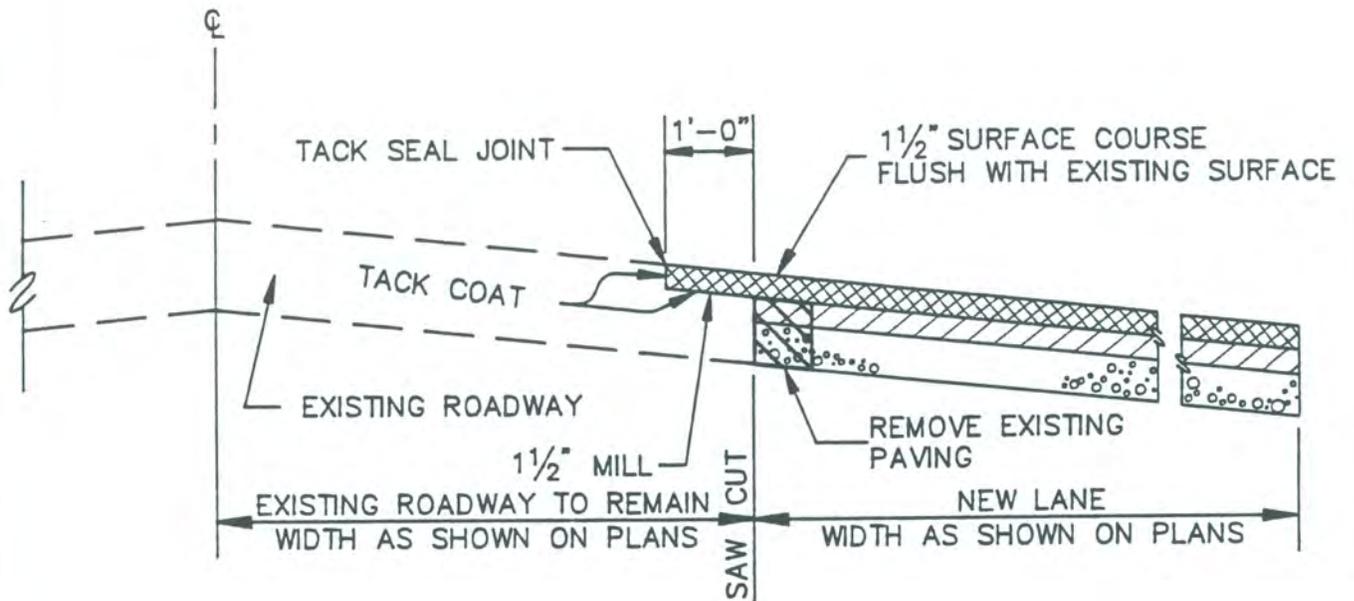
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CURB TRANSITION SECTION  
FROM  
COMBINATION TO MOUNTABLE

PLATE  
6



THIS METHOD OF JOINING SHALL BE USED WHERE A LANE IS BEING ADDED AND OVERLAY OF EXISTING ROAD IS NOT REQUIRED. CURBING OR SHOULDER SHALL BE SPECIFIED IN TYPICAL SECTION.

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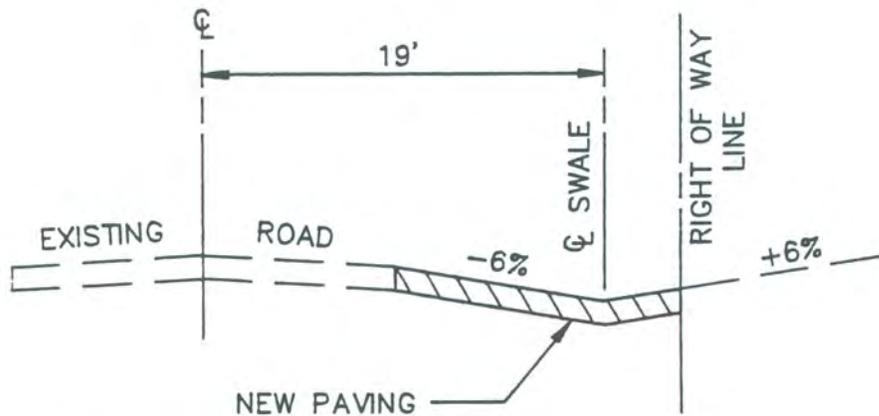
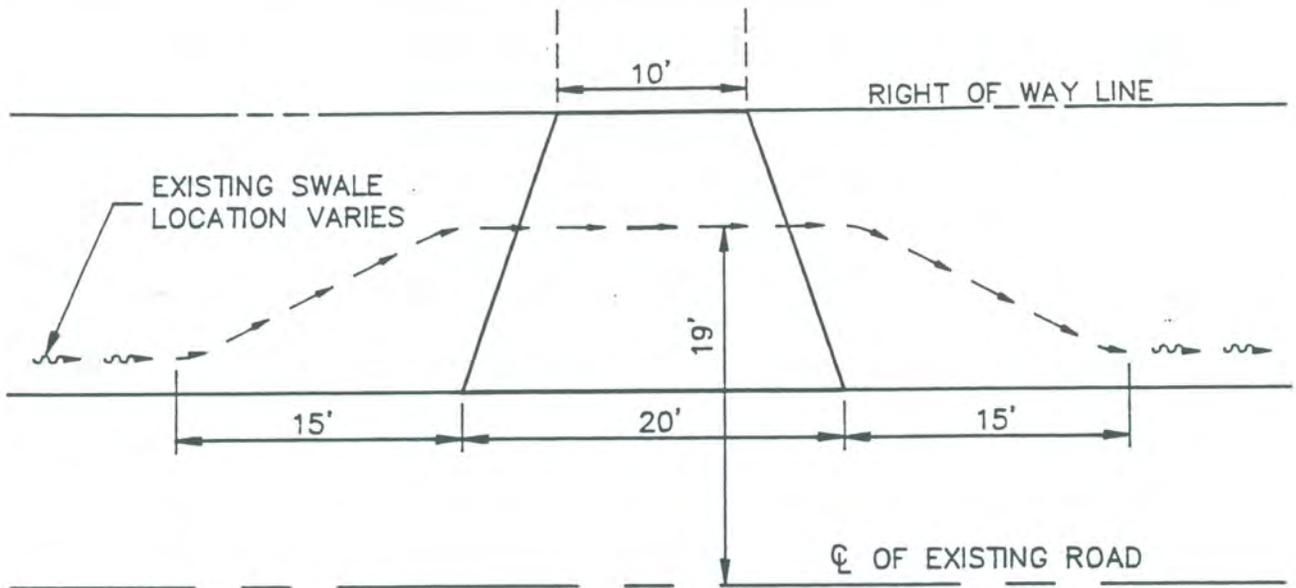
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PAVING JOINT

PLATE

7



PAVING: 7" MIX No. 2 NON-REINFORCED CONCRETE

OR: 1 1/2" BIT. CONC. SURF.  
 3" BIT. CONC. BASE  
 6" DGSA STONE BASE

NOTE:

1. SWALE APRONS MAY BE USED ONLY WHERE UPGRADE DRAINAGE AREA IS 1-3 ACRES OR DISTANCE TO CREST OF HILL IS LESS THAN 150 FEET.
2. APRON SHALL BE CONSTRUCTED FROM EDGE OF ROAD TO R.O.W. LINE. IF NO R.O.W. EXISTS APRON MUST EXTEND A MINIMUM OF 18' FROM EDGE OF ROAD.

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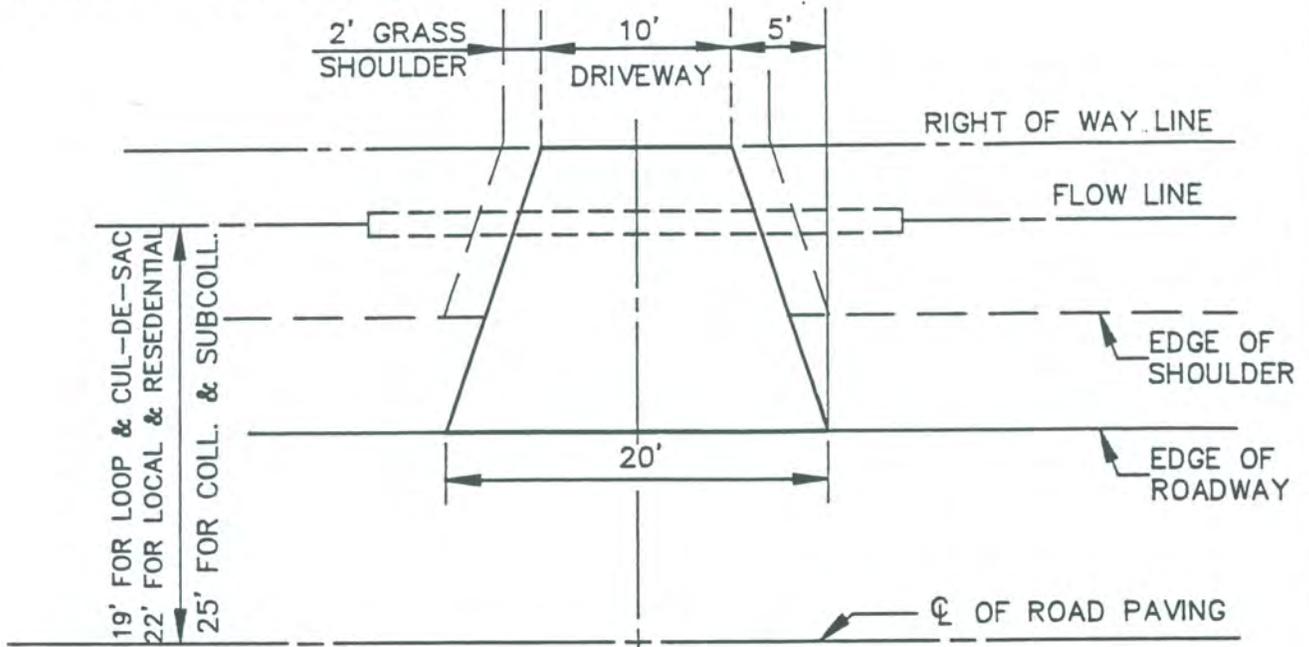
*Keith Stinson* 4-12-94  
 DIRECTOR DATE

RESIDENTIAL DRIVEWAY  
 APRON WITH SWALE

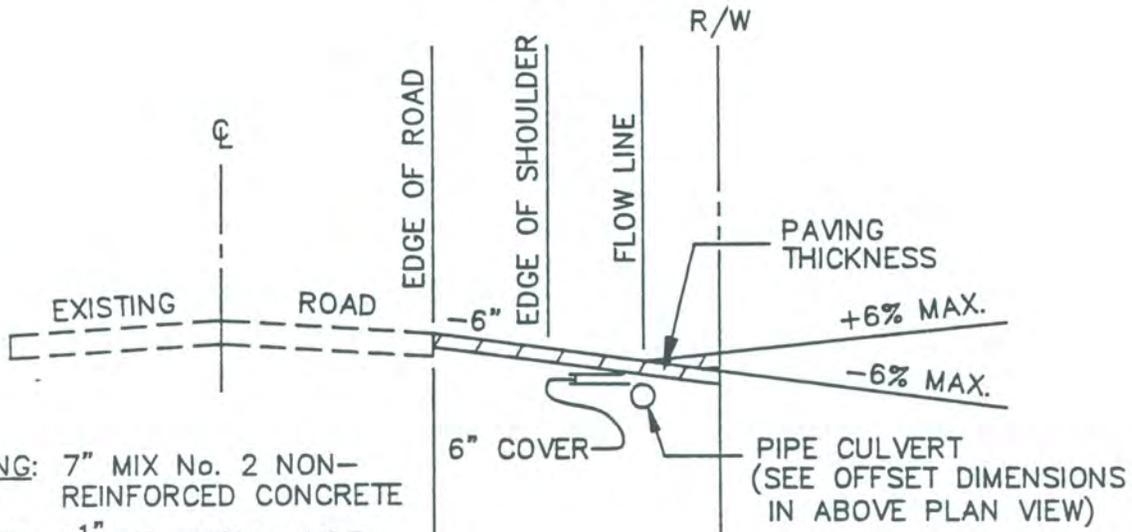
PLATE

8

PIPE CULVERT, WHEN REQUIRED,  
 SHALL BE LOCATED AS SHOWN  
 MIN. SIZE = 15"  
 MIN. LENGTH = 30'  
 MIN. COVER = 6" TOP OF PIPE TO BOTTOM OF APRON.  
 MIN. GAUGE = 14(FOR METAL PIPE)



**PLAN**



PAVING: 7" MIX No. 2 NON-  
 REINFORCED CONCRETE  
OR: 1 1/2" BIT. CONC. SURF.  
 3" BIT. CONC. BASE  
 6" DGSA STONE BASE

**PROFILE**

NOTE:  
 APRON SHALL BE CONSTRUCTED FROM EDGE OF ROAD TO R.O.W. LINE.  
 IF NO R.O.W. EXISTS APRON MUST EXTEND A MINIMUM OF 18' FROM EDGE  
 OF ROAD.

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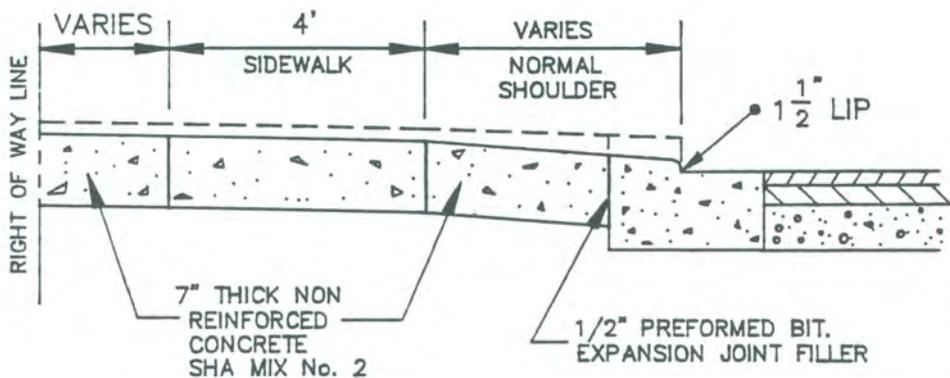
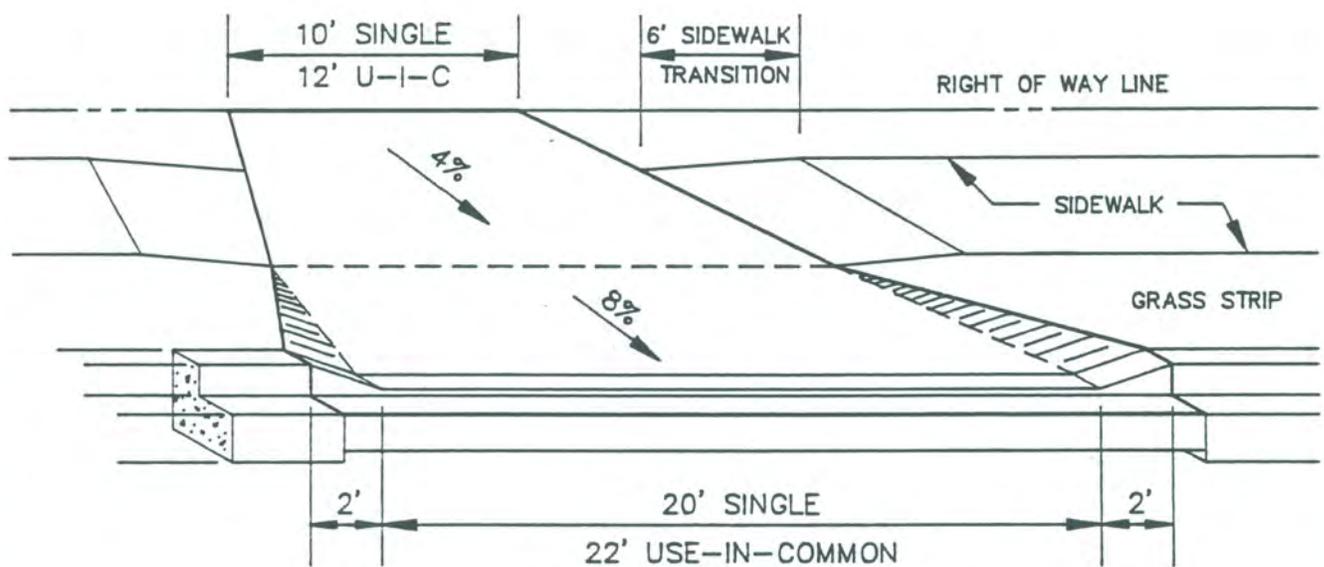
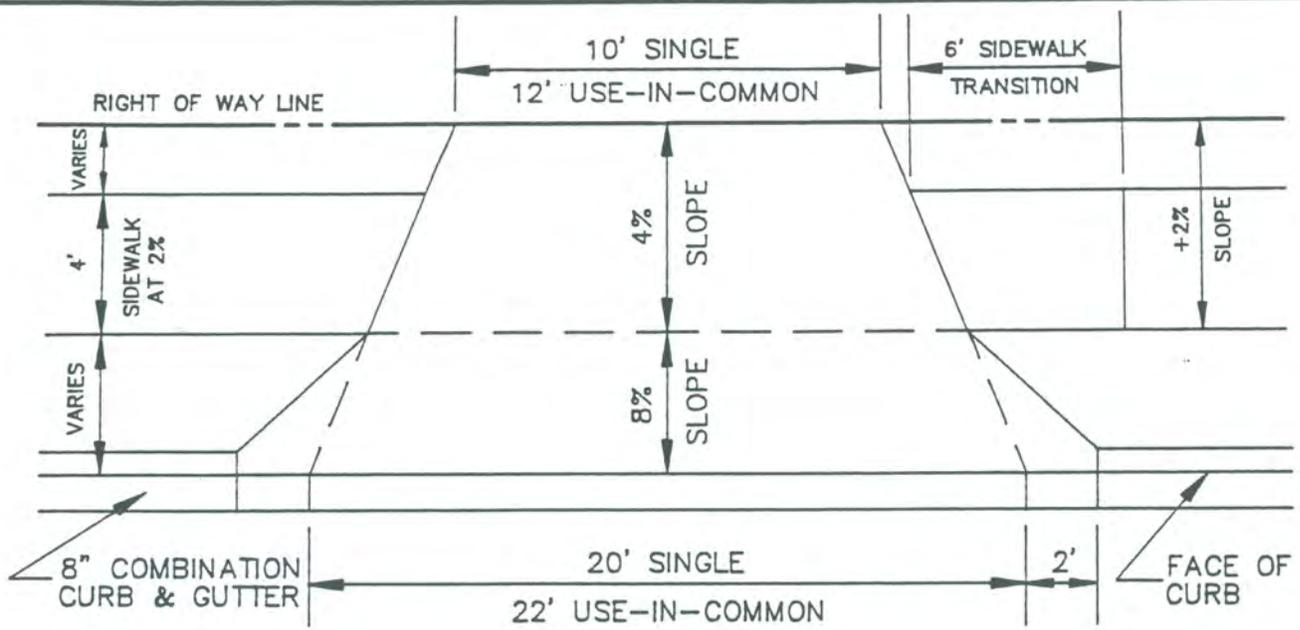
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RESIDENTIAL DRIVEWAY  
 APRON  
 SINGLE USE WITH CULVERT

PLATE

9



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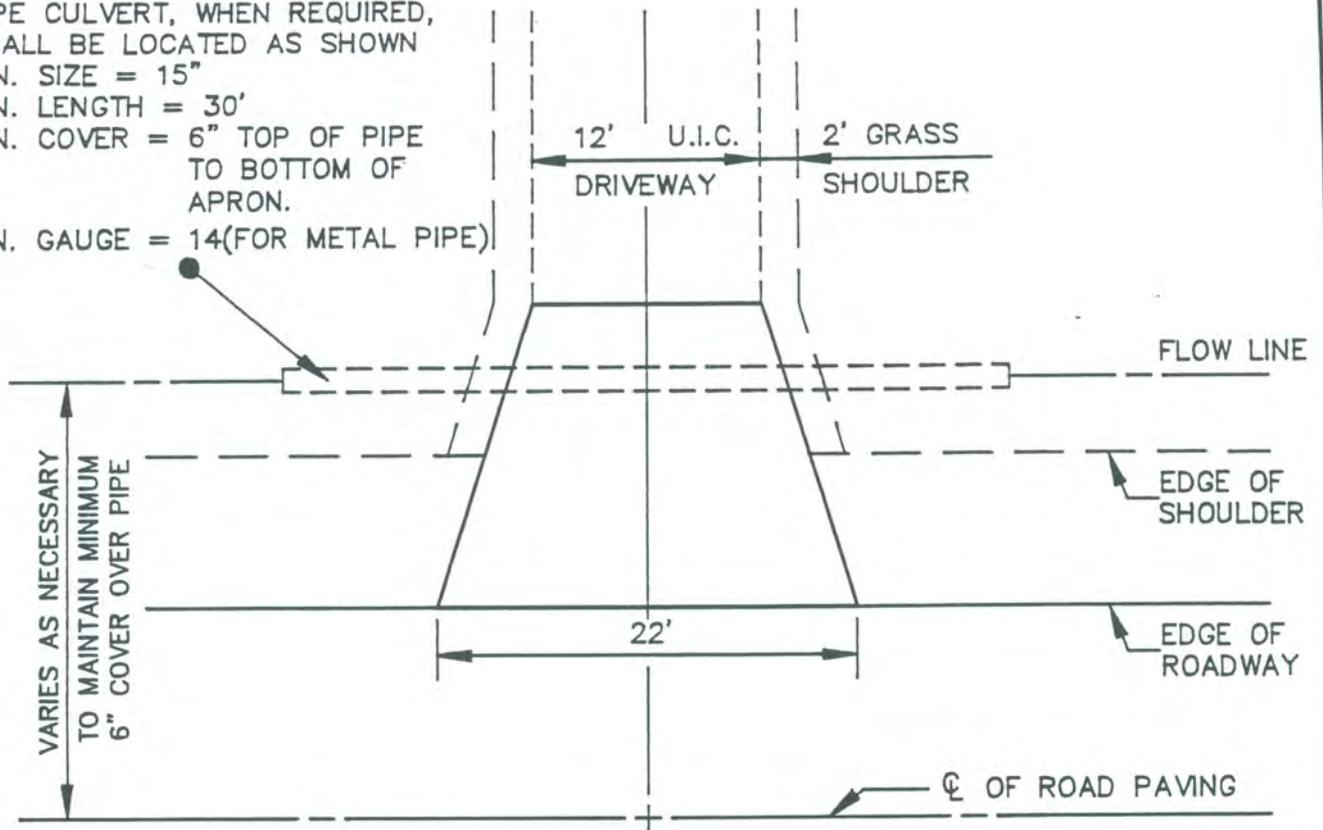
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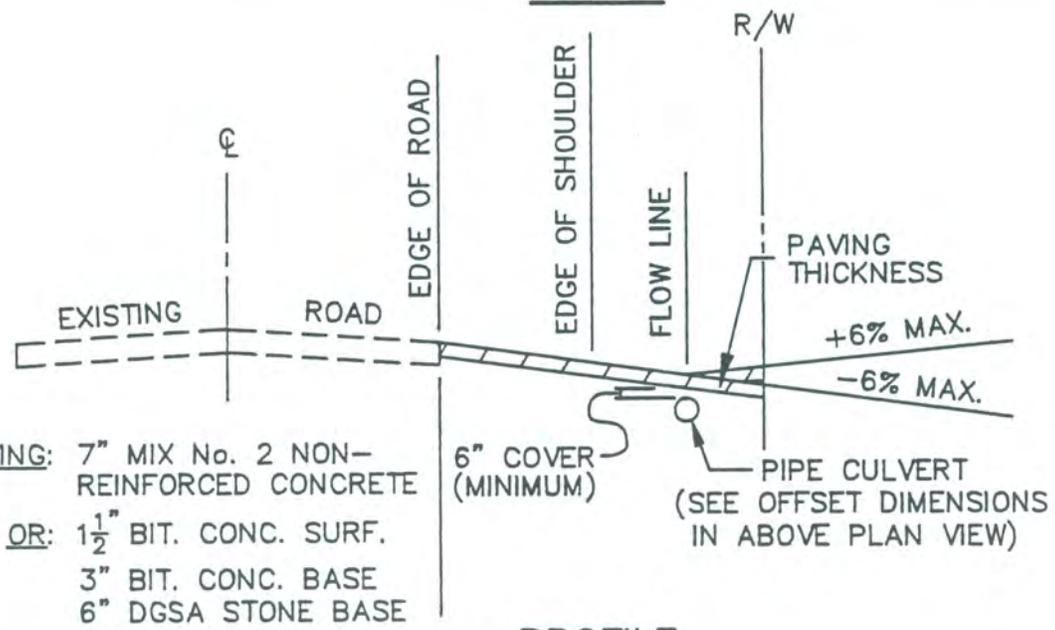
SINGLE AND USE-IN-COMMON  
 DRIVEWAY APRONS  
 WITH 8" COMBINATION C & G

PLATE  
 10

PIPE CULVERT, WHEN REQUIRED,  
 SHALL BE LOCATED AS SHOWN  
 MIN. SIZE = 15"  
 MIN. LENGTH = 30'  
 MIN. COVER = 6" TOP OF PIPE  
 TO BOTTOM OF  
 APRON.  
 MIN. GAUGE = 14(FOR METAL PIPE)



**PLAN**



PAVING: 7" MIX No. 2 NON-  
 REINFORCED CONCRETE  
OR: 1 1/2" BIT. CONC. SURF.  
 3" BIT. CONC. BASE  
 6" DGSA STONE BASE

6" COVER (MINIMUM)  
 PIPE CULVERT  
 (SEE OFFSET DIMENSIONS  
 IN ABOVE PLAN VIEW)

**PROFILE**

NOTE:  
 APRON SHALL BE CONSTRUCTED FROM EDGE OF ROAD TO R.O.W. LINE.  
 IF NO R.O.W. EXISTS APRON MUST EXTEND A MINIMUM OF 18' FROM EDGE  
 OF ROAD.

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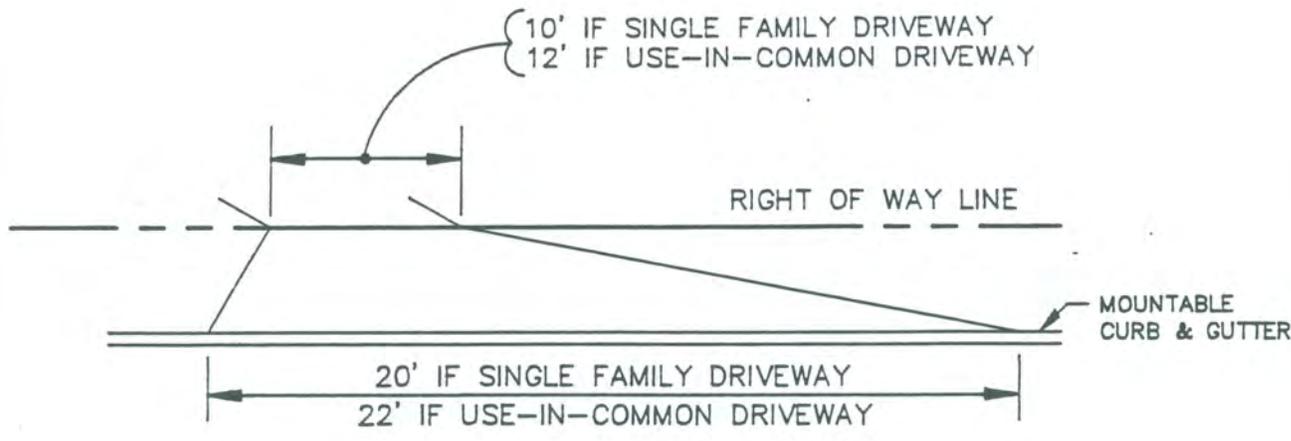
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 DIRECTOR      4-12-94  
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RESIDENTIAL DRIVEWAY  
 APRON USE IN COMMON  
 WITH CULVERT

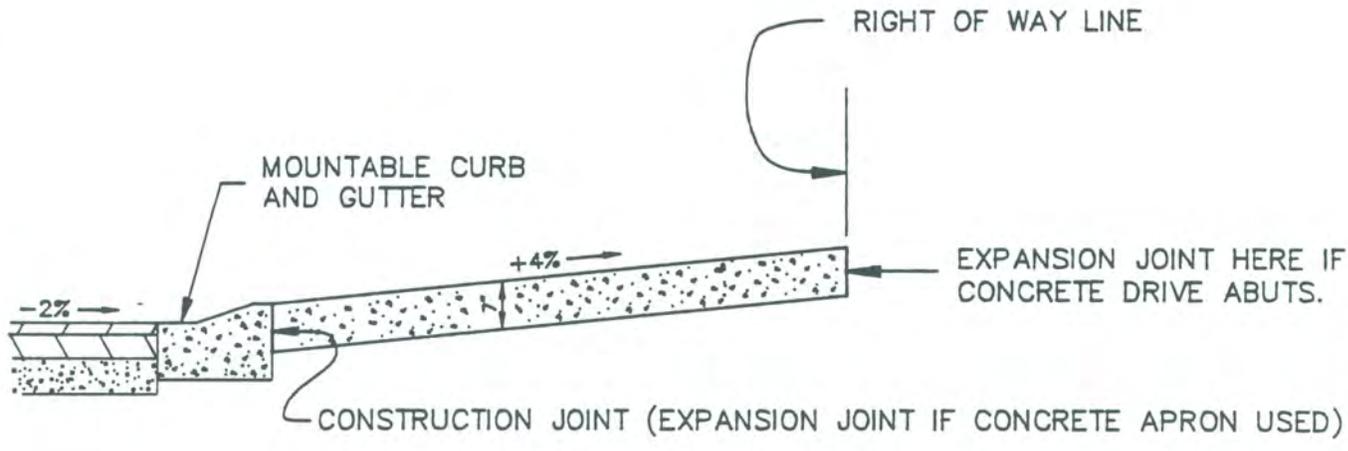
PLATE

11



NOTE: SEE PLATES 8 AND 9 FOR PAVING COURSES.

PLAN



TYPICAL CROSS SECTION

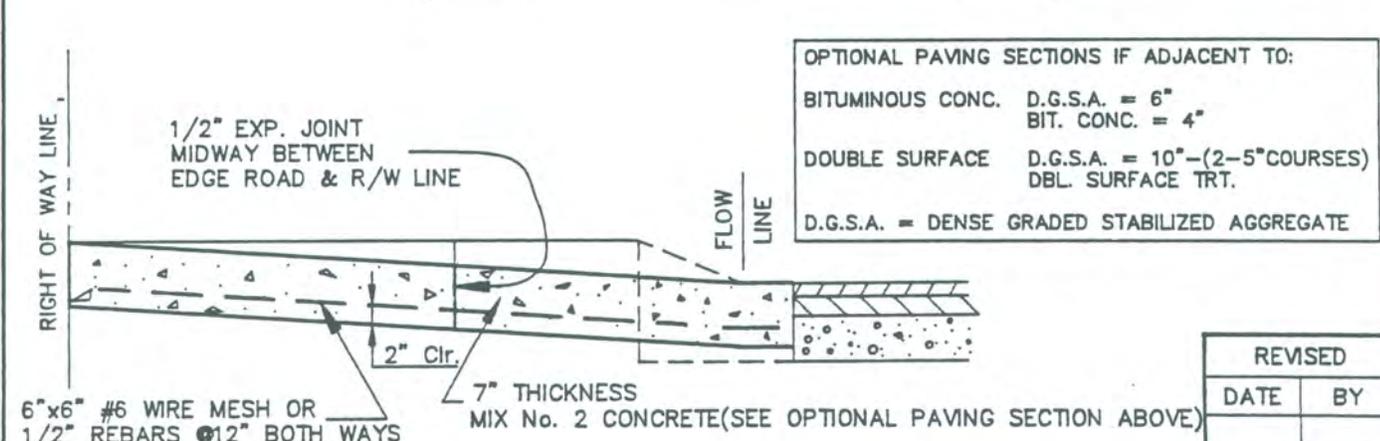
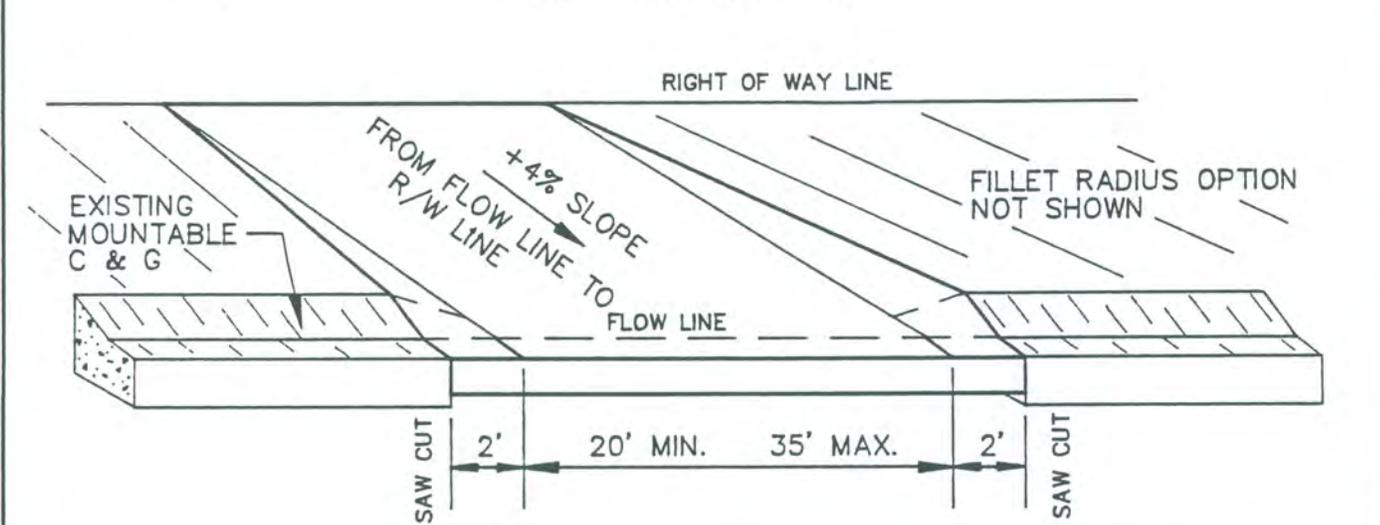
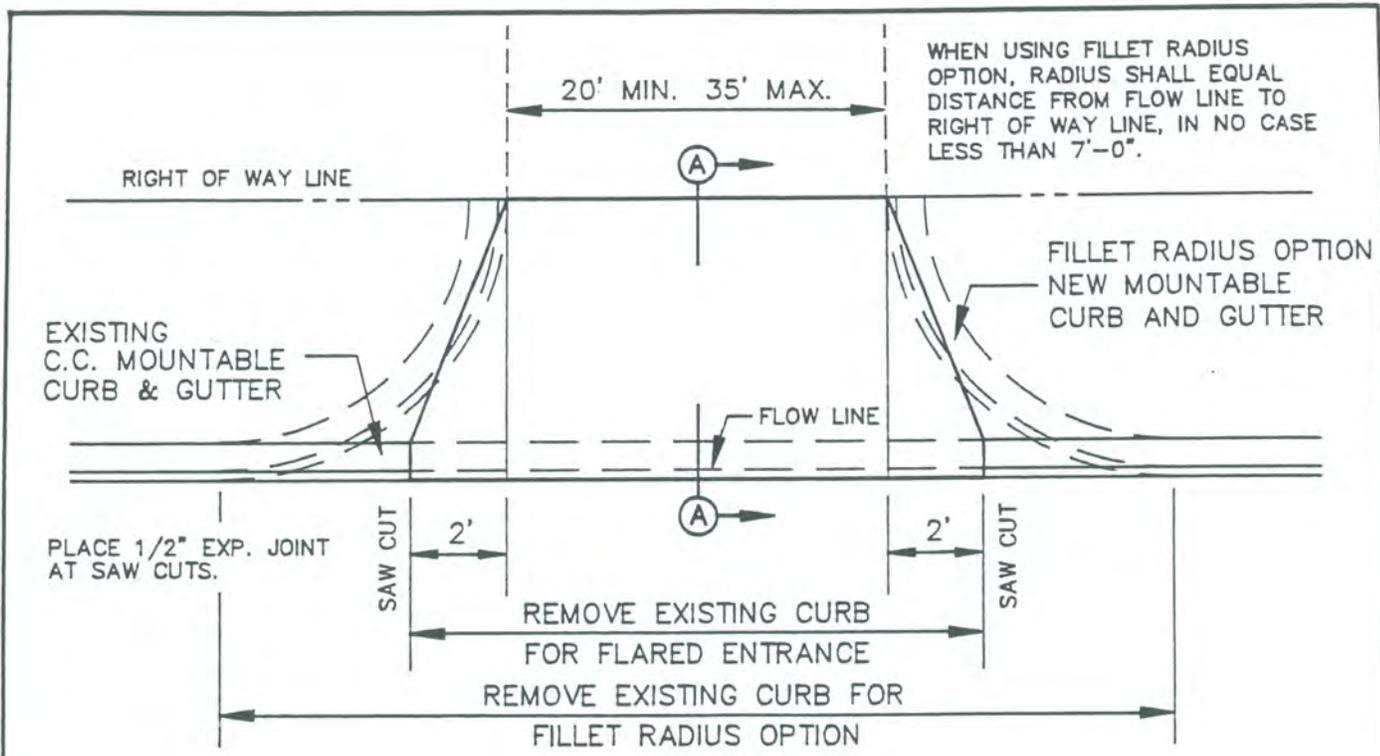
PROFILE

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RESIDENTIAL DRIVEWAY  
 APRONS WITH MOUNTABLE  
 CURB AND GUTTER

PLATE  
 12



OPTIONAL PAVING SECTIONS IF ADJACENT TO:

BITUMINOUS CONC.	D.G.S.A. = 6"
	BIT. CONC. = 4"
DOUBLE SURFACE	D.G.S.A. = 10"-(2-5" COURSES)
	DBL. SURFACE TRT.
D.G.S.A. = DENSE GRADED STABILIZED AGGREGATE	

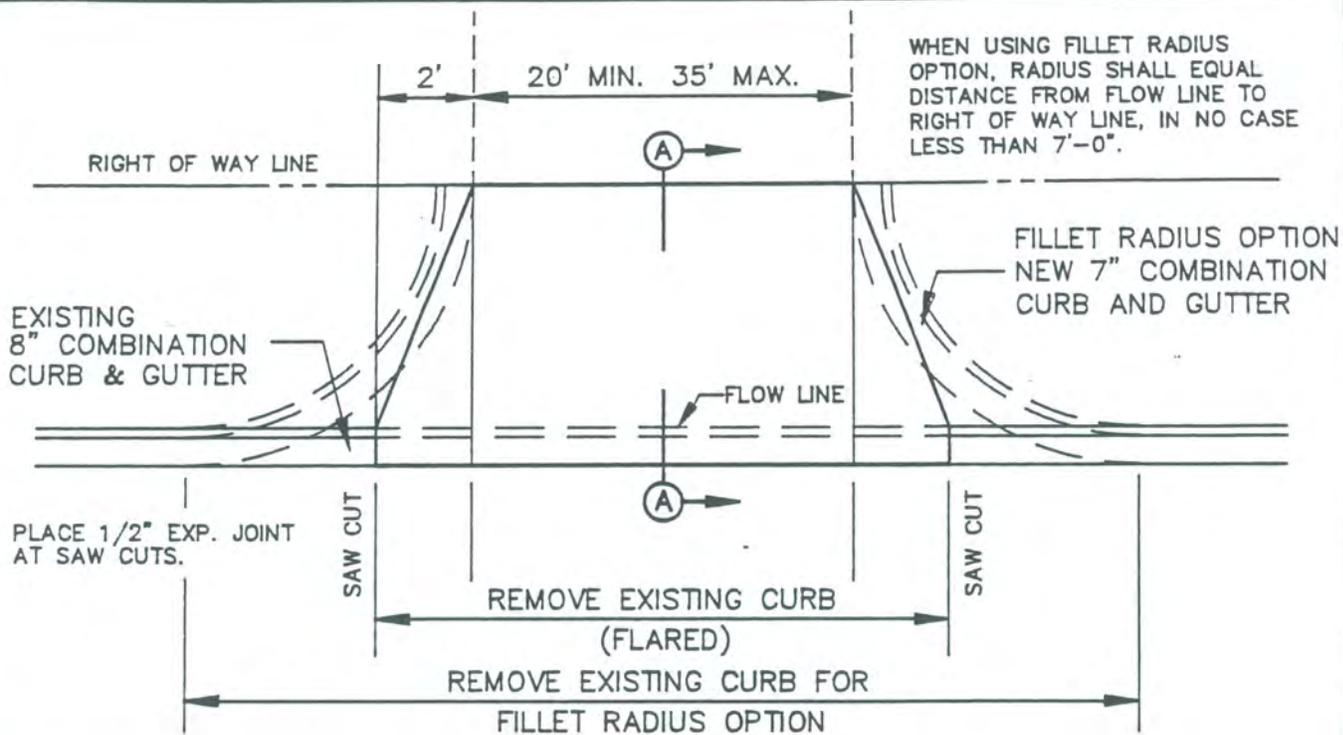
**SECTION A-A**

CARROLL COUNTY, MARYLAND  
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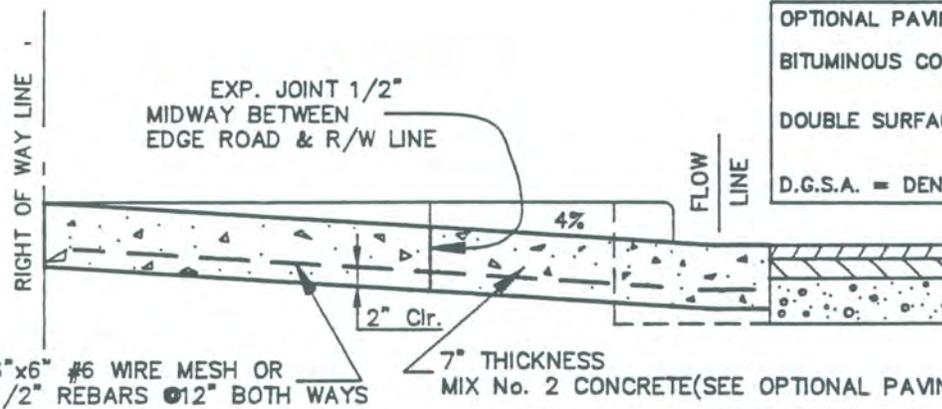
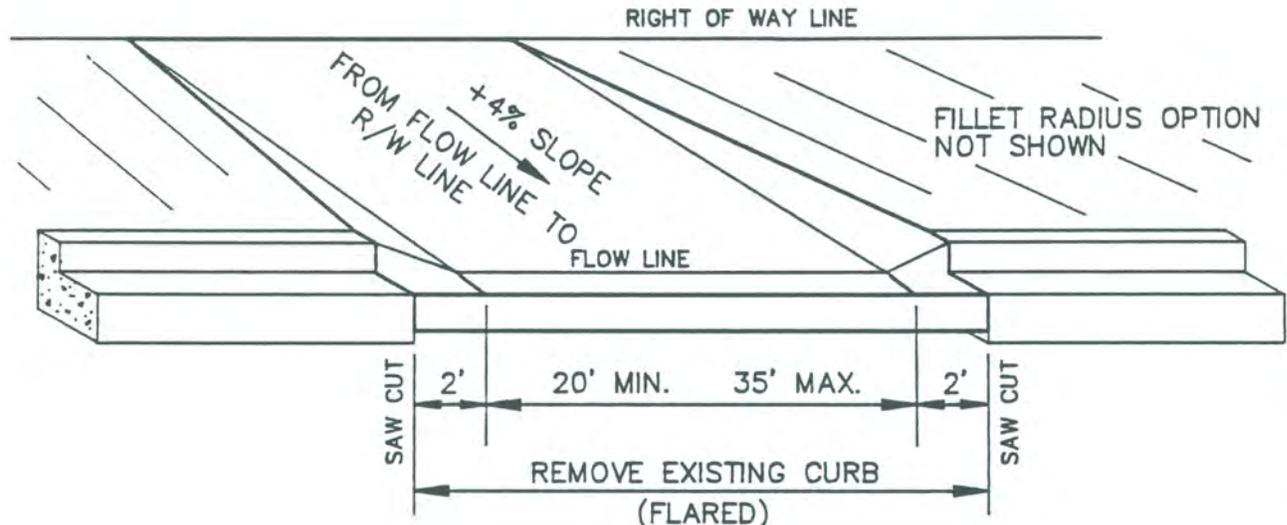
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DIRECTOR DATE

COMMERCIAL ENTRANCE  
WITH EXISTING MOUNTABLE  
CURB AND GUTTER

REVISED	
DATE	BY
PLATE	
13	



WHEN USING FILLET RADIUS OPTION, RADIUS SHALL EQUAL DISTANCE FROM FLOW LINE TO RIGHT OF WAY LINE, IN NO CASE LESS THAN 7'-0".



OPTIONAL PAVING SECTIONS IF ADJACENT TO:	
BITUMINOUS CONC.	D.G.S.A. = 6" BIT. CONC. = 4"
DOUBLE SURFACE	D.G.S.A. = 10"-(2-5" COURSES) DBL. SURFACE TRT.
D.G.S.A. = DENSE GRADED STABILIZED AGGREGATE	

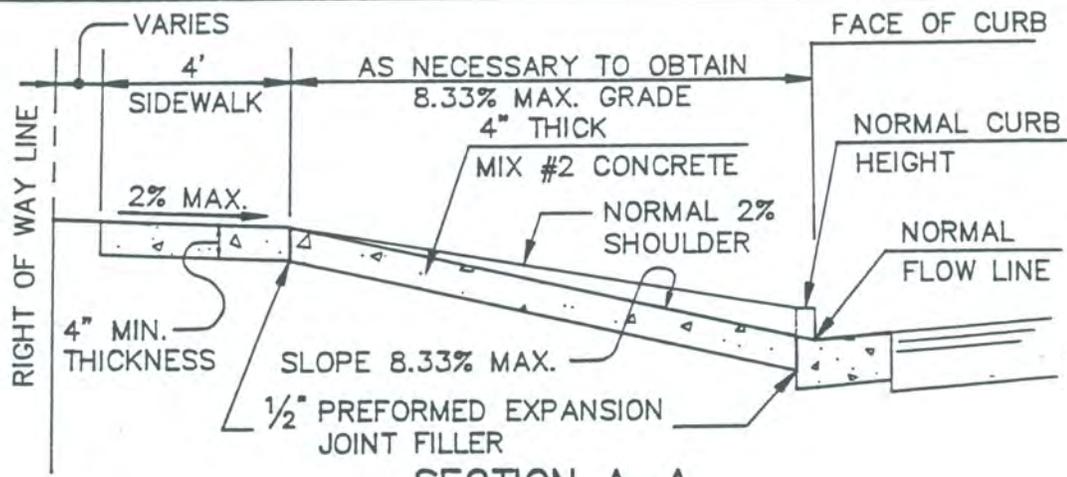
SECTION A-A

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*Eastwood*  
DIRECTOR  
4-12-94  
DATE

COMMERCIAL ENTRANCE WITH  
EXISTING 8" COMBINATION  
CURB AND GUTTER

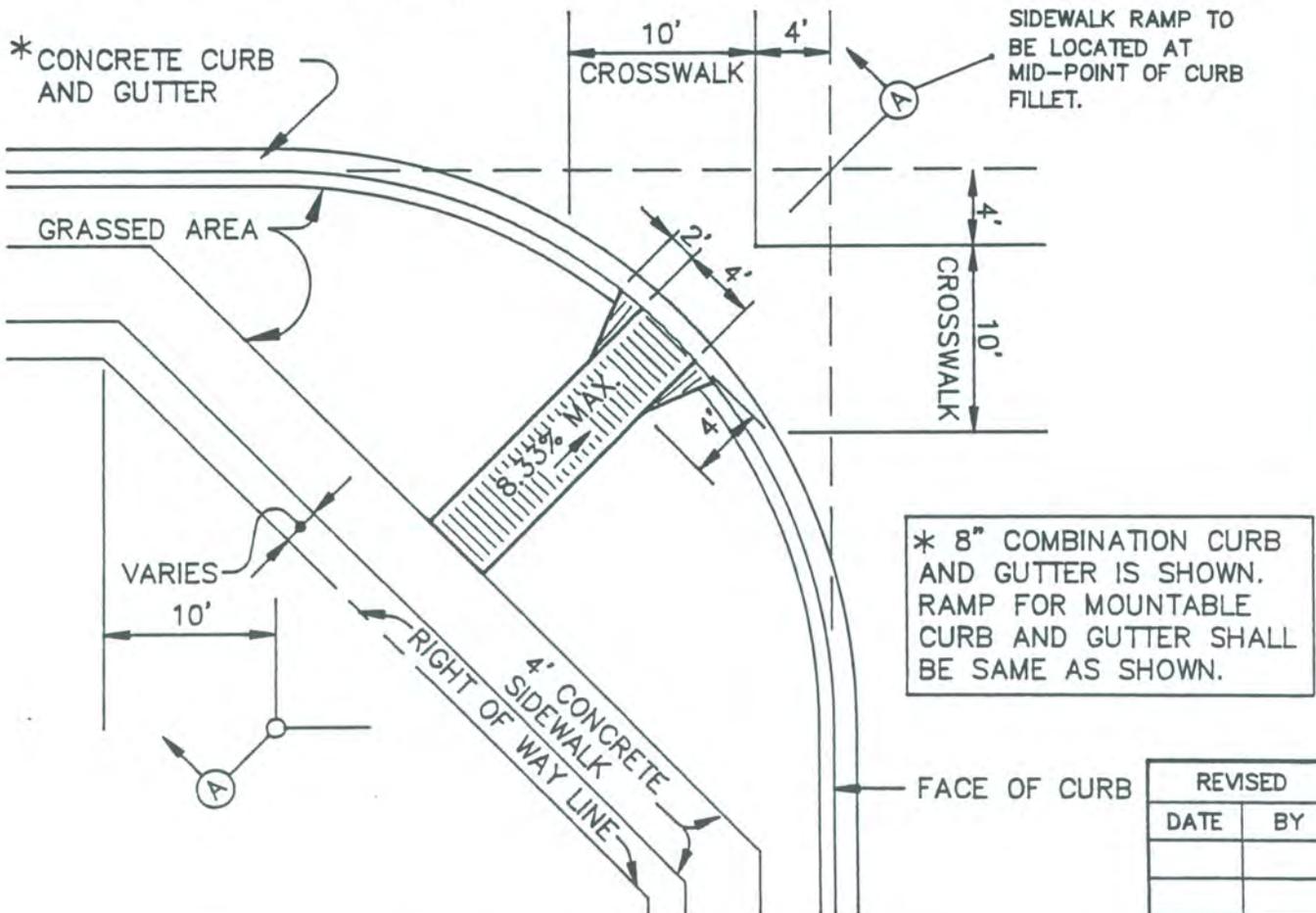
PLATE  
14



**SECTION A-A**

**GENERAL NOTES:**

1. CONSTRUCT 1/4" CONTRACTION JOINTS AT 4'-0" INTERVALS.
2. CONSTRUCT 1/2" PREMOLDED EXPANSION JOINTS AT 100' INTERVALS AT DRIVEWAYS, SIDEWALKS, CURBS, POLES OR ANY OTHER PERMANENT STRUCTURE.
3. A MONOLITHIC CONCRETE FOOTER, 6" THICK, 6" DEEP, FULL WIDTH OF THE SIDEWALK SHALL BE CONSTRUCTED AT 50' INTERVALS, APPROXIMATELY HALFWAY BETWEEN EXPANSION JOINT ON GRADES OF 5% OR OVER.
4. SURFACE OF RAMP AND FLARES SHALL HAVE COARSE TACTILE WARNING TEXTURE DONE WITH BROOM OR AN EQUIVALENT NON-SKID FINISH AS APPROVED BY D.P.W.
5. THIS DETAIL PRESENTS PREFERRED METHOD OF SIDEWALK RAMP CONSTRUCTION. ANY ALTERATIONS TO THIS DESIGN MUST CONFORM TO A.D.A. REQUIREMENTS.



\* 8" COMBINATION CURB AND GUTTER IS SHOWN. RAMP FOR MOUNTABLE CURB AND GUTTER SHALL BE SAME AS SHOWN.

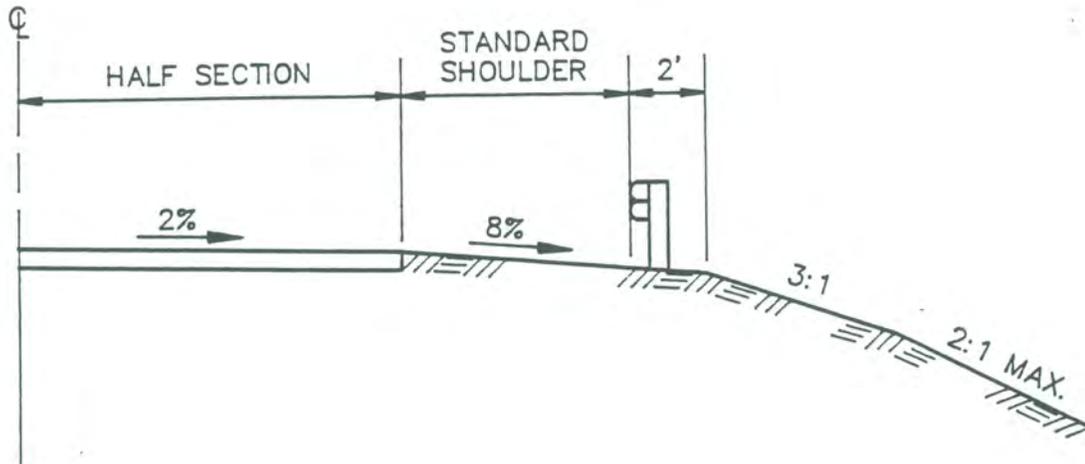
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DATE	BY

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DEPARTMENT OF PUBLIC WORKS

*Kent D. ...* 4-12-94  
DIRECTOR DATE

**SIDEWALK RAMP**

PLATE



NOTES:

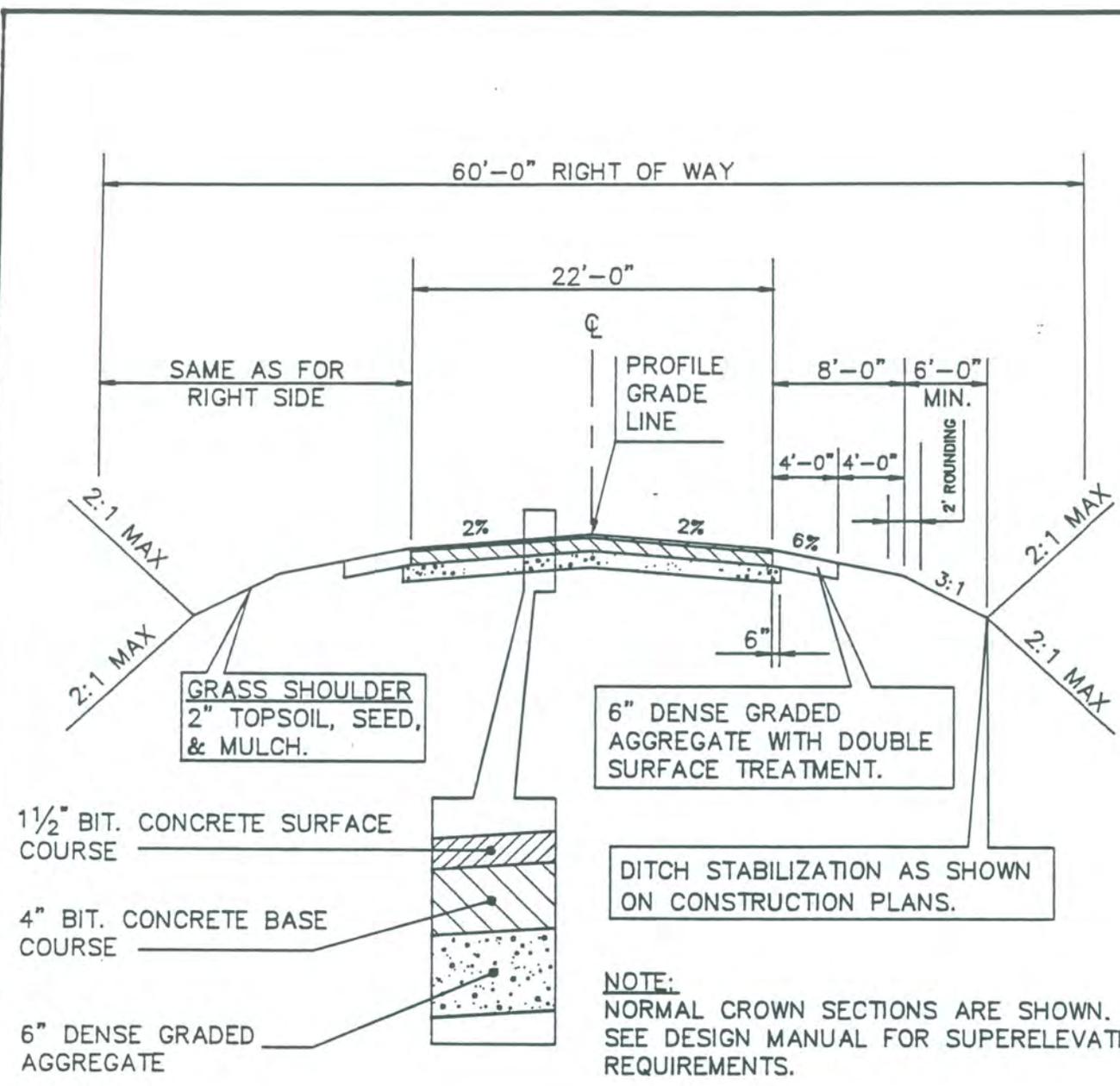
1. WHEN USING GUARDRAIL, HOLD SAME NORMAL SHOULDER SLOPE AND INCREASE AN ADDITIONAL 2' TO ALLOW FOR PLACEMENT AND BACKING.
2. SEE SECTION 2.7.6 OF THIS MANUAL FOR INFORMATION ON GUARDRAIL.

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GUARDRAIL PLACEMENT

PLATE  
 15-A



ALL DISTURBED AREAS WITHIN RIGHT OF WAY OR EASEMENT LIMITS NEEDED FOR ROADWAY CONSTRUCTION SHALL BE SODDED OR SEEDED AND MULCHED ON 2" OF TOPSOIL.

**NOTE:**  
THIS TYPICAL SECTION SHALL BE USED IN THE FOLLOWING ZONES WHEN A COLLECTOR ROAD IS REQUIRED: R-40,000 AGRICULTURAL CONSERVATION

**OVER 1000 ADT**

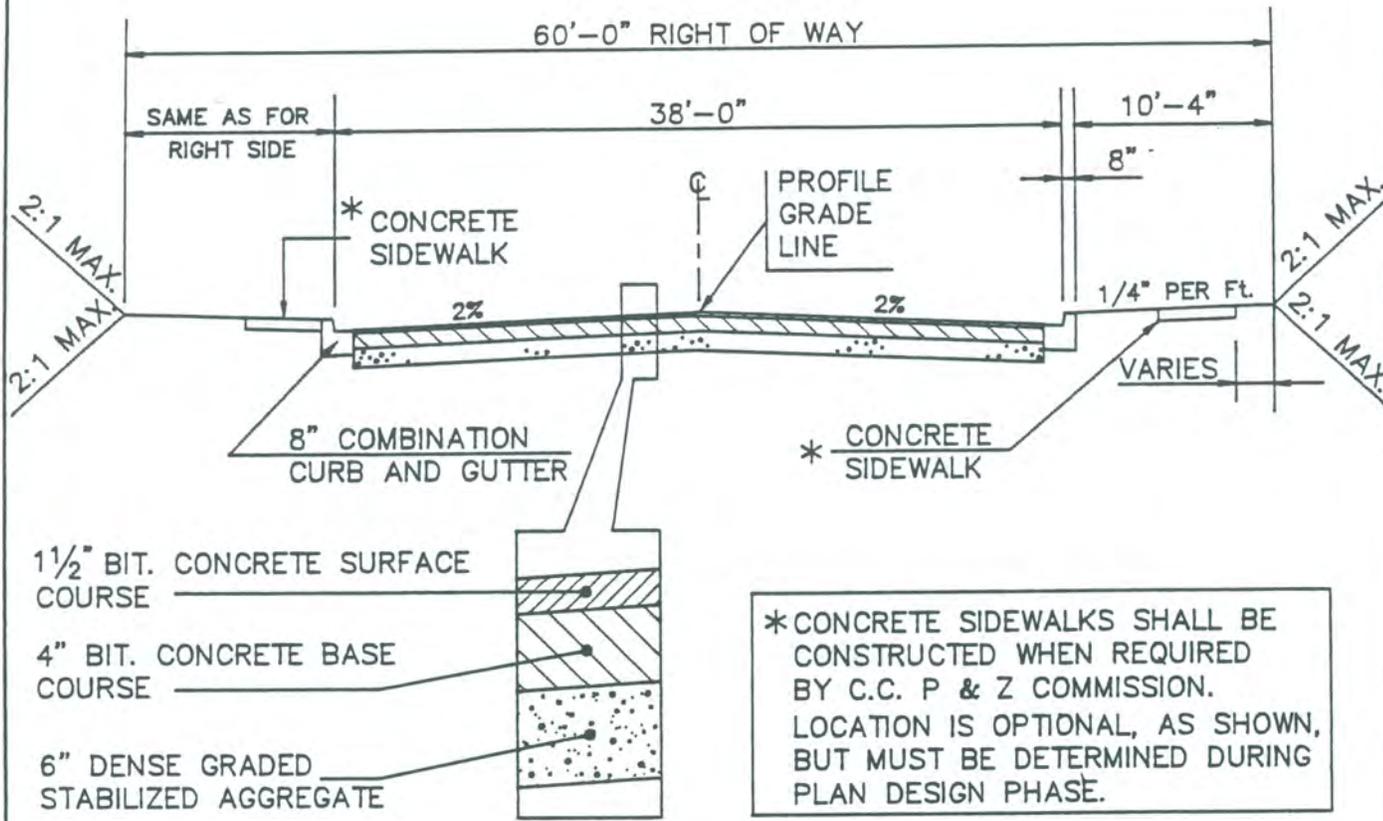
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*Continued* 4-12-94  
DIRECTOR DATE

SUBCOLLECTOR ROAD  
22' OPEN SECTION

PLATE  
16



ALL DISTURBED AREAS WITHIN RIGHT OF WAY OR EASEMENT LIMITS NEEDED FOR ROADWAY CONSTRUCTION SHALL BE SODDED OR SEEDD AND MULCHED ON 2" OF TOPSOIL.

