INTRODUCTION

This manual is developed with the intent of presenting current policy pertaining to roadway design. It will provide a means of developing uniformity and safety in the design and plan preparation of a highway system consistent with the needs of the motoring public.

It is recognized that situations will occur where good engineering judgement dictates deviations from the normal design policy. Any such deviations from normal design policy shall be approved by the Chief Engineer, Design.

It is not the intent of this manual to reproduce information that is adequately covered by textbooks and other publications which are readily available to the designer and the technicians.

This manual, when used in conjunction with engineering knowledge of highway design and good judgement, should enable the designer to perform his job more efficiently.

HIGHWAY DESIGN MANUAL

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NEW JERSEY DEPARTMENT OF TRANSPORTATION

DESIGN MANUAL

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CHAPTER 1

GENERAL DESIGN CRITERIA

CONTENTS

DEFINITIONS
~~DESIGN MANUAL GLOSSARY~~

Acceleration Lane - An added lane of sufficient length to enable a vehicle entering the through lane to increase its speed sufficiently to permit safe mergence with through traffic.

Arterial Highway - A general term denoting a highway primarily for through traffic, usually a continuous route.

Auxiliary Lane - The portion of the roadway adjoining the traveled way intended for speed change, storage, weaving, climbing lane or for other purposes supplementary to through traffic movement.

Average Daily Traffic (ADT) - The annual average 24-hour volume, being the total yearly volume in both directions of travel divided by 365 days.

Capacity - The maximum number of vehicles which has a reasonable expectation of passing over a given section of a lane or a roadway in one direction (or in both directions for a two-lane or a three-lane highway) during a given time period under prevailing roadway and traffic conditions.

Climbing Lane - An auxiliary lane introduced at the beginning of a sustained positive grade in the direction of traffic flow, to be used by slow moving vehicles such as trucks and buses.

Collector-Distributor Road (C-D Road) - An auxiliary roadway separated laterally from, but generally parallel to, an expressway which serves to collect and distribute traffic from several access connections between selected points of ingress to and egress from the through traffic lanes. Control of access is exercised along a C-D Road.

<u>Control of Access</u> - The condition under which the rights of owners, occupants or other persons of land abutting a highway to access, light, air or view in connection with the highway are fully or partially controlled. by Public Authority.

<u>Full Control</u> - The condition under which the authority to control access is exercised to give preference to through traffic by providing interchange connections with selected public roads only, and by prohibiting intersections at grade.

<u>Partial Control</u> - The condition under which the authority to control access is exercised to give preference to through traffic to a degree, but in addition to interchange connections with selected public roads there may be some intersections at grade.

<u>Corridor</u> - A strip of land between two termini within which traffic, topography, environment and other characteristics are evaluated for transportation purposes.

<u>Cul-de-Sac</u> - A local street open at one end only with special provisions for turning around.

<u>Deceleration Lane</u> - An added lane of sufficient length to enable a vehicle leaving the through lane to decrease its speed sufficiently to exit safely.

<u>Density</u> - The number of vehicles per mile on the traveled way at a given instant.

<u>Design Hourly Volume (DHV)</u> - An hourly volume in both direction of travel representing traffic expected to use the highway in a particular year. (Unless otherwise stated, it is the 30th highest hourly volume).

Design Speed - A speed determined for design and correlation of the physical features of a highway that influence vehicle operation. It is the maximum safe speed that can be maintained over a specified section of highway when conditions are so favorable that the design features of the highway govern.

Design Year - The year, twenty years or more as determined, after completion of construction, whose estimated traffic volumes are used as a basis for design.

Direct Connection - A one-way turning roadway which does not deviate greatly from the intended direction of travel.

Directional Design Hourly Volume (DDHV) - An hourly volume determined for use in design, representing traffic expected to use one direction of travel on a highway. (Unless otherwise stated it is the directional hourly volume during the 30th highest hour).

Diverging - The dividing of a single stream of traffic into separate streams.

Divided Highway - A highway with opposing directions of travel separated by a median.

Expressway - A divided arterial highway for through traffic with full or partial control of access and generally with grade separations at major intersections.

Freeway - An expressway with full control of access.

Frontage Road or Frontage Street - A road generally paralleling a controlled access highway designed to furnish access to property, which would otherwise be isolated as a result of the controlled access feature, or to preserve local road circulation. Generally, there is no control of access on the outer margin of a frontage road.

Gore - The area immediately beyond the divergence of two roadways, bounded by the edges of those roadways.

Grade Separation - A crossing of two highways or a highway and a railroad at different levels.

Highway Overpass - A grade separation where the subject highway passes over an intersecting highway or railroad.

Highway, ~~Street or Road~~ - A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way. Recommended usage: in urban areas, highway or street; in rural areas, highway or road.

Highway Underpass - A grade separation where the subject highway passes under an intersecting highway or railroad.

Inside Lane - On a multi-lane highway the extreme left hand traffic lane, in the direction of traffic flow, of those lanes available for traffic moving in one direction. (also referred to as left lane).

Interchange - A system of interconnecting roadways in conjunction with one or more grade separations, providing for the movement of traffic between two or more roadways on different levels.

Interchange Ramp - A turning roadway at an interchange for travel between intersection legs.

Left Turn Slot - A speed-change lane within the median to accommodate left turning vehicles.

Loads - Traffic data required for the establishment of geometric controls for highway design.

<u>Loop</u> - A one-way turning roadway that curves about 270 degrees to the right to accommodate a left-turning movement. It may include provision for a left turn at a terminal to accommodate another turning movement.

<u>Median</u> - The portion of a divided highway separating the traveled ways for traffic in opposing directions.

<u>Merging</u> - The converging of separate streams of traffic into a single stream.

<u>Middle Lane</u> - The traffic lane or lanes between the outside lane and inside lane of a multi-lane highway. (Also referred to as left middle lane and right middle lane or numbered in consecutive order starting with the outside lane as lane number 1).

<u>Outside Lane</u> - On a multi-lane highway the extreme right hand traffic lane, in the direction of traffic flow, of those lanes available for traffic moving in one direction. (Also referred to as right lane or lane number 1).

<u>Outer Connection</u> - A one-way turning roadway primarily for a right-turning movement. It may include provision for a left turn at a terminal to accommodate another turning movement.

<u>Parkway</u> - An arterial highway for noncommercial traffic, with full or partial control of access, and usually located within a park or a ribbon of parklike developments.

<u>Passing Sight Distance</u> - The minimum sight distance that must be available to enable the driver of one vehicle to pass another vehicle safely and comfortably without interfering with the speed of an oncoming vehicle traveling at the design speed should it come into view after the maneuver is started. (The distances used in design are calculated on the basis of the driver's ability to see a 4 feet - 6 inch high object in the road

3

ahead when his eye level is 3 feet - ~~9~~ 6 inches above the roadway surface).

<u>Roadway (General)</u> - The portion of the highway, including shoulders, for the movement of vehicles.

<u>Separated Roadways</u> - A highway with opposing directions of travel having independent alignment and gradient.

<u>Shoulder</u> - The portion of the roadway contiguous with the traveled way (on either side) for accommodation of stopped vehicles for emergency use, and for lateral support of base and surface courses.

<u>Sight Distance</u> - The length of roadway visible to the driver of a vehicle at a given point on the roadway when the view is unobstructed.

<u>Slip Ramp</u> - An angular connection between an expressway and a parallel frontage road.

<u>Stopping Sight Distance</u> - The distance required by a driver of a vehicle, traveling at a given speed, to bring his vehicle to a stop before reaching an object on the roadway after the object has become visible. (The distances used in design are calculated on the basis of the driver's ability to see a 6-inch high object in the road ahead when his eye level is 3 feet - 9 inches above the roadway surface).

<u>Thirtieth Highest Hourly Volume (30 HV)</u> - The hourly volume in both directions of travel that is exceeded by 29 hourly volumes during a designated year.

<u>Through Lane</u> - The lane or lanes signed for through traffic continuing through an interchange area.

<u>Traffic Lane</u> - The portion of the roadway for the movement of a single line of vehicles.

<u>Traveled Way</u> - The portion of the roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes. (Also called Travelway).

<u>Two-way Ramp</u> - A ramp for travel in two directions. At a cloverleaf it serves as both an outer connection and a loop.

<u>Weaving</u> - The crossing of traffic streams, moving in the same general direction, accomplished by merging and diverging.

REFERENCE PUBLICATIONS

AASHTO (AASHO) Publications-American Association of State Highway Officials.

1. A Policy on Geometric Design of Rural Highways. (1965)
2. A Policy on Design of Urban Highways and Arterial Streets. (1973)
3. Highway Definitions. (1968)
4. A Policy on Design Standared for Stopping Sight Distance

Highway Research Board (HRB)

1. Highway Capacity Manual

POLICY ON USE OF AASHTO STANDARDS

The American Association of State Highway and Transportation Officials has published policies on highway practice. These are approved references to be used in conjunction with this manual. AASHTO policies represent nationwide standards which do not satisfy New Jersey conditions. When standards differ, the instructions in this manual shall govern.

TRAFFIC DATA

The design of a highway should be based upon factual data, among which are those relating to traffic. Traffic information serves to establish the "loads" for geometric highway design. Projected volumes and type of traffic indicate the service for which a highway improvement is being made and largely determine the type of highway and the geometric features of design.

The traffic data collected include traffic volumes for days of the year and times of the day.

Traffic volumes, projections and design data can be requested by the Project Engineer. This request is to be made to the Director, Transportation Planning and Research, Attention: Chief, Bureau of Highway Planning. Accompanying the request shall be one print of the plan or key map for the project with its limits delineated in red. The transmittal letter and/or plans shall denote the nature of the project and request the data which is to be obtained (present traffic volumes, projected traffic volumes, turning movements, 18 kip equivalancy factor, design volumes, truck percentage, directional traffic distribution, etc.).

AVERAGE DAILY TRAFFIC

The general unit of measure for traffic on a highway is the annual average daily traffic volume. The ADT volume is essential in determining annual usage for expenditure justification, in design of structural elements of the highway, and estimating projected traffic from which the design hour volume is derived. Although ADT is useful for these purposes and for ranking the relative importance of highways, it has little direct application to the required geometric features of highways.

DESIGN HOUR VOLUME

Traffic volume during an interval of time shorter than a day more appropriately reflects the operating conditions which should be used for design if traffic is to be properly served. The brief but frequently repeated rush-hour periods are significant in this regard. In nearly all cases a practical and adequate time period is one hour.

The Design Hourly Volume (DHV) should be the thirtieth highest hourly volume of the future year chosen for design. Exception may be made on roads with high seasonal traffic fluctuation, where a different volume may need to be used. The thirtieth hourly volume criterion also applies in general to urban areas, but where the fluctuation in traffic flow may be radically different from that on rural highways, other relations may have to be considered. Urban traffic data are discussed in "A Policy on Arterial Highways in Urban Areas".

RELATIONSHIP of DHV to ADT

On the average main rural highway, the Design Hour Volume is about 15 percent of the Average Daily Traffic while the maximum hourly volume is about 25 percent of the ADT. For locations having unusually high or low fluctuations in traffic flow, the design hour volume ranges between 12 and 18 percent of the ADT.

DIRECTIONAL DISTRIBUTION

The average daily traffic is approximately the same in each direction on most highways, excepting holidays and weekend travel which can cause an unbalanced total traffic flow. The volume during any one hour, however, is usually much heavier in one direction than in the other. The imbalance in traffic flow during a specific hour is referred to as the directional distribution (D).

PROJECTED TRAFFIC

Design of proposed improvements must be based on projected traffic volumes. Normally, a 20 year period is recommended for design purposes. Estimating traffic beyond this period on a specific facility usually is not justified because of probable changes in the general regional economy, population and land development along the highway which cannot be predicted with any degree of assurance. Future traffic volumes for design are derived from the current traffic and the traffic increase expected by the end of the period of time selected for design.

Components of future traffic in their logical steps of derivation are as follows:

<u>Current Traffic</u> - existing and attracted (or diverted)

<u>Traffic Increase</u> - (a.) normal traffic growth

(b.) generated traffic

(c.) development traffic

COMPOSITION OF TRAFFIC

Vehicles of different sizes and weights have different operating characteristics which must be considered in highway design. For the purpose of design, light delivery trucks (such as panel and pickups) take on the operational characteristics of passenger cars and are included as such. Other trucks, truck-trailers and buses are referred to as trucks. In order to determine adequate design, it is essential that the designer have available an estimate of the composition of traffic which will be expected in the design year. The overall effect on traffic

COMPOSITION OF TRAFFIC - con't.

operation of one truck is often equivalent to several passenger vehicles, the number of equivalent passenger vehicles depending upon the gradient and the passing sight distance available. Thus, the larger the proportion of trucks in a traffic stream, the greater the traffic load, and the more highway capacity is required.

LEVEL OF SERVICE

Level of Service, as defined by the Highway Capacity Manual is a qualitative measure of the effect of a number of factors, including speed, travel time, interruptions, manueverability, safety, driving comfort, etc.., as may occur on a given roadway when it is accommodating various traffic volumes. A thorough discussion of Level of Service is contained in the Highway Capacity Manual and may also be found in the 1965 edition of the AASHTO "A Policy on Geometric Design of Rural Highways".

The designer may utilize the charts and tables in Chapter 10 of the Highway Capacity Manual to compute Level of Service on two lane rural highways.

The Highway Capacity Manual shall be used to compute Level of Service for intersections, ramps, 3 or more lane highways, weaving sections, municipal (curb & gutter) sections, etc.

CAPACITY

Capacity is the maximum number of vehicles which has a reasonable expectation of passing over a given section of a lane or a roadway in one direction (or in both directions for a two-lane or a three-lane highway) during a given time period under prevailing roadway and traffic conditions. In the absence of a time modifier, capacity is an hourly volume. The capacity would not normally be exceeded without changing one or more of the conditions that prevail. In expressing capacity, it is essential to state the prevailing roadway and traffic conditions under which the capacity is applicable.

As a rule of thumb, the design capacities of multilane highways are 1500 vph/lane in urban areas, 1200 vph/lane in suburban areas and 1000 vph/lane in rural areas.

CHAPTER 2

TYPICAL SECTIONS

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TYPICAL SECTIONS

General

Typical sections should be developed to provide safe and aesthetically pleasing highway sections within reasonable economic limitations.

The typical sections shown in the plans should represent, as their name indicates, conditions that are "typical" or "representative" of the project. It is not necessary to show a separate typical section to delineate relative minor variations from the basic typical. The most common or predominate typical section on the project should be shown first in the plan sheets followed by sections of lesser significance.

Figures __________ through _______ illustrates the various control dimensions for single lane and multi-lane highways.

Curb

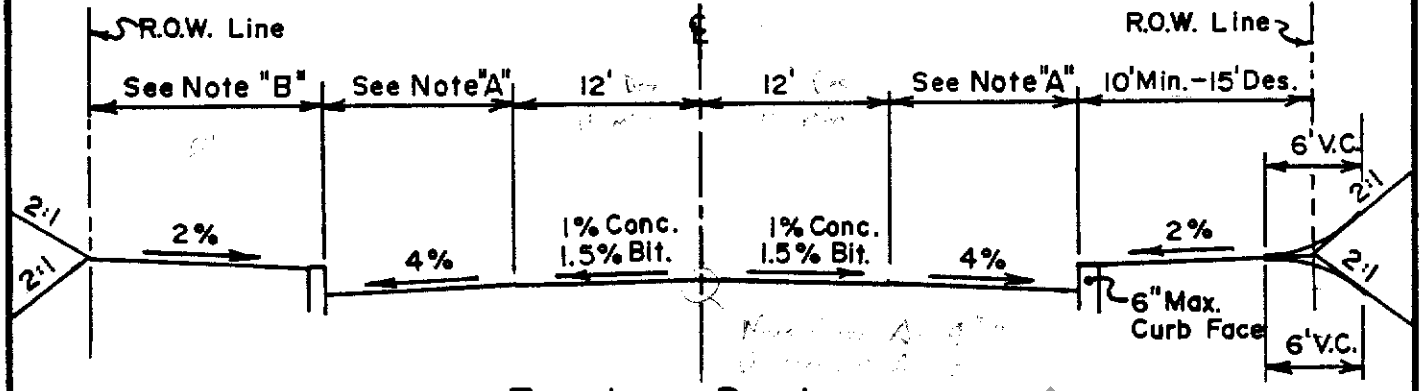
Except where necessary as on some arterial or city streets, ramps, and along raised medians, the use of curbs on highways should be avoided. Curbs are generally used to control drainage or provide access control. Expand

Sidewalks

Where existing sidewalks are to be disturbed by highway construction, the replacement shall apply only to the frontages involved and no other sidewalk construction, such as closing gaps in sidewalks, shall be authorized, except as part of the right-of-way agreements or where vehicle pedestrian accident data indicate a significant safety improvement could be attained by the installation of sidewalks.

Provisions for Physically Handicapped — Place in intersections

LAND-SERVICE HIGHWAYS



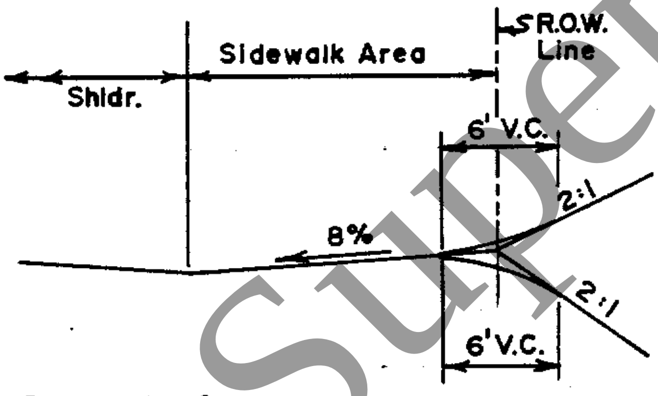
Two-Lane Roadway

Note "A": Shoulder width shall be 8' Absolute Minimum or 10' Minimum Desirable. Shoulder width may be increased to 12' maximum when a large volume of trucks are anticipated (250 DHV), when turning volumes are high or dualization is anticipated.

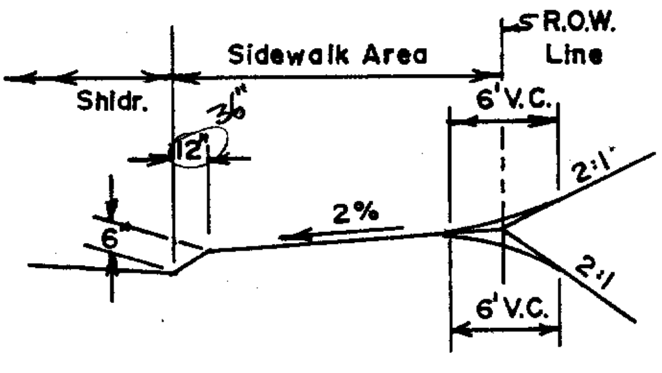
Note "B": Sidewalk area width shall be determined by need, that is, pedestrians, guiderail and utilities. Desirably a clear recovery area should be provided. At least one side of roadway is to accommodate pedestrians.

Note "C": Curb Section may be used with or without sidewalk. Curb Section shall be used in built-up areas, where pedestrian traffic is anticipated or where necessary for drainage.

Note for utility pole placement

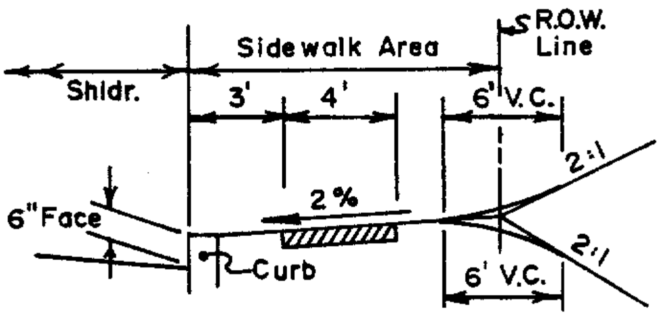


Sidewalk Area – Where pedestrians are not anticipated.



Sidewalk Area – Berm Section

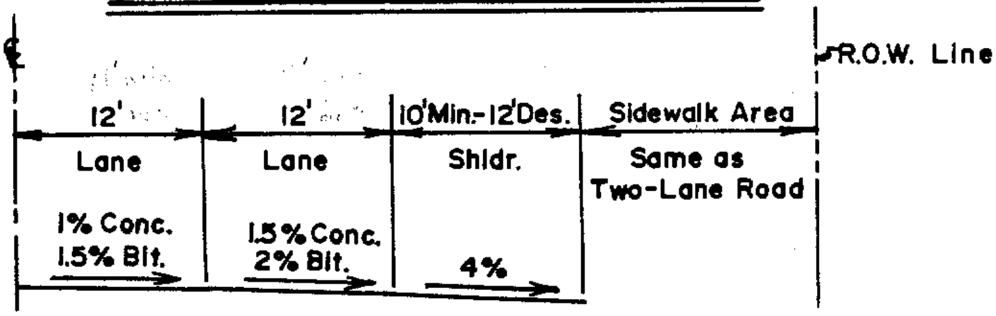
Where pedestrians are to be accommodated; future sidewalk.



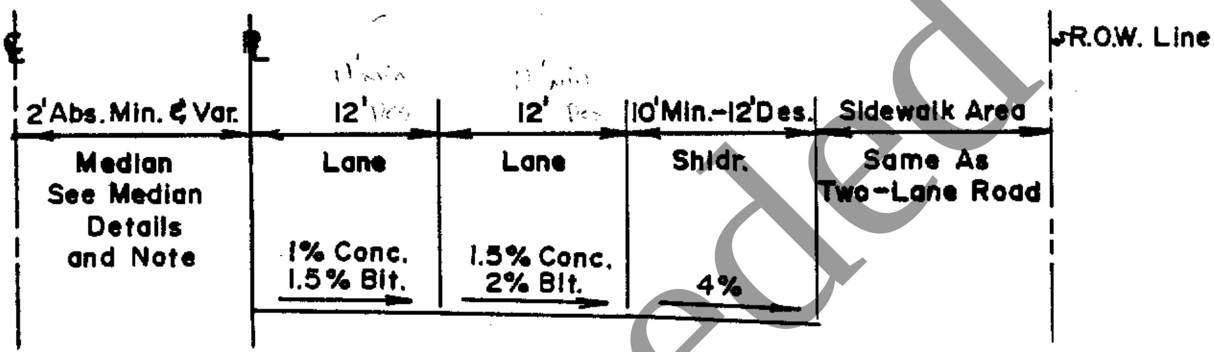
Sidewalk Area – Curb Section

See Note "C"

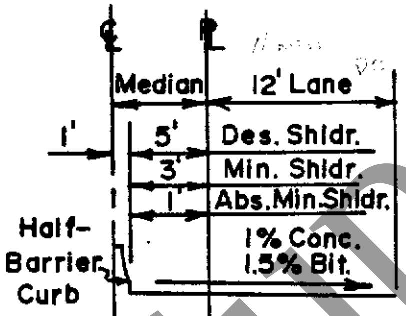
LAND-SERVICE HIGHWAYS



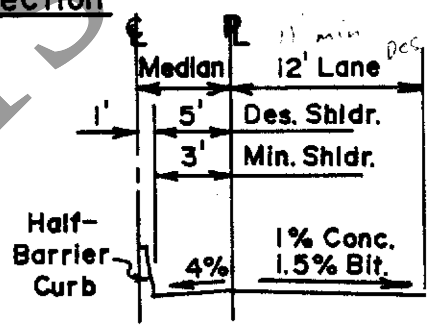
Four Lane-Undivided Highway
Half-Section



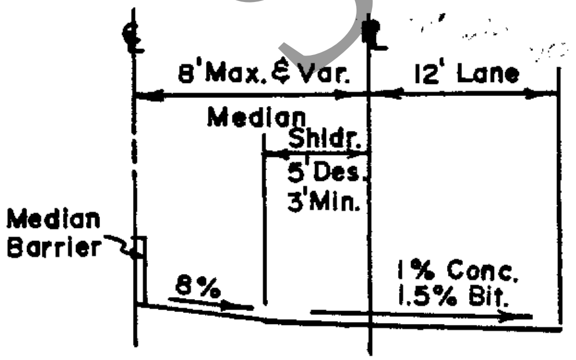
Four Lane-Divided Highway
Half Section



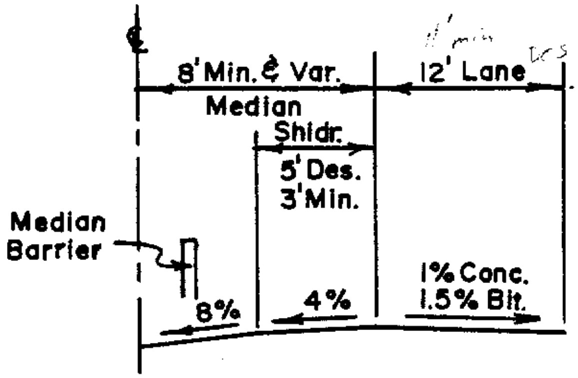
Median Half-Section
No drainage in median.



Median Half-Section
Drainage in median



Median Half-Section
No drainage in median



Median Half-Section
Drainage in median

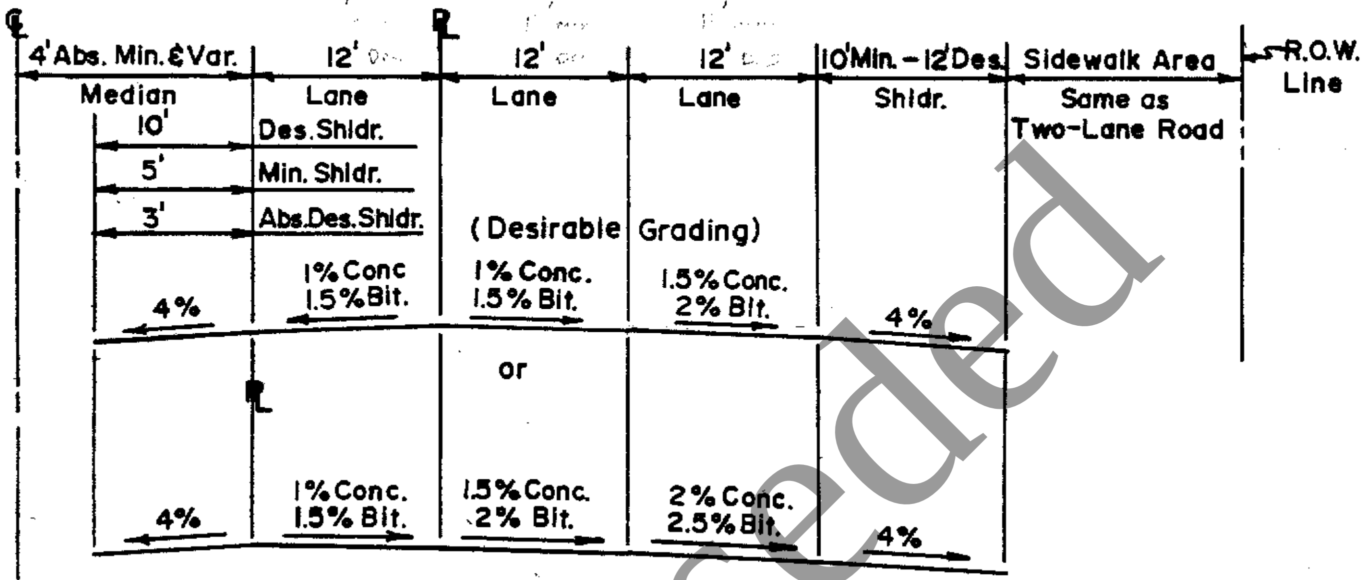
* Median Barrier may be located either side of Low Point.

LAND-SERVICE HIGHWAYS

Note: 1.) Median Barrier will be selected as per "Guide for Selecting, Locating and Designing Traffic Barriers", AASHTO 1977.

2.) The ~~kind~~ of Median Barrier to be used is to be determined by the ~~Design Engineer~~.

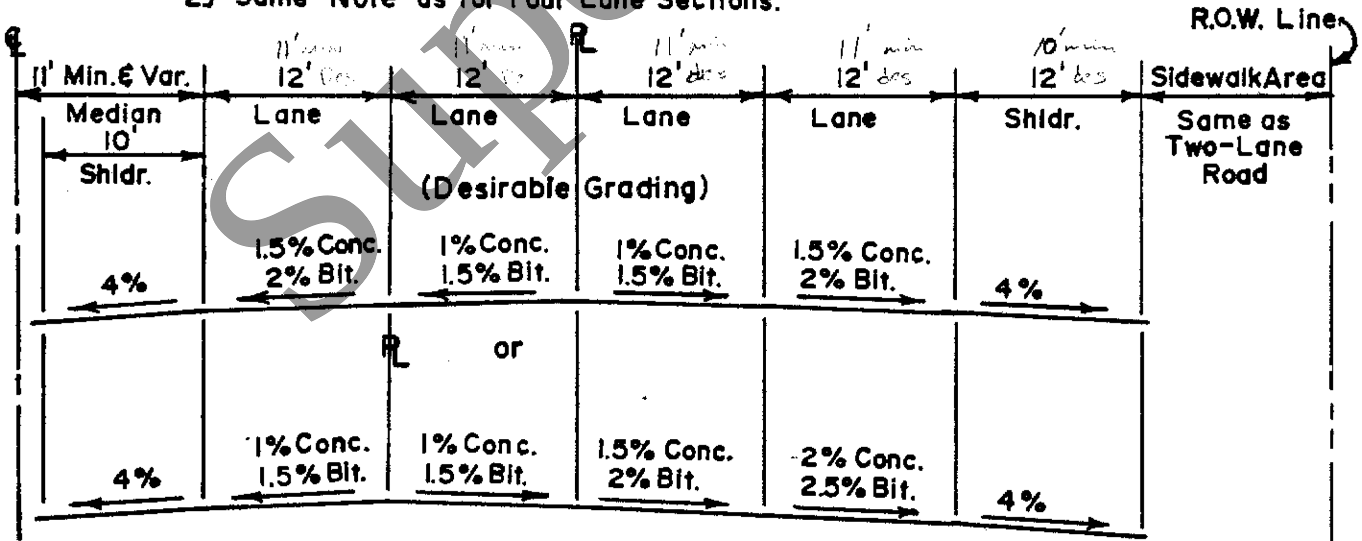
3.) For medians over 30', Median Barrier use is optional. Drainage is to be located in the median area.



Six Lane-Divided Highway
Half-Section

Note: 1.) Similar median treatment as for Four Lane Sections except, the drainage will be provided in the median area.

2.) Same "Note" as for Four Lane Sections.

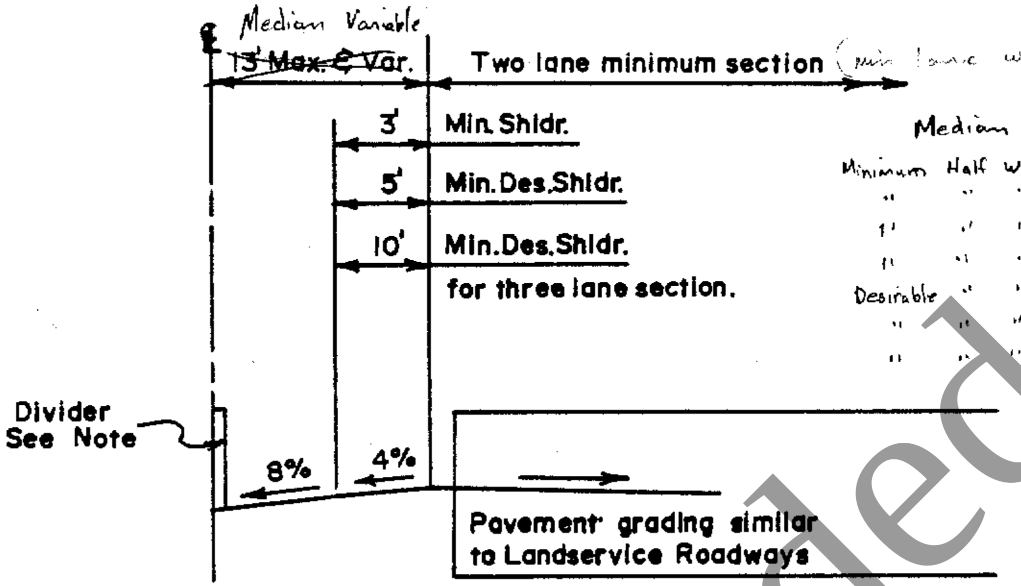


Eight Lane-Divided Highway
Half-Section

Note: 1.) Similar median treatment as for Six Lane Highway.

2.) A maximum of three lanes to be drained in one direction.

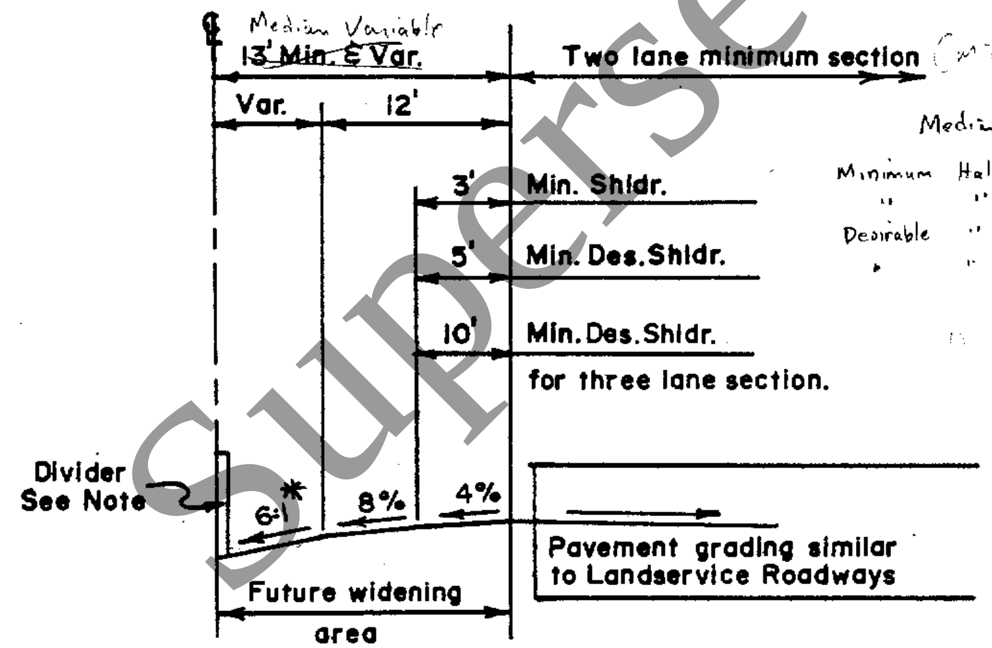
FREEWAY SECTIONS



Half Section

Median Widths

Minimum	Half	Width	—	4' urban (2 lanes)
"	"	"	—	6' urban (3 lanes)
"	"	"	—	6 rural (2 lanes)
"	"	"	—	11 rural (3 lanes)
Desirable	"	"	—	6' urban (2 lanes)
"	"	"	—	11' urban (3 lanes)
"	"	"	—	30 rural (2 or 3 lanes)



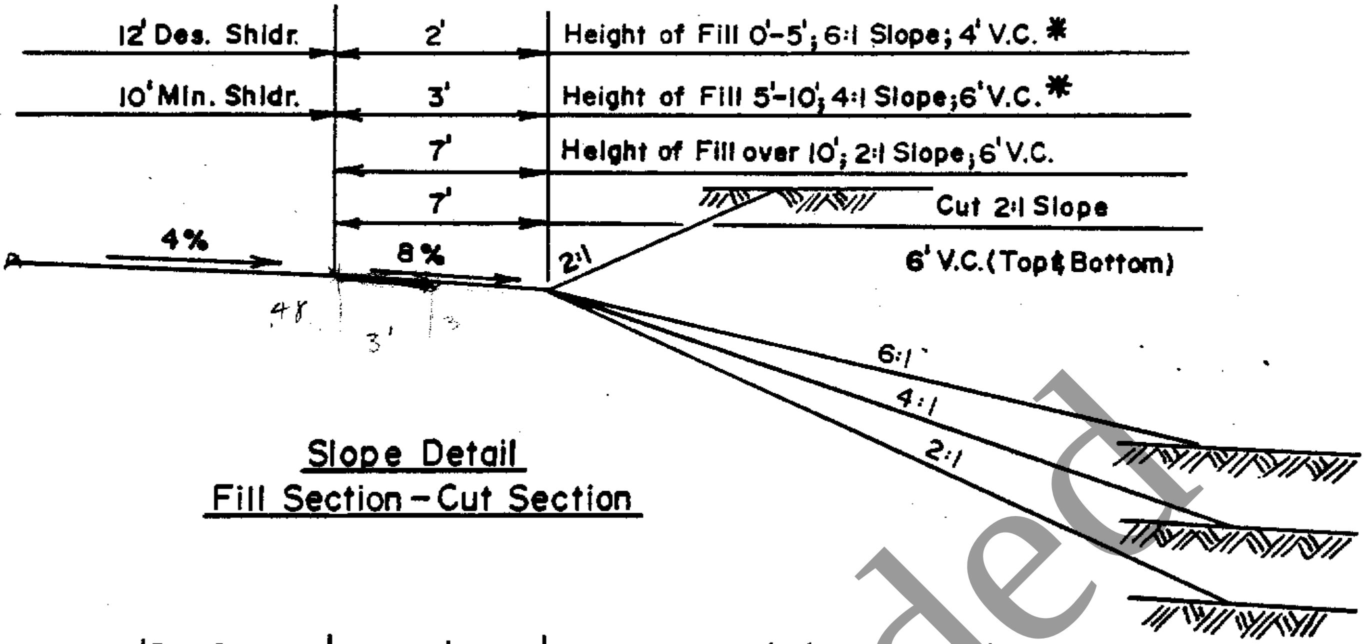
Half Section (Future Expansion)

Median Widths

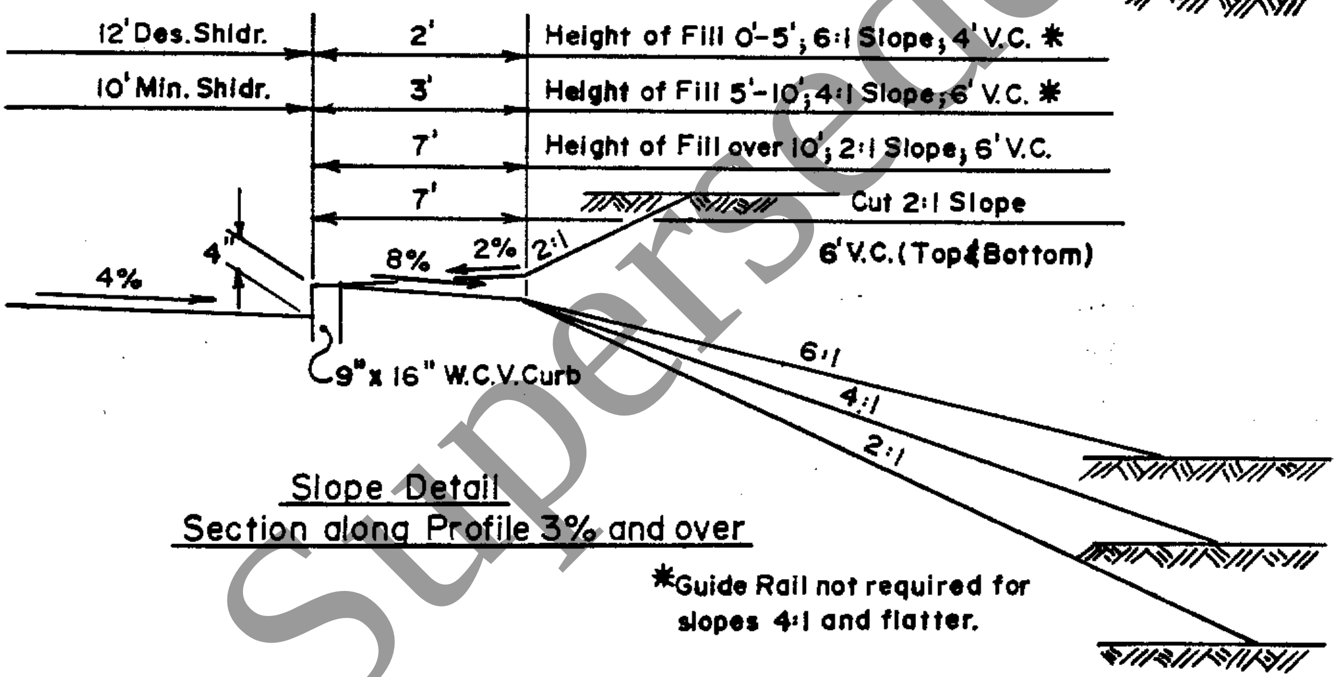
Minimum	Half	Width	—	18' urban
"	"	"	—	23' rural
Desirable	"	"	—	23' urban
"	"	"	—	42' rural

Note:
1.) If median width is up to 12', use Concrete Barrier Curb.
2.) If median width is between 12' and 26', Concrete Barrier Curb is preferred; Dual Face Beam Guide Rail may be accepted. Traffic volumes dictate the type of divider to be used. Where is the [illegible]
3.) If median width is above 26', use Dual Face Beam Guide Rail.
4.) Maximum permissible sideslope adjacent to a median barrier is 10:1.

