APPENDIX A

SECTION A-1-GEOMETRIC DESIGN STANDARDS

INTRODUCTION

Highway improvement plans are based on established geometric design standards for various elements of the roadway under design. The tables on the following pages provide the **minimum** geometric standards which are to be used for development of VDOT projects except those projects which can be developed using the Guidelines for RRR Projects located in Appendix A, Section A-4 of this manual. Note that there are no specific RRR standards for Interstate projects. If the designer has determined that Guidelines for RRR Projects do not apply to the project in question, the Geometric Design Standard Figures A-1-1M through A-1-10M should be used for project development.

The Geometric Standard tables were developed using the 2001 edition of A Policy on Geometric Design of Highways and Streets published by the American Association of State Highway and Transportation Officials (AASHTO). These tables present basic practical guidelines compatible with traffic, topography and safety; however, due to the restrictive format, all variables could not be included. The designer is urged to refer to the above named publication and other related chapters in the Road Design Manual for further discussion of design considerations before selecting the proper design speed criteria for a given project.

THE APPLICATION OF THE CRITERIA PROVIDED IN THE GEOMETRIC STANDARD TABLES MUST BE MADE IN CONJUNCTION WITH SOUND ENGINEERING JUDGMENT TO EFFECT A PROPER DESIGN. The economic, environmental and social factors involved in highway design shall also be considered. The designer should always attempt to provide for the highest degree of safety and best level of service that is economically feasible. The "minimum" design criteria shown in Figures A-1-1M through A-1-10M should only be used when overriding economic or environmental considerations so dictate.

ROADWAY WIDTH

Roadway width as referenced in this section is the portion of the highway, including graded shoulders, for vehicular use.

DESIGN SPEED

Design speed is defined as a speed determined for design and correlation of the physical features of a highway that influence vehicle operation - the maximum safe speed maintainable over a specified section of highway when conditions permit design features to govern.

The geometric Figures indicate a design speed range for each functional classification. The selection of the proper design speed to be used on a particular project is of primary importance in project development. The design speed selected should:

- be logical with respect to topography, anticipated operating speed, adjacent land use, and functional classification of the highway.

- be as high as practicable to attain a desired degree of safety, mobility and efficiency while under the constraints of environmental quality, economics, aesthetics and social or political impacts

- be consistent with the speed a driver is likely to expect. Drivers do not adjust their speeds to the importance of the highway, but to their perception of the physical limitations and traffic thereon.

Although the design speeds for rural highways are coupled with a terrain classification, terrain is only one of the several factors involved in determining the appropriate design speed of a highway.

Although the selected design speed establishes the minimum radius of curvature and minimum sight distance necessary for safe operation, there should be no restriction on the use of flatter horizontal curves or greater sight distances where such improvements can be provided as a part of economic design. However, if a succession of flatter curves or tangent sections would encourage drivers to operate at higher speeds, that section of highway should be designed for a higher speed and all geometric features, particularly that of sight distance on crest vertical curves and intersection sight distance should be related to it.

Table A-1-1M indicates the various speed ranges applicable to each functional classification.

EXCEPTIONS

Where it is impractical or not economical to obtain the minimum design as shown in the Geometric Standard tables, an exception shall be secured from the State Location and Design Engineer on **all** projects. On all new or reconstruction Interstate projects deviations from AASHTO standards (desirable standards where specified) must obtain the written approval of the Federal Highway Administration regardless of funding source. For Interstate projects, other than new or major reconstruction, all deviations from minimum AASHTO standards (in place at the time of original construction of that portion of the interstate) must be given written approval of the Federal Highway Administration regardless of funding source. For projects on the National Highway System with Federal Oversight, deviation from AASHTO Design standards must be given written approval by the Federal Highway Administration.

On State funded rural projects where design constraints require that the overall design speed selected for a project is less than the design speed which would be normally selected based on terrain, a design exception is not required if the speed falls within the range of design speeds shown in Table A-1-1M for the particular class of roadway being designed. The designer must fully document the necessity for the use of a reduced design speed (or any design exception) and have it approved in accordance with Design Exception Requirements form LD-440. For additional instructions on Design Exceptions, see Instructional and informational Memorandum IIM-LD-227. The designer should exercise care to avoid selecting a speed which may be lower than the speed the average driver would expect because of impacts on traffic operations and safety which may result.

DESIGN SPEEDS FOR VARIOUS FUNCTIONAL CLASSIFICATIONS

L=Min. for Level Terrain
R=Min. for Rolling Terrain
M=Min. for Mountainous Terrain (As defined by Section 23 of the Highway Capacity Manual)
CBD=Min. for Central Business District
S=Min. for Suburban Area
D=Min. for Developing Area

ROADWAY CLASSIFICATION		SPEED (kmh) 30	50	60	80	100	110
RURAL ARTERIAL	FREEWAYS MIN. 60 km/h –M MIN. 80 km/h –R 110 km/h-Desirable			✔ M	✔ R	✔ L	✔
RURAL COLLECTOR ROAD	ADT OVER 2000			✔ M	✔ R	✔ L	
	CURRENT ADT 400 TO 2000		✔ M	✔ R	✔ L		
	CURRENT ADT UNDER 400	✔ M	✔ R	✔ L			
RURAL LOCAL ROAD	CURRENT ADT OVER 400		✔ M	✔ R	✔ L		
	CURRENT ADT 400 OR UNDER	✔ M	✔ R	✔ L			
URBAN ARTERIAL	FREEWAYS MIN. 80 km/h		✔ CBD	✔ S	✔	✔ D	✔
URBAN COLLECTOR STREET			✔	✔	✔		
URBAN LOCAL STREET		✔	✔				

DESIRABLE VALUES, unless noted otherwise, are greater than or equal to MINIMUM +10 km/h.

For Urban Local Streets: Desirable value is greater than or equal to minimum + 10 km/h, but less than 80 km/h.