**NOTE:**

THIS TYPICAL SECTION SHALL BE USED IN THE FOLLOWING RESIDENTIAL ZONES WHEN A COLLECTOR ROAD IS REQUIRED:

- R-20,000
- R-10,000
- R-7,500

**OVER 1000 ADT**

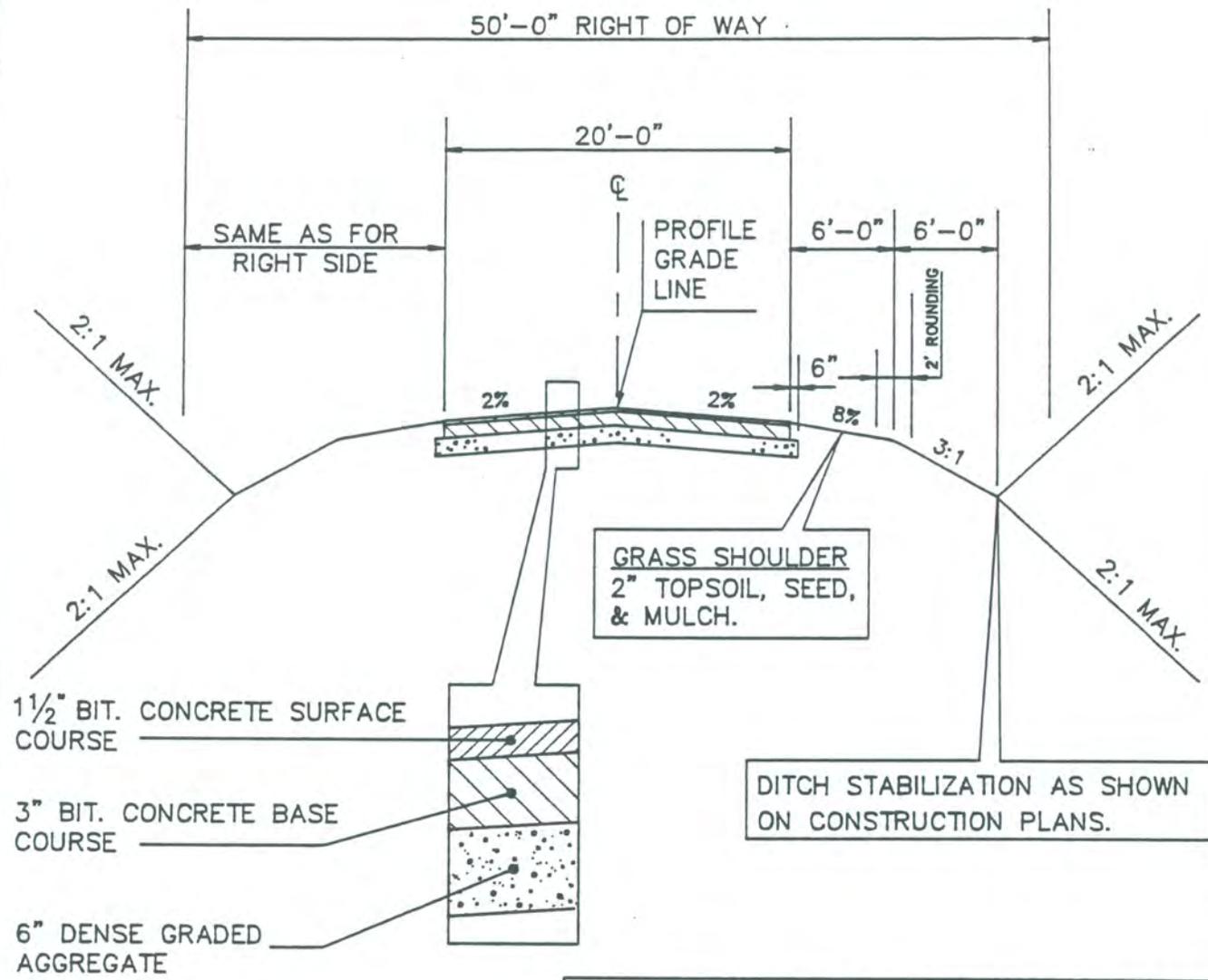
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SUBCOLLECTOR ROAD  
38' CLOSED SECTION

PLATE  
17



**GRASS SHOULDER**  
2" TOPSOIL, SEED,  
& MULCH.

DITCH STABILIZATION AS SHOWN  
ON CONSTRUCTION PLANS.

ALL DISTURBED AREAS WITHIN RIGHT OF WAY  
OR EASEMENT LIMITS NEEDED FOR ROADWAY  
CONSTRUCTION SHALL BE SODDED OR SEEDED  
AND MULCHED ON 2" OF TOPSOIL.

**NOTE:**  
THIS TYPICAL SECTION SHALL BE USED IN  
THE FOLLOWING ZONES WHEN A LOCAL ROAD  
IS REQUIRED: R-40,000  
AGRICULTURAL  
CONSERVATION

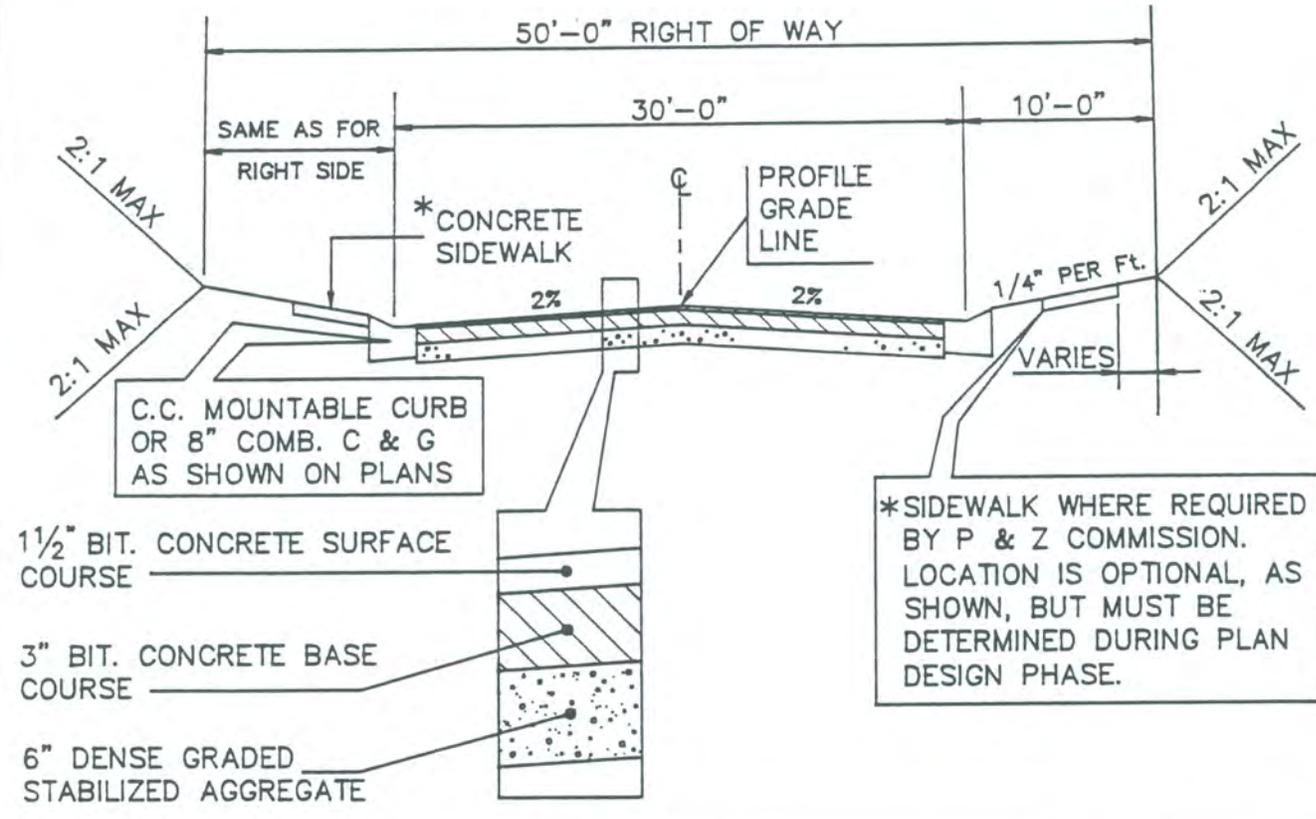
**MAX. ADT = 1000**

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*K. Stinson* 4-12-94  
DIRECTOR DATE

RESIDENTIAL STREET  
20' OPEN SECTION

PLATE  
18



\*SIDEWALK WHERE REQUIRED BY P & Z COMMISSION. LOCATION IS OPTIONAL, AS SHOWN, BUT MUST BE DETERMINED DURING PLAN DESIGN PHASE.

ALL DISTURBED AREAS WITHIN RIGHT OF WAY OR EASEMENT LIMITS NEEDED FOR ROADWAY CONSTRUCTION SHALL BE SODDED OR SEEDING AND MULCHED ON 2" OF TOPSOIL.

**NOTE:**  
 THIS TYPICAL SECTION SHALL BE USED IN THE FOLLOWING ZONES WHEN A LOCAL ROAD IS REQUIRED: R-20,000  
 R-10,000  
 R- 7,500

**MAX. ADT = 1000**

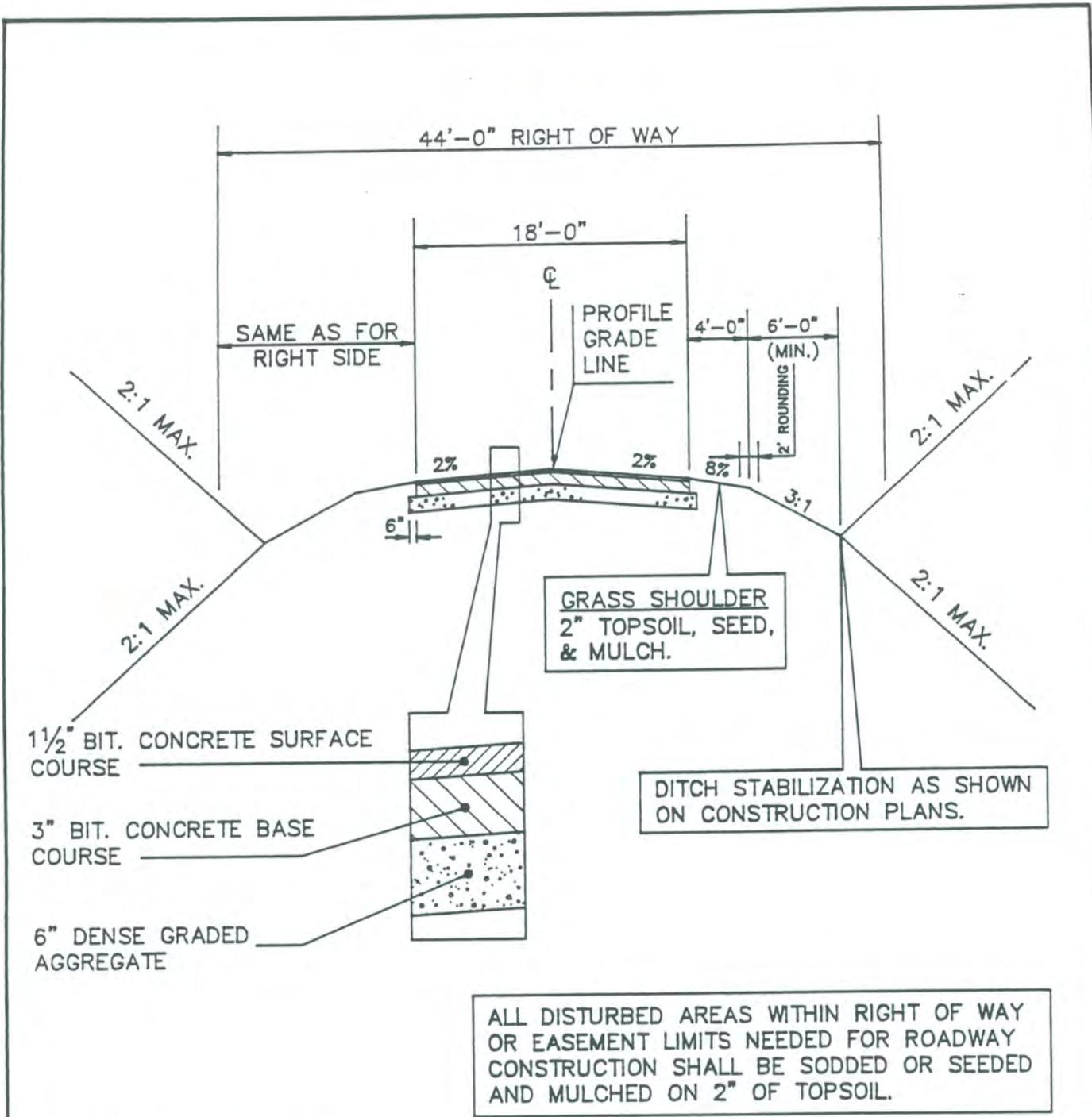
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DATE	BY

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RESIDENTIAL STREET  
 30' CLOSED SECTION

PLATE  
 19



NOTE:

THIS TYPICAL SECTION SHALL BE USED IN THE FOLLOWING ZONES WHEN A LOOP ROAD OR CUL-DE-SAC IS REQUIRED: R-40,000

AGRICULTURAL CONSERVATION

**MAX. LENGTH = 1500'**  
**MAX. ADT = 250**

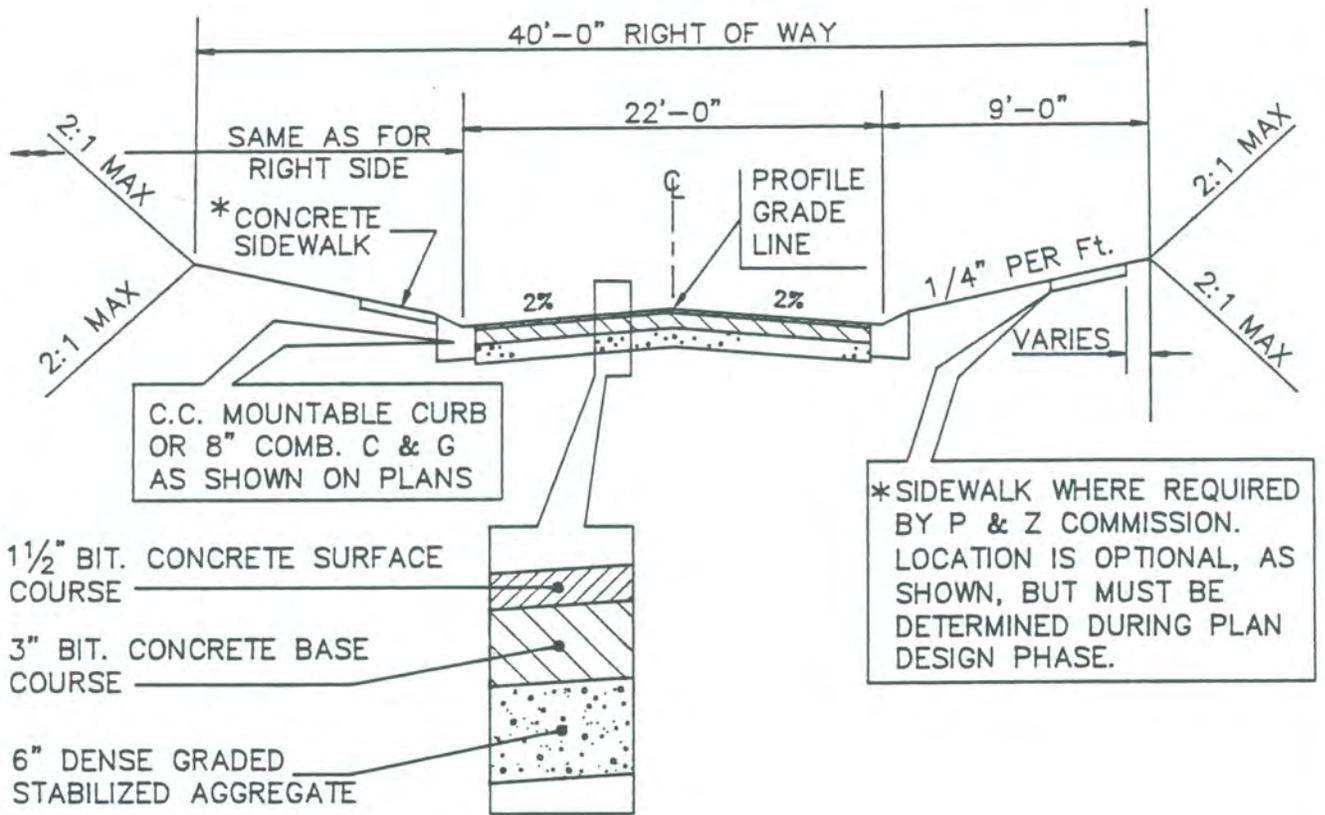
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DATE	BY

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DEPARTMENT OF PUBLIC WORKS

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LOOP ROAD AND  
CUL-DE-SAC ROAD  
18' OPEN SECTION

PLATE  
20



ALL DISTURBED AREAS WITHIN RIGHT OF WAY OR EASEMENT LIMITS NEEDED FOR ROADWAY CONSTRUCTION SHALL BE SODDED OR SEEDDED AND MULCHED ON 2" OF TOPSOIL.

**NOTE:**

THIS TYPICAL SECTION SHALL BE USED IN THE FOLLOWING ZONES WHEN A LOOP ROAD OR CUL-DE-SAC IS REQUIRED: R-20,000  
R-10,000  
R- 7,500

MAX. LENGTH = 1500'  
MAX. ADT = 250

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DATE	BY

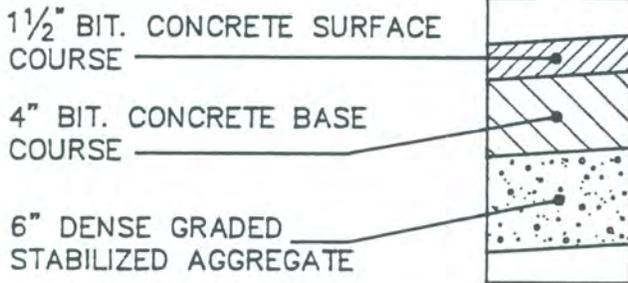
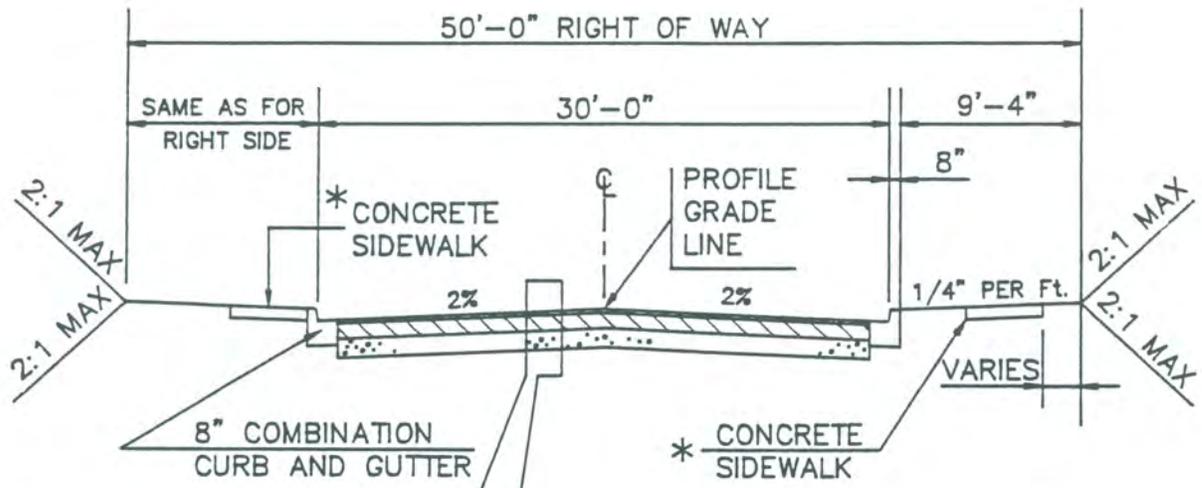
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DEPARTMENT OF PUBLIC WORKS

*Carroll County* 4-12-94  
DIRECTOR DATE

LOOP ROAD AND  
CUL-DE-SAC ROAD  
22' CLOSED SECTION

PLATE

21



\* CONCRETE SIDEWALKS SHALL BE CONSTRUCTED WHEN REQUIRED BY C.C. P & Z COMMISSION. LOCATION IS OPTIONAL, AS SHOWN, BUT MUST BE DETERMINED DURING PLAN DESIGN PHASE.

ALL DISTURBED AREAS WITHIN RIGHT OF WAY OR EASEMENT LIMITS NEEDED FOR ROADWAY CONSTRUCTION SHALL BE SODDED OR SEEDS AND MULCHED ON 2" OF TOPSOIL.

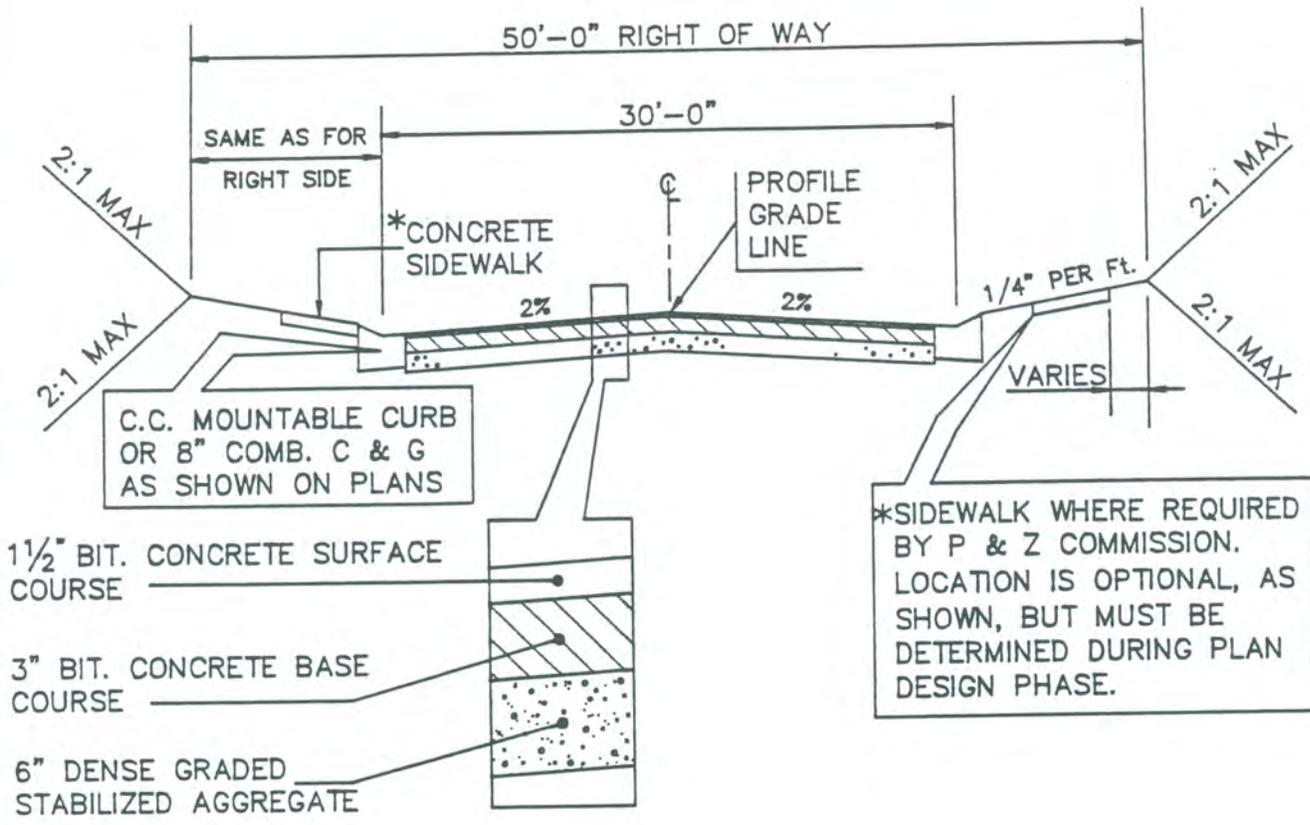
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DATE	BY

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COMMERCIAL - INDUSTRIAL  
ROAD

PLATE  
22



1 1/2" BIT. CONCRETE SURFACE COURSE

3" BIT. CONCRETE BASE COURSE

6" DENSE GRADED STABILIZED AGGREGATE

\*SIDEWALK WHERE REQUIRED BY P & Z COMMISSION. LOCATION IS OPTIONAL, AS SHOWN, BUT MUST BE DETERMINED DURING PLAN DESIGN PHASE.

ALL DISTURBED AREAS WITHIN RIGHT OF WAY OR EASEMENT LIMITS NEEDED FOR ROADWAY CONSTRUCTION SHALL BE SODDED OR SEEDD AND MULCHED ON 2" OF TOPSOIL.

**MAX. ADT = 1000**

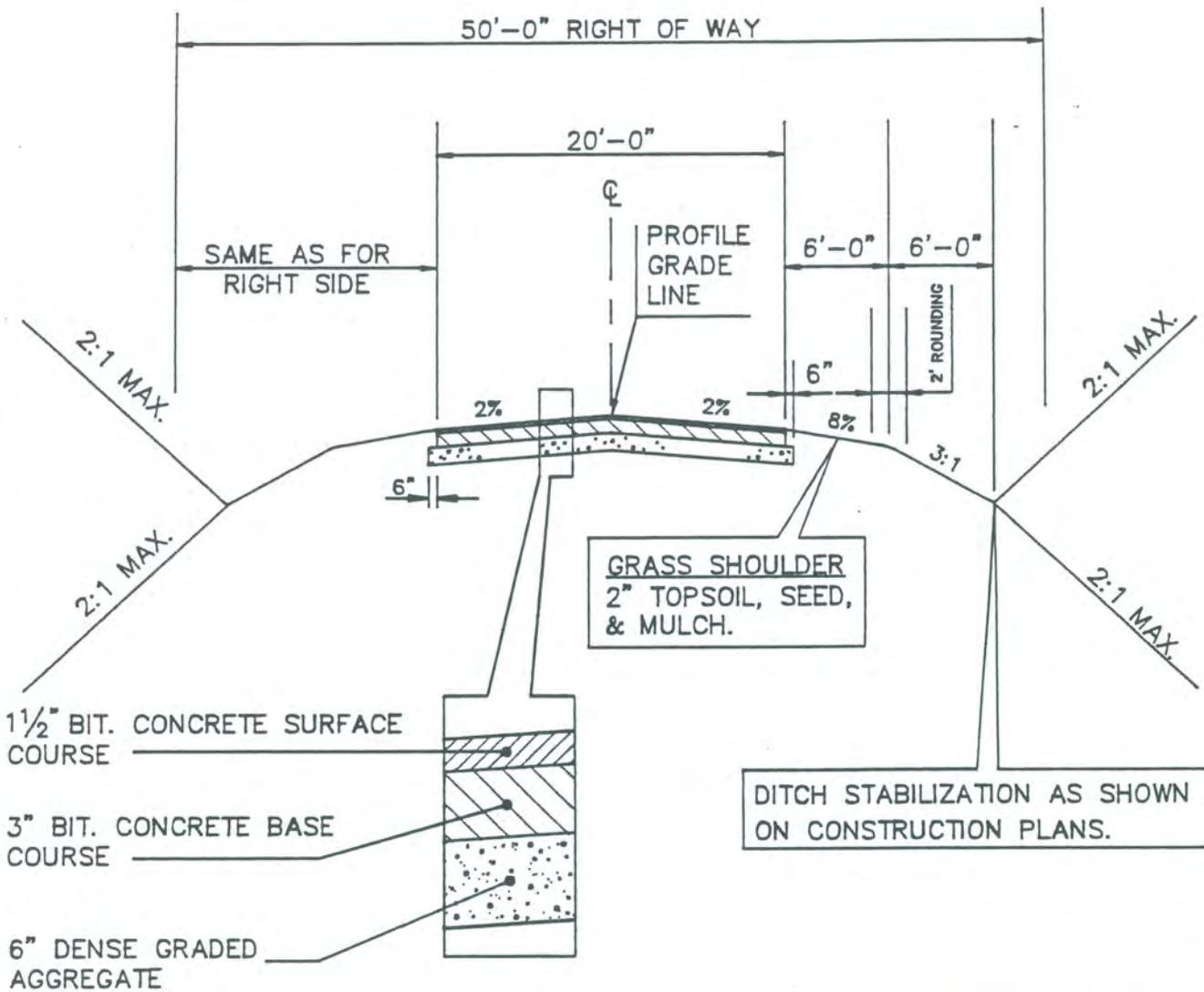
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DATE	BY

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 DIRECTOR DATE

URBAN LOCAL ROAD  
 30' CLOSED SECTION

PLATE  
 23



ALL DISTURBED AREAS WITHIN RIGHT OF WAY OR EASEMENT LIMITS NEEDED FOR ROADWAY CONSTRUCTION SHALL BE SODDED OR SEEDDED AND MULCHED ON 2" OF TOPSOIL.

**MAX. ADT = 1000**

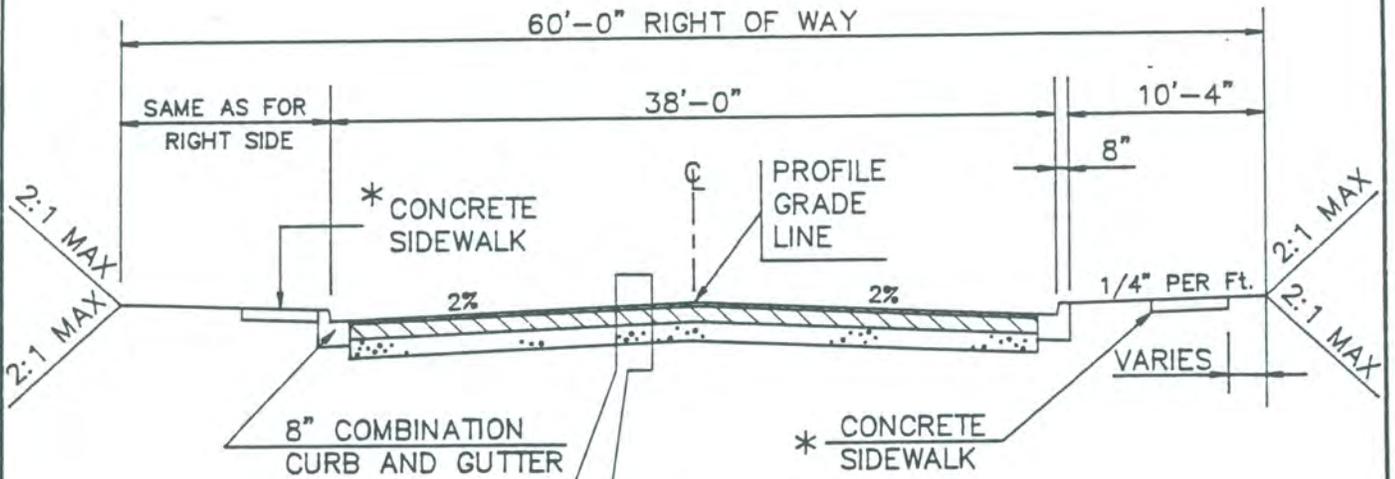
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RURAL LOCAL ROAD  
20' OPEN SECTION

PLATE  
24



1 1/2" BIT. CONCRETE SURFACE COURSE

4" BIT. CONCRETE BASE COURSE

6" DENSE GRADED STABILIZED AGGREGATE



\* CONCRETE SIDEWALKS SHALL BE CONSTRUCTED WHEN REQUIRED BY C.C. P & Z COMMISSION. LOCATION IS OPTIONAL, AS SHOWN, BUT MUST BE DETERMINED DURING PLAN DESIGN PHASE.

ALL DISTURBED AREAS WITHIN RIGHT OF WAY OR EASEMENT LIMITS NEEDED FOR ROADWAY CONSTRUCTION SHALL BE SODDED OR SEEDD AND MULCHED ON 2" OF TOPSOIL.

OVER 1000 ADT

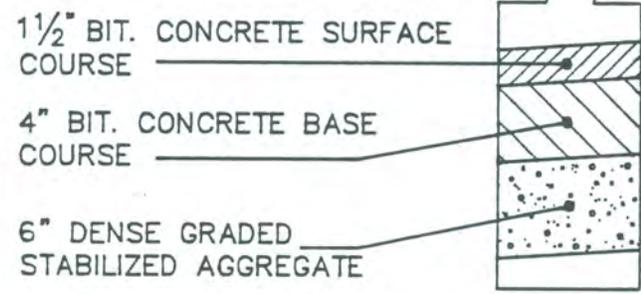
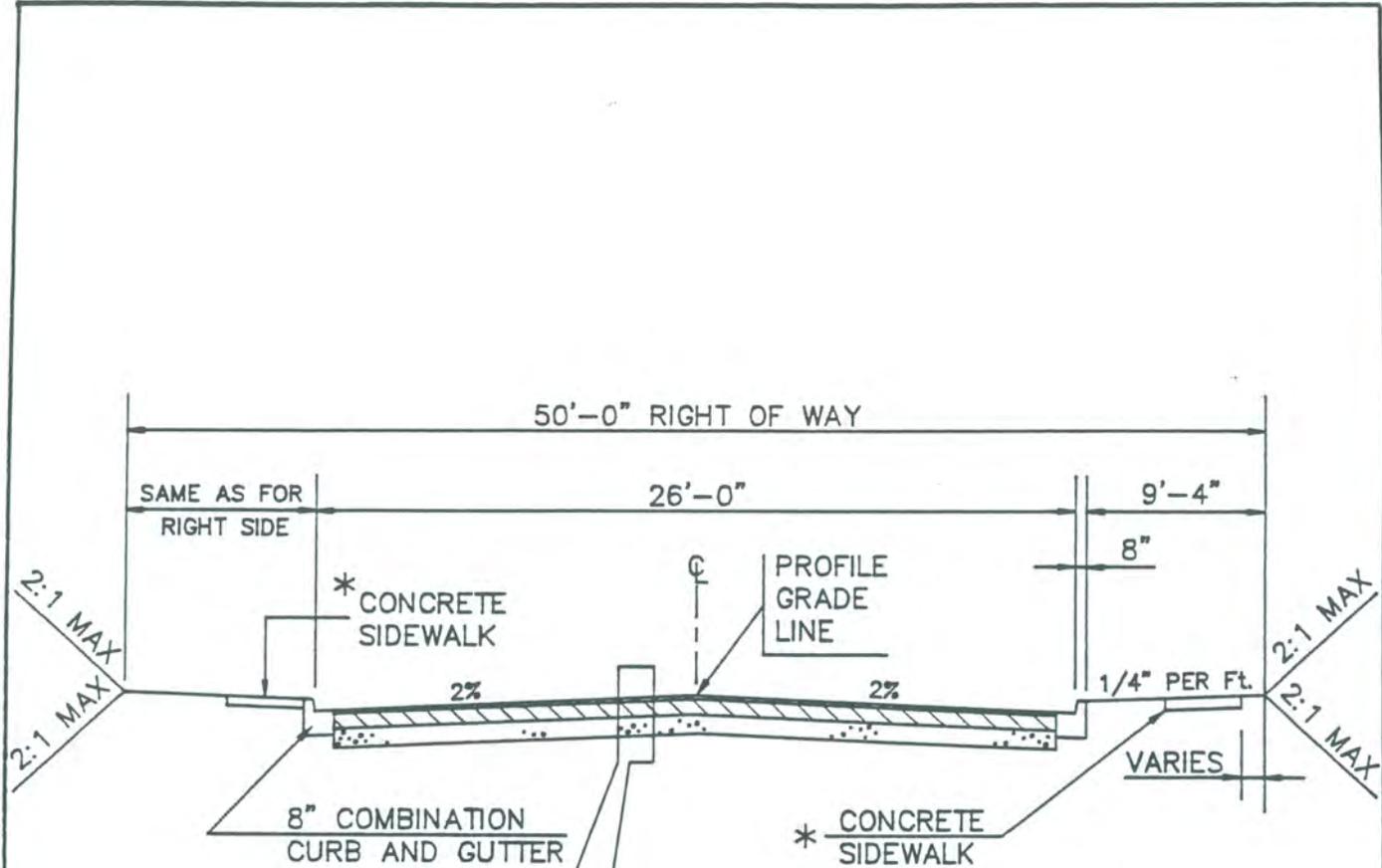
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DIRECTOR DATE

URBAN COLLECTOR ROAD  
38' CLOSED SECTION

PLATE  
25



\* CONCRETE SIDEWALKS SHALL BE CONSTRUCTED WHEN REQUIRED BY C.C.P & Z COMMISSION. LOCATION IS OPTIONAL, AS SHOWN, BUT MUST BE DETERMINED DURING PLAN DESIGN PHASE.

ALL DISTURBED AREAS WITHIN RIGHT OF WAY OR EASEMENT LIMITS NEEDED FOR ROADWAY CONSTRUCTION SHALL BE SODDED OR SEEDED AND MULCHED ON 2" OF TOPSOIL.

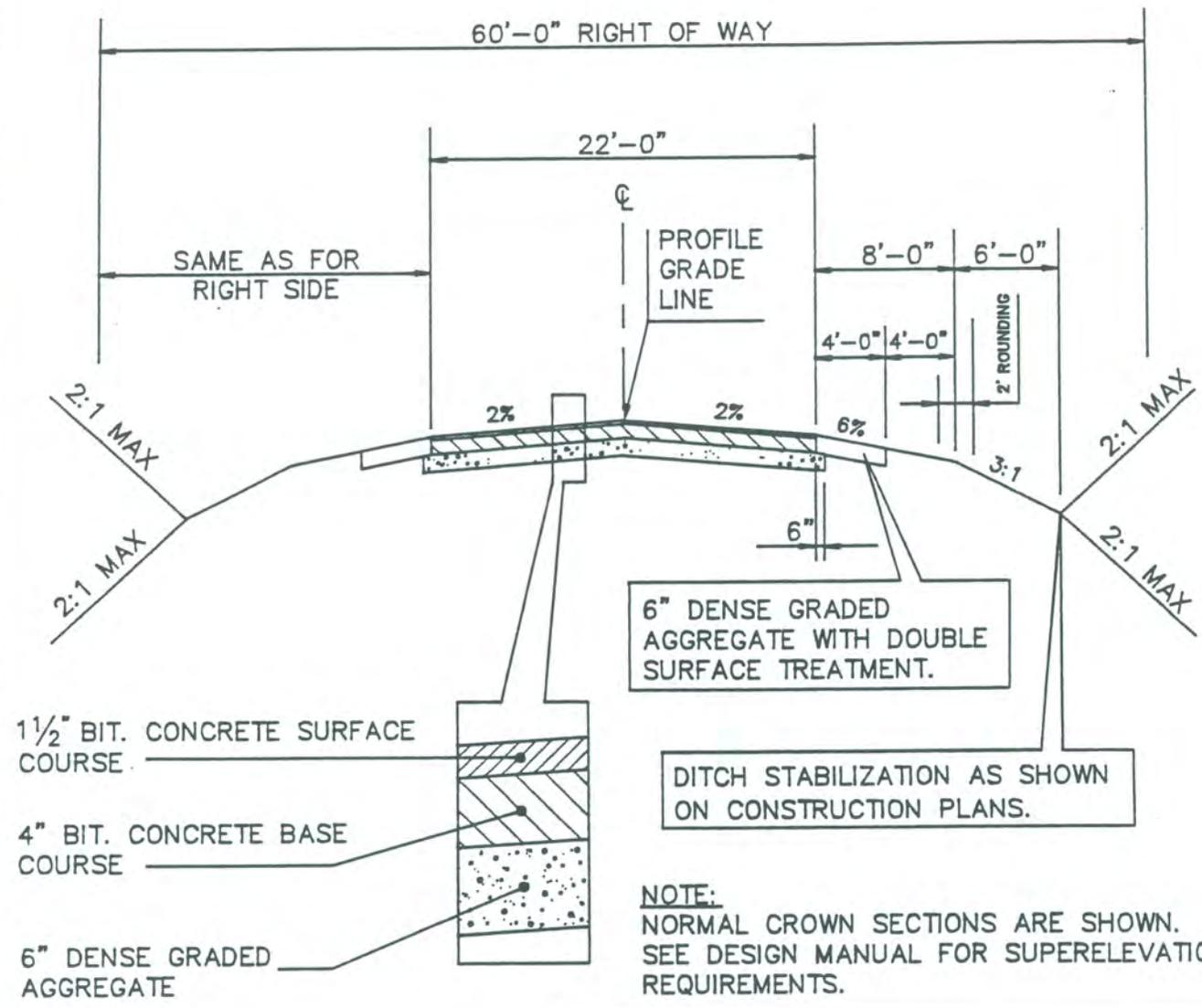
OVER 1000 ADT

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URBAN COLLECTOR ROAD  
 26' CLOSED SECTION

PLATE  
 25-A



**OVER 1000 ADT**

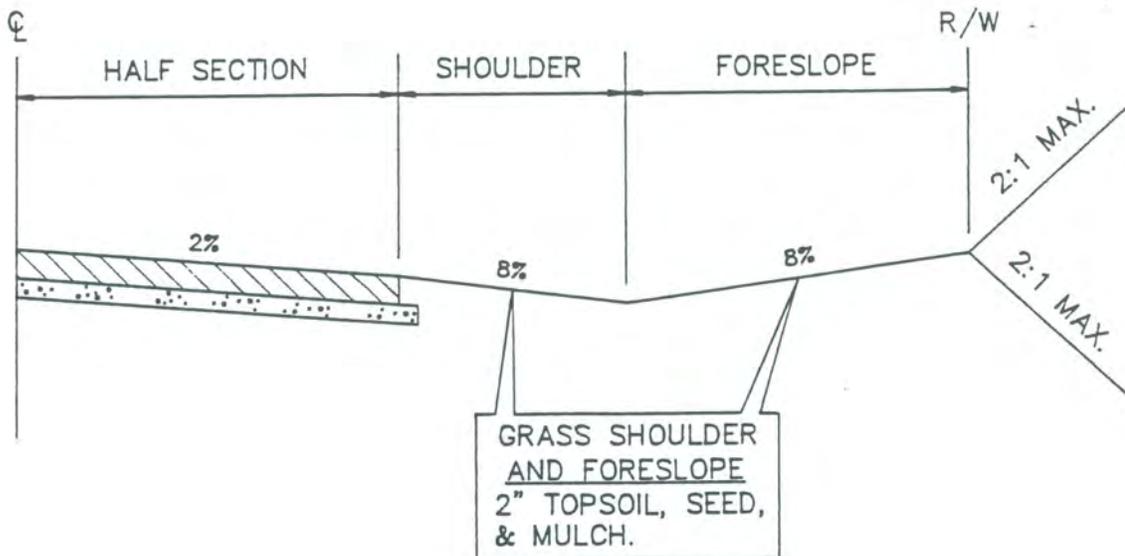
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*Carroll County* 4-12-94  
DIRECTOR DATE

RURAL COLLECTOR ROAD  
22' OPEN SECTION

PLATE  
26



**NOTE:**

THIS DESIGN WILL ONLY BE ALLOWED WITH PRIOR APPROVAL FROM THE BUREAU OF ENGINEERING. SEE 2.7.5 FOR INFORMATION REGARDING IT'S USAGE.

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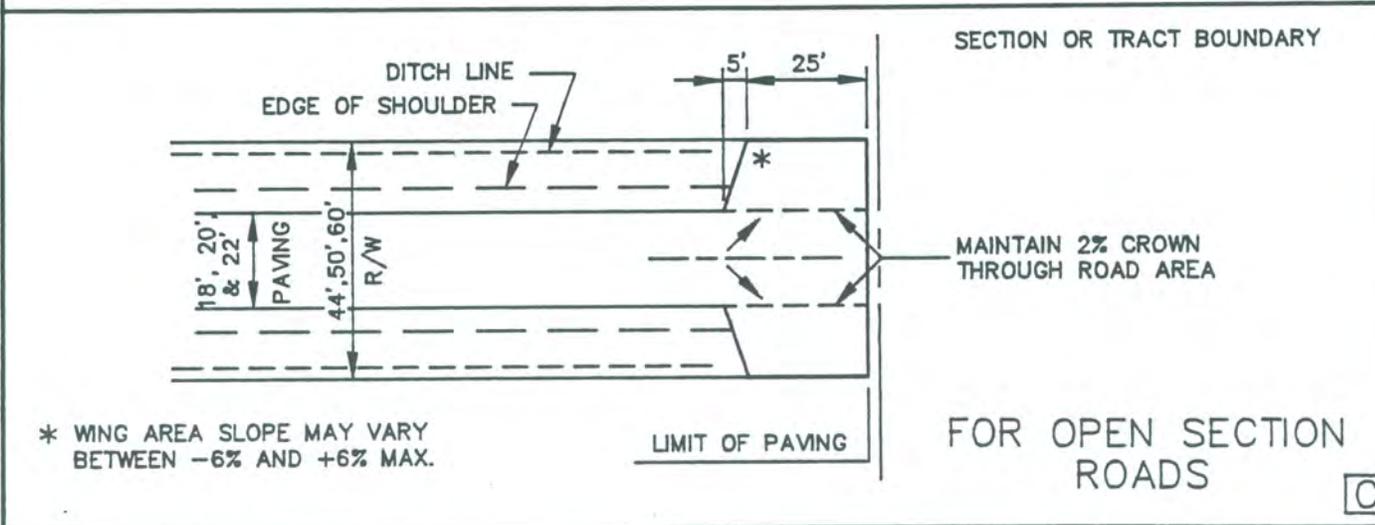
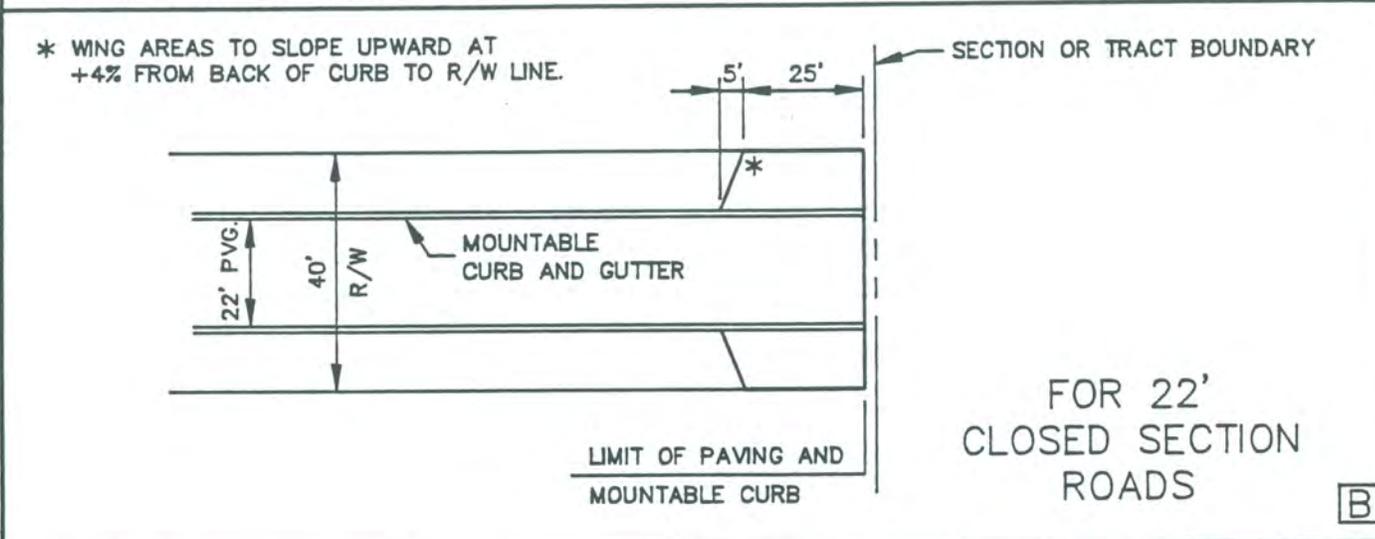
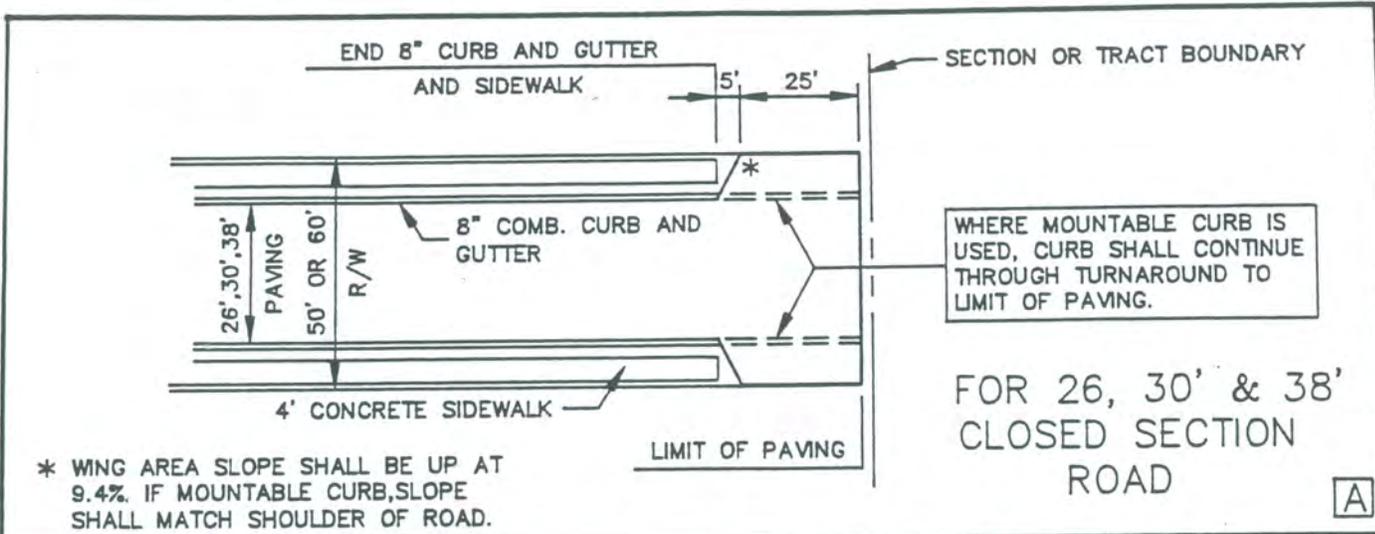
CARROLL COUNTY, MARYLAND  
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DIRECTOR DATE

MODIFIED SWALE DESIGN

PLATE

27



NOTE:  
DRIVEWAY APRONS MAY NOT BE CONSTRUCTED IN "T" TURNAROUNDS.

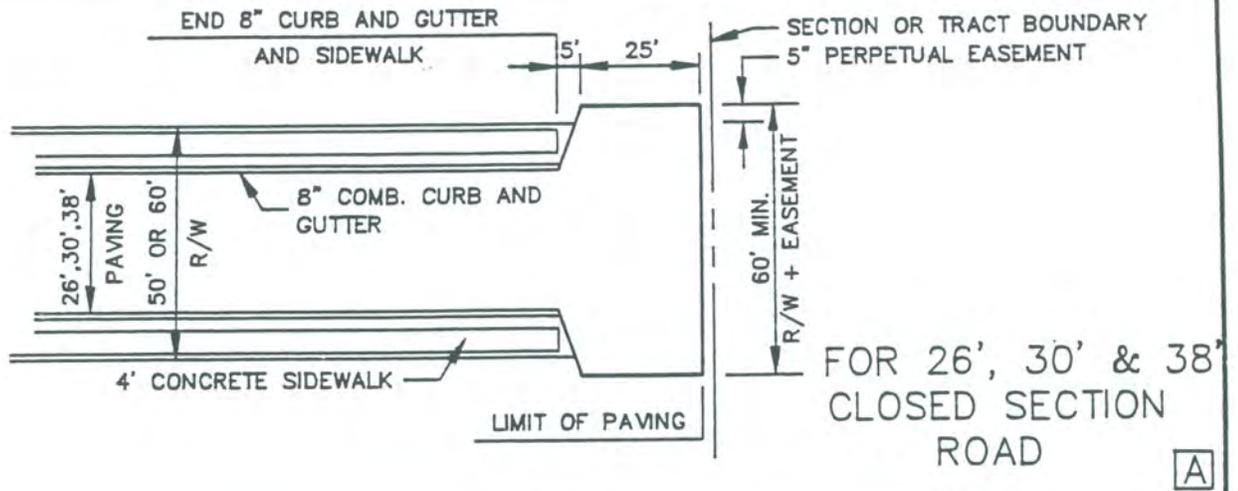
REVISED	
DATE	BY

CARROLL COUNTY, MARYLAND  
DEPARTMENT OF PUBLIC WORKS

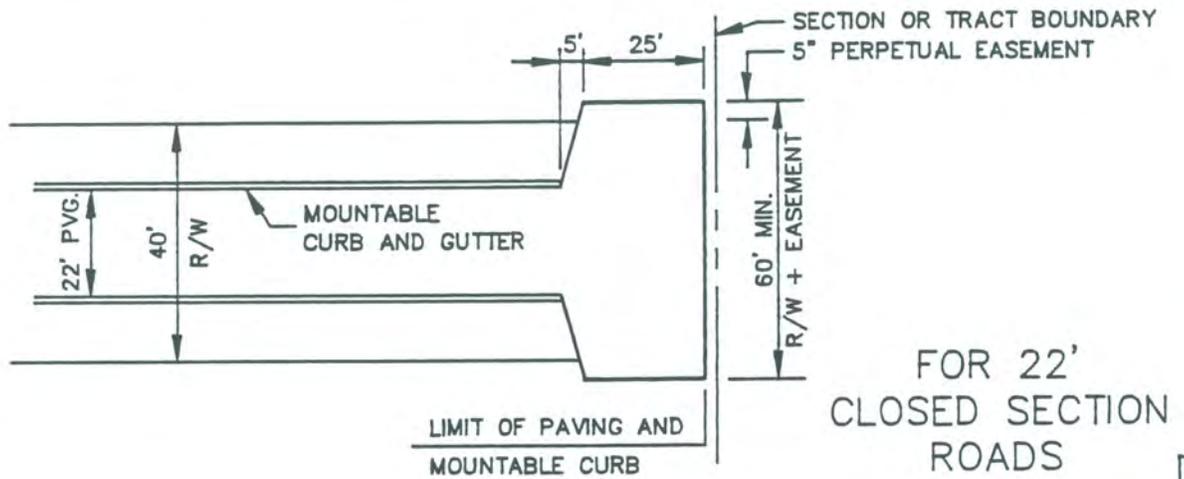
*Edward J. ...* 4-12-94  
DIRECTOR DATE

TEMPORARY  
"T" TURNAROUNDS

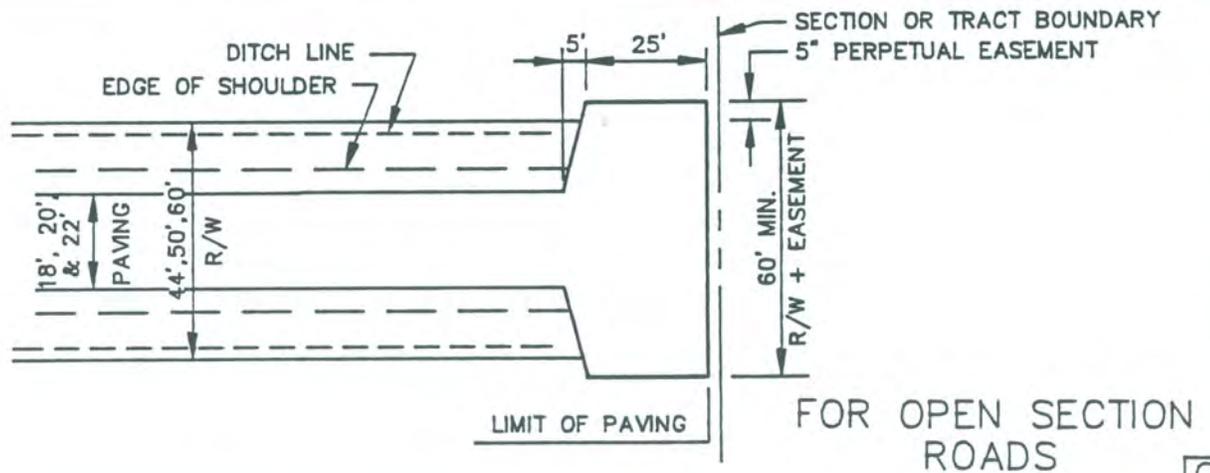
PLATE  
28



A



B



C

NOTE:  
DRIVEWAY APRONS MAY NOT BE CONSTRUCTED IN "T" TURNAROUNDS.