FREEWAY SECTIONS

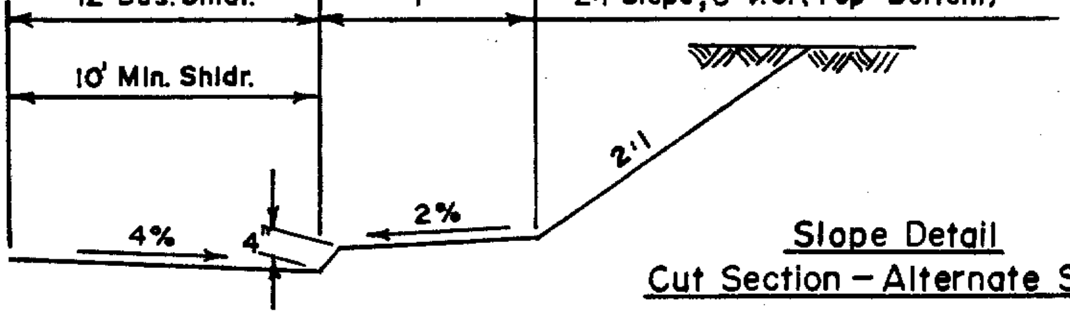


Slope Detail
Fill Section – Cut Section



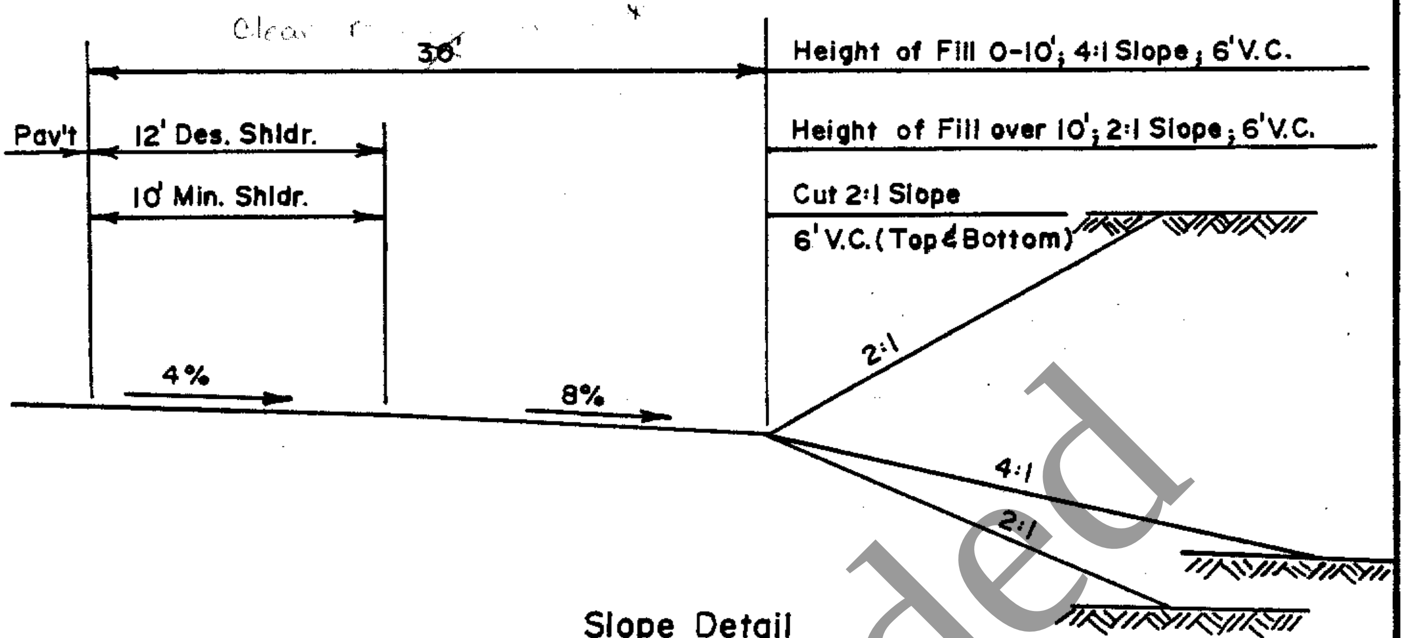
Slope Detail
Section along Profile 3% and over

*Guide Rail not required for slopes 4:1 and flatter.

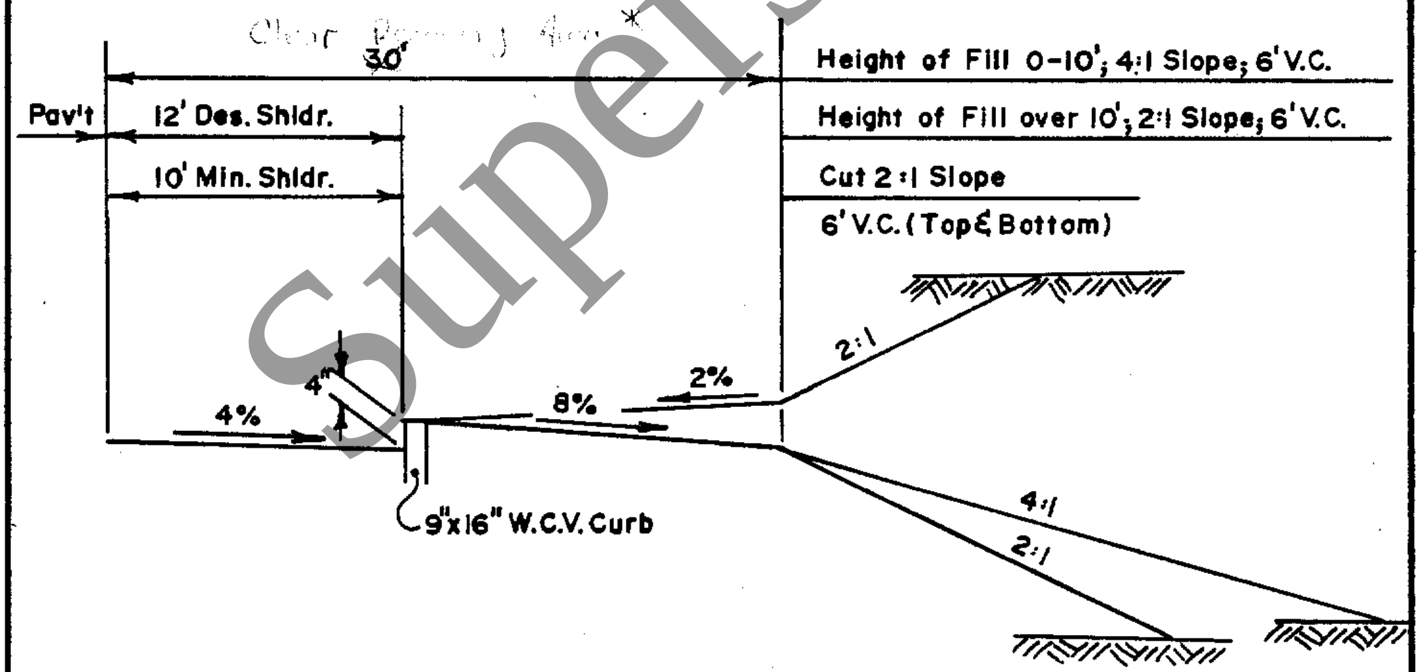


Slope Detail
Cut Section – Alternate Section

FREEWAY SECTIONS



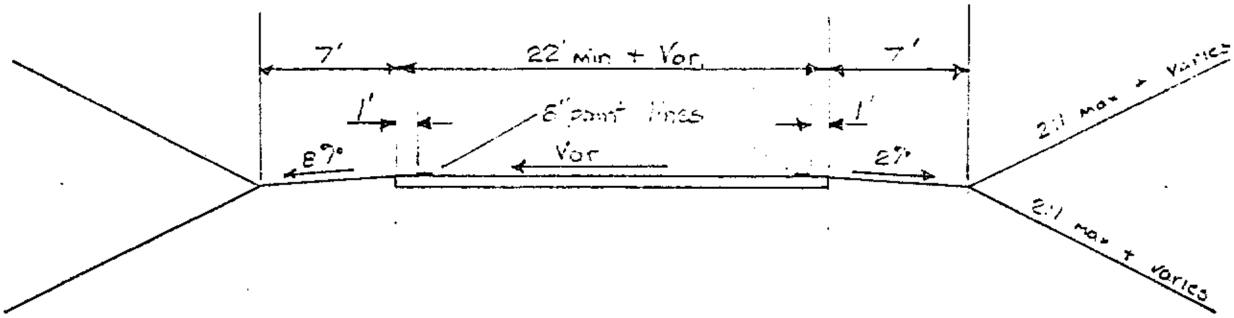
Slope Detail
Fill Safety Section – Cut Safety Section

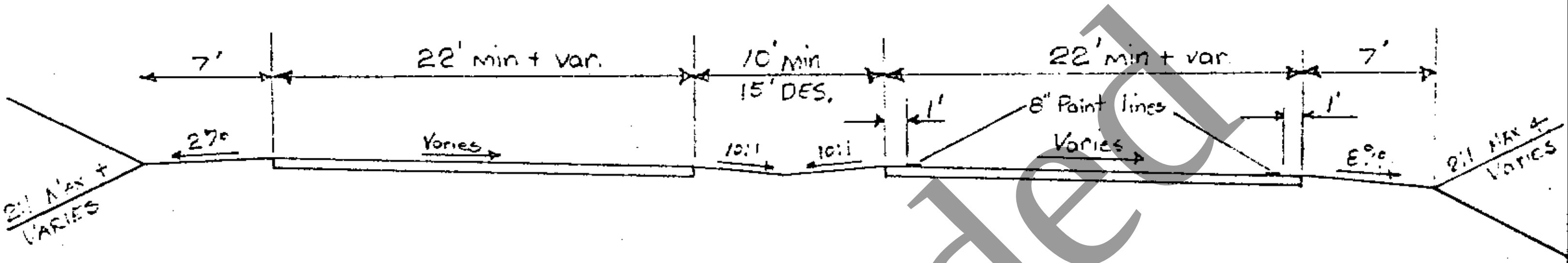


Slope Detail
Fill Safety Section – Cut Safety Section
Curbed Section along Profile 3% and over.

* Note: Clear Recovery Area to be adjusted based on operating speed and volume. [partly illegible handwriting]

RAMP SECTIONS

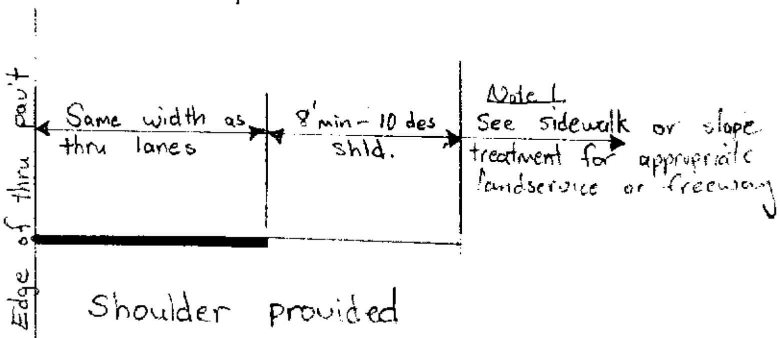




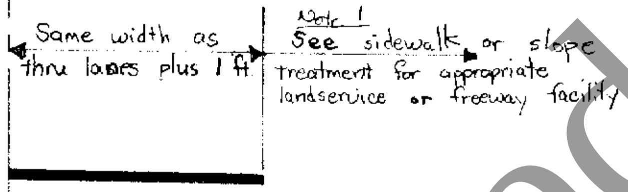
NOTE

1. The minimum ramp width is 22 ft. The width should be adjusted based on various operating conditions, design vehicles and curvature. The required width should be based on the smallest radius of the ramp proper and is applicable throughout the full length of the ramp.
2. Superelevation ~~shall~~ should be provided on ramps.
3. Side slopes where practical should be flatten to eliminate the need for guide rail.
4. Curb may be provided on ramps when required for drainage control or access control. Maximum curb height 6".
5. Guide rail should be located according to the "Guidelines for Guide Rail Design".
6. The median width on opposing ramps may be reduced to 4' where curb is provided.
7. Where barrier curb is provided to separate opposing directions of travel, the median width should be 8'.
8. Fill slopes may be adjusted, see slope details for freeway sections

Auxilary Lanes



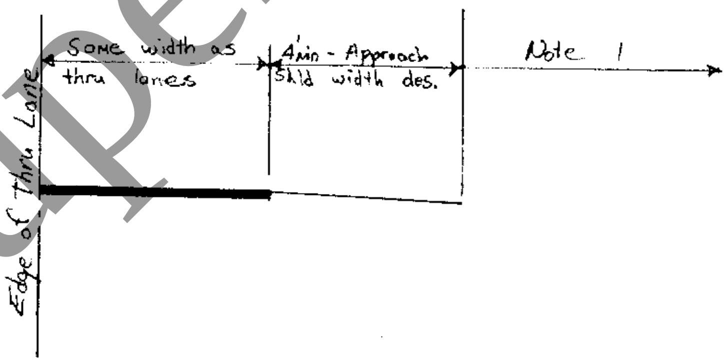
Shoulder provided



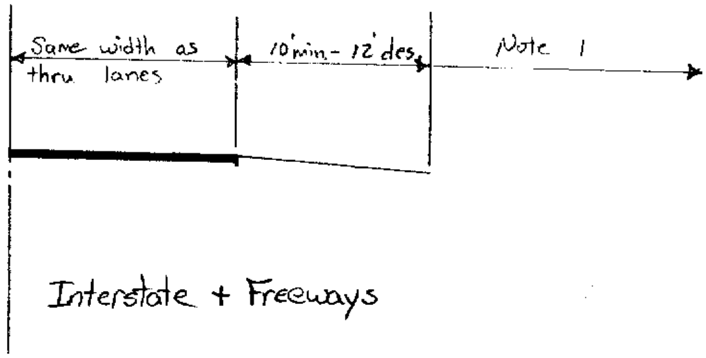
No shoulder

Note : Minimum shoulder width on Freeways and Interstate Highways adjacent to auxilary lanes is 10 ft.

CLimbing Lanes

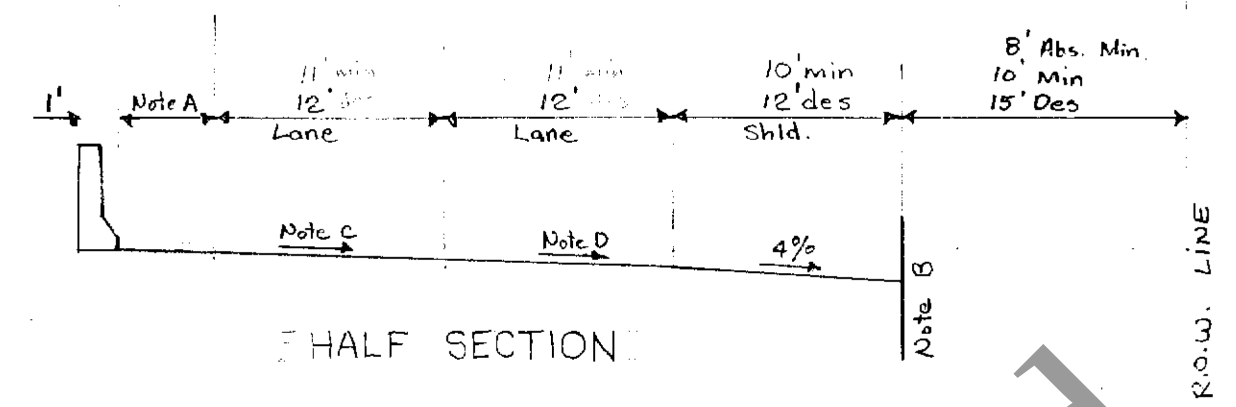


Landservice

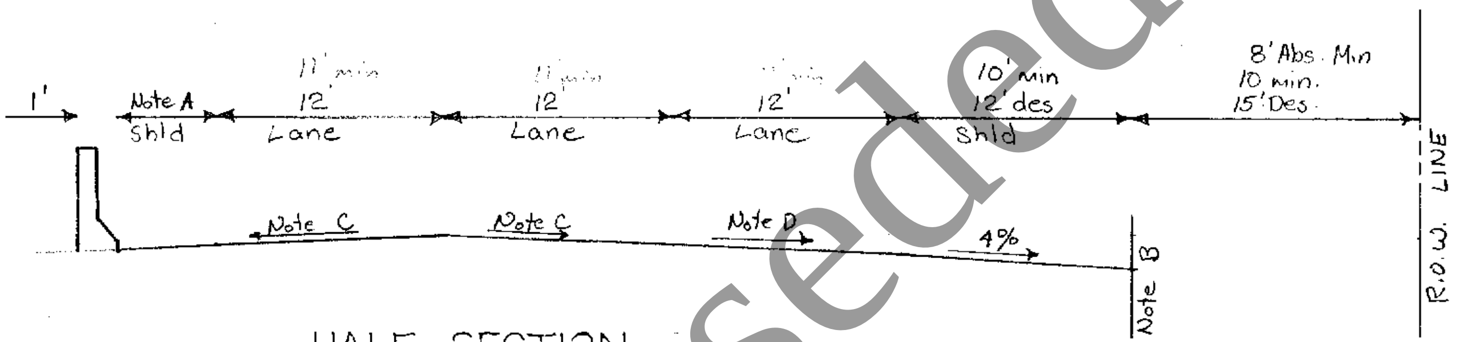


Interstate + Freeways

LANDSERVICE HIGHWAYS
FOUR LANE AND SIX LANE - DIVIDED



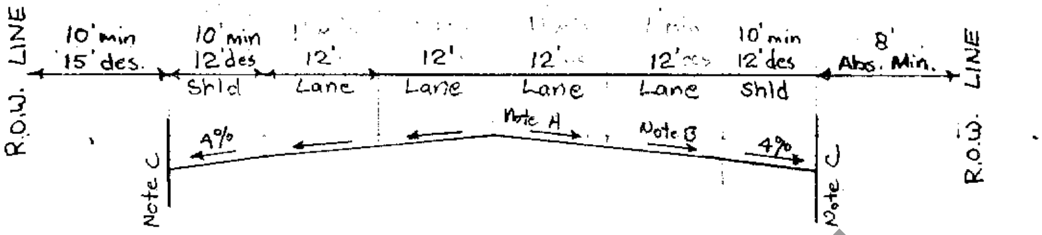
HALF SECTION

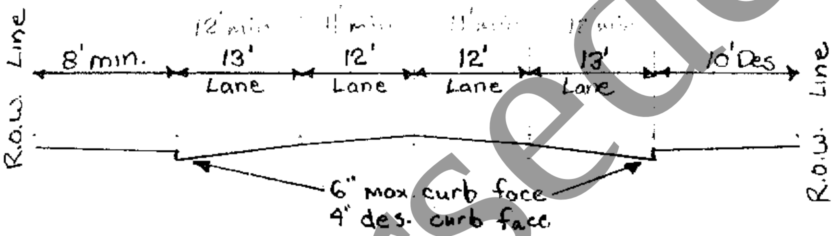


HALF SECTION

Note A : Four lane section, inside shoulder width

LANDSERVICE HIGHWAYS
FOUR LANE - UNDIVIDED





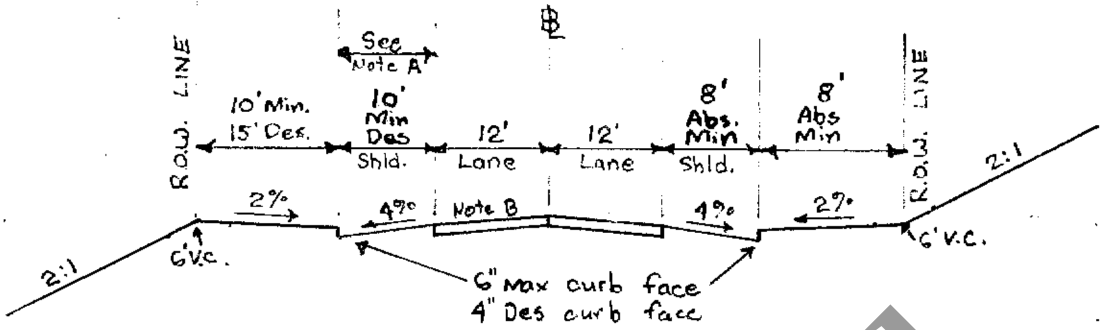
This section is to be use only in urban areas where addition capacity is need but the right-of-way cost to provide shoulders would be prohibitive.

Note A : Normal pavement cross slopes, 1% concrete, ½% bituminous for inside lanes

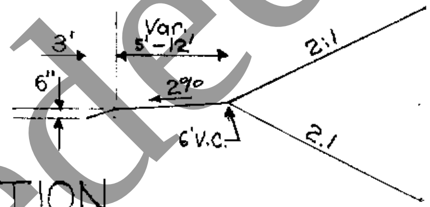
Note B : Normal pavement cross slopes, 1½ concrete, 2% bituminous for outside lanes

Note C : Same treatment as shown on two lane curbed, bermed, and umbrella sections. See also notes C and D on two lane section.

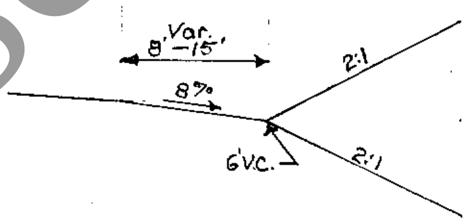
LANDSERVICE HIGHWAYS
TWO LANE



CURBED SECTION



BERMED SECTION



UMBRELLA SECTION

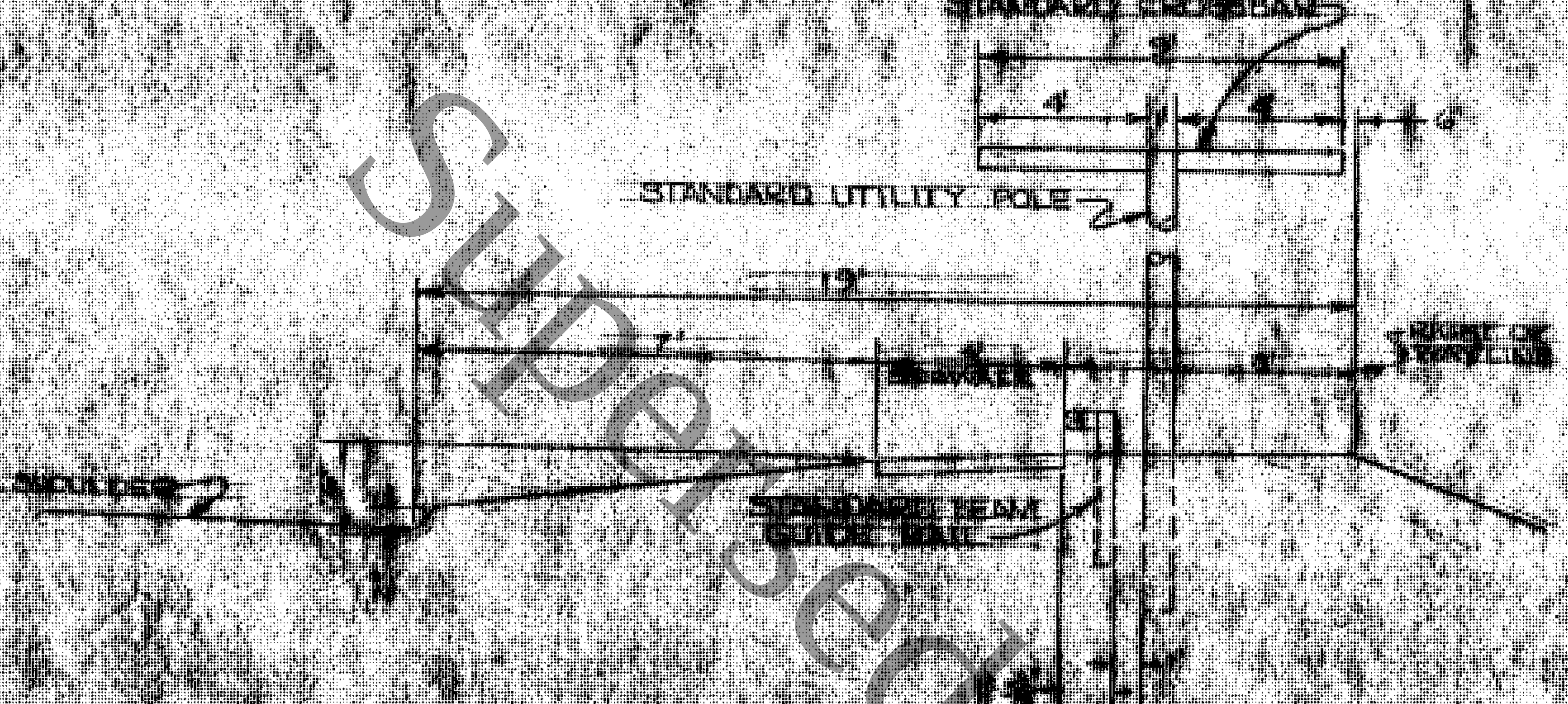
Note A : Shoulder width may be increased to 12 ft when volume of trucks is ≤ 250 DHV, numerous turning vehicles or anticipate dualization

Note B : Normal pavement cross slopes, 1% concrete and 1½ % bituminous

Note C : Utility poles, when possible, should have the following offsets from edge of travelled lane.
Posted Speed 50 mph, Offset 20 ft.
Posted Speed 40 mph, Offset 15 ft.

Note D : Inlets - On curbed sections use "B" inlets, on bermed sections use "B" modified inlets except at low point use "E1" inlet.