TABLE A-1-1

GEOMETRIC DESIGN STANDARDS FOR RURAL PRINCIPAL ARTERIAL SYSTEM (GS-1M)

	TERRAIN	DESIGN SPEED (km/h)	MINIMUM RADIUS (METERS)	(6)(7) STOPPING SIGHT DISTANCE (METERS)		MIN. WIDTH OF LANE	(1) MINIMUM WIDTH OF GRADED SHOULDERS		(2) PAVED SHOULDER WIDTH		(3) WIDTH OF DITCH (FRONT SLOPE)	(4) SLOPE	(5) NEW AND RECONSTRUCTED MINIMUM BRIDGE WIDTHS AND VERTICAL CLEARANCES
				DESIRABLE	MIN.		FILL	CUT	RT.	LT.			
FREEWAYS	LEVEL	110	502	247	220	3.6 m	4.5 m	3.6 m	3.0 m	1.2 m	3.6 m	CS-4B	2 THRU LANES SAME DIRECTION = 1.5 m + PAVE. WIDTH + 3.6 m 3 OR MORE THRU LANES SAME DIRECTION = 3.6 m + PAVE. WIDTH + 3.6 m
	ROLLING	100	394	205	185								
	MOUNTAINOUS	80	230	140	130							CS-4E	
OTHER PRINCIPAL ARTERIALS	LEVEL	110	502	247	220	3.6 m	3.9 m	3.0 m	2.4 m	1.2 m	3.0 m	CS-4 OR 4B	UNDIVIDED & DIVIDED 3 OR MORE THRU LANES SAME DIRECTION = 3.0 m + PAVE. WIDTH +3.0 m
		100	394	205	185								
	ROLLING	100	394	205	185						1.8 m	CS-4 OR 4E	
		80	230	140	130								
	MOUNTAINOUS	80	230	140	130							CD-3 OR 3B	DIVIDED 2 THRU LANES SAME DIRECTION 1.5 m + PAVE. WIDTH + 3.0 m
		60	124	85	85								

GENERAL NOTES

Freeways - A design speed of 110 km/h should be used for Rural Freeways. Where terrain is mountainous a design speed of 100 km/h or 80 km/h, which is consistent with driver expectancy, may be used. All new and major reconstructed Interstate facilities will have a 110 km/h design speed unless a lower design speed is approved by the Location and Design Engineer and FHWA.

Other Principle Arterials - A design speed of 60 to 110 km/h should be used depending on terrain, driver expectancy and whether the design is constructed on new location or reconstruction of an existing facility. An important safety consideration in the selection of one of the lower design speeds in each range is to have a properly posted speed limit which is enforced during off peak hours.

Incorporated towns or other built-up areas, Urban Standard GS-5(M) may be used for design.

Standard TC-5.01R(M) superelevation based on 8% maximum is to be used for all Rural Principle Arterials.

RELATIONSHIP OF MAXIMUM GRADES TO DESIGN SPEEDS

TYPE OF TERRAIN	FREEWAYS			ARTERIALS			
	DESIGN SPEED (km/h)						
	80	100	110	60	80	100	110
	GRADES (PERCENT) *						
LEVEL	4	3	3	5	4	3	3
ROLLING	5	4	4	6	5	4	4
MOUNTAINOUS	6	6	5	8	7	6	5

Grades 1 percent steeper than the value shown may be used on Rural Freeways in extreme situations for one-way downgrades except in mountainous terrain.

Clear Zone and Recoverable Area information can be found in Appendix A(M), Section A-2(M) of the Road Design Manual.

If medians are included, see Section 2D-6 of Chapter 2D of the Road Design Manual.

FOOTNOTES

(1) Shoulder widths shown are for right shoulders and independently graded median shoulders. An 2.4 m graded median shoulder will be provided when the mainline is 4 lanes (both directions). For 6 or more lanes, the median shoulder provided will be the same as that shown for independent grading.

(2) When the mainline is 6 or more lanes, the left paved shoulder width should be the same as the right paved shoulder. On Freeways, if truck traffic exceeds 250 DDHV, the right paved shoulder width preferably should be 3.6 m, and on 6 or more lane Freeways, the left paved shoulder width should also preferably be 3.6 m if truck traffic exceeds 250 DDHV.

(3) Ditch slopes to be 6:1 - 3.0 m and 3.6 m widths and 4:1 - 1.8 m width.

(4) Additional or modified slope criteria to apply where shown on typical sections.

(5) Vertical clearance at roadway underpasses for new and reconstructed bridges is to be 5.05 m (0.3 m additional clearance required for non-vehicular overpasses).

(6) For intersection sight distance requirements, see Appendix C, Table C-1-5.

(7) Use desirable value as minimum on Interstate system.

FIGURE A - 1 - 1M

GEOMETRIC DESIGN STANDARDS FOR RURAL MINOR ARTERIAL SYSTEM (GS-2M)

TRAFFIC VOLUME	TERRAIN	DESIGN SPEED (km/h)	MINIMUM RADIUS (METERS)	(8) STOPPING SIGHT DISTANCE (METERS)		MINIMUM PASSING SIGHT DISTANCE (METERS)	(2) MIN. WIDTH OF LANE	(3) MIN. WIDTH OF GRADED SHOULDERS		(4) PAVED SHOULDER WIDTH		(5) WIDTH OF DITCH (FRONT SLOPE)	(6) SLOPE	(7) NEW AND RECONSTRUCTED MINIMUM BRIDGE WIDTHS AND VERTICAL CLEARANCES
				DESIRABLE	MIN.			FILL W/GR	CUT & FILL	RT.	LT.			
ADT OVER 2000	LEVEL	110	502	247	220	730	3.6 m	3.9 m	3.0 m	2.4 m	1.2 m	3.0 m	CS-4, CS-4A OR CS-4C	3.0 m PLUS PAVEMENT WIDTH PLUS 3.0 m
		100	394	205	185	670								
	ROLLING	100	394	205	185	670								
		80	230	140	130	540						1.8 m	CS-3 OR CS-3B	
	MOUNTAINOUS	80	230	140	130	540								
		60	124	85	85	410								
ADT 1500 TO 2000	LEVEL	110	502	247	220	730	3.6 m	3.3 m	2.4 m	1.8 m	1.2 m	1.8 m	CS-4, CS-4A OR CS-4C	2.4 m PLUS PAVEMENT WIDTH PLUS 2.4 m
		100	394	205	185	670								
	ROLLING	100	394	205	185	670								
		80	230	140	130	540	3.3 m							
	MOUNTAINOUS	80	230	140	130	540							CS-3 OR CS-3B	
		60	124	85	85	410								
ADT 400 TO 1500	LEVEL	110	502	247	220	730	3.6 m	3.3 m	2.4 m	1.8 m	1.2m	1.8 m	CS-4, CS-4A OR CS-4C	
		100	394	205	185	670								
	ROLLING	100	394	205	185	670								
		80	230	140	130	540	3.3 m							
	MOUNTAINOUS	80	230	140	130	540							CS-3 0R CS-3B	
		60	124	85	85	410								
ADT UNDER 400	LEVEL	110	502	247	220	730	3.6 m	2.7 m	1.8 m	1.2 m	1.2 m	1.8 m	CS-4, CS-4A OR CS-4C	1.8 m PLUS PAVEMENT WIDTH PLUS 1.8 m
		100	394	205	185	670								
	ROLLING	100	394	205	185	670								
		80	230	140	130	540	3.3 m							
	MOUNTAINOUS	80	230	140	130	540							CS-3 OR CS-3B	
		60	124	85	85	410								

GENERAL NOTES

Rural Minor Arterials are designed with design speeds of 80 to 110 km/h, dependent on terrain features and traffic volumes, and occasionally may be as low as 60 km/h in mountainous terrain.