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DATE	BY

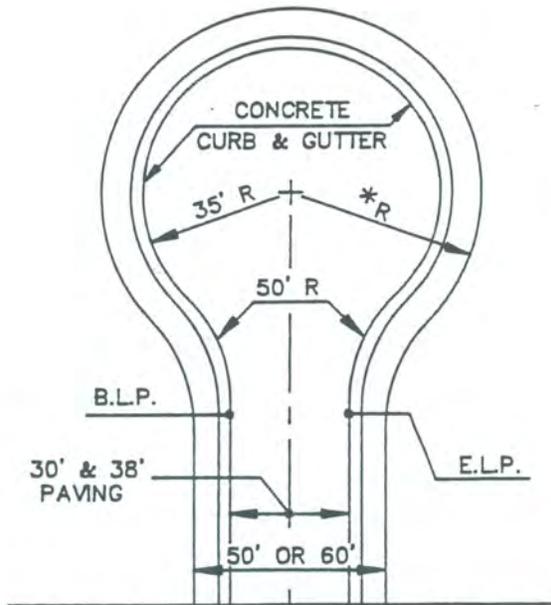
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DEPARTMENT OF PUBLIC WORKS

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DIRECTOR DATE

PERMANENT  
"T" TURNAROUNDS

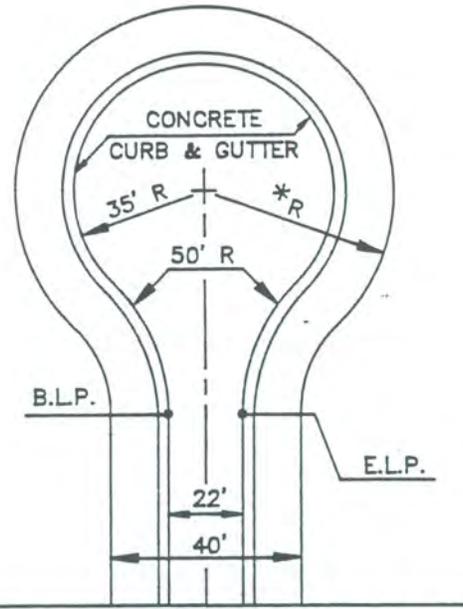
PLATE

29



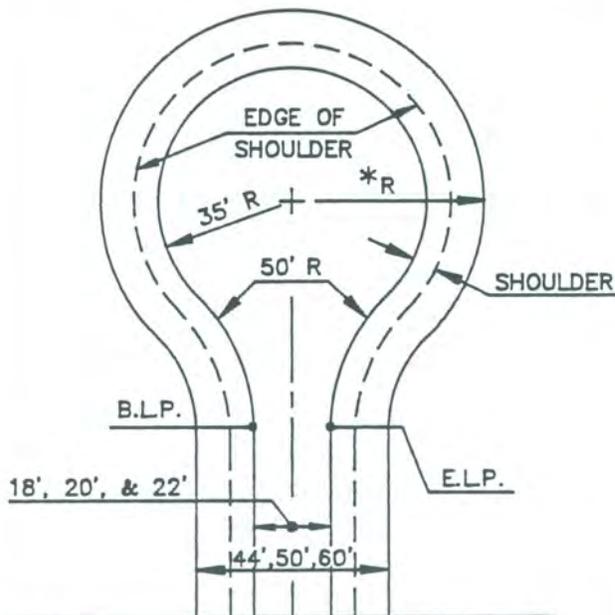
FOR 30' AND 38' CLOSED SECTION ROAD

A



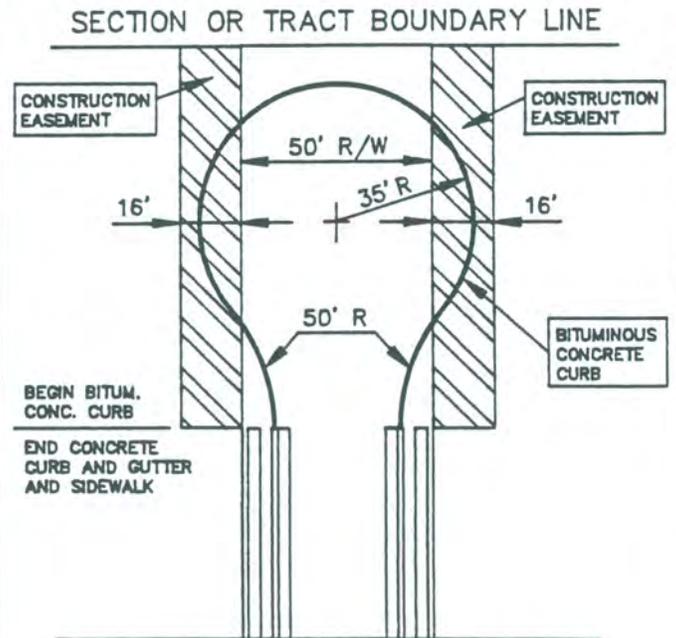
FOR 22' CLOSED SECTION ROAD

B



FOR OPEN SECTION ROADS

C



FOR CLOSED SECTION ROADS TEMPORARY CUL-DE-SAC

D

FOR OPEN SECTION ROADS TEMP. C.D.S. SHALL BE SAME AS FOR PERMANENT. SEE [C] ABOVE.

NOTE:

B.L.P.= BEGIN LINEAR PROFILE  
E.L.P.= END LINEAR PROFILE

\* IN OPTIONS A, B & C PAVING SHALL BE CONCENTRIC WITH RIGHT OF WAY

REVISED	
DATE	BY

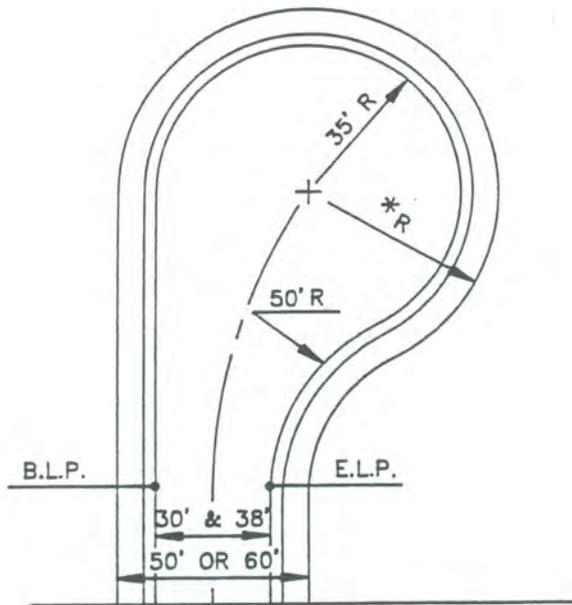
CARROLL COUNTY, MARYLAND  
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*Handwritten signature* 4-12-94  
DIRECTOR DATE

CUL-DE-SAC DETAILS  
STRAIGHT

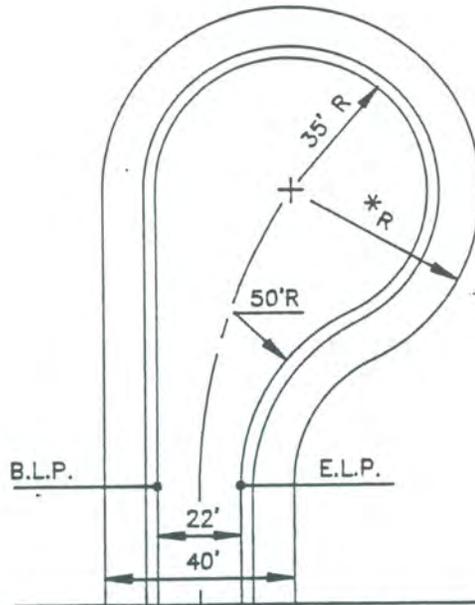
PLATE

30



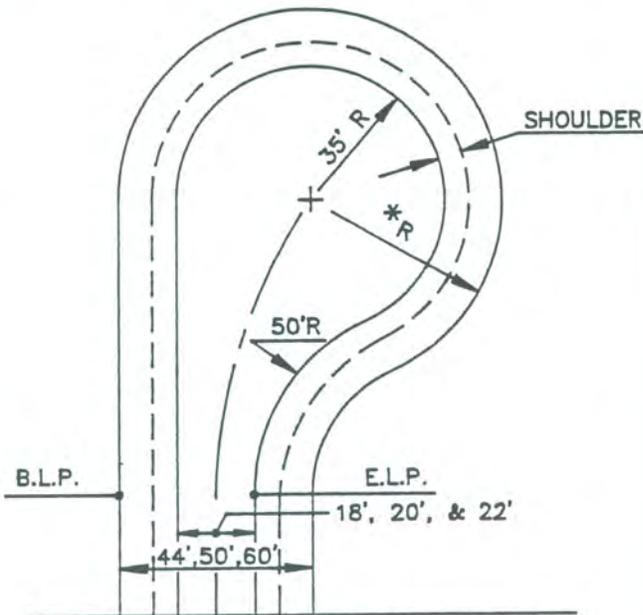
FOR 30' AND 38' CLOSED SECTION ROAD

A



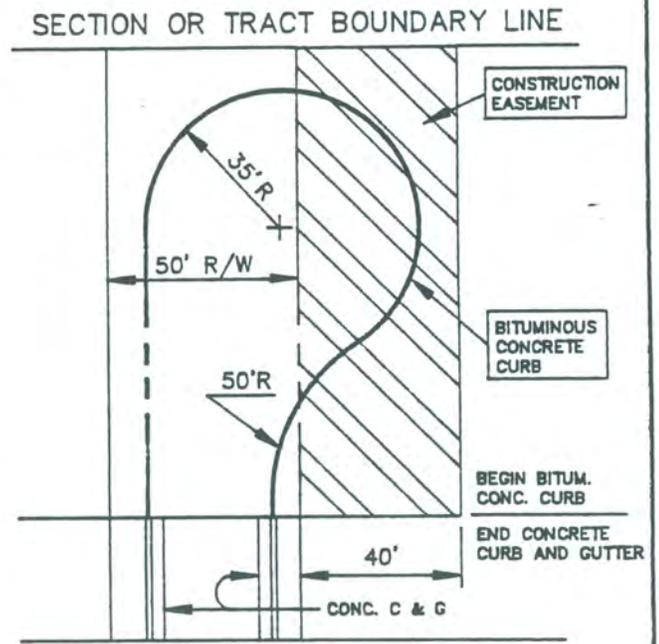
FOR 22' CLOSED SECTION ROAD

B



FOR OPEN SECTION ROADS

C



FOR CLOSED SECTION ROADS TEMPORARY CUL-DE-SAC

D

FOR OPEN SECTION ROADS TEMP. C.D.S. SHALL BE SAME AS FOR PERMANENT. SEE [C] ABOVE.

NOTE:

B.L.P.= BEGIN LINEAR PROFILE  
E.L.P.= END LINEAR PROFILE

\* IN OPTIONS A, B & C PAVING SHALL BE CONCENTRIC WITH RIGHT OF WAY

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DATE	BY

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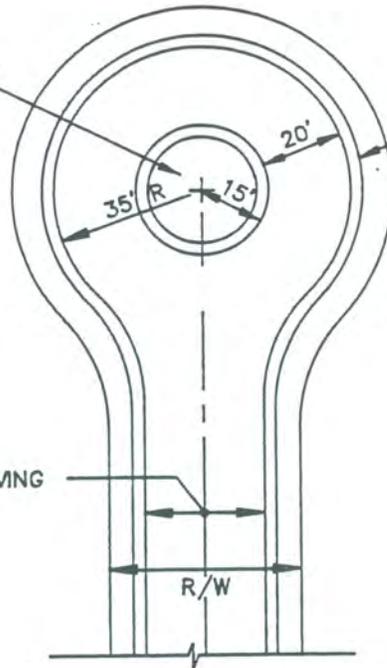
*Ed. D. ...* 4-12-94  
DIRECTOR DATE

CUL-DE-SAC DETAILS  
OFFSET

PLATE

31

GRASS OR LANDSCAPED ISLAND



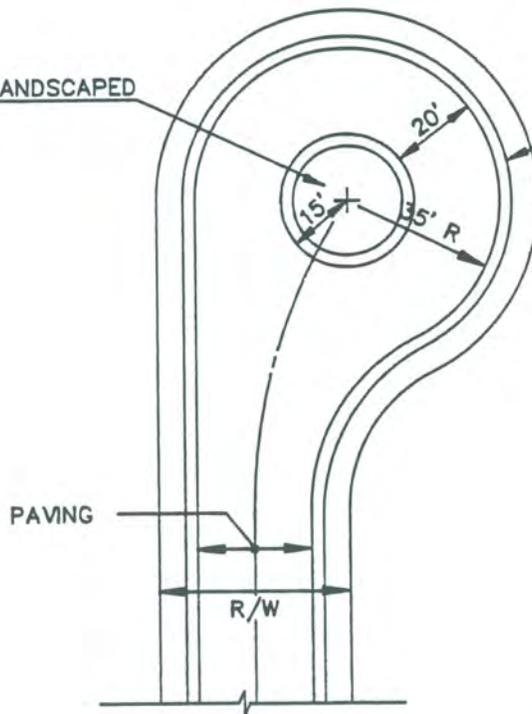
CONCRETE CURB & GUTTER

PAVING

R/W

STRAIGHT

GRASS OR LANDSCAPED ISLAND



CONCRETE CURB & GUTTER

PAVING

R/W

OFFSET

NOTE:

1. ISLANDS TO BE MAINTAINED BY H.O.A.
2. SEE PLATES 30 & 31 FOR CUL-DE-SAC CONSTRUCTION DETAILS.

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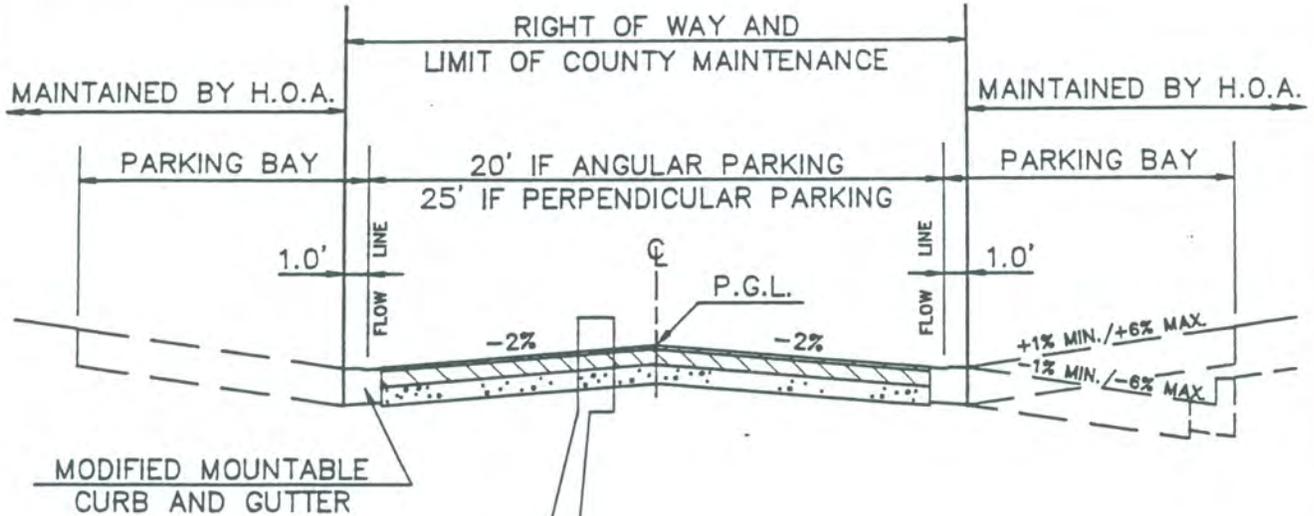
*Keith D. ...* 4-12-94  
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STRAIGHT AND OFFSET  
CUL-DE-SACS WITH ISLANDS

PLATE

32

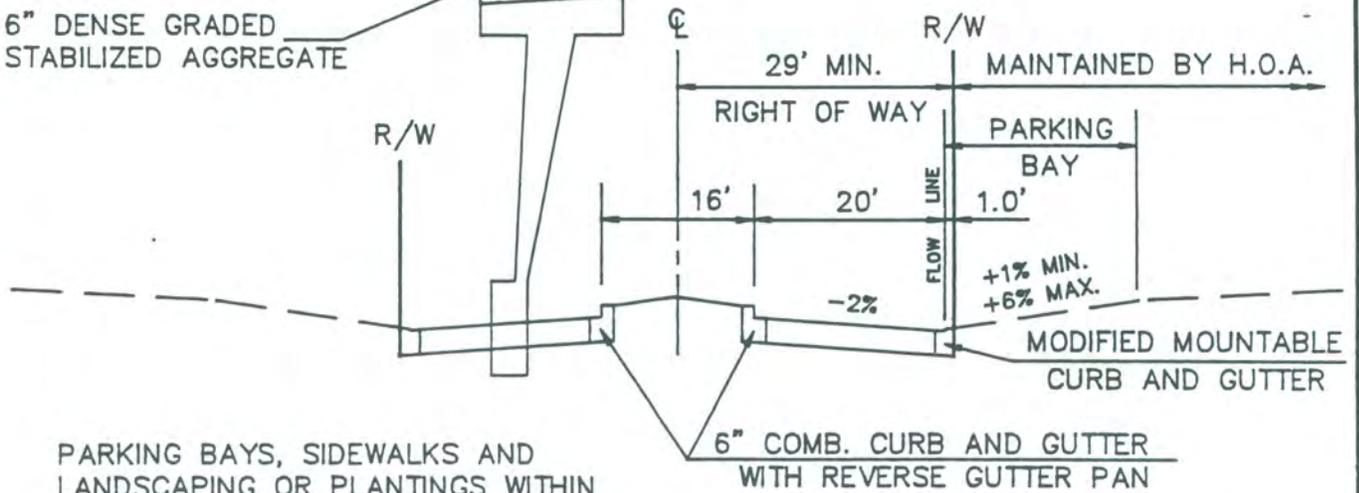
TWO WAY TRAFFIC



1 1/2" BIT. CONCRETE SURFACE COURSE BAND S.C.

3" BIT. CONCRETE BASE COURSE BAND B.C.

6" DENSE GRADED STABILIZED AGGREGATE



PARKING BAYS, SIDEWALKS AND LANDSCAPING OR PLANTINGS WITHIN ISLANDS TO BE MAINTAINED BY H.O.A.

ONE WAY TRAFFIC WITH GRASS ISLAND

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DATE	BY

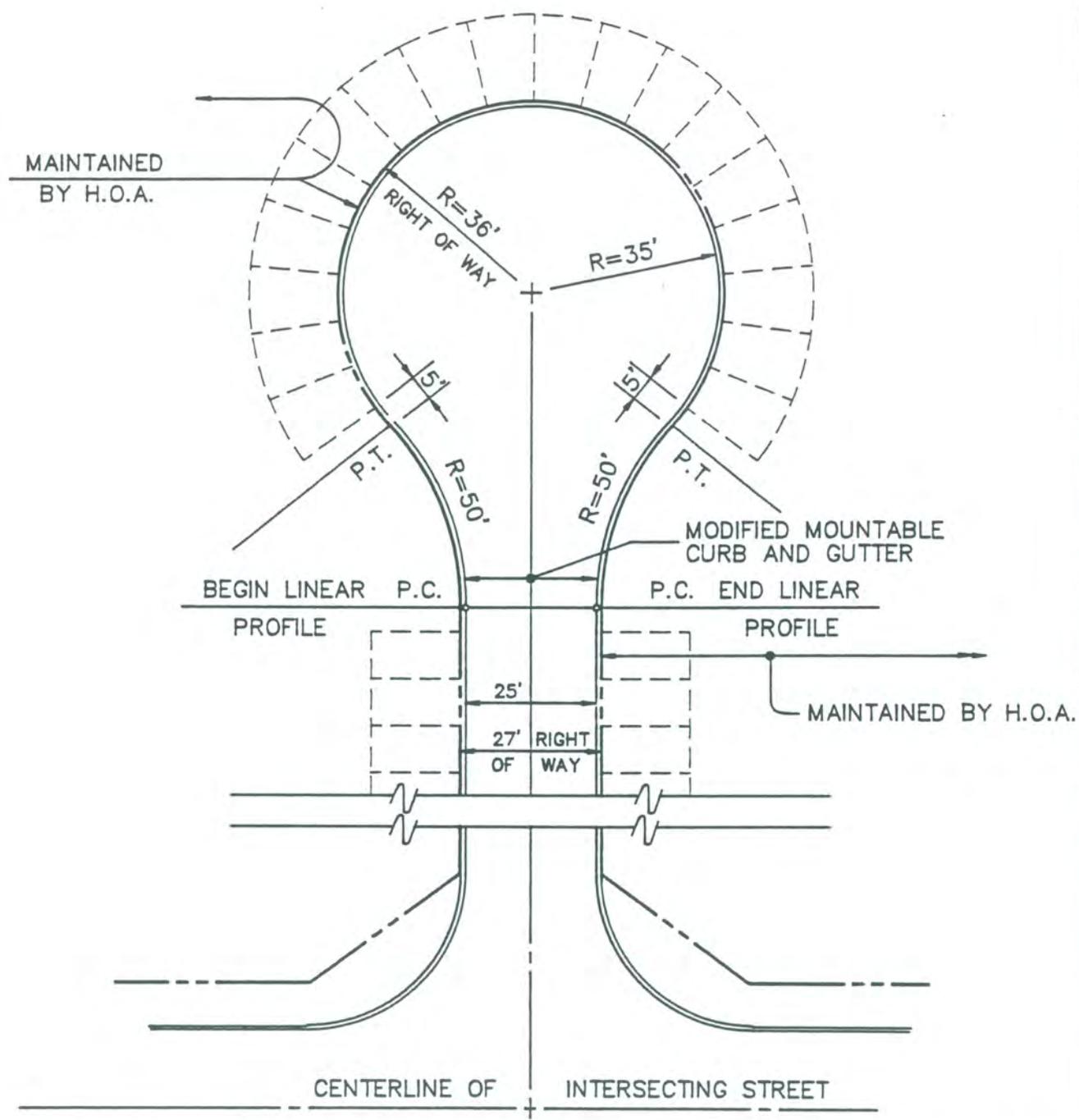
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MULTI-FAMILY DEVELOPMENT  
TYPICAL SECTIONS  
FOR ROADS

PLATE

33



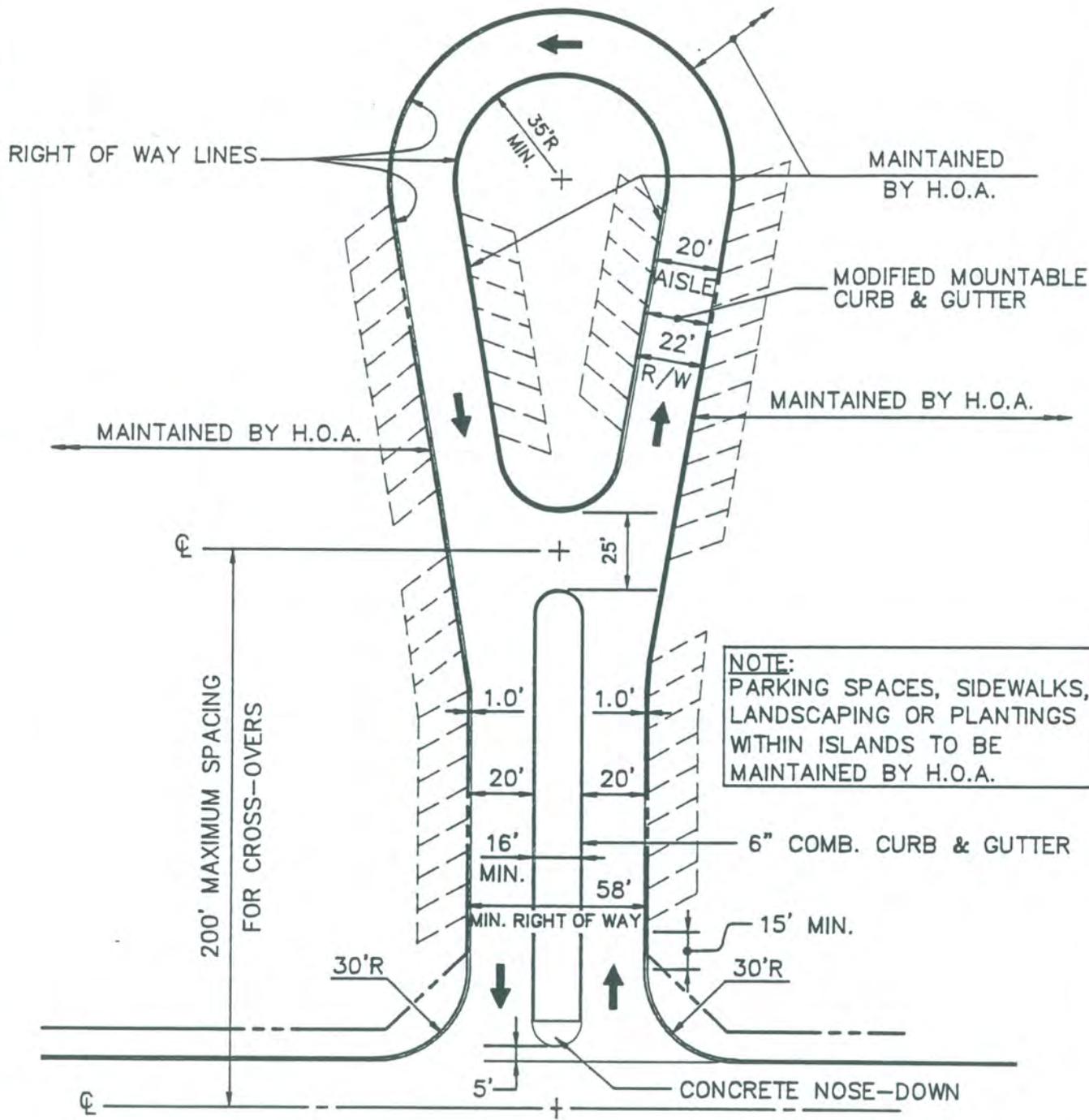
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DATE	BY

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MULTI-FAMILY DEVELOPMENT  
SCHEMATIC DESIGN  
FOR CUL-DE-SAC

*Edward J. ...*  
DIRECTOR      4-12-94  
DATE

PLATE  
34



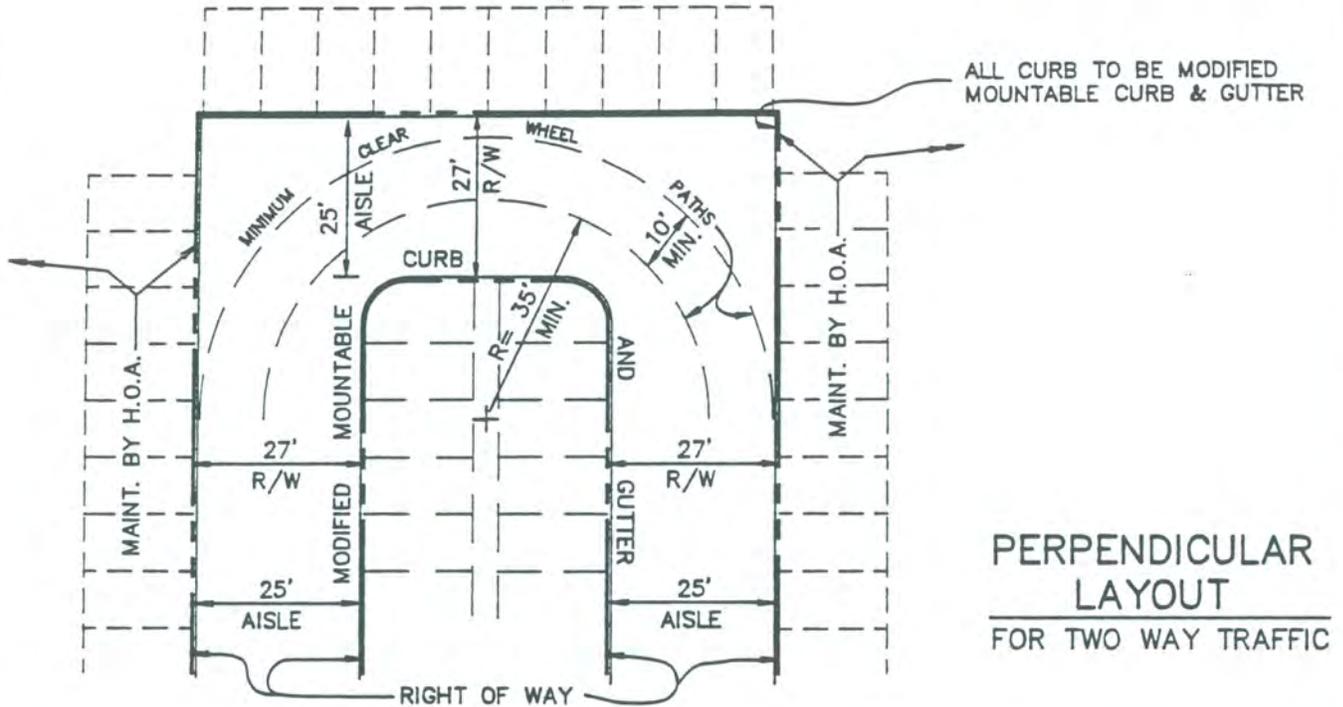
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DATE	BY

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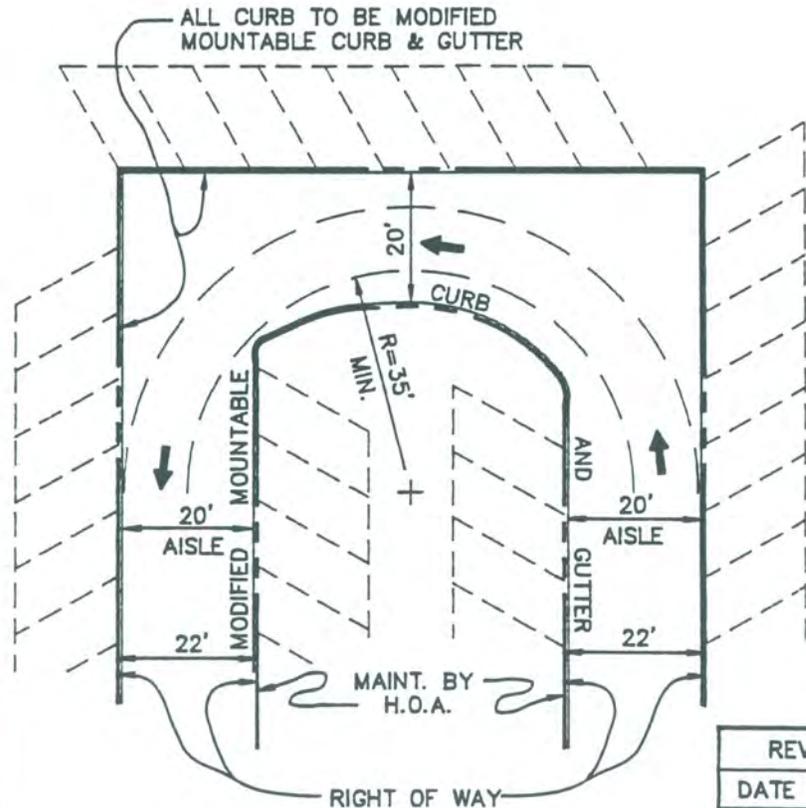
*Carroll County* 4-12-94  
DIRECTOR DATE

**MULTI-FAMILY DEVELOPMENT  
SCHEMATIC DESIGN  
STANDARDS FOR COURTS**

PLATE  
**35**



**ANGLE PARKING  
LAYOUT**  
FOR ONE WAY TRAFFIC



**NOTE:**  
CROSS-OVERS MUST BE  
PROVIDED AT 200' MAX.  
SPACING IN BOTH LAYOUTS.

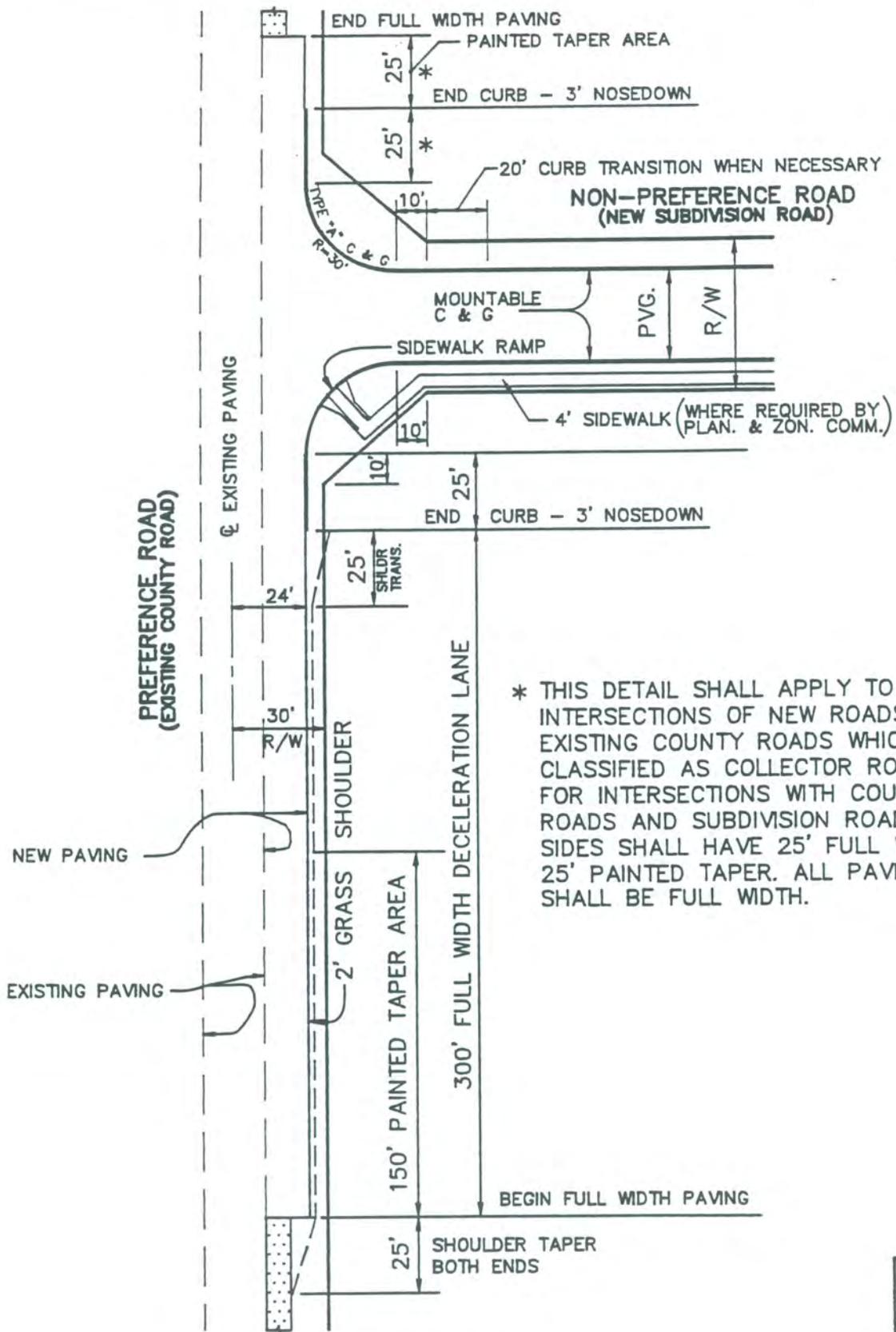
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DATE	BY

CARROLL COUNTY, MARYLAND  
DEPARTMENT OF PUBLIC WORKS

*K. Stinson* 4-12-94  
DIRECTOR DATE

MULTI-FAMILY DEVELOPMENT  
SCHEMATIC LAYOUTS  
FOR PARKING COURTS

PLATE  
36



\* THIS DETAIL SHALL APPLY TO INTERSECTIONS OF NEW ROADS WITH EXISTING COUNTY ROADS WHICH ARE CLASSIFIED AS COLLECTOR ROADS. FOR INTERSECTIONS WITH COUNTY LOCAL ROADS AND SUBDIVISION ROADS BOTH SIDES SHALL HAVE 25' FULL WIDTH AND 25' PAINTED TAPER. ALL PAVING SHALL BE FULL WIDTH.

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DATE	BY

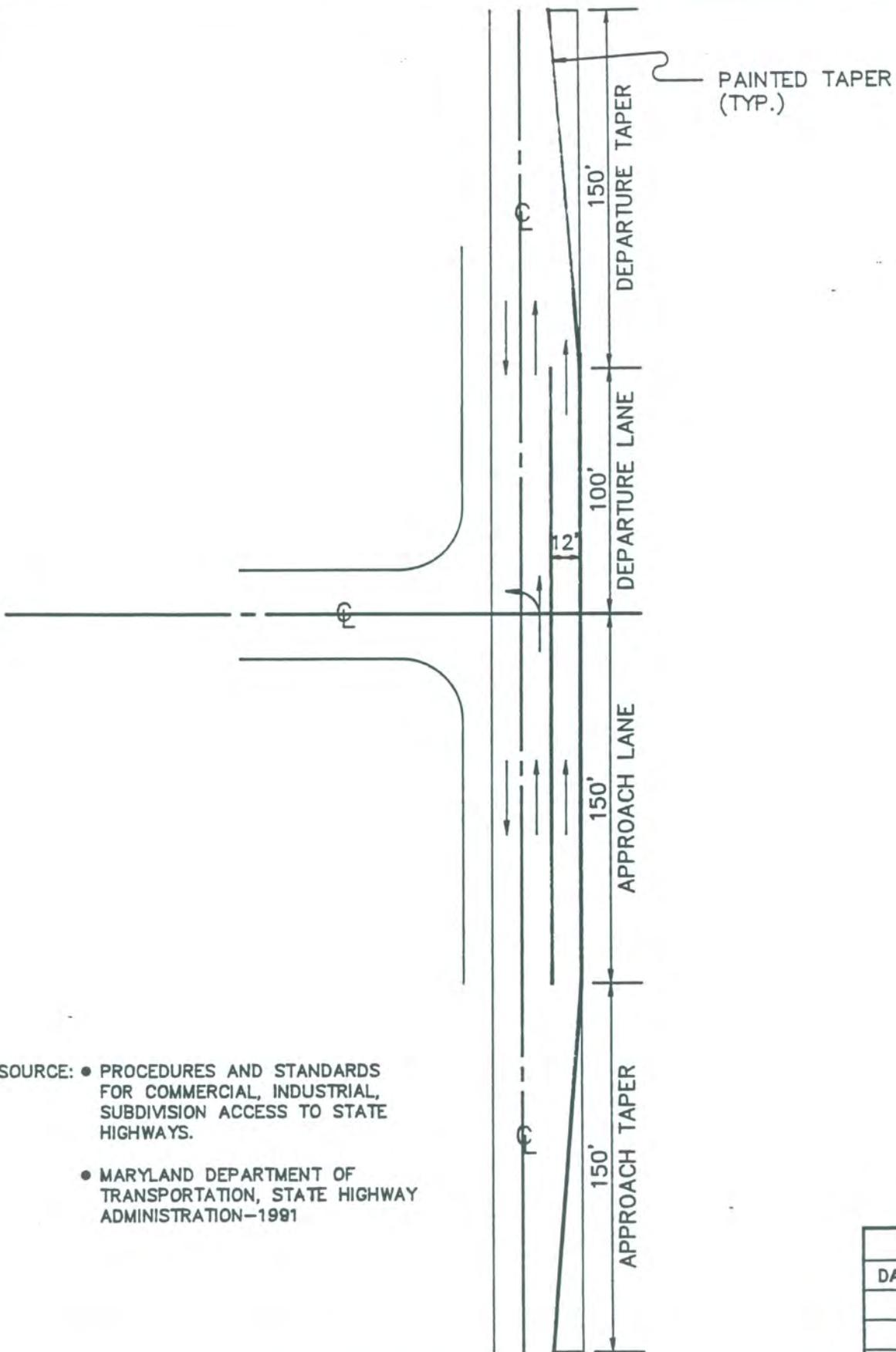
CARROLL COUNTY, MARYLAND  
DEPARTMENT OF PUBLIC WORKS

*K. S. ...* 4-12-94  
DIRECTOR DATE

INTERSECTION DETAIL

PLATE

37



SOURCE: ● PROCEDURES AND STANDARDS FOR COMMERCIAL, INDUSTRIAL, SUBDIVISION ACCESS TO STATE HIGHWAYS.

● MARYLAND DEPARTMENT OF TRANSPORTATION, STATE HIGHWAY ADMINISTRATION-1991

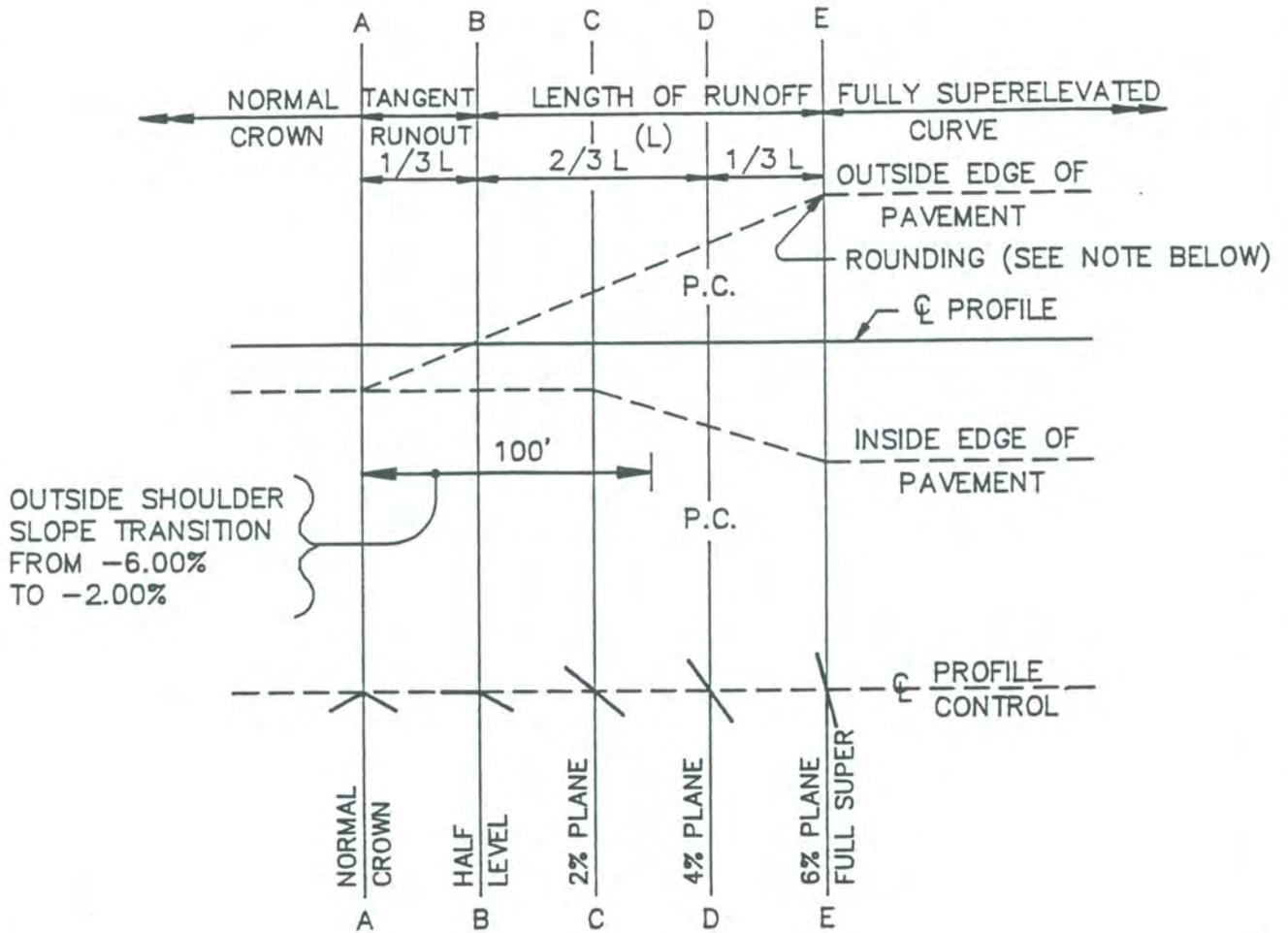
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TYPICAL BY-PASS LANE  
AT A "T" INTERSECTION

PLATE  
38



**NOTES:**

1. ANGULAR BREAKS IN SECTION TO BE ROUNDED TO PROVIDE SMOOTH TRANSITIONS.
2. POINTS A, B, C, D, & E ARE TO BE STATIONED AND IDENTIFIED IN PLAN, PROFILE, AND TRANSITION DATA TABLE.
3. MAXIMUM RATE OF SUPERELEVATION (e) SHALL BE 0.06 FEET PER FOOT (6.00%).
4. SHOULDER ON HIGH SIDE TO SLOPE DOWNWARD AWAY FROM ROADWAY AT 2.00%.

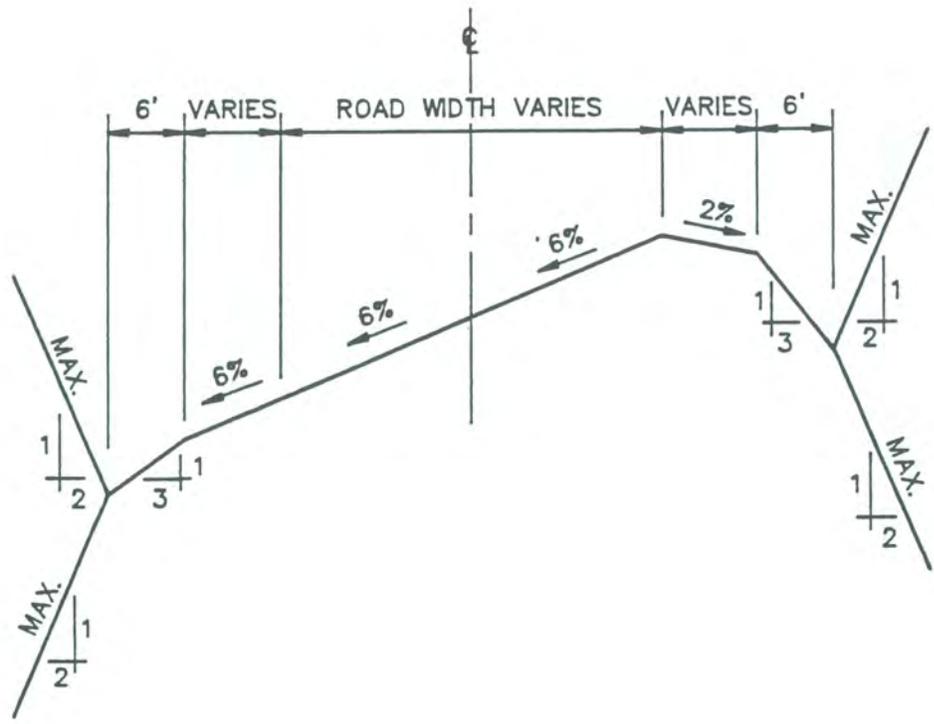
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CROWNED PAVEMENT  
REVOLVED ABOUT CENTERLINE

PLATE  
39



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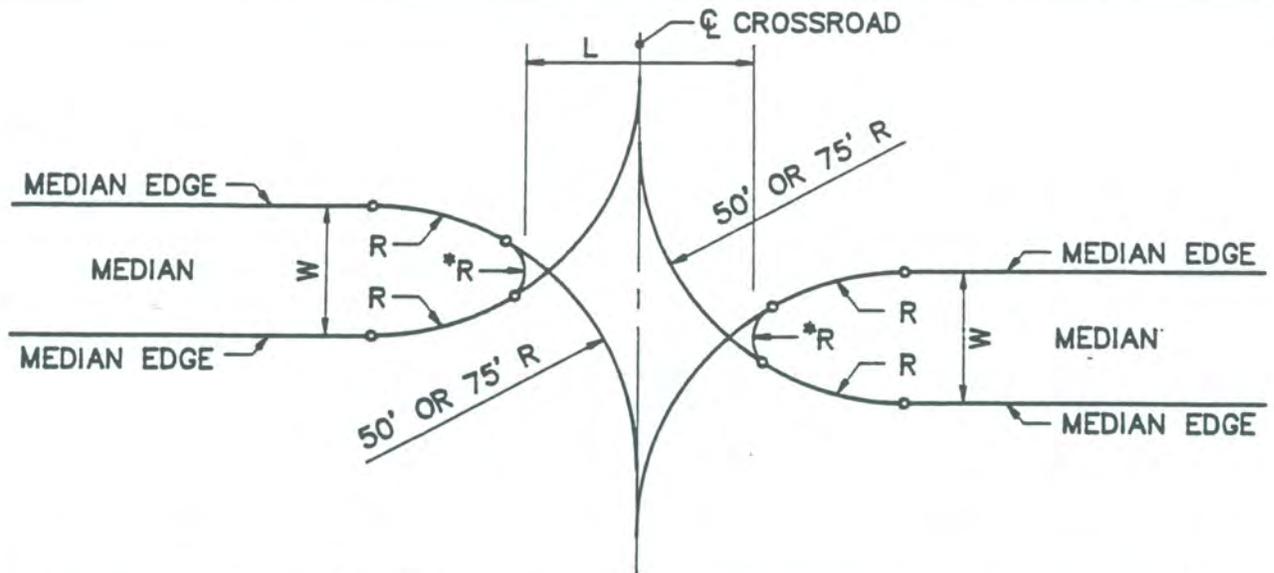
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SCHEMATIC SECTION  
FULL SUPERELEVATION

PLATE

40



MINIMUM LENGTH OF MEDIAN OPENING		(L IN FEET)	
W		R=50	R=75
4		96	146
6		94	144
8		68	110
10		62	105
12		58	100
14		53	96
16		50	92
20		44	85
24		40	78
28		40	73
32		40	67
36		40	62
40		40	57
50		40	50
60		40	40

**NOTE**

1. FOR 4' AND 6' ISLAND WIDTHS USE SEMICIRCULAR END.
2. \*R = W/5
3. IN NO CASE SHALL L BE LESS THAN THE CROSSROAD PAVING WIDTH PLUS 8 FEET.

SOURCE: A POLICY ON GEOMETRIC DESIGN OF RURAL HIGHWAYS, PP. 407-423 (REF. 1)

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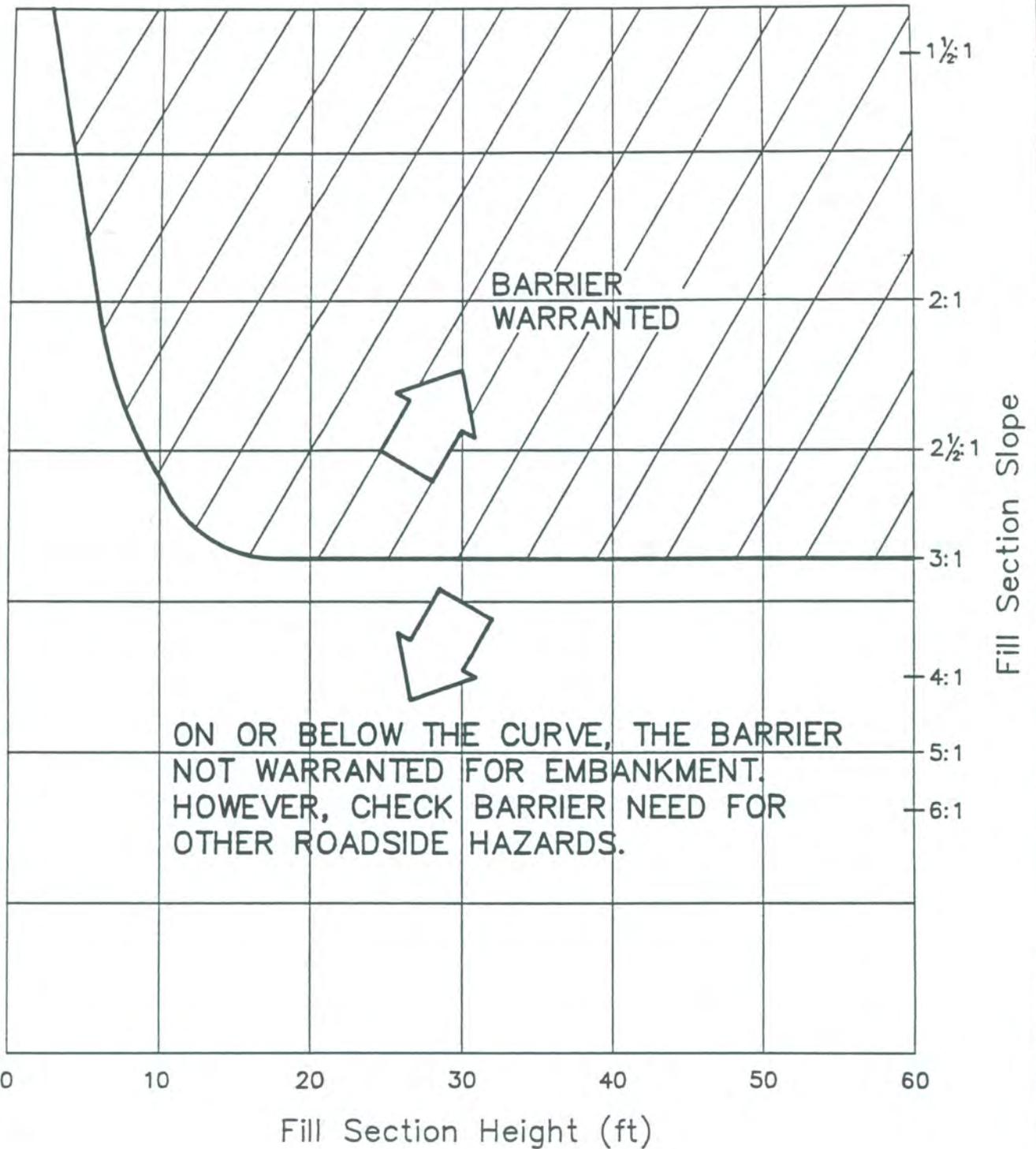
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DIRECTOR DATE

MEDIAN OPENINGS

PLATE

41



SOURCE: GUIDE FOR SELECTING, LOCATING, AND DESIGNING TRAFFIC BARRIERS (AASHTO, 1977 EDITION)

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DATE	BY

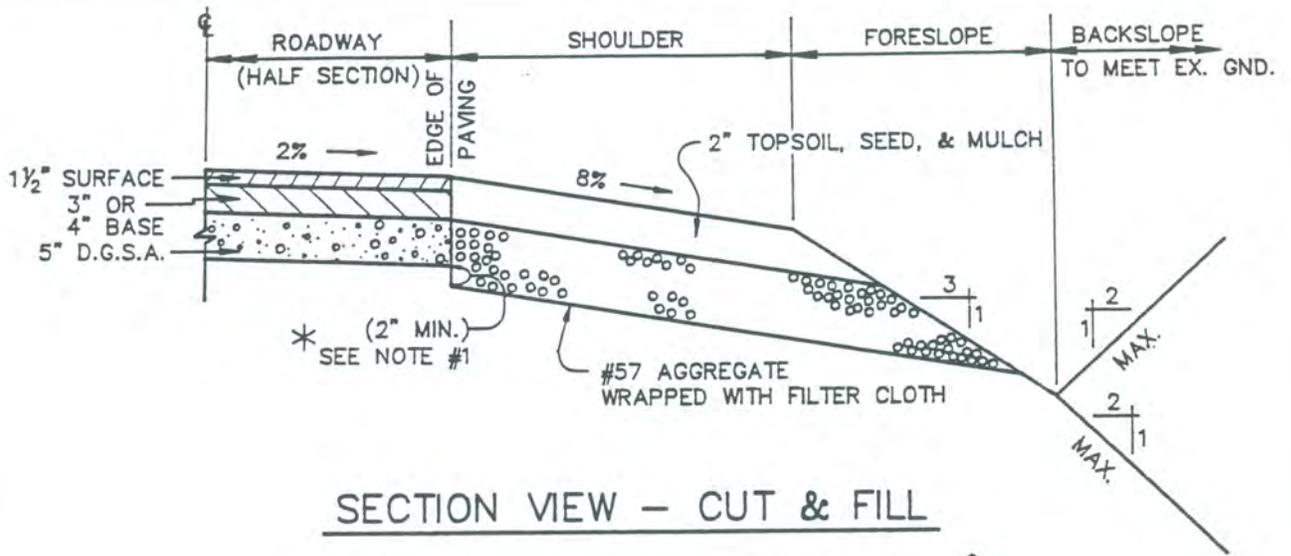
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*Keith D. ...*  
DIRECTOR                      4-12-94  
DATE

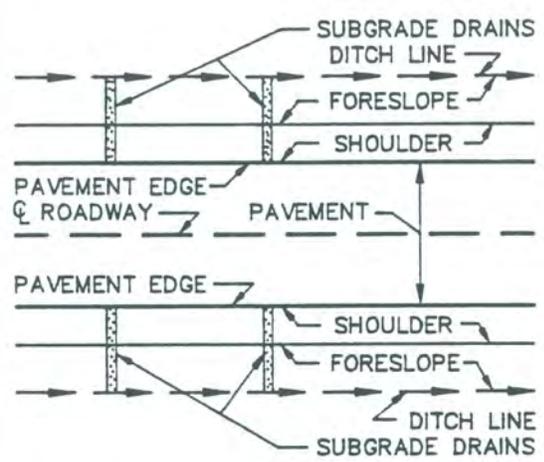
GUARDRAIL REQUIREMENT  
CHART

PLATE

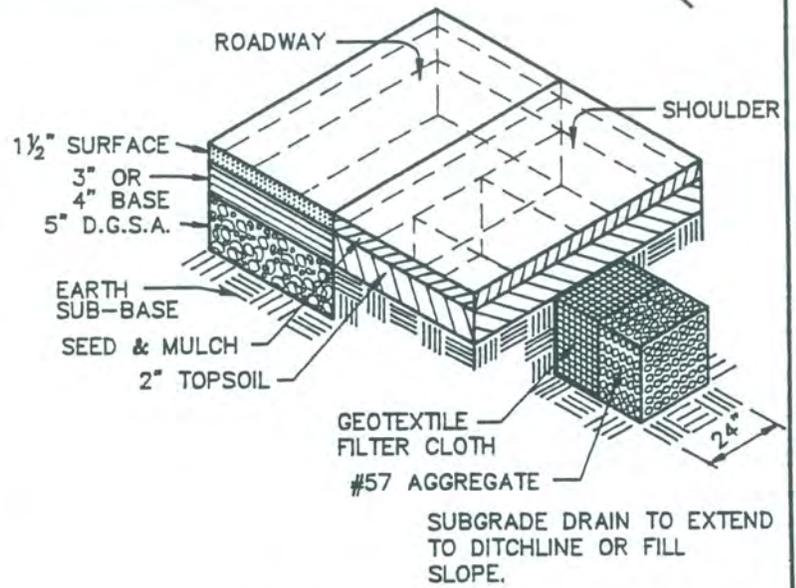
42



**SECTION VIEW - CUT & FILL**



**PLAN VIEW**



**ISOMETRIC VIEW**

**NOTES:**

1. EXTEND DEPTH AS NECESSARY TO MEET DITCHLINE STABILIZATION.
2. DESIGN ENGINEER TO SHOW ACTUAL DIMENSIONS FOR ROADWAY, SHOULDER, AND FORESLOPE ON CONSTRUCTION DRAWINGS.
3. CONSTRUCTION AND MATERIALS SHALL BE IN ACCORDANCE WITH SECTION 306; SUBSECTION 306.03.06 OF THE MARYLAND STATE HIGHWAY ADMINISTRATIONS OCTOBER, 1983 STANDARD SPECIFICATIONS FOR CONSTRUCTION AND MATERIALS.
4. IN NORMAL, CROWNED SECTIONS UNDERDRAINS TO BE PLACED IN SUMP AND AT 25 FOOT INTERVALS FOR 125 FEET UPGRADE FROM SUMP THEN AT 100 FOOT INTERVALS TO WITHIN 125 FEET OF HILL CREST.
5. IN SUPERELEVATED SECTIONS, UNDERDRAINS SHALL BE PLACED AS NOTED ABOVE BUT ON LOW SIDE ONLY AND SHALL EXTEND FROM HALF LEVEL SECTION AT BEGINNING OF CURVE TO HALF LEVEL SECTION AT END OF CURB.
6. FILTER CLOTH SHALL CONFORM TO S.H.A. CLASS "C" SPECIFICATION.

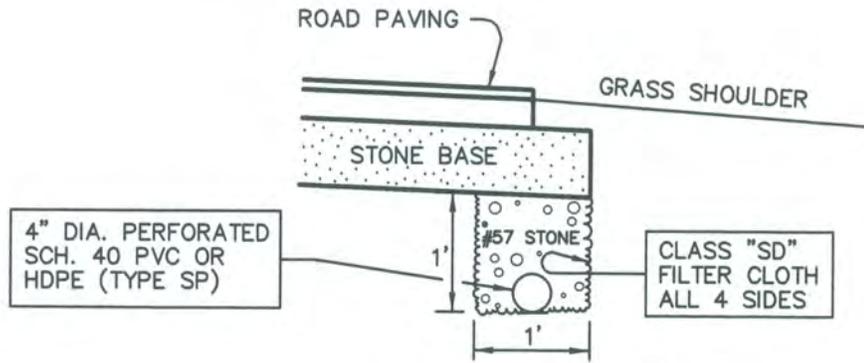
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DATE	BY

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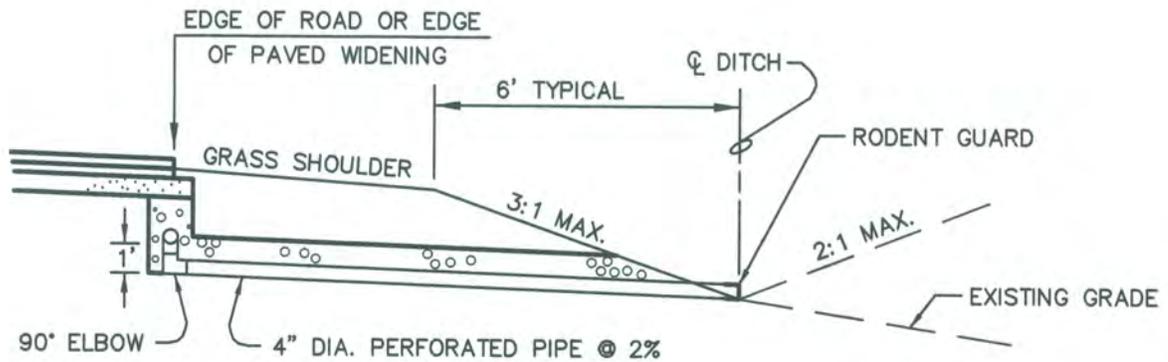
*W. St. ...* 4-12-94  
DIRECTOR DATE

SUBGRADE DRAINS FOR  
FLEXIBLE PAVING

PLATE  
43



**SUBGRADE DRAIN**  
NTS



**OUTFALL DETAIL**  
NTS

**NOTES:**

General: Subgrade drains (Drains) shall run continuously with both edges of road or paved shoulder. Where road improvements are being made along an existing county road which includes the addition of a paved widening such as a turn lane, by-pass lane or auxiliary lane, subgrade drains shall be installed.