NOT TO SCALE

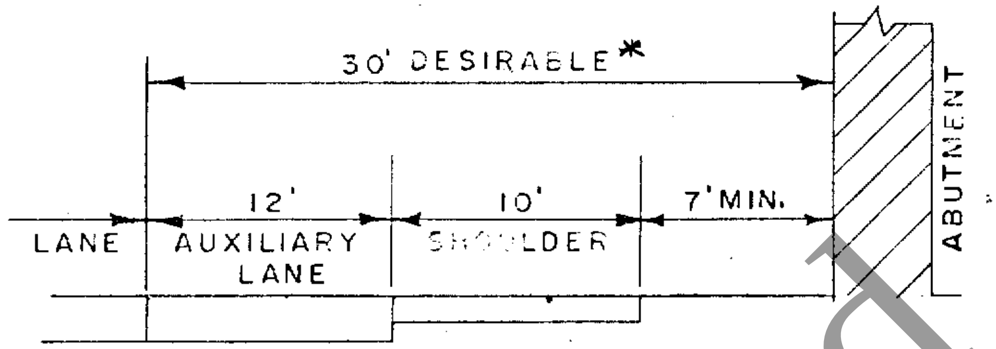


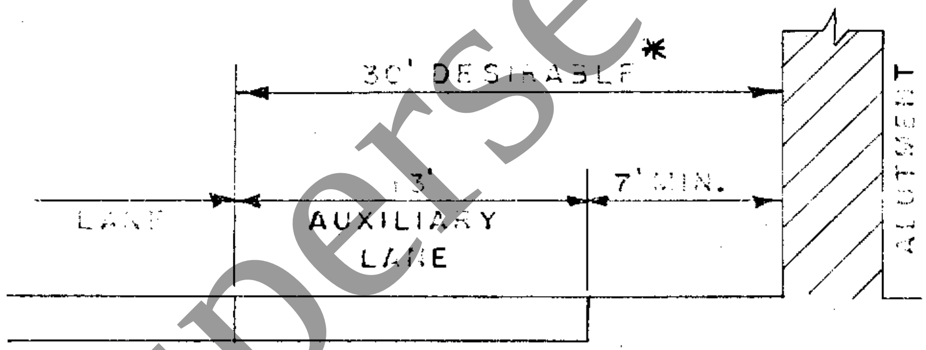
TYPICAL SECTION - SIDEWALK AREA LAND SERVICE ROAD

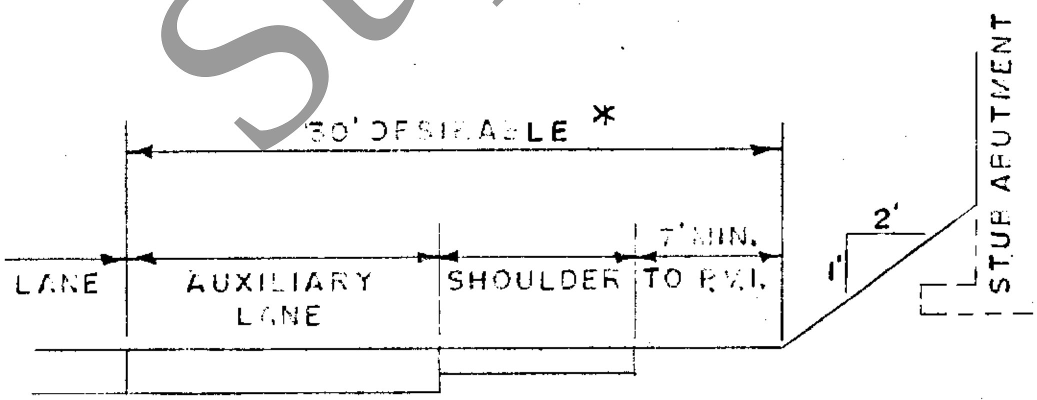
DRAWN BY: S.M. PALMER 12-19-75

AUXILIARY LANES

RIGHT CLEARANCE







* 60 mph Design Speed

70 mph Design speed 36' Desirable

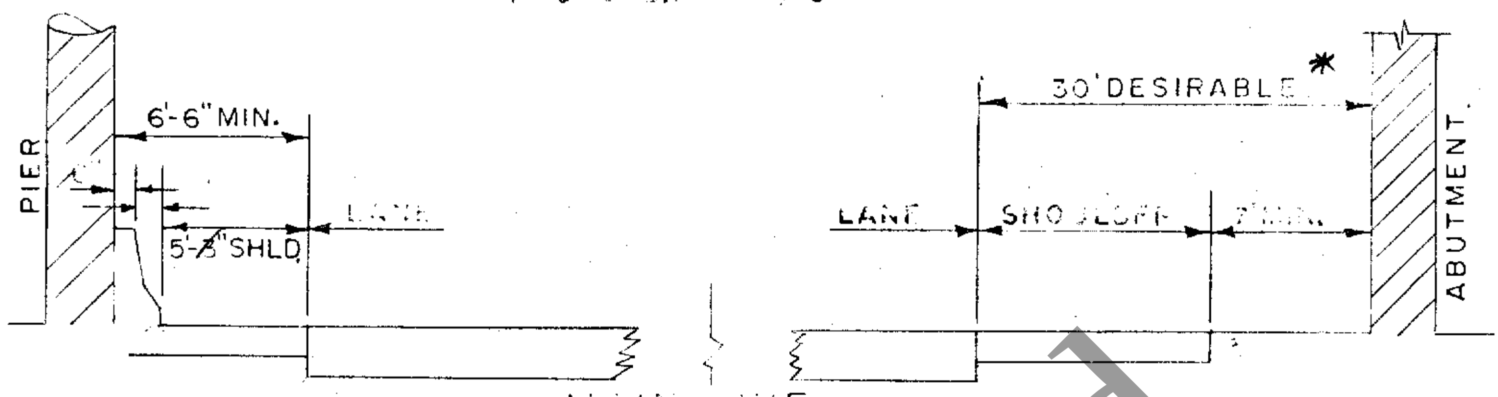
50 mph Design speed 20' Desirable

40 mph Design Speed 15' Desirable

UNDERPASSES - FREEWAYS

LEFT CLEARANCE | RIGHT CLEARANCE

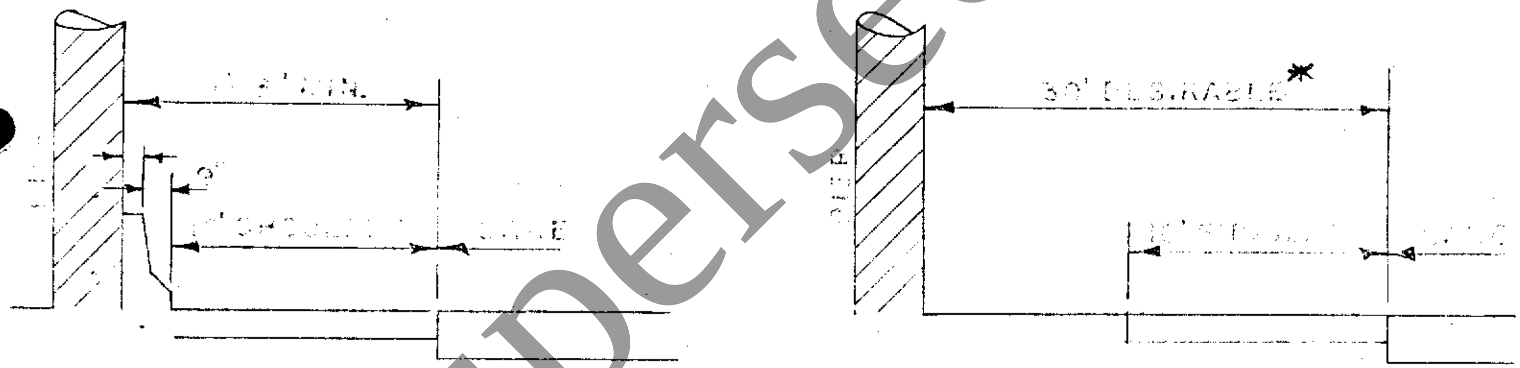
* See sheet 1/10



MAIN LINE

FOR 2 LANES IN EACH DIRECTION IN RURAL & URBAN AREAS

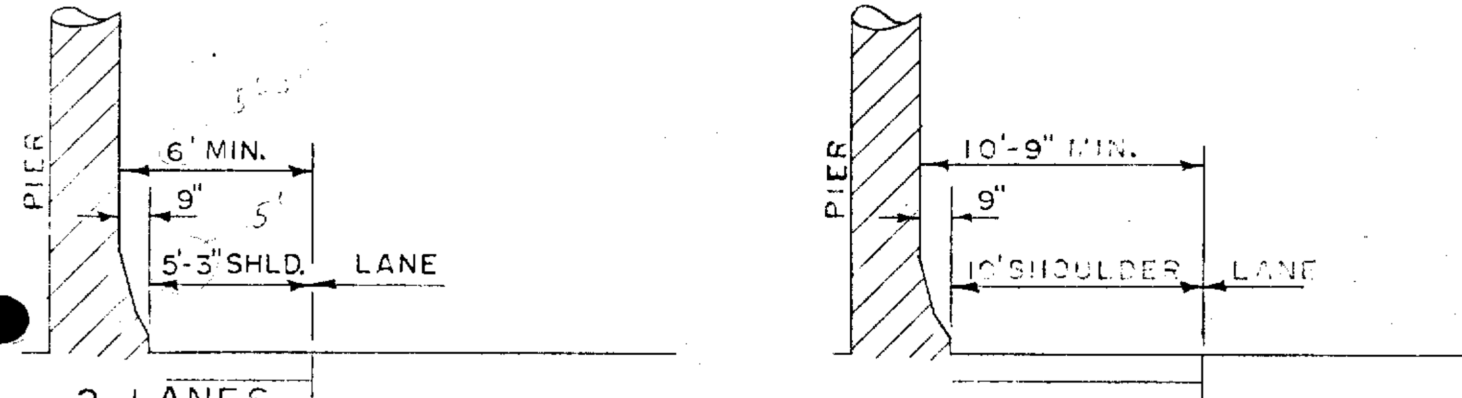
LEFT CLEARANCE | LEFT CLEARANCE



MAIN LINE

FOR 3 OR 4 LANES IN EACH DIRECTION IN RURAL & URBAN AREAS

LEFT CLEARANCE | LEFT CLEARANCE



2-LANES EACH DIRECTION

MAIN LINE IN RURAL & URBAN AREAS

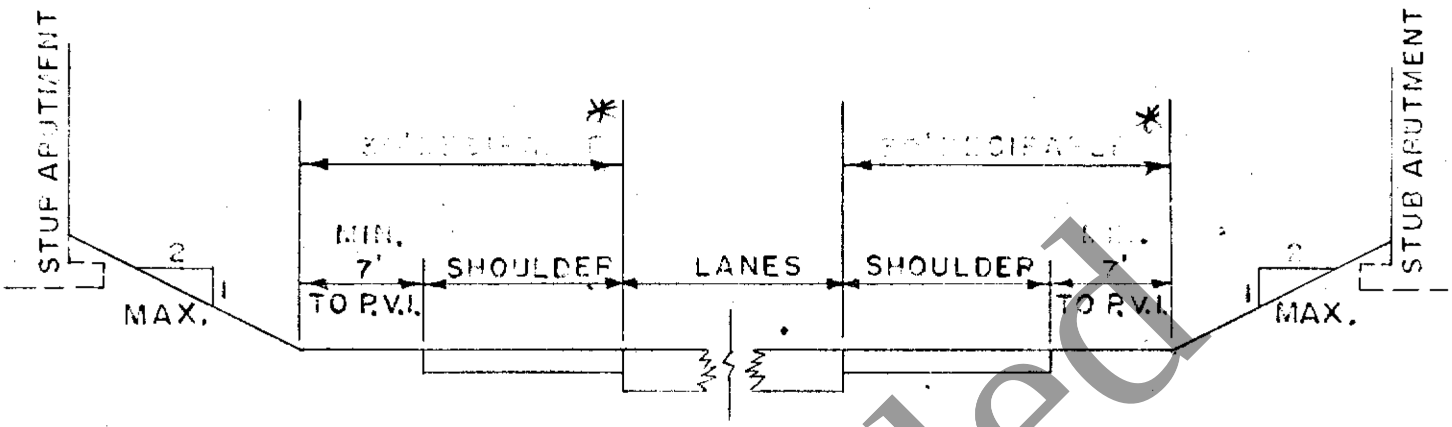
5-LANES EACH DIRECTION

UNDERPASSES - FREEWAYS

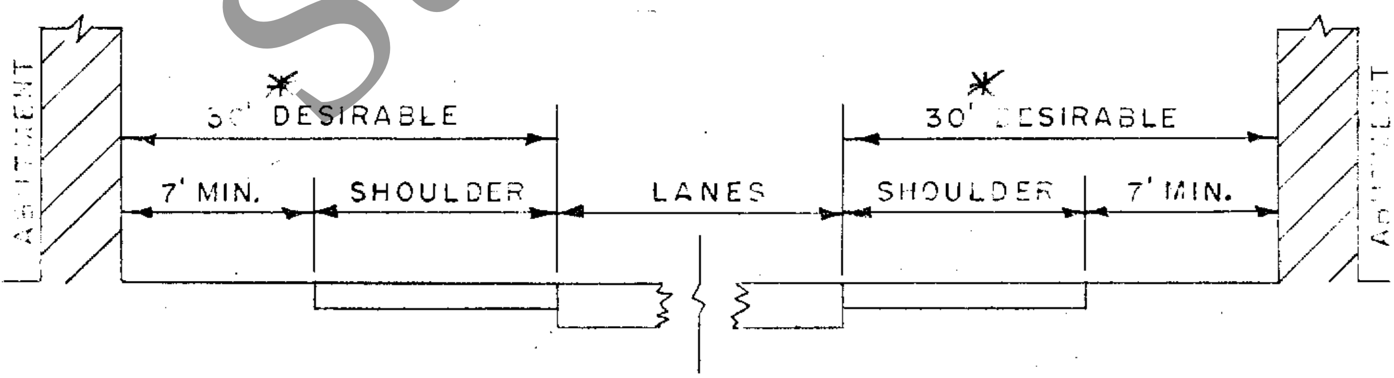
LEFT CLEARANCE

RIGHT CLEARANCE

* See Sheet 1/10



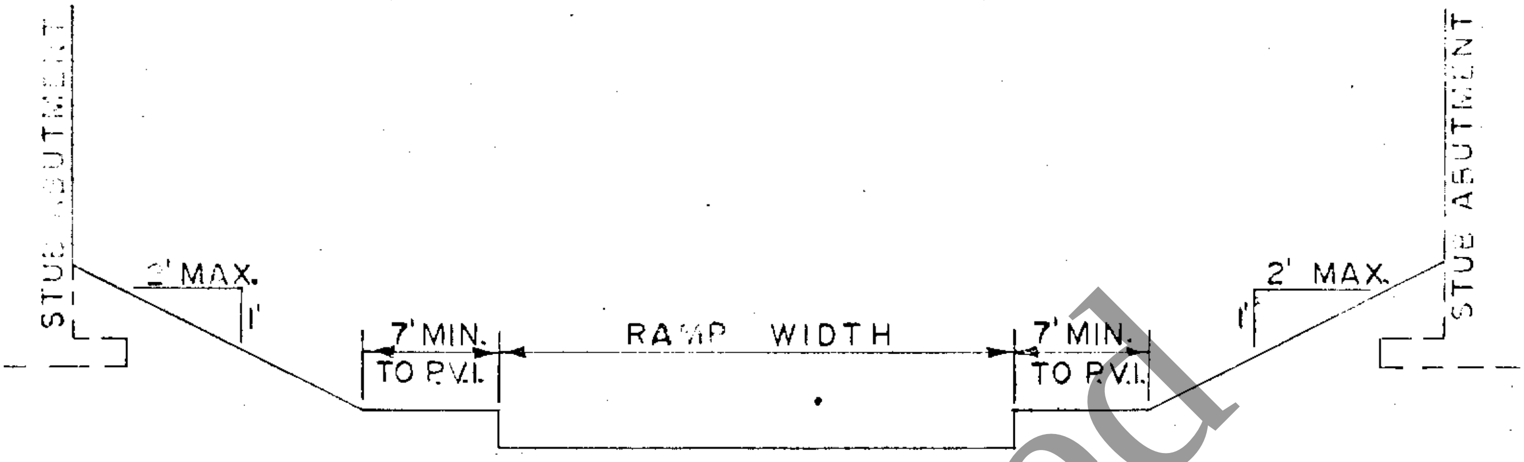
SEPARATE STRUCTURE



SEPARATE STRUCTURE

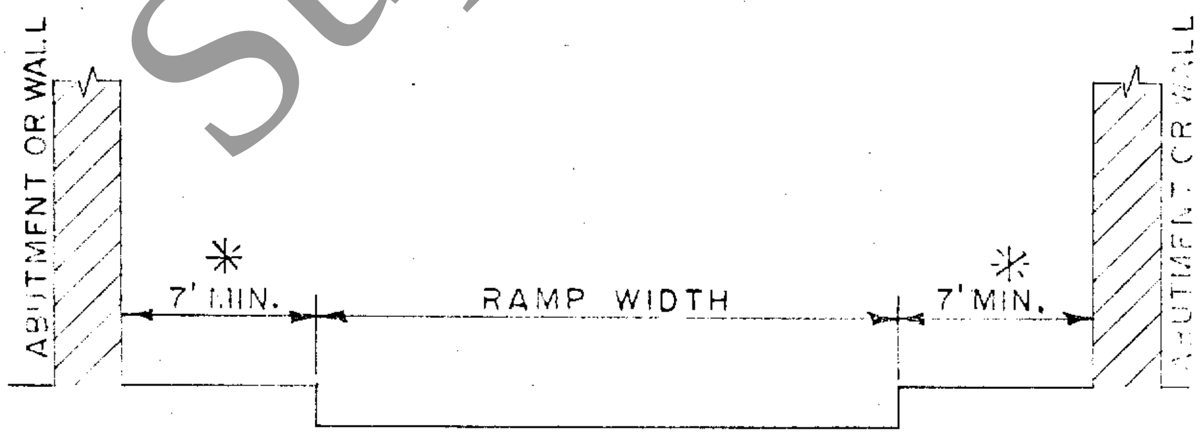
OVERPASSES-FREEWAYS
RAMPS

LEFT CLEARANCE RIGHT CLEARANCE



ONE OR TWO LANE RAMPS

LEFT CLEARANCE RIGHT CLEARANCE



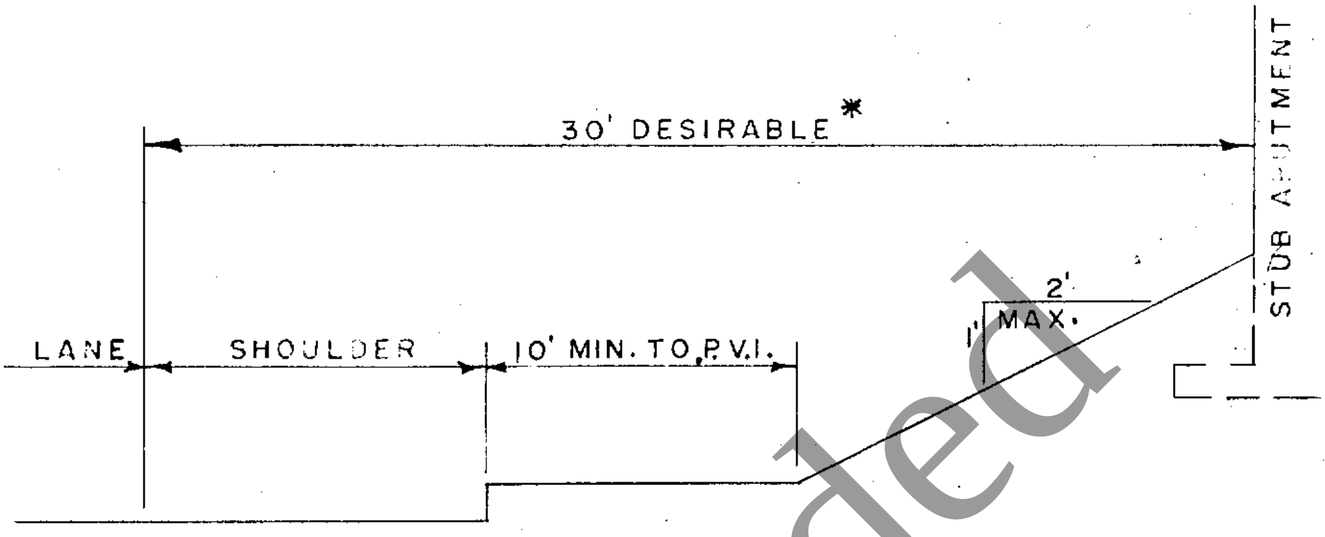
ONE OR TWO LANE RAMPS

* NOTE
SIGHT DISTANCE
GOVERNS

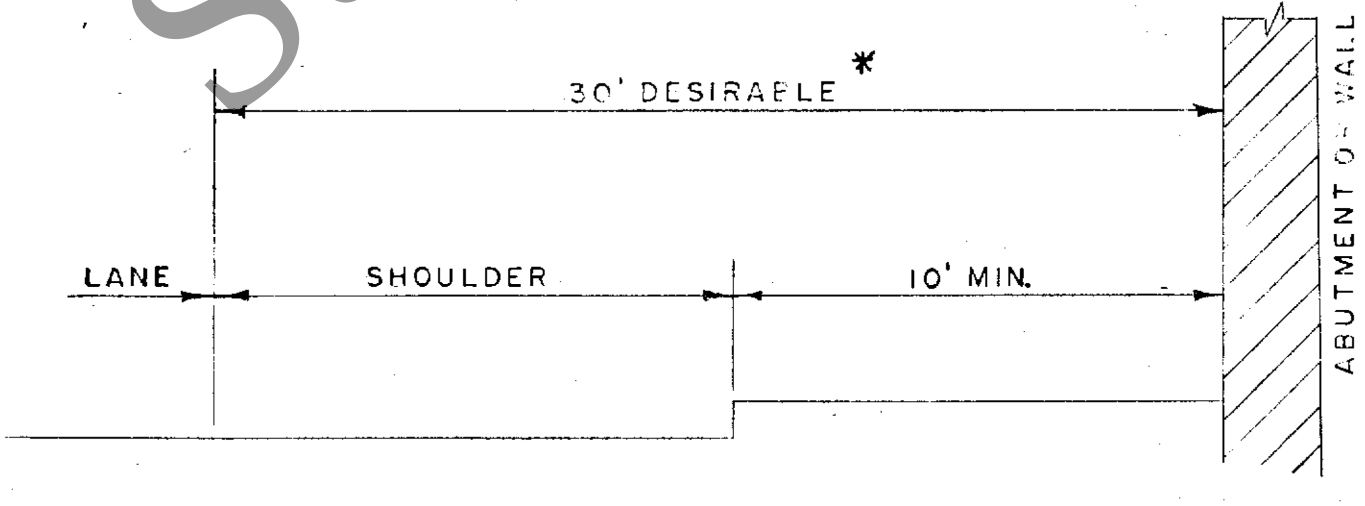
UNDERPASSES

U.S. HIGHWAYS

RIGHT & LEFT CLEARANCES



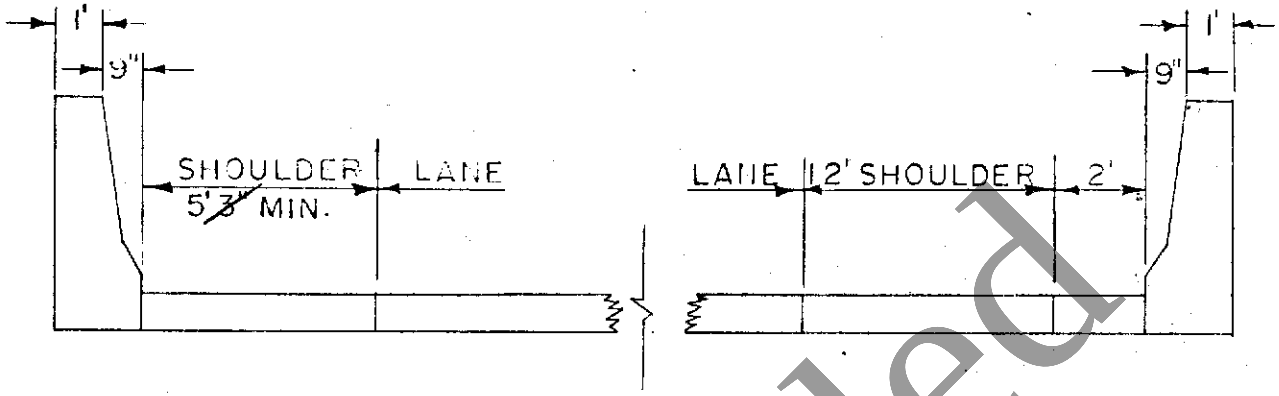
* See sheet 1/10



OVERPASSES-FREEWAYS

LEFT CLEARANCE

RIGHT CLEARANCE

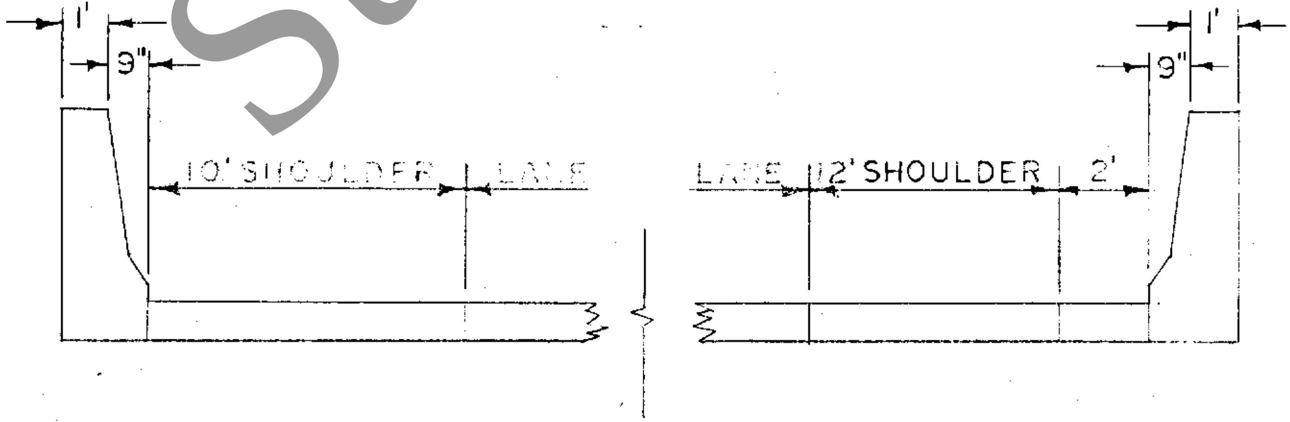


MAIN LINE

FOR 2 LANES IN EACH DIRECTION IN RURAL & URBAN AREAS

LEFT CLEARANCE

RIGHT CLEARANCE



MAIN LINE

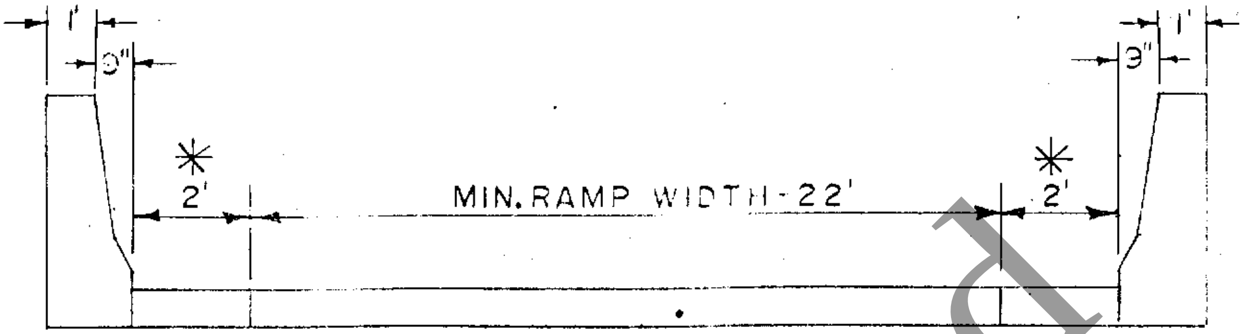
FOR 3 OR 4 LANES IN EACH DIRECTION IN RURAL & URBAN AREAS

7/10

OVERPASSES-FREEWAYS

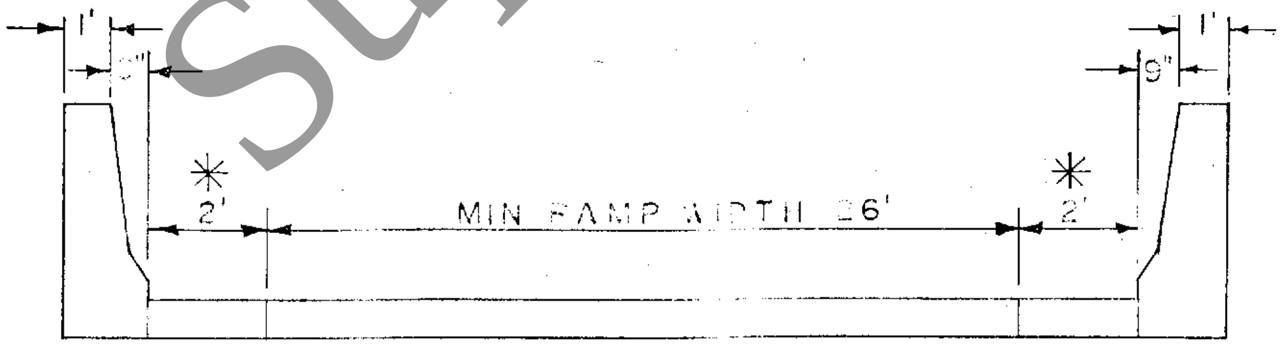
RAMPS

LEFT CLEARANCE | RIGHT CLEARANCE



ONE LANE RAMP

LEFT CLEARANCE | RIGHT CLEARANCE



TWO LANE RAMP

*NOTE

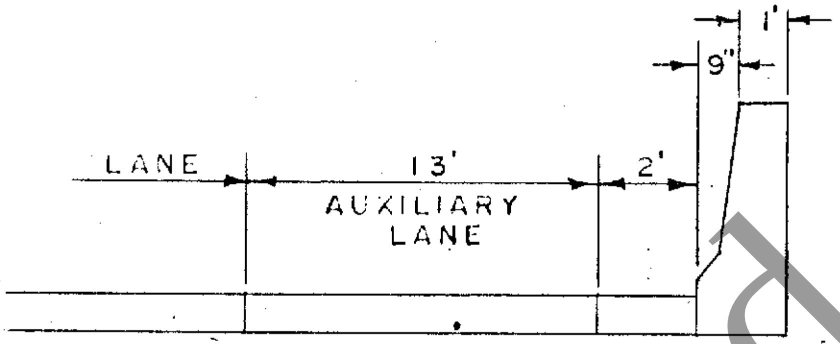
[illegible]

[illegible]

OVERPASSES—FREEWAYS

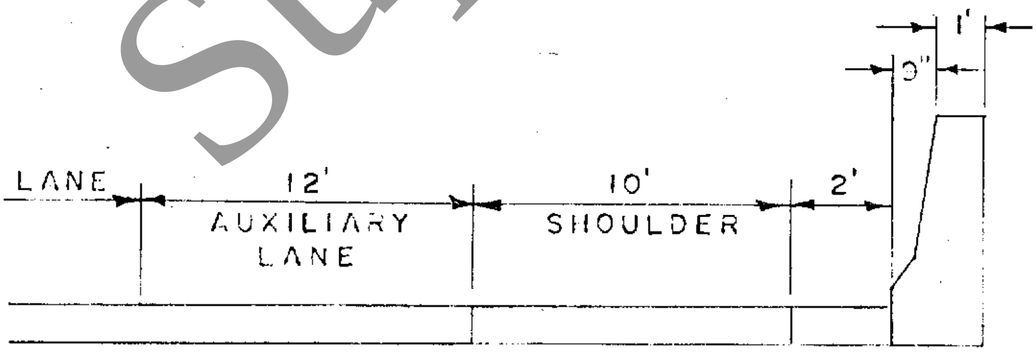
AUXILIARY LANES

RIGHT CLEARANCE



MAIN LINE

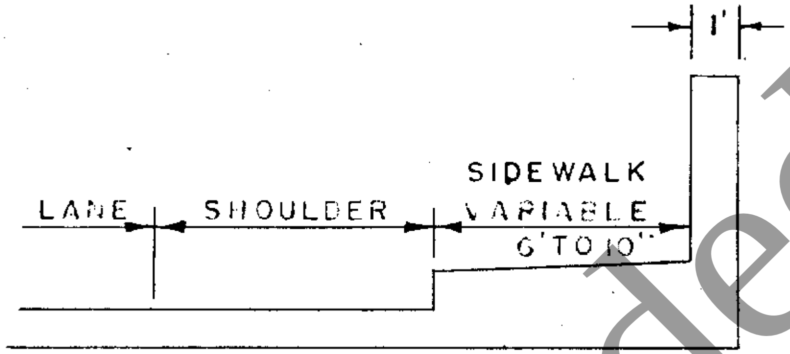
RIGHT CLEARANCE

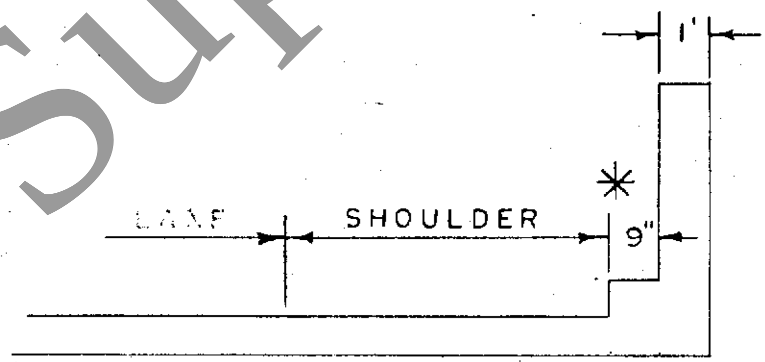


MAIN LINE

OVERPASSES-LOCAL ROADS

RIGHT & LEFT CLEARANCES





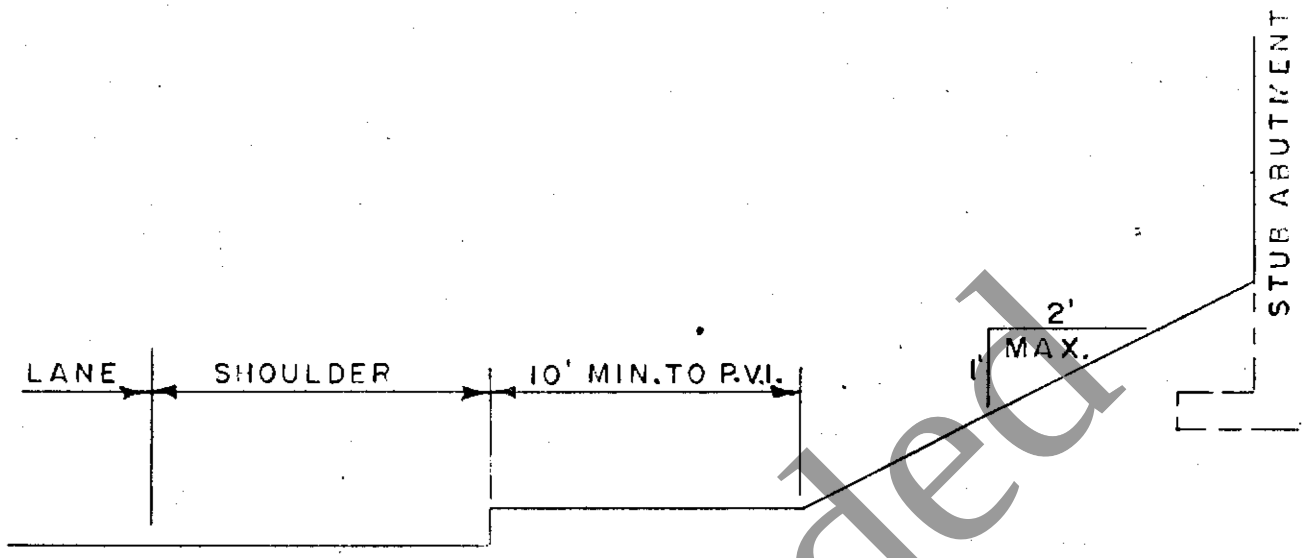
*NOTE

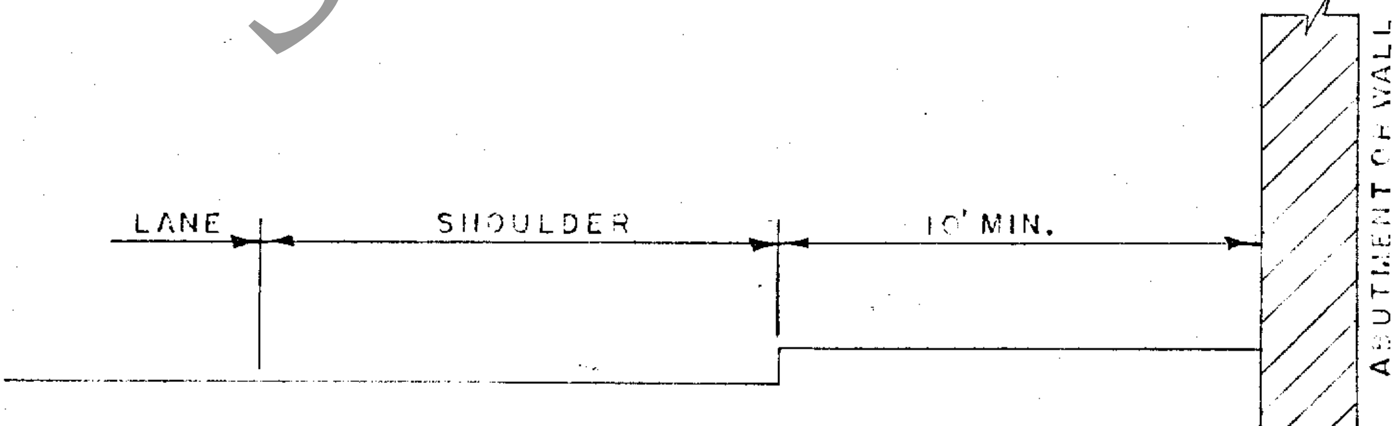
BRUSH CURB TO BE USED ONLY WHEN TWO SIDEWALKS CANNOT BE JUSTIFIED.

EVERY LOCAL ROAD MUST HAVE AT LEAST ONE SIDEWALK AREA.

UNDERPASSES LOCAL ROADS

RIGHT & LEFT CLEARANCES





CHAPTER 3

BASIC GEOMETRIC DESIGN ELEMENTS

CONTENTS

Geometric Design - con't

Sight Distance

General [redacted]

Passing Sight Distance

Stopping Sight Distance
stopping sight distance at crest vertical curves
stopping sight distance at sag vertical curves
~~Horizontal~~ and Vertical ~~Curves~~
stopping sight distance on horizontal curves

~~Overpasses and Underpasses~~

Horizontal Alignment (Main Roadway)

General Controls

Minimum Radius

Degree of Curve

Minimum Length of Curve

Tangent Distance Between Curves

Transition Curves

Superelevation (Description and Chart)

Vertical Alignment (Main Roadway)

General Controls

Minimum Grades

Vertical Alignment (Main Roadway) - con't

Maximum Grades

Length of Crest Vertical Curves

Length of Sag Vertical Curves

Tangent Distance Between Vertical Curves

Climbing Lanes

SIGHT DISTANCE

General

Sight distance is the continuous length of highway ahead visible to the driver. For design purposes, two sight distances are considered; passing sight distance and stopping sight distance. Stopping sight distance is the minimum sight distance to be provided at all points on multilane highways and two lane roads when passing sight distance is not economically obtainable. Variations of stopping sight distance are also required at interchange locations and at grade intersections including private road connections. Desirably, unlimited sight distance should be the goal in designing any highway; however, in no case should the sight distance be less than the minimum specified in Table No.

TABLE NO.

Design Speed mph	MINIMUM SIGHT DISTANCE		Desirable Sight Distance
	Stopping (Feet)	Passing (Feet)	stopping
30	200	1100	200
40	275	1500	325
50	350	1800	475
60	475	2100	650
70	600	2500	850
80	750	2700	1,100

Passing Sight Distance

The minimum passing sight distance is the minimum length of highway required for a vehicle to execute a normal passing maneuver as related to design conditions and design speed. It is based on the assumption that the driver's eyes are 3.75 feet above the pavement surface and he can see the top of an object 4.5 feet high on the road. The minimum passing sight distanced for various design speeds for level or nearly level grades are listed in Table No.

~~STOPPING SIGHT DISTANCE~~

STOPPING SIGHT DISTANCE

The minimum stopping sight distance is the distance required by the driver of a vehicle, traveling at a given speed, to bring his vehicle to a stop after an object on the road becomes visible. Stopping sight distance is measured from the driver's eyes, which are assumed to be 3.75 feet above the pavement surface, to an object 0.5 foot high on the road. For minimum stopping sight distance for see Table

Corrections should be applied to the stopping sight distances for grades of 3% or more either downgrade or upgrade. See "A Policy on Geom. Des. of Rural Highways" for factors to be applied.

~~STOPPING SIGHT DISTANCE ON HORIZONTAL CURVES~~

Stopping Sight Distance on Horizontal Curves

An element of horizontal alignment is the sight distance across the inside of curves. Where there are sight obstructions--walls, bridge piers, cut slopes, bridge railing, buildings, guide rail under certain conditions, etc.--on the inside of curves, a design to provide adequate sight distance may require adjustment in the normal highway cross section or change in alignment if the obstruction cannot be removed. Because of the many variables in alignment and cross sections, and in number, type, and location of possible obstructions, specific study usually is necessary for each condition. Using design speed and selected minimum stopping sight distance as controls, the actual condition should be checked, and necessary adjustments made in the manner most fitting to provide adequate sight distance.

For general use in design of a horizontal curve, the sight line is a chord of the curve and the applicable stopping sight distance is measured along the center line of the inside lane around the curve. Figure is a design chart showing the required middle ordinates for clear sight areas to satisfy minimum stopping sight distance requirements for curves of various degrees.

Horizontal sight restrictions may occur where there is a cut slope on the inside of the curve. For the stopping sight distance height criteria of ~~3.75~~ 3.50-foot height of eye and 6-inch height of object, a height of 2.0 feet can be used to approximate that at the midpoint of the sight line where the cut slope usually obstructs sight. This assumes that there is little or no vertical curvature.

Vertical Curves Section

~~STOPPING SIGHT DISTANCE AT CREST VERTICAL CURVE~~

Stopping Sight Distance at Crest Vertical Curve

Figures give the length of vertical curve required to obtain stopping sight distance for a given design speed when the algebraic difference in grades is known.

~~STOPPING SIGHT DISTANCE AT SAG VERTICAL CURVE~~

Stopping Sight Distance at Sag Vertical Curve

From the curves in Figures , the length of vertical curve which provides headlight sight distance in grade sags for a given design speed is obtained if the algebraic difference in grade rates is known. This is the sight distance used at underpasses where the highway profile dips under the crossing facility.

SIGHT DISTANCE AT INTERSECTIONS

Stop Controlled Intersections

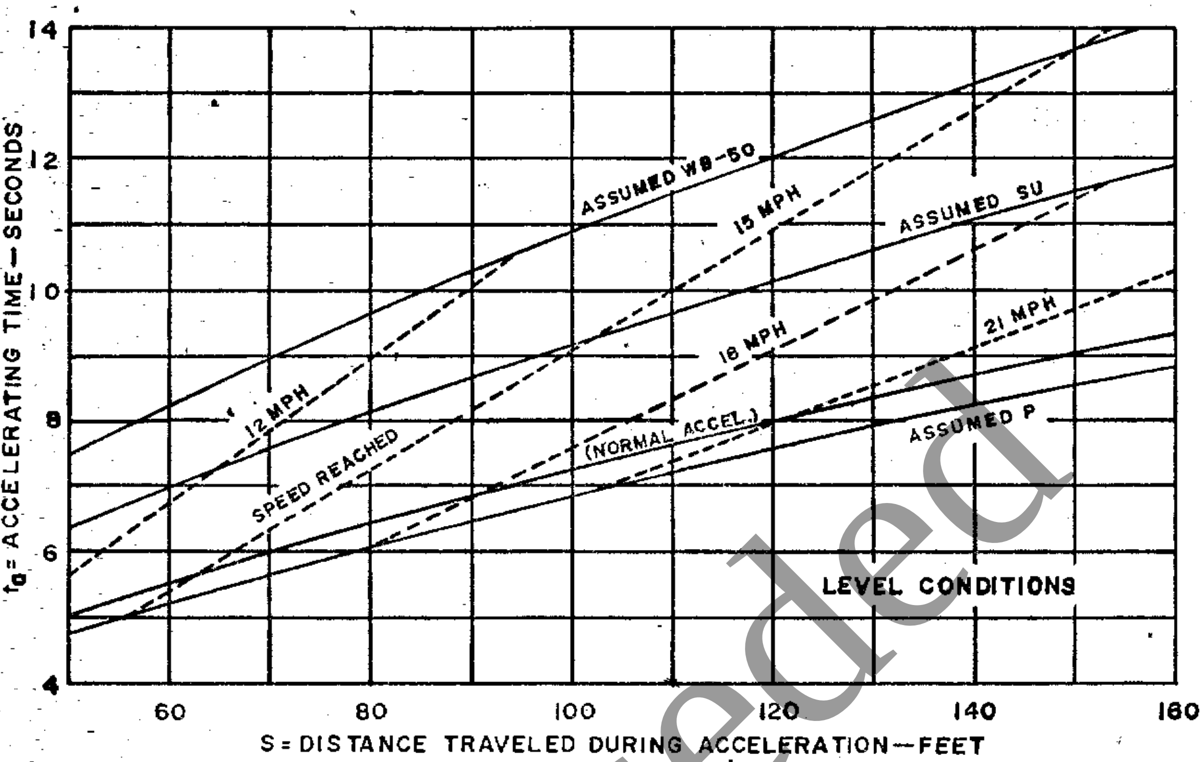
Intersection designs should provide sufficient sight distances to avoid potential conflicts between vehicles turning onto or crossing a highway from a stopped position and a vehicle on the through highway operating at the design speed.

For minimum sight distances and further discussions on intersection sight distance design, see the AASHTO publication, A Policy on Geometric Design of Rural Highways.

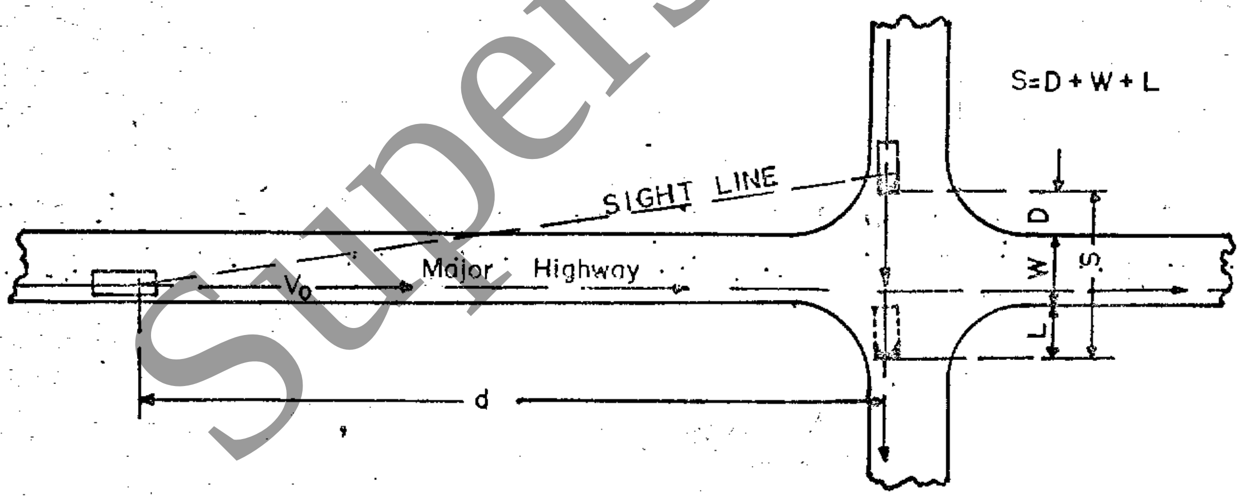
Signal Controlled Intersections

Desirably, the sight distances required for intersections with STOP control should be used at signalized intersections. As a minimum, signalized intersections should have sufficient stopping sight distances for the design speeds involved.

SIGHT DISTANCE AT INTERSECTIONS



SIGHT DISTANCE AT INTERSECTIONS
DATA ON ACCELERATION FROM STOP



STOP CONTROL ON MINOR ROAD

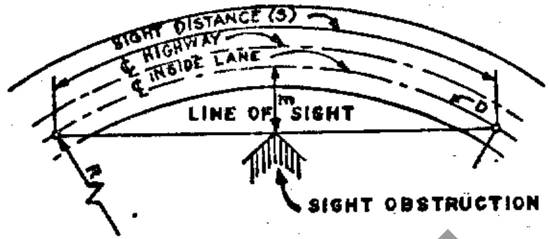
$$d = 1.47\,V\,(J + t_a)$$

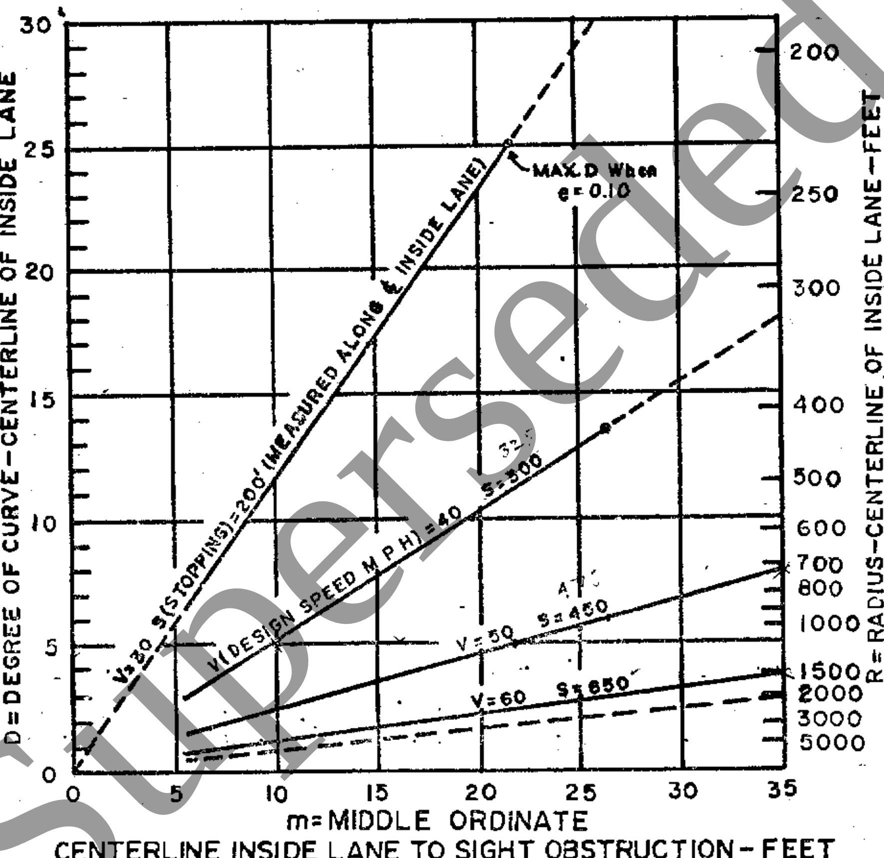
where,
- V = design speed on major highway, mph
- J = perception and reaction time, sec
- t_a = time required to traverse distance S = D + W + L

W = width of roadway including shoulders

D = 10 ft.

DESIRABLE STOPPING SIGHT DISTANCE ON HORIZONTAL CURVES





DESIRABLE STOPPING SIGHT DISTANCE ON HORIZONTAL CURVES

HORIZONTAL ALIGNMENT

In order to attain a safe and smooth flowing highway, horizontal alignment should be as directional as possible, but should be consistent with the topography. On freeways in metropolitan areas, alternate studies often indicate that right-of-way considerations influence alignment more than any other factor. Topography controls both curve radius and design speed to a large extent. The design speed, in turn, controls sight distance but sight distance must be considered concurrently with topography because it often demands a larger radius than the design speed. All these factors must be balanced to produce an alignment that is safest, most economical, in harmony with the natural contour of the land and at the same time adequate for the design classification of the highway.

MINIMUM RADIUS

The following table gives the minimum radius of curvature for specific design speeds. This table is based solely on speed and does not reflect requirements for sight distance.

Design Speed (MPH)	Minimum Radius
30	~~300~~ 275
40	550 ← 500
50	850 ✓
60	1,150 ← 1350
70	~~1,150~~ ~~1650~~ 2100
~~80~~	~~2,700~~ 3,225

The above values are based on a maximum superelevation rate of .06. Every effort should be made to exceed these minimum values. Minimum radius should be used only when the cost of realizing a higher standard is inconsistent with the benefits.

The recommended minimum radii for freeways is 3000 feet.

MINIMUM LENGTH OF CURVE

For small deflection angles, curves should be sufficiently long to avoid the appearance of a kink. Curves should be at least 500 feet long for a central angle of five degrees, and the minimum length should be increased 100 feet for each 1-degree decrease in the central angle.

REVERSE CURVES

The use of reverse curves in alignment on main traffic lanes, without an intervening tangent, should be avoided. Where severe physical restrictions require a reversal in alignment, an intervening tangent of sufficient length to provide adequate superelevation runoff between the curves should be used.

TANGENT DISTANCE BETWEEN CURVES/REVERSE CURVES

a. Minimum Desirable Tangent - 1,000 feet

b. Minimum Tangent - 800 feet

Des. Speed	Min. Tangent	Min. Des. Tangent
50	500	600
60	600	800
70	800	1,000

SAME DIRECTION CURVES

a. Minimum Desirable Tangent - 2,500 feet

b. Minimum Tangent - 1,500 feet

Des. Speed	Min. Des. Tang.
50	1,000
60	1,500
70	2,500

NOTE - The minimum tangent distance for same direction curves should be exceeded when both curves are visible for some distance ahead.