In incorporated towns or other built-up areas, Urban Standard GS-6(M) may be used for design.

Standard TC-5.01R(M) superelevation based on 8% maximum is to be used for Rural Minor Arterials.

If medians are included, see Section 2D of the Road Design Manual.

Clear zone and Recoverable Area information can be found in Appendix A(M), Section A-2(M) of the Road Design Manual.

RELATIONSHIP OF MAXIMUM GRADES TO DESIGN SPEEDS

TYPE OF TERRAIN	DESIGN SPEED (km/h)			
	60	80	100	110
	GRADES (PERCENT)			
LEVEL	5	4	3	3
ROLLING	6	5	4	4
MOUNTAINOUS	8	7	6	5

FOOTNOTES

(1) Use current ADT for restoration type projects and use design year ADT for all other projects.

(2) Lane width to be 3.6 m at all interchange locations. For projects not on the National Highway System, width of traveled way may remain at 6.6 m on reconstructed highways where alignment and safety records are satisfactory.

(3) If graded median is used, the width of median shoulder is to be 2.4 m.

(4) The Paved widths shown are the widths to be used if the Materials Division recommends the shoulders be paved or stabilized. When the mainline is 4 lanes (both directions) a minimum 2.4 m wide paved shoulder will be provided on the right of traffic and a minimum 1.2 m wide paved shoulder on the median side. Where the mainline is 6 or more lanes, both right and median paved shoulders will be 2.4 m in width. If paved shoulders are not recommended by the Materials Division the mainline pavement structure will be extended 0.3 m at the same slope into the shoulder to eliminate raveling of the pavement edge.

(5) Ditch slopes to be 6:1 - 3.0 m width, 4:1 - 1.8 m width.

(6) Additional or modified slope criteria to be applied where shown on typical sections.

(7) Vertical clearance at roadway underpasses for new and reconstructed bridges is to be 5.05 m (0.3 m additional clearance required for non-vehicular overpasses).

(8) For intersection sight distance requirements, see Appendix C, Table C-1-5.

FIGURE A - 1 - 2M

GEOMETRIC DESIGN STANDARDS FOR RURAL COLLECTOR ROAD SYSTEM (GS-3M)

DESIGN YEAR TRAFFIC VOLUME	TERRAIN	DESIGN SPEED (km/h)	MINIMUM RADIUS (METERS)	(9) STOPPING SIGHT DISTANCE (METERS		MINIMUM PASSING SIGHT DISTANCE (METERS)	(2) MIN. WIDTH OF LANE	(3) (4) MIN. WIDTH OF GRADED SHOULDERS		(5) WIDTH OF DITCH (FRONT SLOPE)	(6) RECOMMENDED SLOPE	(7) (8) NEW AND RECONSTRUCTED MINIMUM BRIDGE WIDTHS AND VERTICAL CLEARANCES
				DESIRABLE	MIN.			FILL W/GR	CUT & FILL			
ADT OVER 2000	LEVEL	100	394	205	185	670	3.6 m	3.3 m	2.4 m	3.0 m	CS-4, CS-4A, OR CS-4C	2.4 m PLUS PAVEMENT WIDTH PLUS 2.4m
	ROLLING	80	230	140	130	540						
	MOUNTAINOUS	60	124	85	85	410				1.8 m	CS-3 OR CS-3B	
ADT 1500 TO 2000	LEVEL	80	230	140	130	540	3.3 m	2.7 m	1.8 m	1.8 m	CS-4, CS-4A, OR CS-4C	1.2 m PLUS PAVEMENT WIDTH PLUS 1.2 m
	ROLLING	60	124	85	85	410						
	MOUNTAINOUS	50	83	65	65	345				1.2 m	CS-3 OR CS-3B	
ADT 400 TO 1500	LEVEL	80	230	140	130	540	3.3 m	2.4 m	1.5 m	1.8 m	CS-4, CS-4A, OR CS-4C	1.0 m PLUS PAVEMENT WIDTH PLUS 1.0 m
	ROLLING	60	124	85	85	410						
	MOUNTAINOUS	50	83	65	65	345	3.0 m			1.2 m	CS-3 OR CS-3B	
ADT UNDER 400	LEVEL	60	124	85	85	410	3.0 m	2.1 m	0.6 m	1.8 m	CS-1	0.6 m PLUS PAVEMENT WIDTH PLUS 0.6 m
	ROLLING	50	83	65	65	345				1.2 m		
	MOUNTAINOUS	30	29	35	35	200						

GENERAL NOTES

Geometric design features should be consistent with a design speed appropriate for the conditions.

Low design speeds (60 km/h and below) are generally applicable to highways with curvilinear alignment in rolling or mountainous terrain and where environmental conditions dictate.

High design speeds (80 km/h and above) are generally applicable to highways in level terrain or where other environmental conditions are favorable.

Intermediate design speeds would be appropriate where terrain and other environmental conditions are a combination of those described for low and high speed.

The designer should strive for higher values than the minimum where conditions of safety dictate and costs can be supported.

In incorporated towns or other built-up areas, Urban Standard GS-7M may be used.

Standard TC-5.01R(M) superelevation based on 8% Maximum to be used for Rural Collectors.

RELATIONSHIP OF MAXIMUM GRADES TO DESIGN SPEEDS

TYPE OF TERRAIN	DESIGN SPEED (km/h)					
	30	50	60	80	100	110
	GRADES (PERCENT)					
LEVEL	7	7	7	6	5	4
ROLLING	10	9	8	7	6	5
MOUNTAINOUS	12	10	10	9	8	6

Maximum grades of short length (less than 150 m), on one-way downgrades and on low-volume Rural Collectors may be 2 percent steeper.

Clear zone and Recoverable Area information can be found in Appendix A(M), Section A-2(M) of the Road Design Manual.

FOOTNOTES

(1) 2.7 m minimum for ADT under 250.