Pipe for Drains shall be 4" I.D. perforated Schedule 40 PVC or HDPE (type SP). Stone shall be clean #57 aggregate. Trench shall be lined on all 4 sides with permeable filter cloth. Prefabricated fittings shall be used for abrupt change in direction or when joining pipe systems. Fittings will not be required for normal undulations in road profile.

Filter cloth shall conform to Class "SD" specifications.

Outfall: Outfalls shall be constructed at downgrade ends of subgrade drains and at sumps in road profile using same materials and specifications as for Drains. Outfalls must daylight. Outfall may run with/beneath centerline of ditch if necessary to daylight.

Where outfall will be placed in upland areas, a standard 5" Concrete Gutter will be used, see Plate 44. Final 10' section of pipe shall be non-perforated, trench for final 10' section shall be backfilled with earth.

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10/24/03	R.C.

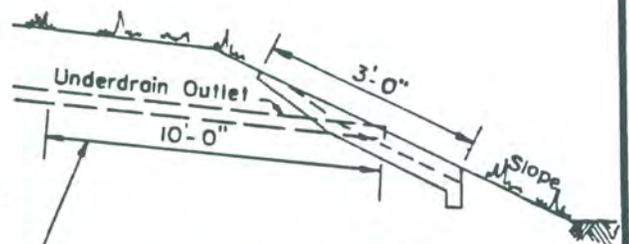
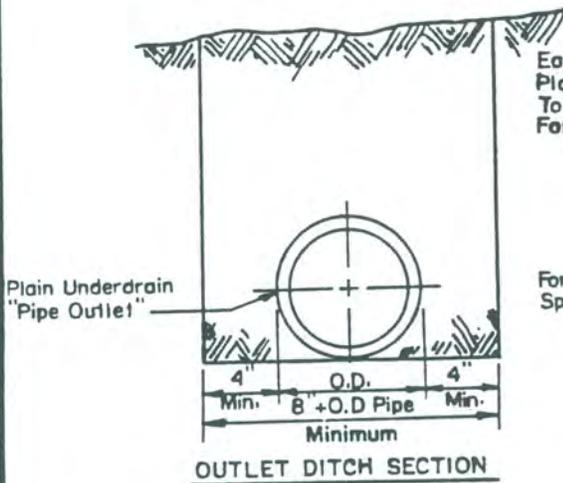
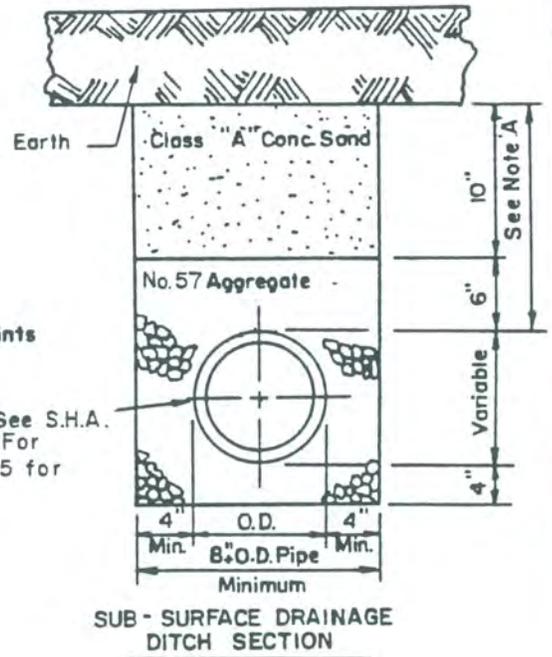
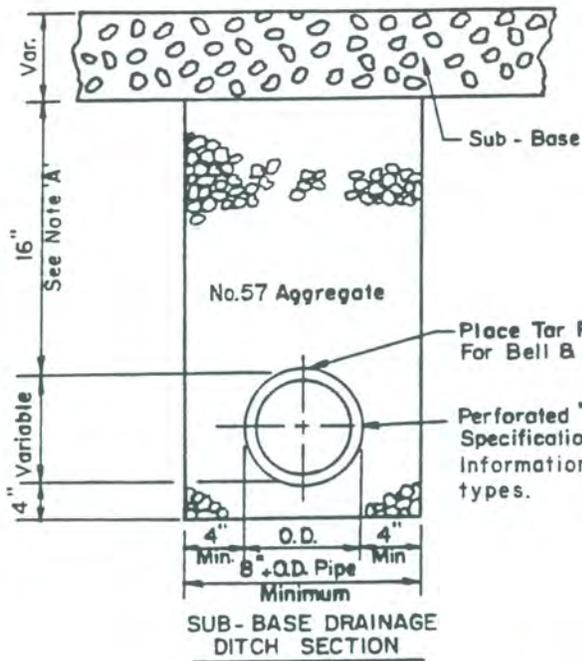
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DEPARTMENT OF PUBLIC WORKS

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DIRECTOR DATE

**SUBGRADE DRAINS**

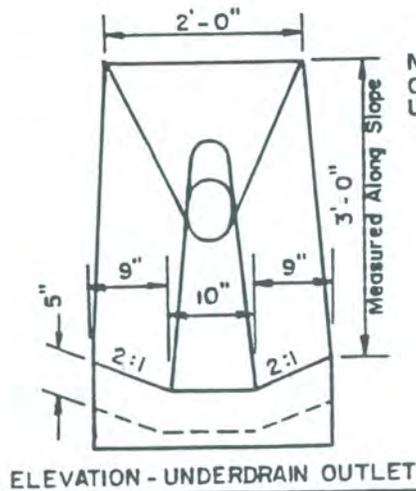
PLATE

43-A



This Length To Be Measured And Paid For At Contract Unit Price For Underdrain Outlet.

5" CONCRETE GUTTER FOR UNDERDRAIN OUTLET



Note: Underdrain To Be Laid On A Minimum Of 0.5% Grade Unless Otherwise Directed.

\* Note 'A': Where Underdrain Is Outletted Into An Inlet, Or Where Any Other Unusual Conditions Prevail, These Dimensions May Be Varied As Directed.

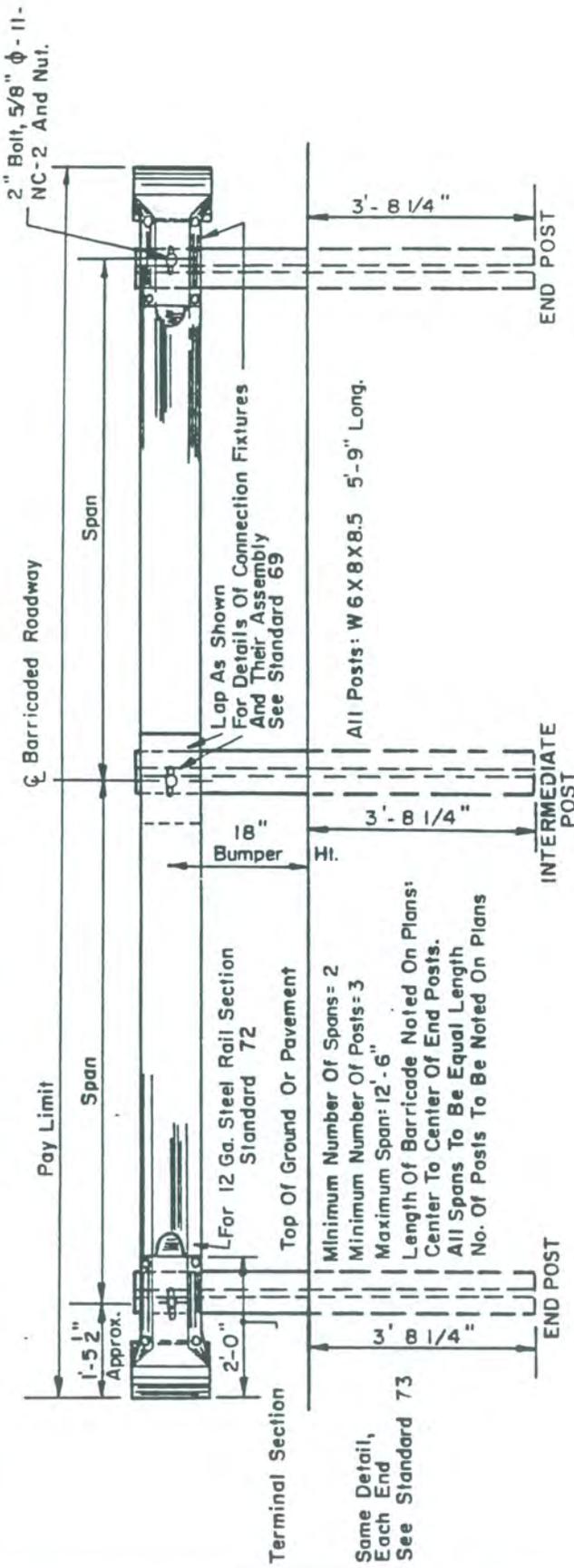


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PLATE	

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STANDARD UNDERDRAINS



Terminal Section  
 Same Detail, Each End  
 See Standard 73

Minimum Number Of Spans = 2  
 Minimum Number Of Posts = 3  
 Maximum Span = 12'-6"  
 Length Of Barricade Noted On Plans:  
 Center To Center Of End Posts.  
 All Spans To Be Equal Length.  
 No. Of Posts To Be Noted On Plans

The Linear Foot Price Bid For "Beam Type Barricade" Shall Include The Furnishing And Installation, At Locations Noted On The Plans Or Where Directed By The Engineer, Of Steel Posts, Standard 12 Ga. "Steel Beam Guard Rail," 5/8" Diam. Post And Splicing Bolts, Terminal And Intermediate Splicing Sections, Galvanizing, The Cost Of All Excavation, Backfilling And Tamping Incidental To Setting The Posts, Or The Cost Of Driving The Posts, The Cost Of Removal Of Existing Pavement, Where Necessary, As Well As The Cost Of All Labor, Approved Tools And Equipment Incidental To Furnishing And Installing The Barricade.

Note: For Material Specifications See Latest Specifications For Standard "Beam Type Guard Rail" Beams, Posts, And All Hardware To Be Galvanized As Required By The Specifications. Add Standard Type 7' Traffic Posts & Reflective Delineators In Back Of Barricade Height 4'-0."

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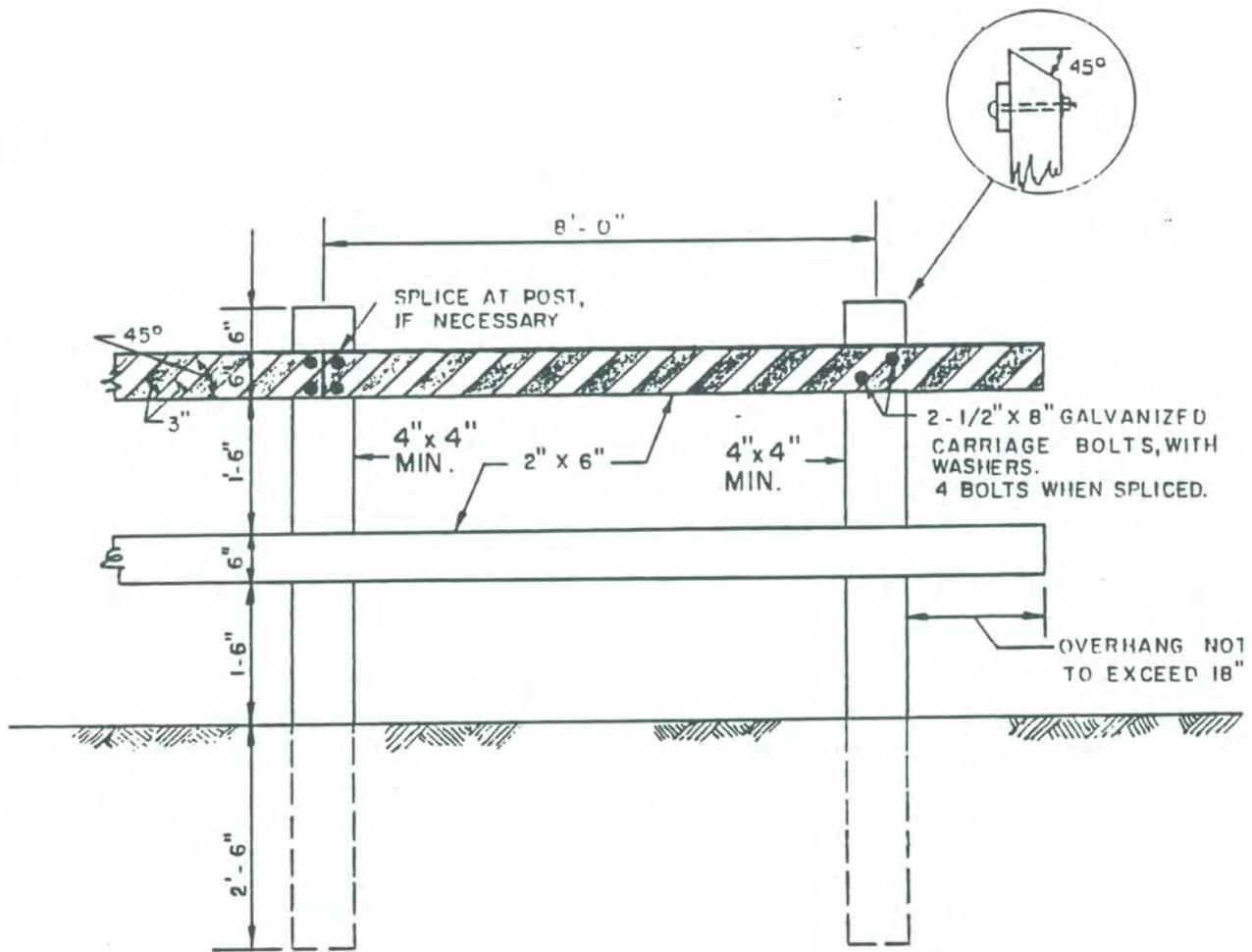
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BEAM TYPE  
 BARRICADE

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DATE	BY

PLATE

45



TYPICAL SECTION

NOTE:

1. LUMBER TO BE OF PRESSURE TREATED GRADE.
2. THE UPRIGHTS AND CROSS PIECES SHALL BE PAINTED WHITE WITH TWO COATS OF APPROVED EXTERIOR PAINT.
3. THE TOP CROSS PIECE SHALL HAVE ORANGE STRIPES AS SHOWN.
4. CONSTRUCT TO FULL WIDTH OF RIGHT-OF-WAY OR AS DIRECTED.
5. THE STRIPING SHALL BE DIRECTED TOWARDS THE CENTER OF THE ROADWAY TO PRODUCE A CHEVRON EFFECT.

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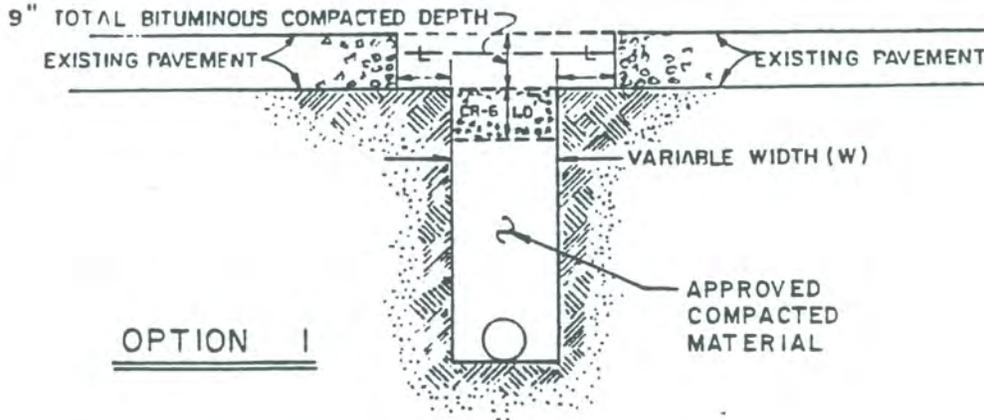
*Kendrick* 4-12-94  
DIRECTOR DATE

TIMBER BARRICADE

PLATE

46

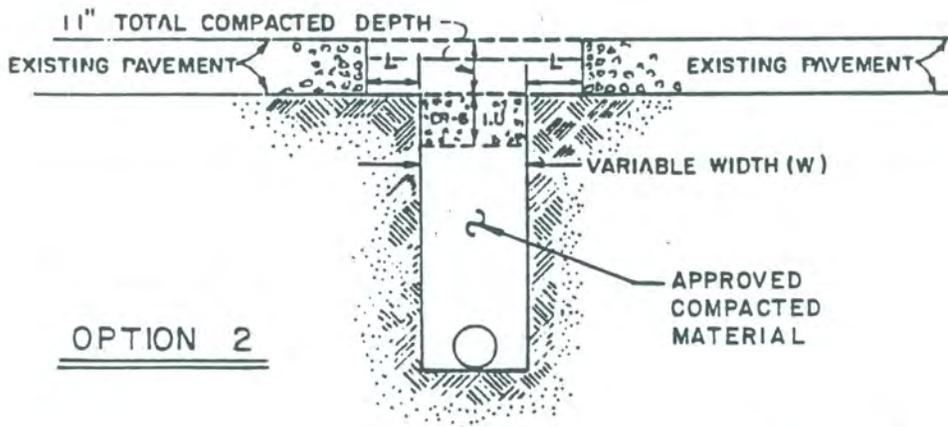
1-1/2" LAYER BITUMINOUS CONCRETE-SURFACE COURSE (SF BAND)  
 2 LAYERS BASE COURSE - 7 1/2" TOTAL { 1-4" LAYER.  
 1-3 1/2" LAYER



OPTION 1

W'	L'
1'	1'
1.5'	1.5'
≥ 2'	2'

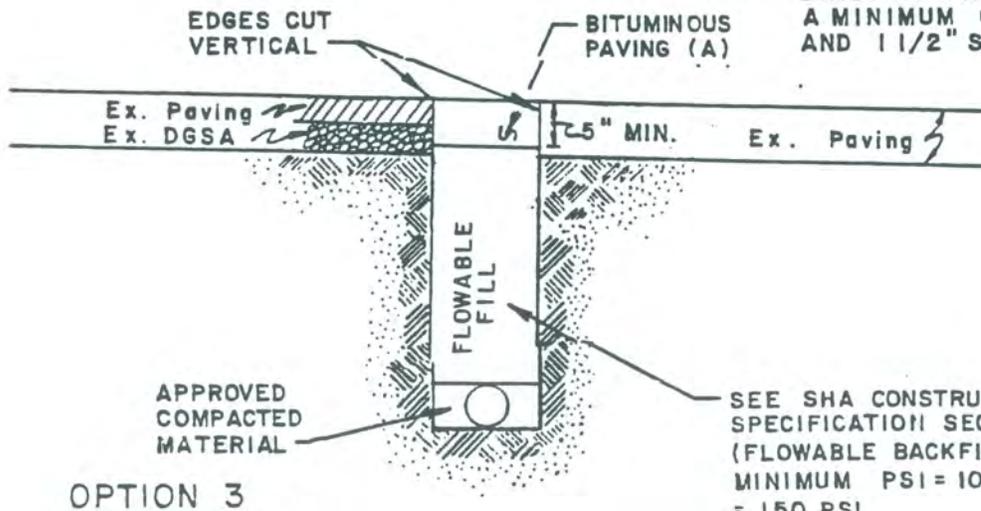
1 - 2" LAYER BITUMINOUS CONCRETE SURFACE COURSE (SF BAND)  
 1 - 9" LAYER CONCRETE



OPTION 2

W'	L'
1'	1'
1.5'	1.5'
≥ 2'	2'

(A) PAVING PATCH SHALL MATCH EXISTING PAVING THICKNESS OR A MINIMUM OF 3 1/2" BASE COURSE AND 1 1/2" SURFACE COURSE.



OPTION 3

W'	L'
1'	N/A
1.5'	N/A
≥ 2'	N/A

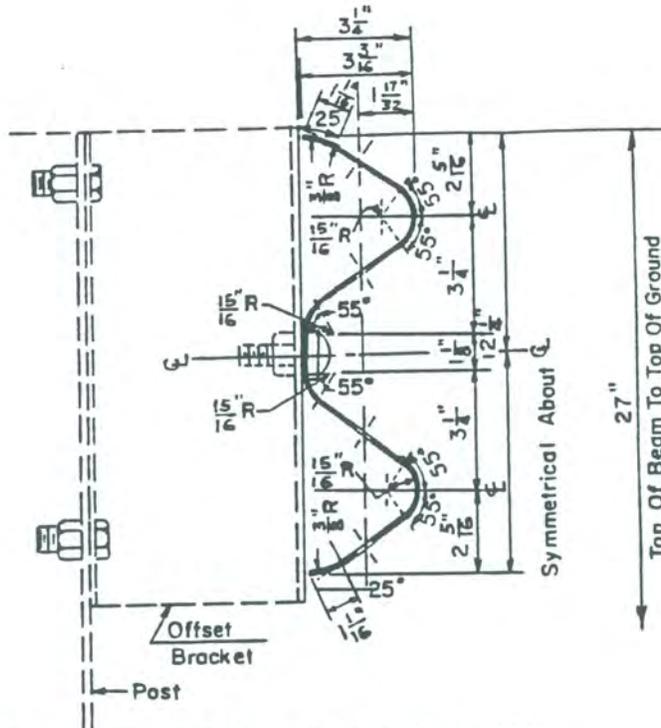
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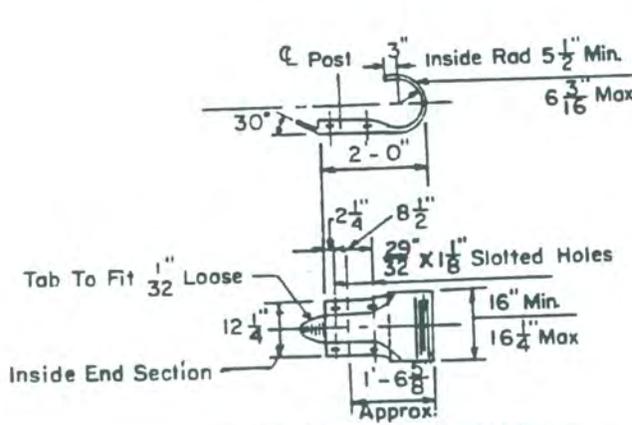
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METHOD OF CUTTING AND  
 REPAIRING ROADWAYS

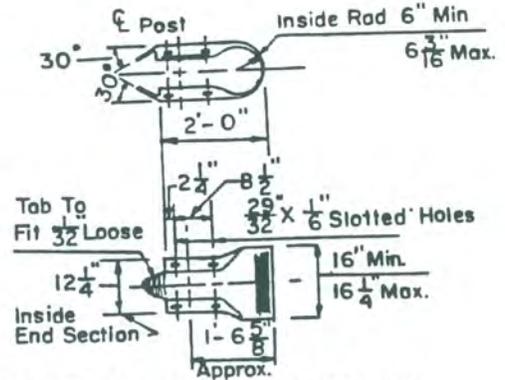
PLATE



SECTION THRU RAIL ELEMENT MATERIAL: 12 GA. STEEL



GUARD RAIL - END SECTION MATERIAL: 10 GA. STEEL



GUARD RAIL BARRIER-END SECTION (For Rail On Both Sides Of Same Post) MATERIAL: 10 GA. STEEL

General Notes:

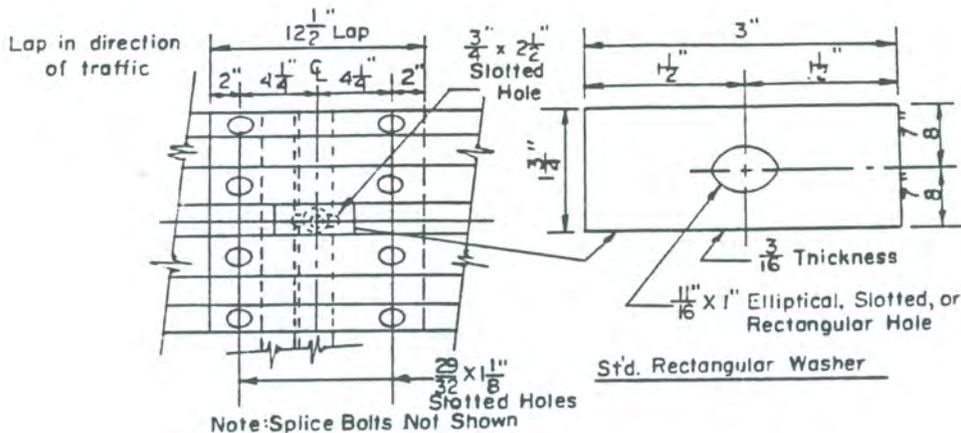
1. All Dimensions Are Subject To MFG Tolerances.
2. Rail Elements Are Furnished Shop Curved, Concave Or Convex To Radial Between 20 Ft & 150 Ft.
3. The Steel For Rail Elements And Bolts Is Of A Quality To Develop Specification Values For Beam And Tensile Strengths.
4. For Materials, Material Processing And Assembly, See Latest Specifications.
5. For Offset Bracket Detail, See ST'D. 72.
6. Posts To Be W6 X 8.5, 5'-9" Long, Spaced At 6'-3" c/c.
7. Back-Up Plate (12" Length Of Beam) Centered On Offset Bracket Bolt. To Be Placed Where No Overlap Of Rail Splice Occurs.

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PLATE
48

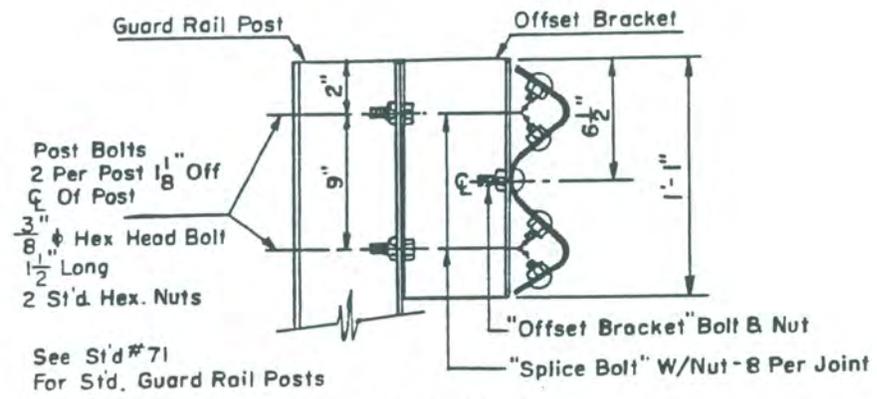
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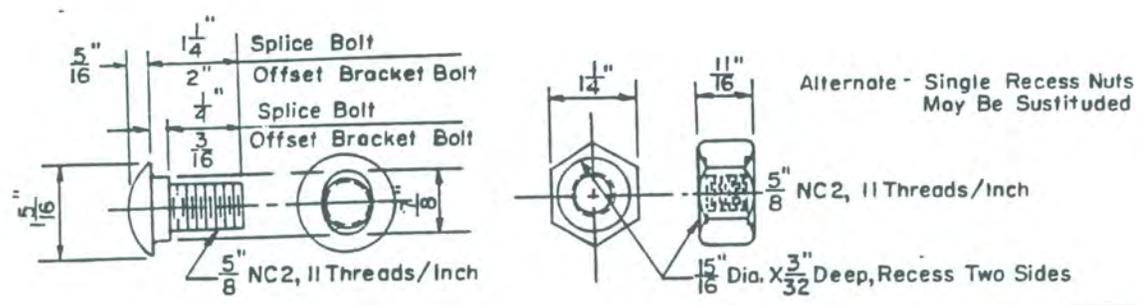
GUARD RAIL W/ BEAM  
DETAILS



**GUARD RAIL SPLICE**



**OFFSET BRACKET**  
6 WF 8.5



"Splice Bolt" & "Offset Bracket Bolt"

8 Per Joint 1 Per Bracket

1 1/4" Long 2" Long

Nut

9 Per Splice

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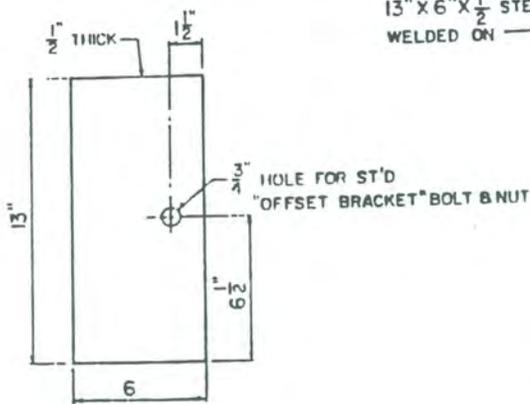
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GUARD RAIL W/ BEAM  
SPLICE JOINT

PLATE

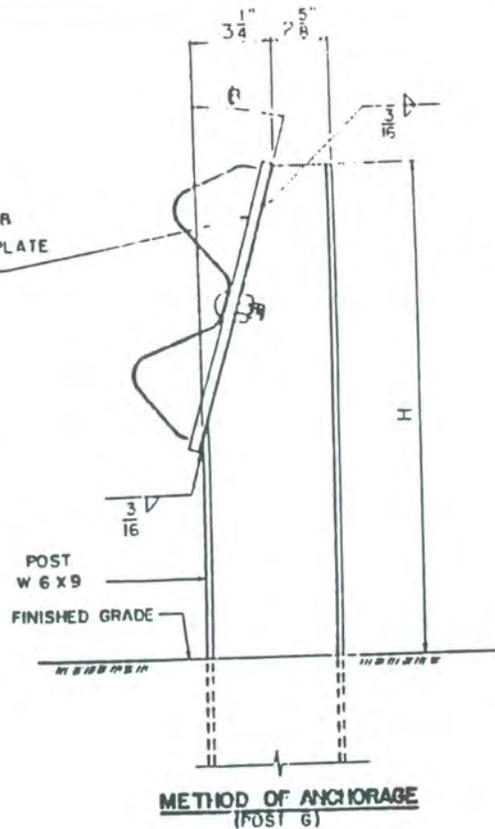
49



**STEEL PLATE DETAIL**

NOTE: ALL STEEL IS TO BE AASHTO DESIGNATION M-183 HOT DIPPED GALVANIZED AFTER FABRICATION TO AASHTO DESIGNATION M-111

I BEAM POST CUT ON INDICATED ANGLE  $\beta$   
 13" X 6" X 1/2" STEEL PLATE WELDED ON

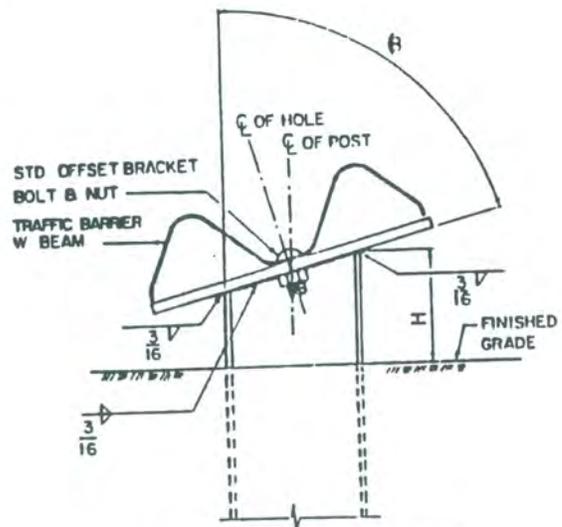


**METHOD OF ANCHORAGE (POST G)**

H = HEIGHT OF TOP OF BARRIER POST ABOVE FINISHED GRADE  
 $\beta$  = ANGLE OF PITCH OF RAIL

POST	H	$\beta$
A	2'-3"	0°
B	2'-3"	0°
C	2'-3"	0°
D	2'-3"	0°
E	2'-3"	0°
F	2'-3"	0°
G	2'-0 1/2"	15°
H	1'-8"	30°
I	1'-2 1/2"	45°
J	0'-9 1/4"	60°
K	0'-4 1/4"	75°
L	0'-0"	90°

NOTE: FOR METHOD OF ANCHORAGE AT POST L, SEE DETAILS ON STANDARD MD-660.31



**TYPICAL METHOD OF ANCHORAGE (POSTS H, I, J & K)**

NOTE: - USE OF ANCHORAGE PLATE IN PLACE OF OFFSET BRACKET BEGINS AT POST G WITH AN ANGLE OF 15°

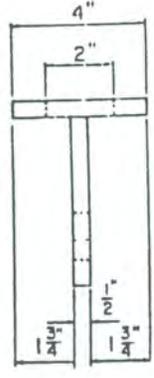
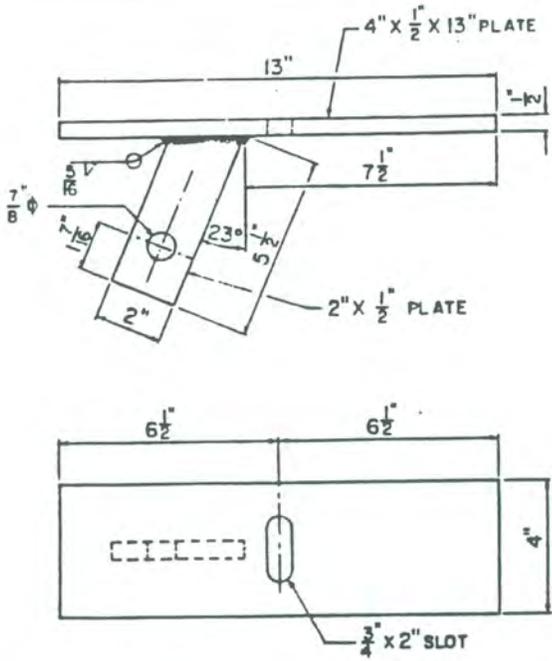
ANCHORAGE PLATE TO BE USED WITH TYPE I-END FLARE

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TRAFFIC BARRIER W BEAM  
 ANCHORAGE PLATE

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DATE	BY
PLATE	
50	

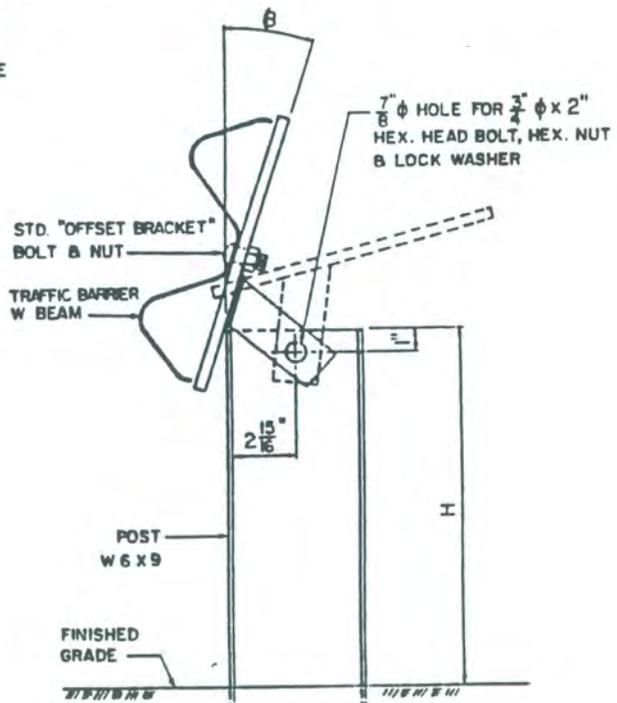


ALL STEEL TO BE AASHTO DESIGNATION M-183  
HOT DIPPED GALVANIZED AFTER FABRICATION  
TO AASHTO DESIGNATION M-111

H = HEIGHT OF TOP OF BARRIER POST ABOVE FINISHED GRADE  
β = ANGLE OF PITCH OF RAIL

POST	H	β
A	2'-3"	0°
B	2'-3"	0°
C	2'-3"	0°
D	2'-3"	0°
E	2'-3"	0°
F	2'-3"	0°
G	1'-1 3/4"	15°
H	0'-10 1/2"	30°
I	0'-7"	45°
J	0'-4 1/2"	60°
K	0'-1 1/2"	75°
L	0'-0"	90°

NOTE: FOR METHOD OF ANCHORAGE  
AT POST L, SEE DETAILS  
ON STANDARD.



**METHOD OF ANCHORAGE**

(POSTS G, H, I, J & K)  
NOTE: - USE OF ANCHORAGE BRACKET IN PLACE OF  
OFFSET BRACKET BEGINS AT POST G  
WITH AN ANGLE OF 15°

ANCHORAGE BRACKET TO BE USED WITH TYPE I- END FLARE

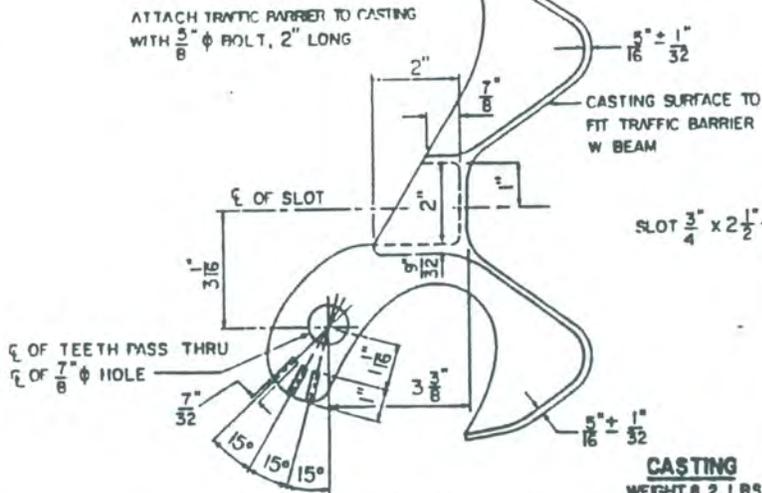
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PLATE	
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TRAFFIC BARRIER W BEAM  
ANCHORAGE BRACKET

*Carroll County* 4-12-94  
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**CASTING**  
WEIGHT 8.2 LBS.

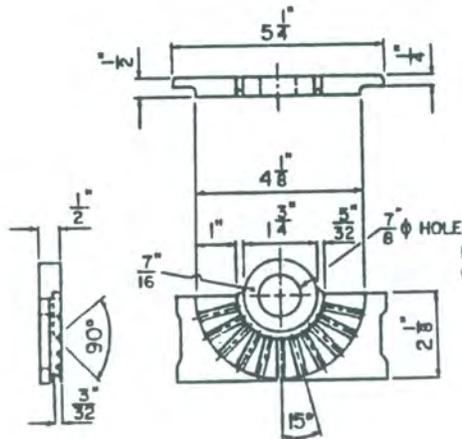
**MATERIAL REQUIREMENTS**

1. THE METAL CASTING SHALL CONFORM TO THE A.S.T.M. DESIGNATION A-47, GRADE 32510.
2. THE ZINC COATING SHALL CONFORM TO THE DESIGNATION AASHTO M-232
3. ALL PARTS TO BE GALVANIZED.

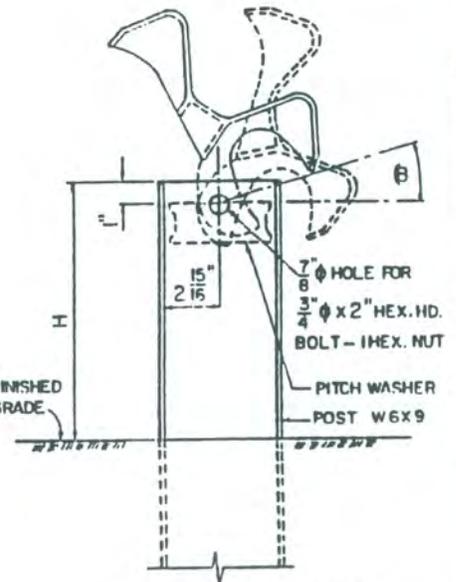
H = HEIGHT OF TOP OF BARRIER POST ABOVE FINISHED GRADE  
β = ANGLE OF PITCH OF RAIL

POST	H	β
A	2'-3"	0°
B	2'-3"	0°
C	2'-3"	0°
D	2'-3"	0°
E	2'-3"	0°
F	2'-3"	0°
G	1'-3 1/2"	15°
H	0'-11 1/8"	30°
I	0'-8 1/2"	45°
J	0'-4 8/8"	60°
K	0'-1"	75°
L	0'-0"	90°

NOTE: FOR METHOD OF ANCHORAGE AT POST L, SEE DETAILS ON STANDARD



**PITCH WASHER**  
WEIGHT 1 LB.



**METHOD OF ANCHORAGE**

(POSTS G, H, I & K)

NOTE: - USE OF ANCHORAGE CASTING IN PLACE OF OFFSET BRACKET BEGINS AT POST G WITH AN ANGLE OF 15°

ANCHORAGE CASTING TO BE USED WITH TYPE I-END FLARE

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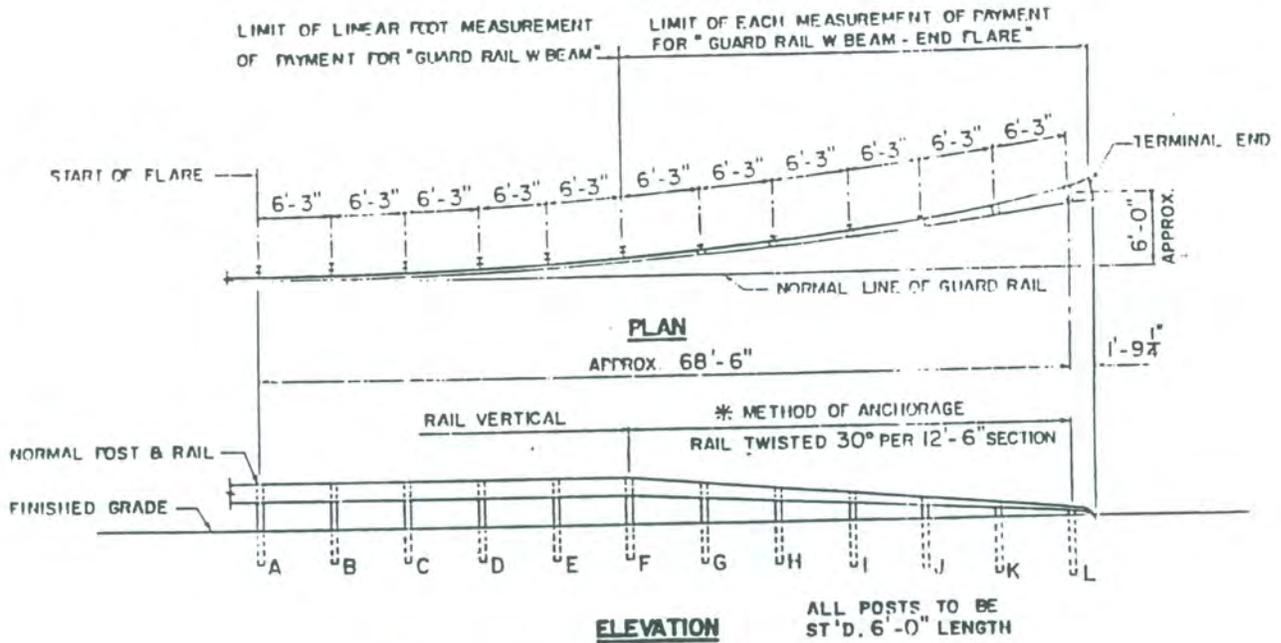
**TRAFFIC BARRIER W BEAM  
ANCHORAGE CASTING**

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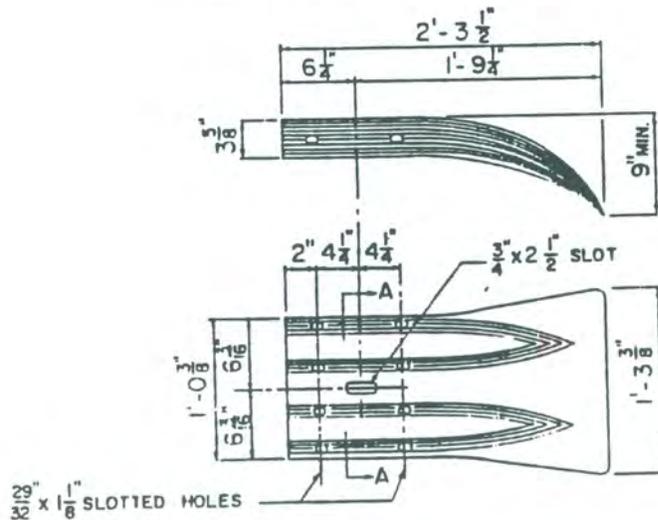
PLATE

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\* NOTE: USE OF GUARD RAIL W BEAM ANCHORAGE IN PLACE OF OFFSET BRACKET BEGINS AT POST G. THE CONTRACTOR HAS THE OPTION FOR THE METHOD OF GUARD RAIL W BEAM ANCHORAGE. FOR DETAILS OF OPTIONS SEE - ST'D MD - 660.32 ANCHORAGE CASTING  
 ST'D MD - 660.33 ANCHORAGE BRACKET  
 ST'D MD - 660.34 ANCHORAGE PLATE

COST OF ANCHORAGE SELECTED SHALL BE INCLUDED IN THE PAYMENT FOR END FLARE AS INDICATED ABOVE.



NOTE: TYPE 1- END FLARE WILL BE USED WHERE THE SPACING OF CROSS-STREETS AND ENTRANCES PRECLUDE THE USE OF STANDARD MD-660.35 "TYPE 2- END FLARE."

SECTION A-A

TERMINAL END (10 GA.)

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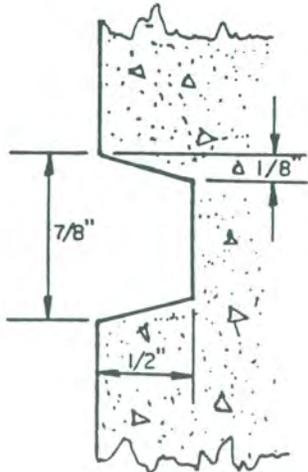
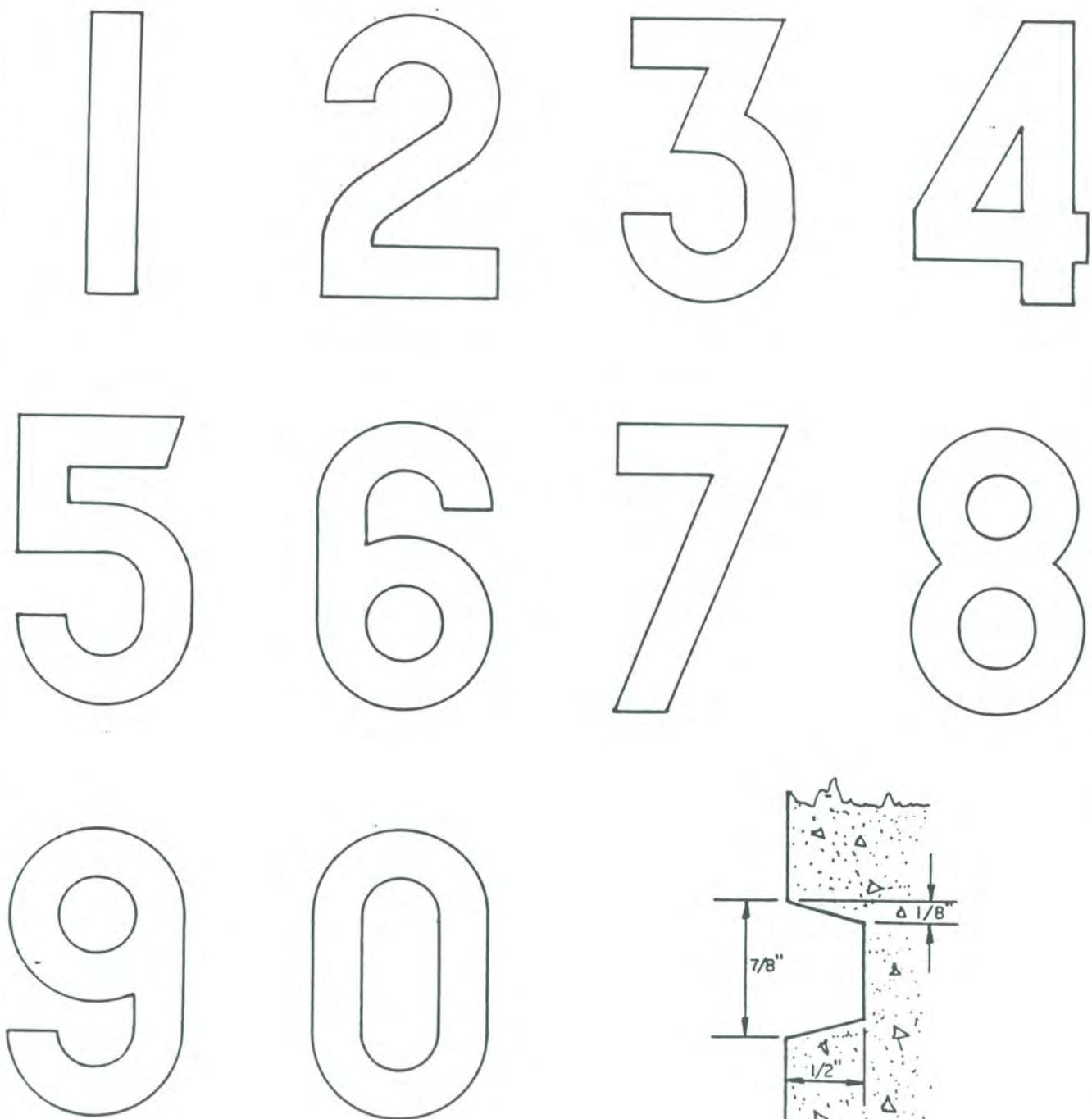
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GUARD RAIL WITH BEAM  
 TYPE 1- END FLARE

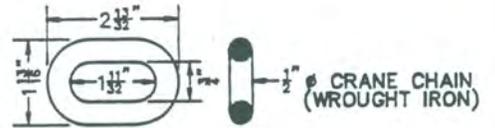
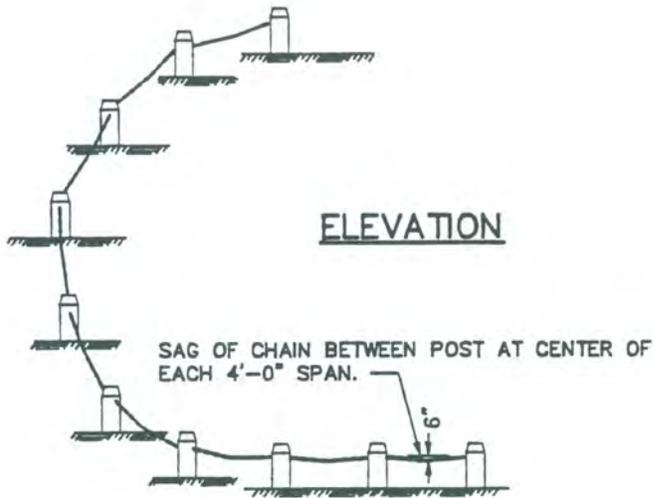
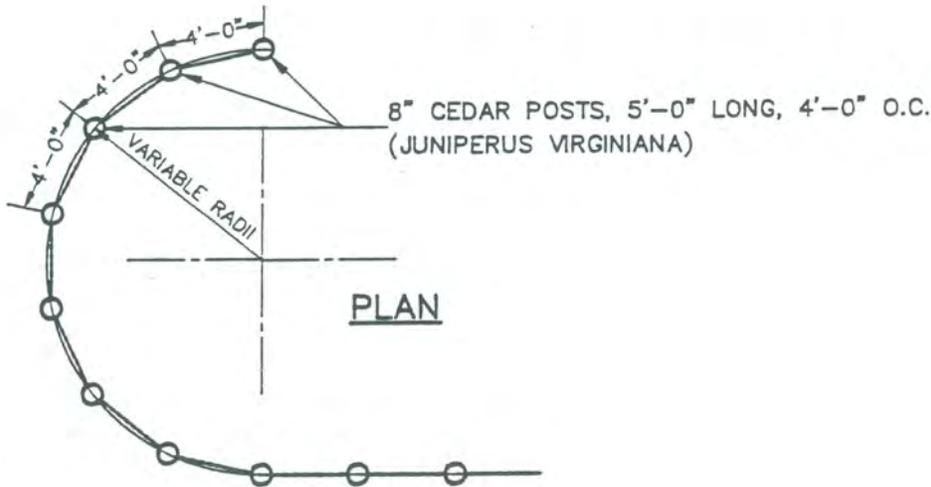
PLATE

53



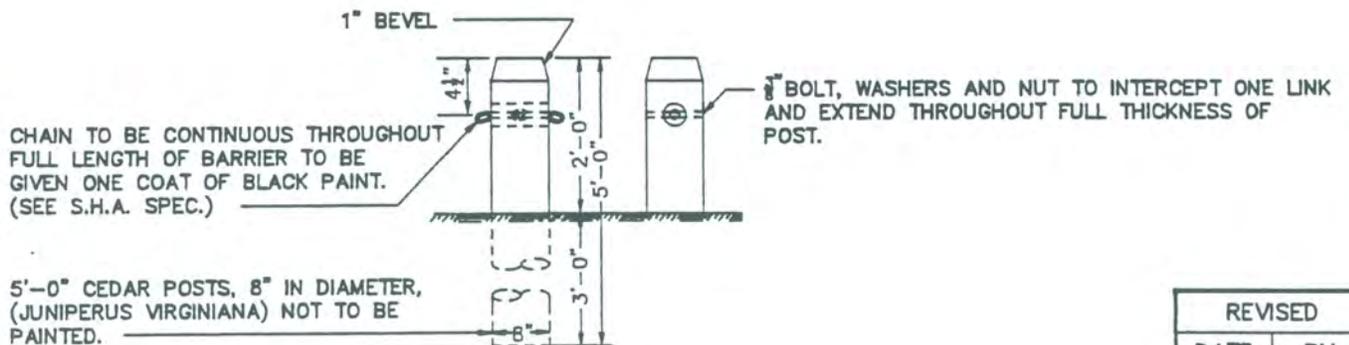
NOTE:  
 ALL NUMERALS TO BE 5" HIGH.  
 ALL NUMERALS TO BE 3" WIDE OVERALL EXCEPT "1" WHICH WILL BE 7/8" WIDE.

REVISED		CARROLL COUNTY DEPARTMENT OF PUBLIC WORKS	STANDARD "YEAR BUILT" NUMERALS	PLATE
DATE	BY			54
		<i>Carol C. ...</i>		
		DIRECTOR	DATE 4-12-94	



**CHAIN LINK DETAIL**

LGTH. 100 LINK	134"
WGT./100'	275 POUNDS
BREAK TEST LOAD	14,145 ...
PROOF TEST LOAD	5,375 ...
SAFE WORKING LOAD	4,240 ...



REVISED	
DATE	BY

CARROLL COUNTY, MARYLAND  
DEPARTMENT OF PUBLIC WORKS

*Carroll County* 4-12-94  
DIRECTOR DATE

WOODEN POST  
AND  
CHAIN GUARDRAIL

PLATE

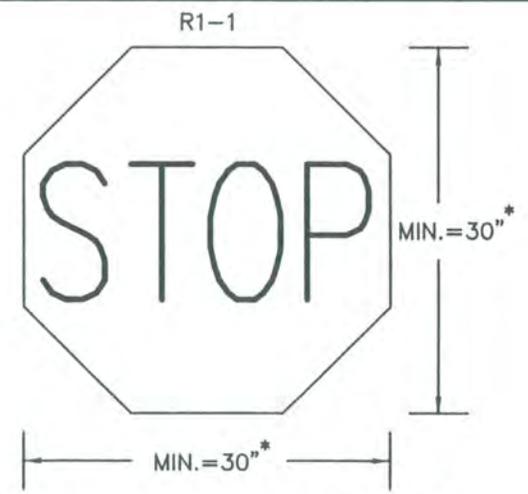
55



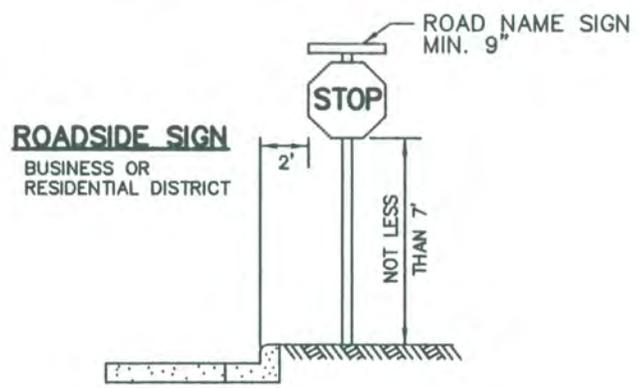
THROUGH STREET



LOCATION PLAN



\* SIZE VARIES BASED UPON ROADWAY



**NOTES**

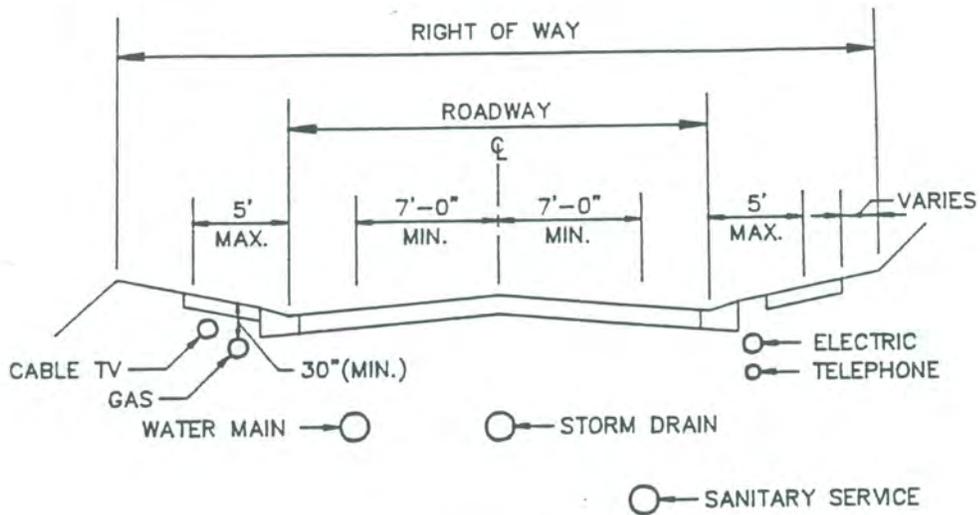
1. All signs shall be installed in compliance with the latest edition of The Manual on Uniform Traffic Control Devices(MUTCD).
2. All signs shall be installed in accordance with current Department of Public Works specifications.
3. All signs installed along Maryland State Highway's(MDSHA) shall be installed in accordance with MDSHA standards with exception of the Road Name Sign.

REVISED	
DATE	BY
2-18-04	C.L.

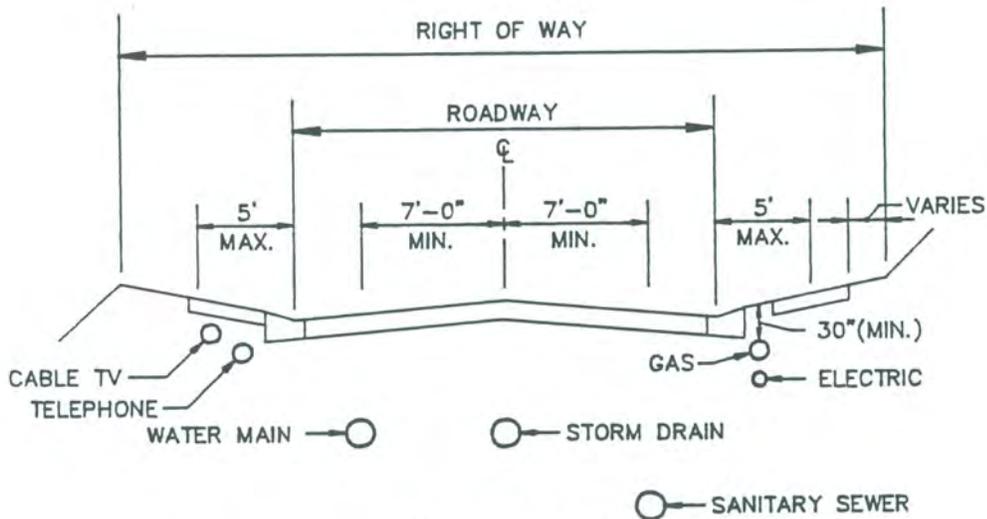
CARROLL COUNTY, MARYLAND  
DEPARTMENT OF PUBLIC WORKS  
*Douglas E. Meyer* 2-10-04  
DIRECTOR DATE

STANDARD STREET  
NAME AND  
STOP SIGNS

PLATE  
56



**OPTION NO. 1**



**OPTION NO. 2**

**NOTES:**

1. LOCATION FOR UTILITIES (NOT INSTALLED UNDER ROADWAY) SHALL BE LIMITED TO A MAXIMUM OF FIVE FEET (5') BEYOND FLOWLINE OF CURB UNLESS OTHERWISE INSTRUCTED BY D.P.W.
2. DEPARTMENT OF PUBLIC WORKS, CONSTRUCTION INSPECTION DIVISION TO BE CONSULTED PRIOR TO INSTALLATION OF GAS, ELECTRIC, TELEPHONE, OR CABLE TV FACILITIES.
3. GAS, ELECTRIC, AND TELEPHONE UTILITIES MAY BE PLACED IN SAME TRENCH AT THE OPTION OF THE POWER COMPANY AND THE C&P TELEPHONE COMPANY.
4. ELECTRIC: 0-600V 24" COVER, OVER 600V 36" COVER.  
 TELEPHONE: MAIN SERVICE 24" COVER.  
 RESIDENTIAL CONNECTION 11" COVER.  
 CABLE TV: 11" COVER.