~~TRANSITION CURVES~~

MAIN ROADWAY

Radius In Feet	Desirable Minimum Length of Transition
1000 to 1600	350'
1600 to 1800	300'
1800 to 2200	250'
2200 to 3000	200'
3000 to 3500	200'
3500 to 4500	200'
over 4500	No transition needed

See Figures

SUPERELEVATION

General

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

The maximum rates of superelevation used by the Department are 0.06 for all expressways and other major rural highways, and 4% on local rural streets and other urban highways.

Tables ______________ give the design values for each rate of superelevation to be used for various design speeds and radii.

Superelevation Transition

To meet the requirements of comfort and safety, the superelevation transition should be affected uniformly over a length adequate for the design speeds.

Tables __________ illustrates the desired transition curves and the method of distributing superelevation.

Table ________ 10/4/76

6% Maximum Rate

RADIUS (ft)	SUPERELEVATION (PERCENT) FOR DESIGN SPEEDS OF 30 MPH	40 MPH	50 MPH	60 MPH	70 MPH
300	5.9				
400	5.6				
500	5.1				
600	4.7	5.9			
700	4.4	5.7			
800	4.1	5.4			
900	3.9	5.1	6.0		
1,000	3.7	4.9	5.9		
1,200	3.3	4.5	5.5		
1,400	2.9	4.1	5.2	6.0	
1,600	2.7	3.8	4.9	5.8	
1,800	2.4	3.6	4.6	5.5	
2,000	2.2	3.3	4.3	5.3	5.9
2,500	1.8	2.8	3.8	4.7	5.6
3,000	1.6	2.4	3.4	4.3	5.1
3,500	1.5	2.1	3.0	3.9	4.7
4,000	1.5	1.9	2.7	3.5	4.3
4,500		1.7	2.5	3.2	3.9
5,000		1.6	2.2	3.0	3.6
6,000		1.5	1.9	2.6	3.1
7,000		1.5	1.7	2.3	2.8
8,000			1.5	2.0	2.5
9,000			1.5	1.8	2.2
10,000			1.5	1.6	2.0
12,000				1.5	1.7
14,000				1.5	1.5
16,000					1.5
18,000					1.5

NO SUPERELEVATION REQUIRED WHEN RADIUS (FEET) IS GREATER THAN 30 MPH	40 MPH	50 MPH	60 MPH	70 MPH
4,250	7,160	10,810	14,690	19,100

Transition not essential when Radius (feet) is greater than 30 MPH	40 MPH	50 MPH	60 MPH	70 MPH
1,500	3,000	4,000	6,000	8,000

Min R 275 500 850 1275 [illegible]

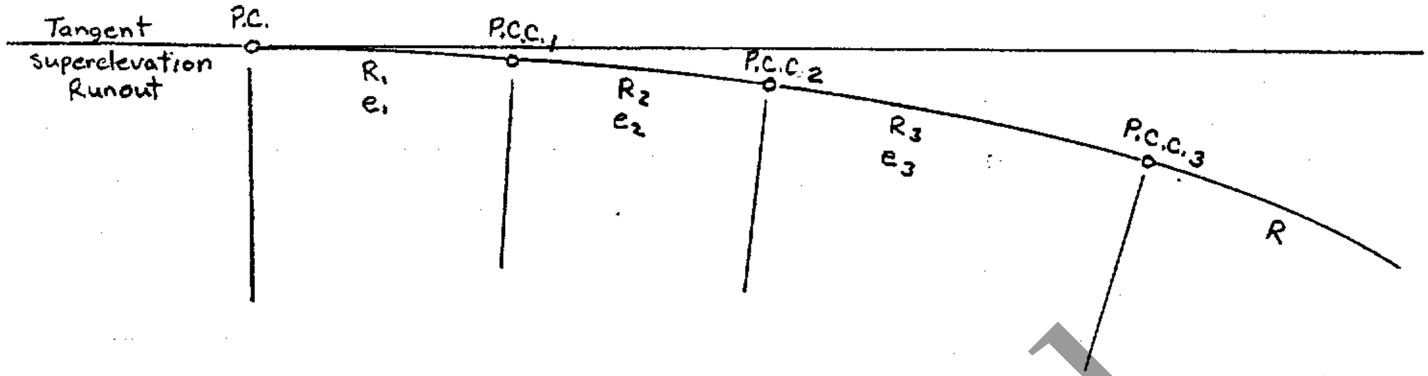
Table ________ 10/4/76

4% Maximum Rate

RADIUS (ft)	SUPERELEVATION (PERCENT) FOR DESIGN SPEEDS OF			
	30 MPH	40 MPH	50 MPH	60 MPH
300	4.0			
400	3.5			
500	3.2			
600	2.9	3.9		
700	2.6	3.6		
800	2.4	3.4		
900	2.3	3.2	4.0	
1,000	2.3	3.0	3.9	
1,200	2.0	2.8	3.6	
1,400	1.8	2.6	3.3	4.0
1,600	1.7	2.4	3.0	3.8
1,800	1.6	2.2	2.9	3.5
2,000	1.6	2.1	2.7	3.3
2,500	1.5	1.9	2.5	3.0
3,000		1.7	2.2	2.7
3,500		1.6	2.1	2.6
4,000			1.9	2.5
4,500			1.8	2.3
5,000			1.7	2.2
6,000			1.5	2.0
7,000				1.7
8,000				1.5
9,000				
10,000				
12,000				
14,000				
16,000				
18,000				

— 3%

TRANSITION CURVES



For Design Speeds 30 thru 70 mph

1. Determine if radii transition is needed for radius R using chart "Transition Not Essential When Radius (R) is greater than".

2. If required, use standard Transition Curves

3. At P.C.C.3 hold maximum e for radius R

4. Using superelevation chart, determine if superelevation is needed for R1

5. If superelevation is needed for R1, use 2/3 maximum superelevation for R1 at P.C.

6. Distribute superelevation evenly between P.C.C.3 and P.C.

7. Distribute superelevation at the same rate as in Step 6 on tangent up to normal section

On Existing Roadways or Where Radii Transitions Can Not be Provided

1. Determine maximum superelevation needed for radius (R)

2. Use 2/3 maximum superelevation at P.C. and P.T of curve.

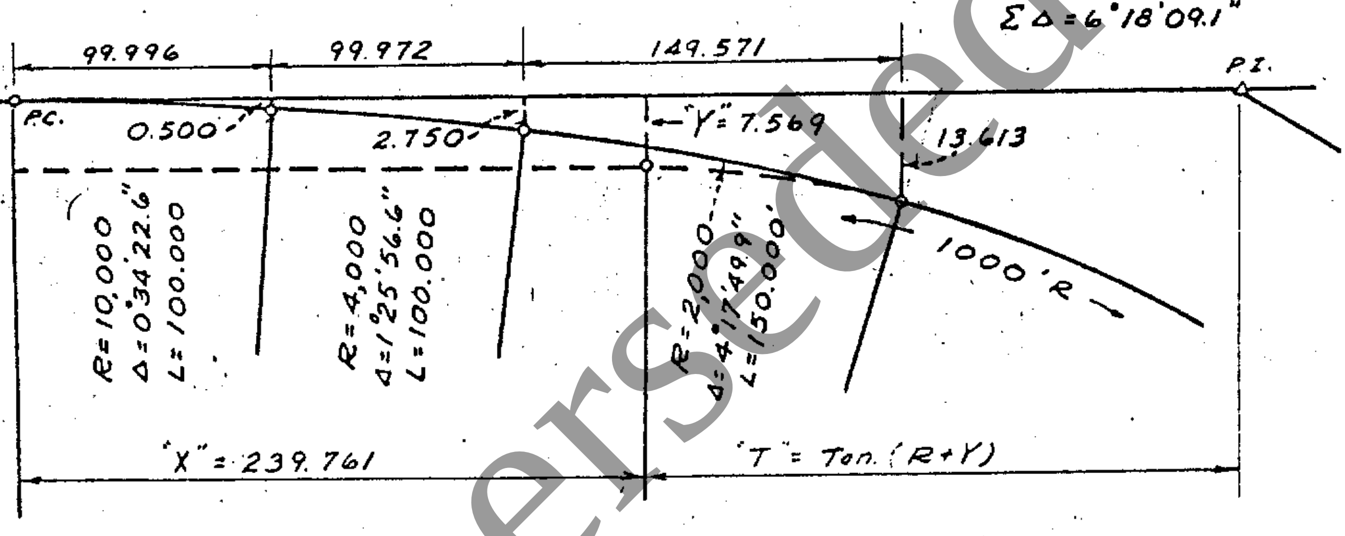
3. Distribute superelevation at a maximum rate of 2%/sec of time for the design speed.

TRANSITION CURVES

NOTE: To Locate Transition P.C.;
(1) Find "X" and "Y" for desired Radius*
(2) Add Radius "R" to "Y" distance
(3) Find "T" for (R+Y)
(4) Add "T" to "X" for distance P.C. to P.I.

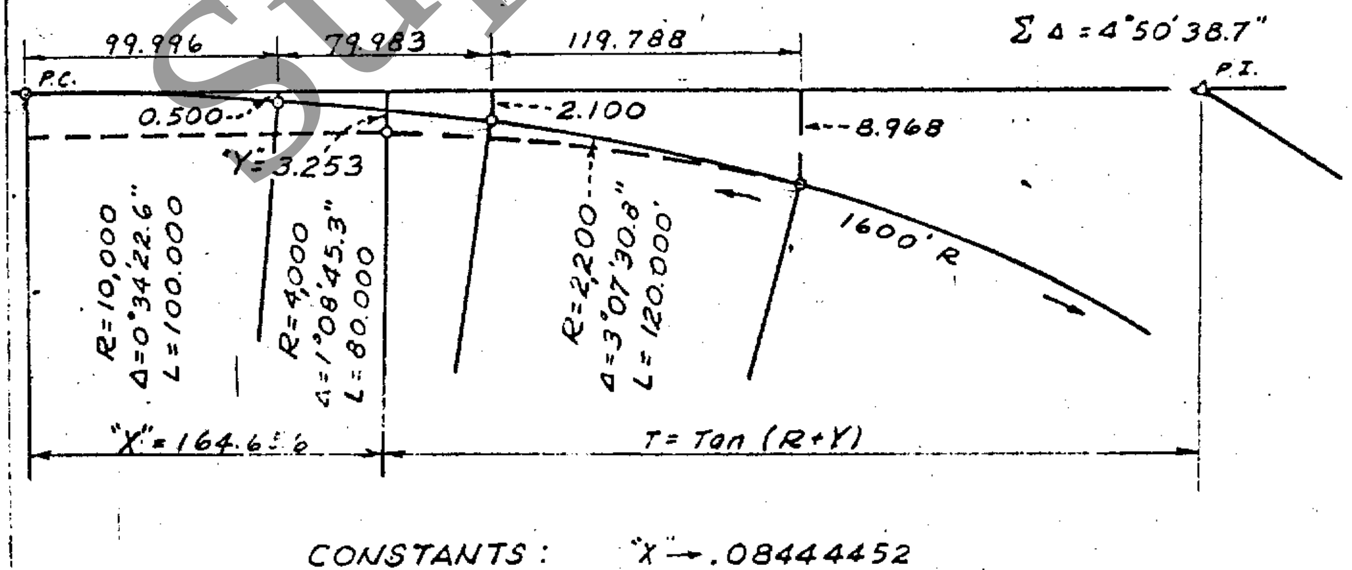
* "X" and "Y" decrease by the amount of the constant per foot of increase in Radius "R".

1000' TO 1600' RADIUS



CONSTANTS: X → .10977816
Y → .00604388

1600' TO 1800' RADIUS



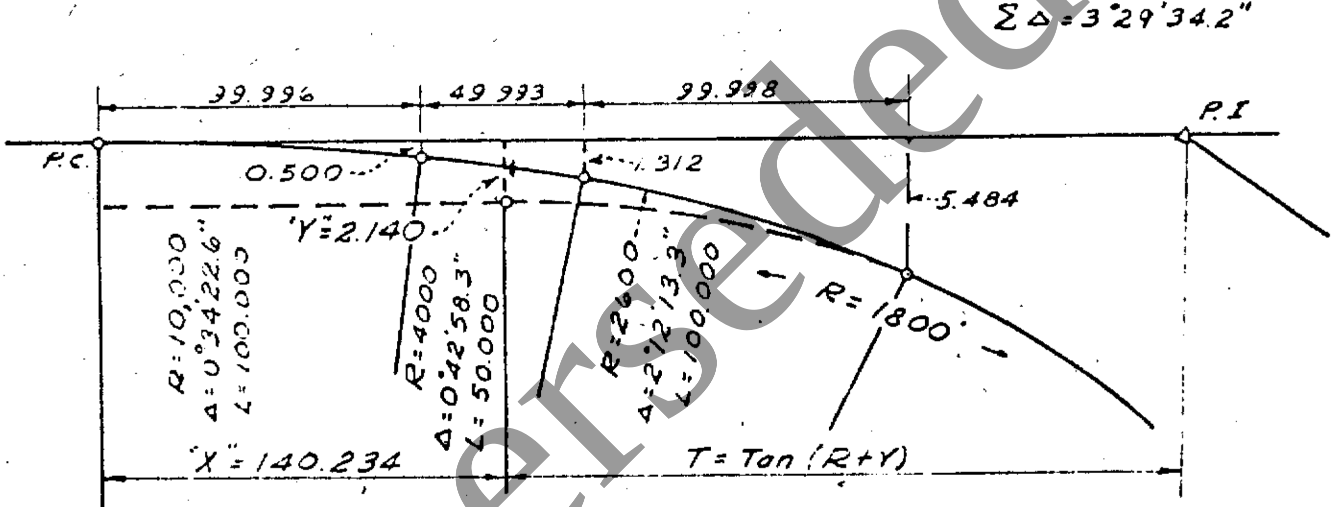
CONSTANTS: "X" → .08444452
"Y" → .00357182

TRANSITION CURVES

NOTE: *To Locate Transition P.C.;*
*(1) Find "X" and "Y" for desired Radius**
(2) Add Radius "R" to "Y" distance
(3) Find "T" for (R+Y)
(4) Add "T" to "X" for distance P.C. to P.I.

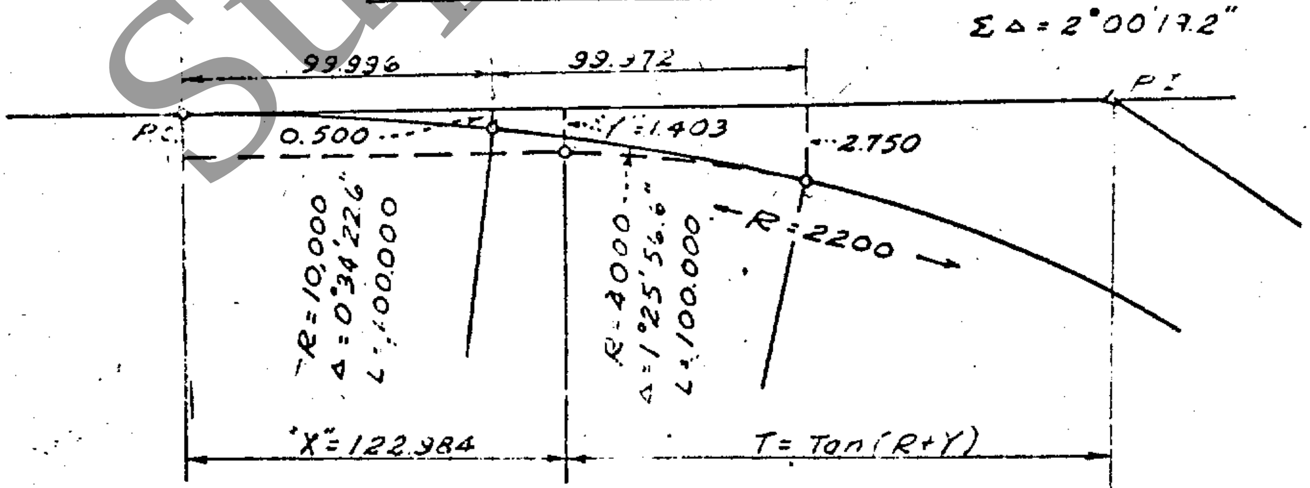
*: * "X" and "Y" decrease by the amount of the constant per foot of increase in Radius "R"*

1800' TO 2200' RADIUS



CONSTANTS: X → .06092369
Y → .00185753

2200' TO 3000' RADIUS



CONSTANTS: 'X' → .03493253
'Y' → .00061242

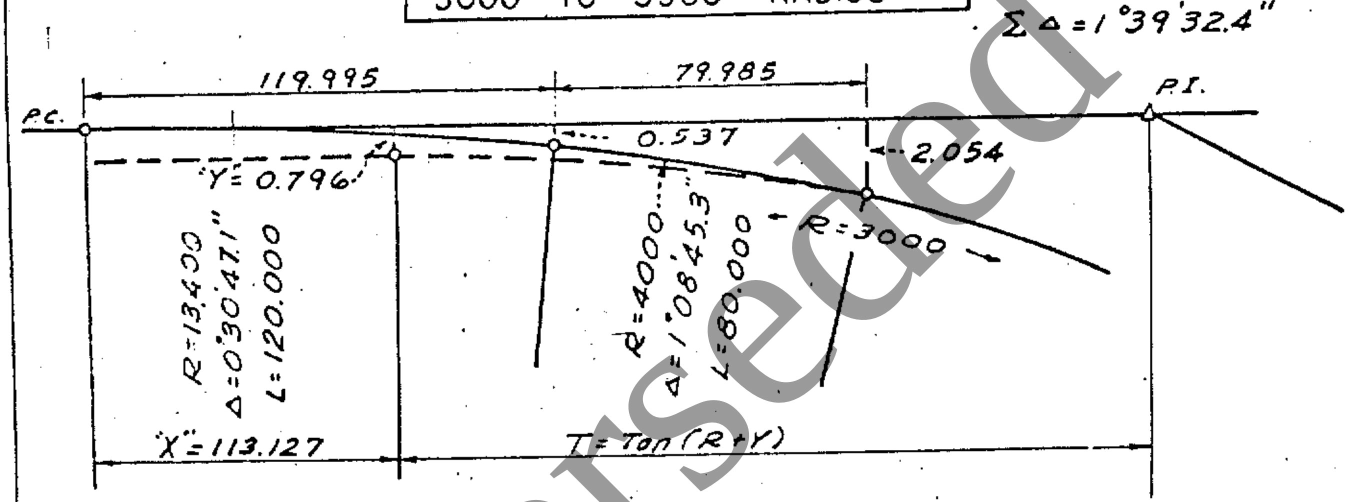
TRENTON FIELD OFFICE
SEPT. 1963

TRANSITION CURVES

NOTE: To Locate Transition P.C.;
(1) Find "X" and "Y" for desired Radius*
(2) Add Radius "R" to "Y" distance
(3) Find "T" for (R+Y)
(4) Add "T" to "X" for distance P.C. to P.I.

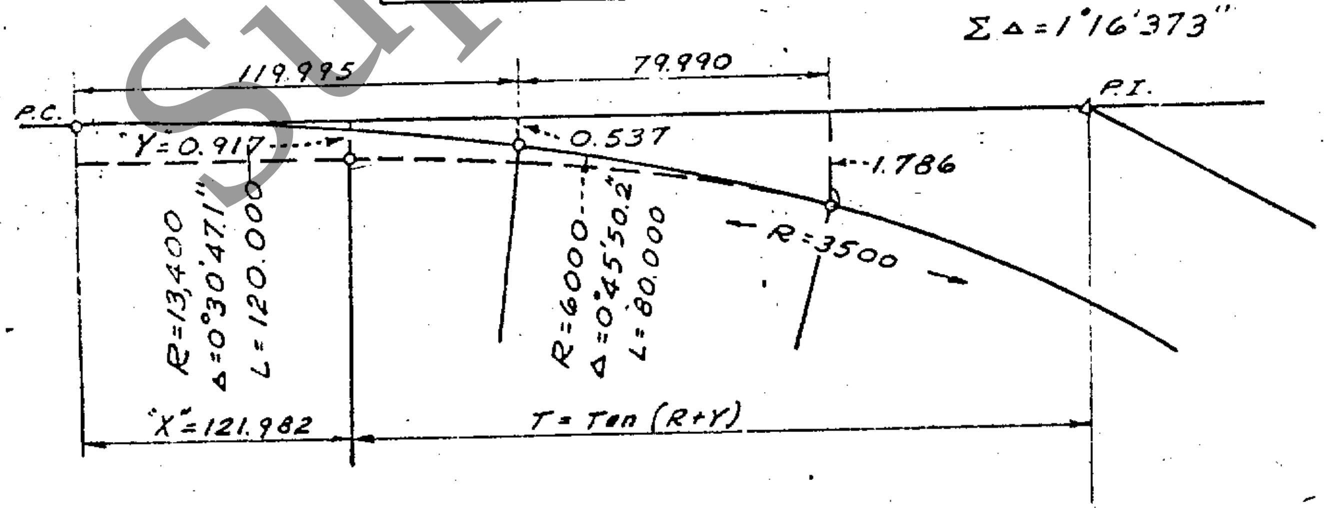
:* "X" and "Y" decrease by the amount of the constant per foot of increase in Radius R

3000' TO 3500' RADIUS



CONSTANTS: "X" → .02895097
"Y" → .00041917

3500' TO 4500' RADIUS



CONSTANTS: "X" → .02228650
"Y" → .00024837

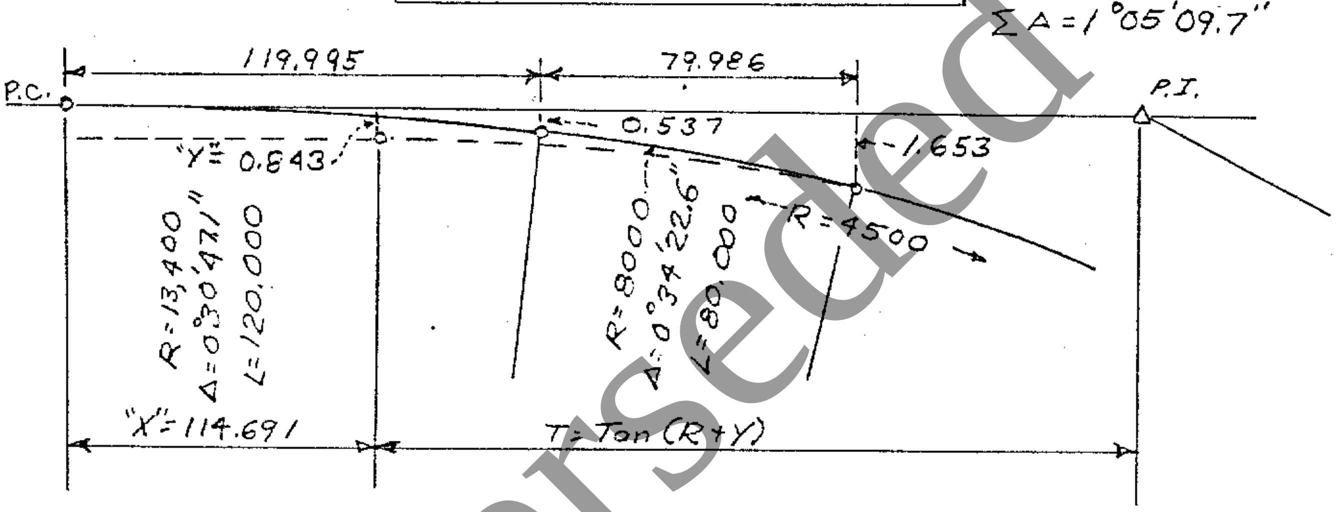
TRANSITION CURVES

NOTE: To Locate Transition P.C.:

(1) Find "X" and "Y" for desired Radius*
(2) Add Radius "R" to "Y" distance
(3) Find "T" for (R+Y)
(4) Add "T" to "X" for distance P.C. to P.I.

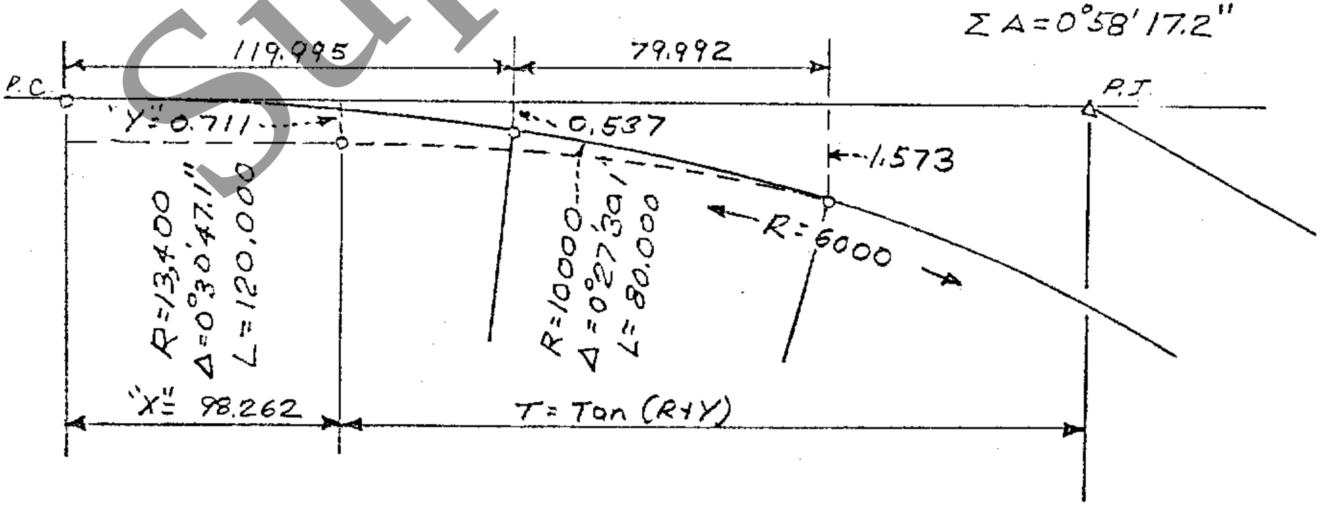
*"X" and "Y" decrease by the amount of the constant per foot of increase in Radius R

4500' TO 6000' RADIUS



CONSTANTS: "X" →
"Y" →

6000' TO 8000' RADIUS



CONSTANTS: "X" →
"Y" →

VERTICAL ALIGNMENT (Main Roadway)

General Controls

The grade line is a reference line by which the pavement elevation and the elevations of other features along the highway are established. It is controlled by topography, horizontal alignment, safety, sight distance, construction costs, cultural development, drainage, aesthetics and the standards for the particular type of highway involved. The operating characteristics of trucks must also be considered.

Minimum Grades

A minimum grade of 0.5 percent should be provided to facilitate surface drainage. Absolute minimum grade 0.35%

Maximum Grades

Maximum grade in itself is not a complete design control. It is necessary also to consider the length of a particular grade in relation to desirable vehicle operation.

Maximum Desirable Grade	= 5.0%
Maximum Grade	= 6.0%
Recommended Maximum Grade	= 3.0%

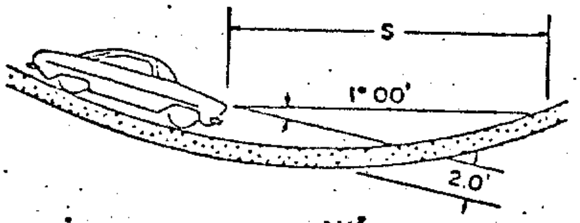
Differences in grade of 0.3% or less do not generally require vertical curves

Vertical Curves

Vertical curves should be simple in application and should result in a design which is safe, comfortable in operation, pleasing in appearance and adequate for drainage. The major control for safe operation on crest vertical curves is the provision for adequate sight distance for the design speed. Minimum stopping sight distance or greater value should be provided in all cases. Considerations of comfort require that vehicular rate of change of grade be kept within tolerable limits. This is most important in sag vertical curves where gravititional and vertical centrifugal forces act in the same direction.

STOPPING SIGHT DISTANCE ON VERTICAL CURVES

SAG



Comfort $L = \frac{AV^2}{46.5}$

Headlight

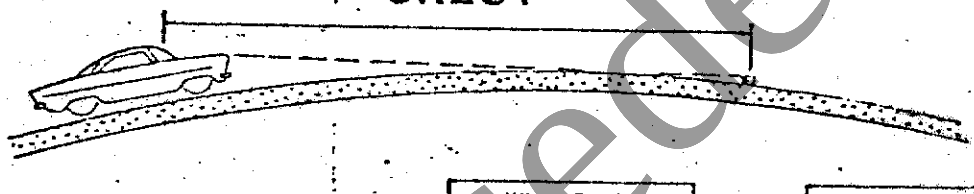
When S > L	When S < L
$L = 2S - \left[\frac{400 + 3.5S}{A}\right]$	$L = \frac{AS^2}{400 + 3.5S}$

Where:
- L = Length of sag vertical curve in feet
- A = Algebraic difference of grades in percent
- S = Sight distance in feet
- V = Design speed in M.P.H. for "S"

K = Length of vertical curve per unit of algebraic difference in grade

L = KA

CREST



Note: Height of eye = ~~3.75~~ 3.50' feet
Height of object = 0.5 feet

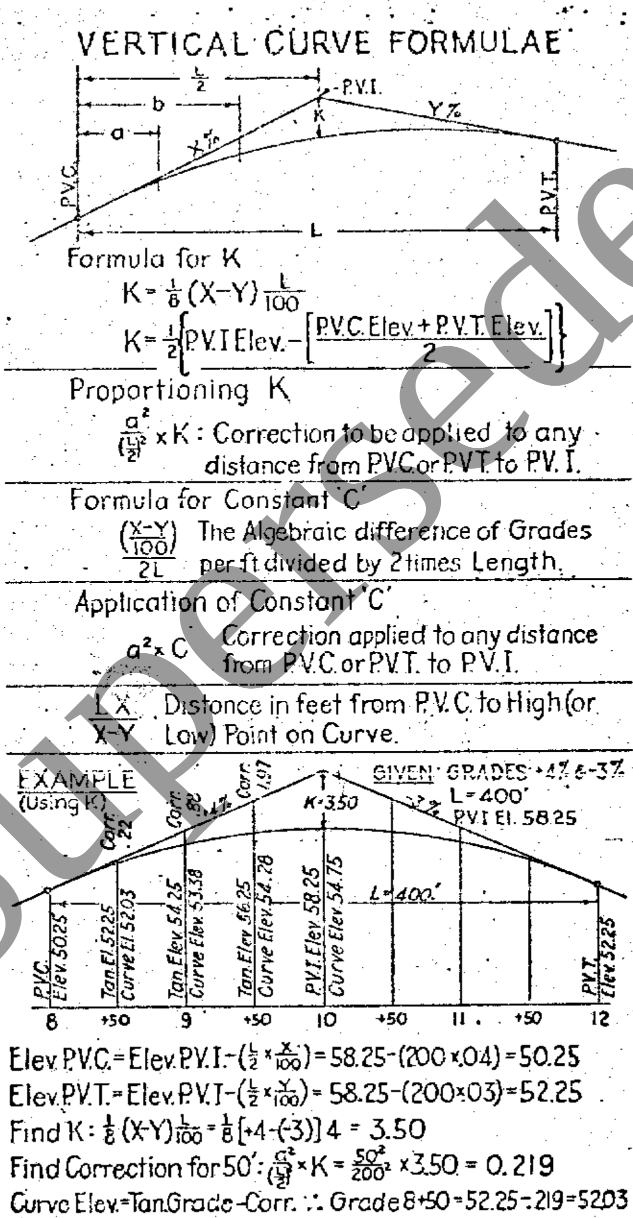
When S > L	When S < L
* $L = 2S - \left[\frac{1398}{A}\right]$	* $L = \frac{AS^2}{1398}$

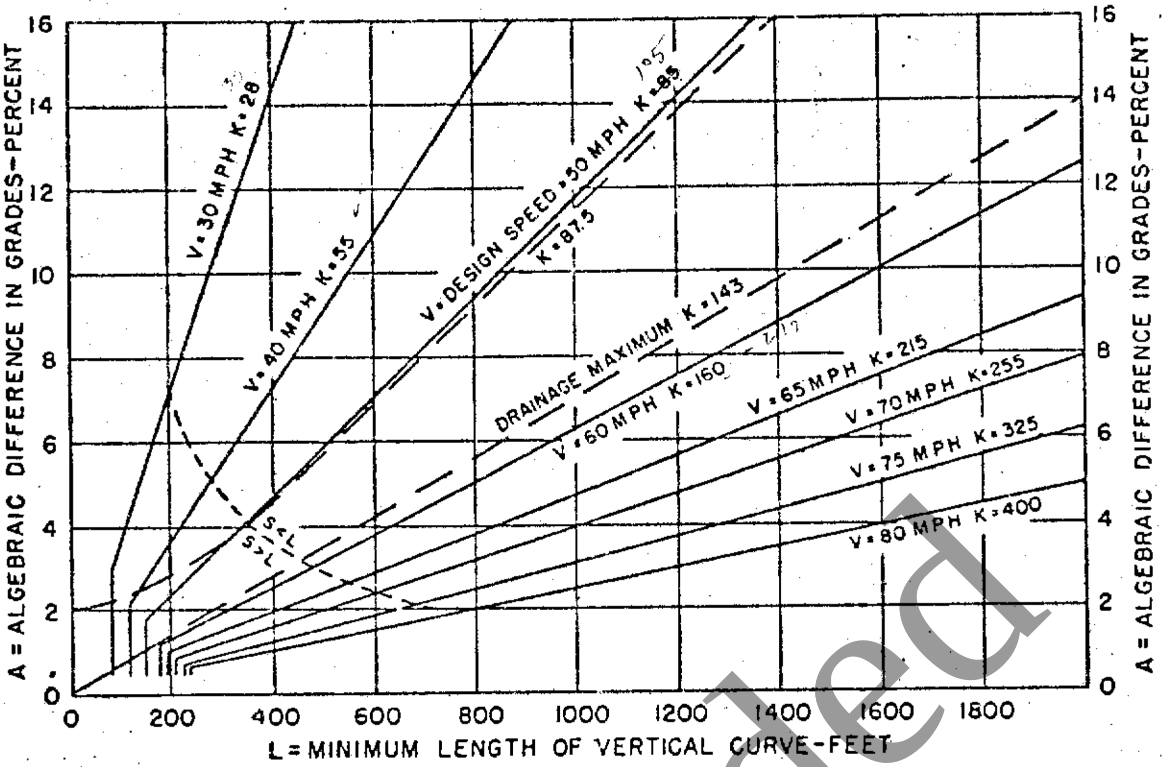
Where:
- L = Length of crest vertical curve in feet
- A = Algebraic difference of grades in percent
- S = Sight distance in feet
- V = Design speed in M.P.H. for "S"

* - For derivation refer to (AASHTO) A Policy on Geometric Design of Rural Highways (1965)

Properties of Vertical Curves

The simple parabola is the accepted curve for use in highway profile design. Figure __________ gives the necessary mathematical relations for computing a vertical curve.

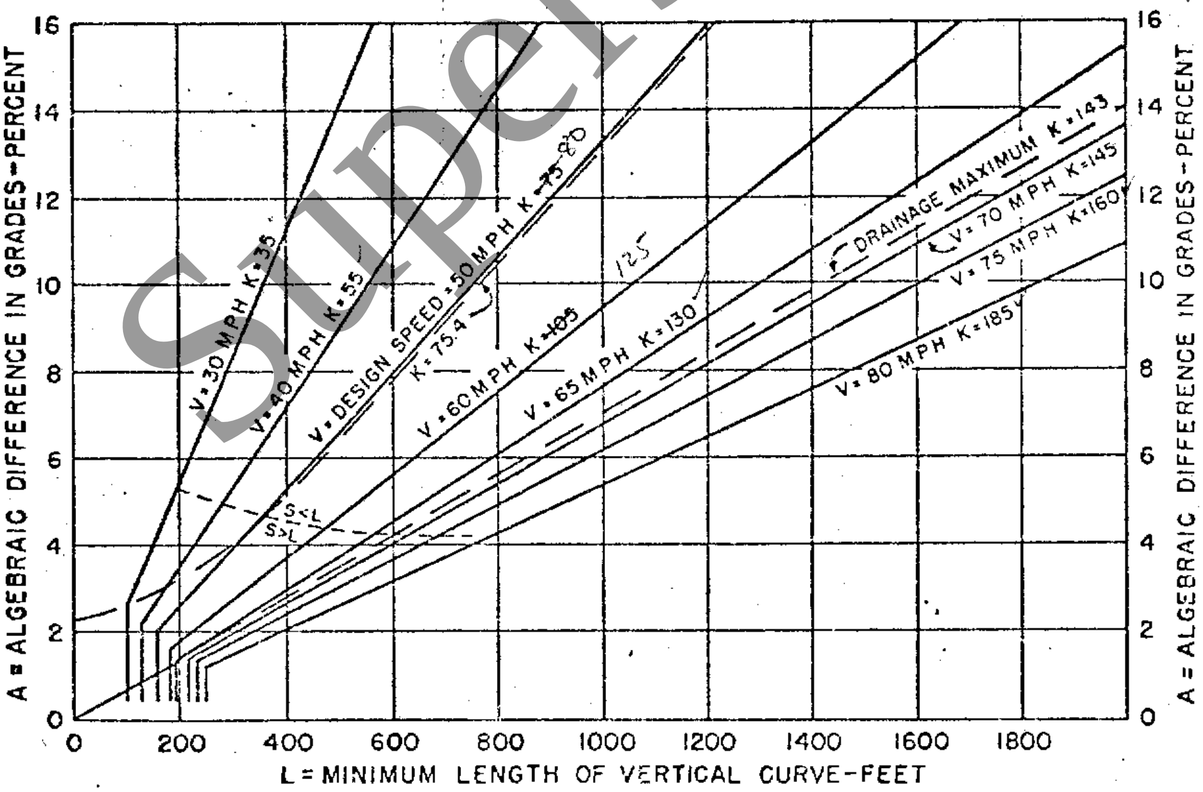




DESIGN CONTROLS FOR CREST VERTICAL CURVES

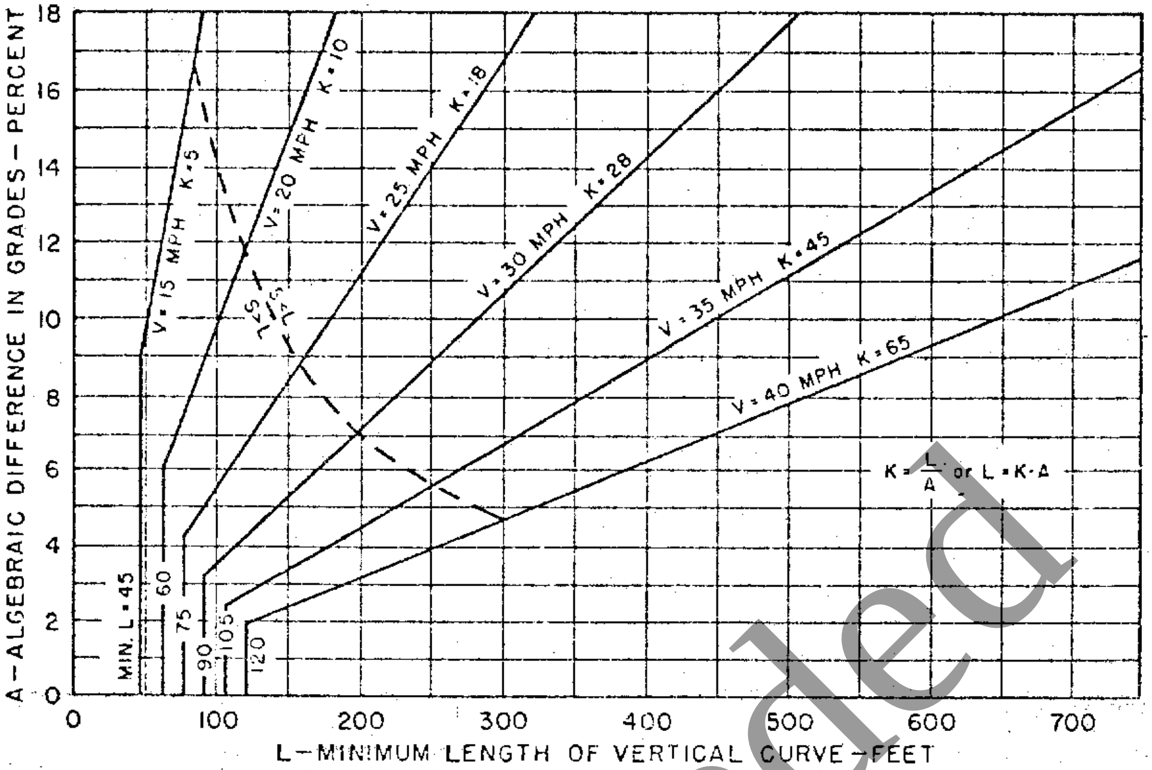
STOPPING SIGHT DISTANCE

FIGURE



DESIGN CONTROLS FOR SAG VERTICAL CURVES

FIGURE



DESIGN CONTROLS FOR CREST VERTICAL CURVES ON TURNING ROADWAYS

WITH DESIRABLE STOPPING SIGHT DISTANCE

SAME CONTROLS APPLY TO SAG VERTICAL CURVES

FIGURE

MINIMUM LENGTH IN FEET FOR SAG & CREST VERTICAL CURVES

[redacted]

A	30 MPH SAG K=35	30 MPH CREST K=28 (30)	40 MPH SAG K=55	40 MPH CREST K=55 (55)	50 MPH SAG K=75 (80)	50 MPH CREST K=85 (105)	60 MPH SAG K=105 (125)	60 MPH CREST K=160 (210)	70 MPH SAG K=145 (150)	70 MPH CREST K=255 (275)	80 MPH SAG K=185	80 MPH CREST K=400 (425)
0.5	20	14	28	28	40	45	55	80	75	130	95	200
1.0	35	28	55	55	75	85	105	160	145	255	185	400
1.5	55	42	85	85	115	130	160	240	220	385	280	600
2.0	70	56	110	110	150	170	210	320	290	510	370	800
2.5	90	70	140	140	190	215	265	400	365	640	465	1000
3.0	105	84	165	165	225	255	315	480	435	765	555	1200
3.5	125	98	195	195	265	300	370	560	510	895	650	1400
4.0	140	112	220	220	300	340	420	640	580	1020	740	1600
4.5	160	126	250	250	340	385	475	720	655	1150	835	1800
5.0	175	140	275	275	375	425	525	800	725	1275	925	2000
5.5	195	154	305	305	415	470	580	880	800	1405	1020	2200
6.0	210	168	330	330	450	510	630	960	870	1530	1110	2400
6.5	230	182	355	355	490	555	685	1040	945	1660	1205	2600
7.0	245	196	385	385	525	595	735	1120	1015	1785	1295	2800
7.5	265	210	410	410	565	640	790	1200	1090	1915	1390	3000
8.0	280	224	440	440	600	680	840	1280	1160	2040	1480	3200
8.5	300	238	465	465	640	725	895	1360	1235	2170	1575	3400
9.0	315	252	495	495	675	765	945	1440	1305	2295	1665	3600
9.5	335	266	520	520	715	810	1000	1520	1380	2425	1760	3800
10.0	350	280	550	550	750	850	1050	1600	1450	2550	1850	4000

L = KA BASED ON HEIGHT OF EYE 3.75 FEET, HEIGHT OF OBJECT 6"
L = LENGTH OF VERTICAL CURVE IN FEET A = ALGEBRAIC DIFFERENCE IN GRADE

Table #

5.05.05 CLIMBING LANE

A climbing lane is an ~~extra~~ lane ~~in the upgrade direction~~ for the diversion of slow traffic. Generally, climbing lanes will be provided when the requirements of two warrants, speed reduction and design capacity are satisfied. The requirements of one or the other of these warrants could be waived if, for example, slower moving truck traffic was the major contributing factor causing a high accident rate and could be corrected by addition of a climbing lane.