(2) Lane width to be 3.6 m at all interchange locations.

(3) Provide 1.2 m wide paved shoulders when design year ADT exceeds 2000 VPD, with 5% or more truck and bus usage. All shoulders not being paved will have the mainline pavement structure extended 0.3 m on the same slope into the shoulder to eliminate raveling at the pavement edge.

(4) When the mainline is four lanes, a minimum paved shoulder width of 1.8 m right of traffic and 0.9 m left of traffic will be provided.

(5) Ditch slopes to be 6:1 - 3.0 m width, 4:1 - 1.8 m width, 3:1 - 1.2 m width.

(6) Additional or modified slope criteria to be applied where shown on typical sections.

(7) Where the approach roadway width (traveled way plus shoulder) is surfaced, that surfaced width shall be carried across all structures if that width exceeds the width shown in this table.

(8) Vertical clearance at roadway underpasses for new and reconstructed bridges is to be 5.05 m desirable and 4.45 m minimum (0.3 m additional clearance required for non-vehicular overpasses).

(9) For intersection sight distance requirements, see Appendix C, Table C-1-5.

FIGURE A - 1 - 3M

GEOMETRIC DESIGN STANDARDS FOR RURAL LOCAL ROAD SYSTEM (GS-4M)

TRAFFIC VOLUME	TERRAIN	DESIGN SPEED (km/h)	MINIMUM RADIUS (METERS)	(8) STOPPING SIGHT DISTANCE		MINIMUM PASSING SIGHT DISTANCE	(1) MIN. WIDTH OF SURFACING OR PAVEMENT	(2)(3)(4) MIN. WIDTH OF GRADED SHOULDERS		(5) WIDTH OF DITCH (FRONT SLOPE)	(6) RECOMMENDED SLOPE	(7) NEW AND RECONSTRUCTED MINIMUM BRIDGE WIDTHS AND VERTICAL CLEARANCE
				DESIRABLE	MIN.			FILL W/GR	CUT & FILL			
ADT OVER 2000	LEVEL	80	230	140	130	550	7.2 m	3.3 m	2.4 m	1.8 m	CS-4, 4A OR 4C	APPROACH ROADWAY WIDTH
	ROLLING	60	124	85	85	410					CS-3, 3A OR 3B	
	MOUNTAINOUS	50	83	65	65	345				1.2 m		
ADT 1500 TO 2000	LEVEL	80	230	140	130	550	6.6 m	2.7 m	1.8 m	1.8 m	CS-4, 4A OR 4C	10 m PLUS PAVEMENT WIDTH PLUS 10 m
	ROLLING	60	124	85	85	410					CS-3, 3A OR 3B	
	MOUNTAINOUS	50	83	65	65	345				1.2 m		
ADT 400 TO 1500	LEVEL	80	230	140	130	550	6.6 m	2.4 m	1.5 m	1.8 m	CS-4, 4A OR 4C	
	ROLLING	60	124	85	85	410	6.0 m				CS-3, 3A OR 3B	
	MOUNTAINOUS	50	83	65	65	345				1.2 m		
ADT 400 TO 250	LEVEL	60	124	85	85	410	5.4 m	2.1 m	0.6 m	1.8 m	CS-1	0.6 m PLUS PAVEMENT WIDTH PLUS 0.6 m
	ROLLING	50	83	65	65	345				1.2 m		
	MOUNTAINOUS	30	29	35	35	200						
ADT 250 TO 50	LEVEL	50	83	65	65	345	5.4 m	2.1 m	0.6 m	1.2 m	CS-1	
	ROLLING	50	83									
	MOUNTAINOUS	30	29	35	35	200						
ADT UNDER 50	LEVEL	50	83	65	65	345	5.4 m	2.1 m	0.6 m	1.2 m	CS-1	
	ROLLING	30	29	35	35	200						
	MOUNTAINOUS	30	29									

GENERAL NOTES

Low design speeds are generally applicable to roads with winding alignment in rolling or mountainous terrain where environmental conditions dictate.

High design speeds are generally applicable to roads in level terrain or where other environmental conditions are favorable.

Intermediate design speeds would be appropriate where terrain and other environmental conditions are a combination of those described for low and high speed.

Standard TC-5.01R(M) superelevation based on 8% maximum is to be used.

In incorporated towns or other built-up areas, Urban Standard GS-8(M) may be used.

RELATIONSHIP OF MAXIMUM GRADES TO DESIGN SPEEDS

TYPE OF TERRAIN	DESIGN SPEED (km/h)				
	30	50	60	80	100
	GRADES (PERCENT)				
LEVEL	8	7	7	6	5
ROLLING	11	10	10	8	6
MOUNTAINOUS	16	14	13	10	--

FOOTNOTES

(1) Lane width to be 3.6 m at all interchange locations.

(2) In mountainous terrain or sections with heavy earthwork, the graded width of shoulder in cuts may be decreased 0.6 m, but in no case shall the shoulder width be less than 0.6 m.

(3) Minimum shoulder slope shall be 8% on low side and same slope as pavement on high side.

(4) Provide 1.2 m wide paved shoulders when design year ADT exceeds 2000 VPD, with 5% or more truck and bus usage. All shoulders not being paved will have the mainline pavement structure extended 0.3 m on the same slope into the shoulder to eliminate raveling at the pavement edge.

(5) Ditch slopes to be 4:1 - 1.8 m width, 3:1 - 1.2 m width.

(6) Additional or modified slope criteria to be applied where shown on typical sections.

(7) Vertical clearance at roadway underpasses for new and reconstructed bridges is 5.05 m desirable and 4.45 m minimum (0.3 m additional clearance required for non-vehicular overpasses).

(8) For intersection sight distance requirements, see Appendix C, Table C-1-5.