REVISED	
DATE	BY

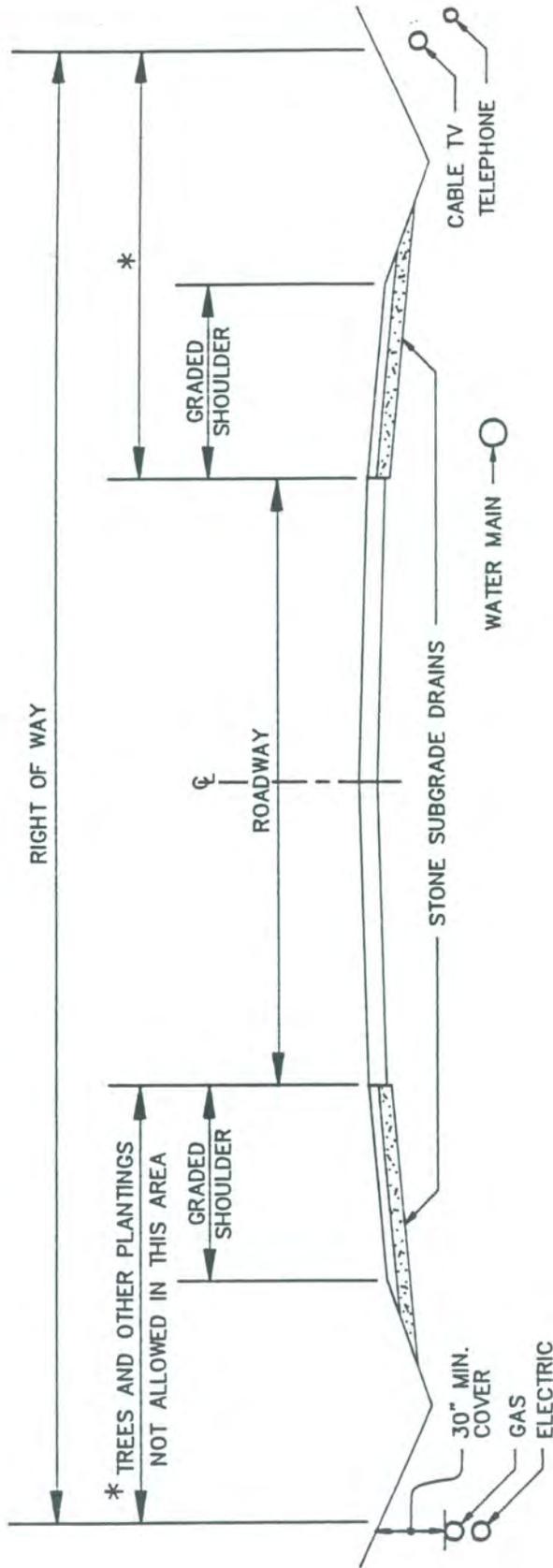
CARROLL COUNTY, MARYLAND  
 DEPARTMENT OF PUBLIC WORKS

*[Signature]* 4-12-94  
 DIRECTOR DATE

UTILITY LOCATIONS IN  
 CLOSED SECTION ROADWAYS

PLATE

57



○—SANITARY SERVICE

**NOTES:**

1. WHERE SUBGRADE DRAINS ARE REQUIRED, UTILITIES ARE TO BE INSTALLED AS SHOWN UNLESS OTHERWISE INSTRUCTED BY THE DEPARTMENT OF PUBLIC WORKS.
2. DEPARTMENT OF PUBLIC WORKS, CONSTRUCTION INSPECTION DIVISION TO BE CONSULTED PRIOR TO INSTALLATION OF GAS, ELECTRIC, TELEPHONE, OR CABLE TV FACILITIES.
3. GAS, ELECTRIC, AND TELEPHONE UTILITIES MAY BE PLACED IN SAME TRENCH AT THE OPTION OF THE POWER COMPANY AND THE C&P TELEPHONE COMPANY.
4. ELECTRIC: 0-600V 24" COVER, OVER 600V 36" COVER.  
 TELEPHONE: MAIN SERVICE 24" COVER.  
 RESIDENTIAL CONNECTION 11" COVER.  
 CABLE TV: 11" COVER.

CARROLL COUNTY, MARYLAND  
 DEPARTMENT OF PUBLIC WORKS

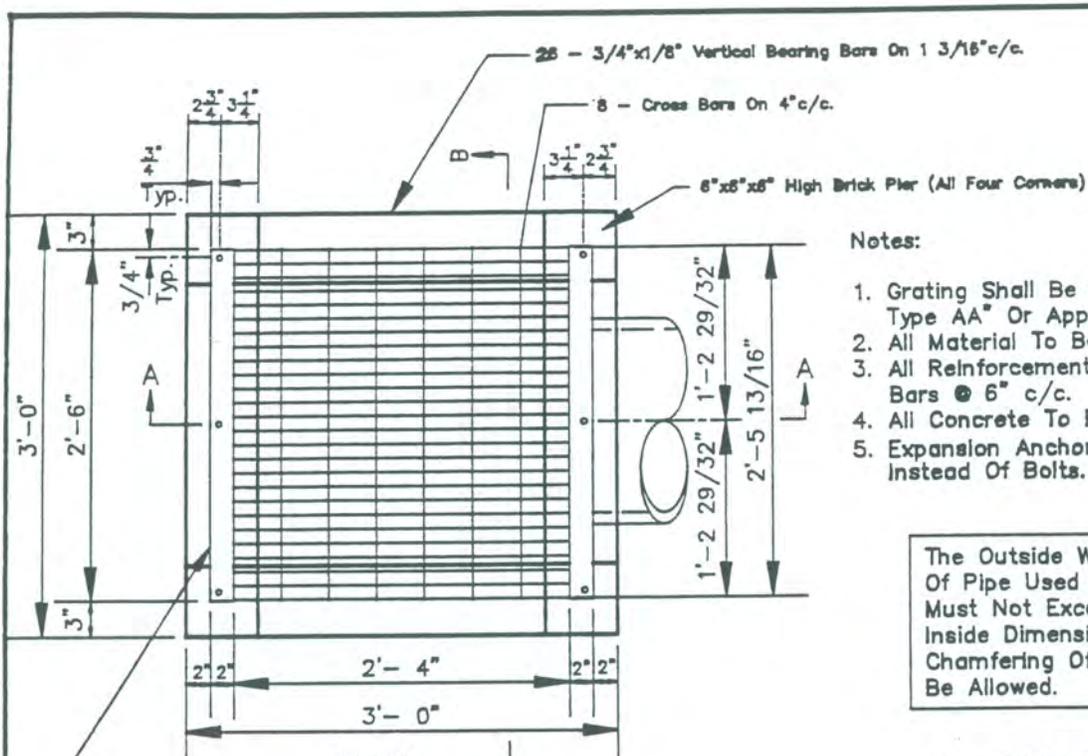
*[Signature]* 4-12-94  
 DIRECTOR DATE

UTILITY LOCATIONS IN  
 OPEN SECTION ROADWAYS

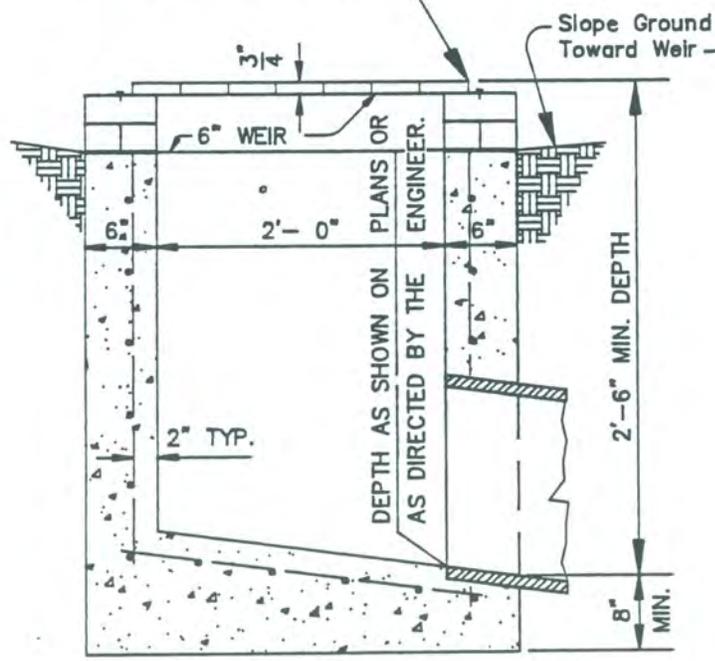
REVISED	
DATE	BY

PLATE

58

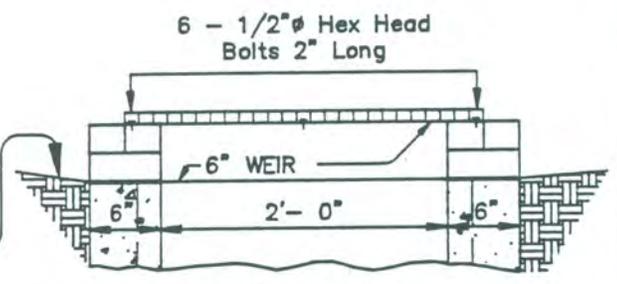


2 - 2"x1 1/4"x3/16"x2'-6"L (Centered On Grate)  
 Trim Vertical Leg Of Angle To 3/4" In Height  
 Weld Securely To Grating At Every 4th Bar  
 (Welded Areas To Be Touched Up With Zinc Rich Paint After Welding.)

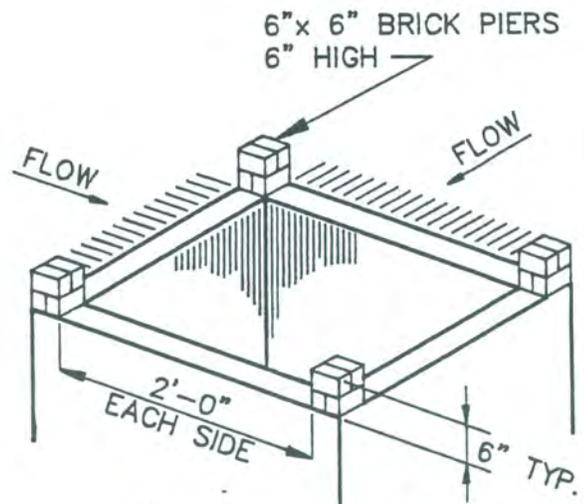


SECTION A-A

Brick Piers To Be Parged With Concrete



SECTION B-B



ISOMETRIC (GRATE REMOVED)

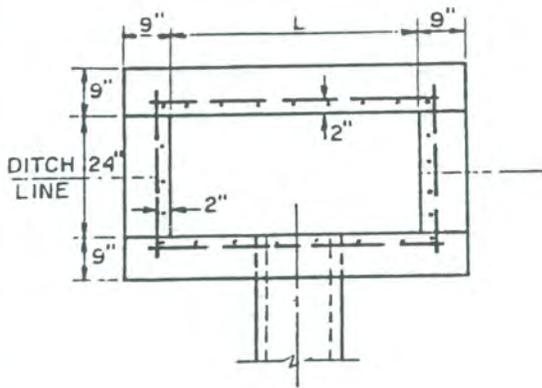
REVISED	
DATE	BY

CARROLL COUNTY, MARYLAND  
 DEPARTMENT OF PUBLIC WORKS

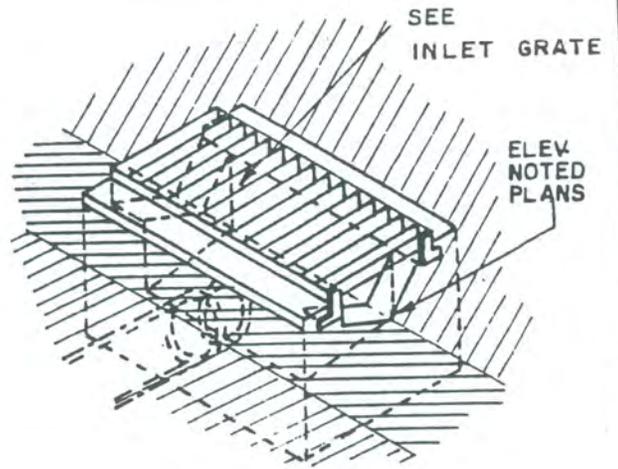
*Carroll County Seal* 4-12-94  
 DIRECTOR DATE

MODIFIED  
 STANDARD YARD INLET

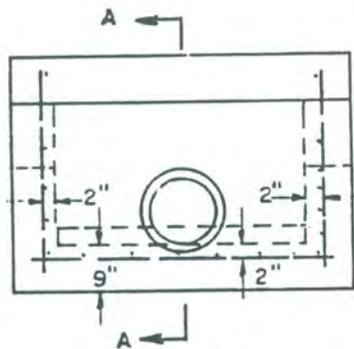
PLATE  
 59



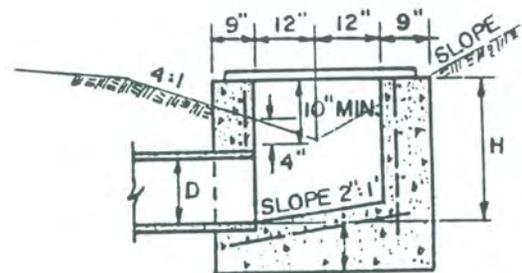
PLAN



ISOMETRIC VIEW



ELEVATION



SECTION A-A

**GENERAL NOTES**

STEEL: VERT 4 BARS, 6" C.C.  
 HOR. 4 BARS, 6" C.C.  
 BOT. 4 BARS, 6" C.C.

CONCRETE: SEE GENERAL

SPECIFICATIONS. HEIGHT OF FRONT & BACK WALLS MUST CONFORM TO GRADE OF ADJACENT ROAD SECTION.

BRICK MAY ONLY BE USED WITH CARROLL COUNTY DEPT. OF PUBLIC WORKS APPROVAL.

NOTE 1. DEPTH OF INLET SHALL BE INCREASED AS REQUIRED TO ACCOMMODATE PIPE GRADE AND NOTCH ELEVATION SHOWN ON THE PLAN.

REVISED	
DATE	BY

"J" SLOPE 2:1 OR FLATTER					
OPENING DIA	AREA SQ FT	DIMENSION		TYPE OF GRATE	
		L	MIN. H		
12"	0.79	4'-0"	2'-4"	C	
15"	1.23	4'-0"	2'-7"	C	
16"	1.39	4'-0"	2'-8"	C	
18"	1.78	4'-0"	2'-10"	C	
21"	2.41	5'-0"	3'-2"	E	
24"	3.14	5'-0"	3'-5"	E	
27"	3.98	6'-0"	3'-8"	G	
30"	4.91	6'-0"	4'-0"	G	
33"	5.94	6'-0"	4'-3"	G	
36"	7.07	6'-0"	4'-6"	G	

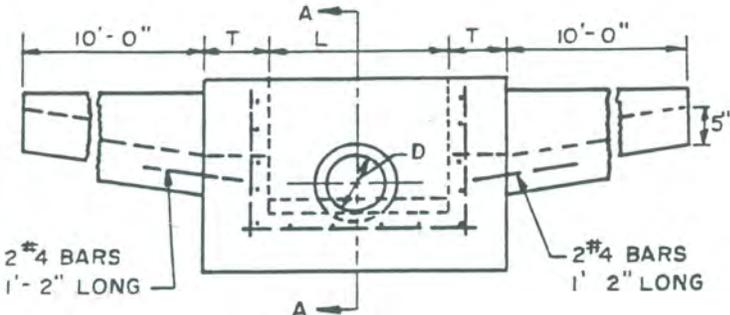
CARROLL COUNTY, MARYLAND  
 DEPARTMENT OF PUBLIC WORKS

*[Signature]* 4-12-94  
 DIRECTOR DATE

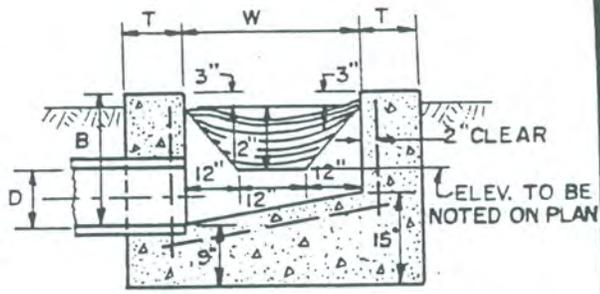
MODIFIED "J" INLET

PLATE

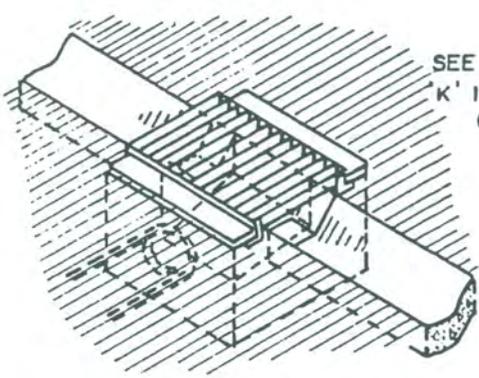
60



ELEVATION



SECTION A A



ISOMETRIC VIEW

SEE STANDARD  
K' INLET  
GRATE.

"K"						
OPENING		DIMENSIONS				TYPE OF GRATE
DIAM. D	AREA SQ. FT.	L	W	MIN. B	T	
12"	0.79	3'-0"	3'-0"	2'-3"	9"	A
15"	1.23	3'-0"	3'-0"	2'-6"	9"	
18"	1.78	3'-0"	3'-0"	2'-9"	9"	
24"	3.14	3'-0"	3'-0"	3'-3"	12"	B
30"	4.91	3'-6"	3'-0"	3'-9"	12"	C
36"	7.07	4'-0"	3'-0"	4'-3"	12"	D
42"	9.62	4'-6"	3'-0"	4'-9"	12"	E
48"	12.57	5'-0"	3'-0"	5'-3"	12"	F

CONSTRUCT WITH REINFORCED CONCRETE. THIS INLET MAY ONLY BE USED WITH PRIOR APPROVAL FROM THE D.P.W.

GENERAL NOTES

- STEEL #4 BARS 6" C.C. - VERTICAL
- #4 BARS 6" C.C. - HORIZONTAL
- #4 BARS 6" C.C. - BOTTOM

CONCRETE - S.H.A. MIX NO. 2

NOTES:

1. THE CONCRETE VALLEY GUTTER TO BE USED IN CONNECTION WITH THIS INLET, WILL BE WARPED FROM THE STANDARD SECTION TO MEET THE SECTION AT THE END OF THE INLET. THIS TRANSITION WILL TAKE PLACE WITHIN A DISTANCE OF TEN (10) FEET FROM THE INLET.
2. PIPE OUTLETS AND GUTTER APPROACHES CAN BE REVISED TO MEET EXISTING CONDITIONS.
3. DEPTH OF INLET SHALL BE INCREASED AS REQUIRED TO ACCOMMODATE PIPE GRADE AND NOTCH ELEVATION SHOWN ON THE PLAN.
4. THIS INLET SHALL NOT BE USED WITHOUT MODIFICATION FOR PIPES OVER 36" IN END OF INLET.
5. THROUGH INLETS SHALL HAVE BRICK CHANNELIZATION AS ON PLATE 90. SUCH INLETS NOT TO BE USED WITHOUT MODIFICATION FOR PIPES OVER 24".

CARROLL COUNTY, MARYLAND  
DEPARTMENT OF PUBLIC WORKS

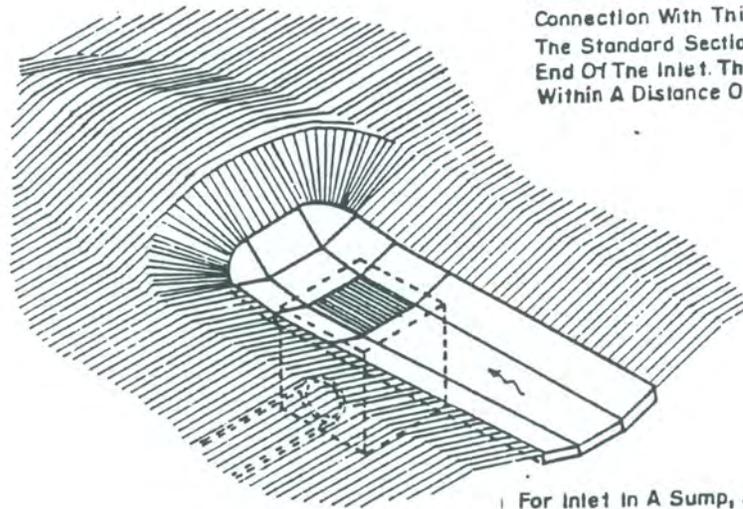
*W. St. ...* 4-12-94  
DIRECTOR DATE

"K" INLET

PLATE

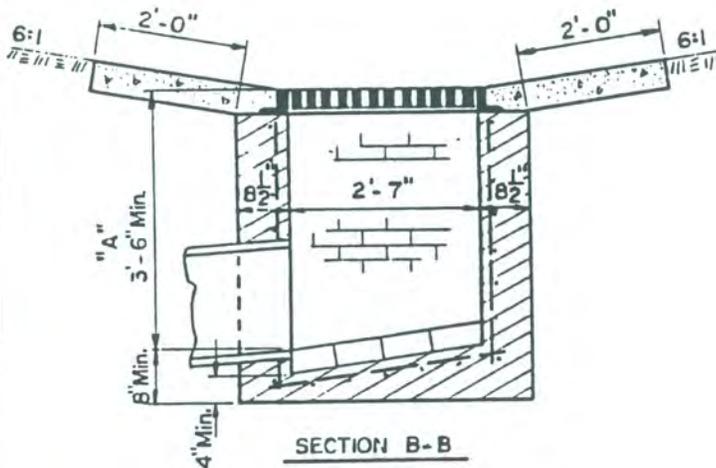
61

Note: The Concrete Median Ditch To Be Used In Connection With This Inlet, Will Be Warped From The Standard Section To Meet The Section At The End Of The Inlet. This Transition Will Take Place Within A Distance Of Ten (10) Feet From The Inlet.

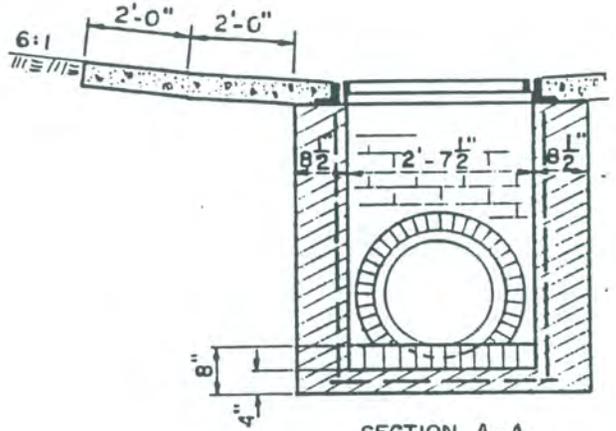


ISOMETRIC VIEW

For Inlet In A Sump, See Gutter Details As Shown In The Isometric View On Plate No. 63



SECTION B-B



SECTION A-A

1. INLET TO BE CONSTRUCTED OF REINFORCED CONCRETE. SIZE, TYPE AND DIRECTION OF INLET CONNECTION WILL VARY TO SUIT CONDITIONS.
2. TOP 4" OF WALLS MAY BE BRICK MASONRY. ADDITIONAL BRICK MAY BE USED TO BRING THE GRATE TO GRADE IF REQUIRED.
3. GRATE STANDARD SHA 379.02
4. "BRICK FOR MASONRY," TO COMPLY WITH THE LATEST SPECIFICATIONS. REINFORCEMENT: NO. 4  $\emptyset$  DEFORMED BARS AT 6" c/c 2" COVER.
5. REINFORCEMENT REQUIRED ON OUTSIDE, AS WELL AS ON INSIDE OF WALLS BELOW 7'-0" WHEN "A" IS GREATER THAN 7'-0" SPACING, SAME AS FOR INSIDE OF WALL.
6. INVERT MAY BE PLAIN CONCRETE OR 4" BRICK LAID ON EDGE. INVERT TO SLOPE DOWN TOWARD OUTLET AT THE RATE OF TWO (2) INCHES PER FOOT, OR AS DIRECTED.
7. BRICK FOR CONSTRUCTION OF INLET MAY BE USED IF AUTHORIZED BY DEPT. OF PUBLIC WORKS.

REVISED	
DATE	BY

CARROLL COUNTY, MARYLAND  
DEPARTMENT OF PUBLIC WORKS

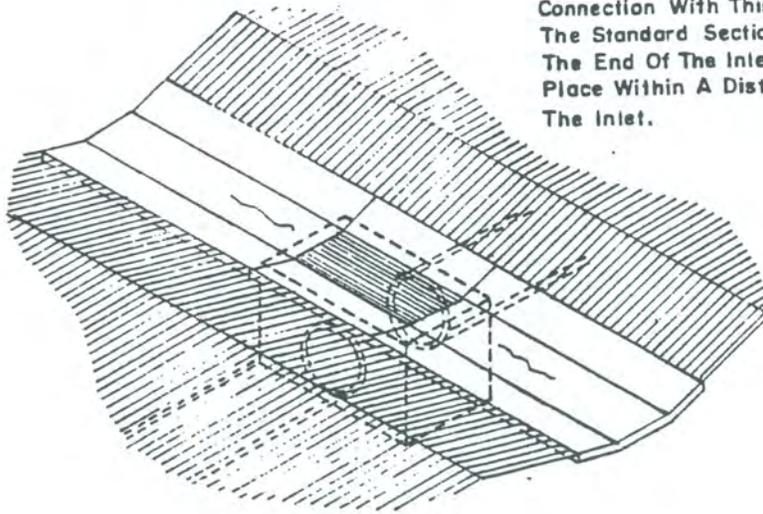
*K. D. C. ...* 4-12-44  
DIRECTOR                      DATE

STANDARD TYPE K INLET  
SINGLE GRATE

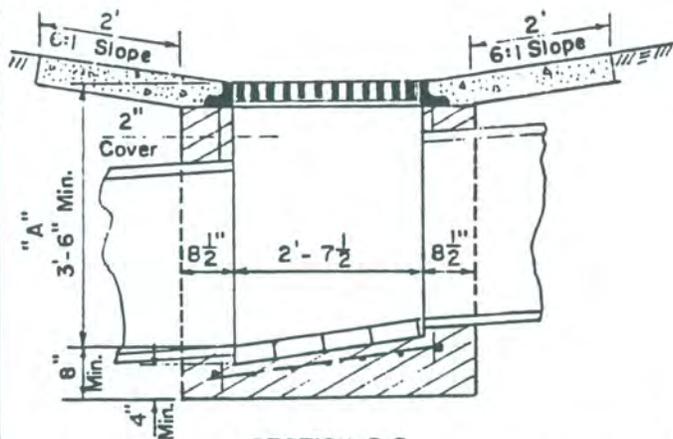
PLATE

62

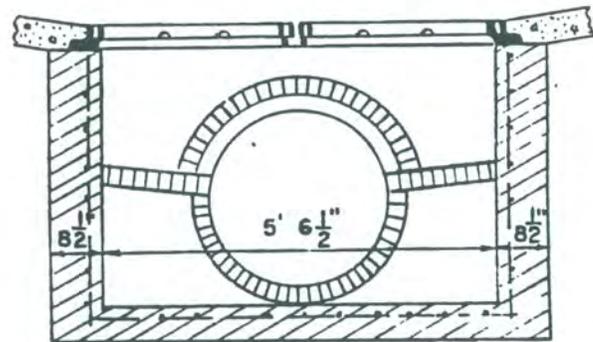
NOTE: The Concrete Median Ditch To Be Used In Connection With This Inlet, Will Be Warped From The Standard Section To Meet The Section At The End Of The Inlet. This Transition Will Take Place Within A Distance Of Ten (10) Feet From The Inlet.



ISOMETRIC VIEW



SECTION B-B



SECTION A-A

GENERAL NOTES

1. Inlet Shall Be Constructed Of S.H.A. Mix No. 2 Reinforced Concrete. Size And Type And Direction Of Inlet Construction Will Vary To Suit Conditions.
2. Top 4" Of Walls May Be Brick Masonry. Additional Brick May Be Used To Bring The Grate To Grade If Required, See Latest Specifications.
3. "Brick For Masonry," To Comply With The Latest S.H.A. Specifications. Reinforcement: No. 4  $\emptyset$  Deformed Bars At 6" o/c, 2" Cover.
4. Reinforcement Required On Outside, As Well As On Inside Walls Below 7'-0". When "A" Is Greater Than 7'-0". Spacing Same As For Inside Of Wall.
5. Invert May Be Plain Concrete Or 4" Brick Laid On Edge Invert Of Slope. Down Toward Outlet At The Rate Of Two (2) Inches Per Foot Or As Directed.
6. Brick for Construction Of Inlet May Only Be Used If Authorized By Dept. Of Public Works.
7. Grate to be SHA Standard 379.05.

REVISED	
DATE	BY

CARROLL COUNTY, MARYLAND  
DEPARTMENT OF PUBLIC WORKS

*K. D. ...* 4-12-94  
DIRECTOR DATE

STANDARD TYPE K INLET  
DOUBLE GRATE TANDEM

PLATE

63

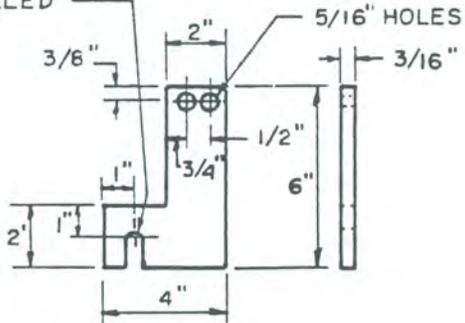
4 ANGULAR STEEL STRAPS BOLTED TO OUTSIDE BARS OF GRATING PRIOR TO SHIPPING.

LONGITUDINAL DIRECTION OF GRATING

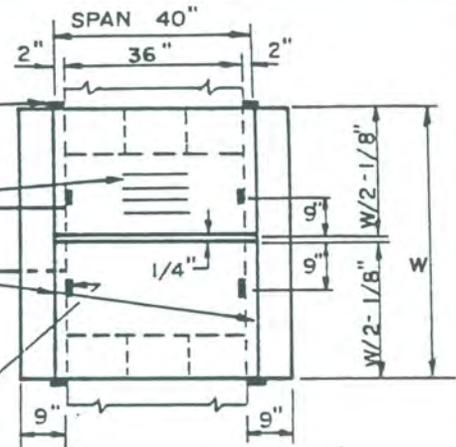
END OR BINDING BARS

4 ANGLE CLIPS  $\angle$  2" x 2" x 3/16" x 2 1/2" WELDED TO BOTTOM OF GRATING.

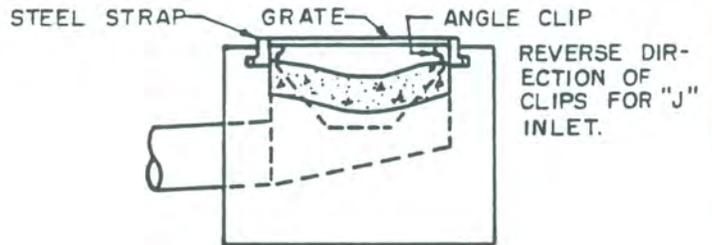
9/16" SLOTTED HOLE TO RECEIVE 1/2" x 4" MACHINE BOLT (GALV.) IMBEDDED 3" IN CONC. WALL. NUT TO BE PLACED ON END OF BOLT AFTER GRATE IS INSTALLED



END STRAP DETAIL

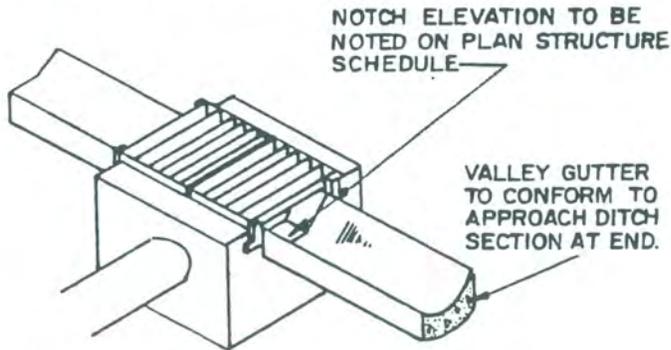


PLAN



END ELEVATION

ALL MATERIAL TO BE HOT DIPPED GALVANIZED AFTER FABRICATION



ISOMETRIC VIEW

GRATINGS ARE SUBJECT TO APPROVAL FOR EACH JOB. ANY TYPE OF SUBSTANTIAL TRANSVERSE BARS MAY BE USED WHICH WILL SUPPORT A MINIMUM UNIFORM LOAD OF 150 LBS/SQ.FT. THE TRANSVERSE BARS SHALL BE HELD RIGID BY SPACER BARS. MAXIMUM BAR SPACING SHALL BE 3"

	GRATE	SPAN	PIPE SIZE	
			K INLET	J INLET
54" WIDE	GRATE A	40" SPAN	12" - 18"	
60" WIDE	GRATE B	40" SPAN	21" & 24"	
66" WIDE	GRATE C	40" SPAN	27" & 30"	12" - 18"
72" WIDE	GRATE D	40" SPAN	33" & 36"	
78" WIDE	GRATE E	40" SPAN	42"	21" & 24"
84" WIDE	GRATE F	40" SPAN	48"	
90" WIDE	GRATE G	40" SPAN		27" - 36"

CARROLL COUNTY, MARYLAND  
DEPARTMENT OF PUBLIC WORKS

STANDARD NON-TRAFFIC  
GRATES FOR "J" & "K"  
INLETS

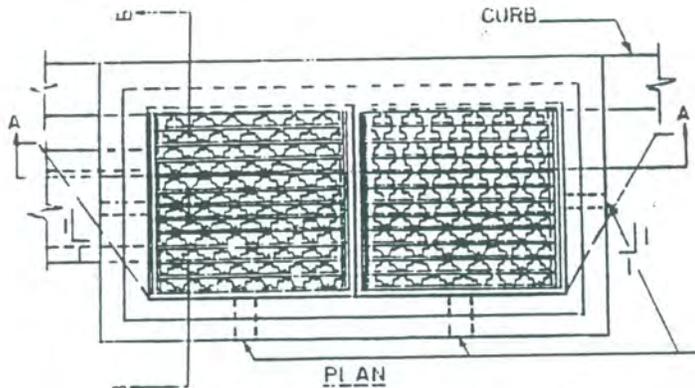
PLATE

64

DIRECTOR

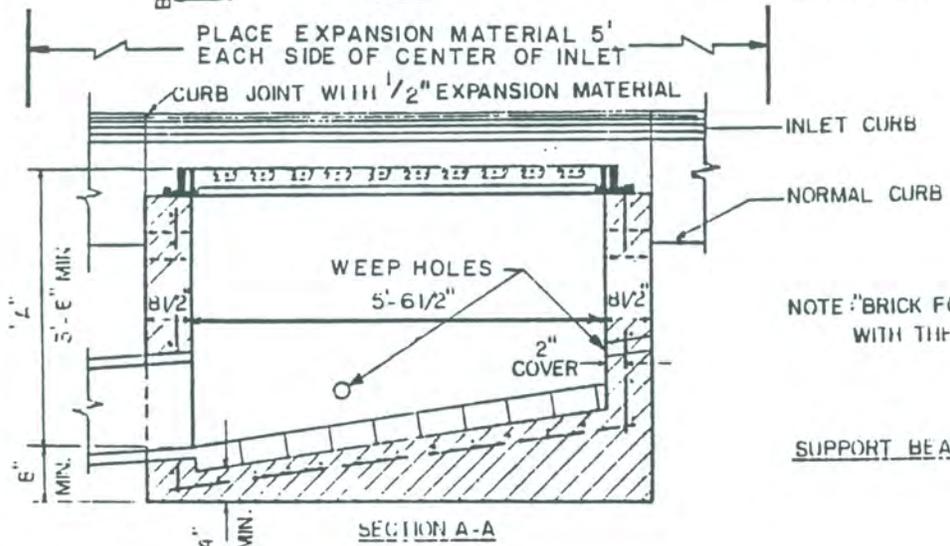
DATE

*Handwritten signature* 4-12-94



INVERT MAY BE PLAIN CONCRETE OR 4" BRICK LAID ON EDGE INVERT TO SLOPE DOWN TOWARD OUTLET AT THE RATE OF 2" PER FOOT, OR AS DIRECTED.

LEAVE 4" X 4" OPENING FOR SUBGRADE DRAINAGE, IF DIRECTED.



NOTE: "BRICK FOR MASONRY" TO COMPLY WITH THE LATEST SPECIFICATIONS.

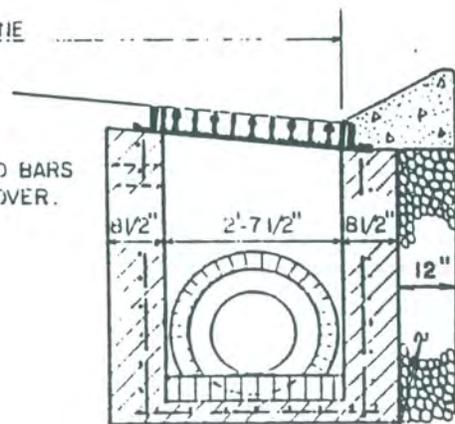
SUPPORT BEAM IS NOT TO BE USED

GENERAL NOTES

1. INLET SHALL BE CONSTRUCTED OF REINFORCED CONCRETE. SIZE, TYPE, AND DIRECTION OF INLET WILL VARY TO SUIT CONDITIONS.
2. TOP 4" OF WALLS MAY BE BRICK MASONRY. ADDITIONAL BRICK MAY BE USED TO BRING THE GRATE TO GRADE IF REQUIRED. SEE LATEST SPECIFICATIONS FOR INLETS.
3. REINFORCEMENT REQUIRED ON OUTSIDE AS WELL AS ON INSIDE OF WALLS BELOW 7'-0" WHEN "A" IS GREATER THAN 7'-0" SPACING, SAME AS FOR INSIDE OF WALL.
4. PLACE 1/2" EXPANSION MATERIAL OF SAME TYPE APPROVED FOR PAVEMENT (SEE SECTION A-A).
5. THE ENTIRE INLET EXCAVATION TO BE BACK FILLED WITH CLEAN COMPACTED NO. 57 STONE AGGREGATE COMPLETELY TO SUBGRADE.
6. WEEP HOLES TO BE COVERED WITH STAINLESS STEEL OR GALVANIZED WIRE MESH.
7. FOOTERS CAN BE 4" MIN. CONCRETE BUILT TO ALLOW FOR A 4" BRICK INVERT OR ALL CONCRETE
8. FLARE CURB GUTTER AT INLET AT 1:1 MEET FRONT OF FRAME. SEE PLAN VIEW.
9. BRICK FOR CONSTRUCTION OF INLET MAY ONLY BE USED IF AUTHORIZED BY DEPT. OF PUBLIC WORKS.

NORMAL CURB LINE

REINFORCEMENT:  
"4 (1/2") DEFORMED BARS  
AT 6" C. TO C. 2" COVER.



SECTION B-B

WEEP HOLES  
LEAVE 2" X 2" OPENING  
6" ABOVE R. MINIMUM 2  
REQUIRED.

NO. 57  
AGGREGATE  
ALL SIDES

REVISED	
DATE	BY

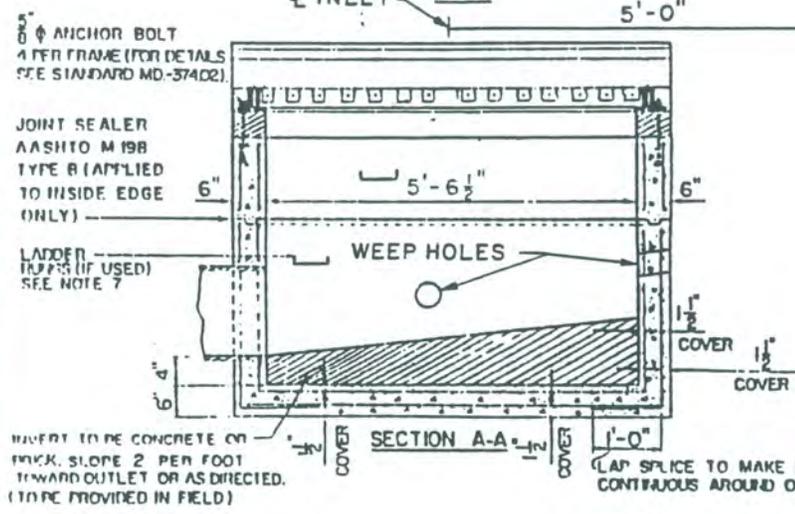
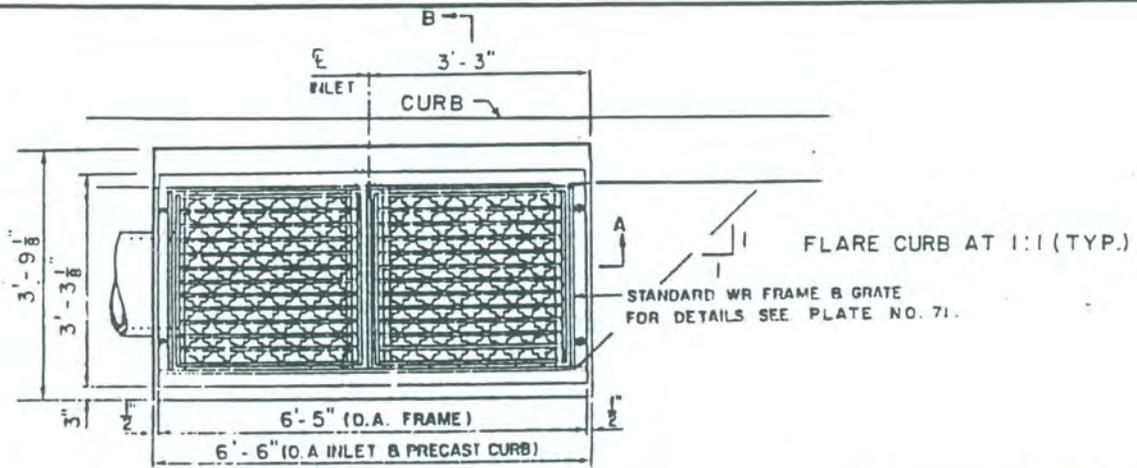
CARROLL COUNTY, MARYLAND  
DEPARTMENT OF PUBLIC WORKS

STANDARD TYPE S INLET  
DOUBLE GRATE TANDEM

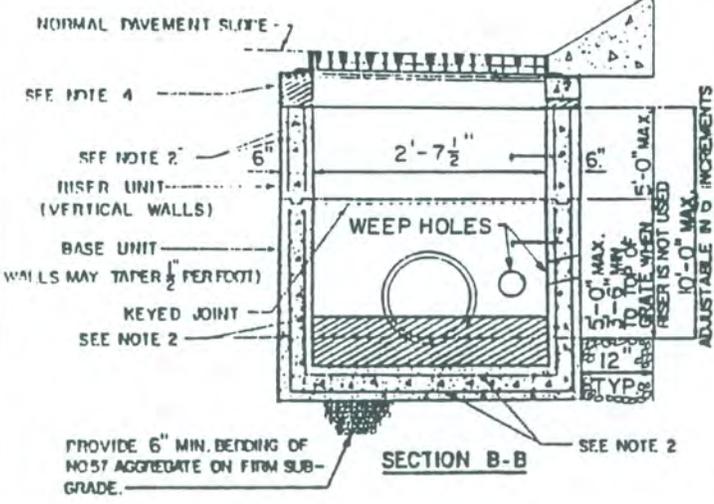
PLATE

*Handwritten signature* 4-12-94  
DIRECTOR DATE

65



INVERT TO BE CONCRETE OR BRICK. SLOPE 2 PER FOOT TOWARD OUTLET OR AS DIRECTED. (TO BE PROVIDED IN FIELD)



**GENERAL NOTES**

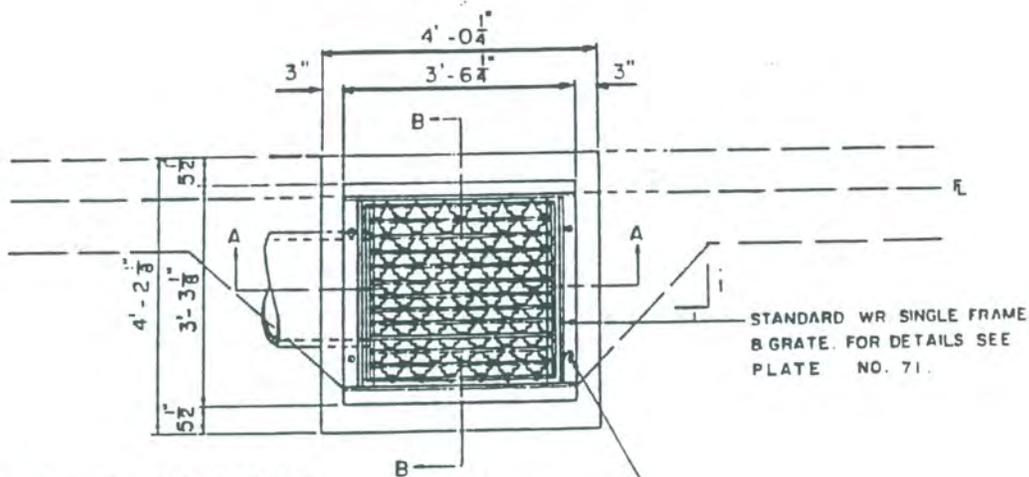
1. CONCRETE TO BE MIX NO 6 (4500PSI).
2. REINFORCING-2 LAYERS OF 4X4-W 4.0 X W 4.0 WELDED WIRE FABRIC
3. THREADED PLASTIC INSERTS TO BE PROVIDED FOR HANDLING
4. GRADE AND SLOPE ADJUSTMENTS COMPLETED IN THE FIELD USING CONCRETE MIX NO 6 OR BRICK AND MORTAR.
5. PIPE OPENINGS TO BE PROVIDED AS REQUIRED FOR SIZE, LOCATION AND INVERT ELEVATIONS REFER TO CONSTRUCTION PLANS.
6. PLACEMENT OF SUBGRADE DRAINAGE WILL BE AS DIRECTED BY THE ENGINEER OR AS NOTED ON THE CONSTRUCTION PLANS.
7. LADDER RUNGS SHALL BE IN ACCORDANCE WITH STANDARD MD-383.91 AND MD-383.92 OR AS DIRECTED BY THE ENGINEER.
8. MINIMUM DEPTH PAYMENT PER "EACH" INLET INCLUDES DEPTHS UP TO 3'-6". VERTICAL DEPTH PAYMENT PER LINEAR FOOT FOR DEPTHS IN EXCESS OF 3'-6".
9. A 6" PERFORATED CIRCULAR PIPE, FOR EROSION AND SEDIMENT CONTROL, SHALL BE PLACED IN THE INLET WALL AT ALL INLET SEDIMENT TRAPS AS SHOWN ON THE PLANS.
10. MINIMUM OF 2 WEEP HOLES TO BE CAST IN BASE UNIT 6" ABOVE FLOW LINE - PVC MAY BE USED (2" MIN. DIAMETER) - COVER OUTSIDE W/ STAINLESS STEEL OR GALVANIZED WIRE CLOTH.

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DEPARTMENT OF PUBLIC WORKS  
*Frank S. ...* 4-12-94  
DIRECTOR DATE

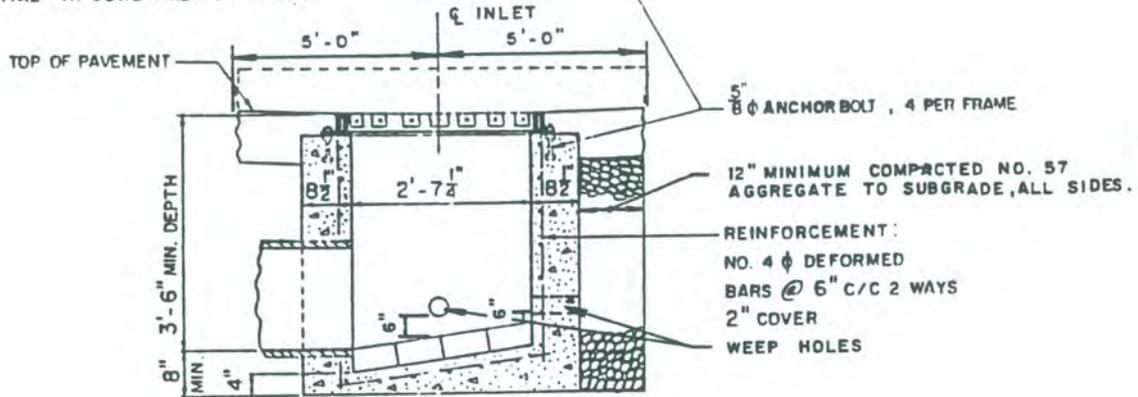
PRECAST  
STANDARD TYPE S INLET  
DOUBLE GRATE TANDEM

PLATE  
66

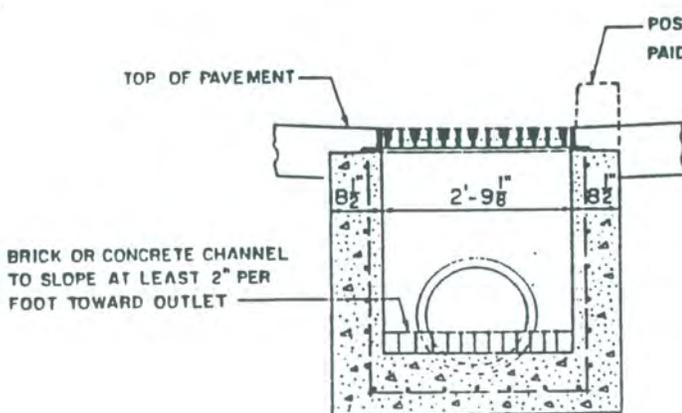


PLACEMENT OF 1/2" EXPANSION MATERIAL IN CURB AREA OF INLET

PLAN



SECTION A-A



SECTION B-B

POSITION OF CURB WHEN REQUIRED - TO BE PAID FOR PER LINEAR FEET OF STANDARD CURB.

NOTES:

1. INLET SHALL BE CONSTRUCTED OF REINFORCED CONCRETE (MIX NO. 2).
2. SIZE, TYPE AND DIRECTION OF OUTLET PIPE WILL VARY TO SUIT EACH CASE AND THE INV. WILL BE ALTERED ACCORDINGLY.
3. BRICK FOR MASONRY, TO COMPLY WITH THE LATEST S.H.A. SPECIFICATIONS.
4. IF LADDER RUNGS ARE REQUIRED, SEE STANDARD MD.-383.91 OR MD-383.92.
5. PLACE 1/2" PREFORMED EXPANSION MATERIAL IN CURB, 5' EITHER SIDE OF CENTERLINE INLET.
6. TRANSITION CURB GUTTER AT 1:1 TO TIE INTO FRONT EDGE OF FRAME. (SEE PLAN SECTION)
7. BRICK FOR CONSTRUCTION OF INLET MAY ONLY BE USED IF AUTHORIZED BY DEPT. OF PUBLIC WORKS.

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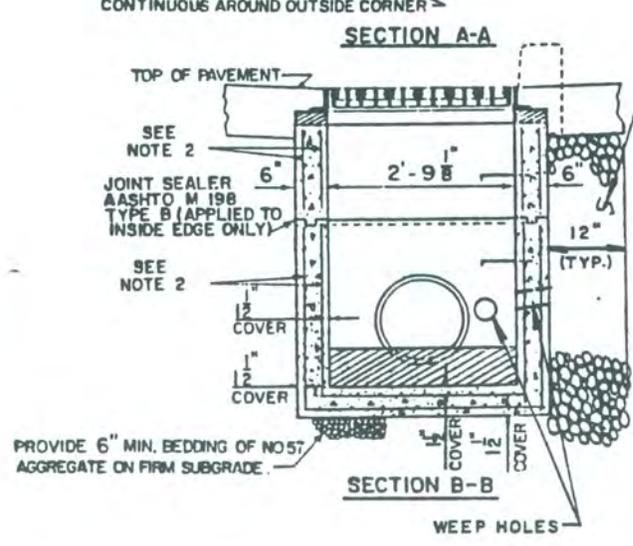
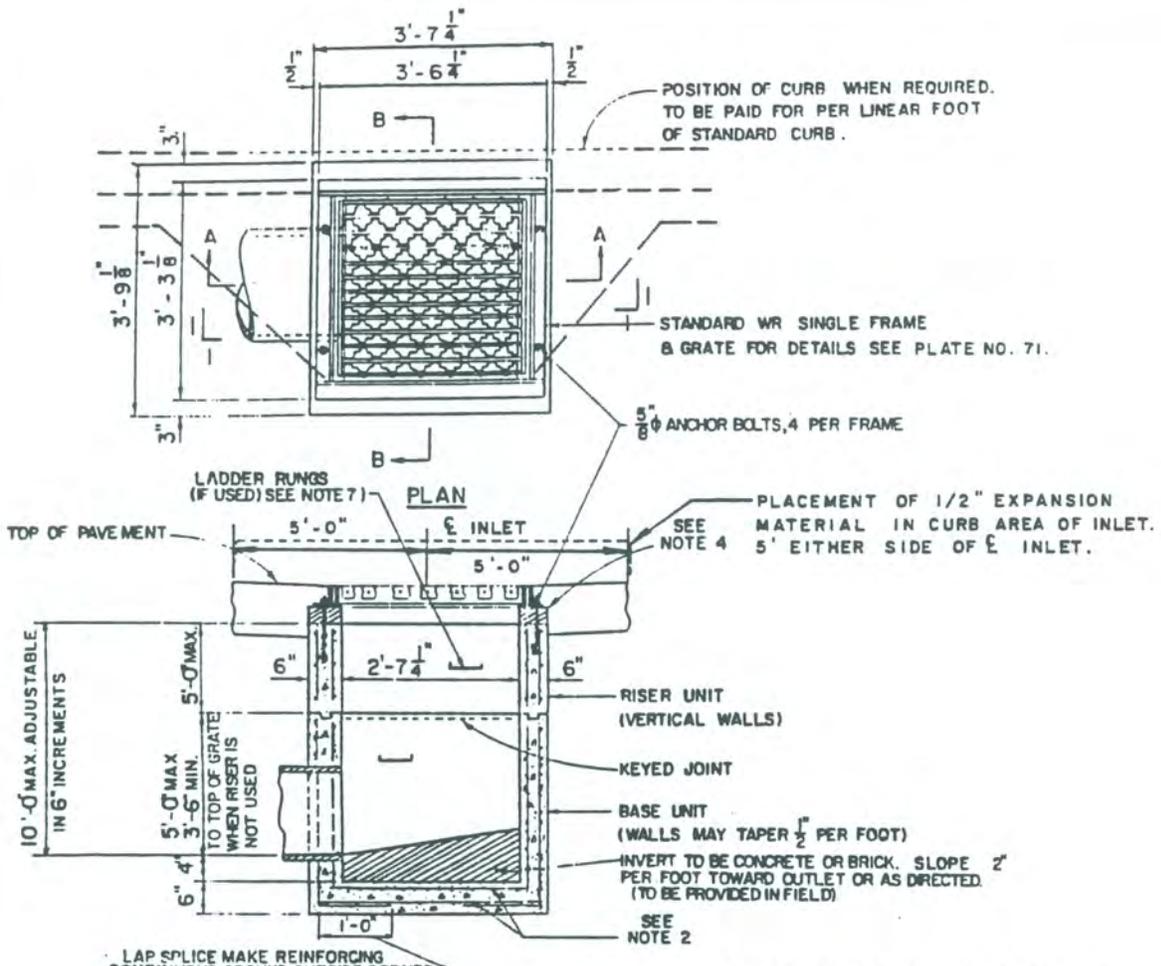
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DEPARTMENT OF PUBLIC WORKS

SINGLE WR INLET

*K. D. ...* 4-12-44  
DIRECTOR DATE

PLATE

67



- NO. 57 AGGREGATE TO SUBGRADE, ALL SIDES.
- GENERAL NOTES**
1. CONCRETE TO BE MIX NO. 6 (4500PSI).
  2. REINFORCING-2 LAYERS OF 4X4-W 40 X W 4.0 WELDED WIRE FABRIC.
  3. THREADED PLASTIC INSERTS TO BE PROVIDED FOR HANDLING.
  4. GRADE AND SLOPE ADJUSTMENTS COMPLETED IN THE FIELD USING CONCRETE MIX NO. 6 OR BRICK AND MORTAR.
  5. PIPE OPENINGS TO BE PROVIDED AS REQUIRED, FOR SIZE, LOCATION AND INVERT ELEVATIONS REFER TO CONSTRUCTION PLANS.
  6. PLACEMENT OF SUBGRADE DRAINAGE WILL BE AS DIRECTED BY THE ENGINEER OR AS NOTED ON THE CONSTRUCTION PLANS.
  7. LADDER RUNGS SHALL BE IN ACCORDANCE WITH STANDARD MD-383.01, AND MD-383.92 OR AS DIRECTED BY THE ENGINEER.
  8. MINIMUM DEPTH PAYMENT PER EACH INLET INCLUDES DEPTHS UP TO 3'-6". VERTICAL DEPTH PAYMENT PER LINEAR FOOT FOR DEPTHS IN EXCESS OF 3'-6".
  9. MINIMUM OF 2 WEEP HOLES 2" MIN. DIAMETER PLACED 6" ABOVE INVERT PER BASE UNIT. COVER OUTSIDE WITH STAINLESS STEEL OR GALVANIZED WIRE MESH.
  10. EXPANSION PLACED IN CURB AS DETAILED IN SECTION A-A.