A. Speed Reduction - The beginning warrant for a truck climbing lane shall be that point where truck operating speed is reduced 10 MPH. Figure ~~III-14 of "A Policy on Geometric Design of Rural Highways" by AASHO~~ ~~shall~~ be used for locating this point. The ~~distance in advance of the point of need for the point of beginning of taper shall be 250' and an abrupt taper of 150' shall be used (see Figure 5.07).~~

B. Reduction in Capacity - The capacity warrant for a climbing lane is met when the traffic volume is 120% and 130% of the design capacity for two lane and multilane highways respectively. The capacity, level of service and truck equivalent factors shall be those in the Highway Capacity Manual.

The point of ending of a climbing lane shall be determined from Figure ~~III-14 of the Rural Policy~~ using 15 MPH less than the normal truck operating speed. The ending taper beyond this point shall be the highway ~~operating~~ speed times the travel lane width ~~(See Figure)~~. Desirable ~~stopping~~ sight distance ~~must~~ be available at the point of end of need ~~(see page 5-19)~~.

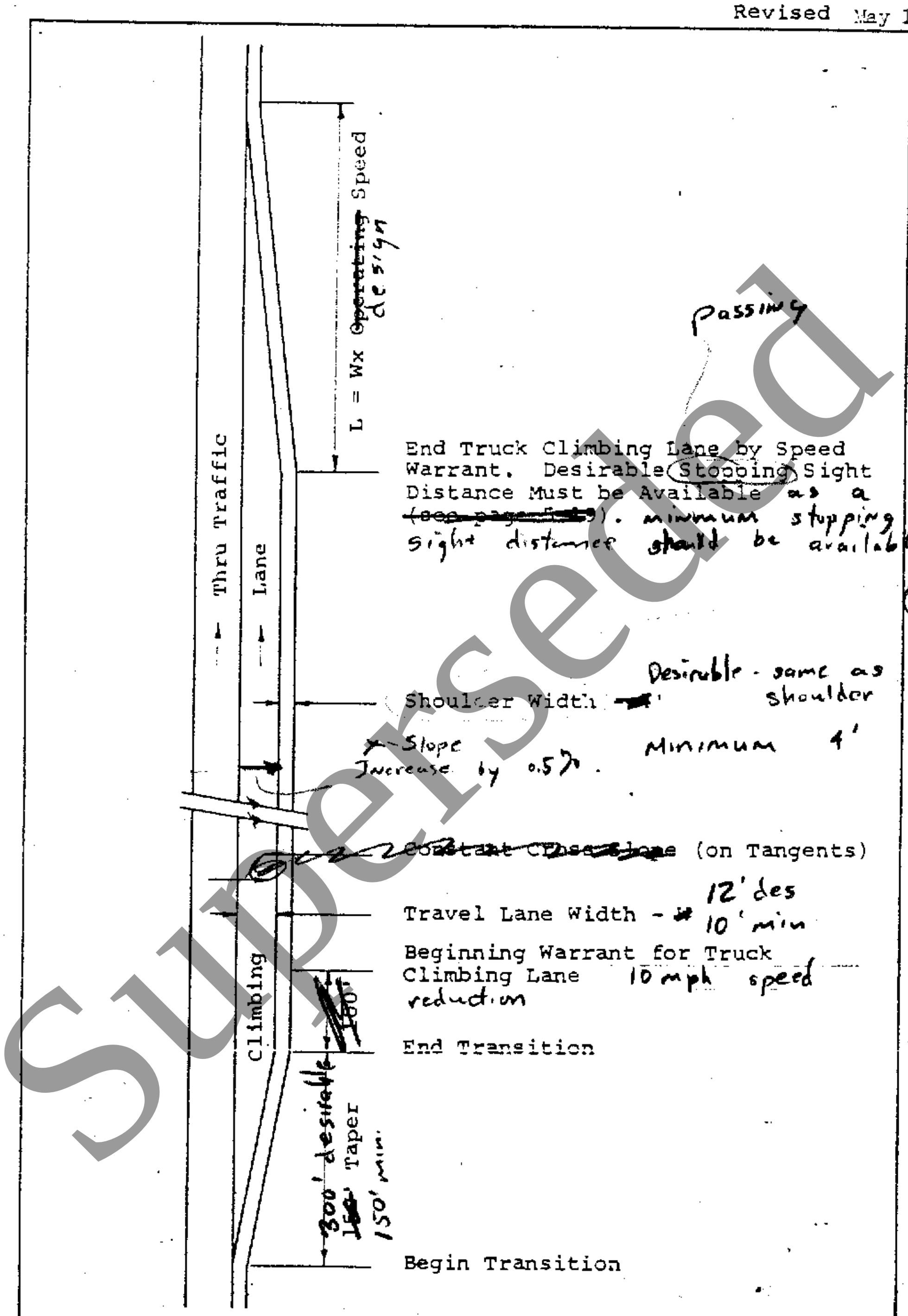
A speed profile should be prepared for the area of a climbing lane. The profile should start at the bottom of the first long downgrade prior to the upgrade being considered for a climbing lane, speeds through vertical curves can be approximated by using 100' cords.

~~5.05.06 LANE DROPS~~

~~At diamond, cloverleaf or other conventional types of interchanges, do not drop a lane at the exit terminal and then subsequently pick it up again at the next entrance terminal. Instead, carry the outside lane through the interchange area.~~

No shoulder on multi lane highways

Revised May 1976



STATE OF NEW YORK DEPT. OF TRANSPORTATION	CLIMBING LANE DESIGN	FIG. 5-C

Figure III-31.--Critical lengths of grade for design, assumed typical heavy truck of 300 lb/hp, intial speed 55 mph.

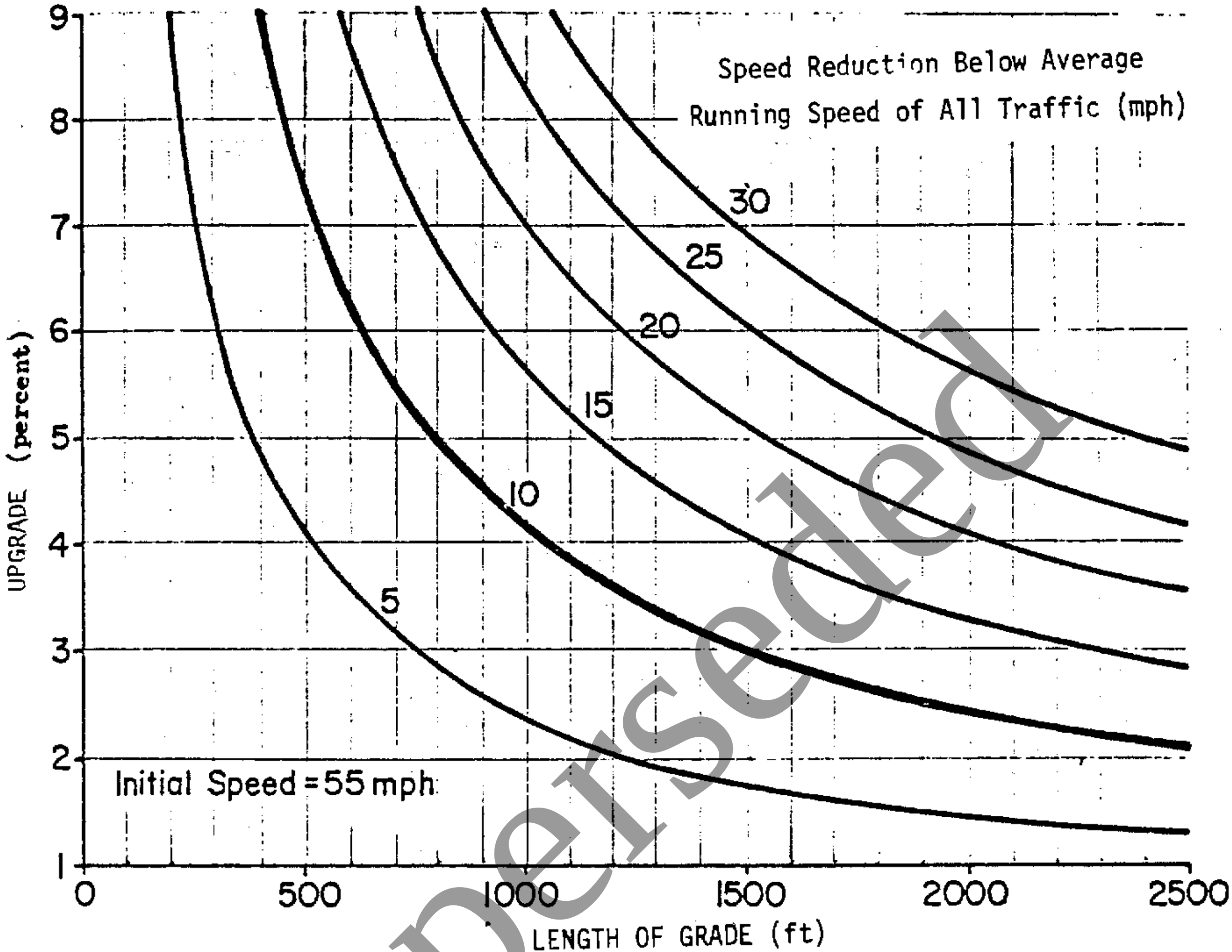


Figure III-27A.--Speed-distance curves for a typical heavy truck of 300 lb/hp for deceleration on ascending upgrades (34).

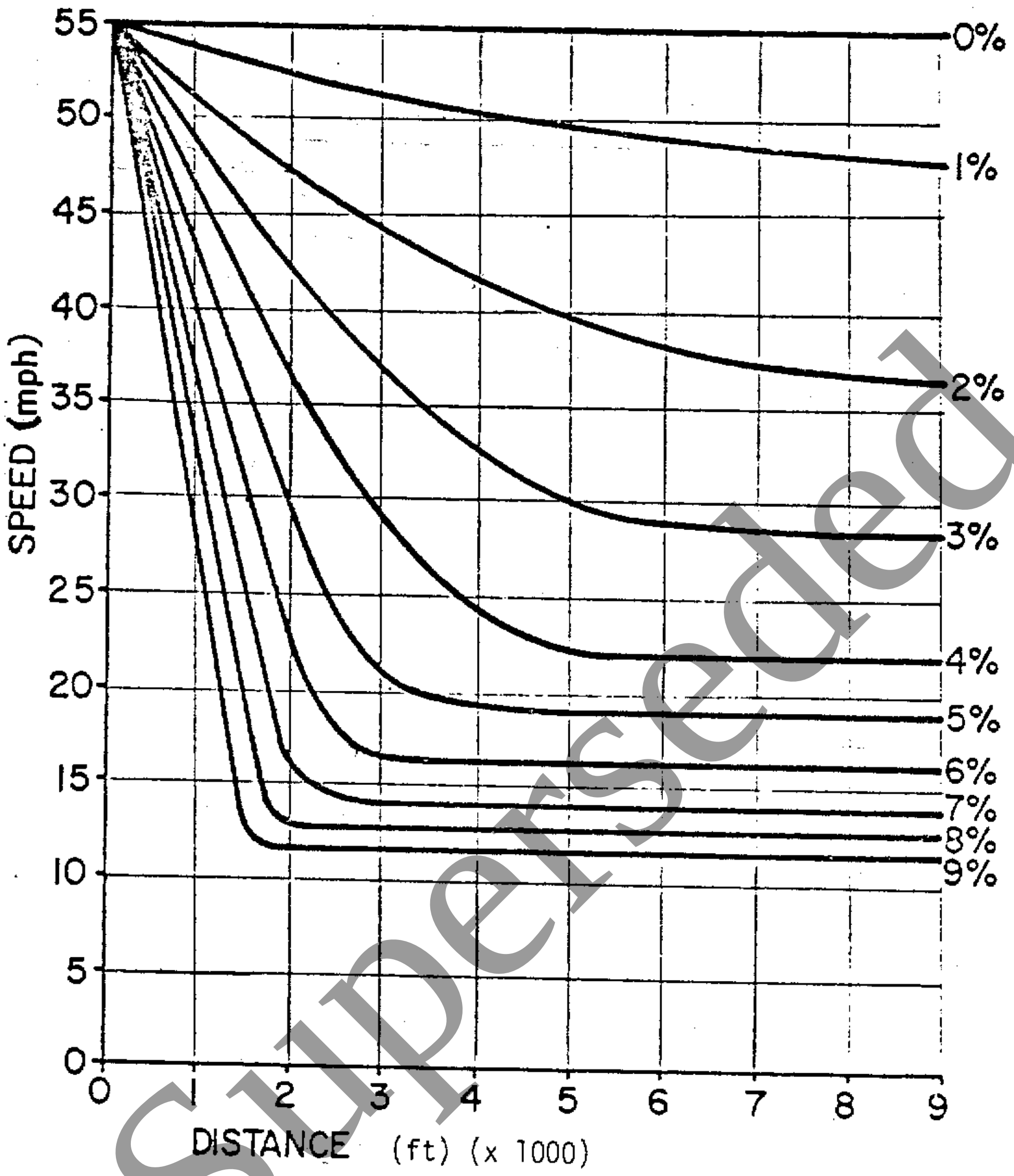
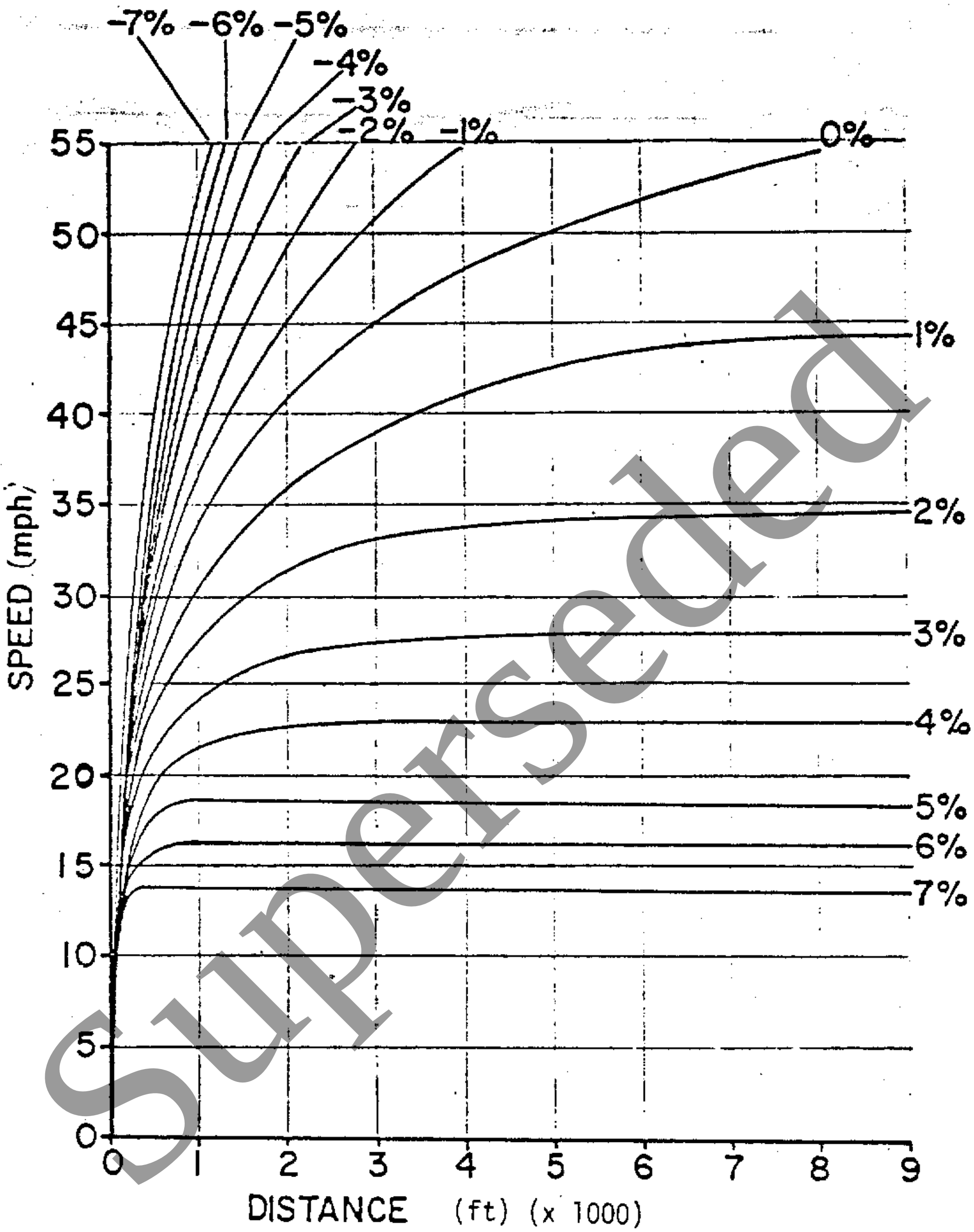


Figure III-27B.--Speed-distance curves for a typical heavy truck of 300 lb/hp for acceleration on descending and ascending grades (34).



Superseded

CHAPTER 4

INTERSECTIONS AT GRADE

CONTENTS

INTERSECTIONS AT GRADE ([redacted])

~~Intersection Types (7-401)~~

General

~~7-401.1 General~~

Most highways intersect at grade. ~~The intersectional area is at once an integral part of each highway.~~ To minimize the resulting conflicts and to provide adequately for the anticipated crossing and turning movements, the geometric design of the intersection at grade must be given careful consideration.

In varying degrees, four ~~principal factors determine the character~~ *basic elements enter into the design* of an intersection. These ~~factors~~ *elements* are traffic, physical, economic and human. Although intersections have many common factors, they are not subject to class treatment, and they must be looked upon as individual problems.

Traffic factors to be considered include: possible and practical capacities, turning movements, size and operating characteristics of vehicles, control of movements at points of intersection, vehicle speeds, pedestrian movements, transit operations and accident experience.

Physical factors which control intersection design and the application of channelization are topography, improvements and physical requirements for highway and channelization features.

Economic factors, which are important and often controlling, include the cost of the improvement and the economic effect on abutting businesses where channelization restricts or prohibits certain vehicular movements within the intersectional area.

Human factors such as driving habits, ability of drivers to make decisions, effect of surprise, decision and reaction times, and natural paths of movement, must be considered.

An intersection may be extremely simple or highly developed, depending on the proper evaluation of the foregoing factors.

~~7-401.2 All-paved Public Road Intersection~~

~~The all-paved public road intersection is the standard minimum intersection treatment provided at public road intersections. This applies to both 2-lane and multiple facilities. It is adequate for low volume movements. (See Figure 7-406.1)~~

Channelized Intersections

~~7-401.3 Channelized Intersections~~

Channelized intersections are provided where traffic volumes, complexity of movements, or other considerations ~~discussed under "Principles of Channelization" (Index No. 7-400)~~ warrant the expansion of intersection design beyond the minimum *standard intersection treatment* ~~all-paved standard~~. Channelization applies to 2-lane and multilane highways, but reaches its highest degree of development and is more generally used under multilane-divided conditions.

~~Design standards and warrants for channelization features are discussed under Topic No. 7-405. The degree of development of a channelization is dependent on the warrants within the separate quadrants.~~

For basic information, the AASHO publications entitled, *A Policy on Geometric Design of Rural Highways* and *A Policy on Arterial Highways in Urban Areas*, should be consulted.

~~Data Required for Design (7-402)~~

~~7-402.1 General~~

~~Data relative to traffic, physical and economic factors must be available before undertaking intersection design. For the redesign of an existing intersection, accident data also are required.~~

In the redesign of an existing intersection, standards sometimes must be compromised due to the high cost of existing development or to the necessity of meeting rigid physical controls. In the design of a new intersection, however, such controls frequently can be avoided by a shift in line or grade of one or both of the intersecting highways.

~~7-402.2 Traffic Analysis~~

~~A traffic flow diagram, showing average daily traffic and design hourly volumes, as well as time of day (a.m. or p.m.) of design hourly volumes, is essential in determining the relative importance of conflicting movements. The flow diagram shall state the year for which the indicated volumes are anticipated and the expansion factor used, or to be used, in arriving at the volume for the design year.~~

~~The type of traffic control, if any, to be installed must be determined in advance of intersection design, since it frequently affects channelization. If signals~~

Typical Intersection Designs

Figures ____ thru ____ illustrate various intersection treatments that may be used on the State highway system.

Access Control for Superhighway

ISLANDS

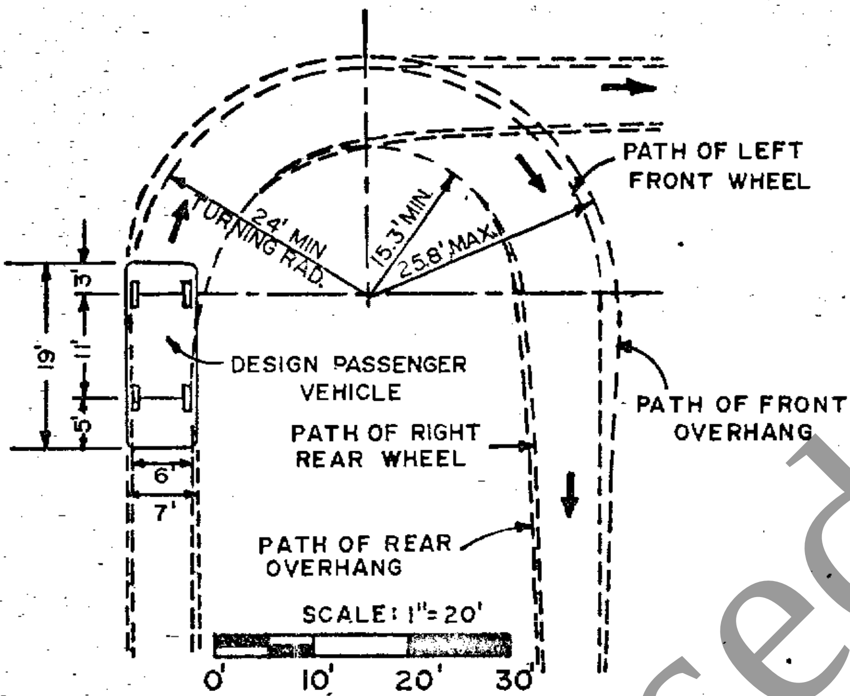
General

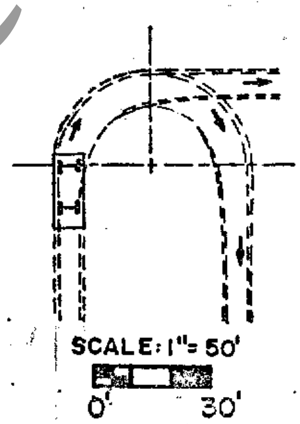
An island is a defined area between traffic lanes for control of vehicle movements or for pedestrian refuge.

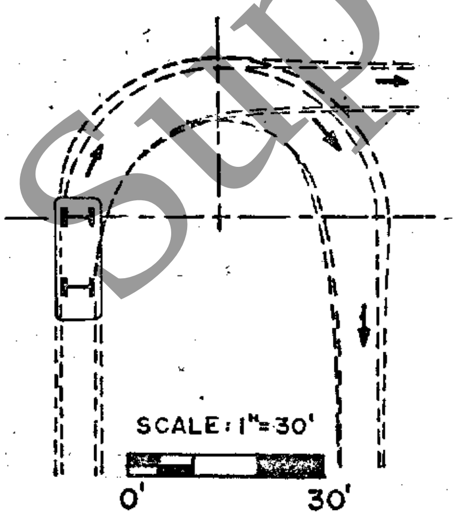
Islands generally are either triangular or elongated in shape, the dimension depending upon the particular intersection layout. Triangular corner islands are normally used to separate right turning traffic from through traffic. Elongated or divisional islands are often introduced at intersections on undivided highways to separate opposing traffic and to regulate traffic at the intersection, particularly to provide storage for, and control of, left turning vehicles.

See figures ______ and _____ for dimensional controls for triangular and elongated islands.

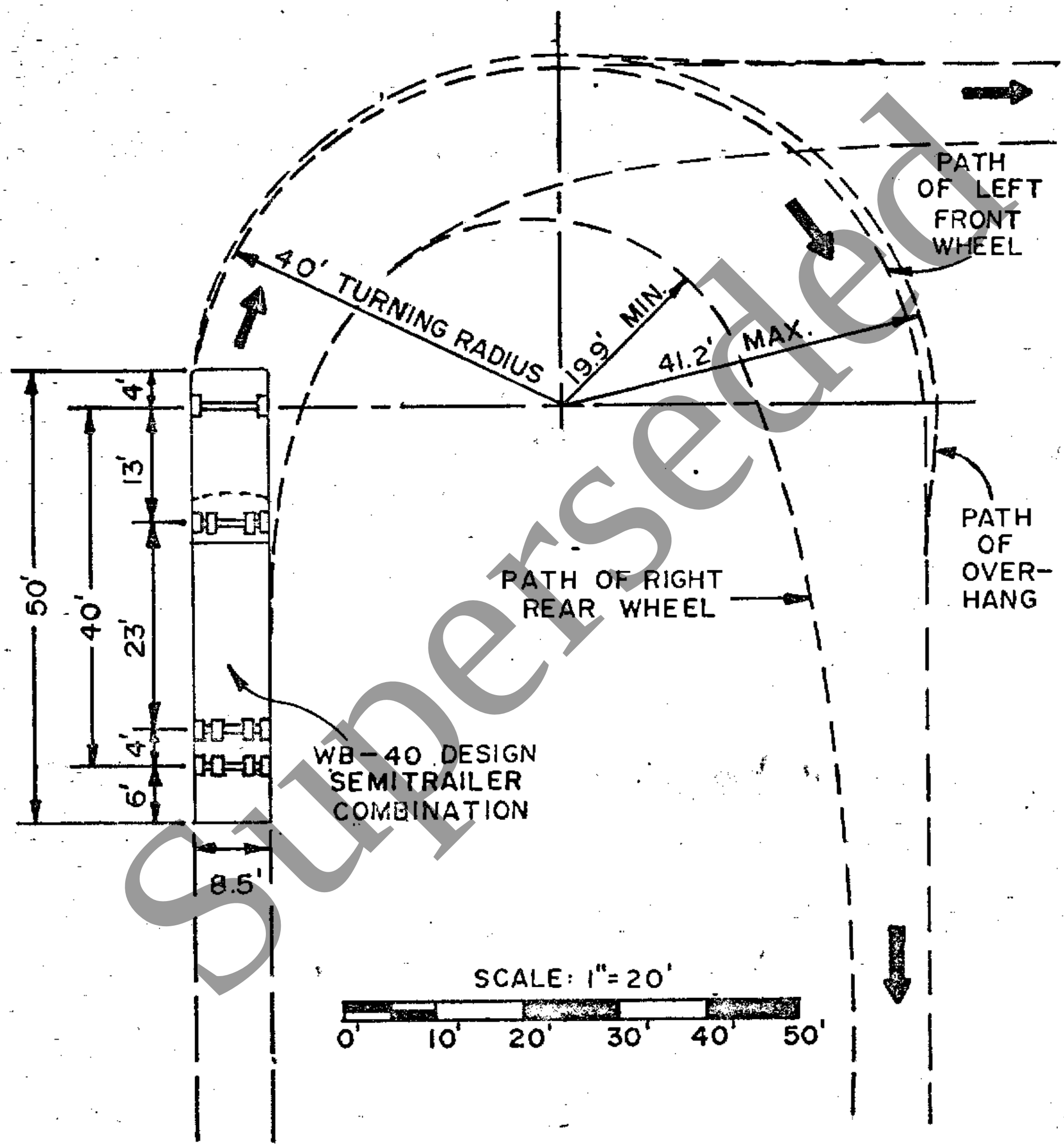
MINIMUM TURNING PATH FOR P DESIGN VEHICLE