FIGURE A - 1 - 4M

GEOMETRIC DESIGN STANDARDS FOR URBAN PRINCIPAL ARTERIAL SYSTEM (GS-5M)

	DESIGN SPEED (km/h)	MINIMUM RADIUS (METERS)		(13) STOPPING SIGHT DISTANCE (METERS)		MIN. WIDTH OF LANE	(1) MIN. WIDTH GRADED SHOULDERS		(2) PAVED SHOULDER WIDTH		(3) WIDTH OF DITCH (FRONT SLOPE)	(4) SLOPE	(7) NEW AND RECONSTRUCTED MINIMUM BRIDGE WIDTHS AND VERTICAL CLEARANCES
		U	ULS	DESIRABLE	MIN.		FILL W/GR	CUT & FILL	RT.	LT.			
FREEWAYS	110	502	-	247	220	3.6 m	4.5 m	3.6 m	3.0 m	1.2 m	3.6 m	CS-4 OR CS-4B	2 THRU LANES SAME DIRECTION = 1.8 m + PAVE. WIDTH + 3.6 m
	100	394	-	205	185								3 OR MORE THRU LANES SAME DIRECTION = 3.6 m + PAVE. WIDTH + 3.6 m
	80	280	-	140	130							CS-4 OR 4E	
OTHER PRINCIPAL ARTERIAL WITH SHOULDER DESIGN	100	394	-	205	185	(12) 3.6 m	3.9 m	3.0 m	2.4 m	1.2 m	3.0 m	CS-4 OR CS-4E	UNDIVIDED & DIVIDED 3 OR MORE THRU LANES SAME DIRECTION = 3.6 m + PAVE. WIDTH + 3.6 m
	80	280	-	140	130						1.8 m		
	60	150	138	85	85	(5)(6)(12) 3.3 m						CS-3 OR CS-3B	2 THRU LANES (DIVIDED) SAME DIRECTION 1.8 m + PAVE. WIDTH + 3.0 m
	50	99	85	65	65								
	MIN. DESIGN SPEED (km/h)	MINIMUM RADIUS (METERS)		STOPPING SIGHT DISTANCE (METERS)		MIN. WIDTH OF LANE	(8) STANDARD CURB & GUTTER		BUFFER STRIP WIDTH		(9) MIN. SIDEWALK WIDTH	(10) SLOPE	(7) NEW AND RECONSTRUCTED MINIMUM BRIDGE WIDTHS AND VERTICAL CLEARANCES
		U	ULS	DESIRABLE	MIN.								
OTHER PRINCIPAL ARTERIAL WITH GUTTER	100	394	-	205	185	(12) 3.6 m	CG-7		(11)		1.5 m	2:1	SAME AS CURB TO CURB OF APPROACHES
	80	280	-	140	130								
	70	215	211	111	105								
	60	150	138	85	85	(5)(6)(12) 3.3 m	CG-6						
	50	99	85	65	65								

GENERAL NOTES

Freeways - Urban Freeways should accommodate desired safe operating speeds during non-peak hours, but should not be so high as to exceed the limits of prudent construction, right of way and socioeconomic costs due to the large proportion of vehicles which are accommodated during periods of peak flow when lower speeds are necessary. The design speeds for Freeways should never be less than 80 km/h.

On many Urban Freeways, particularly in suburban areas, a design speed of 100 km/h or higher can be provided with little additional cost above that required for 80 km/h design speed. The corridor of the mainline may be relatively straight and the character and location of interchanges may permit high speed design. Under these conditions, a design speed of 110 km/h is most desirable because the higher design speeds are closely related to the overall quality and safety of the facility.

Other Principal Arterials - Design speeds for Urban Arterials generally range from 60 to 100 km/h, and occasionally may be as low as 50 km/h. The lower (60 km/h and below) speeds apply in the central business district and intermediate areas. The higher speeds are more applicable to the outlying business and developing areas.
Standard TC-5R(M) (Rural) superelevation based on 8% maximum is to be used for all Freeways and other Principal Arterials with a design speed greater than or equal to 100 km/h.

RELATIONSHIP OF MAXIMUM GRADES TO DESIGN SPEEDS

TYPE OF TERRAIN	FREEWAYS *			ARTERIALS				
	DESIGN SPEED (km/h)							
	80	100	110	50	60	70	80	100
	GRADES (PERCENT)							
LEVEL	4	3	3	8	7	6	6	5
ROLLING	5	4	4	9	8	7	7	6
MOUNTAINOUS	6	6	5	11	10	9	9	8

* Grades 1 percent steeper that the value shown may be used on Urban Freeways for extreme cases in urban areas where development precludes the use of flatter grades and for one-way downgrades, except in mountainous terrain.

Standard TC-5U(M) (Urban) superelevation based on 4% maximum is to be used on Other Principal Arterials with a design speed less than 100 km/h.

Standard TC-5ULS(M) (Urban Low Speed) superelevation based on 2% maximum is to be used on Other Principal Arterials with a design speed less than or equal to 70 km/h (70 km/h = 211 m minimum radius).

Clear Zone and Recoverable Area information can be found in Appendix A(M), Section A-2(M) of the Road Design Manual.

If medians are included, see Section 2D-6 of Chapter 2D of the Road Design Manual.

A minimum 9.2 m width of surfacing or a minimum 9.2 m face to face of curb is to be used within incorporated cities or towns to qualify for maintenance payments.

For guidelines on Interchange Ramp, see Standard GS-R(M).

FOOTNOTES

(1) Shoulder widths shown are for right shoulders and independently graded median shoulders. A 2.4 m graded median shoulder will be provided when the mainline is 4 lanes (both directions). For 6 or more lanes, the median shoulder provided will be the same as that shown for independent grading.
(2) When the mainline is 6 or more lanes, the left paved shoulder width should be the same as the right paved shoulder. On Freeways, if truck traffic exceeds 250 DDHV, the right paved shoulder width preferably should be 3.6 m, and on 6 or more lane Freeways, the left paved shoulder width should also preferably be 3.6 m if truck traffic exceeds 250 DDHV.
(3) Ditch slopes to be 6:1 - 3.0 m and 3.6 m widths and 4:1 - 1.8 m width.
(4) Additional or modified slope criteria to apply where shown on typical sections.
(5) Minimum lane width to be 3.6 m at all interchange locations.
(6) If heavy truck traffic is anticipated, an additional 0.3 m width is desirable.
(7) Vertical clearance at roadway underpasses for new and reconstructed bridges is to be 5.05 m (0.3 m additional clearance required for non-vehicular overpasses).
(8) Or equivalent City or Town design.
(9) Width of 2.4 m or more may be needed in commercial areas.
(10) 3:1 and flatter slopes may be used when the right of way is behind the sidewalk (or sidewalk space) in residential or other areas where slopes will be maintained by the property owner.
(11) If a buffer strip is used between the back of curb and sidewalk, it should be 0.6 m minimum.
(12) Situations having restrictions on trucks may allow the use of lanes 0.3 m less in width.
(13) For intersection sight distance requirements, see Appendix C, Table C-1-5.