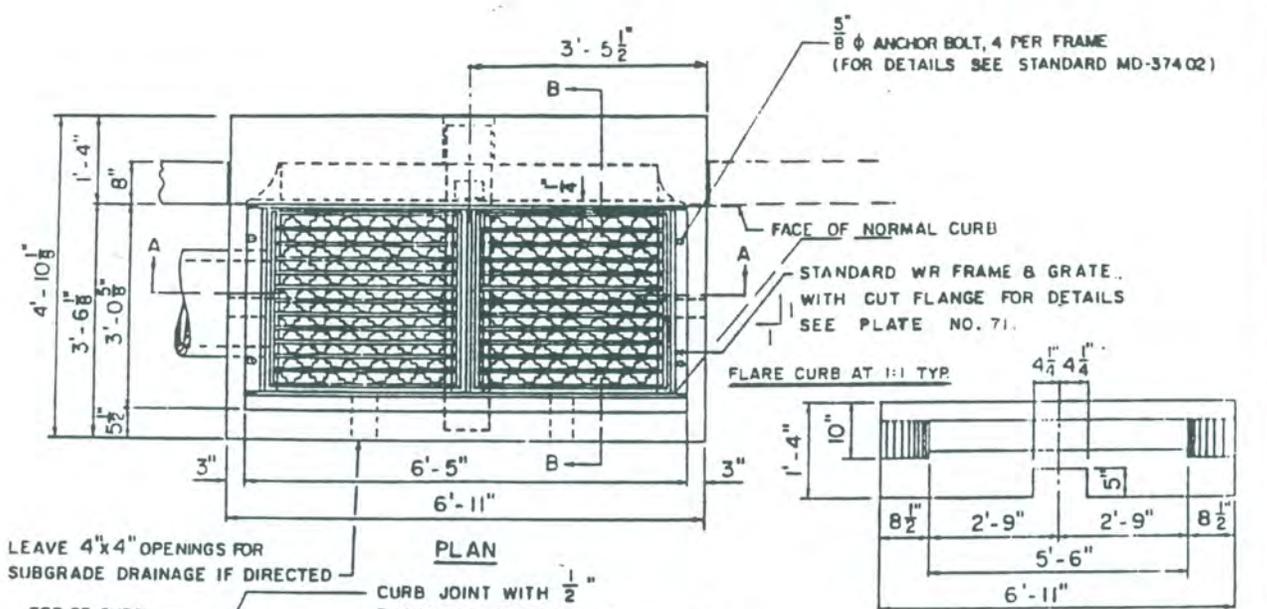
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*W. St. ...* 4-12-94  
DIRECTOR DATE

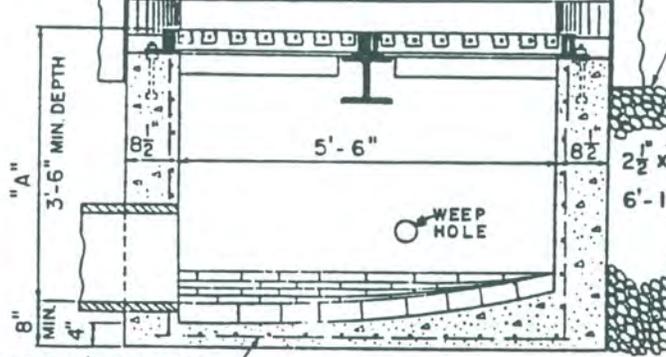
PRECAST  
SINGLE WR INLET

PLATE  
68



LEAVE 4"x4" OPENINGS FOR SUBGRADE DRAINAGE IF DIRECTED

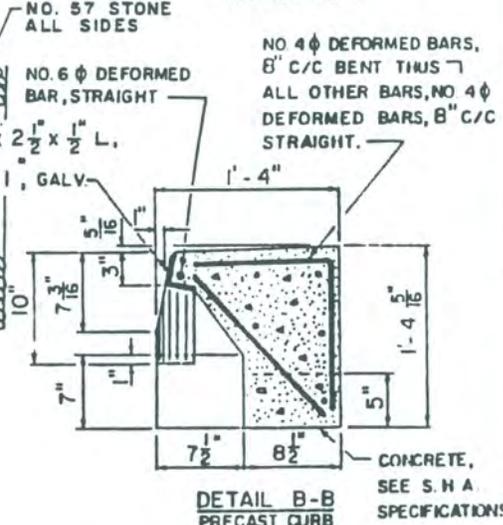
TOP OF CURB CURB JOINT WITH 1/2" EXPANSION MATERIAL



REINFORCEMENT: NO. 4  $\phi$  DEFORMED BARS @ 6" C/C 2 WAYS 2" COVER

SECTION A-A

FRONT ELEVATION PRECAST CURB

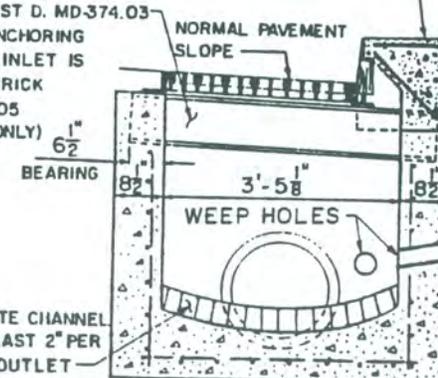


DETAIL B-B PRECAST CURB

CONCRETE, SEE S.H.A. SPECIFICATIONS

WB X 3I (GALVANIZED) SUPPORT BEAM 4'-6 1/8" LONG FOR DETAILS SEE STD. MD-374.03 FOR METHOD OF ANCHORING SUPPORT BEAM IF INLET IS CONSTRUCTED OF BRICK SEE STD. MD-374.05 (FOR INLET REPAIR ONLY)

SPECIAL PRECAST CURB (SEE DETAIL B-B)



SECTION B-B

BRICK OR CONCRETE CHANNEL TO SLOPE AT LEAST 2" PER FOOT TOWARD OUTLET

- NOTES:
1. INLET SHALL BE CONSTRUCTED OF REINFORCED CONCRETE MIX NO. 2. SIZE, TYPE, AND DIRECTION OF INLET CONNECTION WILL VARY TO SUIT CONDITIONS. SEE S.H.A. SPECIFICATION FOR INLETS.
  2. REINFORCEMENT REQUIRED ON OUTSIDE, AS WELL AS ON INSIDE, OF WALLS BELOW 7'-0" WHEN "A" IS GREATER THAN 7'-0" SPACING, SAME AS FOR INSIDE WALL.
  3. BRICK FOR MASONRY TO COMPLY WITH THE S.H.A. SPECIFICATIONS.
  4. FOR UNDEPRESSED INLETS, USE NORMAL PAVEMENT SLOPE.
  5. LADDER RUNGS ARE REQUIRED SEE STANDARD MD-383.91 OR MD-383.92.
  6. BRICK FOR CONSTRUCTION OF INLET MAY ONLY BE USED IF AUTHORIZED BY DEPARTMENT OF PUBLIC WORKS.
  7. A 6" PERFORATED CIRCULAR PIPE, FOR EROSION AND SEDIMENT CONTROL, SHALL BE PLACED IN THE INLET WALL AT ALL INLET SEDIMENT TRAPS AS SHOWN ON THE PLANS.
  8. MINIMUM OF 2 WEEP HOLES TO BE CAST IN BASE UNIT 6" ABOVE FLOW LINE - PVC MAY BE USED (2" MIN. DIAMETER) - COVER OUTSIDE WITH STAINLESS STEEL OR GALVANIZED WIRE CLOTH.

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PLATE

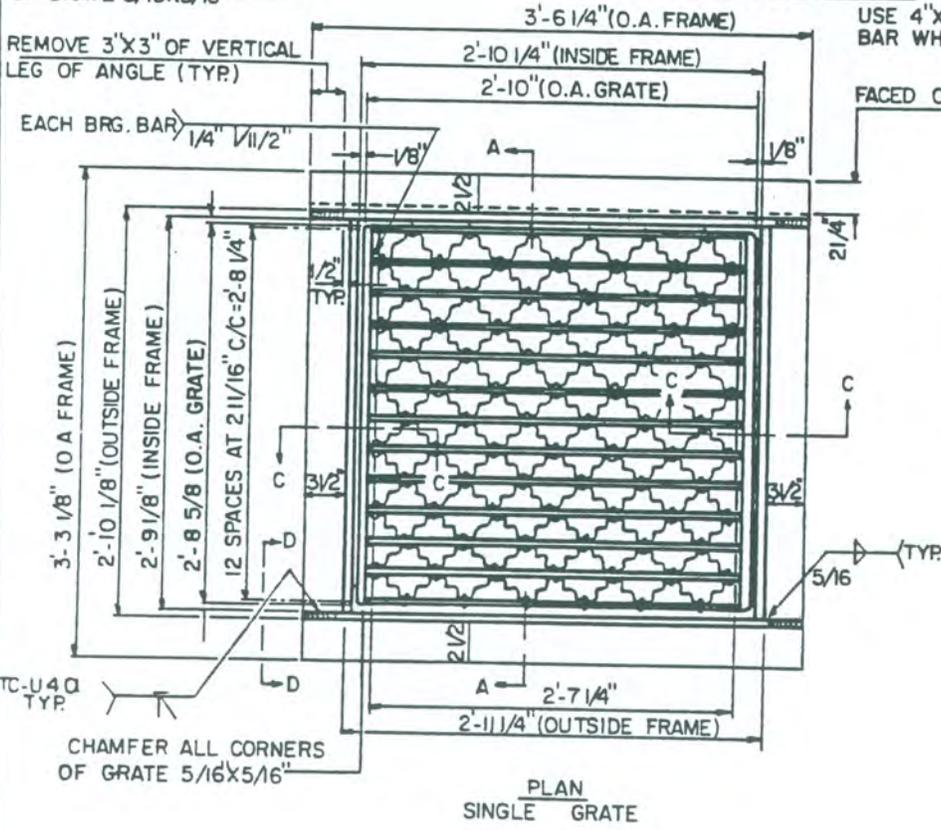
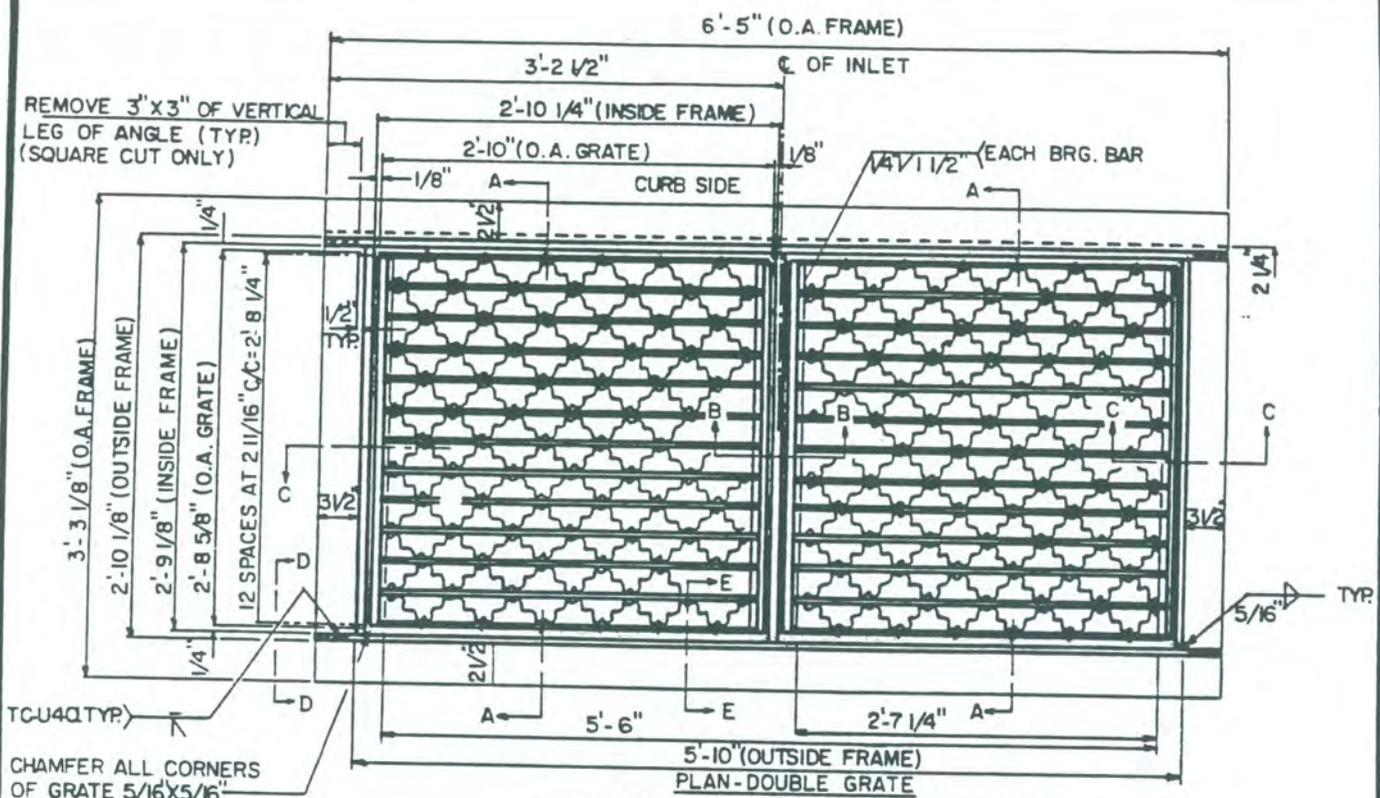
69

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*Carroll County* 4-12-94  
DIRECTOR DATE

STANDARD WR INLET





- REMOVE 3"X3" OF VERTICAL LEG OF ANGLE (TYP) (SQUARE CUT ONLY)
- REMOVE 3"X3" OF VERTICAL LEG OF ANGLE (TYP)
- CHAMFER ALL CORNERS OF GRATE 5/16X5/16"
- CHAMFER ALL CORNERS OF GRATE 5/16X5/16"
- TC-U4Q TYP
- TC-U4Q TYP
- USE 4"X 1/2" FLAT BAR WHEN OPEN
- FACED CURB IS USED
- GENERAL NOTES**
1. FRAMES & GRATES TO BE SQUARE FLAT & TRUE.
  2. STRUCTURAL STEEL SHALL BE A.S.T.M. DESIGNATION A-36.
  3. FRAMES & GRATES TO BE GALVANIZED AFTER FABRICATION IN ACCORDANCE WITH A.S.T.M. DESIGNATION A-123 EXCEPT FOR ADHERENCE WHICH SHALL BE IN ACCORDANCE WITH A.S.T.M. DESIGNATION A-153.

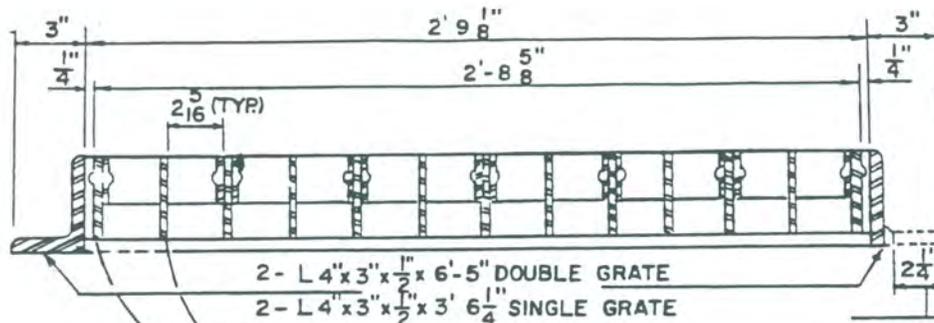
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PLATE	

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DEPARTMENT OF PUBLIC WORKS

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STANDARD WR INLET  
FRAME AND GRATE



SECTION A-A

USE 4" x 1/2" FLAT BAR WHEN OPEN FACED CURB IS USED

13- 3 1/2" x 3/8" x 2'-9" Bearing Bars (Per Grate)

2- 3 1/2" x 1/2" x 2'-8 5/8" Band Bars (Per Grate)

12- 2" x 1/8" Reticular Bars (Per Grate)

3/8"  $\phi$  Rivets (Flat Or Round Head)

@ 5" C/C In 13/32"  $\phi$  Holes

Chamber Bottom Of

Band Bars 5/16 x 5/16

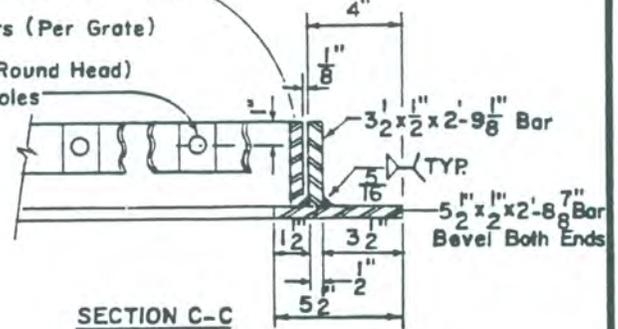
3 1/2" x 1/2" x 2'-9 1/8" Bar

3 1/2" x 1/2" x 2'-8 7/8" Bar

Bevel Both Ends

$\zeta$  Of Inlet

SECTION B-B



SECTION C-C

NOTE 'B' - Weld 3 1/2" x 1/2" x 2'-8 7/8" Bar To 4" x 3" x 1/2" L Before Welding 3 1/2" x 1/2" x 2'-9 1/8" Bar

NOTE 'A' - Weld 5 1/2" x 1/2" Bar To 4" x 3" x 1/2" L Before Welding 3 1/2" x 1/2" Bar

TC-U4a NOTE 'A'

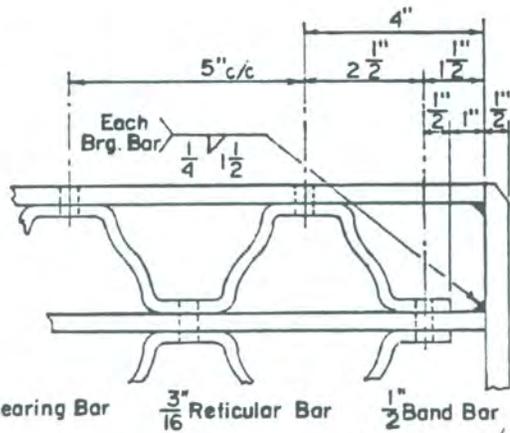
TC-U4a NOTE 'B'

5 1/2" x 1/2" x 2'-8 7/8" Bar Bevel Both Ends

3 1/2" x 1/2" x 2'-8 7/8" Bar Bevel Both Ends

SECTION E-E (Shown Without Grate)

SECTION D-D



GRATING DETAIL

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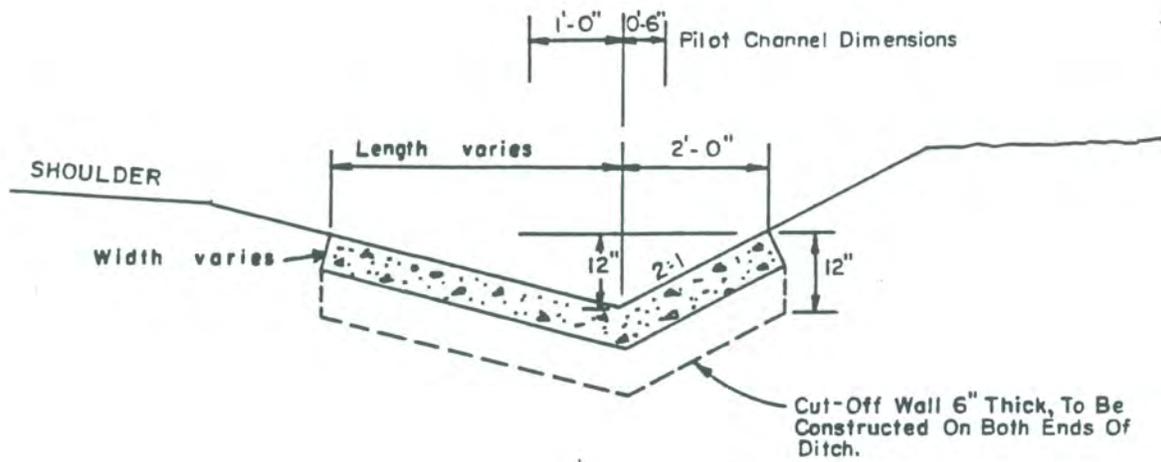
PLATE

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STANDARD WR INLET FRAME AND GRATE (SECTIONAL VIEW)

*[Signature]* 4-12-94  
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Notes:

1. Mix No. 2 Concrete.
2. Expansion Joints (1/2" Non-Extruding) 100' Maximum.
3. Contraction Joints At 10' C.C.
4. 1/4" Radius On Top Edge Of Concrete.
5. Check Walls, 6" Thick And 6" Deep, To Be Constructed To The Full Width Of The Concrete Ditch At 50' Intervals, Approximately Halfway Between Expansion Joints On Grades Of 5% Or More.

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PLATE

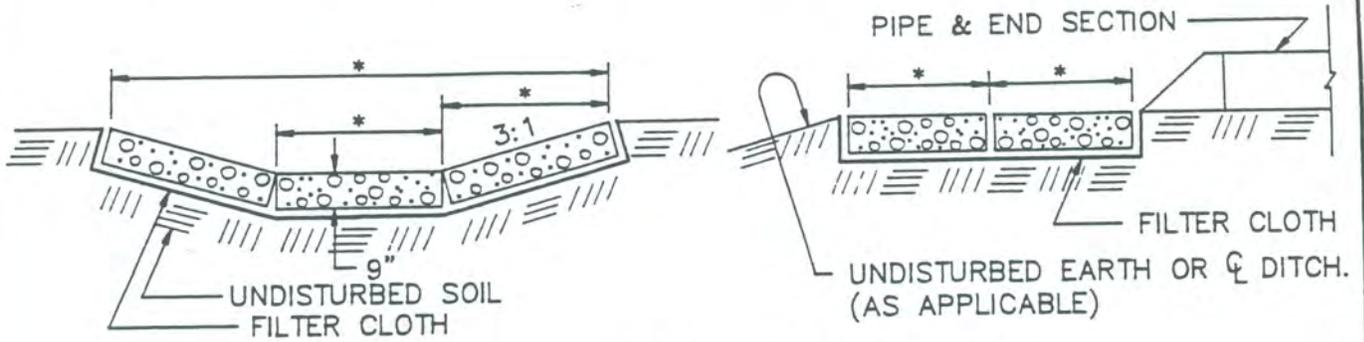
73

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DEPARTMENT OF PUBLIC WORKS

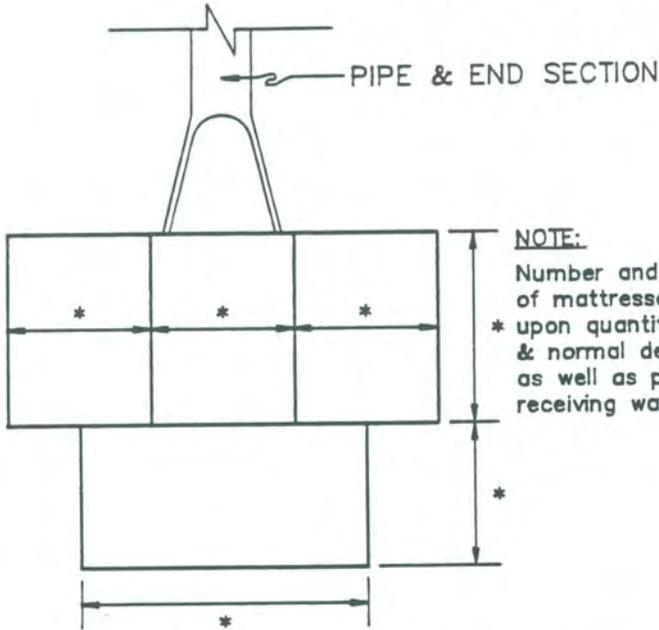
CONCRETE SIDE  
DITCH

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DIRECTOR DATE

**SAMPLE DETAIL - OUTFALL PROTECTION**



\* ACTUAL DIMENSIONS SHALL BE SHOWN



**NOTE:**  
 Number and placement of mattresses dependent upon quantity, velocities, & normal depth of flows as well as pipe size and receiving watercourse.

GENERAL NOTES:

1. ALL MATTRESSES MUST BE PVC COATED.
2. ALL MATTRESSES SHALL BE PLACED ON FILTER CLOTH.
3. EACH INSTALLATION SHALL SHOW A LAYOUT DIAGRAM GIVING SIZE AND LOCATION OF EACH BASKET.
4. STONE SHALL BE 4"-6"(NOM.)
5. MATERIALS AND SPECIFICATIONS NOT COVERED ABOVE SHALL BE IN ACCORDANCE WITH THE MANUFACTURERS RECOMMENDATIONS.

LENGTH	WIDTH	No. of THICKNESS	No. of CELLS	AREA SQUARE YARDS	CAPACITY CUBIC YARDS
9'	6'	9"	3	6	1.5
12'	6'	9"	4	8	2

SPECIFICATIONS PVC COATED	
Mesh opening	Hex. nom. $2\frac{1}{2}$ " x $3\frac{1}{4}$ "
Wire for netting	0.0866" nom. diam. plus nom. 0.02165" PVC
Wire for selvages	0.1062" nom. diam. plus nom. 0.02165" PVC
Wire for binding	0.0866" nom. diam. plus nom. 0.02165" PVC
Zinc coating	0.70 ozs. per sq.ft. plus nom. 0.02165" PVC
Minimum thickness of PVC coating shall be not less than 0.015".	

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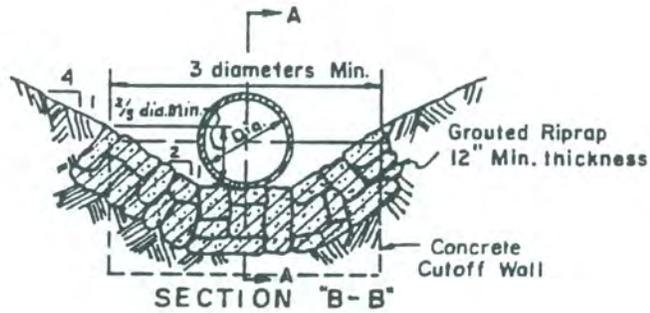
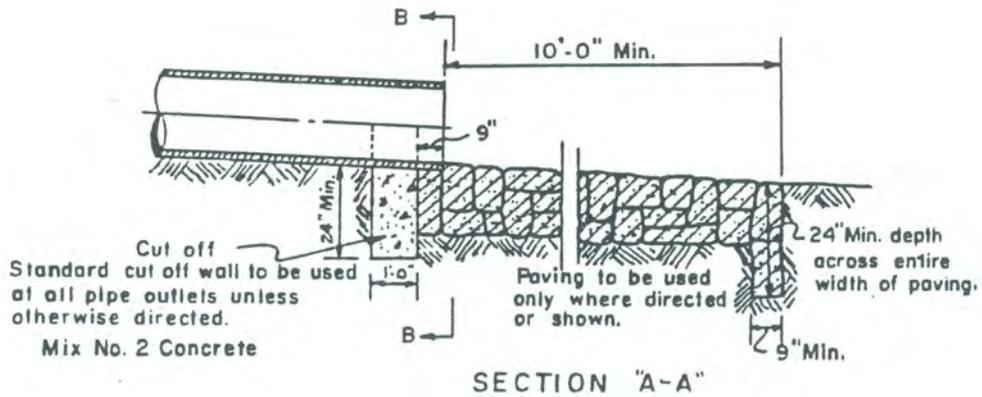
*Keith C. ...* 4-12-94  
 DIRECTOR DATE

STONE OUTFALL PROTECTION

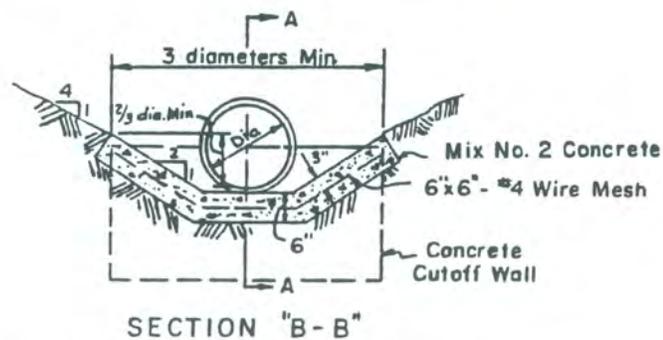
PLATE

74

When concrete paving is used wire mesh shall be extended down into cutoff wall at lower end of paving.



CUTOFF WALL AND RIPRAP PAVING



CUTOFF WALL AND CONCRETE PAVING

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DATE	BY

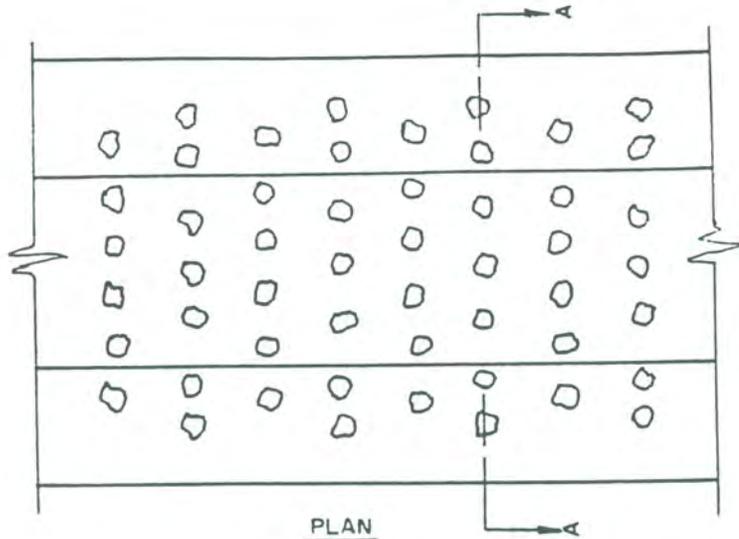
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DIRECTOR DATE

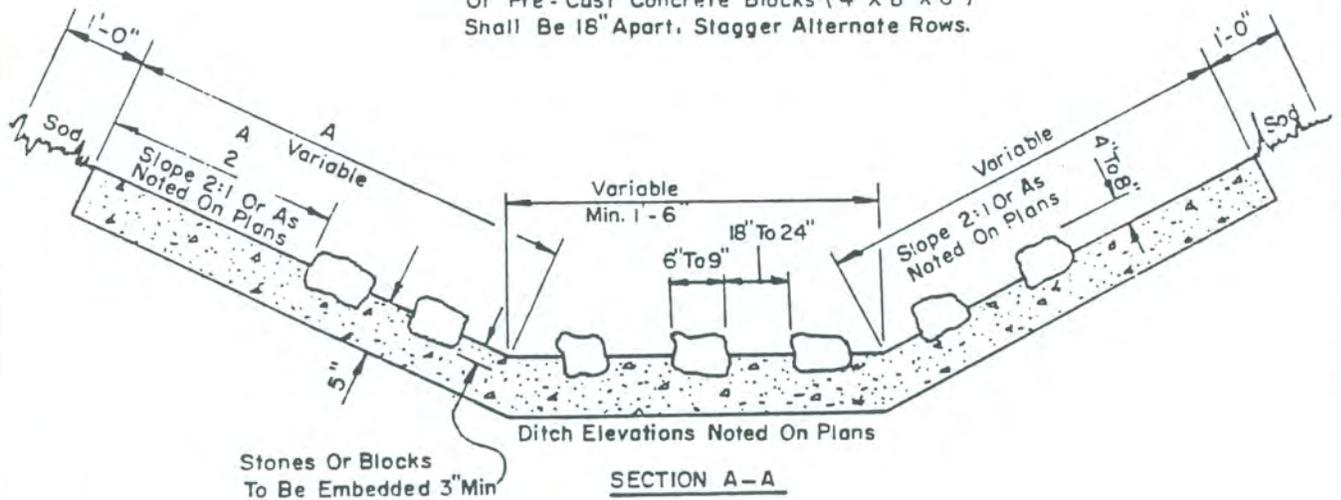
CUTOFF WALL & PAVING

PLATE

75



Note: Row Of Stones (As Shown Below)  
 Or Pre - Cast Concrete Blocks (4" X 8" X 8")  
 Shall Be 18" Apart, Stagger Alternate Rows.



Ditch Elevations Noted On Plans

Stones Or Blocks  
 To Be Embedded 3" Min

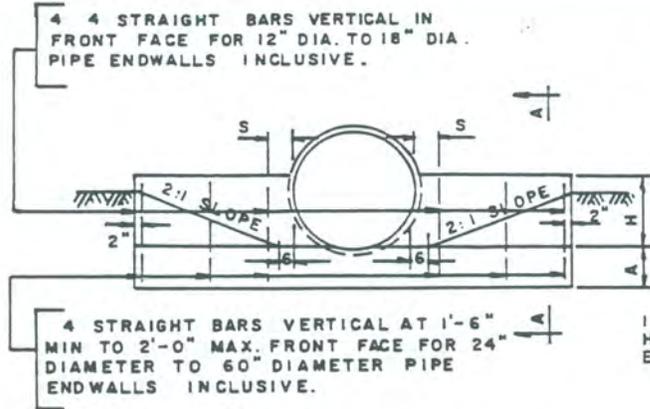
SECTION A-A

General Note:  
 All Dimensions And Locations  
 Not Indicated, For Items Appearing  
 On This Sheet Or On The Plans,  
 Shall Be Directed By The Engineer.

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DATE	BY
PLATE	
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5" CONCRETE ENERGY  
 DISSIPATING GUTTER



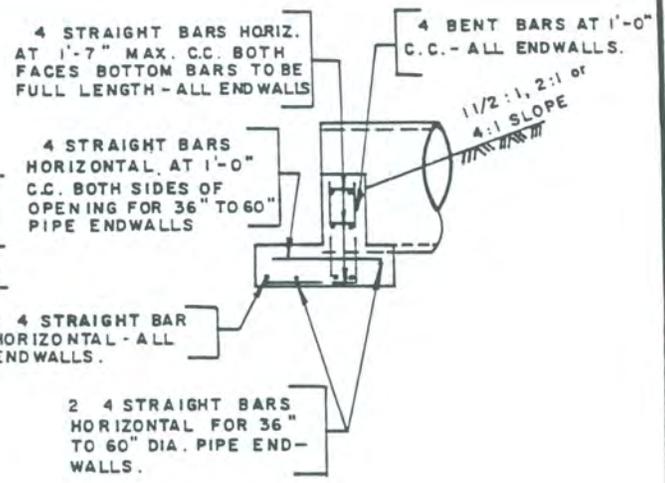
"S" DISTANCES FROM INSIDE SURFACE OF PIPE TO VERTICAL BARS IN FRONT AND REAR FACE

4" FOR 12" DIA. TO 18" DIA. PIPES INCL.

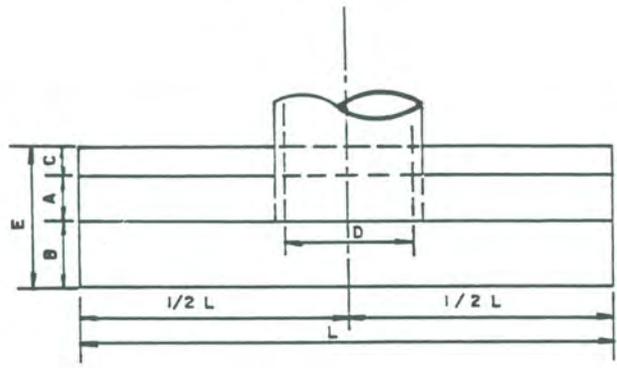
6" FOR 24" DIA. TO 36" DIA. PIPES INCL.

8" FOR 42" DIA. TO 60" DIA. PIPES INCL.

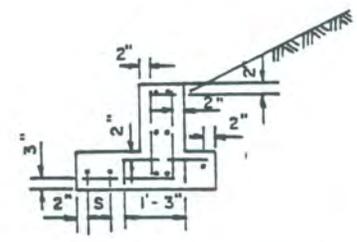
ELEVATION



SECTION A-A



PLAN



DISPOSITION OF BARS  
DETAIL

Openings -		Dimensions						Volume Conc.	Steel
D	Area	A	B	C	E	H	L	C.Y.	Lbs.
Inches	Sq. Ft.								
12	0.79	9"	6"	6"	1'-9"	0'-10"	4'-0"	0.27	19
15	1.23	9"	6"	6"	1'-9"	1'-0"	4'-9"	0.34	23
18	1.78	9"	6"	6"	1'-9"	1'-3"	5'-6"	0.41	29
24	3.14	9"	14"	6"	2'-5"	1'-6"	7'-0"	0.69	38
30	4.91	9"	14"	6"	2'-5"	1'-9"	8'-6"	0.88	58
36	7.07	12"	16"	10"	3'-2"	2'-0"	10'-0"	1.74	90
42	9.62	12"	16"	10"	3'-2"	2'-3"	11'-6"	2.07	99
48	12.57	12"	16"	10"	3'-2"	2'-6"	13'-0"	2.43	119
54	15.90	12"	20"	12"	3'-8"	2'-9"	14'-6"	3.08	132
60	19.64	12"	20"	12"	3'-8"	3'-0"	16'-0"	3.50	158

Quantities in Table to be used for Estimating Only

General Notes

- Concrete : See Specifications
- Reinforcing : Deformed steel bars + 4 bars (1/2" dia)
- Chamfer : All exposed edges 1x1 or as directed

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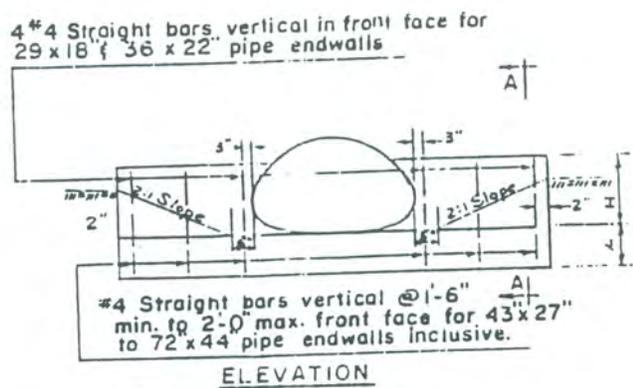
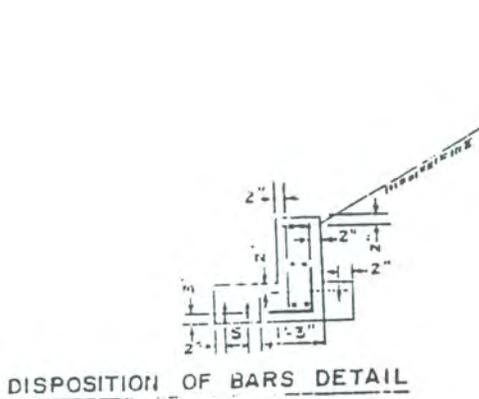
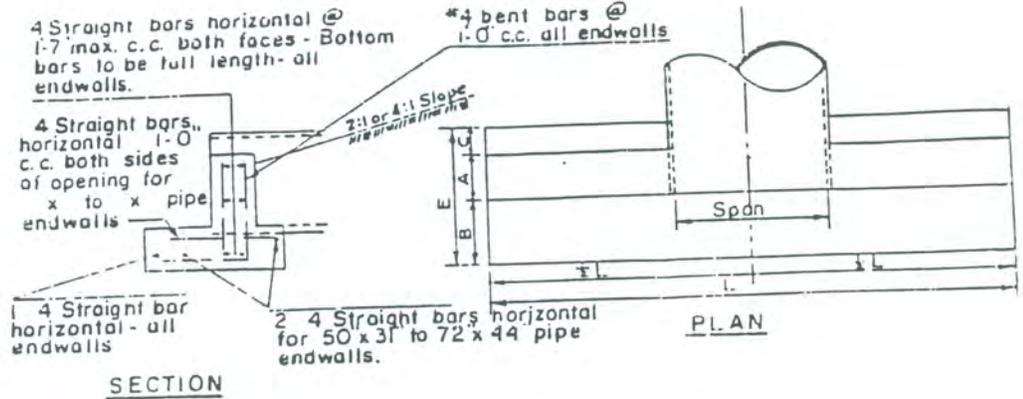
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DIRECTOR DATE

STANDARD END SUPPORT  
WALL ROUND PIPE

PLATE

77



"S" Distances  
 6" for 29"x18" to 43"x27" incl.  
 8" for 50"x31" to 72"x44" incl.

**GENERAL NOTES**

Concrete Reinforcing Chamfer See Specifications Deformed Steel bars - 4 bars ( # ) All exposed edges 1"x1" or as directed

**QUANTITIES FOR ESTIMATING PURPOSES ONLY**

OPENING		DIMENSIONS						QUANTITIES	
SIZE	AREA	A	B	C	E	H	L	CONC. C.Y.	STEEL LBS.
INCHES S X R	SQ. FT.								
28x20	3.14	9"	14"	6"	2'-5"	1'-2"	5'-11"	.50	33
35x24	4.91	9"	14"	6"	2'-5"	1'-5"	7'-5"	.65	37
42x29	7.07	12"	16"	10"	3'-2"	1'-8"	8'-10"	1.32	54
49x33	9.62	12"	16"	10"	3'-2"	1'-11"	10'-4"	1.59	77
57x38	12.57	12"	16"	10"	3'-2"	2'-2"	12'-1"	1.92	90
64x43	15.90	12"	20"	12"	3'-8"	2'-6"	13'-7"	2.51	102
71x47	19.64	12"	20"	12"	3'-8"	2'-9"	15'-1"	2.86	112

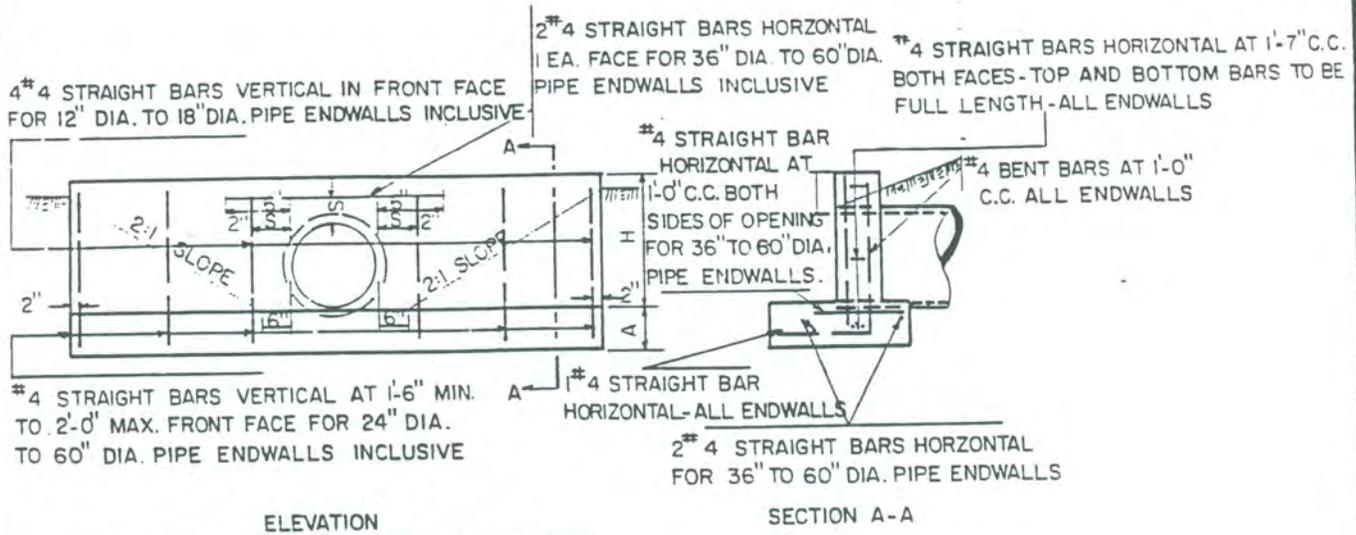
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DATE	BY

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STANDARD END SUPPORT  
 WALL ARCH PIPE

PLATE  
 78

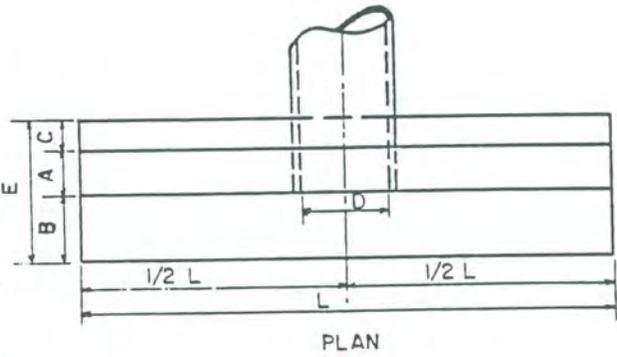


"S" DISTANCES FROM INSIDE SURFACE OF PIPE TO VERTICAL BARS IN FRONT AND FACE.

4" FOR 12" DIA. TO 18" DIA. PIPES INCL.

6" FOR 24" DIA. TO 36" DIA. PIPES INCL.

8" FOR 42" DIA. TO 60" DIA. PIPES INCL.



GENERAL NOTES

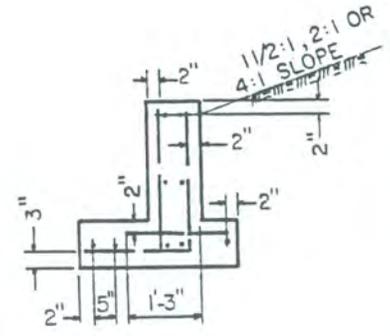
CONCRETE : SEE SPECIFICATIONS

REINFORCING : DEFORMED STEEL BARS - #4 BARS (1/2"  $\phi$ )

CHAMFER : ALL EXPOSED EDGES 1"X1" OR AS DIRECTED.

OPENINGS		DIMENSIONS							VOL. STEEL	
D INCHES	AREA SQ. FT.	A	B	C	E	F	H	L	CONC. C.Y.	LBS.
12	0.79	9"	6"	6"	1'-9"	9"	1'-9"	6'-6"	0.61	38
15	1.23	9"	6"	6"	1'-9"	9"	2'-0"	7'-9"	0.78	55
18	1.78	9"	6"	6"	1'-9"	9"	2'-3"	9'-0"	0.95	62
24	3.14	9"	14"	6"	2'-5"	9"	2'-9"	11'-6"	1.56	91
30	4.91	9"	14"	6"	2'-5"	12"	3'-6"	14'-2"	2.19	136
36	7.07	12"	16"	10"	3'-2"	12"	4'-0"	16'-8"	4.18	222
42	9.62	12"	16"	10"	3'-2"	12"	4'-6"	19'-2"	5.13	265
48	12.57	12"	16"	10"	3'-2"	12"	5'-0"	21'-8"	6.12	326
54	15.90	12"	20"	12"	3'-8"	12"	5'-6"	24'-2"	7.68	384
60	19.64	12"	20"	12"	3'-8"	12"	6'-0"	26'-8"	8.86	428

QUANTITIES IN TABLE TO BE USED FOR ESTIMATING ONLY



CARROLL COUNTY, MARYLAND  
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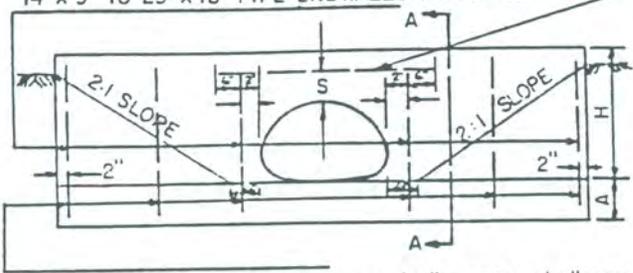
STANDARD TYPE 'C'  
ENDWALL ROUND PIPE

REVISED	
DATE	BY
PLATE	
79	

*L. S. ... 1-12-91*

4 #4 STRAIGHT BARS VERTICAL IN FRONT FACE FOR 14" X 9" TO 29" X 18" PIPE ENDWALLS INCLUSIVE

2 #4 STRAIGHT BARS HORIZONTAL, 1 EACH FACE FOR 50" X 31" TO 72" X 44" PIPE ENDWALLS INCLUSIVE



4 #4 STRAIGHT BARS HORIZONTAL AT 1'-7" C.C. BOTH FACES - TOP AND BOTTOM BARS TO BE FULL LENGTH - ALL ENDWALLS

4 #4 STRAIGHT BARS VERTICAL AT 1'-6" MIN. TO 2'-0" MAX. FROM FACE FOR 36" X 22" TO 22" X 44" PIPE ENDWALLS INCLUSIVE

ELEVATION

"S" DISTANCES

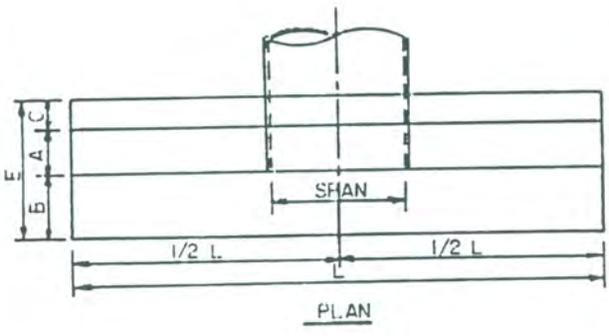
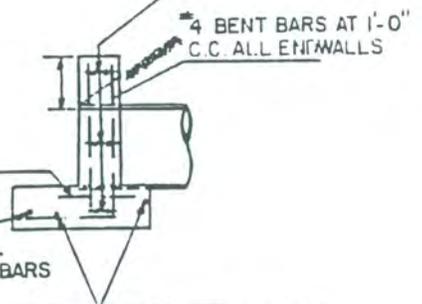
4" FOR 14" X 9" TO 22" X 13" INCL.  
6" FOR 29" X 18" TO 43" X 27" INCL.  
8" FOR 50" X 31" TO 72" X 44" INCL.

4 #4 STRAIGHT BAR HORIZONTAL AT 1'-0" C.C. BOTH SIDES OF OPENING FOR 50" X 31" TO 72" X 44" PIPE ENDWALLS INCLUSIVE

1 #4 STRAIGHT BAR HORIZONTAL ALL BARS

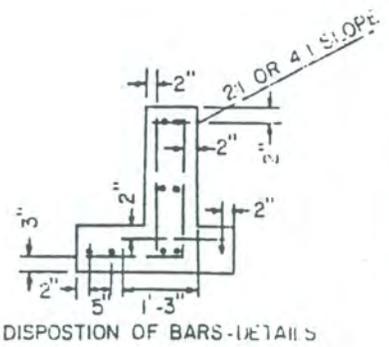
2 #4 STRAIGHT BARS HORIZONTAL FOR 50" X 31" TO 72" X 44" PIPE ENDWALLS, INCL.

SECTION A-A



QUANTITIES FOR ESTIMATING PURPOSES ONLY

OPENING		DIMENSIONS							QUANTITIES	
D	AREA	A	B	C	E	F	H	L	CONC.	STEEL
INCHES S X R	SQ. FT.								C.Y.	LBS.
17 X 13	1.23	9"	6"	6"	1'-9"	6"	1'-9"	6'-3"	0.54	38
21 X 15	1.77	9"	6"	6"	1'-9"	11"	2'-2"	9'-6"	0.98	56
24 X 18	2.40	9"	6"	6"	1'-9"	8"	2'-2"	9'-6"	0.96	55
28 X 20	3.14	9"	6"	6"	1'-9"	9"	2'-4"	9'-6"	0.96	55
35 X 24	4.91	9"	14"	6"	2'-5"	14"	3'-2"	13'-8"	1.98	96
42 X 29	7.07	9"	14"	6"	2'-5"	9"	3'-2"	13'-8"	1.92	95
49 X 33	9.62	12"	16"	10"	3'-2"	14"	3'-11"	17'-11"	4.34	186
57 X 38	12.57	12"	16"	10"	3'-2"	10"	4'-0"	17'-11"	4.73	186
64 X 43	15.90	12"	20"	12"	3'-8"	13"	4'-8"	21'-9"	6.27	243
71 X 47	19.64	12"	20"	12"	3'-8"	10"	4'-9"	21'-9"	6.05	243



DISPOSITION OF BARS - DETAILS

GENERAL NOTES

CONCRETE : SEE SPECIFICATIONS  
REINFORCING : DEFORMED STEEL BARS #4 BARS, (1/2" Φ)  
CHAMFER : ALL EXPOSED EDGES 1" X 1" OR AS DIRECTED.

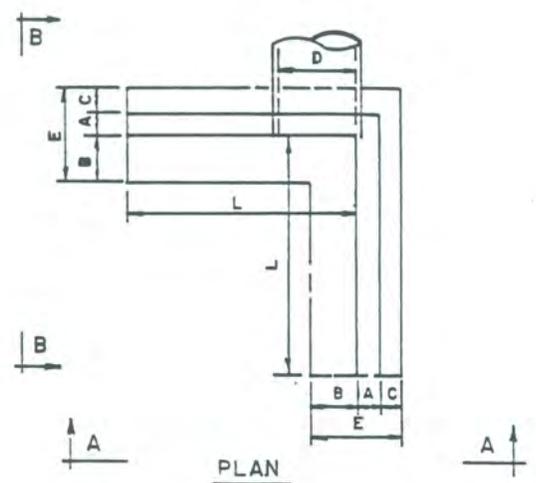
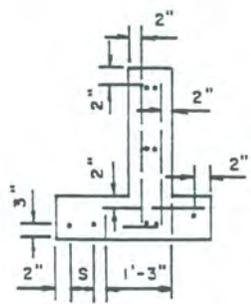
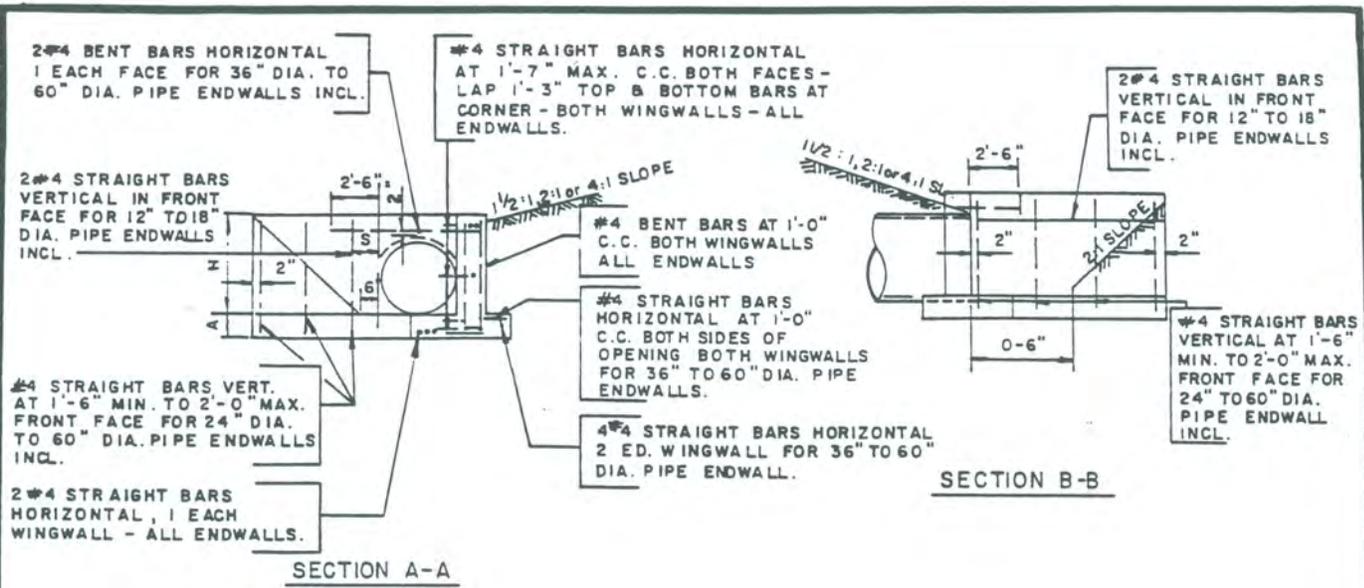
CARROLL COUNTY, MARYLAND  
DEPARTMENT OF PUBLIC WORKS

*W. S. ...* 4-12-94  
DIRECTOR DATE

STANDARD TYPE C  
ENDWALL ARCH PIPE

PLATE

80



Openings		Dimensions						Volume		Steel
D	Area	A	B	C	E	H	L	Conc.	Lbs.	
inches	Sq. Ft.							C.Y.		
12	0.799	9-0	6-0	6	1-9	1-9	3-6	0.73	56	
15	1.23	9-0	6-0	6	1-9	2-0	4-3	0.93	77	
18	1.78	9-0	6-0	6	1-9	3-3	5-0	1.14	89	
24	3.14	9-0	6-0	6	2-5	2-9	6-6	1.8	124	
30	4.91	9-0	6-0	6	2-5	3-6	8-0	2.6	160	
36	7.07	9-0	6-0	10	3-2	4-0	9-6	5.0	287	
42	9.62	12-0	10-0	10	3-2	4-6	11-0	6.2	333	
48	12.57	12-0	10-0	10	3-2	5-0	12-6	7.4	387	
54	15.90	12-0	20-0	12	3-8	5-6	14-0	9.2	458	
60	19.64	12-0	20-0	12	3-8	6-0	15-6	10.7	519	

Quantities in Table to be used for Estimating Only

S Distances from inside surface of pipe to vertical bars in front and rear face  
 4" for 12" Dia to 18" Dia pipes incl.  
 6" for 24" Dia to 36" Dia pipes incl.  
 8" for 42" Dia to 60" Dia pipes incl.

**GENERAL NOTES**

- Concrete : See specifications.
- Reinforcing : Deformed steel bars - 4 bars ( $\frac{1}{2}\phi$ )
- Chamfer : All exposed edges 1x1 or as directed.

REVISION	
DATE	BY

CARROLL COUNTY, MARYLAND  
 DEPARTMENT OF PUBLIC WORKS  
*[Signature]* 4-12-94  
 DIRECTOR DATE

**STANDARD TYPE E ENDWALL  
 ROUND PIPE**

PLATE  
 81

2#4 BENT BARS, HORIZONTAL  
1 EACH FACE FOR 50" X 31" TO  
72" X 44" ENDWALLS, INCL.

#4 STRAIGHT BARS HORIZONTAL AT  
1'-7" MAX. C.C. BOTH FACES - LAP 1'-3"  
TOP & BOTTOM BARS AT CORNER - BOTH  
WINGWALLS - ALL ENDWALLS.

2#4 STRAIGHT BARS  
VERTICAL IN  
FRONT FACE FOR  
14" X 9" TO  
29" X 18" ENDWALLS  
INCL.

2:1 or 4:1 SLOPE

#4 BENT BARS AT 1'-0"  
C.C. BOTH WINGWALLS ALL  
ENDWALLS

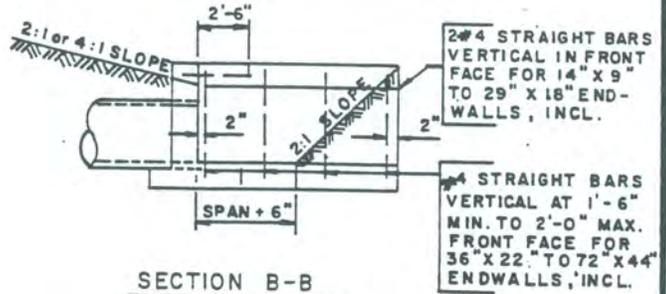
#4 STRAIGHT BARS HORIZONTAL AT  
1'-0" C.C. BOTH SIDES OF OPENING FOR  
BOTH WINGWALLS FOR 50" X 31" TO  
72" X 44" ENDWALLS INCL.

#4 STRAIGHT BARS VERTICAL  
AT 1'-6" MIN. TO 2'-0" MAX.  
FRONT FACE FOR 36" X 22"  
TO 72" X 44" ENDWALLS, INCL.

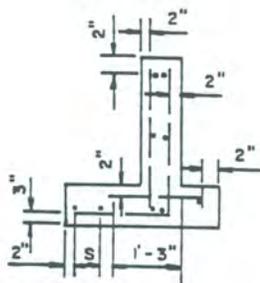
4#4 STRAIGHT BARS HORIZONTAL,  
2 EACH WINGWALL FOR 50" X 31"  
TO 72" X 44" ENDWALLS INCL.

2#4 STRAIGHT BARS  
HORIZONTAL, 1 EACH  
WINGWALL - ALL ENDWALL

SECTION A-A

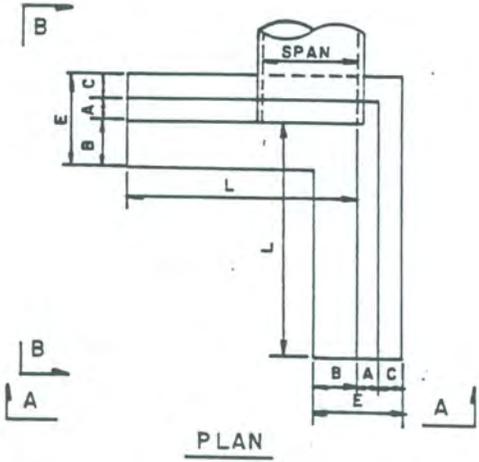


SECTION B-B



DISPOSITION OF BARS DETAIL  
GENERAL NOTES

- Concrete : See Specifications
- Reinforcing : Deformed steel bars 4 bars (1/2" o)
- Chamfer : All exposed edges 1" X 1"



PLAN

QUANTITIES FOR ESTIMATING PURPOSES

OPENING		DIMENSIONS							QUANTITIES	
D	AREA	A	B	C	E	F	H	L	CONC.	STEEL
INCHES	S.F.								CY.	LBS.
S X R										
17x13	1.23	9"	6"	6"	1'-9"	6"	1'-9"	6'-3"	0.54	38
21x15	1.77	9"	6"	6"	1'-9"	11"	2'-2"	9'-6"	0.98	56
24x18	2.40	9"	6"	6"	1'-9"	8"	2'-2"	9'-6"	0.96	55
28x20	3.14	9"	6"	6"	1'-9"	9"	2'-4"	9'-6"	0.96	55
35x24	4.91	9"	14"	6"	2'-5"	14"	3'-2"	8'-8"	1.98	96
42x29	7.07	9"	14"	6"	2'-5"	9"	3'-2"	13'-8"	1.92	95
49x33	9.62	12"	16"	10"	3'-2"	14"	3'-11"	17'-11"	4.34	186
57x38	12.57	12"	16"	10"	3'-2"	10"	4'-0"	17'-11"	4.73	186
64x43	15.90	12"	20"	12"	3'-8"	13"	4'-8"	21'-9"	6.27	243
71x47	19.64	12"	20"	12"	3'-8"	10"	4'-9"	21'-9"	6.05	243

"S" DISTANCES  
 4" for 14" x 9" to 22" x 13" incl.  
 6" for 29" x 18" to 43" x 27" incl.  
 8" for 50" x 31" to 72" x 44" incl.