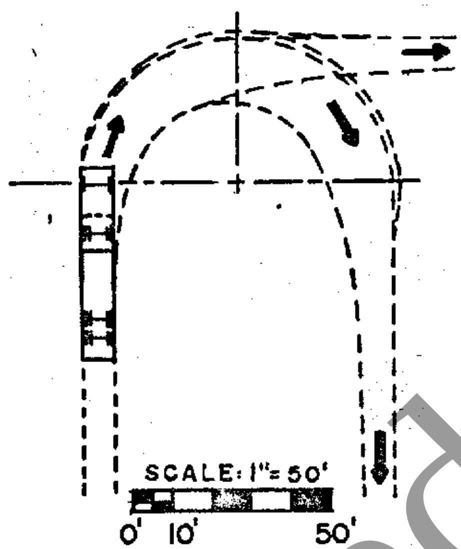


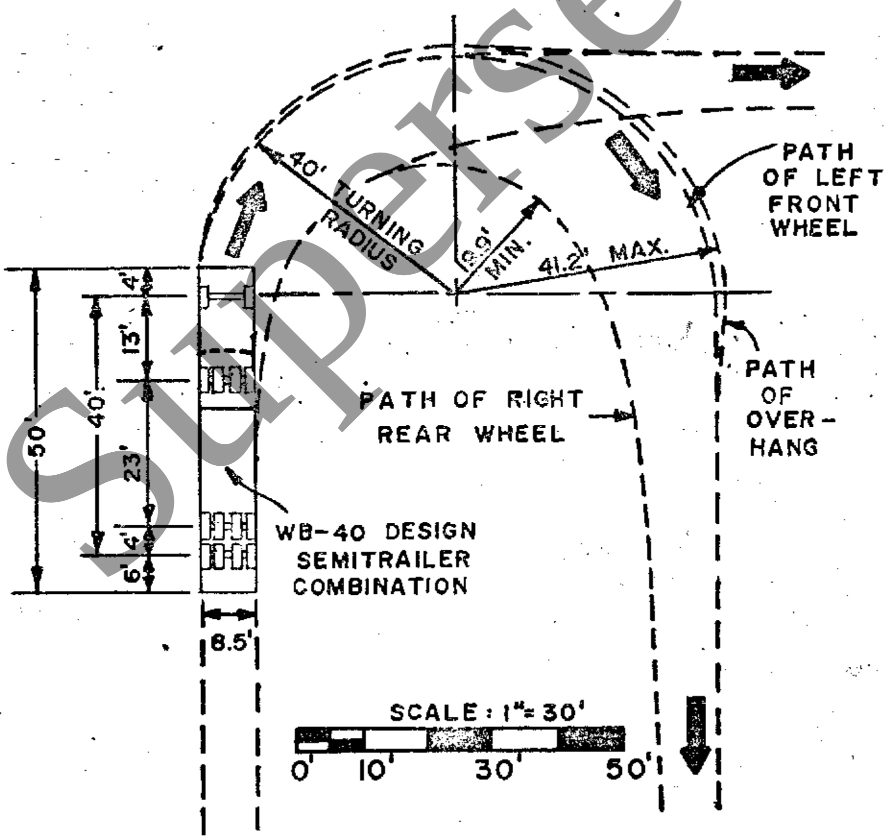


MINIMUM TURNING PATH FOR WB-40 DESIGN VEHICLE

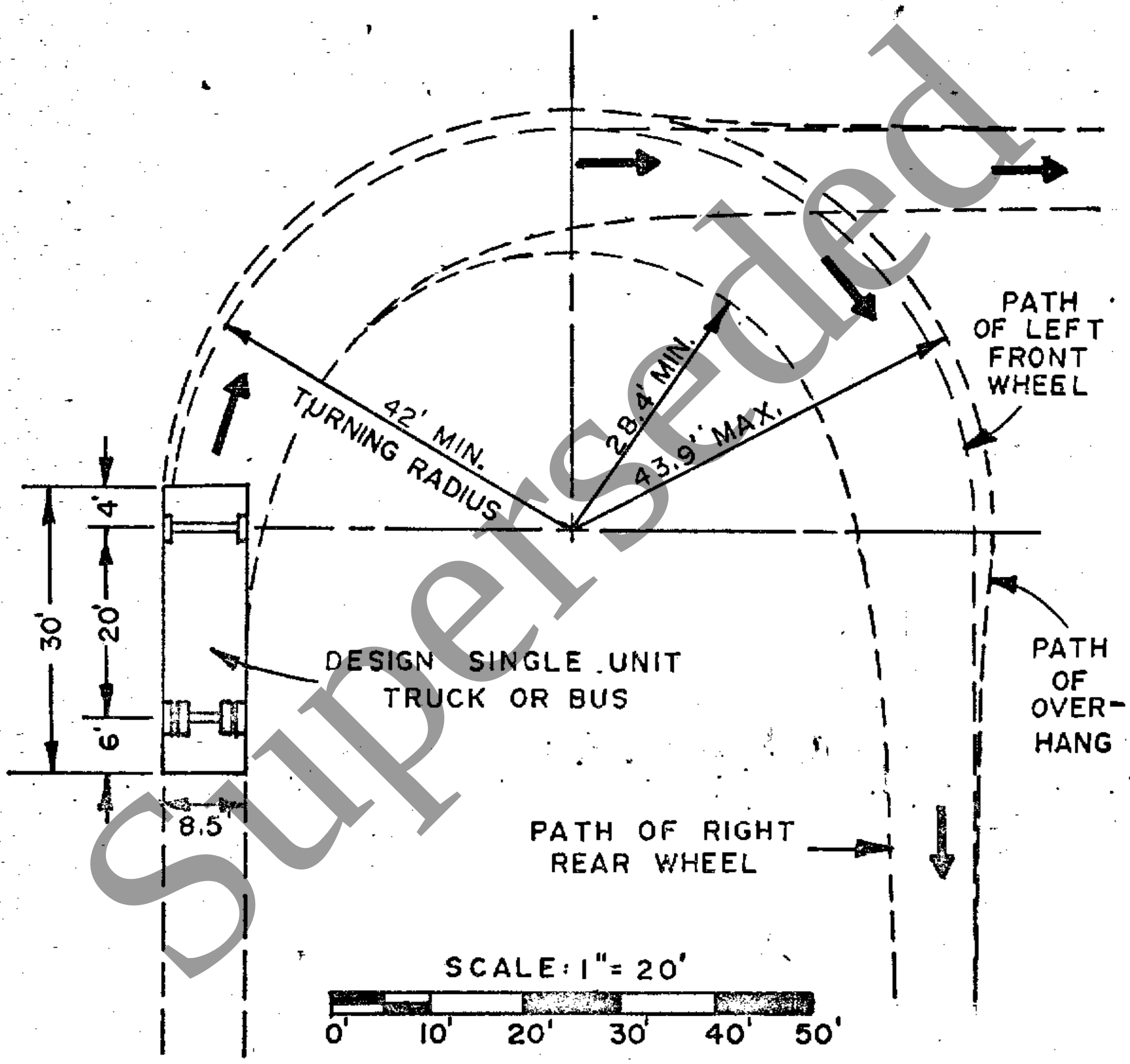


MINIMUM TURNING PATH FOR WB-40 DESIGN VEHICLE

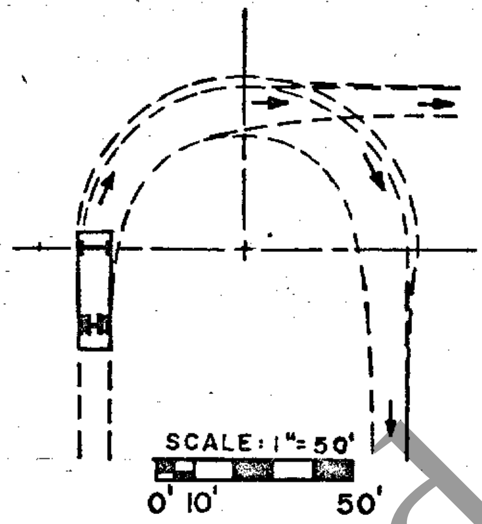


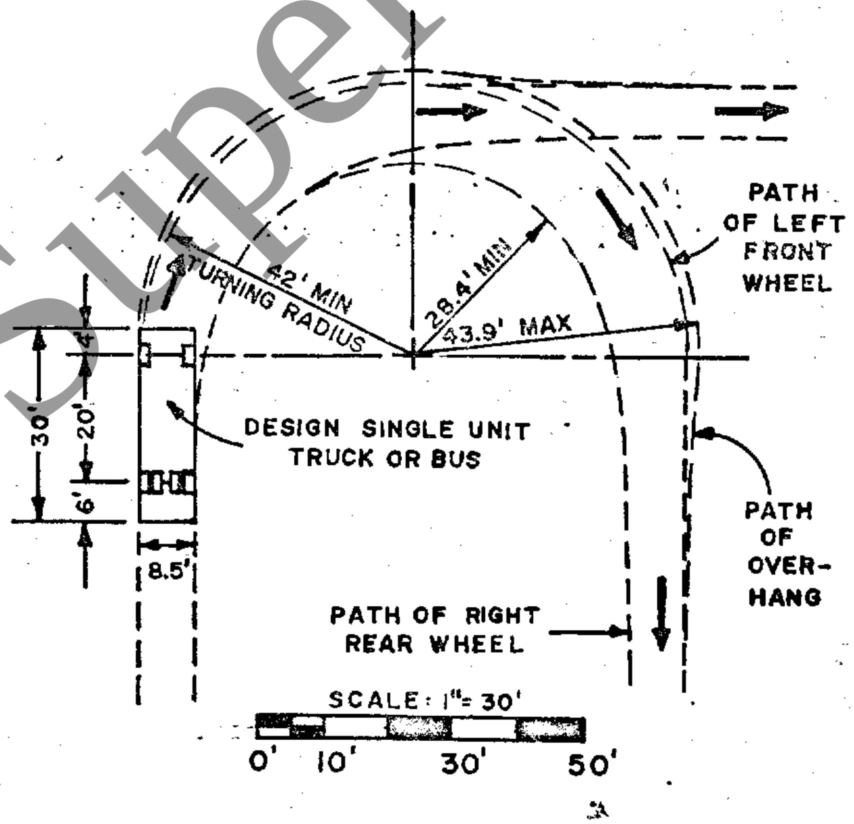


MINIMUM TURNING PATH FOR SU DESIGN VEHICLE

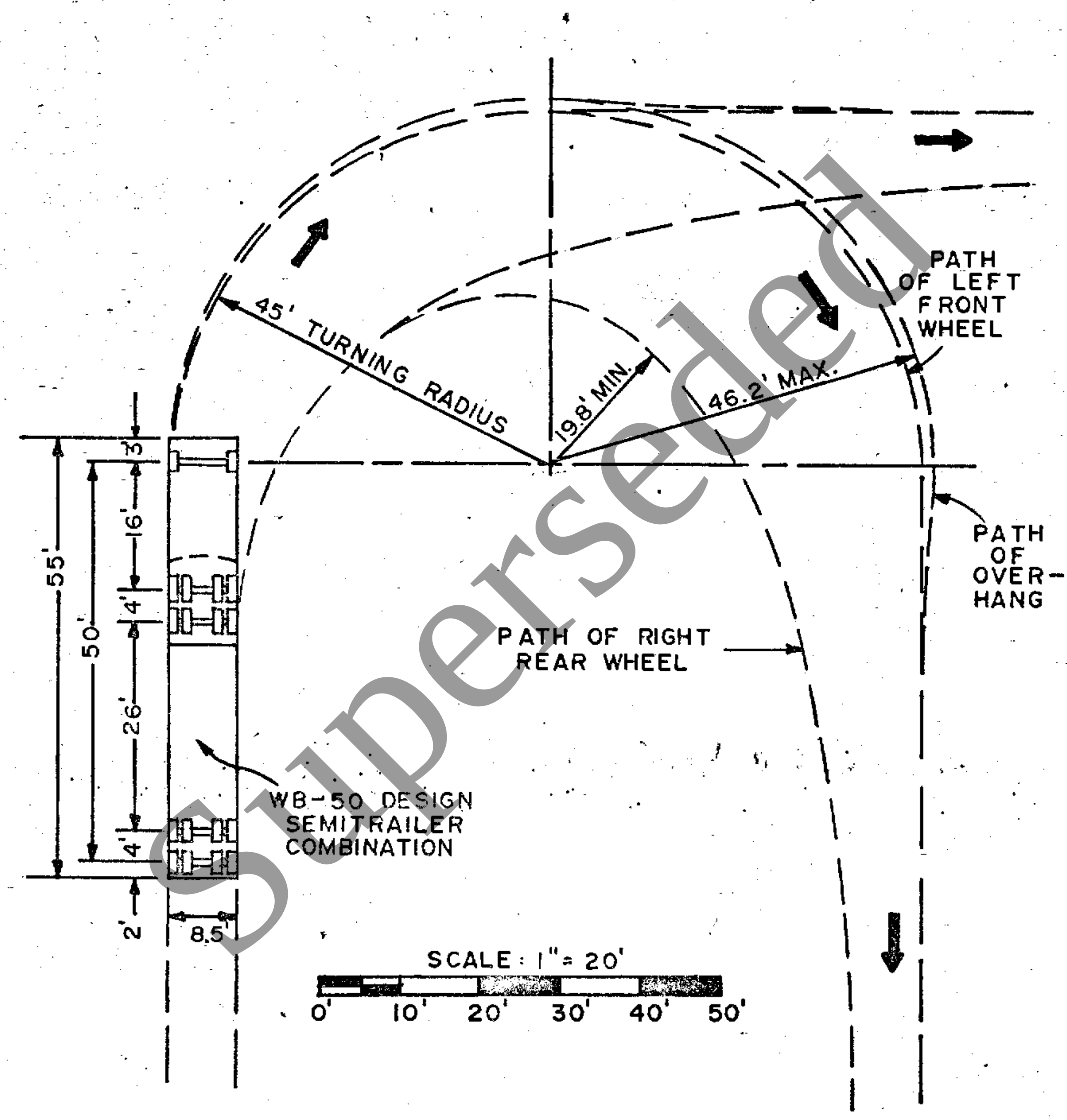


MINIMUM TURNING PATH FOR SU DESIGN VEHICLE

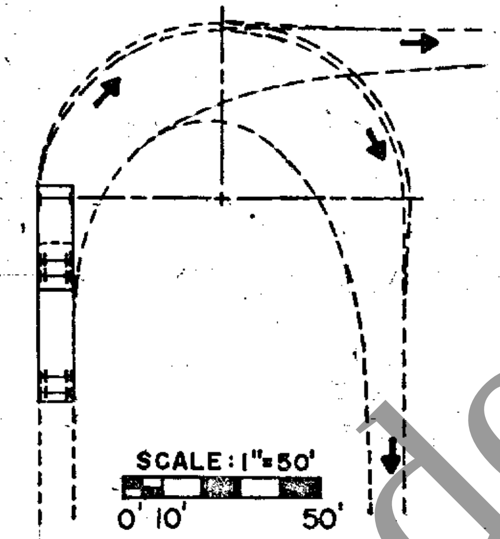


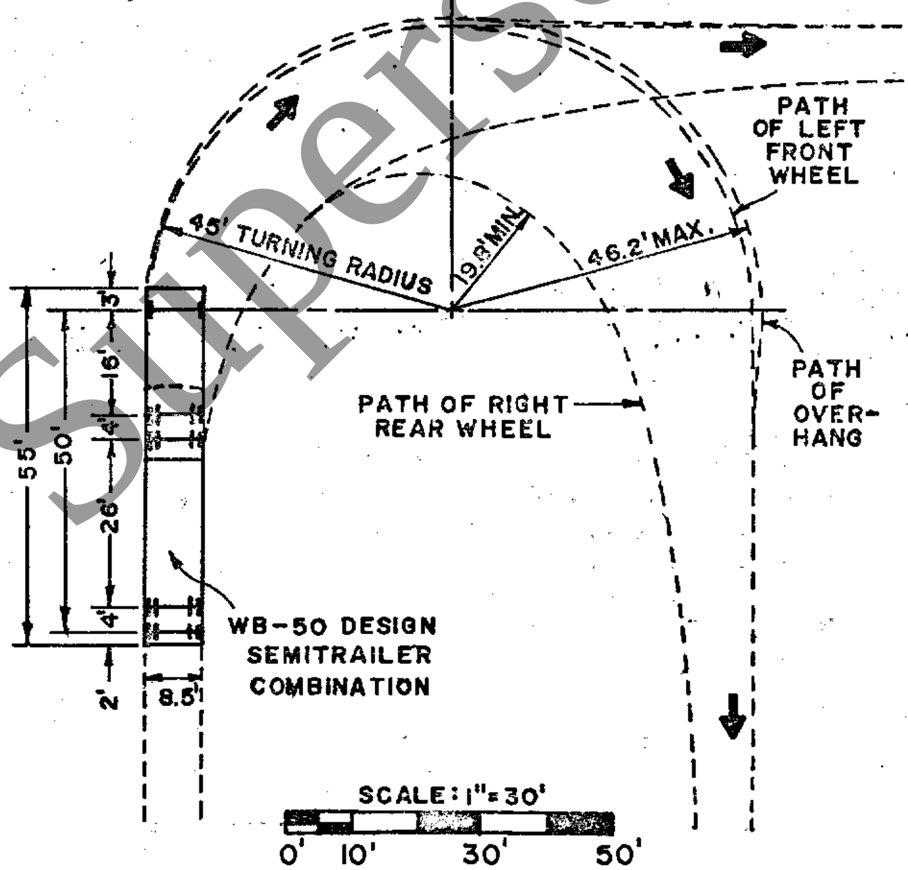


MINIMUM TURNING PATH FOR WB-50 DESIGN VEHICLE

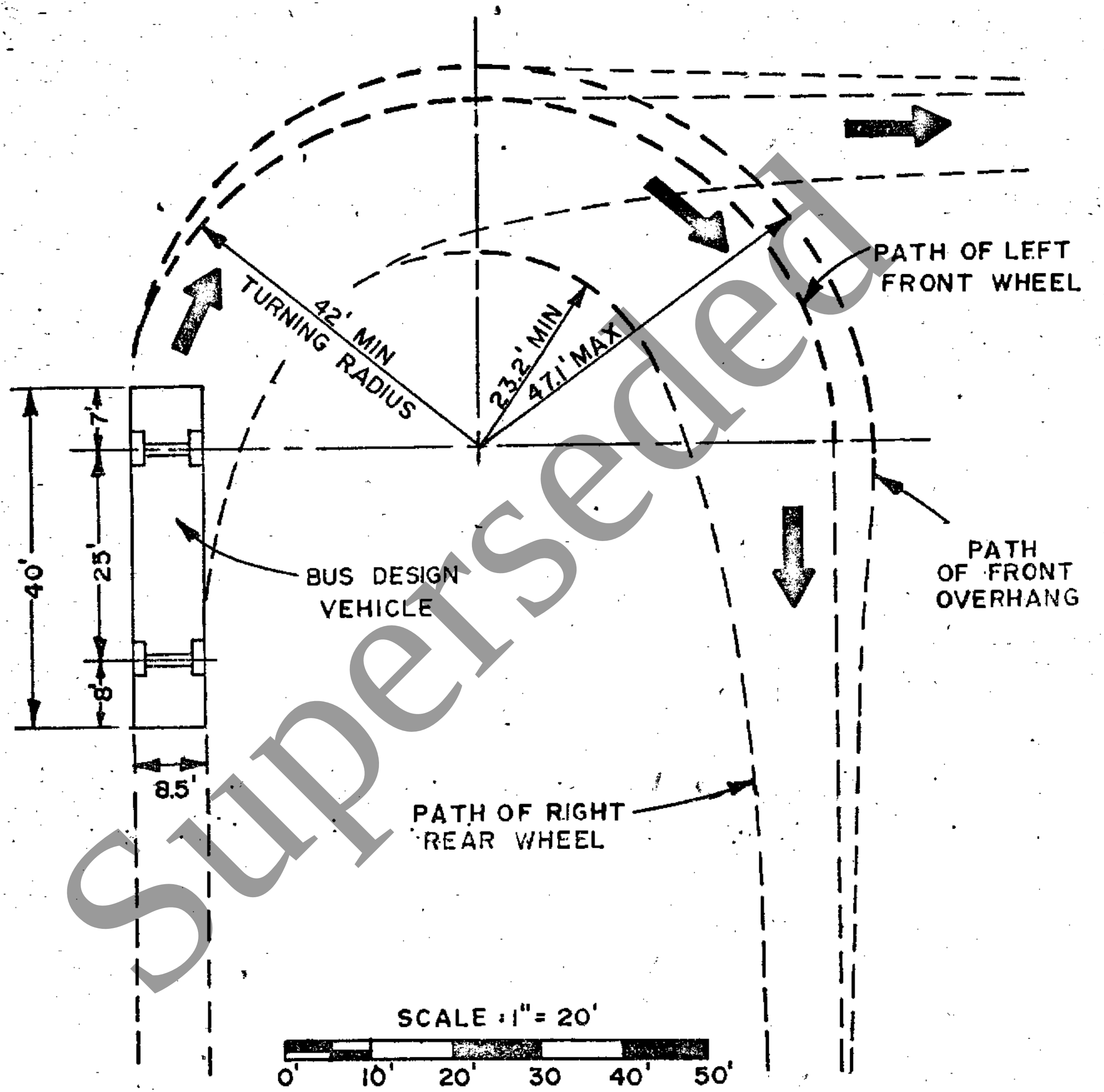


MINIMUM TURNING PATH FOR WB-50 DESIGN VEHICLE

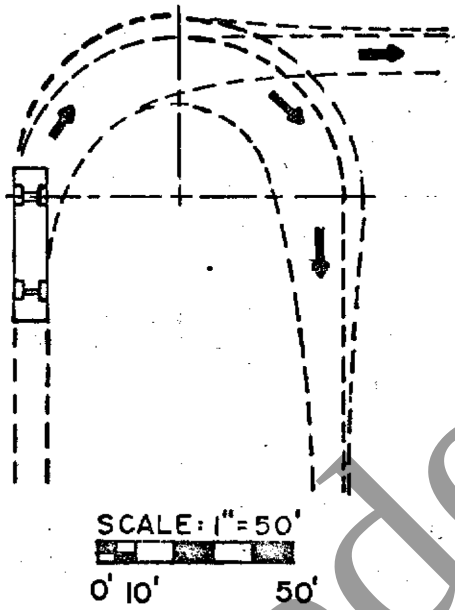


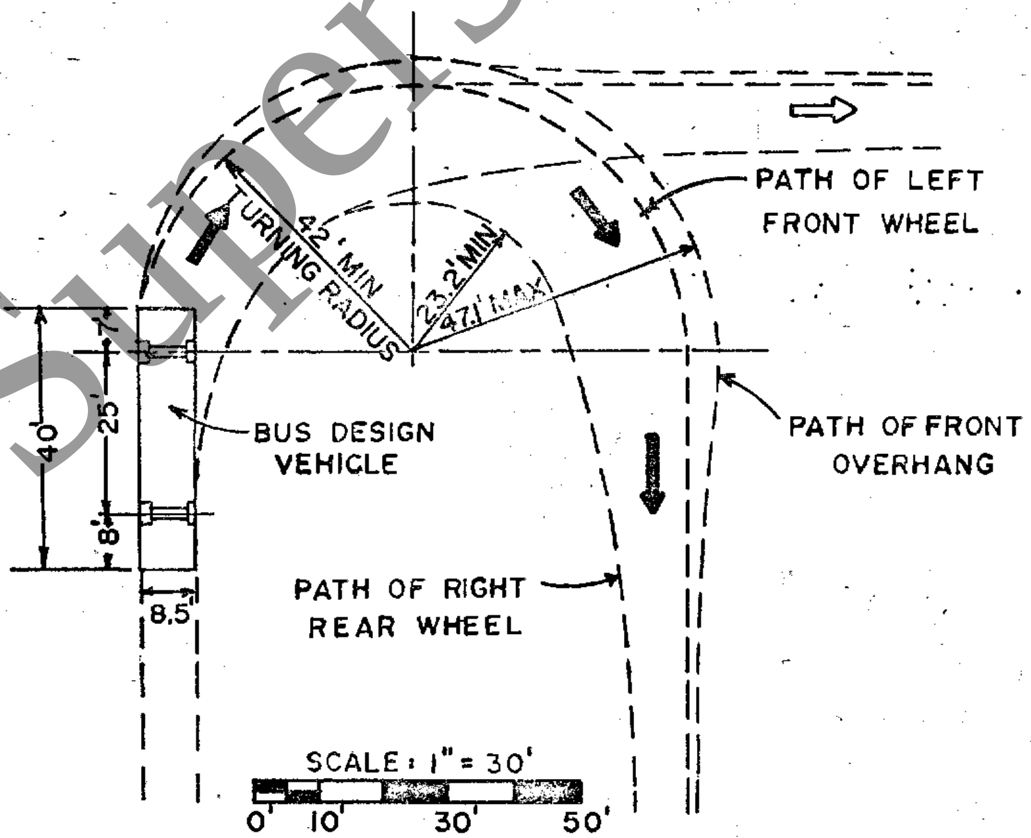


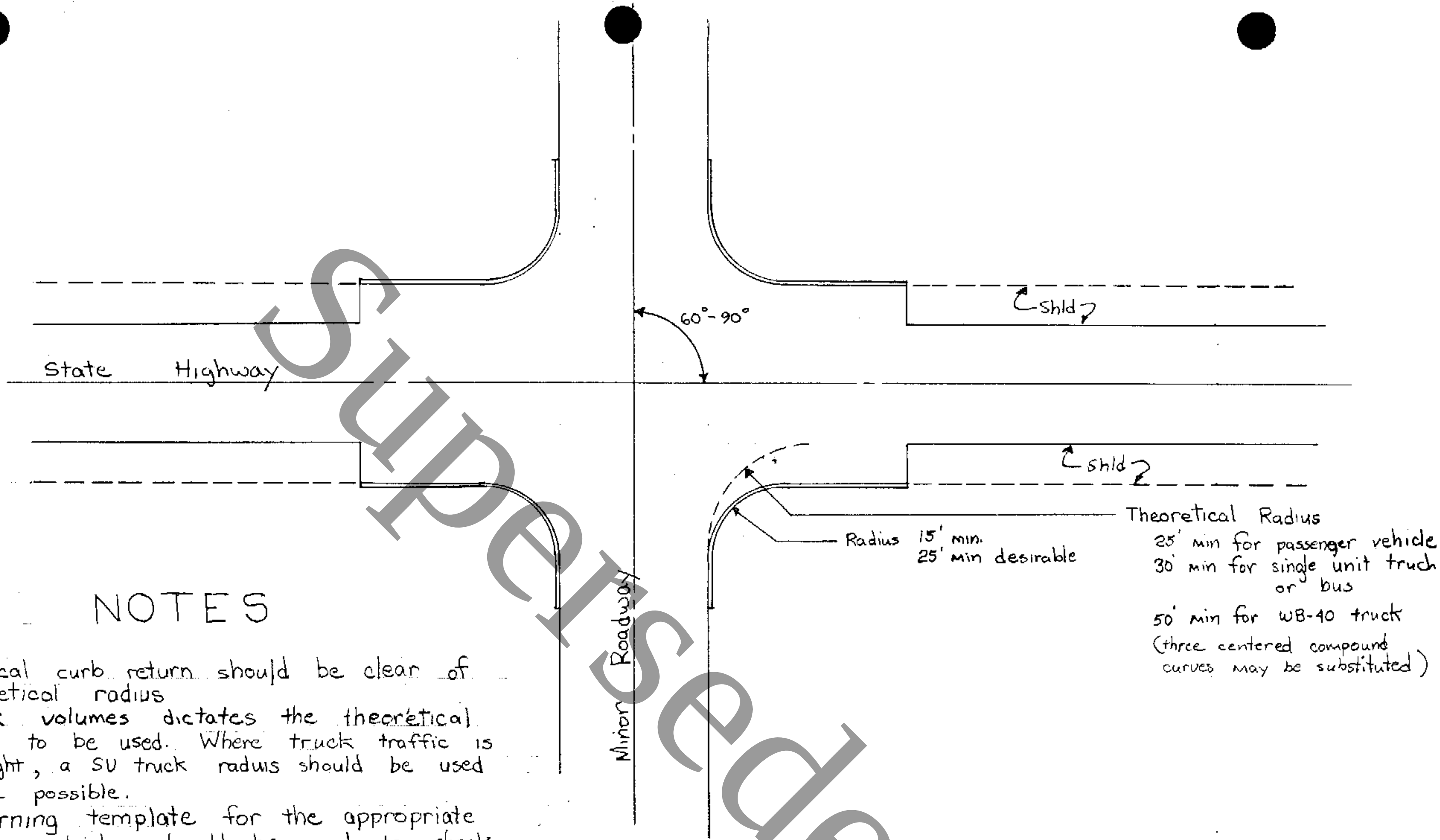
MINIMUM TURNING PATH FOR BUS DESIGN VEHICLE



MINIMUM TURNING PATH FOR BUS DESIGN VEHICLE



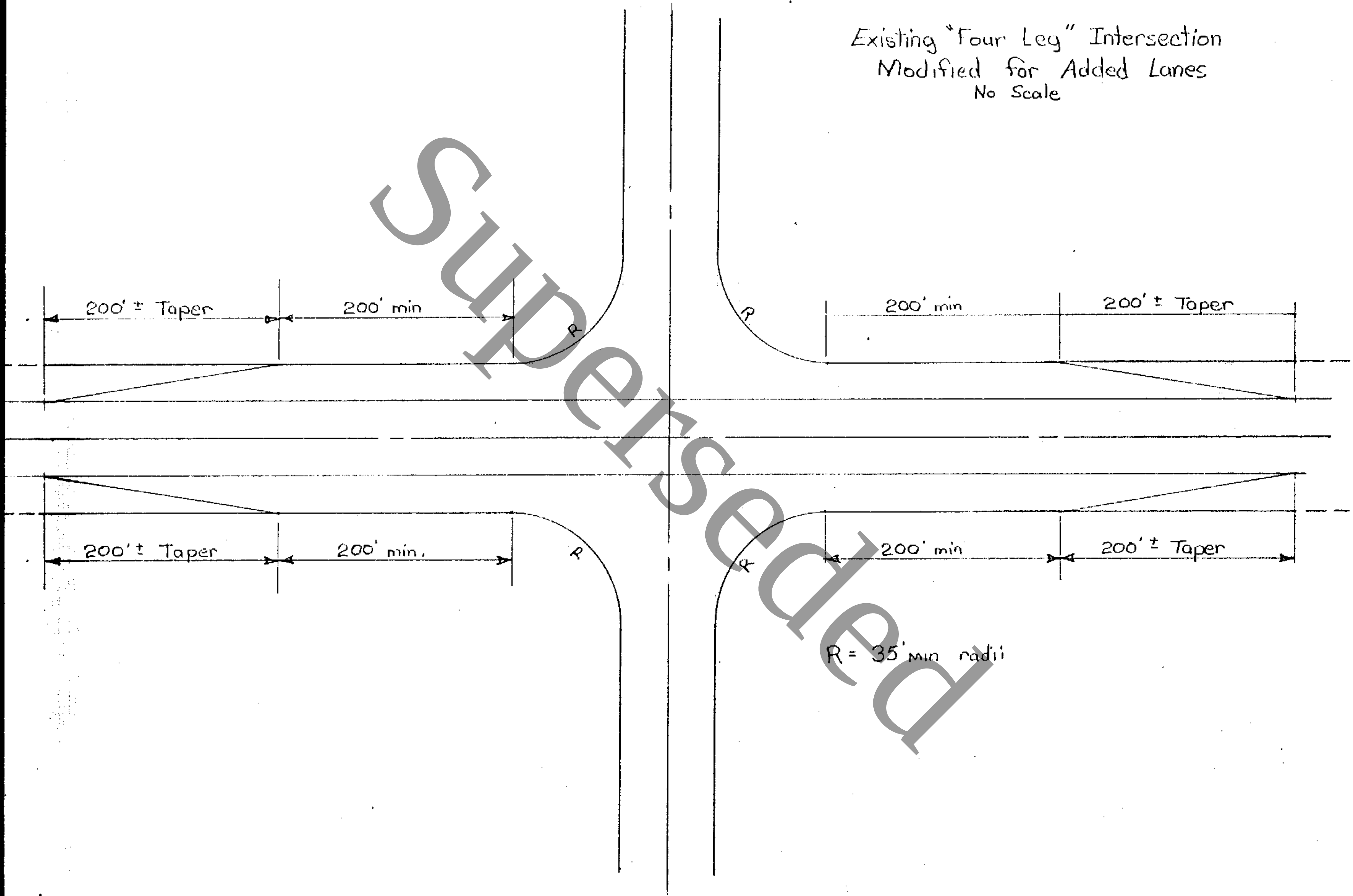


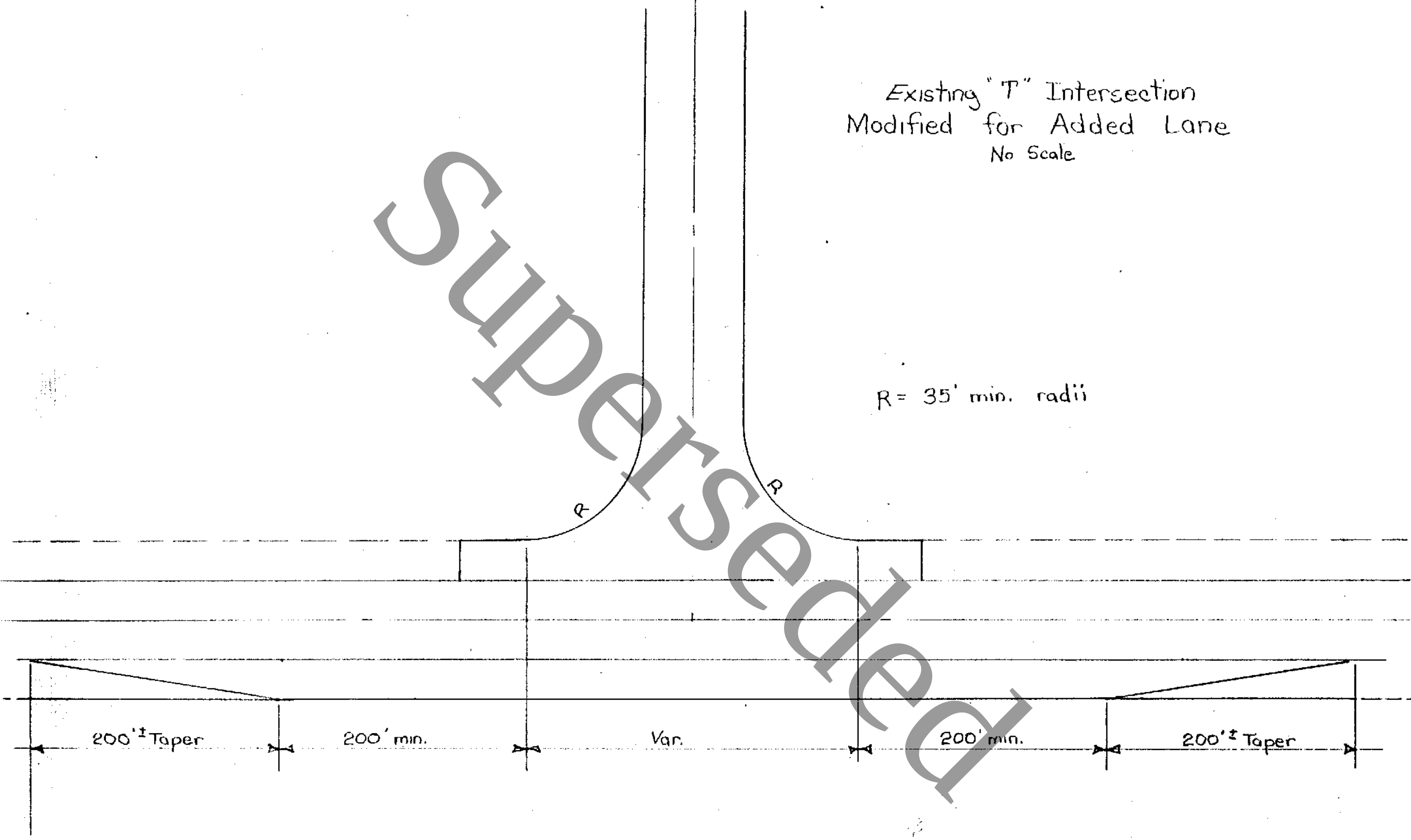


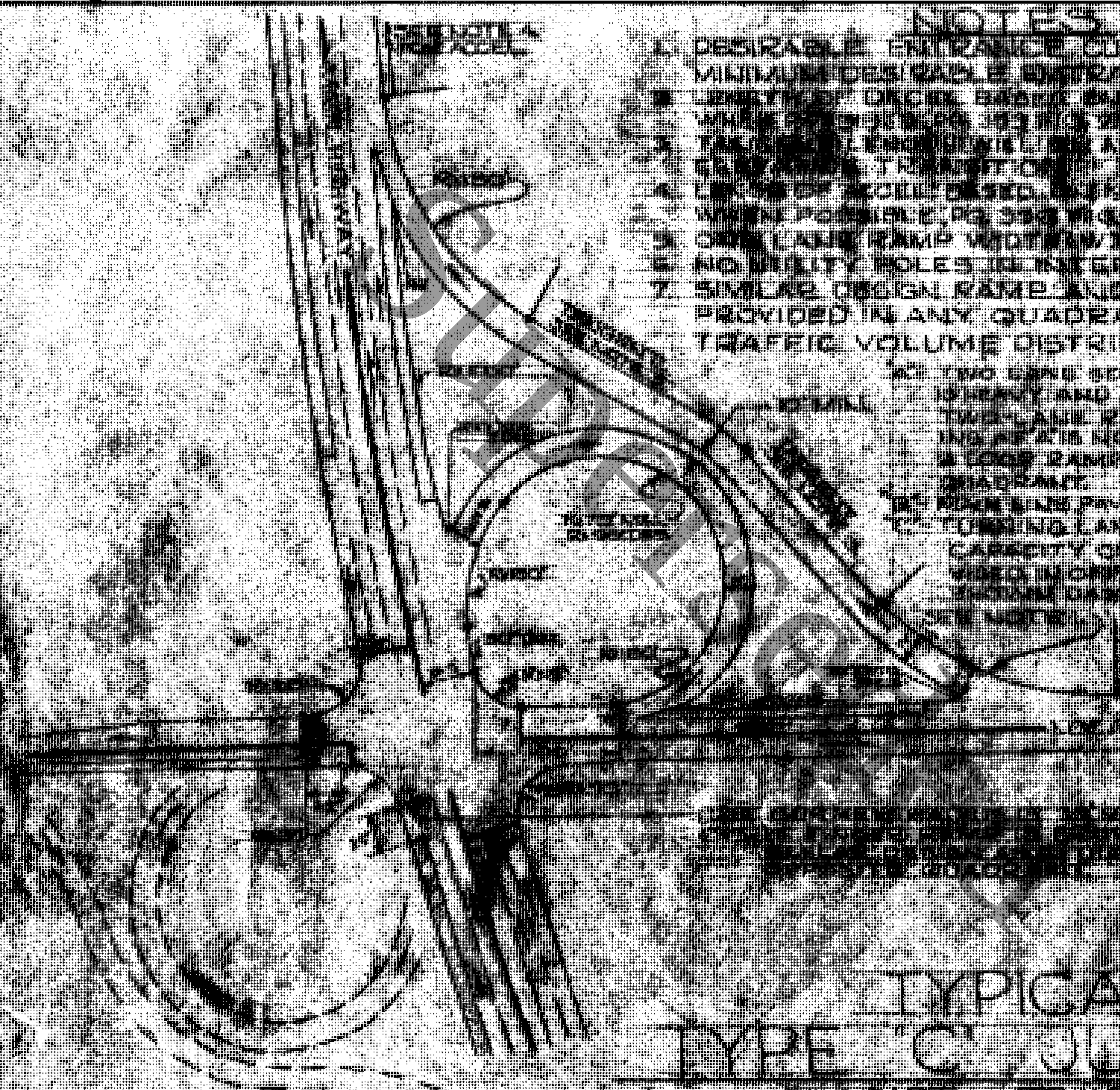
NOTES

1. Physical curb return should be clear of theoretical radius
2. Truck volumes dictates the theoretical radius to be used. Where truck traffic is is light, a SU truck radius should be used where possible.
3. A turning template for the appropriate design vehicle should be used to check the adequacy of radii returns.
4. For intersection skew angles less than 60°, channelization should be provided.
5. Where turning volumes are high, auxilary lanes through the intersection may be warranted.
6. Check applicable sight distances

Existing "Four Leg" Intersection Modified for Added Lanes
No Scale




Existing "T" Intersection
Modified for Added Lane
No Scale
R = 35' min. radii
R
R
200'± Taper
200' min.
Var.
200' min.
200'± Taper



NOTES

1. DESIRABLE ENTRANCE CURVE 250' R TO 300' R. MINIMUM DESIRABLE ENTRANCE CURVE 100' R.
2. LENGTH OF DECEL. BEFORE [illegible]
3. TANGENT [illegible] AS REQUIRED FOR SUPER [illegible]
4. [illegible]
5. ONE LANE RAMP WIDTH MINIMUM 22'
6. NO UTILITY POLES IN INTERIOR OF JUGHANDLE.
7. SIMILAR DESIGN RAMP AND/OR RAMPS MAY BE PROVIDED IN ANY QUADRANT, AS DICTATED BY TRAFFIC VOLUME DISTRIBUTION.

(A) TWO LANE SECTION IF [illegible] MOVEMENT IS HEAVY AND THE APPROACH ROWY. IS TWO-LANE ROWY. A FURTHER WIDENING AT A IS NOT RECOMMENDED UNLESS A LOOP RAMP IS PROVIDED IN ADJACENT QUADRANT.

(B) MAIN LINE PAVEMENT PLUS DECEL. LANE.

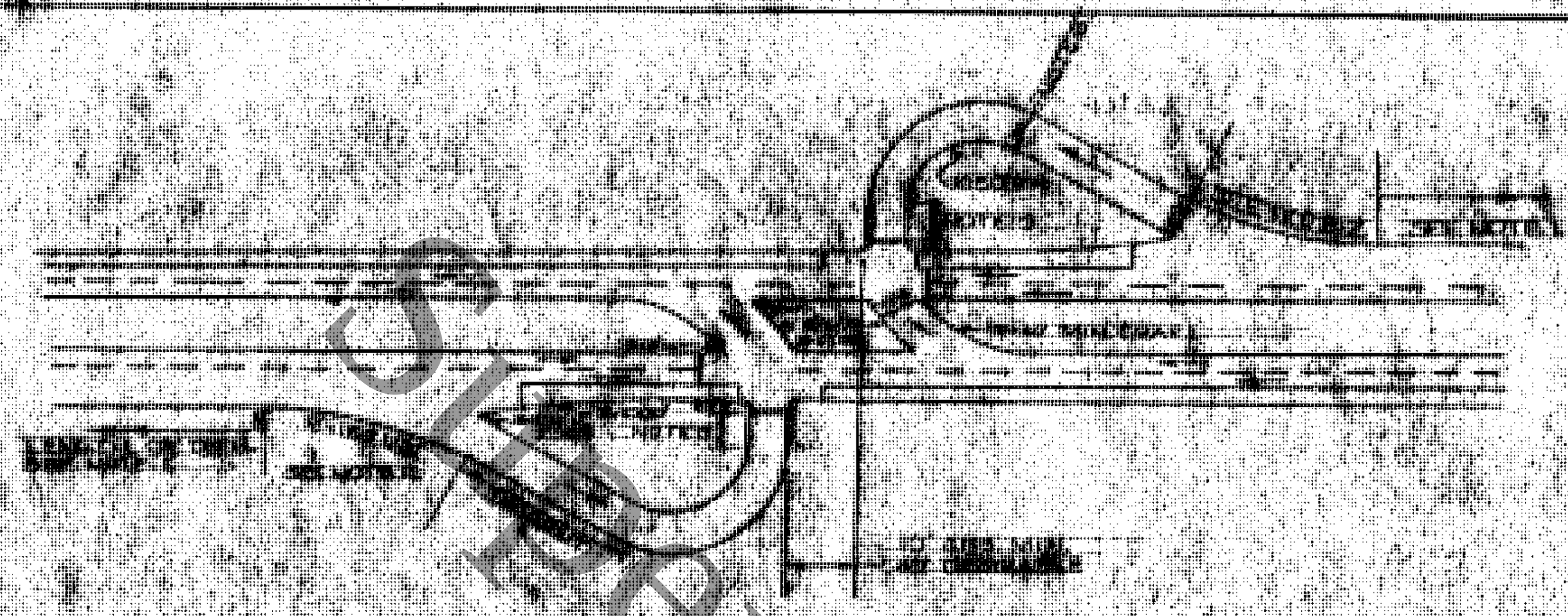
(C) TURNING LANE NEEDED FOR SIGNAL CAPACITY OR IF LOOP RAMP IS PROVIDED IN OPPOSITE QUADRANT AS SHOWN DASHED.

TYPICAL
TYPE "C" JUGHANDLE

NOT TO SCALE

REVISED 7-18-[illegible]

DRAWN BY: S.M. PALMER [illegible]



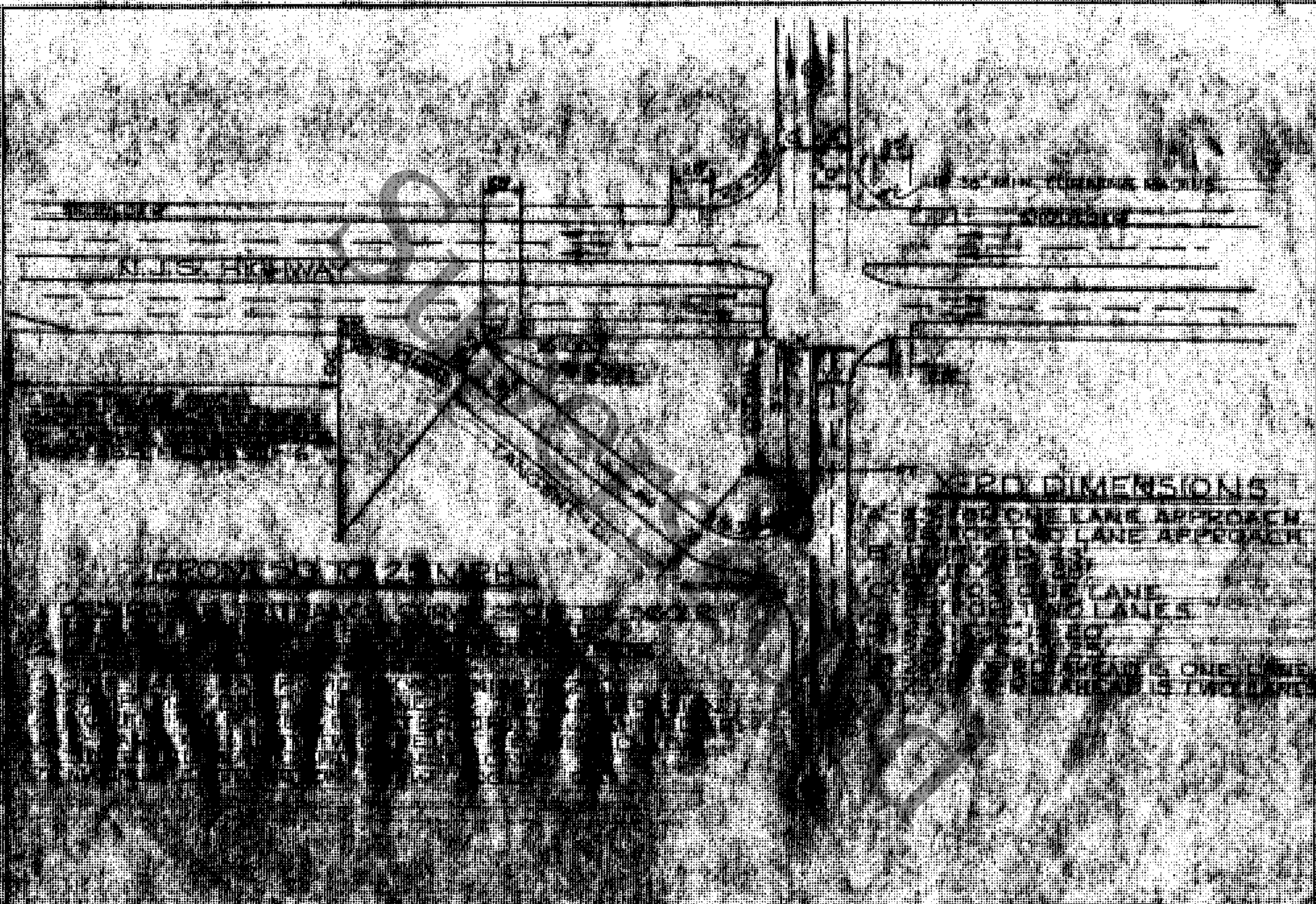
FROM 50 TO 25 M.P.H.

1. LENGTH OF DECEL. BASED ON 1965 EDITION OF AASHO, WHEN POSSIBLE. [illegible]
2. MINIMUM [illegible] ENTRANCE TURN [illegible] DESIRABLE ENTRANCE [illegible]
3. LENGTH OF RAMP [illegible] SUFFICIENT FOR TRAFFIC VOLUME & STORAGE.
4. [illegible] POINT [illegible] INTERIOR OF JUGHANDLE.
5. TANGENT DISTANCE [illegible] MIN. [illegible] DESIRABLE.
6. RAMP MAY BE OF ONE LANE OR TWO LANE DESIGN.
7. [illegible] TANGENT LENGTH WILL BE AS REQUIRED FOR SUPERELEVATION TRANSITION.