FIGURE A-1-5M

GEOMETRIC DESIGN STANDARDS - URBAN MINOR ARTERIAL STREET SYSTEM (GS-6M)

	DESIGN SPEED (km/h)	MINIMUM RADIUS (METERS)		(12) STOPPING SIGHT DISTANCE (METERS)		(11) MIN. WIDTH OF LANE	(3) STANDARD CURB & GUTTER		BUFFER STRIP WIDTH		(4) MIN. SIDEWALK WIDTH	(5) SLOPE	(6) NEW AND RECONSTRUCTED MINIMUM BRIDGE WIDTHS AND VERTICAL CLEARANCES
		U	ULS	DESIRABLE	MIN.								
STREETS WITH CURB & GUTTER	100	394	-	205	185	3.6 m	CG-7		(10)		1.5 m	2:1	SAME AS CURB TO CURB OF APPROACHES
	80	280	-	140	130								
	70	215	211	111	105		CG-6						
	60	150	138	85	85	(1)(2) 3.3 m							
	50	99	85	65	65								
	MIN. DESIGN SPEED (km/h)	MINIMUM RADIUS (METERS)		STOPPING SIGHT DISTANCE (METERS)		MIN. WIDTH OF LANE	(7) MIN. WIDTH OF GRADED SHOULDERS		(8) PAVED SHOULDER WIDTH		(9) MIN. SIDEWALK WIDTH	(5) SLOPE	(6) NEW AND RECONSTRUCTED MINIMUM BRIDGE WIDTHS AND VERTICAL CLEARANCES
		U	ULS	DESIRABLE	MIN.		FILL W/GR	CUT & FILL	RT	LT			
STREETS WITH SHOULDER DESIGN	100	394	-	205	185	3.6 m	3.9 m	3.0 m	2.4 m	1.2 m	3.0 m	2:1	3.0 m + PAVEMENT WIDTH + 3.0 m
	80	280	-	140	130								
	60	150	138	85	85	(1)(2) 3.3 m	3.3 m	2.4 m	1.8 m	1.2 m	1.8 m		2.4 m + PAVEMENT WIDTH + 2.4 m
	50	99	85	65	65								

GENERAL NOTES

Design Speeds for Urban Arterials generally range from 60 to 80 km/h and occasionally may be as low as 50 km/h. The lower (60 km/h and below) speeds apply in the central business district and intermediate areas. The higher speeds are more applicable to the outlying business and developing areas.

Standard TC-5.01R(M) superelevation based on 8% maximum is to be used for 100 km/h design speed.

Standard TC-5.01U(M) (Urban) superelevation based on 4% maximum is to be used for design speeds less than 100 km/h.

Standard TC-5.01ULS(M) (Urban Low Speed) superelevation based on 2% maximum may be used for design speeds less than or equal to 70 km/h (70 km/h = 211 m minimum radius).

Clear Zone and Recoverable Area information can be found in Appendix A(M), Section A-2(M) of the Road Design Manual.

If medians are included, see Section 2D-6 of Chapter 2D of the Road Design Manual.

A minimum 9.2 m width of surfacing or a minimum 9.2 m face to face of curb is to be used within incorporated cities or towns to qualify for maintenance payments.

RELATIONSHIP OF MAXIMUM GRADES TO DESIGN SPEEDS

TYPE OF TERRAIN	DESIGN SPEED (km/h)				
	50	60	70	80	100
	GRADES (PERCENT)				
LEVEL	8	7	6	6	5
ROLLING	9	8	7	7	6
MOUNTAINOUS	11	10	9	9	8

FOOTNOTES

(1) Lane width to be 3.6 m at all interchanges or if design year ADT exceeds 2000.

(2) If heavy truck traffic is anticipated, an additional 0.3 m width is desirable.

(3) Or equivalent City or Town design.

(4) A width of 2.4 m or more may be needed in commercial areas.

(5) 3:1 and flatter slopes may be used when the right of way is behind the sidewalk (or sidewalk space) in residential or other areas where slopes will be maintained by the property owner.

(6) Vertical clearance at roadway underpasses for new and reconstructed bridges is to be 5.05 m (0.3 m additional clearance required for non-vehicular overpasses).

(7) If graded median is used, the width of median shoulder is to be 2.4 m.

(8) The Paved widths shown are the widths to be used if the Materials Division recommends the shoulders be paved or stabilized. When the mainline is 4 lanes (both directions) a minimum 2.4 m wide paved shoulder will be provided on the right of traffic and a minimum 1.2 m wide paved shoulder on the median side. Where the mainline is 6 or more lanes, both the right and median paved shoulders will be 2.4 m in width. If paved shoulders are not recommended by the Materials Division, the mainline pavement structure will be extended 0.3 m at the same slope into the shoulder to eliminate raveling of the pavement edge.

(9) Ditch slope to be 6:1 - 3.0 m width and 4:1 - 1.8 m width.

(10) If a buffer strip is used between the back of curb and sidewalk, it should be 0.6 m minimum.

(11) Situations having restrictions on trucks may allow the use of lanes 0.3 m less in width.

(12) For intersection sight distance requirements, see Appendix C, Table C-1-5.

FIGURE A - 1 - 6M

GEOMETRIC DESIGN STANDARDS FOR URBAN COLLECTOR STREET SYSTEM (GS-7M)

	DESIGN SPEED (km/h)	MINIMUM RADIUS (METERS)		STOPPING SIGHT (11) DISTANCE (METERS)		(1) (2) MIN. WIDTH OF LANE	(3) STANDARD CURB & GUTTER	BUFFER STRIP WIDTH	(4) MIN. SIDEWALK WIDTH	(5) SLOPES	(8) (9) NEW AND RECONSTRUCTED MINIMUM BRIDGE WIDTHS AND VERTICAL CLEARANCES
		U	ULS	DESIRABLE	MIN.						
STREETS WITH CURB & GUTTER	80	280	--	140	130	3.3 m	CG-7	(10)	1.5 m	2:1	SAME AS CURB TO CURB OF APPROACHES
	70	215	211	111	105		CG-6				
	60	150	138	85	85						
	50	99	85	65	65						

	DESIGN SPEED (km/h)	MINIMUM RADIUS (METERS)		STOPPING SIGHT DISTANCE (METERS)		(1) (2) MIN. WIDTH OF LANE	(7) MINIMUM WIDTH OF GRADED SHOULDERS		(6) WIDTH OF DITCH (FRONT SLOPE)	(5) SLOPES	(8)(9) NEW AND RECONSTRUCTED MINIMUM BRIDGE WIDTHS AND VERTICAL CLEARANCES
		U	ULS	DESIRABLE	MIN.		FILL W/GR.	CUT & FILL			
STREETS W/ SHOULDER DESIGN	80	280	--	140	130	3.3 m	3.3 m	2.4 m	1.8 m	2:1	2.4 m + PAVEMENT WIDTH + 2.4 m
	60	150	138	85	85						
	50	99	85	65	65		2.1 m	1.2 m	1.2 m		1.2 m + PAVE. WIDTH + 1.2 m

GENERAL NOTES

A minimum design speed of 50 km/h or higher should be used for collector streets, depending on available right of way, terrain, adjacent development and other area controls.