REVISED	
DATE	BY

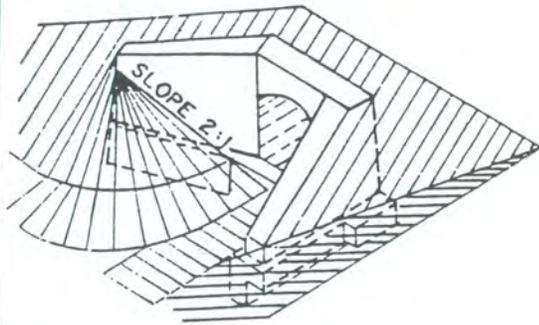
CARROLL COUNTY, MARYLAND  
DEPARTMENT OF PUBLIC WORKS

STANDARD TYPE E  
ENDWALL ARCH PIPE

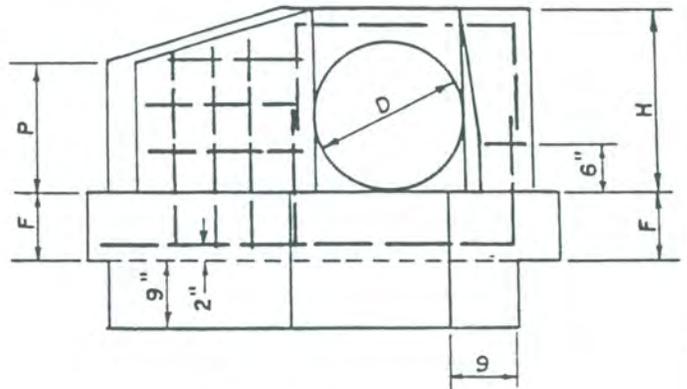
*C. S. Stankard* 4-12-11  
DIRECTOR DATE

PLATE

82



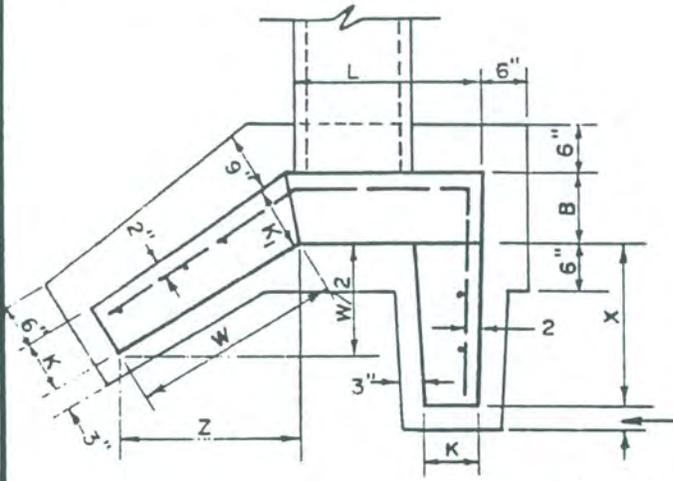
ISOMETRIC VIEW



ELEVATION

STEEL IN WINGS

VERT. 3/4"  $\phi$  BARS 12" C.C.  
 HOR. 1/2"  $\phi$  BARS 12" C.C.  
 HOOKED ON ONE END



PLAN

1 1/2 : 1 SLOPE = 9"  
 2 : 1 SLOPE = 12"  
 4 : 1 SLOPE = 24"

CONCRETE, MIX No. 2 (AIR-ENTRAINED)  
 REINFORCEMENT, DEFORMED STEEL BARS.  
 CHAMFER ALL EXPOSED EDGES 1" x 1"  
 OR AS DIRECTED.

SLOPE 1 1/2 : 1											
OPENING		DIMENSIONS FOR CONCRETE									
PIPE DIA.	AREA	ENDWALLS					WINGS				
		L	B	F	H	W	X	Z	K	K	P
12"	0.79	1'-9"	9"	9"	1'-8"	2'-0"	1'-3"	1'-9"	9"	7"	1'-4"
15"	1.23	2'-0"	9"	9"	2'-0"	2'-4"	1'-9"	2'-0"	9"	7"	1'-5"
16"	1.39	2'-1"	9"	9"	2'-0"	2'-4"	1'-9"	2'-0"	9"	7"	1'-5"
18"	1.78	2'-3"	9"	9"	2'-3"	2'-8"	2'-1"	2'-4"	9"	8"	1'-6"
24"	3.14	3'-0"	12"	9"	2'-11"	3'-6"	2'-11"	3'-0"	12"	11"	2'-1"
30"	4.91	3'-6"	12"	9"	3'-6"	4'-4"	3'-9"	3'-9"	12"	11"	2'-4"
36"	7.07	4'-0"	12"	9"	4'-0"	5'-0"	4'-6"	4'-4"	12"	11"	2'-7"
42"	9.62	4'-6"	12"	9"	4'-7"	5'-9"	5'-4"	5'-0"	12"	11"	2'-1"
48"	12.57	5'-0"	12"	9"	5'-1"	6'-4"	6'-2"	5'-6"	12"	11"	3'-3"

SLOPE 2 : 1												SLOPE 4 : 1											
OPENING		DIMENSIONS FOR CONCRETE										OPENING		DIMENSIONS FOR CONCRETE									
D	SQ FT	ENDWALLS					WINGS					PIPE DIA.	AREA	ENDWALLS					WINGS				
		L	B	F	H	W	X	Z	K	K	P			L	B	F	H	W	X	Z	K	K	P
12"	0.79	1'-9"	9"	9"	1'-7"	2'-3"	1'-10"	2'-0"	9"	7"	1'-3"	12"	0.79	1'-9"	9"	9"	1'-5"	2'-6"	3'-8"	2'-2"	9"	8"	1'-3"
15"	1.23	2'-0"	9"	9"	1'-11"	2'-6"	2'-6"	2'-2"	9"	8"	1'-5"	15"	1.23	2'-0"	9"	9"	1'-9"	3'-0"	5'-0"	2'-7"	9"	8"	1'-5"
16"	1.39	2'-1"	9"	9"	1'-11"	2'-7"	2'-6"	2'-3"	9"	8"	1'-5"	16"	1.39	2'-1"	9"	9"	1'-9"	3'-0"	5'-0"	2'-7"	9"	8"	1'-5"
18"	1.78	2'-3"	9"	9"	2'-2"	3'-0"	3'-0"	2'-7"	9"	8"	1'-7"	18"	1.78	2'-3"	9"	9"	2'-0"	3'-6"	6'-0"	3'-0"	9"	8"	1'-7"
24"	3.14	3'-0"	12"	9"	2'-9"	4'-0"	4'-0"	3'-5"	12"	11"	2'-1"	24"	3.14	3'-0"	12"	9"	2'-6"	4'-6"	8'-0"	3'-11"	12"	11"	2'-2"
30"	4.91	3'-6"	12"	9"	3'-4"	4'-8"	5'-2"	4'-1"	12"	11"	2'-6"	30"	4.91	3'-6"	12"	9"	3'-1"	5'-6"	10'-4"	4'-9"	12"	11"	2'-7"
36"	7.07	4'-0"	12"	9"	3'-10"	5'-4"	6'-2"	4'-7"	12"	11"	2'-10"	36"	7.07	4'-0"	12"	9"	3'-7"	6'-6"	12'-4"	5'-8"	12"	11"	3'-0"
42"	9.62	4'-6"	12"	9"	4'-5"	6'-4"	7'-4"	5'-6"	12"	11"	3'-2"	42"	9.62	4'-6"	12"	9"	4'-2"	7'-6"	14'-8"	6'-6"	12"	11"	3'-5"
48"	12.57	5'-0"	12"	9"	4'-11"	7'-0"	8'-4"	6'-1"	12"	11"	3'-6"	48"	12.57	5'-0"	12"	9"	4'-8"	8'-3"	16'-8"	7'-2"	12"	11"	3'-10"

CARROLL COUNTY, MARYLAND  
 DEPARTMENT OF PUBLIC WORKS

*[Signature]* 4-12-41  
 DIRECTOR DATE

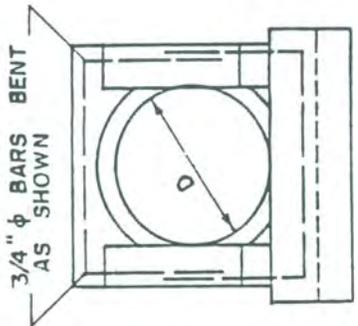
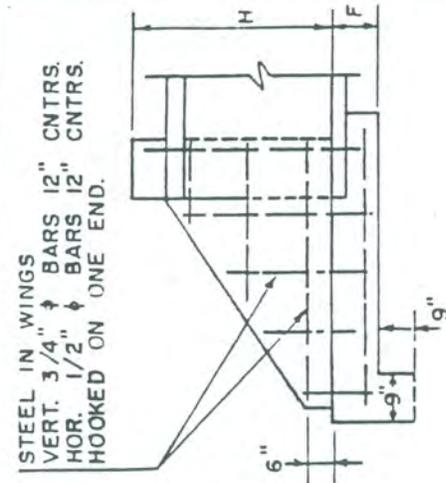
"F" ENDWALL

PLATE

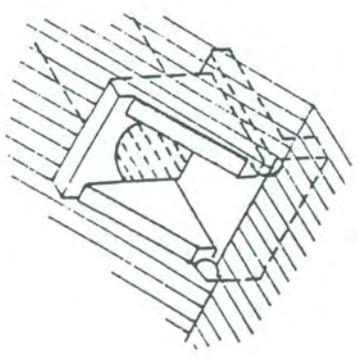
83

CARROLL COUNTY, MARYLAND  
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*W. St. ...*  
DIRECTOR DATE 4-12-94



STEEL IN WINGS  
VERT. 3/4" φ BARS 12" CNTRS.  
HOR. 1/2" φ BARS 12" CNTRS.  
HOOKED ON ONE END.



1 1/2" | SLOPE = 9"  
2 | SLOPE = 12"  
4 | SLOPE = 24"

PLAN

ISOMETRIC VIEW

ELEVATION

SECTION A-A

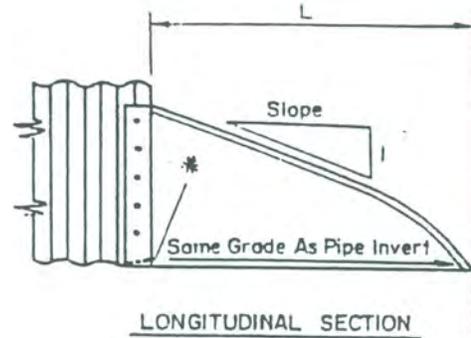
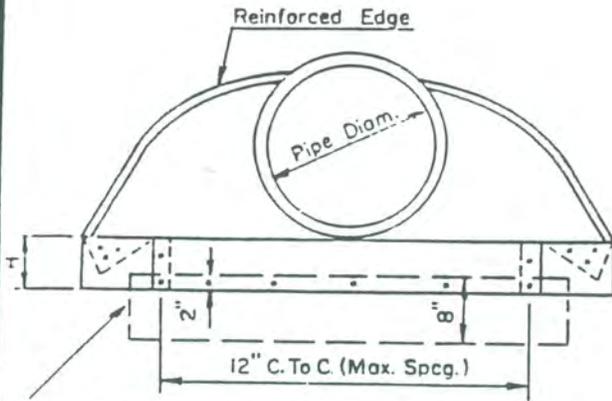
CONCRETE, MIX No. 2 (AIR-ENTRAINED)  
REINFORCEMENT, DEFORMED STEEL BARS  
CHAMFER ALL EXPOSED EDGES 1" x 1" AS DIRECTED.

SLOPE 1 1/2 : 1		SLOPE 2 : 1																				
DIMENSIONS FOR CONCRETE		DIMENSIONS FOR CONCRETE																				
OPENING	D	ENDWALLS						WINGS						OPENING	DIMENSIONS FOR CONCRETE							
		L	B	F	H	W	K	L	B	F	H	W	K		D	L	B	F	H	W	K	
12"	0.79	2'-0"	9"	9"	1'-8"	1'-0"	6"	6"	6"	6"	1'-0"	6"	6"	12"	0.79	2'-0"	9"	9"	1'-7"	1'-4"	6"	6"
15"	1.23	2'-3"	9"	9"	2'-0"	1'-5"	6"	6"	6"	1'-5"	6"	6"	15"	1.23	2'-3"	9"	9"	1'-11"	1'-11"	6"	6"	6"
16"	1.39	2'-4"	9"	9"	2'-0"	1'-6"	6"	6"	6"	1'-6"	6"	6"	16"	1.39	2'-4"	9"	9"	1'-11"	2'-0"	6"	6"	6"
18"	1.78	2'-6"	9"	9"	2'-3"	1'-10"	6"	6"	6"	1'-10"	6"	6"	18"	1.78	2'-6"	9"	9"	2'-2"	2'-6"	6"	6"	6"
24"	3.14	3'-6"	12"	9"	2'-11"	2'-8"	9"	9"	9"	2'-8"	9"	9"	24"	3.14	3'-6"	12"	9"	2'-9"	3'-6"	9"	9"	9"
30"	4.91	4'-0"	12"	9"	3'-6"	3'-6"	9"	9"	9"	3'-6"	9"	9"	30"	4.91	4'-0"	12"	9"	3'-4"	4'-7"	9"	9"	9"
36"	7.07	4'-6"	12"	9"	4'-0"	4'-3"	9"	9"	9"	4'-3"	9"	9"	36"	7.07	4'-6"	12"	9"	3'-10"	5'-8"	9"	9"	9"
42"	9.62	5'-6"	12"	9"	4'-7"	5'-1"	9"	12"	9"	5'-1"	9"	12"	42"	9.62	5'-6"	12"	9"	4'-5"	6'-9"	9"	12"	12"
48"	12.57	6'-0"	12"	9"	5'-1"	5'-1"	9"	12"	9"	5'-1"	9"	12"	48"	12.57	6'-0"	12"	9"	4'-11"	7'-10"	9"	12"	12"

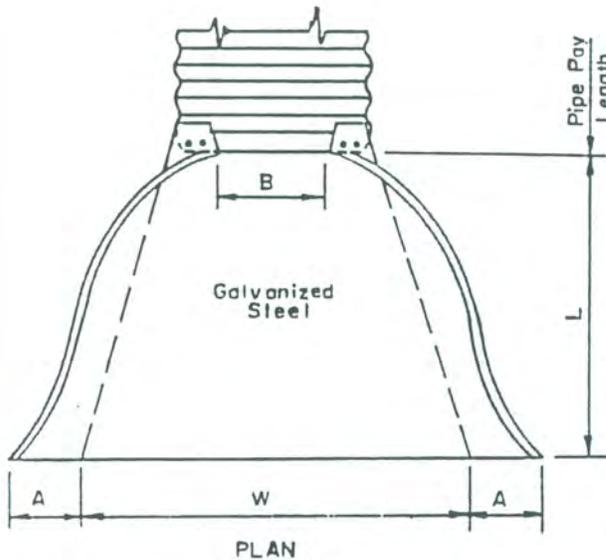
"G" ENDWALL

PLATE

84



\* Invert Elevation To Be At The Pipe End Of The Standard End Section. Elevations To Be Noted On Construction Plans.



Pipe Diam	Ga.	A 1"±	B Max.	H 1"±	L 1/2"±	W 2"±	Approx Slope	Body
12"	16	6"	6"	6"	21"	24"	2 1/2	1 Pc.
15"	16	7"	8"	6"	26"	30"	2 1/2	1 Pc.
18"	16	8"	10"	6"	31"	36"	2 1/2	1 Pc.
21"	16	9"	12"	6"	36"	42"	2 1/2	1 Pc.
24"	16	10"	13"	6"	41"	48"	2 1/2	1 Pc.
30"	14	12"	16"	8"	51"	60"	2 1/2	1 Pc.
36"	14	14"	19"	9"	60"	72"	2 1/2	2 Pc.
42"	12	16"	22"	11"	69"	84"	2 1/2	2 Pc.
48"	12	18"	27"	12"	78"	90"	2 1/4	2 Pc.
54"	12	18"	30"	12"	84"	102"	2	2 Pc.
60"	12	18"	33"	12"	87"	114"	1 3/4	3 Pc.
66"	12	18"	36"	12"	87"	120"	1 1/2	3 Pc.
72"	12	18"	39"	12"	87"	126"	1 1/3	3 Pc.
78"	12	18"	42"	12"	87"	132"	1 1/4	3 Pc.
84"	12	18"	45"	12"	87"	138"	1 1/6	3 Pc.

Notes:

- All 3 Piece Bodies To Have 12 Ga. Sides And 10 Ga. Center Panels. Width Of Center Panels To Be Greater Than 20% Of The Pipe Periphery. Multiple Panel Bodies To Have Lap Seams Which Are To Be Tightly Joined By 3/8" Φ Galvanized Rivets Or Bolts.
- For 60" Thru 84" Sizes, Reinforced Edges To Be Supplemented With Galvanized Stiffener Angles. The Angles Will Be 2" x 2" x 1/4" For 60" Thru 72" Diameter And 2 1/2" x 2 1/2" x 1/4" For 78" And 84" Diameter. The Angles To Be Attached By 3/8" Φ Galvanized Nuts And Bolts.
- Toe Plate Shall Be Used When Specified On The Plans. Cost Of Toe Plate To Be Included In Bid Price Per Each Of Metal End Section.
- Type 3 Connection Includes One Foot Of Pipe Length For 42" Thru 84" Diameter As A Connector Section. The Connector Section Will Be Attached To The End Section By Galvanized Rivets Or Bolts. See Plate No. 87

- Where End Section is To Be Applied To A Structural Plate Pipe, The End Section Shall Be Orderd Without The One Foot Of Pipe Length As Stipulated In Note 4, Instead, Drill Holes And Field Bolt The End Section Directly To The Structural Plate Pipe.

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DATE	BY

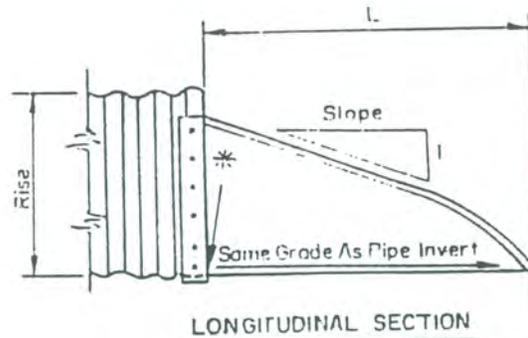
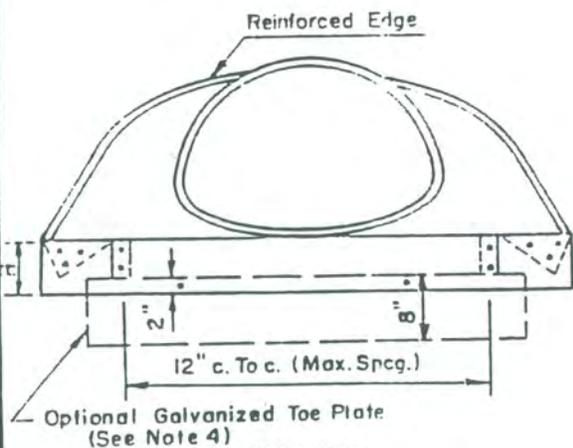
CARROLL COUNTY, MARYLAND  
DEPARTMENT OF PUBLIC WORKS

*[Signature]* 4-12-94  
DIRECTOR DATE

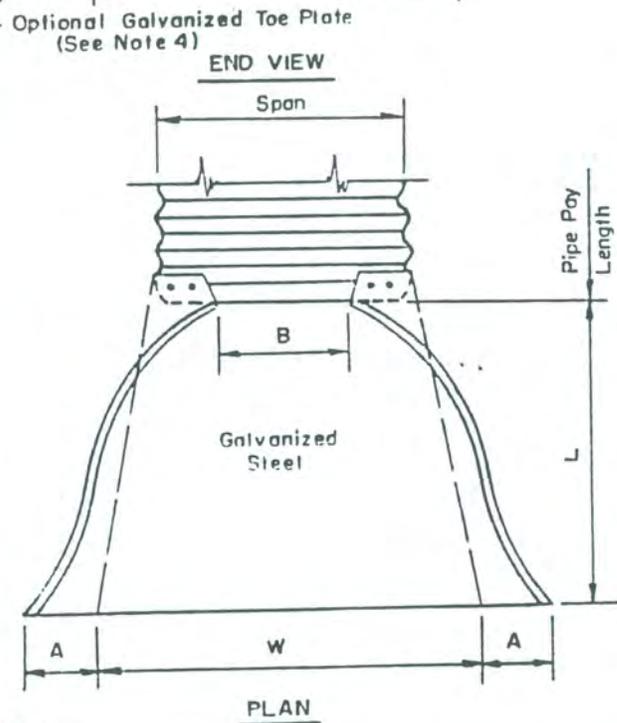
STANDARD METAL END SECTION  
ROUND METAL PIPE

PLATE

85



\* Invert Elevation To Be At The Pipe End Of The Standard End Section. Elevations To Be Noted On Construction Plans



PIPE ARCH DIMENSIONS		DIMENSIONS							
SPAN	RISE	GA.	A 1" ±	B MAX.	H 1" ±	L 1 1/2" ±	W 2" ±	APPROX. SLOPE	UNIT
17"	13"	16	7"	9"	6"	19"	30"	2 1/4	1 PC.
21"	15"	16	7"	10"	6"	23"	36"	2 1/2	1 PC.
24"	18"	16	8"	12"	6"	28"	42"	2 1/2	1 PC.
28"	20"	16	9"	14"	6"	32"	48"	2 1/2	1 PC.
35"	24"	14	10"	16"	6"	39"	60"	2 1/2	1 PC.
42"	29"	14	12"	18"	8"	46"	75"	2 1/2	1 PC.
49"	33"	12	13"	21"	9"	53"	85"	2 1/2	2 PC.
57"	38"	12	18"	26"	12"	63"	90"	2 1/2	2 OR 3 PC.
64"	43"	12	18"	30"	12"	70"	102"	2 1/4	2 OR 3 PC.
71"	47"	12	18"	33"	12"	77"	114"	2 1/4	3 PC.
77"	52"	12	18"	36"	12"	77"	126"	2	3 PC.
83"	57"	12	18"	39"	12"	77"	138"	2	3 PC.

5. Type 3 Connection Includes One Foot Of Pipe Length For 65" X 40" Thru 85" X 54" Diameter As A Connector Section. The Connector Section Will Be Attached To The End Section By Galvanized Rivets Or Bolts.

Notes:

- All 3 Piece Bodies To Have 12 Ga. Sides And 10 Ga. Center Panels. Width Of Center Panels To Be Greater Than 20% Of The Pipe Periphery. Multiple Panel Bodies To Have Lap Seams Which Are To Be Tightly Joined By 3/8" Galvanized Rivets Or Bolts.
- For The 79" X 49" And 85" X 54" Sizes, Reinforced Edge To Be Supplemented By 2" X 2" X 1/4" Galvanized Angles. The Angles To Be Attached By 3/8" Galvanized Nuts And Bolts.
- Angle Reinforcement Will Be Placed Under The Center Panel Seams On The 79" X 49" And 85" X 54" Sizes.
- Toe Plate Shall Be Used When Specified On The Plans. Cost Of Toe Plate To Be Included In Bid Price Per Each Of Metal End Section.

6. Where End Section is To Be Applied To A Structural Plate Arch Pipe, The End Section Shall Be Ordered Without The One Foot Of Pipe Length As Stipulated In Note 5, Instead Drill Holes And Field Bolt The End Section Directly To The Structural Plate Arch Pipe.

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DATE	BY

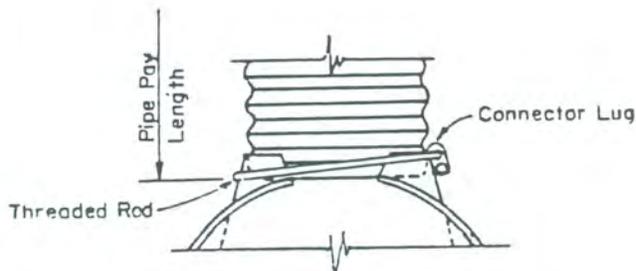
CARROLL COUNTY, MARYLAND  
DEPARTMENT OF PUBLIC WORKS

*[Signature]* 4-12-94  
DIRECTOR DATE

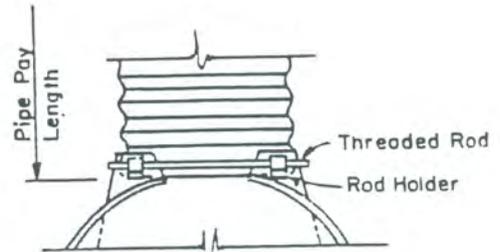
STANDARD METAL END  
SECTION ARCH METAL PIPE

PLATE

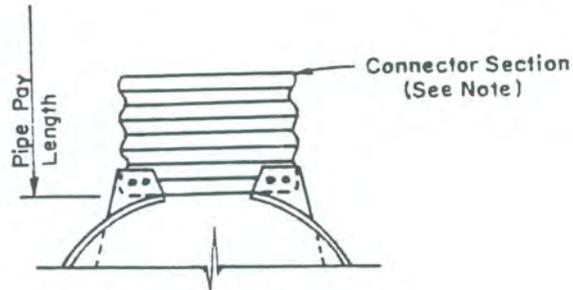
86



**TYPE 1**  
For 12" Thru 24" Only



**TYPE 2**  
For 30" And 36" Only

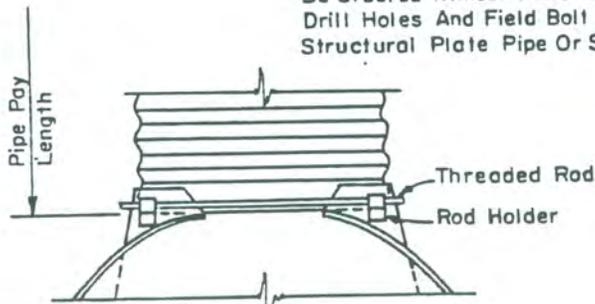


**TYPE 3**  
For 42" Thru 84" Only

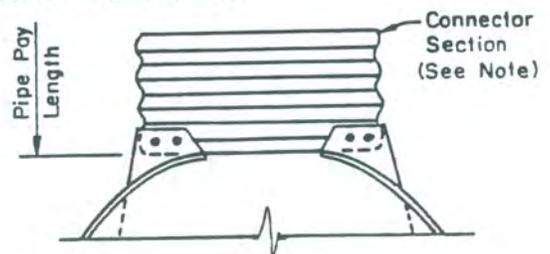
CONNECTIONS FOR ROUND PIPE

Notes:

- A. Type 3 Connection Includes One Foot Of The Pipe Length For 65" X 40" Thru 85" X 54" Sizes As A Connector Section. The Connector Section Will Be Attached To The End Section By Galvanized Rivets Or Bolts.
- B. Where End Section Is To Be Applied To A Structural Plate Pipe Or Structural Plate Arch Pipe The End Section Shall Be Ordered Without The One Foot Of Pipe Length. Instead, Drill Holes And Field Bolt The End Section Directly To The Structural Plate Pipe Or Structural Plate Arch Pipe.



**TYPE 2**  
For 18" X 11" Thru 58" X 36" Only



**TYPE 3**  
For 65" X 40 Thru 85" X 54" Only

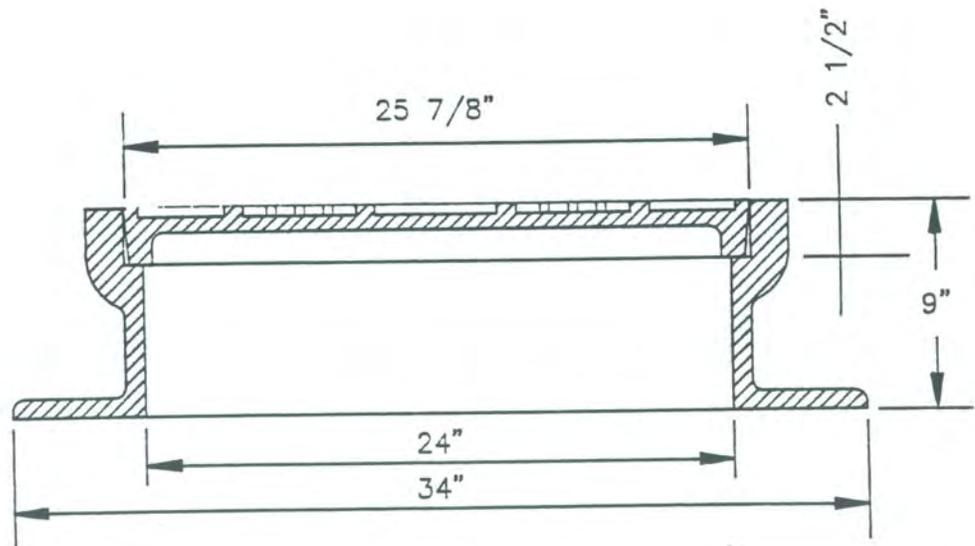
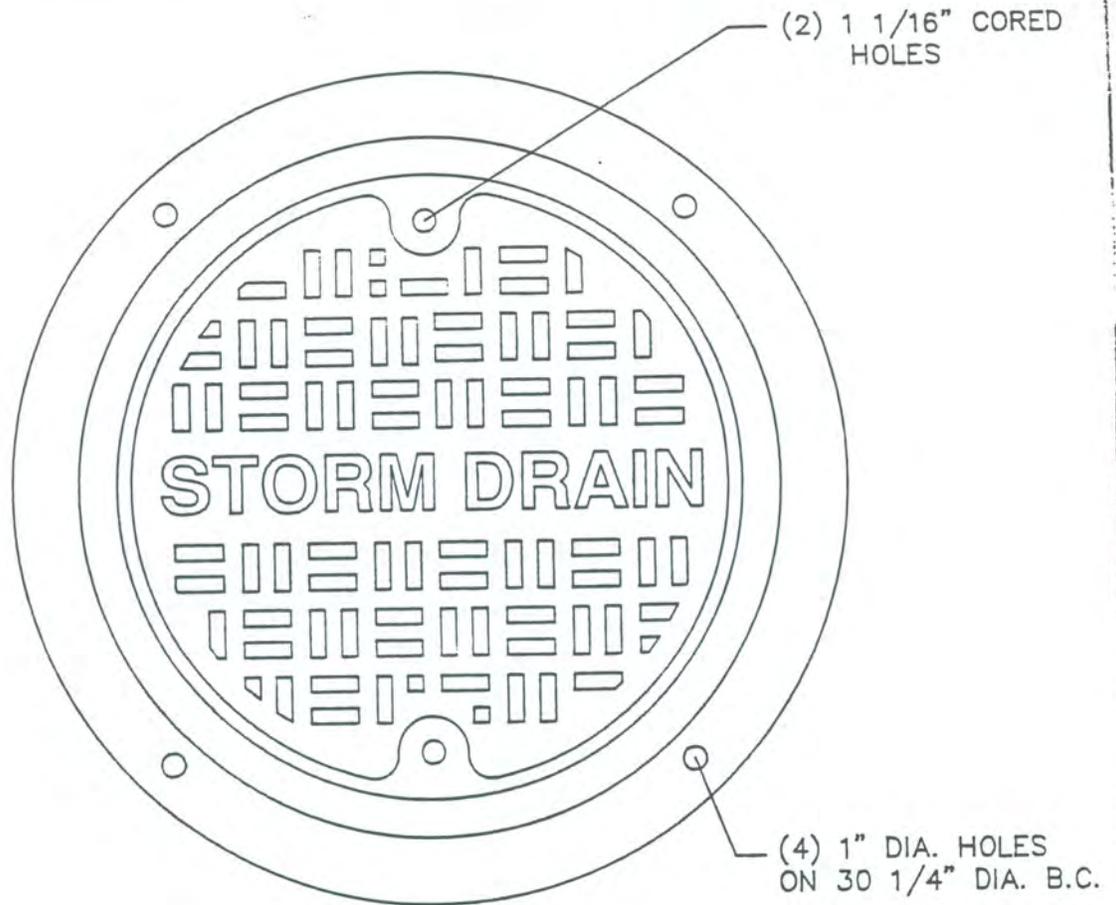
CONNECTIONS FOR ARCH PIPE

REVISED	
DATE	BY
PLATE	

CARROLL COUNTY, MARYLAND  
DEPARTMENT OF PUBLIC WORKS

*[Signature]* 4-12-94  
DIRECTOR DATE

STANDARD CONNECTIONS  
METAL END SECTIONS



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DATE	BY

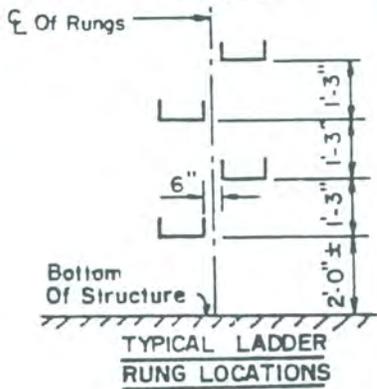
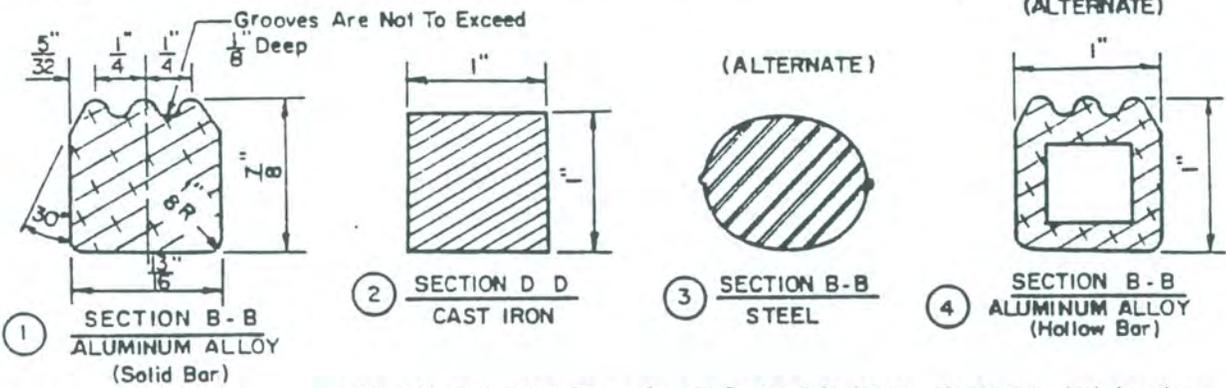
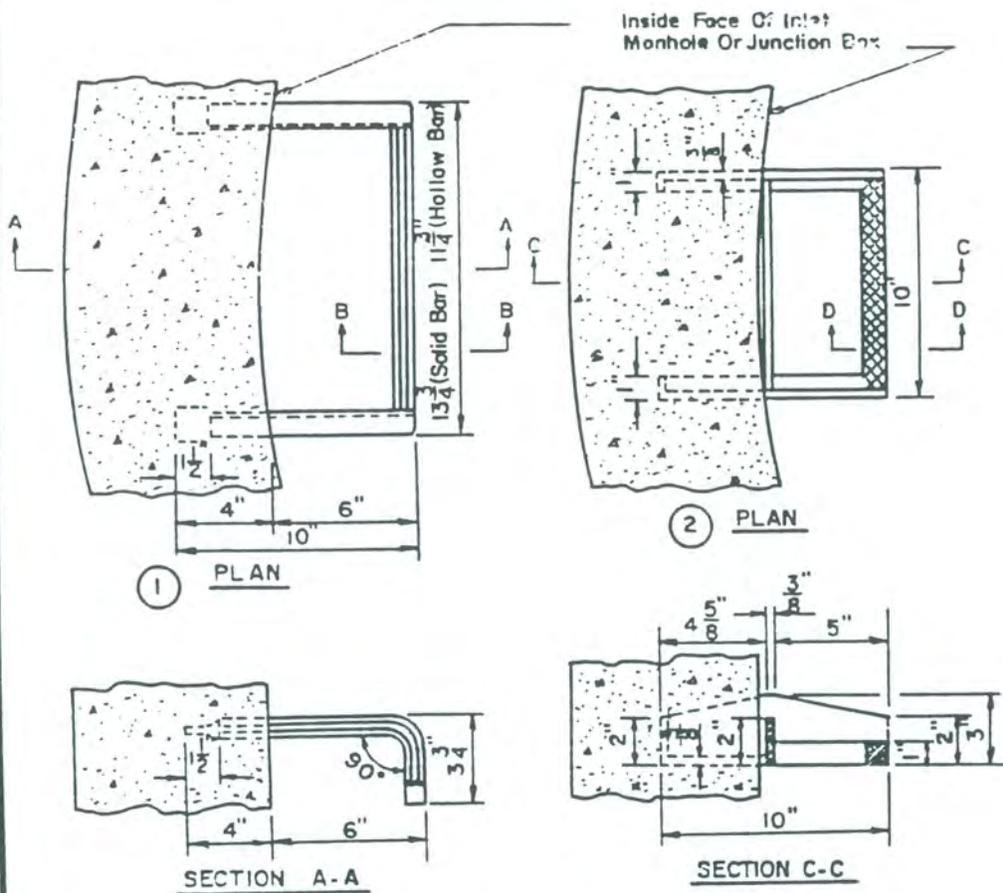
CARROLL COUNTY, MARYLAND  
DEPARTMENT OF PUBLIC WORKS

*W. S. ...* 4-12-94  
DIRECTOR DATE

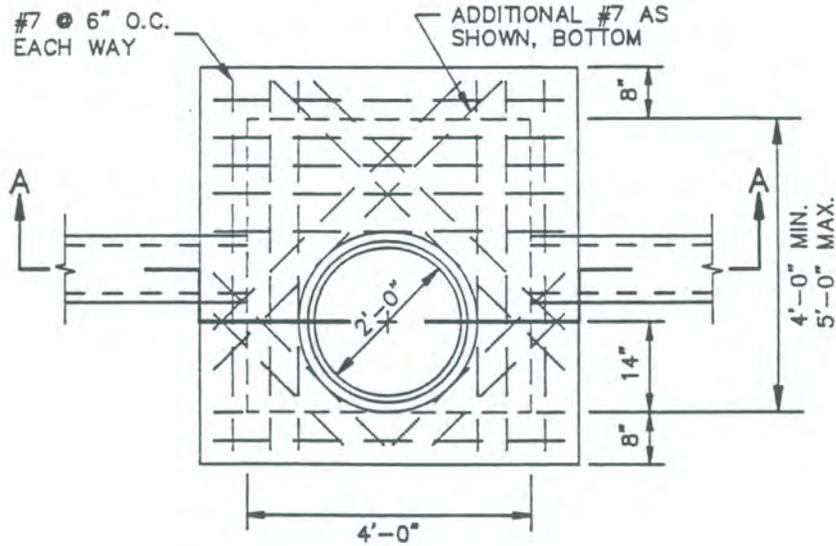
STANDARD MANHOLE COVER

PLATE

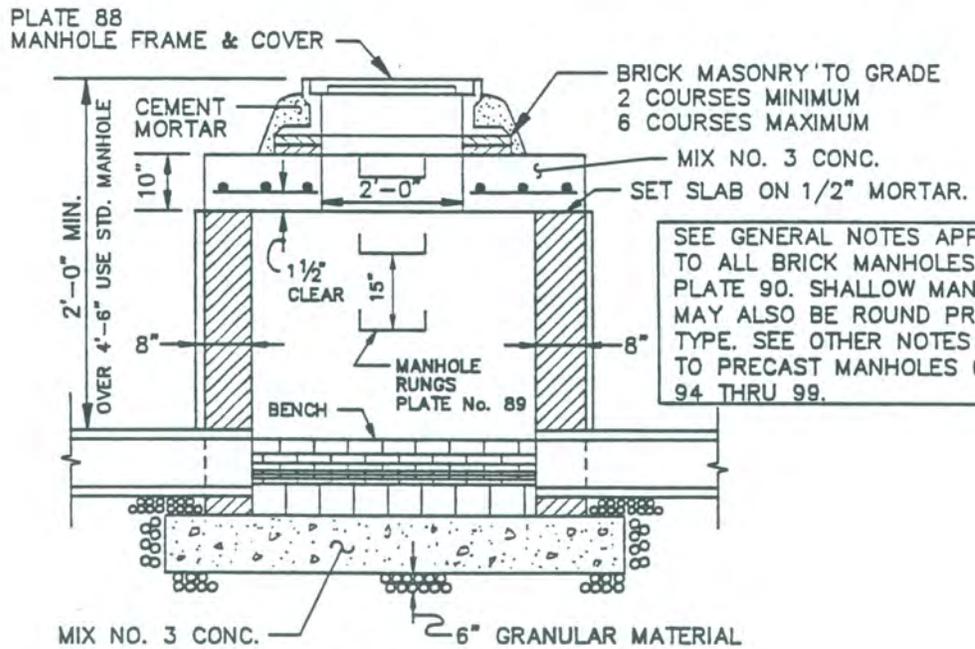
88



- Note: Metal Ladder Rungs Are To Be Used In Inlets, Manholes, And Junction Boxes Over Three Feet In Depth Or As Directed By The Engineer, Used Either With Brick Or Concrete Construction. Where Brick Construction Is Employed, The Mortar Joints Shall Be Adjusted To Accomodate Ladder Rungs Metal Ladder Rungs May Be Comprised Of One Of The Following.
- (1) Aluminum Alloy - Shall Conform To A.S.T.M. Designation B 221 Alloy 6061-T6. That Portion Embedded In The Structure Shall Be Coated With Zinc Chromate Or Approved Equivalent Coating.
  - (2) Cast Iron - Shall Conform To A.S.T.M. Designation 48 Class 30B.
  - (3) Steel - Shall Conform To A.S.T.M. Designation A- 615 Grade 40, Galvanized After Fabrication As Per A.S.T.M Designation A-153
  - (4) Aluminum Alloy - Shall Conform To A.S.T.M. Designation B221 Alloy 6061-T6. That Portion Embedded In The Structure Shall Be Coated With Zinc Chromate Or Approved Equivalent Coating.



PLAN



SECTION A-A

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DATE	BY

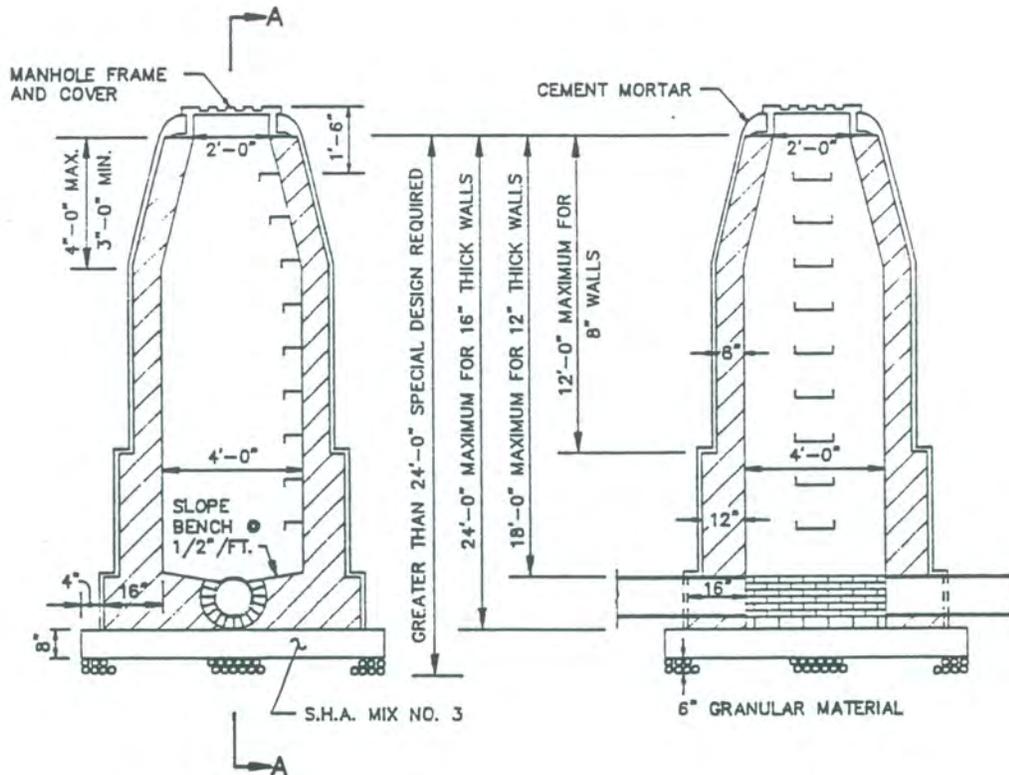
CARROLL COUNTY, MARYLAND  
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*K. St. ...* 4-12-94  
 DIRECTOR DATE

SHALLOW MANHOLE

PLATE

89-A



**ELEVATION**  
NO SCALE

**SECTION A-A**  
NO SCALE

**GENERAL NOTES APPLICABLE TO ALL BRICK MANHOLES**

1. MANHOLE BASE SHALL BE 8-INCH CAST IN PLACE CONCRETE SLAB, MIX NO. 3 AIR ENTRAINED. ALL OTHER SLABS SHALL BE MIX NO. 3 AIR ENTRAINED.
2. MANHOLE BASE SHALL BE BEDDED ON 6-INCH GRANULAR MATERIAL ON FIRM SUBGRADE.
3. EXCAVATION BELOW PIPES SHALL BE BACKFILLED WITH GRANULAR MATERIAL 1/3 OF WAY TO TOP OF PIPE.
4. CONNECTION BETWEEN MANHOLE WALL AND PIPE SHALL BE NON-SHRINK GROUT.
5. MANHOLE STEPS SHALL BE AS SPECIFIED ON DETAIL
6. MANHOLE COVER SHALL BE AS SHOWN ON DETAIL
7. PIPE JOINTS SHALL BE PROVIDED WITHIN 2' MAX. FROM OUTSIDE OF MANHOLE WALL
8. MANHOLE CHANNELS SHALL BE FORMED TO PROVIDE A SMOOTH TRANSITION BETWEEN PIPES. EXTEND BENCH TO FULL HEIGHT OF PIPE OPENING.
9. MANHOLE WALL THICKNESS SHALL BE AS SHOWN BELOW:

DEPTH BELOW MANHOLE COVER	WALL THICKNESS
TO 12'-0"	8"
12'-1" TO 18'-0"	12"
18'-1" TO 24'-0"	16"
GREATER THAN 24'-0"	SPECIAL DESIGN

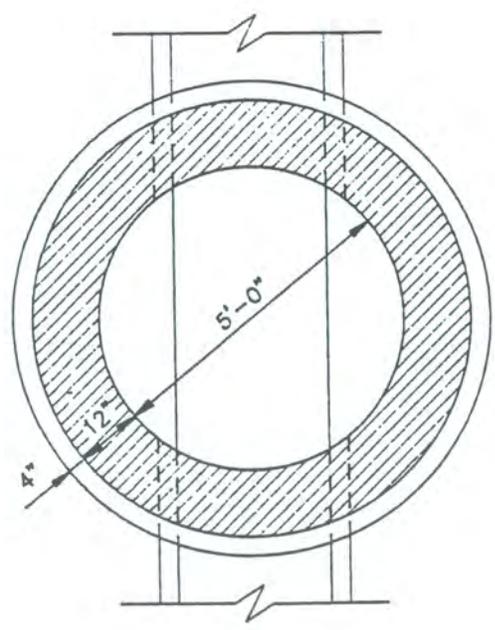
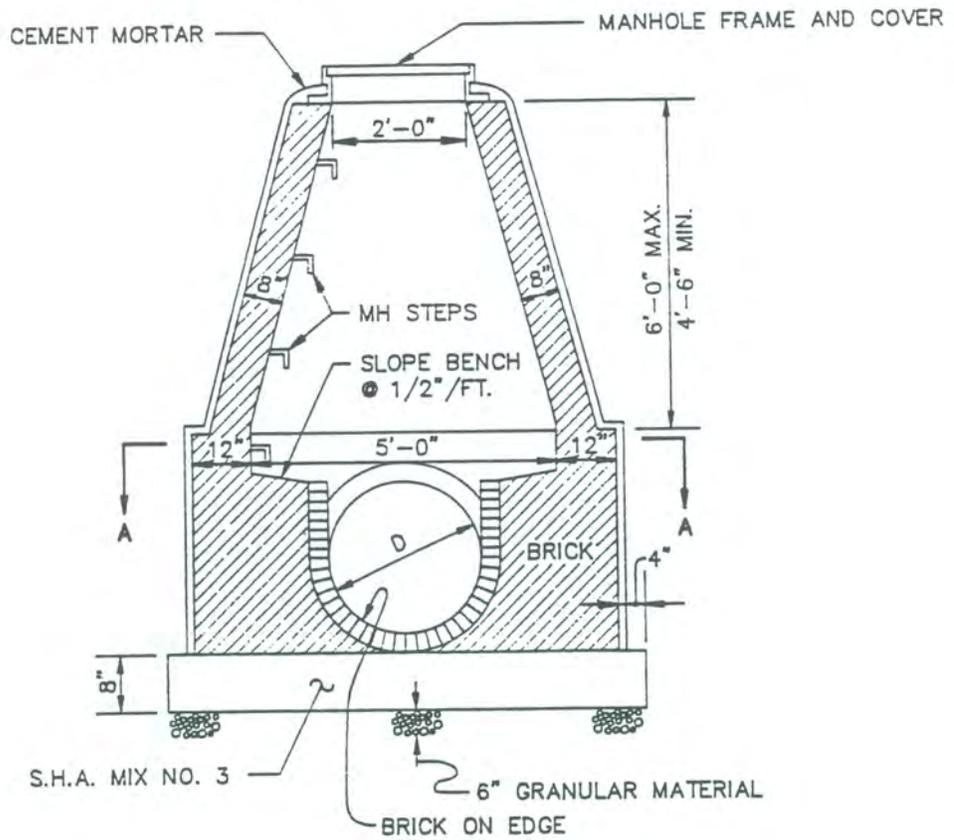
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DATE	BY

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DEPARTMENT OF PUBLIC WORKS

*[Signature]* 4-12-94  
DIRECTOR DATE

4'-0" BRICK MANHOLE  
FOR USE WITH PIPES  
24" AND SMALLER

PLATE  
90



**SECTION A-A**

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DATE	BY

**PLATE**

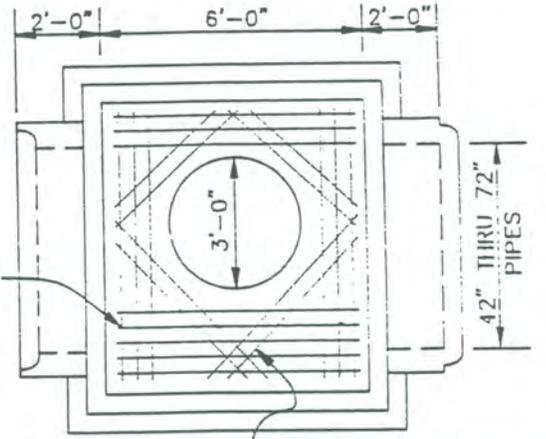
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*[Signature]* 4-12-94  
 DIRECTOR DATE

5'-0" BRICK MANHOLE FOR  
 USE WITH 27" TO 36" PIPE

SEE GENERAL NOTES APPLICABLE  
TO ALL BRICK MANHOLES ON  
DETAIL

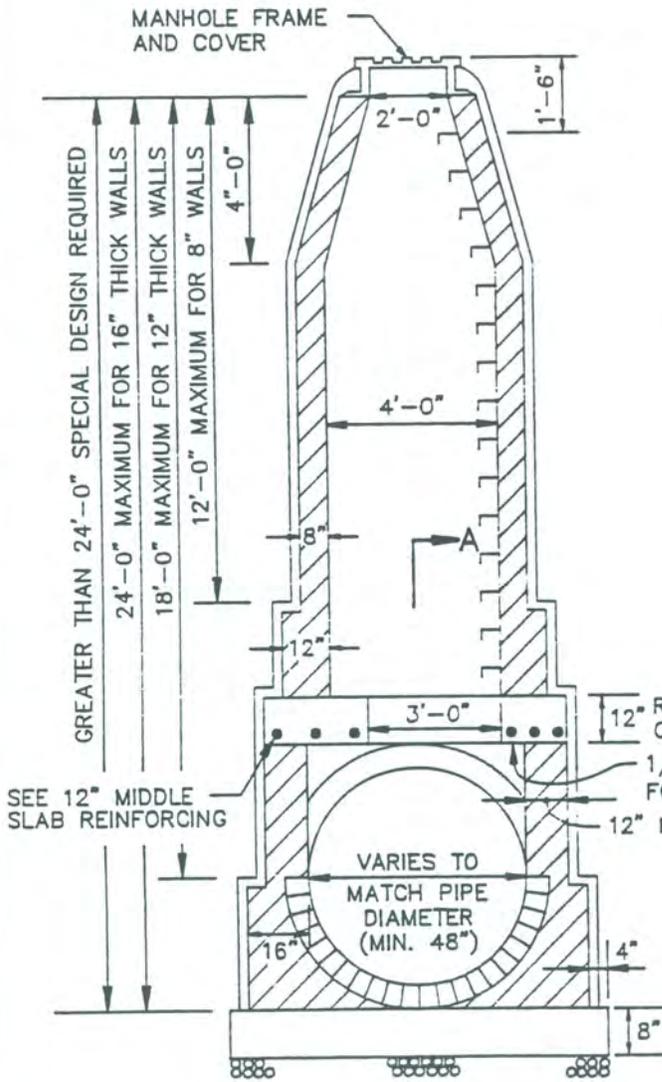
#7 @ 6" O/C  
EACH WAY,  
BOTTOM.

ADDITIONAL #7 @ 6" O/C  
AS SHOWN, BOTTOM

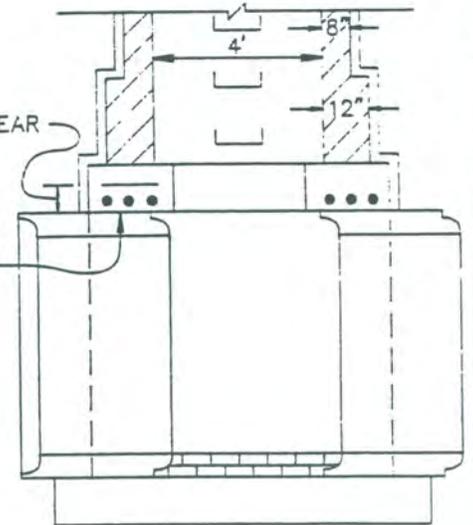


PLAN

12-INCH MIDDLE SLAB REINFORCING  
MIDDLE SLAB SHALL BE A 12" PRECAST  
CONCRETE SLAB, MIX NO.3, AIR ENTRAINED.



ELEVATION



SECTION A-A

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DATE	BY

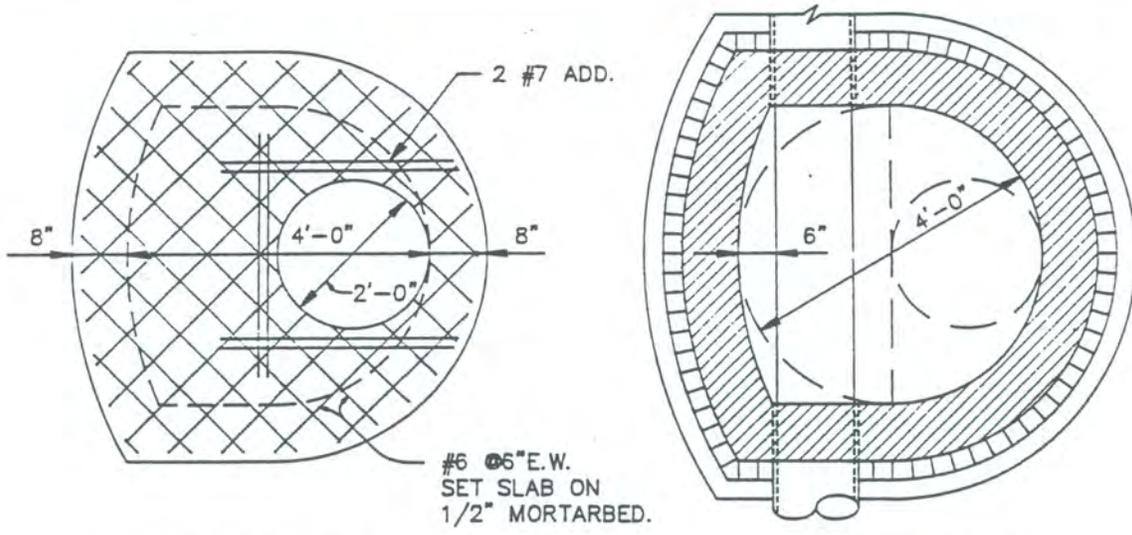
CARROLL COUNTY, MARYLAND  
DEPARTMENT OF PUBLIC WORKS

*K. J. ...*  
DIRECTOR      4-12-94  
DATE

BRICK MANHOLE FOR USE  
WITH 42" THRU 72" PIPES

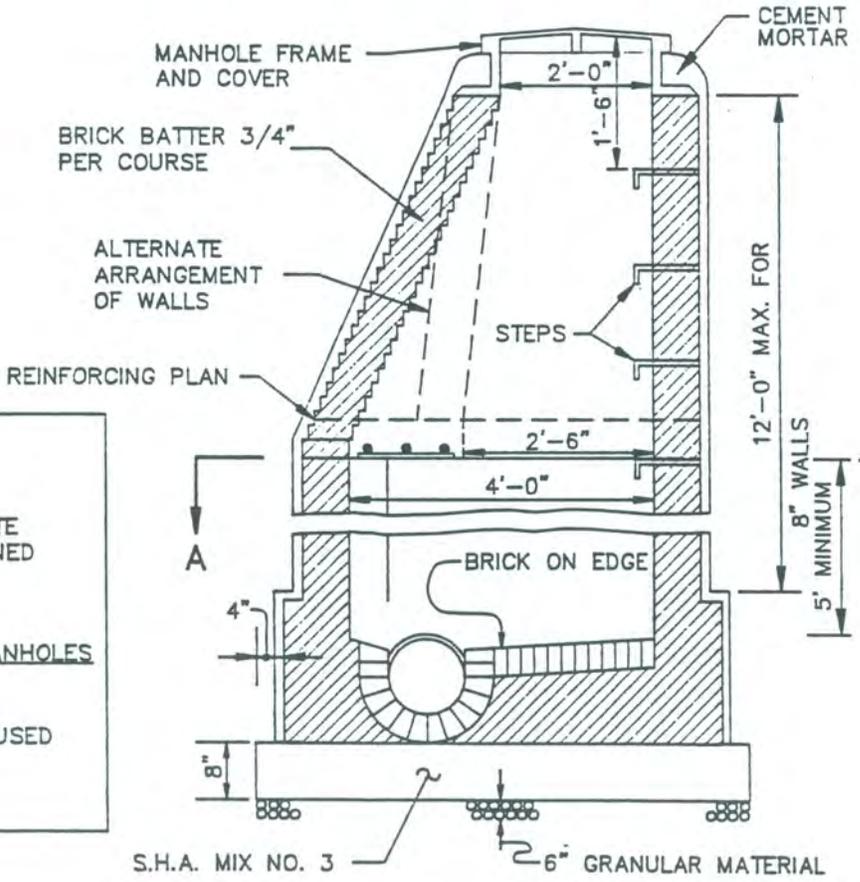
PLATE

92



**SLAB REINFORCING  
PLAN**

**SECTION A-A**



- NOTES**
1. IF USED, MIDDLE SLAB SHALL BE 8-INCH PRECAST CONCRETE SLAB, MIX NO. 3, AIR ENTRAINED CONCRETE.
  2. SEE GENERAL NOTES APPLICABLE TO ALL BRICK MANHOLES ON DETAIL
  3. MIDDLE SLAB SHALL NOT BE USED WITH LESS THAN 5 FEET TO TOP OF PIPE.