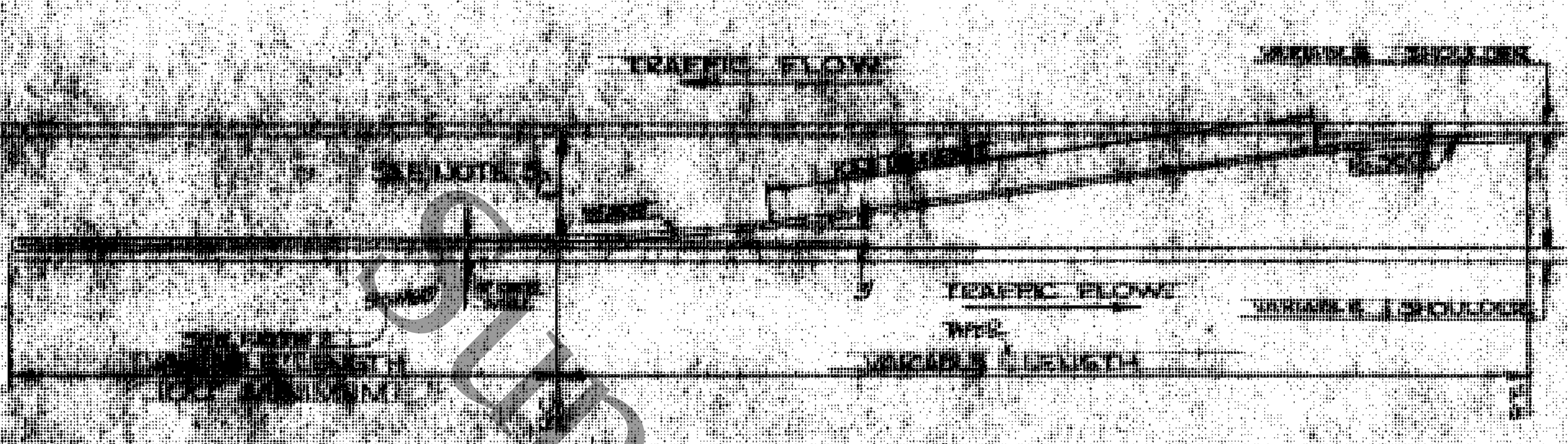
TYPICAL TYPE "B" JUGHANDLE

NOT TO SCALE

REVISED 7-[illegible]-79
DRAWN BY: S.M.PALMER 1-9-79



TYPICAL TYPE 'A' JUGHANDLE



2. ... TRAFFIC ... VEHICLES ...
... CHECK LENGTH WITH TRAFFIC ENGINEERING
4. ... MEDIAN ...
... PAINT STRIPES

TYPICAL LEFT TURN SLOT

NOT TO SCALE

DRAWN BY: S.M. PALMER 1-11-78

CHAPTER 5

INTERCHANGES

CONTENTS

INTERCHANGES

General

A traffic interchange is a combination of ramps and grade separations at the junction of two or more highways for the purpose of reducing or eliminating traffic conflicts, thereby improving traffic safety and capacity.

Interchange types are characterized by the basic shapes of ramps: namely; diamond, loop, directional or variations of these types. Many interchange designs are combinations of these basic types. Schematic interchange patterns are illustrated in Figure ________.

The minimum spacing of interchanges for proper signing on the main road should be at least one mile between urban crossroads and three miles along rural sections. Too closely spaced interchanges interfer with free traffic flow and safety, even with the addition of extra lanes, because of insufficient distance for weaving maneuvers. During the early design stage the Bureau of Traffic engineering should be consulted to assure that proper signing of the interchange possible.

Ramp Capacity

There are three elements of a ramp which affect the operating characteristics and capacity of the total ramp facility. These are the (a) exit terminal, (b) ramp proper, (c) entrance terminal.

The capacity of a ramp is generally controlled by one of its terminals. Where speeds are significantly affected by curvature, grades, and truck operations, the ramp proper may determine the capacity. Deficiencies at either the entrance terminal or the exit terminal can be overcome in design by the introduction of an auxilary lane beyond the entrance or in advance of the exit. Deficiencies in the ramp proper can be accounted for by providing an additional lane throughout the length of the ramp.

Table ______ gives values for capacity of the ramp proper under various conditions of curvature, grades and __% truck.

Weaving

"Weaving" is created by vehicles entering and leaving the highway at common points, resulting in vehicle paths crossing each other. Weaving normally occurs within an interchange or between closely spaced interchanges.

Desirably on cloverleaf interchanges the distance between loop ramp terminals should not exceed 800-1000 ft. Where the weaving volumes require separations greater than the desirable, consideration should be given to providing a collector distributor road.

Table ____ is a guide for the required lengths of weaving for the level of service noted. The "Highway Capacity Manual" should be consulted for further information on weaving.

Ramp Widths

Table _____ illustrates the desired ramp widths for various ramp curvatures. Single lane ramp widths will be based on Case II for the ramp proper and Case I at the entrance terminal. Case III should be used in determining ramp widths on two lane ramps. See Chapter ________, Figure ______ for typical single and two lane ramp sections.

Ramp Terminals

The ramp terminal is the portion of the ramp adjacent to the through lanes and includes the speed change lanes, tapers, gore areas, and merging ends. Figures _______ through ______ illustrate the various ramp terminal treatments.

Ramp Design Speeds

Ramp design speeds should not be less than 25 mph. On cloverleaf interchanges the outer connection should desirably be designed for 35 mph. Where right-of-way or physical restrictions are not conducive to a

35 mph design speed, a minimum design speed of 25 mph may be used.

Minimum ramp design speeds for various ramp configurations are as follows: Loop ramps, 25 mph; semidirect, 30 mph; and direct connections 40 mph.

Ramp Grades

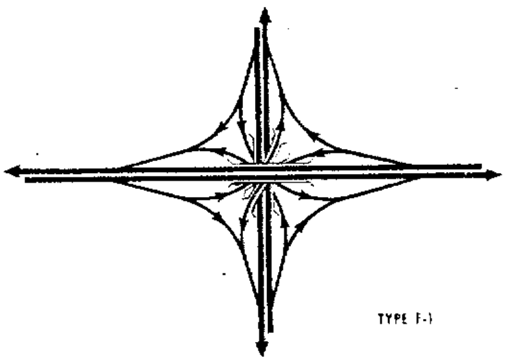
Ramp grades should be as flat as feasible to minimize driving effort required in maneuvering from one road to another. The following guidelines should be used in designing ramp profiles:

1. Ramp gradients should be limited to a maximum upgrade of 7% (desirable maximum of 5%) and 5% on downgrades.

2. Minimum ramp grades should not be less than 0.5%.

3. When the ramp is to be used by predominant truck traffic (many heavy trucks), upgrades should be limited to 4%.

TYPICAL FREEWAY TO FREEWAY INTERCHANGES



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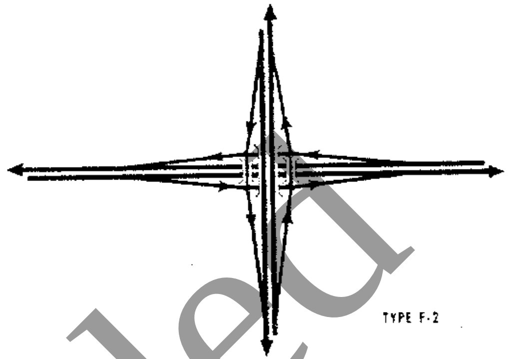

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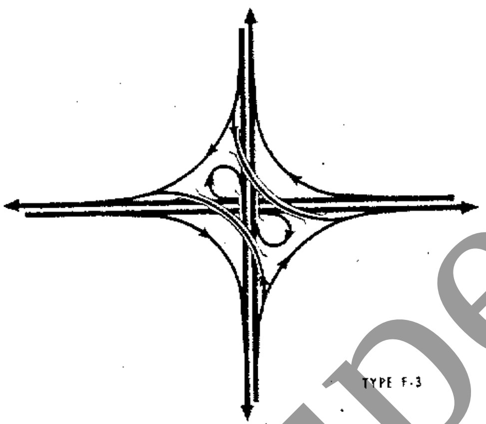

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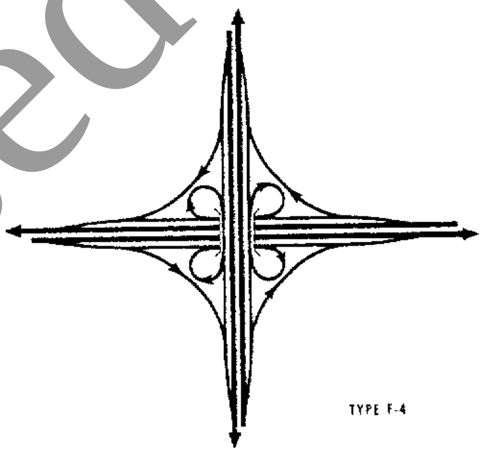

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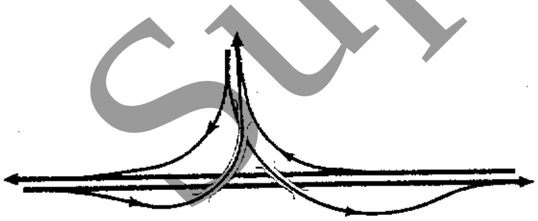

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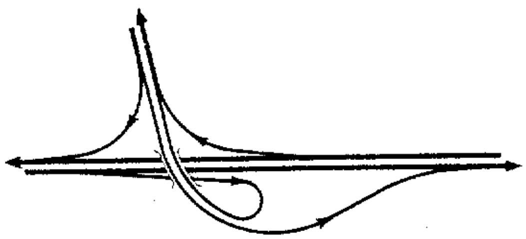

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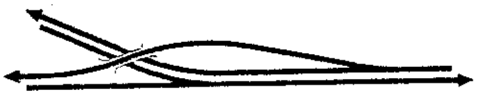
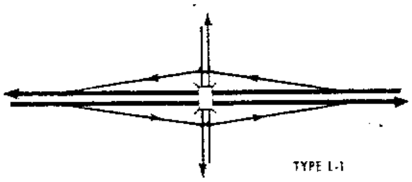


TYPE F-7

TYPE F-8

TYPICAL LOCAL STREET INTERCHANGES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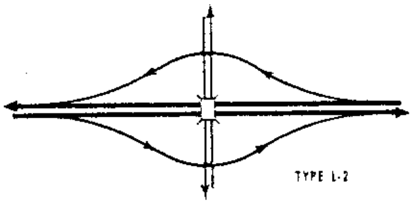
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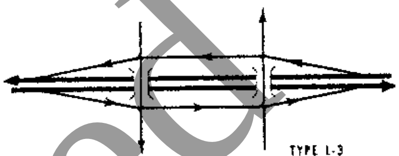
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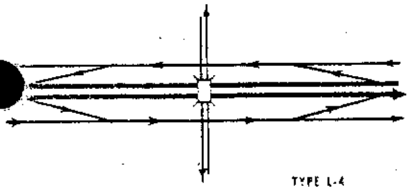
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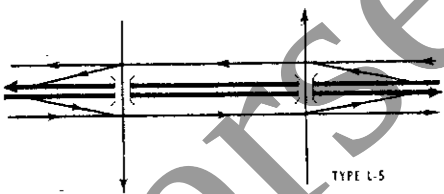
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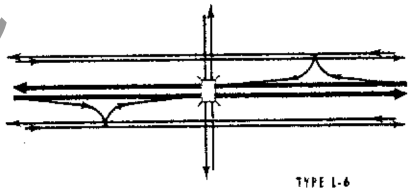
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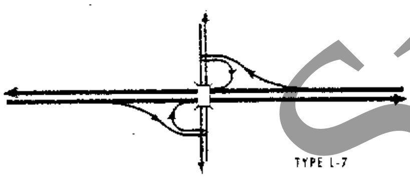
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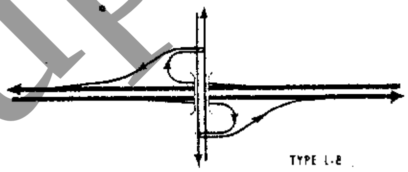
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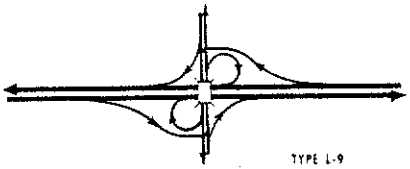
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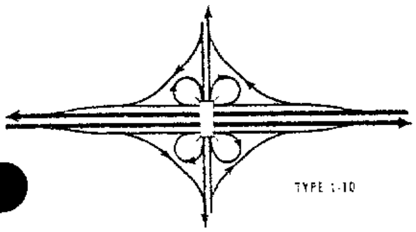
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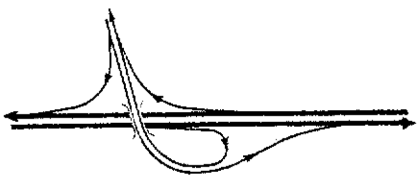
TYPE L-11


TYPE L-12

Design Widths of Pavements for Turning Roadways

R Radius on inner edge of pavement, feet	Pavement width in feet for:		
	Case I Entrance Terminal Width	Case II Ramp Proper Width 1-lane, one-way operation	Case III Ramp Proper Width 2-lane one-way or two-way operation
50	20	25	—
75	18	24	—
100	17	23	—
150	17	22	29
200	17	22	29
300	17	22	28
400	17	22	28
500	17	22	28
Tangent	17	22	26

Note: 1. On 2-lane ramps where shoulders are provided, reduce pavement width by 2 ft.

2. In urban areas increase 1-lane ramp proper width by 1 ft.

3. 2-lane operation should not be considered on ramps with radii less than 150'

4. Minimum ramp radii will be use to determine ramp width. Width will be applied through entire ramp except at ramp terminals.

CAPACITY OF RAMP PROPER

Single-Lane Operation

DESIGN CONDITION	T % TRUCKS DURING PEAK HOUR	DESIGN SPEED $V \leq 20$ mph, R = 90' min – 125' Des. RATE OF UPGRADE % 0-2	3-4	≥ 5	DESIGN SPEED V = 25 mph, R = 150' RATE OF UPGRADE % 0-2	3-4	≥ 5	DESIGN SPEED V = 30-40, R = 230'–430' RATE OF UPGRADE % 0-2	3-4	≥ 5	DESIGN SPEED $V \geq 50$, R = 690' RATE OF UPGRADE % 0-2	3-4	≥ 5
Service Level B	0	800	800	800	1000	1000	1000	1100	1100	1100	1220	1220	1220
	5	760	720	700	950	900	870	1050	1000	950	1140	1090	1040
	10	720	670	610	910	830	770	1000	920	850	1090	1000	920
	20	670	570	500	830	720	620	920	780	690	1000	860	750
	30	610	500	420	770	620	530	850	690	580	920	750	630
Service Level C	0	1000	1000	1000	1250	1250	1250	1400	1400	1400	1500	1500	1500
	5	950	900	870	1190	1140	1090	1330	1270	1220	1420	1360	1300
	10	910	830	770	1140	1040	960	1270	1170	1080	1360	1250	1150
	20	830	720	620	1040	890	780	1170	1000	870	1250	1070	940
	30	770	620	530	960	780	660	1080	880	740	1150	940	790

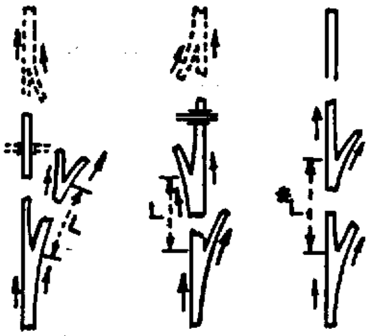
Adapted from FHWA Report on "Capacity Analysis for Design and Operation of Freeway Facilities" 1974

Notes:
1. For 2-lane ramps multiply tabular values as follows: 1.7 for 20mph or less, 1.8 for 25mph, 1.9 for 30-40mph, 2.0 for 50mph or more
2. For down grades use same values as for 0-2% upgrade
3. To approximate level of service E, multiply above values by 1.25
4. Minimum ramp radius on interstate highways should not be less than 150'.

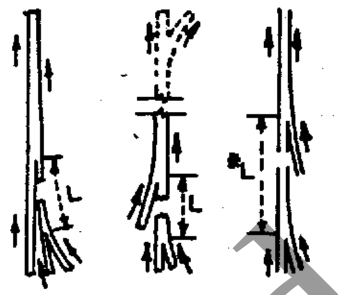
ARRANGEMENTS FOR SUCCESSIVE RAMP TERMINALS

FIGURE-

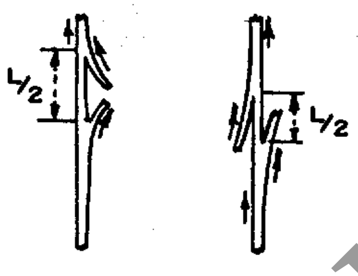
DATE: 8/79



SUCCESSIVE EXIT TERMINALS



SUCCESSIVE ENTRANCE TERMINALS



EXIT TERMINAL FOLLOWED BY ENTRANCE TERMINAL

ENTRANCE TERMINAL FOLLOWED BY EXIT TERMINAL

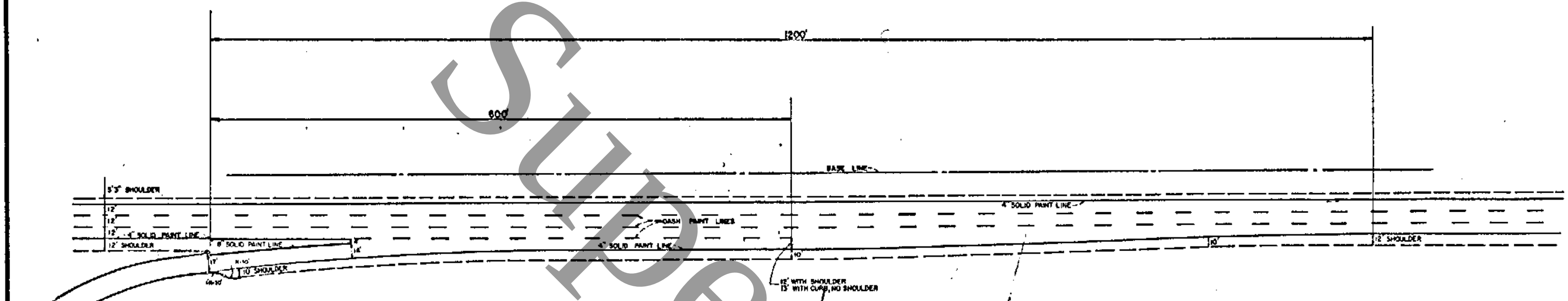
*L as in table but not less than length required for accel. or decel. lanes.

**L as in table but not less than length required for weaving.

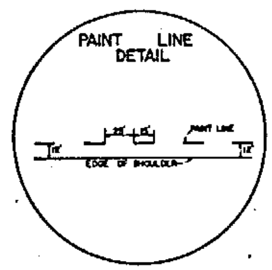
DISTANCE BETWEEN SUCCESSIVE RAMP TERMINALS

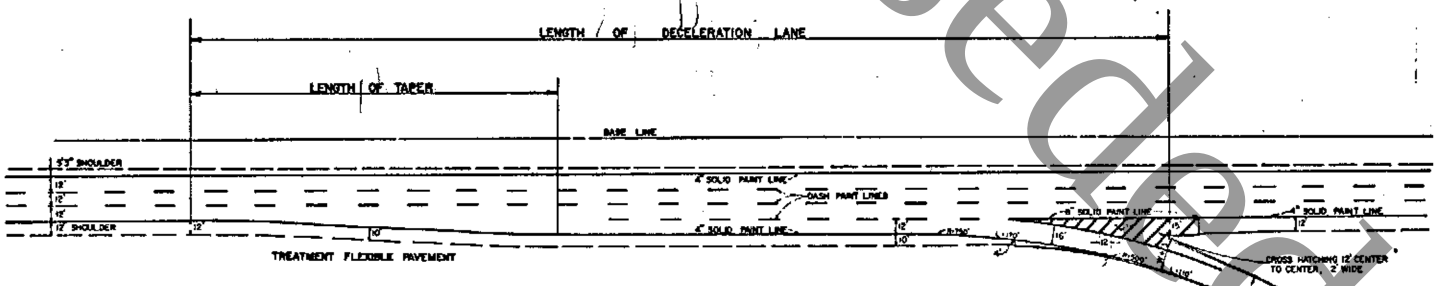
Design speed, mph	30 or less	40 to 50	60 to 70	80
Av. running speed, mph	23 to 28	36 to 44	52 to 58	64
<u>Distance L-Feet</u>				
Minimum	200	400	500	900
Desirable	400	700	900	1200

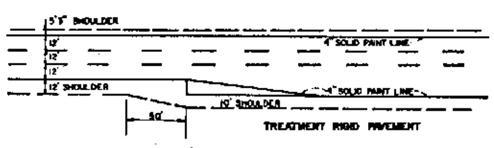
Adapted From "A Policy on Geometric Design of Rural Highways" AASHTO 1965



ACCELERATION LANE







DESIGN SPEED M.P.H.	SPECIAL DECELERATION LANE TOTAL LENGTH	SPECIAL DECELERATION LANE LENGTH OF TAPER	NORMAL DECELERATION LANE TOTAL LENGTH	NORMAL DECELERATION LANE LENGTH OF TAPER
70	800	300	600	250
60	700	250	500	225
50	600	200	400	110
	HIGH VOLUME			
	HIGH % TRUCK			
	NO DECREASE IN LANES BEYOND EXIT NOSE			
	HAVE JUSTIFICATION WHEN USED			

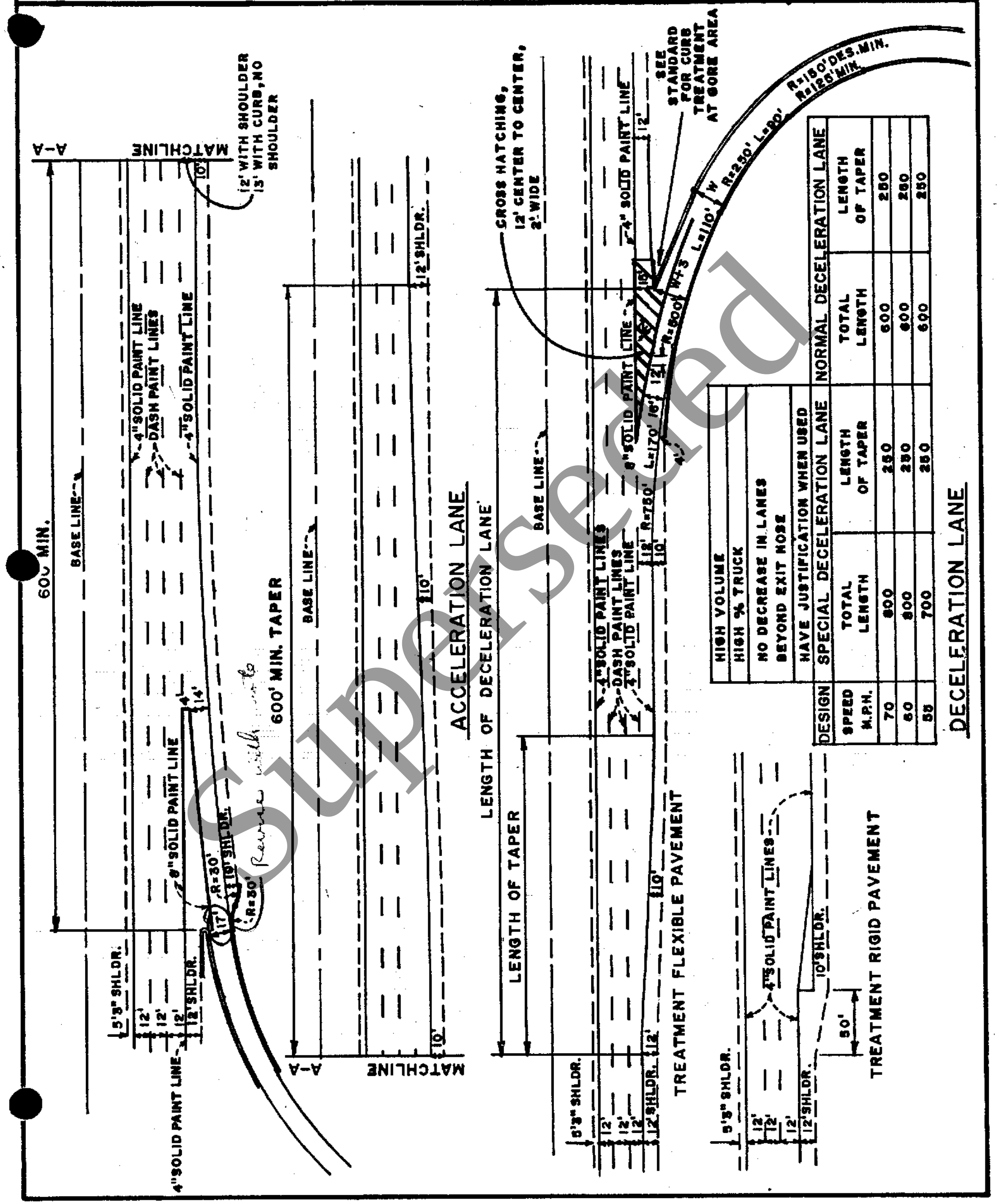
DECELERATION LANE

INTERSTATE & FREEWAY RAMP TERMINAL TREATMENT

INTERSTATE AND FREEWAY RAMP TERMINAL TREATMENT

FIGURE-

DATE: 9/79



DESIGN SPEED M.P.H.	SPECIAL DECELERATION LANE TOTAL LENGTH	SPECIAL DECELERATION LANE LENGTH OF TAPER	NORMAL DECELERATION LANE TOTAL LENGTH	NORMAL DECELERATION LANE LENGTH OF TAPER
70	800	250	600	250
60	800	250	600	250
55	700	250	600	250

Special deceleration lane: HIGH VOLUME; HIGH % TRUCK; NO DECREASE IN LANES BEYOND EXIT NOSE; HAVE JUSTIFICATION WHEN USED

Form AD-40

New Jersey Department of Transportation

MEMORANDUM

TO ALL DESIGN UNITS

FROM Mr. Frank S. Parker
Chief Engineer
Design

SUBJECT Guide Rail Design

DATE October 13, 1976

Enclosed are guidelines to be used for the design of guide rail. These guidelines should be used on all future projects.

Frank S. Parker
Chief Engineer, Design

Attachments

FSP:CT:icn

10/13/76

GUIDELINES FOR GUIDE RAIL DESIGN

I. INTRODUCTION

This is not intended to be a statement of policy on guide rail design but rather is intended to serve as guidelines which will assist the designer in determining conditions which warrant the installation of guide rail as well as the dimensional characteristics of the installations.

It cannot be overemphasized that guide rail should be installed discriminately. Every effort should be made to eliminate the obstruction which warrants the guide rail. Guide rail should be installed only when it is not feasible to eliminate the warranting obstruction.

The recommendations presented herein have been kept general where possible so that the designer has the flexibility needed to deal with the many different site conditions that will be encountered. Therefore, it is important that application of these guidelines be made in conjunction with engineering judgement and a thorough evaluation of site conditions so that a proper solution is arrived at.

In some cases, another type of traffic barrier, might be a better choice than guide rail. For example, obstructions in the median, such as bridge piers, can often be effectively shielded with a crash cushion. The designer should consider such alternatives and choose the most suitable solution based on safety requirements, economic limitations, maintenance, and aesthetic considerations.

II. GUIDE RAIL WARRANTS

A. How Warrants are Determined

The nature of the obstruction and its distance from the edge of the traveled way are the basic factors to be considered in determining if an obstruction warrants guide rail.

Although a wide range of roadside obstructions are covered below, special cases will probably arise for which there is no clear choice as to whether or not guide rail is warranted. Such cases should be evaluated on an individual basis, and, in the final analysis must usually be resolved by engineering judgement.

B. Definition of Obstruction

An obstruction is defined as any fixed object or nontraversable hazard.

1. Examples of fixed objects which may warrant guide rail are: sign, traffic signal and luminaire supports of non-breakaway design; bridge piers and abutments; ends of bridge parapets; retaining walls; culverts; concrete pedestals extending more than 6 inches above the ground; trees, 6 inches or more in diameter, or likely to grow to 6 inches or more in diameter; wood poles or posts with a cross-sectional area greater than 50 square inches, except utility poles (See paragraph III.B.7 for requirements regarding utility poles).

2. Nontraversable Hazards

   Examples of nontraversable hazards which may warrant guide rail are: rough rock cuts; streams or permanent bodies of water more than 2 feet in depth; vertical drop-offs of more than 2 feet; ditches with a nontraversable cross section; and embankment (fill) slopes as designated below.

Embankment Slopes	Maximum Height Without Guide Rail
1 1/2:1	3'-0
2:1	6'-0
2 1/2:1	9'-0
3:1 and flatter	guide rail not required

Slopes in cut sections do not require guide rail unless there is a warranting obstruction on the slope, in which case the following applies:

a. Guide rail should be installed if the warranting obstruction is on a slope flatter than 0.7:1 and is within the clear distance specified in paragraph II.C.

b. Guide rail should be installed if the warranting obstruction is on slope of 0.7:1 or steeper and is less than 6 feet (measured along the slope) from the toe of slope and is within the clear distance specified in paragraph II.C.

c. Guide rail is not required if the warranting obstruction is on a slope of 0.7:1 or steeper and is 6 feet or more (measured along the slope) from the toe of slope.

C. <u>Definition of Clear Distance</u>

Clear Distance is defined as the minimum lateral distance from the edge of the traveled way needed by driver of an errant vehicle to either regain control and begin a return to the roadway or to slow the vehicle to a safe speed.

Clear Distance varies with the operating speed and roadside slope.

Figure 11 shows the clear distance required for operating speeds of 60, 50, and 40 MPH.

Operating Speed is the highest speed at which reasonably prudent drivers can be expected to drive on a section of highway under low traffic densities and good weather conditions. This speed may be higher or lower than posted or legislated speed limits or nominal design speeds where alignment, surface, roadside development, or other features affect vehicle operation.

When unable to determine the operating speed, it may be considered to be 5 MPH more than the speed limit but in no case less than 40 MPH.

III. DIMENSIONAL CHARACTERISTICS

A. The length of "approach" guide rail should be determined in accordance with Figure 1.

1. On a two-way, undivided roadway or on a divided roadway with a traversable median, an "approach" treatment may be required for both directions of traffic (see Figure 2).

B. Placement Details

1. See Figures 2 thru 10.

2. End Treatments

a. Beam Guide Rail Anchorage

In cut sections the ends of guide rail installations should be anchored with a Beam Guide Rail Anchorage and buried in the slope as shown in Figure 9.

On a divided roadway with a nontraversable median, trailing ends of guide rail installations should be anchored with a Beam Guide Rail Anchorage.

In special cases, where the end of a guide rail installation is located so that an end hit is unlikely, the end should be anchored with a Beam Guide Rail Anchorage.

b. Breakaway Cable Terminal (BCT)

Breakaway Cable Terminals should be used at ends of beam guide rail installations, not covered in paragraph III.B.2.a.

3. Offset

Guide rail should be located as far from the edge of the traveled way as possible.

a. On interstate routes and freeways, the front face of the guide rail should be a minimum of 4 feet from the outside edge of shoulder except as provided in paragraph III.B.6.

b. On land service roads with a sidewalk or a sidewalk area used by pedestrians, the front face of the guide rail should be a minimum of 7 feet from the outside edge of shoulder.

c. At Obstructions:

On Roadways With an Operating Speed of More Than 40 MPH:

The distance from the back of the rail element to the obstruction should be a minimum of 4 feet. If less than 4 feet must be used, the guide rail system must be modified (see Figures 4 and 5).

On Roadways With an Operating Speed of 40 MPH or Less:

The distance from the back of the rail element to the obstruction should be a minimum of 2 feet. If less than 2 feet must be used, the guide rail system should be modified as follows: use a reduced post spacing as shown in Figure 4 except when the guide rail is attached to the obstruction in which case the modifications shown in Figure 5 should be used.

4. Flare

A straight flare of 15:1 should be used whenever possible. A straight flare flatter than 15:1 may be used when necessary.

5. Guide Rail on Embankment (fill) Slopes

a. Guide rail may be placed on slopes 10:1 or flatter.

b. On slopes steeper than 10:1 but flatter than or equal to 6:1, guide rail may be placed on the slope but should be located 12 feet or more from the top of the slope.

c. Guide rail should not be placed on slopes steeper than 6:1.

6. Curb or Raised Berm in Front of Guide Rail

Curb or a raised berm in front of guide rail should be avoided.

On new construction, a design without curb or raised berm in front of guide rail should be provided where possible.

On projects which involve upgrading existing roadways, where there is curb or a raised berm in front of guide rail, removal or modification of the curb or raised berm should be considered.

On land service roads where curb is required because of a sidewalk or sidewalk area used by pedestrians see paragraph III.B.3.b.

a. Roadways With an Operating Speed of More Than 40 MPH:

At locations where there is curb or a raised berm in front of the guide rail and it is not practical to remove or modify the curb or raised berm, the following applies:

Where sufficient roadside width is availiable, guide rail could be placed 10 feet or more behind the gutter line. Where this is not possible, the face of the guide rail should be set no more than 9 inches behind the gutter line, except that the 9 inch offset may be modified as required to provide a flared end treatment, or to avoid underground utilities and electrical installations.

Whenever an offset of 3 feet or less is used, a rub rail is required. However, a rub rail should not be used in the first 37' -6" at an "approach" end.

b. On Roadways With an Operating Speed of 40 MPH or Less:

Guide rail may be placed any distance behind the gutter line, but usually an offset of 4 or 7 feet should be used.

7. Utility Poles

Although utility poles have a cross sectional area greater than 50 square inches, they should not be handled the same as other warranting obstructions. It is questionable whether a safer roadside would result from installing guide rail for utility poles within the clear distance. The expected increase in accident frequency versus a reduction in accident severity must be carefully weighed including consideration of such factors as accident experience and roadway geometry. Ordinarily, an acceptable solution is to locate the poles as far from the traveled way as possible without guide rail. However, if guide rail is used, see Figures 2, 3,4,5, and 10 for placement details.

C. Guide Rail Details

The dimensions and other characteristics of beam guide rail posts, rail elements, fasteners, etc. are shown in the Standard Details.

D. General Comments

1. Gaps of 200 feet or less between individual guide rail installations should be avoided where possible.

2. The clearance from the edge of the traveled way to the face of the guide rail should be uniform.

3. Guide rail should not be installed beyond the right-of-way unless easements are provided.

4. Guide rail posts should preferably be kept 2 feet from the PVI at the top of an embankment slope. If less than 2 feet is used, post embedment should be increased by 2 feet (see Figure 8).

LENGTH OF NEED

FIGURE-1

DATE: 10-13-76

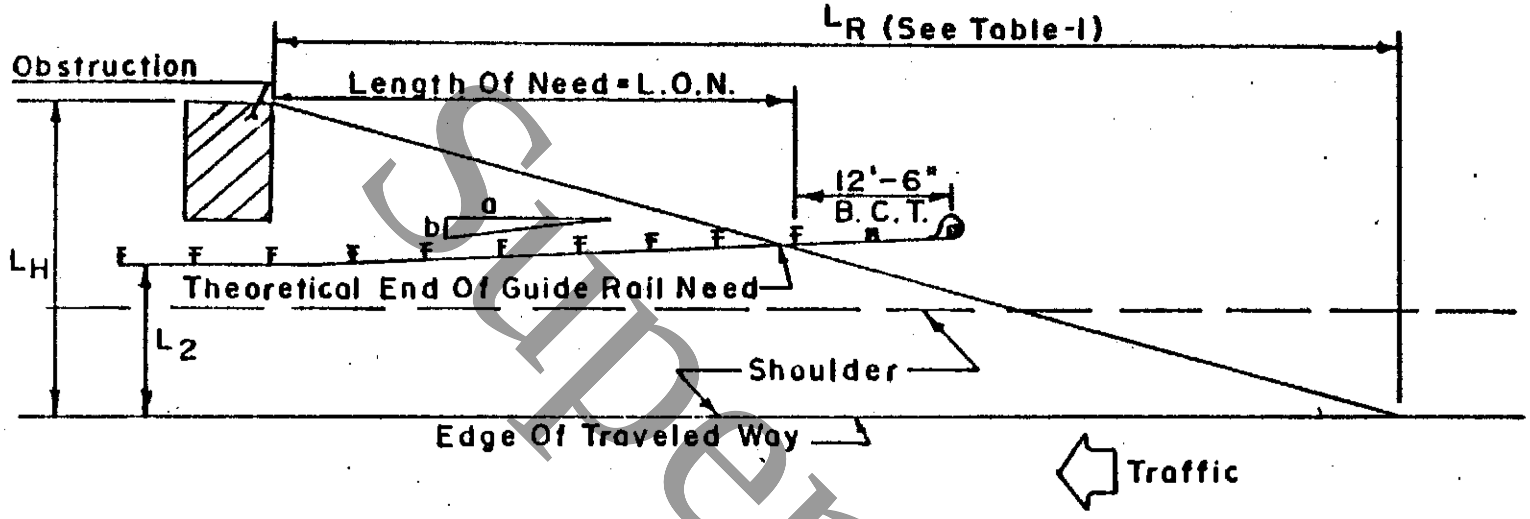


TABLE 1				
	Traffic Volume (A.D.T.)			
	Over 6000	2000-6000	800-2000	Under 800
Operating Speed (MPH)	L_R	L_R	L_R	L_R
70	480	440	400	360
60	400	360	330	300
50	320	290	260	240
40	240	220	200	180
25	120	110	100	90

EXAMPLE

$$L.O.N. = \frac{L_H - L_2}{\frac{b}{a} + \frac{L_H}{L_R}}$$

$\frac{b}{a} = 0$, If Guide Rail Is Parallel To Roadway

If $L_H > L_c$, Use L_c (L_c = Clear Distance)

$L_2 = 16'$

$L_H = 22'$

$L_R = 480'$ (From Table 1)

$\frac{b}{a} = \frac{1}{15}$

$$L.O.N. = \frac{22 - 16}{\frac{1}{15} + \frac{22}{480}}$$

L.O.N. = 53.3'

Increase 53.3' To Nearest Multiple Of 6'-3", Use L.O.N. = 56'-3"

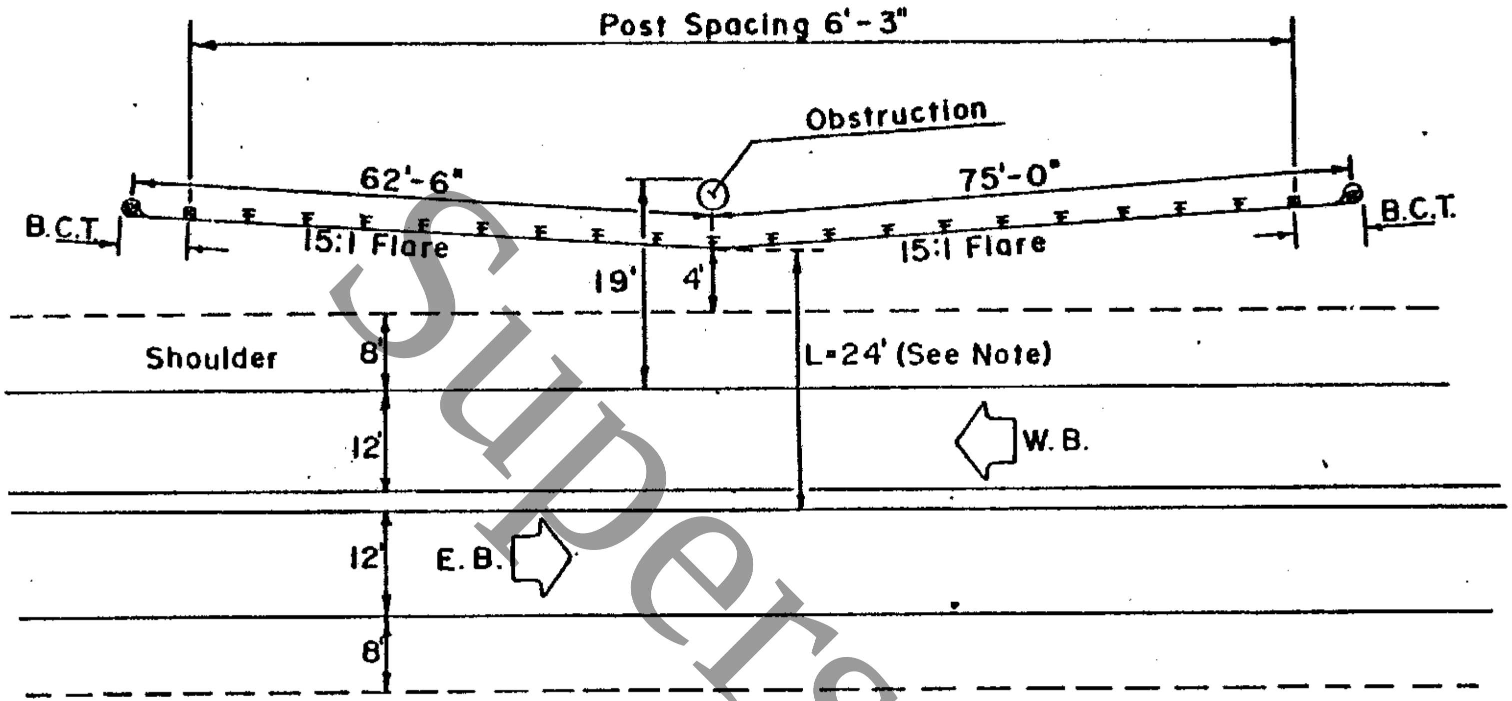
NOTE

If Roadway Is Curved, Draw Layout To Scale And Obtain L.O.N. Directly By Scaling From Drawing.