In the typical street grid, the closely spaced intersections usually limit vehicular speeds and thus make the effect of design speed of less significance. Nevertheless, the longer sight distances and curve radii commensurate with design speeds higher than the value indicated result in safer highways and should be used to the extent practicable.

Standard TC-5.01U(M) (Urban) superelevation based on 4% maximum.

Standard TC-5.01ULS(M) (Urban-Low Speed) superelevation based on 2% maximum may be used with a design speed of 70 km/h or less (70 km/h = 211 m minimum radius).

A minimum 9.2 m width of surfacing or a minimum 9.2 m curb to curb is to be used within incorporated cities or towns to qualify for maintenance payments.

Clear zone and Recoverable Area information can be found in Appendix A(M), Section A-2(M) of the Road Design Manual.

RELATIONSHIP OF MAXIMUM GRADES TO DESIGN SPEEDS

TYPE OF TERRAIN	DESIGN SPEED (km/h)			
	50	60	70	80
	GRADES (PERCENT)			
LEVEL	9	9	8	7
ROLLING	11	10	9	8
MOUNTAINOUS	12	12	11	10

Maximum grades of short lengths (less than 150 m) and one-way down grades may be 2% steeper.

FOOTNOTES

(1) 3.6 m if ADT exceeds 2000. Where feasible, lanes should be 3.6 m wide in industrial areas; however, where available or attainable right of way imposes severe limitations, 3.0 m lanes can be used in residential areas and 3.3 m lanes can be used in industrial areas.

(2) Lane width to be 3.6 m at all interchange locations.

(3) Or equivalent City or Town Design.

(4) A width of 2.4 m or more may be needed in commercial areas.

(5) 3:1 and flatter slopes may be used when right of way is behind the sidewalk (or sidewalk space) in residential or other areas where the slopes will be maintained by the property owner.

(6) Ditch slopes to be 4:1 - 1.8 m width and 3:1 - 1.2 m width.

(7) When Design year ADT exceeds 2000VPD, with greater than 5% total truck and bus usage:
Provide 1.2 m wide paved shoulders when the graded shoulder is 1.5 m wide or greater or provide 1 m wide paved shoulders when the graded shoulder is 1.2 m wide. All shoulders not being paved will have the mainline pavement structure extended 0.3 m, on the same slope, into the shoulder to eliminate raveling at the pavement edge.

(8) Where the approach roadway width (traveled way plus shoulder) is surfaced, that surfaced width shall be carried across all structures if that width exceeds the width shown in this table.

(9) Vertical clearance at roadway underpasses for new and reconstructed bridges is to be 5.05 m desirable and 4.45 m minimum (0.3 m additional clearance required for non-vehicular overpasses).

(10) If a buffer strip is used between the back of curb and sidewalk, it should be 0.6 m minimum.

(11) For intersection sight distance requirements, see Appendix C, Table C-1-5.

FIGURE A - 1 - 7M

GEOMETRIC DESIGN STANDARDS FOR URBAN LOCAL STREET SYSTEM (GS-8M)

	DESIGN SPEED (km/h)	MINIMUM RADIUS (METERS) U	MINIMUM RADIUS (METERS) ULS	(1) MAX. PERCENT OF GRADE	(11) STOPPING SIGHT DISTANCE (METERS)	(2) MIN. WIDTH OF LANE	(3) STANDARD CURB & GUTTER	(4) BUFFER STRIP WIDTH	(5) MIN. SIDEWALK WIDTH	(6) SLOPE	(9) (10) NEW AND RECONSTRUCTED MINIMUM BRIDGE WIDTHS AND VERTICAL CLEARANCES
STREETS WITH CURB & GUTTER	50	99m	85m	15	58m	3.0m	CG-6	(10)	1.5m	2:1	SAME AS CURB TO CURB OF APPROACHES
	30	34m	22m		30m						

	DESIGN SPEED (km/h)	MINMUM RADIUS (METERS) U	MINMUM RADIUS (METERS) ULS	(1) MAX. PERCENT OF GRADE	STOPPING SIGHT DISTANCE (METERS)	(2) MIN. WIDTH OF LANE	(7) MIN. WIDTH GRADED SHOULDERS FILL W/GR.	(7) MIN. WIDTH GRADED SHOULDERS CUT & FILL	(8) WIDTH OF DITCH (FRONT) SLOPE	(6) SLOPE	(9) NEW AND RECONSTRUCTED MINIMUM BRIDGE WIDTHS AND VERTICAL CLEARANCES
STREETS WITH SHOULDER DESIGN	50	99m	85 m	15	58m	3.0m	2.1 m	1.2 m	1.2 m	3:1	1.2 m + PAVEMENT WIDTH +1.2 m
	30	34m	22 m		30m						

GENERAL NOTES

Design Speeds is not a major factor for local streets. For consistency in design elements, design speeds ranging from 30 to 50 km/h may be used, depending on available right of way, terrain, adjacent development and other area controls.

In the typical street grid, the closely spaced intersections usually limit vehicular speeds, making the effect of a design speed of less significance.

Design speeds exceeding 50 km/h in residential areas may require longer sight distances and increased curve radii, which would be contrary to the basic function of a local street.

Standard TC-5.01U(M) (Urban) superelevation based on 4% maximum.

Standard TC-5.01ULS(M) (Urban Low Speed) superelevation based on 2% maximum may be used with a design speed of 70 km/h or less (70 km/h = 211 m minimum radius).

A minimum 9.2 m width of surfacing or a minimum 9.2 m curb to curb is to be used within incorporated cities or towns to qualify for maintenance payments.

FOOTNOTES

(1) Grades in commercial and industrial areas should be less than 8 percent; desirably, less than 5 percent.

(2) Where feasible, lanes should be 3.3 m wide and in industrial areas should be 3.6 m wide; however, where available or attainable right of way imposes severe limitations, 2.7 m lanes can be used in residential areas and 3.3 m lanes can be used in industrial areas.

(3) Or equivalent City or Town design.

4) The minimum buffer strip width with no sidewalk or sidewalk space is to be 1.5 m.