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DATE	BY

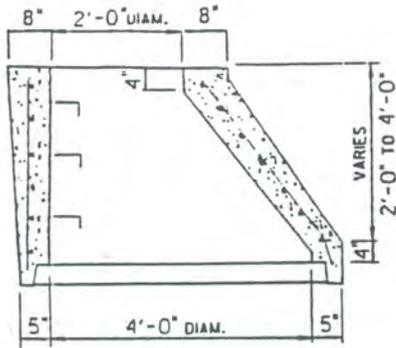
CARROLL COUNTY, MARYLAND  
DEPARTMENT OF PUBLIC WORKS

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DIRECTOR DATE

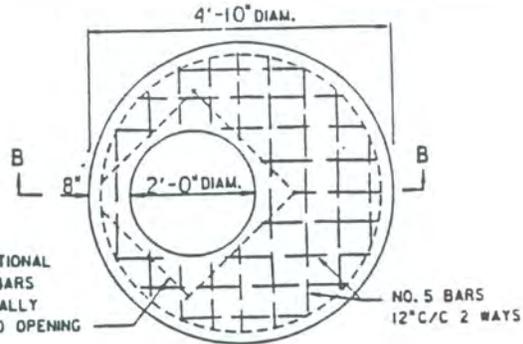
BRICK MANHOLE WITH OFFSET  
COVER FOR USE WITH  
24" PIPES AND SMALLER

PLATE

93



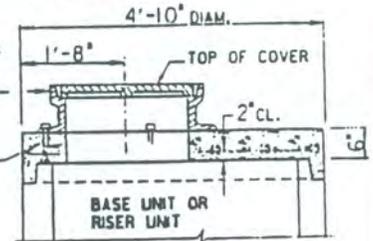
**ALTERNATE ECCENTRIC  
CONE UNIT**



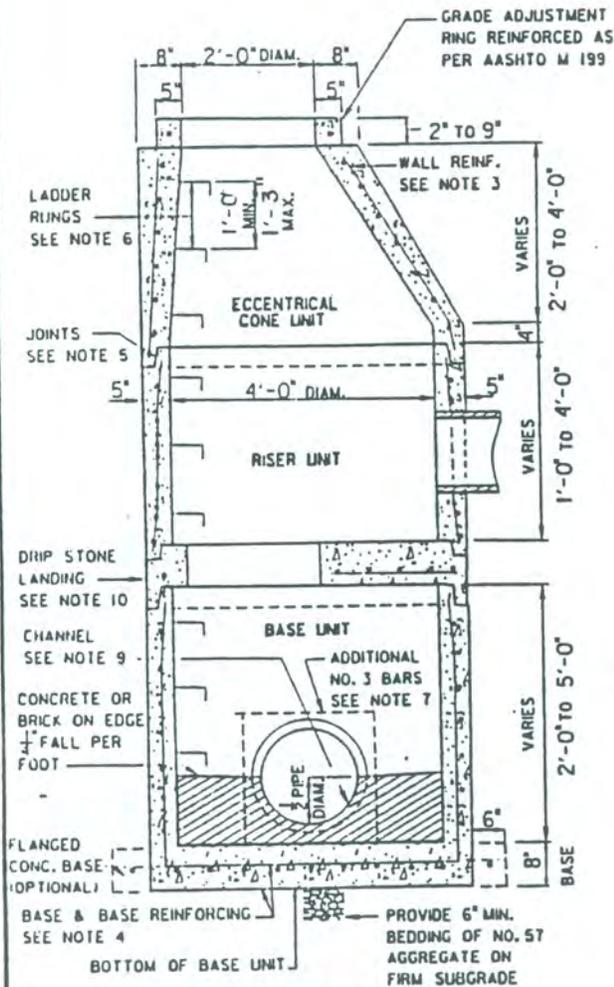
**FLAT SLAB TOP**  
(SHOWN WITHOUT FRAME & COVER)

STANDARD TYPE A MANHOLE  
FRAME & COVER SEE STD.

FRAME ANCHORAGE  
SEE STD.



**SECTION B-B**



**SECTION VIEW**  
(SHOWN WITHOUT FRAME & COVER)

**NOTES:**

1. MANHOLES SHALL BE CONSTRUCTED IN ACCORDANCE WITH AASHTO M 199.
2. CONCRETE SHALL BE MIX NO. 6 (4500 PSI).
3. WALL REINFORCEMENT FOR BASE UNITS, RISER UNITS AND ECCENTRIC CONE UNITS SHALL BE REINFORCEMENT BASE OR WELDED WIRE FABRIC WITH A MINIMUM AREA OF 0.2 IN.<sup>2</sup>/FT FOR THE 48" DIAMETER MANHOLES. WELDED WIRE FABRIC SHALL CONFORM TO ASTM A 185 AND A B2. REINFORCEMENT BARS SHALL MEET ASTM A 615, GRADE 60.
4. BASE REINFORCEMENT SHALL BE REINFORCEMENT BARS OR WELDED WIRE FABRIC WITH A MINIMUM AREA OF 0.14 IN.<sup>2</sup>/FT. THE BASE MAY BE CAST MONOLITHIC WITH THE BASE UNIT OR JOINTED PER MANUFACTURER'S DESIGN.
5. THE MANUFACTURER SHALL FORM MALE AND FEMALE ENDS OF JOINTS USING THEIR OWN DESIGN. THE JOINTS SHALL BE SEALED BY THE CONTRACTOR AND MADE WATERTIGHT USING (WHERE APPLICABLE) MORTAR, RUBBER O-RING GASKETS MEETING ASTM C 361 & C 443 OR FLEXIBLE PLASTIC GASKETS MEETING AASHTO M 198 TYPE B.
6. LADDER RUNGS SHALL BE INSTALLED IN VERTICAL ALIGNMENT AT 1'-3" MAXIMUM C/C. RUNG TYPES SHALL BE IN ACCORDANCE WITH CARROLL COUNTY STANDARDS. LADDER RUNGS SHALL BE INCIDENTAL TO THE COST OF THE MANHOLE.
7. WHEN THE DISTANCE BETWEEN MULTIPLE OPENINGS IN THE BASE UNIT OR ANY RISER UNIT IS LESS THAN 6" ADDITIONAL NO. 3 BARS ARE REQUIRED AROUND OPENINGS.
8. LIFT HOLES OR LIFT EYES SHALL BE PROVIDED IN EACH SECTION FOR HANDLING.
9. MIX NO. 2 CONCRETE OR BRICK CHANNEL SHALL BE PROVIDED IN THE FIELD AND SHALL SLOPE 2" PER FOOT TOWARD OUTLET OR AS DIRECTED BY THE ENGINEER.
10. THE DRIP STONE LANDING SHALL BE USED ONLY WHEN THERE ARE PIPES CONNECTED TO THE RISER UNITS. SEE PLATE 101 FOR DETAILS.
11. MINIMUM DEPTH PAYMENT PER EACH SHALL BE 3'-11" MEASURED FROM THE BOTTOM OF THE BASE UNIT TO THE TOP OF THE MANHOLE COVER. VERTICAL DEPTH PAYMENT PER LINEAR FOOT SHALL INCLUDE ALL DEPTHS IN EXCESS OF 3'-11". THE COST OF THE DRIP STONE LANDING, NO. 57 AGGREGATE, GROUT, SEALANT, AND ALL NECESSARY APPURTENANCES SHALL BE INCIDENTAL TO THE PRICE BID.

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DATE	BY

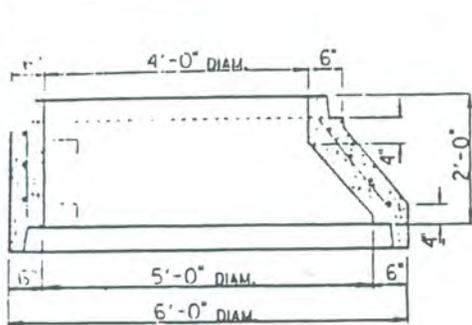
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DEPARTMENT OF PUBLIC WORKS

*[Signature]* 4-12-94  
DIRECTOR DATE

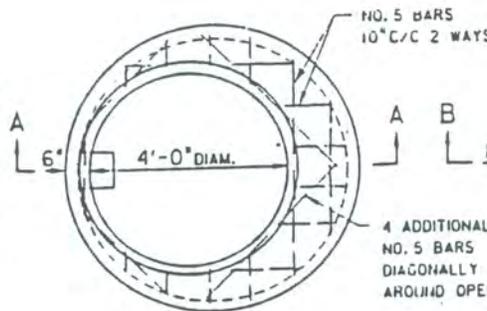
48" DIAMETER PRECAST  
MANHOLE FOR  
PIPES 24" AND SMALLER

PLATE

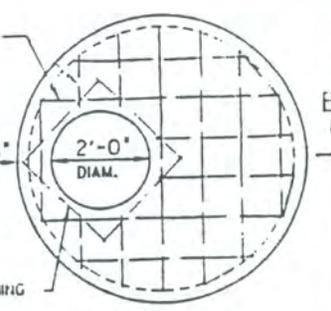
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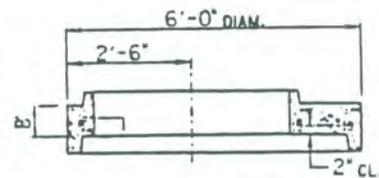
**ECCENTRIC CONE REDUCER**  
(ALTERNATE FOR FLATTOP REDUCER)



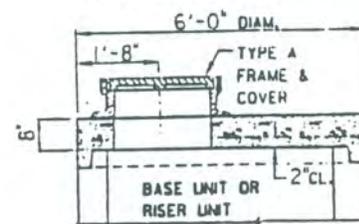
**FLATTOP REDUCER**



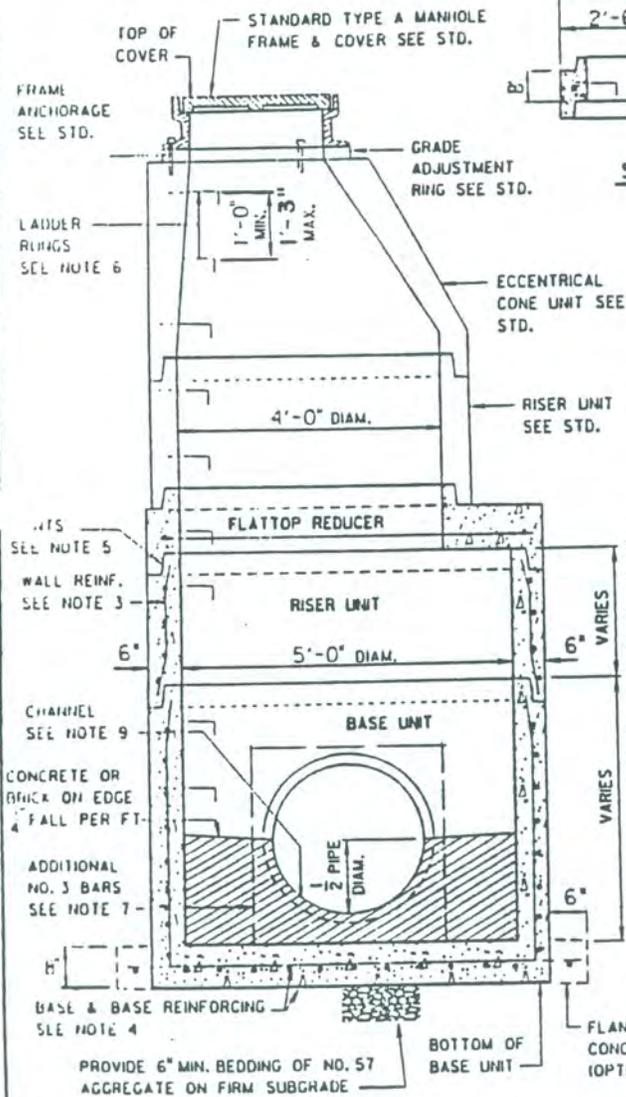
**FLAT SLAB TOP**  
(SHOWN WITHOUT FRAME & COVER)



**SECTION A-A**



**SECTION B-B**



**SECTION VIEW**

**NOTES:**

1. MANHOLES SHALL BE CONSTRUCTED IN ACCORDANCE WITH AASHTO M 199.
2. CONCRETE SHALL BE MIX NO. 6 (4500 PSI).
3. WALL REINFORCEMENT FOR BASE UNITS, RISER UNITS AND ECCENTRIC CONE UNITS SHALL BE REINFORCEMENT BARS OR WELDED WIRE FABRIC WITH A MINIMUM AREA OF 0.15 IN.<sup>2</sup>/FT FOR THE 60" DIAMETER MANHOLES. WELDED WIRE FABRIC SHALL CONFORM TO ASTM A 185 AND A 82. REINFORCEMENT BARS SHALL MEET ASTM A 615, GRADE 60.
4. BASE REINFORCEMENT TO BE REINFORCEMENT BARS OR WELDED WIRE FABRIC WITH A MINIMUM AREA OF 0.17 IN.<sup>2</sup>/FT. THE BASE SHALL BE CAST MONOLITHIC WITH THE BASE UNIT OR JOINTED PER MANUFACTURER'S DESIGN.
5. THE MANUFACTURER SHALL FORM MALE AND FEMALE ENDS OF JOINTS USING THEIR OWN DESIGN. THE JOINTS SHALL BE SEALED BY THE CONTRACTOR AND MADE WATERTIGHT USING (WHERE APPLICABLE) MORTAR, RUBBER O-RING GASKETS MEETING ASTM C 361 AND C 443 OR FLEXIBLE PLASTIC GASKETS MEETING AASHTO M 198 TYPE B.
6. LADDER RUNGS SHALL BE INSTALLED IN VERTICAL ALIGNMENT AT 1'-3" MAXIMUM C/C. RUNG TYPES SHALL BE IN ACCORDANCE WITH CARROLL COUNTY STANDARDS. LADDER RUNGS SHALL BE INCIDENTAL TO THE COST OF THE MANHOLE.
7. WHEN THE DISTANCE BETWEEN MULTIPLE OPENINGS IN THE BASE UNIT OR ANY RISER UNIT IS LESS THAN 6" ADDITIONAL NO. 3 BARS ARE REQUIRED AROUND OPENINGS.
8. LIFT HOLES OR LIFT EYES SHALL BE PROVIDED IN EACH SECTION FOR HANDLING.
9. MIX NO. 2 CONCRETE OR BRICK CHANNEL SHALL BE PROVIDED IN THE FIELD AND SHALL SLOPE 2" PER FOOT TOWARD OUTLET OR AS DIRECTED BY THE ENGINEER.
10. THE DRIP STONE LANDING SHALL BE USED ONLY WHEN THERE ARE PIPES CONNECTED TO THE RISER UNITS. SEE PLATE 101 FOR DETAILS.
11. MINIMUM DEPTH PAYMENT PER EACH SHALL BE 5'-1" MEASURED FROM THE BOTTOM OF THE BASE UNIT TO THE TOP OF THE MANHOLE COVER. VERTICAL DEPTH PAYMENT PER LINEAR FOOT SHALL INCLUDE ALL DEPTHS IN EXCESS OF 5'-1". THE COST OF THE DRIP STONE LANDING, NO. 57 AGGREGATE, GROUT, SEALANT, AND ALL NECESSARY APPURTENANCES SHALL BE INCIDENTAL TO THE PRICE BID.

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DATE BY

PLATE

95

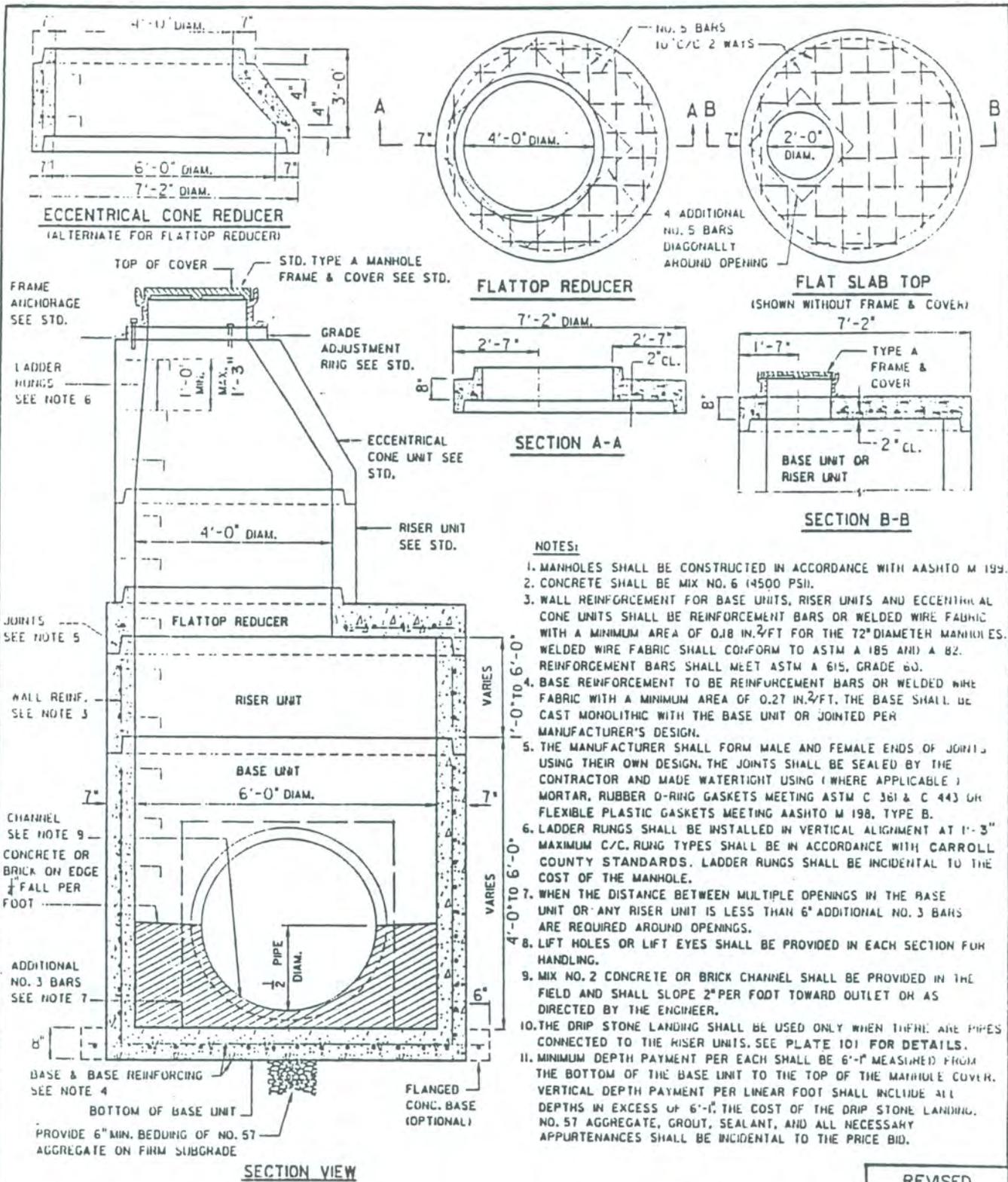
CARROLL COUNTY, MARYLAND  
DEPARTMENT OF PUBLIC WORKS

60" DIAMETER PRECAST  
MANHOLE FOR 27" TO  
36" PIPES

DIRECTOR

DATE

*[Signature]* 4-12-94



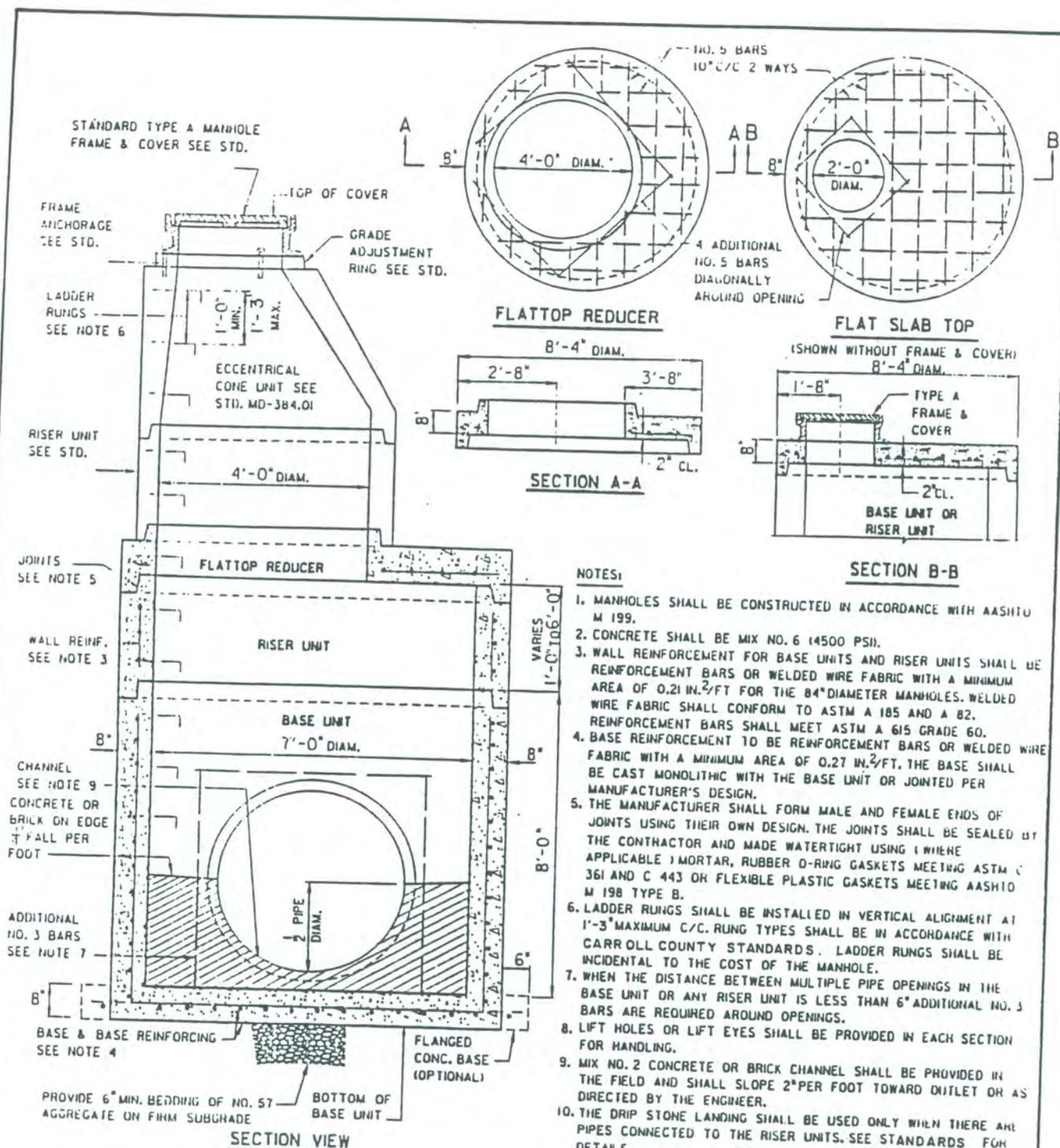
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*Carroll* 4-12-94  
DIRECTOR                      DATE

72" DIAMETER PRECAST  
MANHOLE FOR 42" AND  
48" PIPES

PLATE  
96



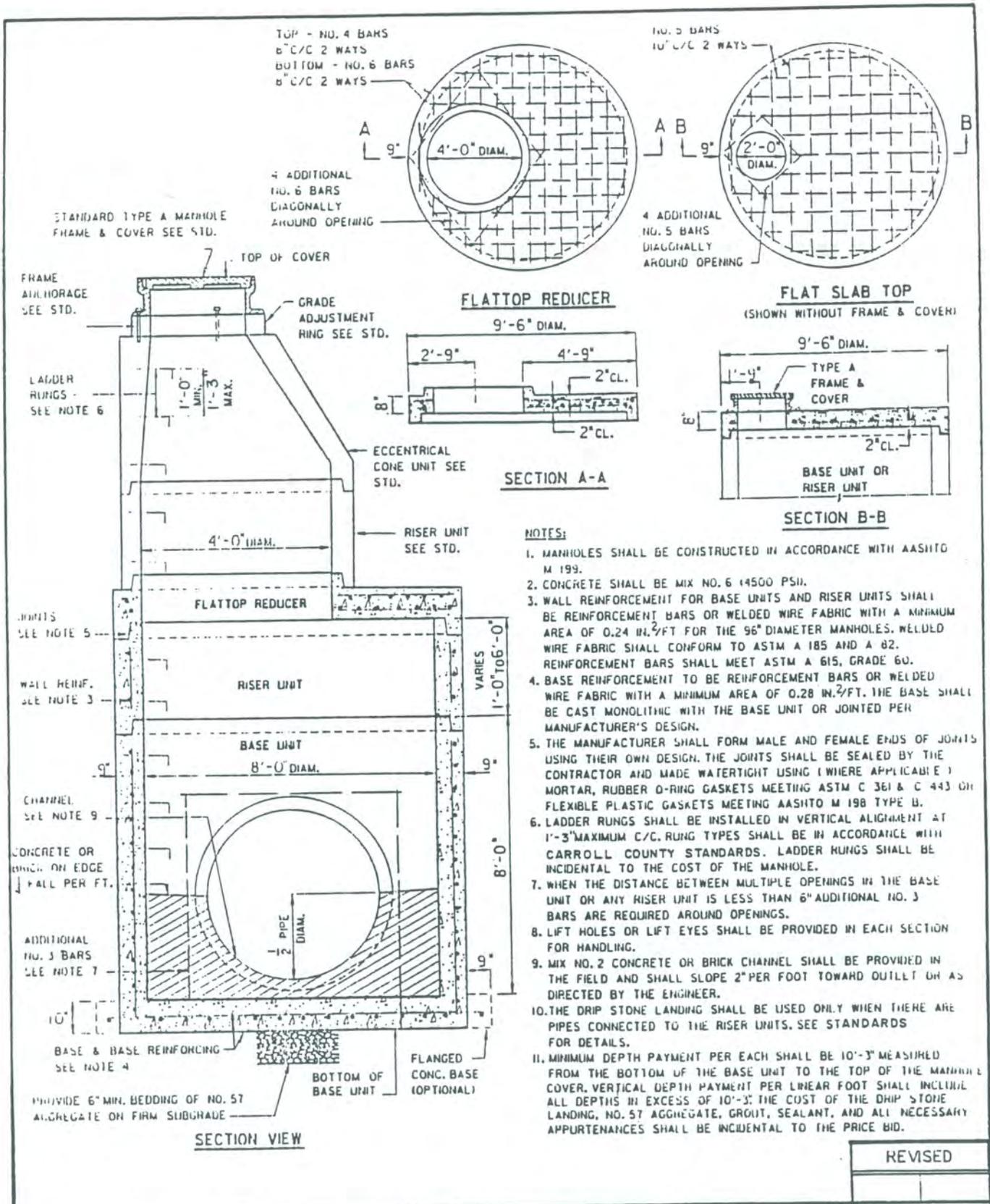
- NOTES:**
1. MANHOLES SHALL BE CONSTRUCTED IN ACCORDANCE WITH AASHTO M 199.
  2. CONCRETE SHALL BE MIX NO. 6 (4500 PSI).
  3. WALL REINFORCEMENT FOR BASE UNITS AND RISER UNITS SHALL USE REINFORCEMENT BARS OR WELDED WIRE FABRIC WITH A MINIMUM AREA OF 0.21 IN.<sup>2</sup>/FT FOR THE 84" DIAMETER MANHOLES. WELDED WIRE FABRIC SHALL CONFORM TO ASTM A 185 AND A 82. REINFORCEMENT BARS SHALL MEET ASTM A 615 GRADE 60.
  4. BASE REINFORCEMENT TO BE REINFORCEMENT BARS OR WELDED WIRE FABRIC WITH A MINIMUM AREA OF 0.27 IN.<sup>2</sup>/FT. THE BASE SHALL BE CAST MONOLITHIC WITH THE BASE UNIT OR JOINTED PER MANUFACTURER'S DESIGN.
  5. THE MANUFACTURER SHALL FORM MALE AND FEMALE ENDS OF JOINTS USING THEIR OWN DESIGN. THE JOINTS SHALL BE SEALED BY THE CONTRACTOR AND MADE WATERTIGHT USING (WHICHE APPLICABLE) MORTAR, RUBBER O-RING GASKETS MEETING ASTM C 361 AND C 443 OR FLEXIBLE PLASTIC GASKETS MEETING AASHTO M 198 TYPE B.
  6. LADDER RUNGS SHALL BE INSTALLED IN VERTICAL ALIGNMENT AT 1'-3" MAXIMUM C/C. RUNG TYPES SHALL BE IN ACCORDANCE WITH CARROLL COUNTY STANDARDS. LADDER RUNGS SHALL BE INCIDENTAL TO THE COST OF THE MANHOLE.
  7. WHEN THE DISTANCE BETWEEN MULTIPLE PIPE OPENINGS IN THE BASE UNIT OR ANY RISER UNIT IS LESS THAN 6" ADDITIONAL NO. 3 BARS ARE REQUIRED AROUND OPENINGS.
  8. LIFT HOLES OR LIFT EYES SHALL BE PROVIDED IN EACH SECTION FOR HANDLING.
  9. MIX NO. 2 CONCRETE OR BRICK CHANNEL SHALL BE PROVIDED IN THE FIELD AND SHALL SLOPE 2" PER FOOT TOWARD OUTLET OR AS DIRECTED BY THE ENGINEER.
  10. THE DRIP STONE LANDING SHALL BE USED ONLY WHEN THERE ARE PIPES CONNECTED TO THE RISER UNITS. SEE STANDARDS FOR DETAILS.
  11. MINIMUM DEPTH PAYMENT PER EACH SHALL BE 10'-1" MEASURED FROM THE BOTTOM OF THE BASE UNIT TO THE TOP OF THE MANHOLE COVER. VERTICAL DEPTH PAYMENT PER LINEAR FOOT SHALL INCLUDE ALL DEPTHS IN EXCESS OF 10'-1". THE COST OF THE DRIP STONE LANDING, NO. 57 AGGREGATE, GROUT, SEALANT, AND ALL NECESSARY APPURTENANCES SHALL BE INCIDENTAL TO THE PRICE BID.

CARROLL COUNTY, MARYLAND  
DEPARTMENT OF PUBLIC WORKS

*[Signature]* 4-12-94  
DIRECTOR DATE

84" DIAMETER PRECAST  
MANHOLE FOR 54" AND  
60" PIPES

REVISED
PLATE
97



CARROLL COUNTY, MARYLAND  
DEPARTMENT OF PUBLIC WORKS

*Handwritten Signature* 4-12-94  
DIRECTOR DATE

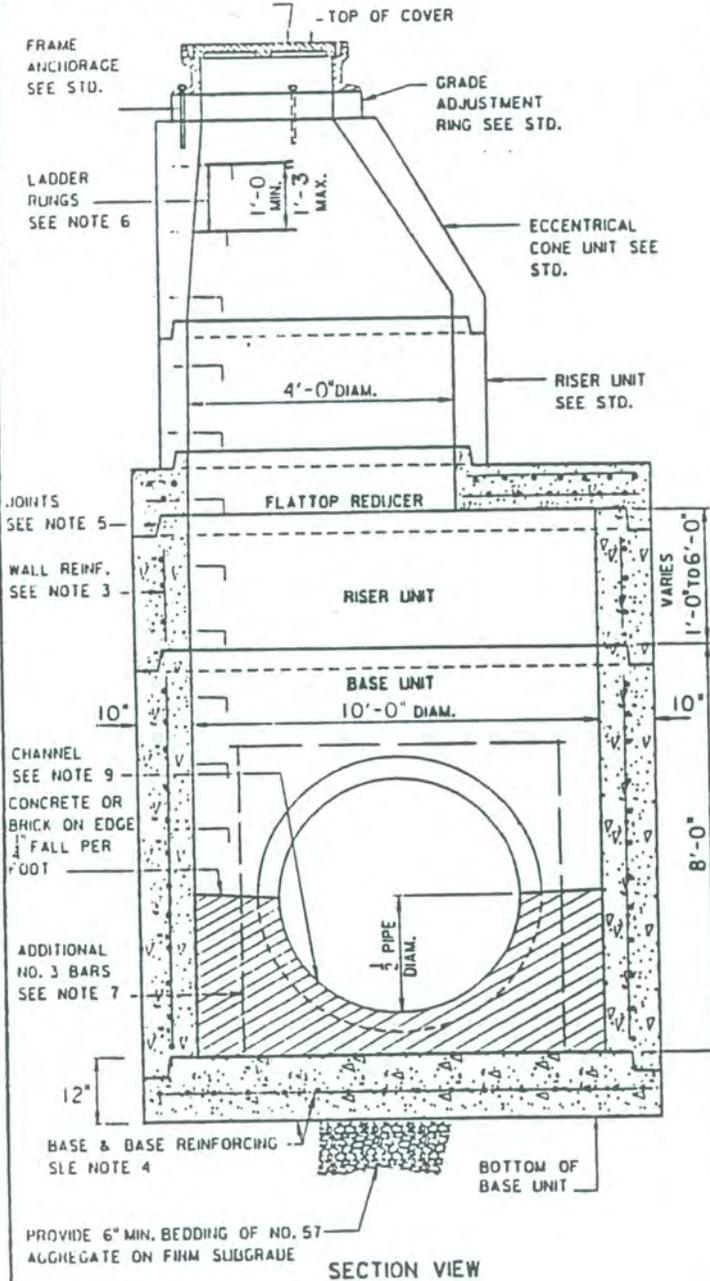
96" DIAMETER PRECAST  
MANHOLE FOR 72" PIPES

REVISED

PLATE

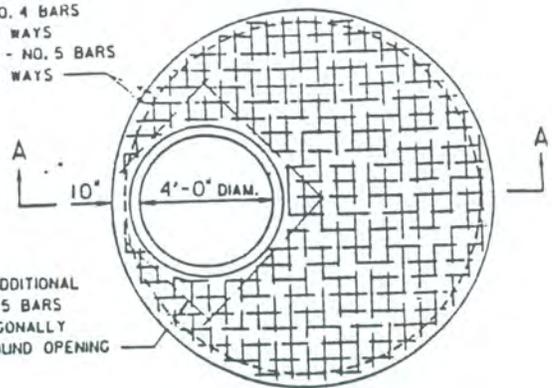
98

STANDARD TYPE A MANHOLE  
FRAME & COVER SEE STD.

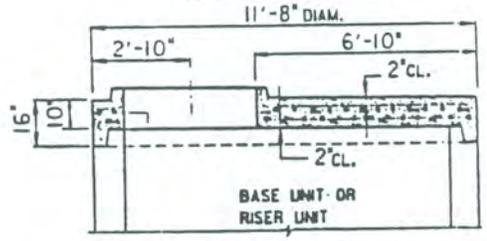


SECTION VIEW

TOP - NO. 4 BARS  
6" C/C 2 WAYS  
BOTTOM - NO. 5 BARS  
6" C/C 2 WAYS



FLATTOP REDUCER



SECTION A-A

NOTES:

1. MANHOLES SHALL BE CONSTRUCTED IN ACCORDANCE WITH AASHTO M 199.
2. CONCRETE SHALL BE MIX NO. 6 (4500 PSI).
3. WALL REINFORCEMENT FOR BASE UNITS AND RISER UNITS SHALL BE REINFORCEMENT BARS OR WELDED WIRE FABRIC WITH A MINIMUM AREA OF 0.30 IN.<sup>2</sup>/FT FOR THE 120" DIAMETER MANHOLES. WELDED WIRE FABRIC SHALL CONFORM TO ASTM A 185 AND A 82. REINFORCEMENT BARS SHALL MEET ASTM A 615, GRADE 60.
4. BASE REINFORCEMENT TO BE REINFORCEMENT BARS OR WELDED WIRE FABRIC WITH A MINIMUM AREA OF 0.39 IN.<sup>2</sup>/FT. THE BASE SHALL BE CAST MONOLITHIC WITH THE BASE UNIT OR JOINTED PER THE MANUFACTURER'S DESIGN.
5. THE MANUFACTURER SHALL FORM MALE AND FEMALE ENDS OF JOINTS USING THEIR OWN DESIGN. THE JOINTS SHALL BE SEALED BY THE CONTRACTOR AND MADE WATERTIGHT USING (WHERE APPLICABLE) MORTAR, RUBBER O-RING GASKETS MEETING ASTM C 361 & C 443 OR FLEXIBLE PLASTIC GASKETS MEETING AASHTO M 198 TYPE B.
6. LADDER RUNGS SHALL BE INSTALLED IN VERTICAL ALIGNMENT AT 1'-3" MAXIMUM C/C. RUNG TYPES SHALL BE IN ACCORDANCE WITH CARROLL COUNTY STANDARDS. LADDER RUNGS SHALL BE INCIDENTAL TO THE COST OF THE MANHOLE.
7. WHEN THE DISTANCE BETWEEN MULTIPLE OPENINGS IN THE BASE UNIT OR ANY RISER UNIT IS LESS THAN 6" ADDITIONAL NO. 3 BARS ARE REQUIRED AROUND OPENINGS.
8. LIFT HOLES OR LIFT EYES SHALL BE PROVIDED IN EACH SECTION FOR HANDLING.
9. MIX NO. 2 CONCRETE OR BRICK CHANNEL SHALL BE PROVIDED IN THE FIELD AND SHALL SLOPE 2" PER FOOT TOWARD OUTLET OR AS DIRECTED BY THE ENGINEER.
10. THE DRIP STONE LANDING SHALL BE USED ONLY WHEN THERE ARE PIPES CONNECTED TO THE RISER UNITS. SEE STANDARDS FOR DETAILS.
11. MINIMUM DEPTH PAYMENT PER EACH SHALL BE 10'-7" MEASURED FROM THE BOTTOM OF THE BASE UNIT TO THE TOP OF THE MANHOLE COVER. VERTICAL DEPTH PAYMENT PER LINEAR FOOT SHALL INCLUDE ALL DEPTHS IN EXCESS OF 10'-7". THE COST OF THE DRIP STONE LANDING, NO. 57 AGGREGATE, GROUT, SEALANT, AND ALL APPURTENANCES SHALL BE INCIDENTAL TO THE PRICE BID.

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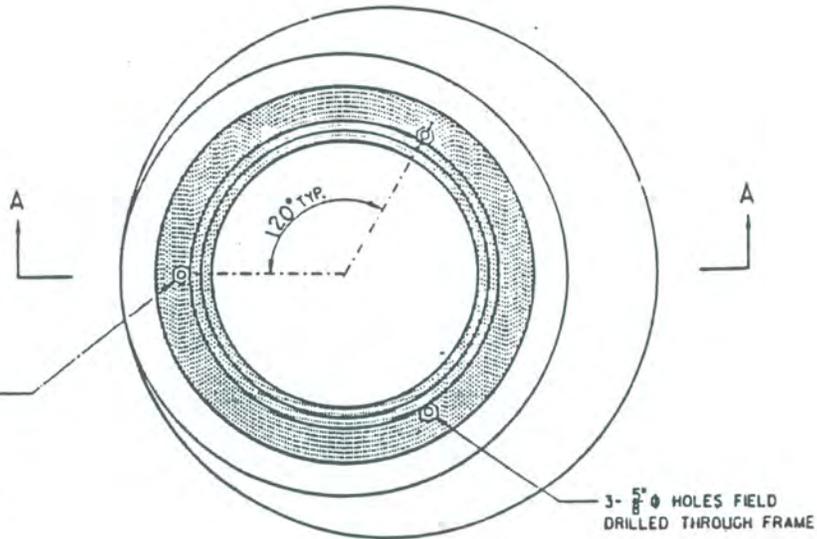
PLATE	
99	

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DEPARTMENT OF PUBLIC WORKS

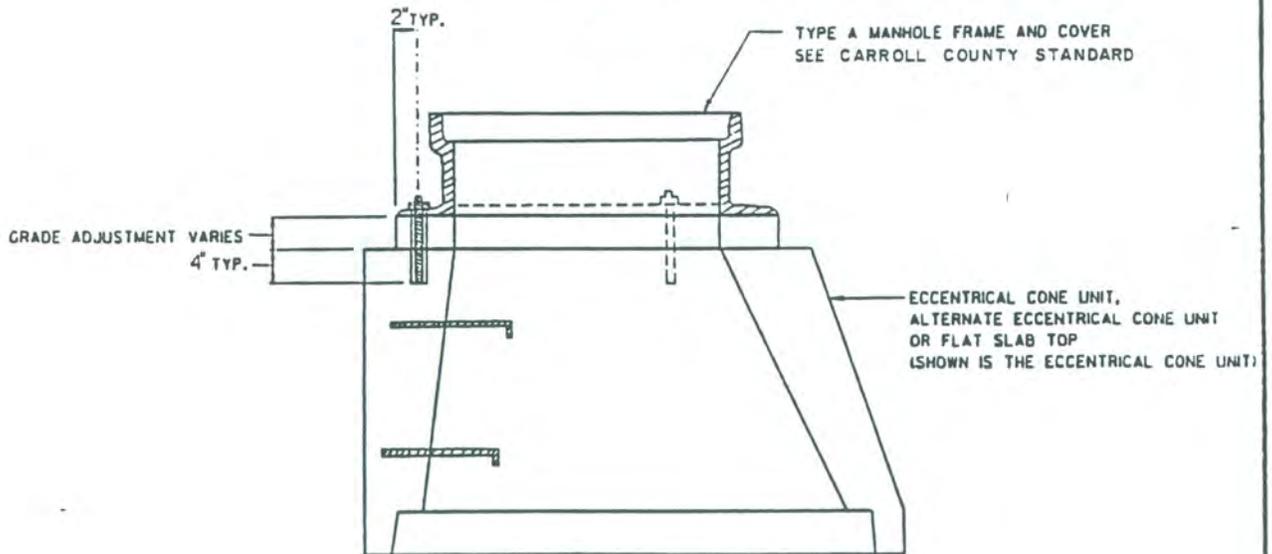
*E. Standaert* 4-12-94  
DIRECTOR DATE

120" DIAMETER PRECAST  
MANHOLE FOR 78" TO  
84" PIPES

3- $\frac{1}{2}$ "  $\varnothing$  HEX HEAD BOLTS  
WITH THREADED INSERTS  
OR  
3- $\frac{1}{2}$ "  $\varnothing$  THREADED STUDS  
WITH HEX HEAD NUTS.  
STUDS TO BE GROUTED  
IN PLACE OR ANCHORED  
WITH A CONCRETE COMPATIBLE  
CHEMICAL ADHESIVE.



PLAN



SECTION A-A

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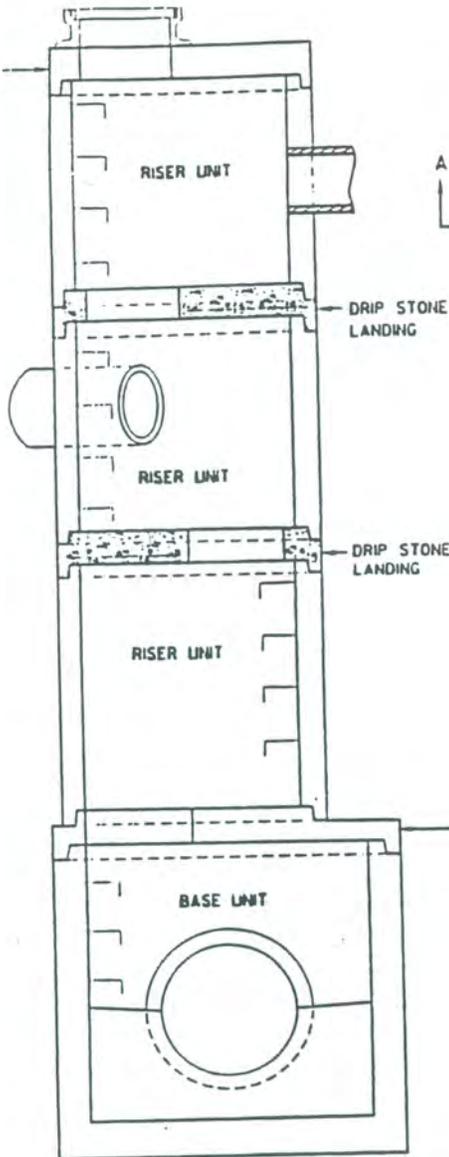
*W. S. ...* 4-12-94  
DIRECTOR DATE

FRAME ANCHORAGE FOR  
PRECAST MANHOLES

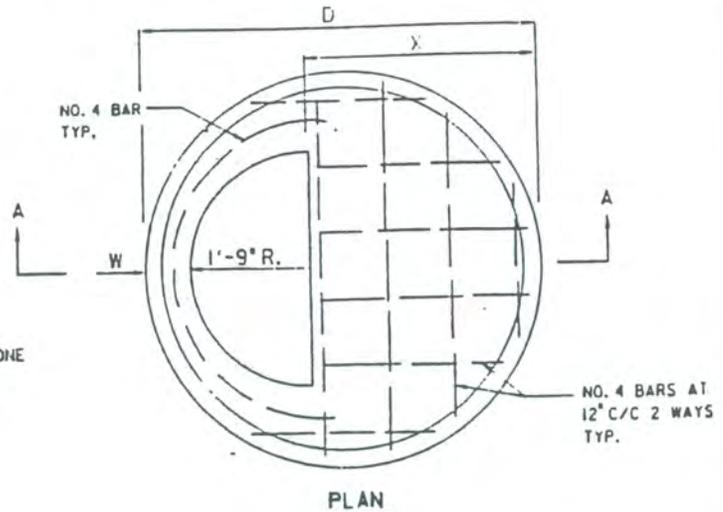
PLATE

100

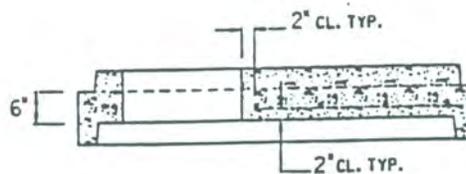
FLAT SLAB TOP  
(OR ECCENTRICAL  
CONE UNIT)



METHOD OF PLACING DRIP STONE LANDINGS



PLAN



SECTION A-A  
DRIP STONE LANDING

SEE C. CO. STD. FOR PRECAST COMBINATION FLATTOP REDUCER AND DRIP STONE LANDING FOR 60" TO 120" DIAMETER MANHOLES AND STANDARD FOR PRECAST COMBINATION ECCENTRICAL CONE REDUCER AND DRIP STONE LANDING FOR 60" AND 72" DIAMETER MANHOLES. OTHERWISE USE 48" DIAMETER DRIP STONE LANDING ON THIS SHEET.

PRECAST MANHOLE DIAMETER	DRIP STONE DIMENSIONS		
	D	W	X
48"	4'-10"	8"	2'-5"
60"	6'-0"	8"	3'-7"
72"	7'-2"	8"	4'-9"
84"	8'-4"	8"	5'-11"
96"	9'-6"	9"	7'-0"
120"	11'-8"	10"	9'-1"

NOTES:

1. THE DRIP STONE LANDING SHALL BE USED ONLY WHEN THERE ARE PIPES CONNECTED TO THE RISER UNITS.
2. CONCRETE SHALL BE MIX NO. 6 (4500 PSI).
3. REINFORCEMENT SHALL MEET ASTM A 615 GRADE 60.
4. THE MANUFACTURER SHALL FORM MALE AND FEMALE ENDS OF JOINTS USING THEIR OWN DESIGN.
5. LIFT EYES SHALL BE PROVIDED FOR HANDLING.
6. COST FOR THE DRIP STONE LANDING IS INCIDENTAL TO THE COST OF THE MANHOLE.

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DATE	BY

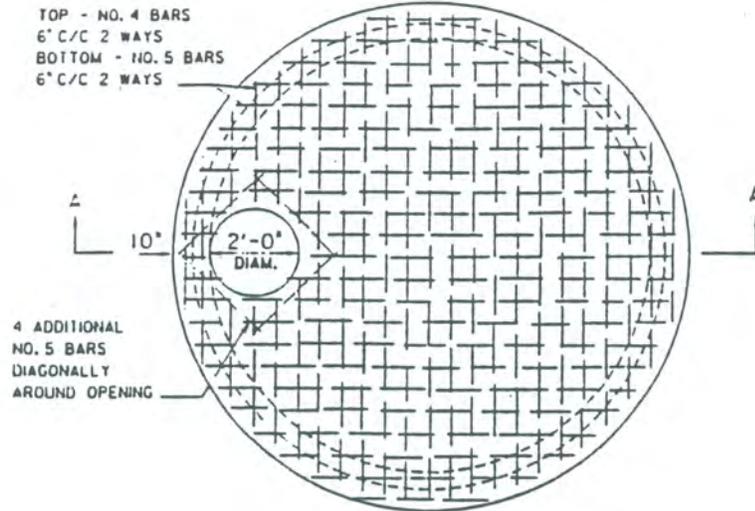
CARROLL COUNTY, MARYLAND  
DEPARTMENT OF PUBLIC WORKS

*[Signature]* 4-12-94  
DIRECTOR DATE

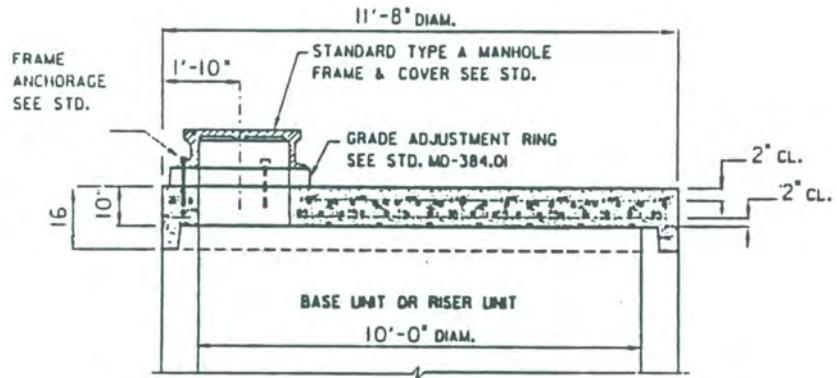
PRECAST DRIP STONE  
LANDING DETAILS FOR 48"  
TO 120" DIAMETER  
MANHOLES.

PLATE

101



**PLAN**  
(FRAME AND COVER NOT SHOWN)



**SECTION A-A**

- NOTES:**
1. CONCRETE SHALL BE MIX NO. 6 (4500 PSI)
  2. THE MANUFACTURER SHALL FORM MALE AND FEMALE ENDS OF JOINTS USING THEIR OWN DESIGN.
  3. LIFT EYES SHALL BE PROVIDED FOR HANDLING.
  4. COST FOR THE PRECAST FLAT SLAB TOP IS INCIDENTAL TO THE COST OF THE 120" PRECAST MANHOLE.
  5. FOR USE WITH THE 120" DIAMETER PRECAST MANHOLE, SEE STANDARD NO.

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DATE	BY

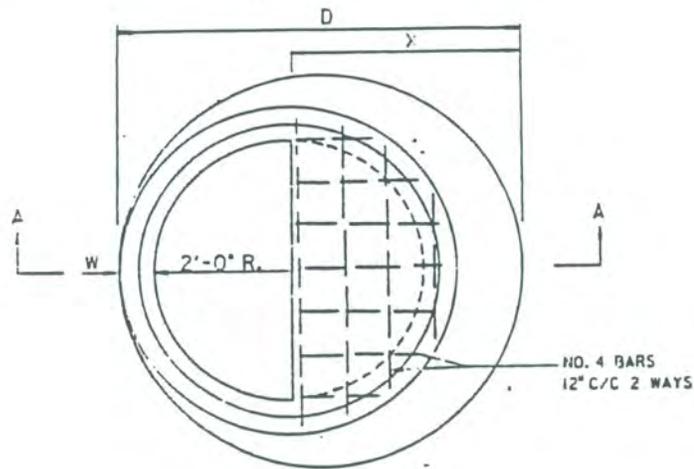
**CARROLL COUNTY, MARYLAND**  
**DEPARTMENT OF PUBLIC WORKS**

*Carol C. ...* 4-12-94  
DIRECTOR                      DATE

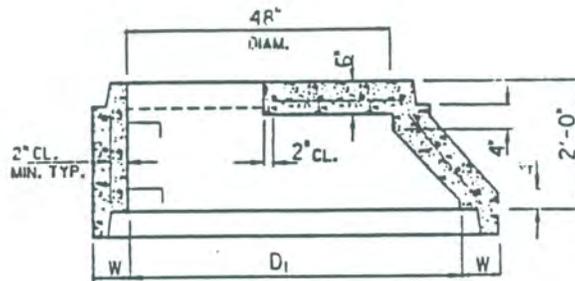
**PRECAST FLAT SLAB TOP**  
**FOR 120" DIAMETER**  
**PRECAST MANHOLE**

**PLATE**

102



**PLAN**



**SECTION A-A**

PRECAST MANHOLE DIAMETER	DIMENSIONS			
	D	D <sub>1</sub>	W	X
60"	6'-0"	5'-0"	6"	3'-6"
72"	7'-2"	6'-0"	7"	4'-7"

**NOTES:**

1. THE COMBINATION ECCENTRIC CONE REDUCER AND DRIP STONE LANDING SHALL BE USED ONLY WHEN THERE ARE PIPES CONNECTED TO THE RISER UNITS. SEE CARROLL COUNTY PLATE No. 101 FOR PLACEMENT.
2. CONCRETE SHALL BE MIX NO. 6 (4500 PSI).
3. REINFORCEMENT SHALL BE REINFORCING BARS OR WELDED WIRE FABRIC WITH A MINIMUM AREA OF 0.15 IN.<sup>2</sup>/FT FOR THE 60" DIAMETER CONE UNIT AND 0.18 IN.<sup>2</sup>/FT FOR THE 72" DIAMETER CONE UNIT.
4. THE MANUFACTURER SHALL FORM MALE AND FEMALE ENDS OF JOINTS USING THEIR OWN DESIGN.
5. LIFT EYES SHALL BE PROVIDED FOR HANDLING.
6. COST FOR THE COMBINATION ECCENTRIC CONE REDUCER AND DRIP STONE LANDING IS INCIDENTAL TO THE COST OF THE MANHOLE.

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DATE	BY

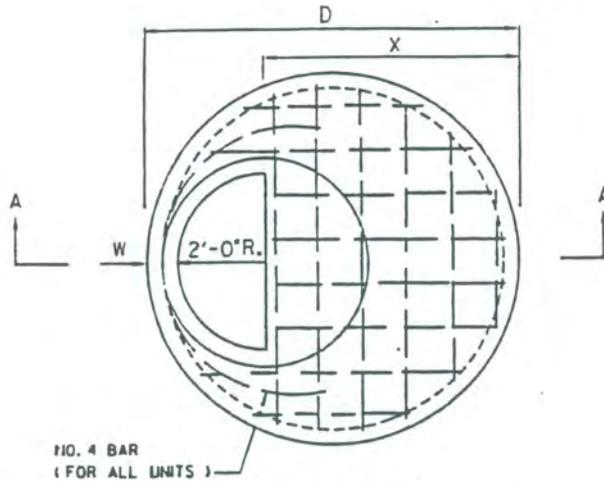
CARROLL COUNTY, MARYLAND  
DEPARTMENT OF PUBLIC WORKS

*[Signature]* 4-12-94  
DIRECTOR DATE

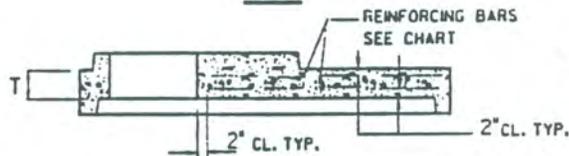
PRECAST COMBINATION  
FLAT TOP REDUCER AND DRIP  
STONE LANDING FOR 60" TO  
72" DIAMETER MANHOLES

PLATE

103



PLAN



SECTION A-A

PRECAST MANHOLE DIAMETER	DIMENSIONS				REINFORCING BARS PLACED 2 WAYS	
	D	T	W	X	TOP LAYER	BOTTOM LAYER
60"	6'-0"	5"	6"	3'-6"	N/A	NO. 5 AT 10" C/C
72"	7'-2"	6"	7"	4'-7"	N/A	NO. 5 AT 10" C/C
84"	8'-4"	7"	8"	5'-8"	N/A	NO. 5 AT 10" C/C
96"	9'-6"	8"	9"	6'-9"	NO. 4 AT 8" C/C	NO. 6 AT 8" C/C
120"	11'-8"	9"	10"	8'-10"	NO. 4 AT 6" C/C	NO. 5 AT 6" C/C

**NOTES:**

1. THE COMBINATION FLATTOP REDUCER DRIP STONE LANDING SHALL BE USED ONLY WHEN THERE ARE PIPES CONNECTED TO THE RISER UNITS. SEE SEE CARROLL COUNTY PLATE No. 101 FOR PLACEMENT.
2. CONCRETE SHALL BE MIX NO. 6 (4500 PSI).
3. REINFORCEMENT SHALL MEET ASTM A 615 GRADE 60.
4. THE MANUFACTURER SHALL FORM MALE AND FEMALE ENDS OF JOINTS USING THEIR OWN DESIGN.
5. LIFT EYES SHALL BE PROVIDED FOR HANDLING.
6. COST FOR THE COMBINATION FLATTOP REDUCER AND DRIP STONE LANDING IS INCIDENTAL TO THE COST OF THE MANHOLE.

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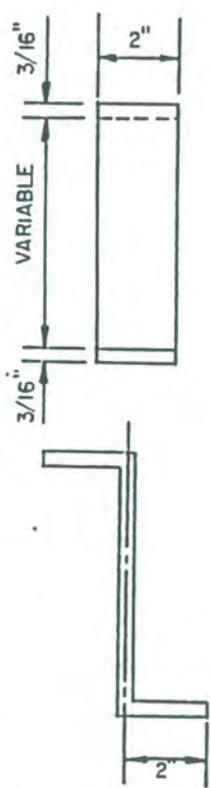
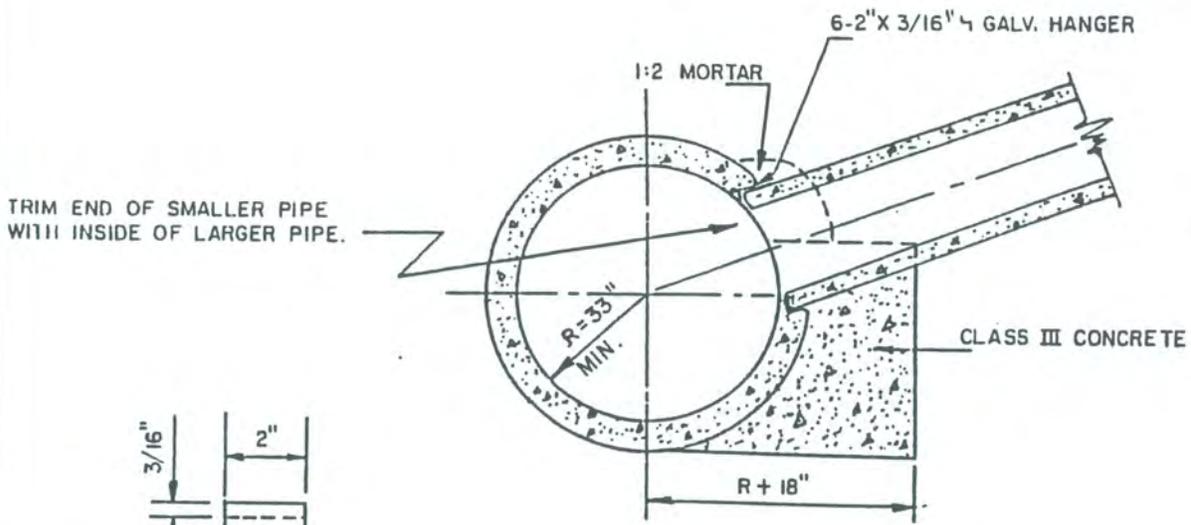
CARROLL COUNTY, MARYLAND  
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*[Signature]* 4-12-94  
DIRECTOR DATE

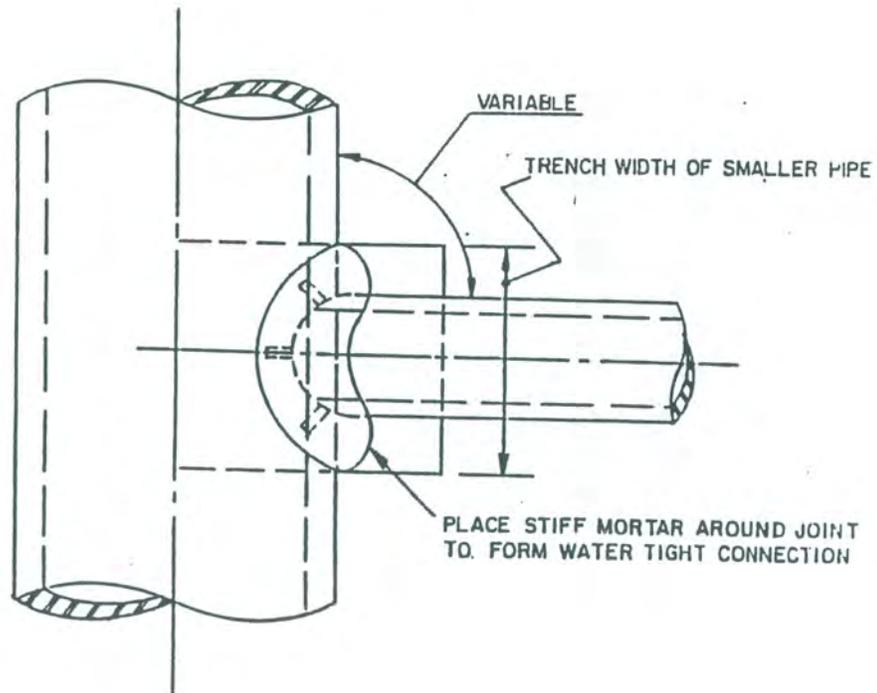
PRECAST COMBINATION  
ECCENTRIC CONE REDUCER  
AND DRIP STONE LANDING  
FOR 60" & 120" DIA. MANHOLES

PLATE

104



PIPE HANGER



NOTES:

1. MINIMUM INSIDE DIAMETER OF LARGER PIPE = 33"
2. MINIMUM RATIO OF SMALLER PIPE DIAMETER TO LARGER PIPE DIAMETER = 0.45
3. ONLY ONE FIELD CONNECTION PERMITTED IN A SINGLE LENGTH OF LARGER PIPE.
4. SEE SECTION 6.4.5 OF THE "STORM DRAINAGE CRITERIA" (IN THIS MANUAL) FOR DIRECTIVES IN USING THIS METHOD.

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4-12-94  
DIRECTOR                      DATE

FIELD CONNECTION

PLATE