(5) Widths of 2.4 m or more may be needed in commercial areas.

(6) 3:1 and flatter slopes may be used when the right of way is behind the sidewalk (or sidewalk space) in residential or other areas where slopes will be maintained by the property owner.

(7) When Design year ADT exceeds 2000 VPD, with greater than 5% total truck and bus usage:
Provide 1.2 m wide paved shoulders when the graded shoulder is 1.5 m wide or greater or provide 1 m wide paved shoulders when the graded shoulder is 1.2 m wide. All shoulders not being paved will have the mainline pavement structure extended 0.3 m, on the same slope, into the shoulder to eliminate raveling at the pavement edge.

(8) Ditch slopes to be 3:1 - 1.2 m width.

(9) Vertical clearance at roadway underpasses for new and reconstructed bridges is to be 5.05 m desirable and 4.45 m minimum (0.3 m additional clearance required for non-vehicular overpasses).

(10) If a buffer strip is used between the back of curb and sidewalk, it should be 0.6 m minimum.

(11) For intersection sight distance requirements, see Appendix C, Table C-1-5.

FIGURE A - 1 - 8M

GEOMETRIC DESIGN STANDARDS FOR SERVICE ROADS (GS-9M)

(1) DEAD END SERVICE ROADS UNDER 25 VPD									
PROPERTIES SERVED	DESIGN SPEED (km/h)	MINIMUM RADIUS (METERS)	STOPPING SIGHT DISTANCE (METERS)	MINIMUM PASSING SIGHT DISTANCE (METERS)	(2) MINIMUM TRAVELED WAY WIDTH	MINIMUM WIDTH OF SHOULDER		(3) WIDTH OF DITCH (FRONT SLOPE)	SLOPES
						FILL W/GR.	CUT & FILL		
1	20	10m	40m	-	3.6m	1.2m	0.6m	0.9m	(4)
OVER 1	30	29m	70m	20m	4.2m	1.5m			

GENERAL NOTES

The minimum design speed for service roads should be 30 km/h except for one lane service roads serving one property which may have a minimum design speed of 20 km/h.

Standard TC-5.01R(M) superelevation based on 8% maximum to be used.

RELATIONSHIP OF MAXIMUM GRADES TO DESIGN SPEEDS				
TYPE OF TERRAIN	DESIGN SPEED (km/h)			
	20	30	50	60
	GRADES (PERCENT)			
LEVEL	8	8	7	7
ROLLING	12	11	10	9
MOUNTAINOUS	18	16	14	12

FOOTNOTES

(1) For through service roads and dead end service roads with over 25 VPD, use Standards shown for Local Roads and Streets.

(2) Under adverse conditions, intermittent shoulder sections or turnouts for passing may be required (see page 415, 2001 AASHTO A Policy on Geometric Design of Highways and Streets).

(3) Ditch slope to be 3:1.

(4) Slopes to be same as mainline when service road is parallel to or otherwise visible from the mainline. For other cases slopes should be in accordance with standards for Local Roads and Streets.

FIGURE A - 1 - 9M

GEOMETRIC DESIGN STANDARDS FOR INTERCHANGE RAMPS (GS-RM)

	RAMP DESIGN SPEED (km/h)	MINIMUM RADIUS (METERS)	(6) STOPPING SIGHT DISTANCE (METERS)		(1) MINIMUM RAMP PAVEMENT WIDTHS	MINIMUM WIDTH OF SHOULDER					(5) WIDTH OF DITCH (FRONT SLOPE)	(4) NEW AND RECONSTRUCTED MINIMUM BRIDGE WIDTHS
						RIGHT OF TRAFFIC		LEFT OF TRAFFIC				
						GRADED WIDTH	(2)(3) PAVED WIDTH	GRADED WIDTH		(2) (3) PAVED WIDTH		
			DESIRABLE	MIN.				FILL W/GR.	CUT & FILL			
INTERCHANGE RAMPS	100	394	205	185	4.8m	3.3m	2.4m	2.7m	1.8m	1.2m	3.0m	1.8 m PLUS PAVEMENT WIDTH PLUS 2.4 m
	80	230	140	130								
	60	124	85	85								
	50	83	65	65								
	40	51	50	50	5.4m							
	30	29	35	35								
AUXILIARY LANES												AUXILIARY LANE SHOULDER WIDTHS ARE TO BE THE SAME AS MAINLINE THROUGH LANES

GENERAL NOTES

The determination of the proper design speed for any particular ramp should be made using guidelines shown in the latest edition of the AASHTO A Policy On Geometric Design of Highways and Streets.

Maximum ramp superelevation to be 8%.

Clear Zone and Recoverable Area information can be found in Appendix A(M), Section A-2(M) of the Road Design Manual.

RELATIONSHIP OF MAXIMUM GRADES TO DESIGN SPEED			
DESIGN SPEED (km/h)			
20 - 30	40 - 50	60	70 - 80
GRADES (PERCENT)			
6 - 8	5 - 7	4 - 6	3 - 5

Where topographic conditions dictate, grades steeper than desirable may be used. One-way descending gradients on ramps should be held to the same general maximums, but in special cases they may be 2 percent greater.

FOOTNOTES

(1) Interchange ramp widths shown are for one lane traffic. For two lane or other conditions see Exhibit 10-67 in the 2001 AASHTO A Policy on Geometric Design of Highways and Streets.

(2) Shoulder widths on ramps with a design speed of 40 mph or less may be reduced to 1.8 m right, or 0.9 m left, when justifiable. However, the sum of the right and left shoulder shall not be less than 3.0 m. See 2001 AASHTO Green Book, page 842.

(3) On ramps with a radius of less than 150 m, consider (depending on radius and percent of trucks) the extension of the full pavement structure (on the same slope as the pavement) through the inside paved shoulder area to eliminate raveling of the pavement edge.

(4) Vertical clearance at roadway underpasses for new and reconstructed bridges is to be 5.05 m desirable and 4.42 m minimum (0.3 m additional clearance required for non-vehicular overpasses).

(5) Ditch slopes to be 6:1.

(6) For intersection sight distance requirements, see Appendix C, Table C-1-5.

FIGURE A - 1 - 10M

SHEETS A-14 THROUGH A-31 ARE INTENTIONALLY OMITTED.

STANDARDS GS-10 THROUGH GS-13 AND CS-1 THROUGH CS-4E, SD-1, SD-3 AND SD-4 ARE AVAILABLE IN VDOT'S ROAD AND BRIDGE STANDARDS.