L.O.N. FOR TWO WAY ROADWAY

FIGURE - 2

DATE: 10-13-76



EXAMPLE

Operating Speed = 60 M.P.H.

A.D.T. = 7000

L.O.N. For W.B.

$L_2 = 12'$

$L_H = 19'$

L_R (From Table I) = 400

$$\text{L.O.N.} = \frac{19-12}{\frac{1}{15}+\frac{19}{400}} = 61.3'$$

Use L.O.N. = 62'-6"
Plus 12'-6" Gives Length = 75'-0"

L.O.N. For E.B.

$L_2 = 24'$

$L_H = 31'$, Use $L_c = 30$

$L_R = 400$

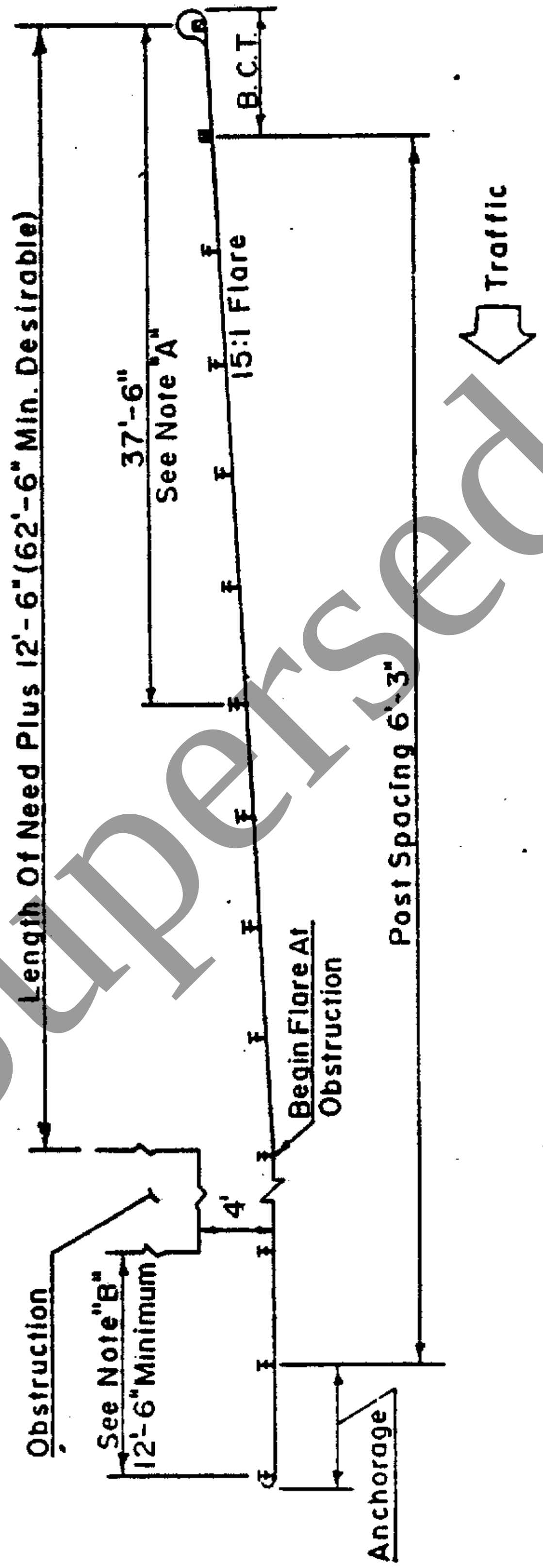
$$\text{L.O.N.} = \frac{30-24}{\frac{1}{15}+\frac{30}{400}} = 42.4'$$

Use L.O.N. = 50' So That The Length Including A B.C.T. Will Be 62'-6" Which Is The Minimum Desirable Length.

NOTE

"Approach" Length For E.B. Not Required If $L \geq L_c$. If E.B. & W.B. Are Separated By A Transversable Median, The Median Width Should Be Included When Determining L. (L_c = Clear Distance)

USE WHEN BACK OF RAIL ELEMENT IS 4 FEET FROM THE OBSTRUCTION	FIGURE - 3
	DATE:10-13-76



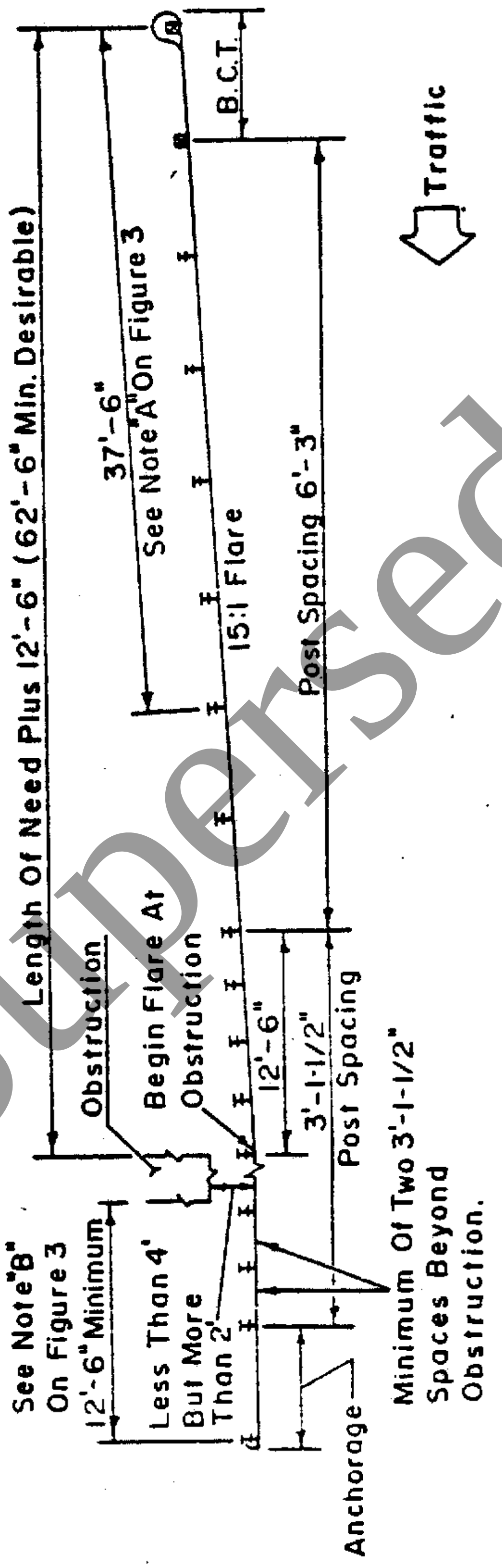
NOTE "A"

1. Omit Flat Plate Washer
2. No Rub Rail (See Paragraph III. B. 6. a Of Text)

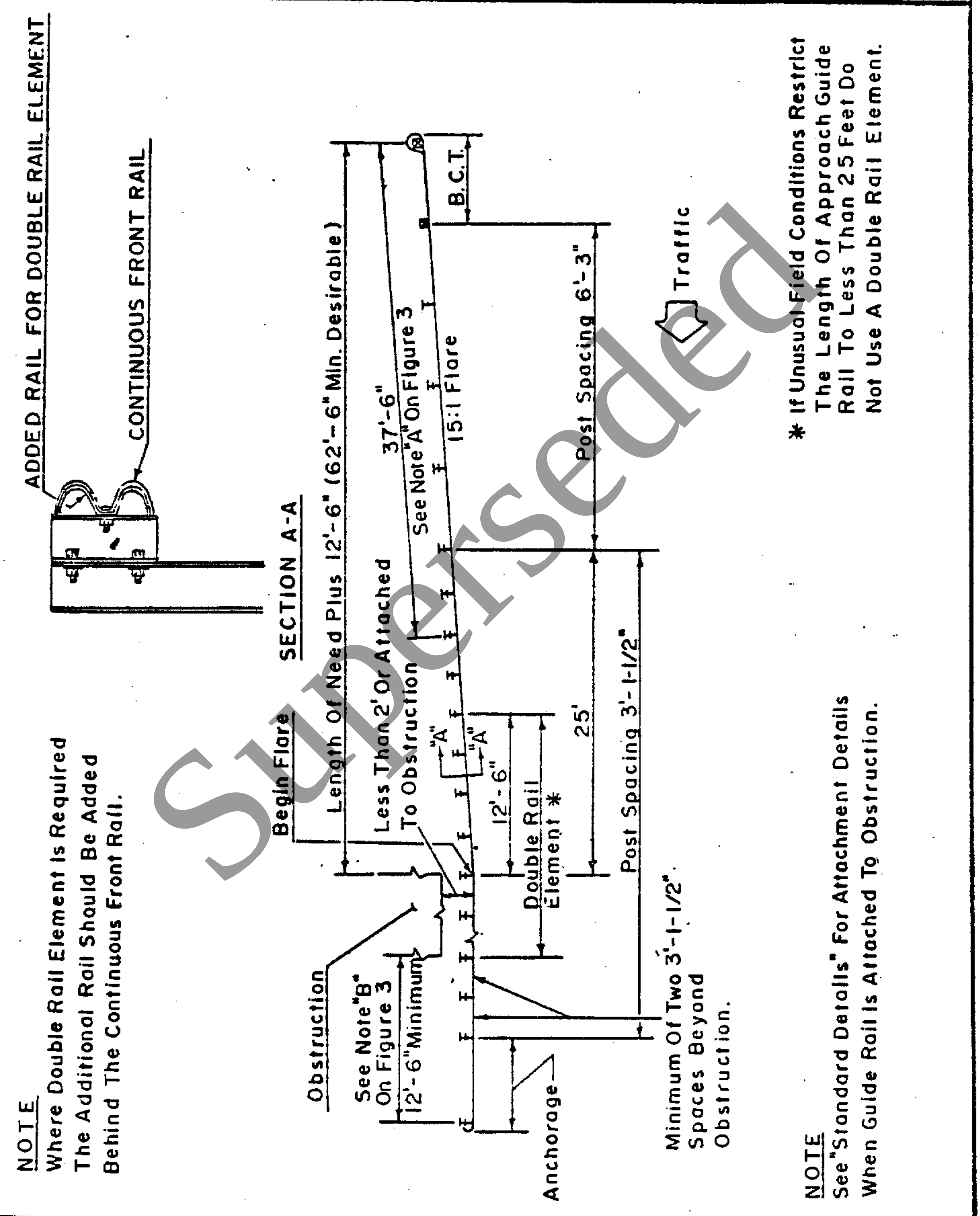
NOTE "B"

On A Two Way Undivided Roadway Or On A Divided Roadway With A Traversable Median, An "Approach" Treatment May Be Required (See Figure 2)

USE WHEN BACK OF RAIL ELEMENT IS LESS THAN 4 FEET BUT NOT LESS THAN 2 FEET FROM OBSTRUCTION	FIGURE - 4
	DATE:10-13-76



USE WHEN BACK OF RAIL ELEMENT IS LESS THAN 2 FEET FROM OBSTRUCTION OR ATTACHED TO OBSTRUCTION	FIGURE - 5
	DATE: 10-13-76

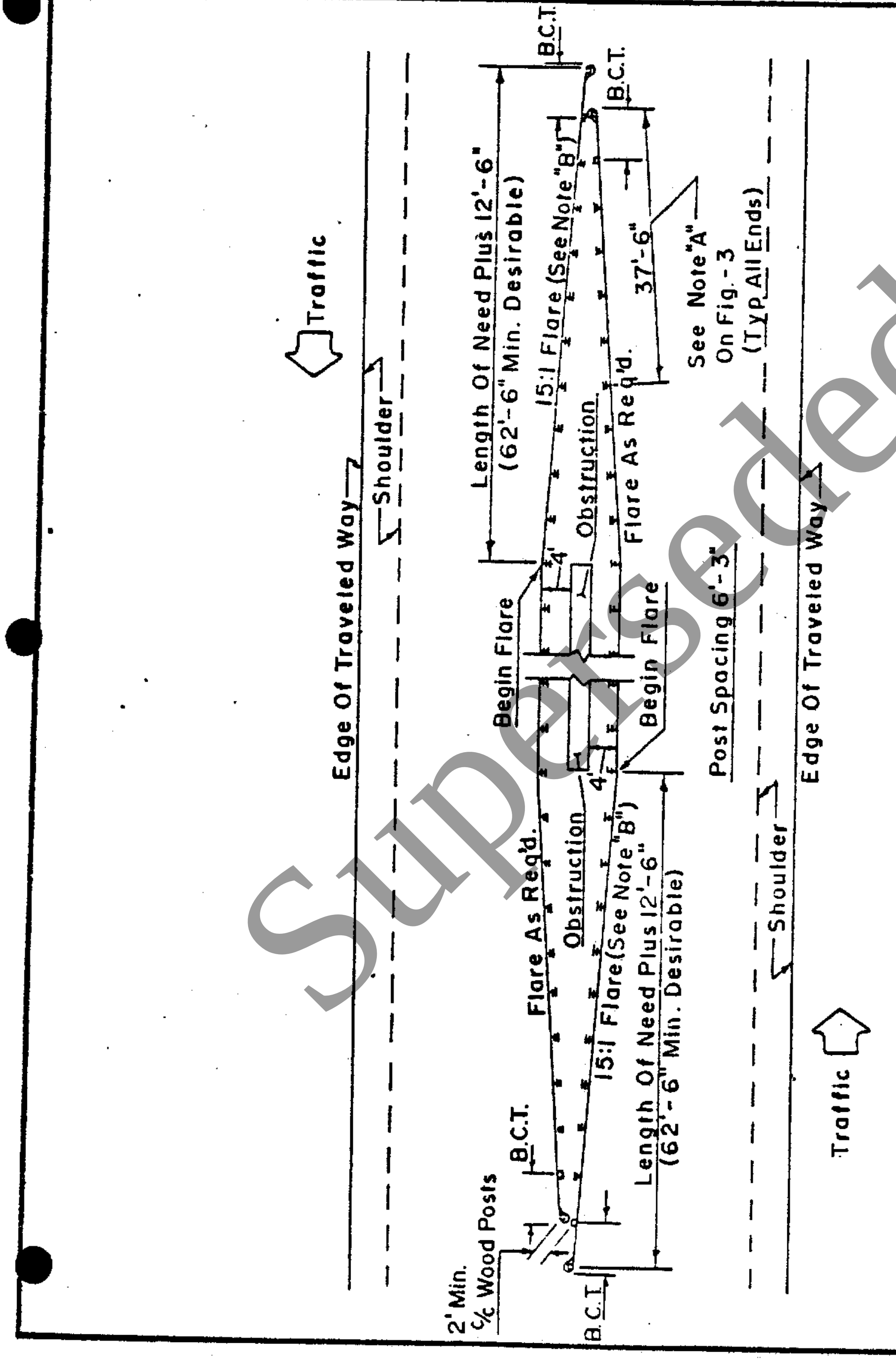


OBSTRUCTION IN MEDIAN

CLEARANCE TO OBSTRUCTION 4 FEET

FIGURE - 6

DATE: 10-13-76



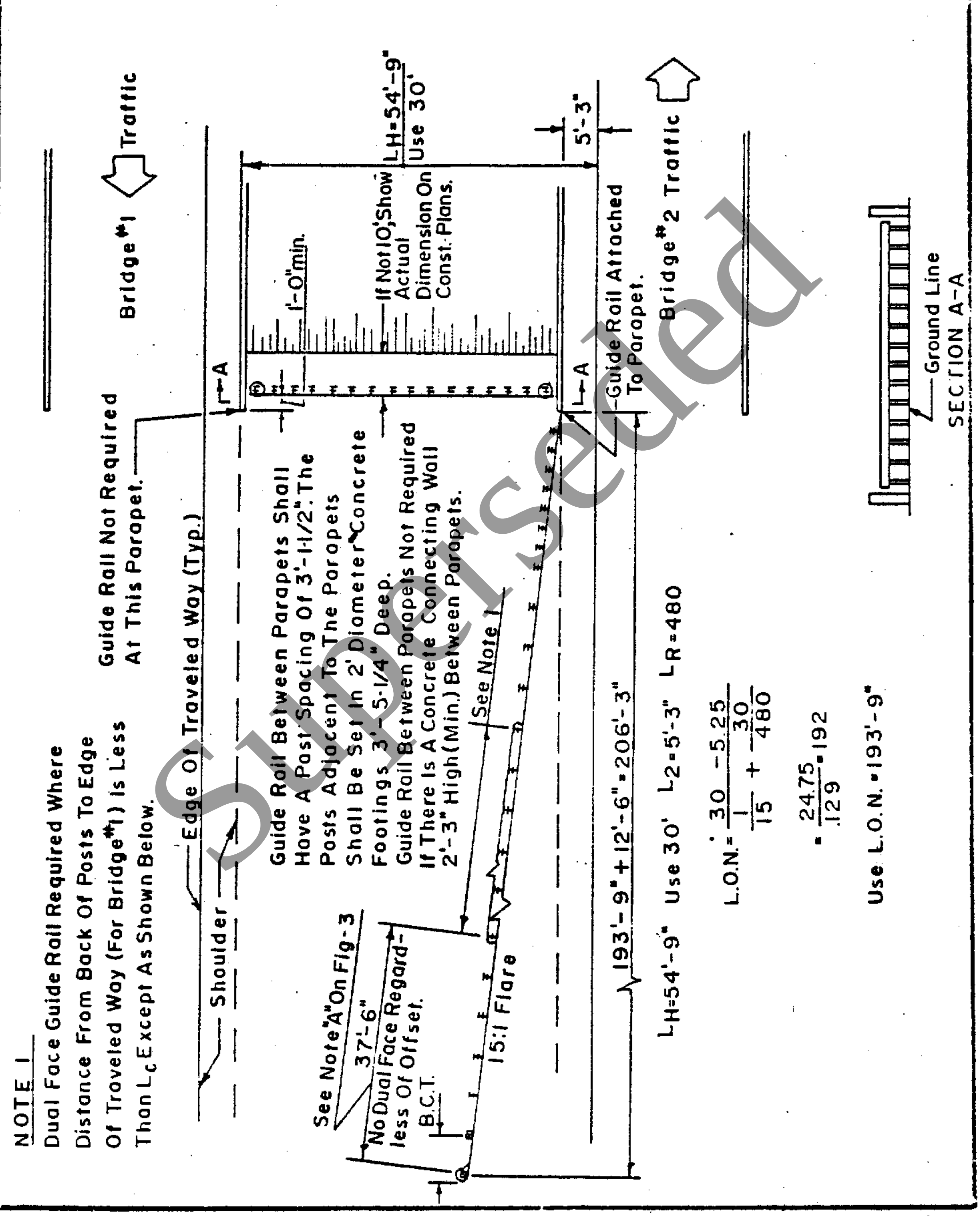
NOTE "B"

Use Less Flare If 15:1 Would Cause Guide Rail At The Adjacent Trailing End To Flare Towards Traffic.

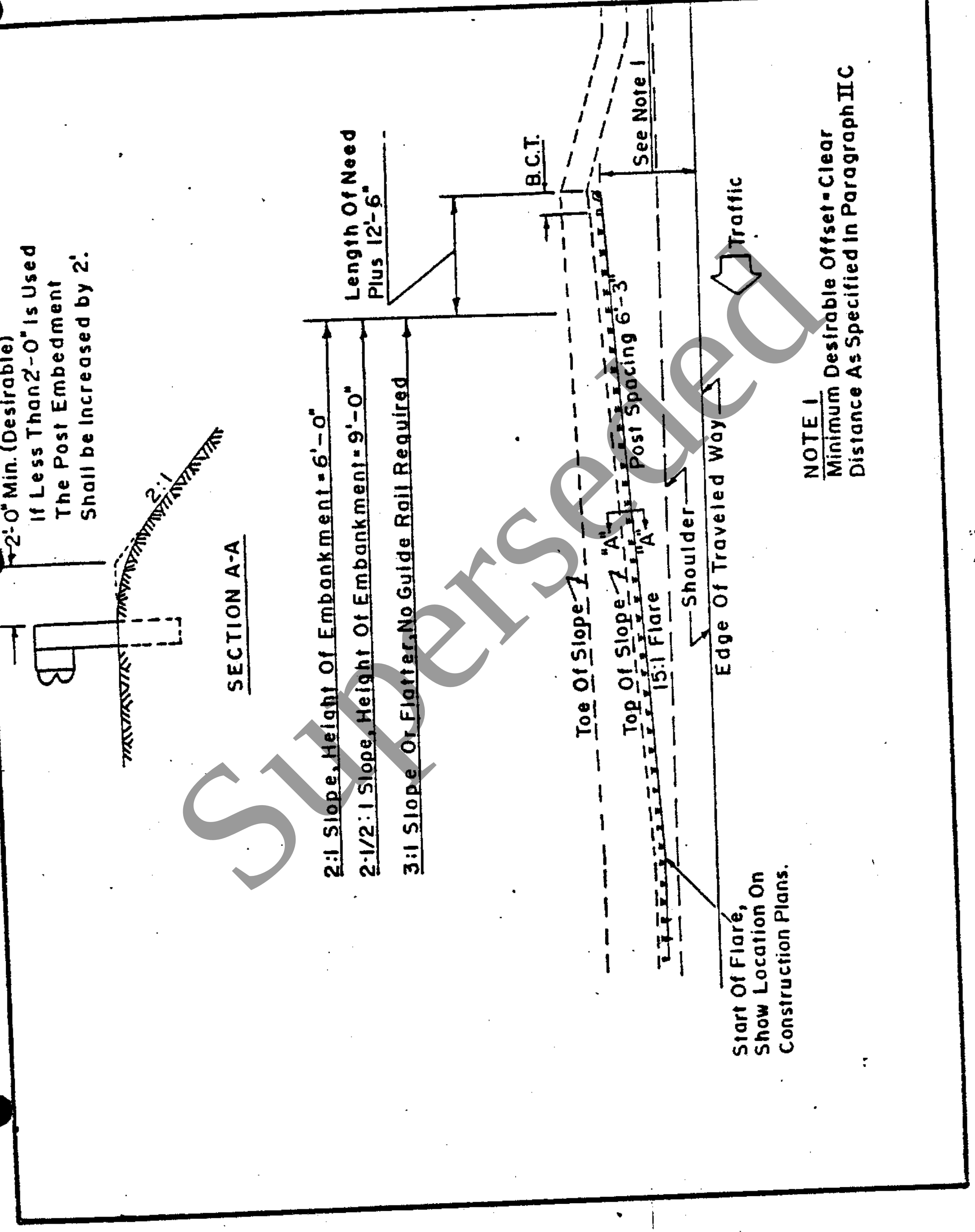
GUIDE RAIL AT ADJACENT BRIDGES

FIGURE-7

DATE: 10-13-76



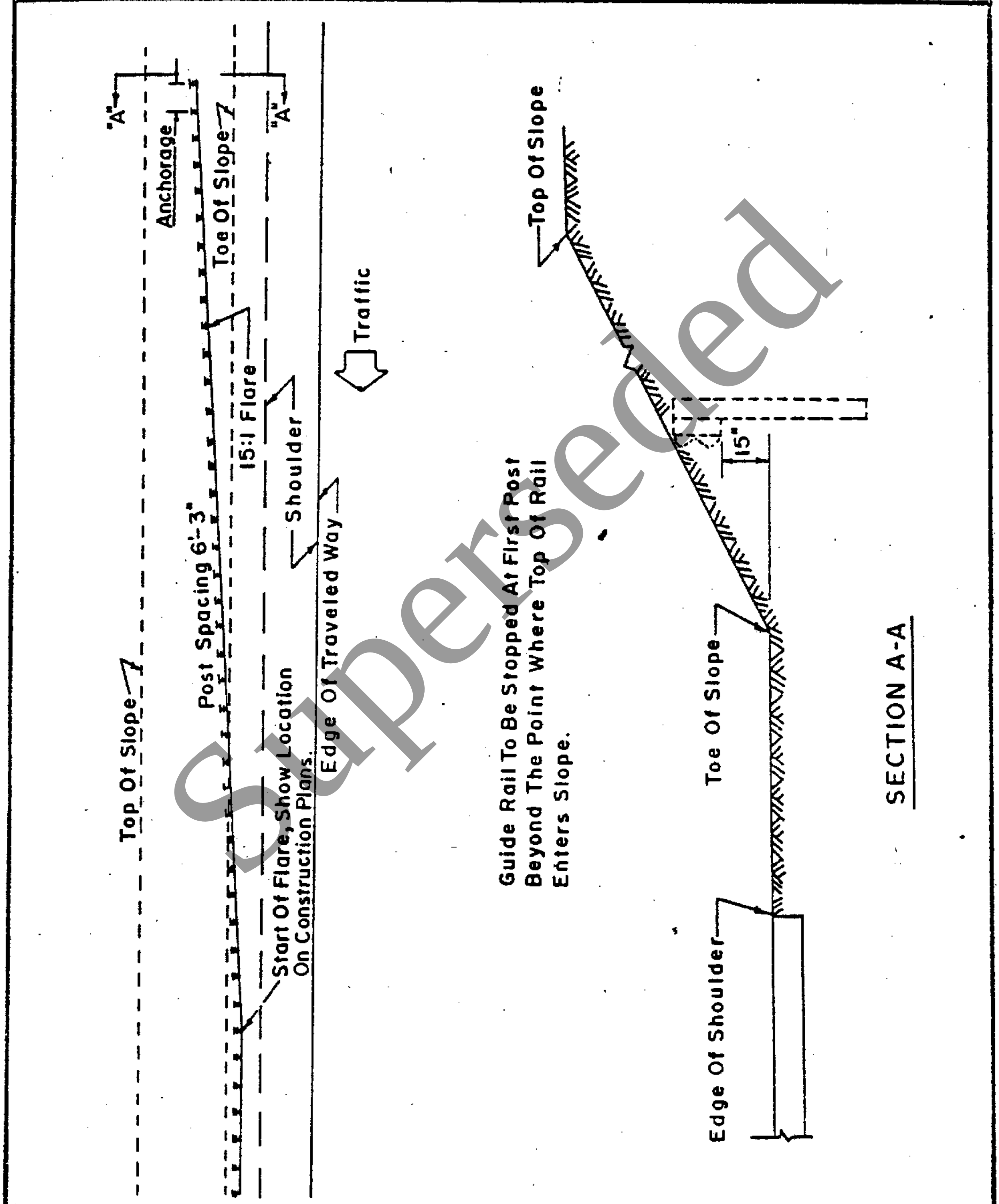
GUIDE RAIL TREATMENT FOR EMBANKMENT	FIGURE-8
	DATE:10-13-76



GUIDE RAIL TREATMENT FOR CUTS
(END BURIED IN SLOPE)

FIGURE-9

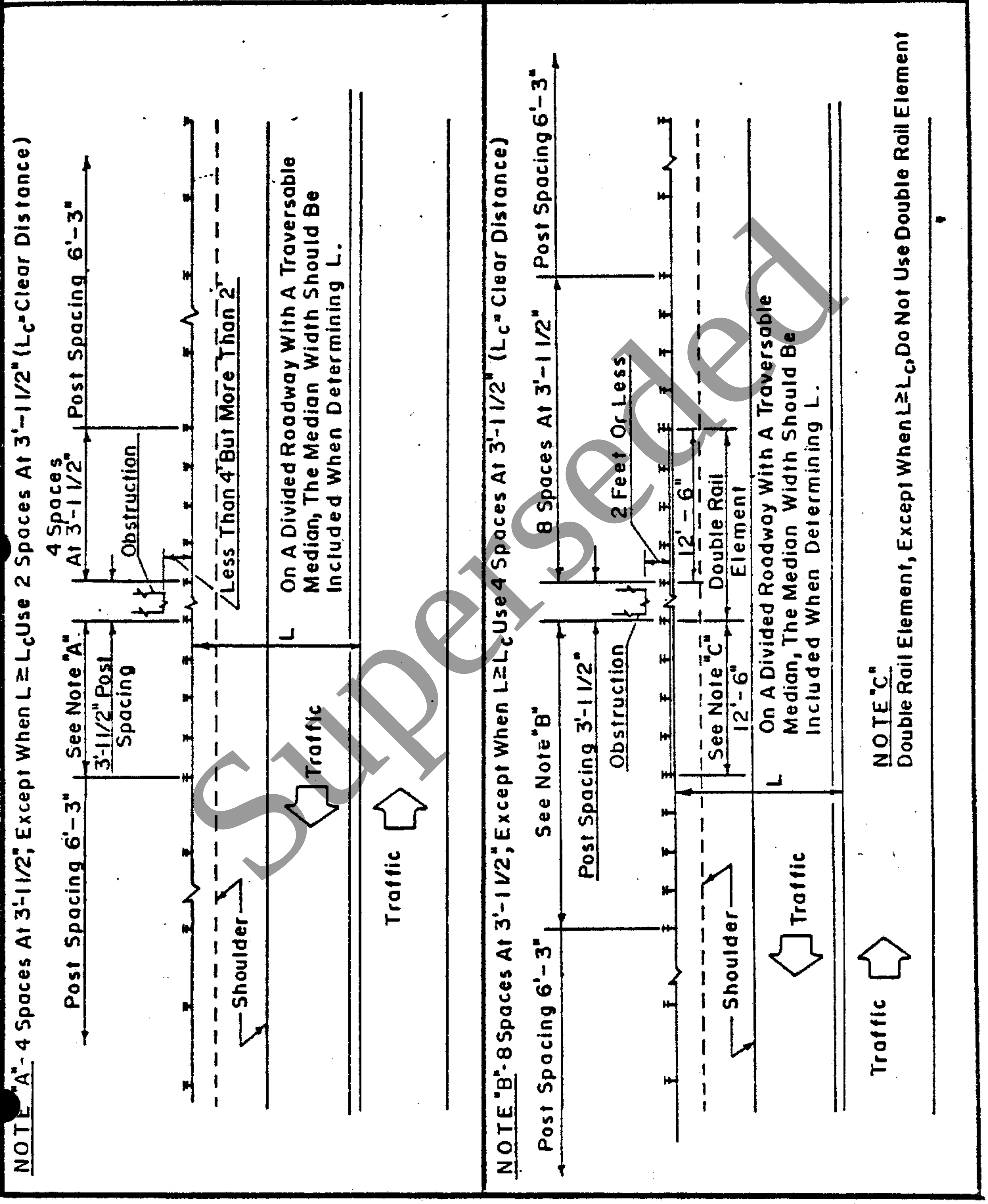
DATE: 10-13-76



CONTINUOUS GUIDE RAIL AT OBSTRUCTION

FIGURE-10

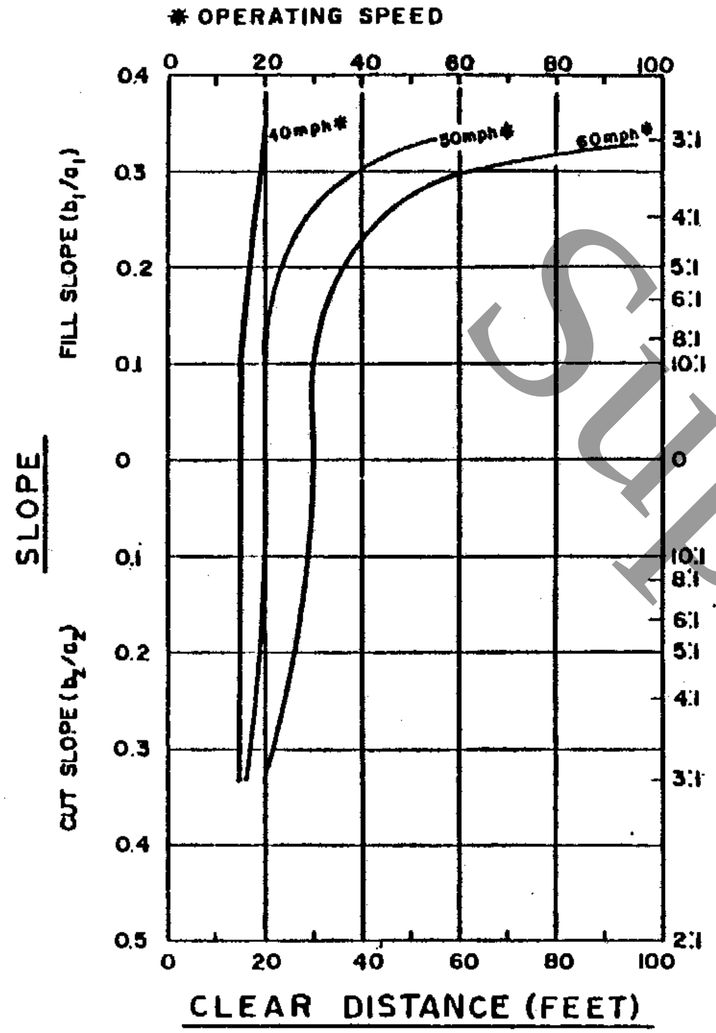
DATE: 10-13-76

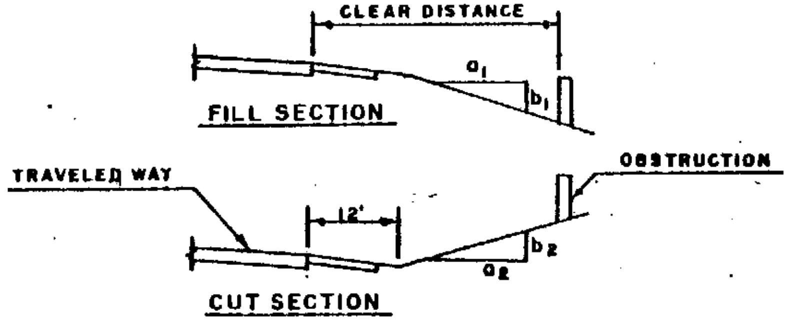


CLEAR DISTANCE

FIGURE-11

DATE: 10-13-76



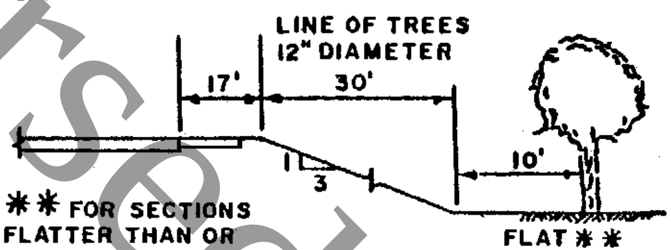


The graph may be used directly when the obstruction is on the slope and the distance from the edge of traveled way to the top or toe of slope is 12 feet.

When the distance from the edge of traveled way to the top or toe of slope is more than 12 feet, the difference between the actual distance and 12 feet should be <u>subtracted</u> from the clear distance obtained from the graph. If the actual distance is less than 12 feet, the difference should be <u>added</u>.

When the obstruction is not on the slope, a "weighted" average slope method should be used.

EXAMPLE



** FOR SECTIONS FLATTER THAN OR EQUAL TO 10:1, A SLOPE OF 10:1 SHOULD BE USED.

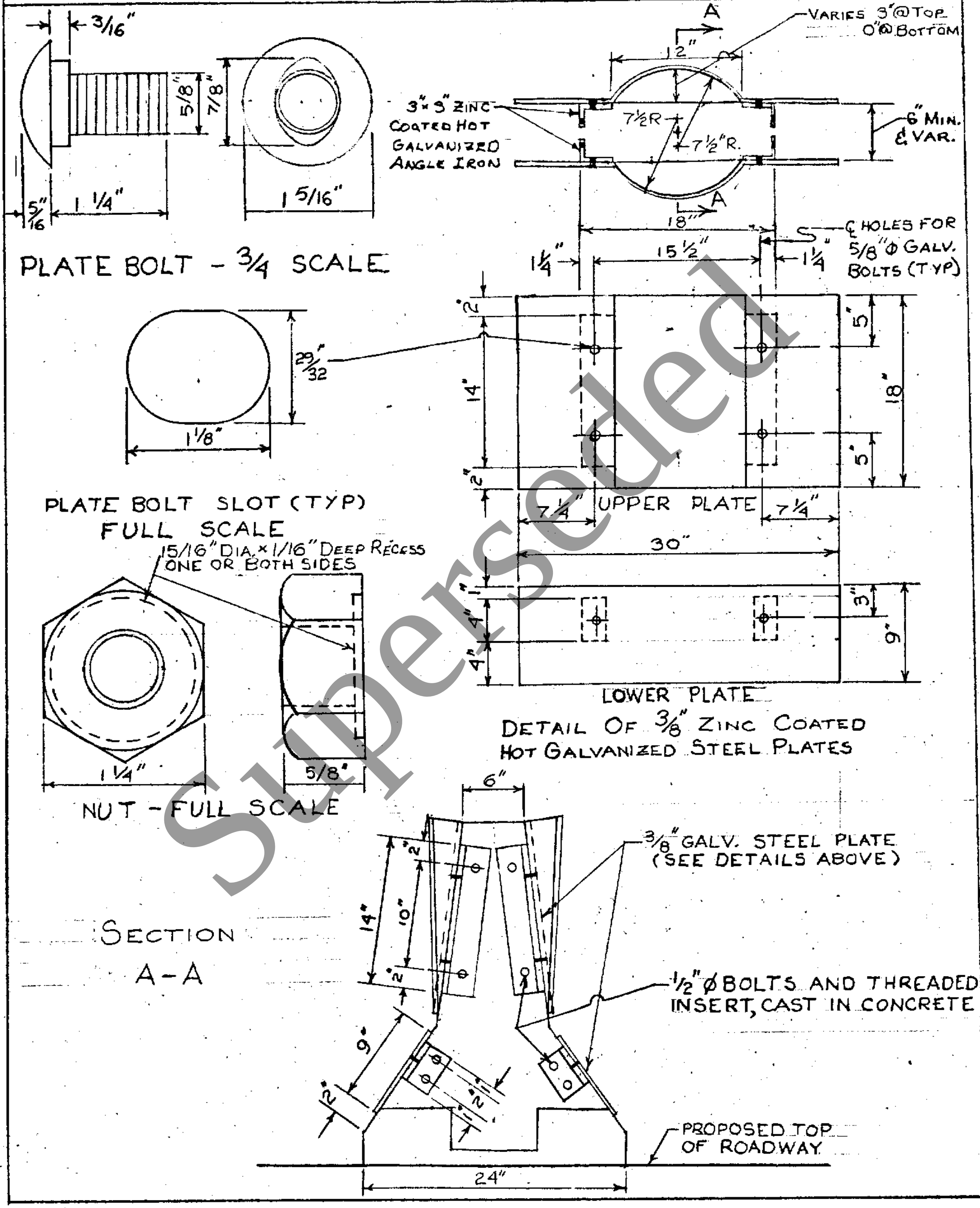
$$(b_1/a_1) \text{ AVERAGE} = \frac{(30\text{ft.})(0.333)+(10\text{ft.})(0.1)}{40\text{ft.}} = 0.275$$

ENTER GRAPH WITH $(b_1/a_1) = 0.275$ AND GET CLEAR DISTANCE = 50 ft. (FOR 60 M.P.H.) ACTUAL REQUIRED CLEAR DISTANCE = 50-(17-12) = 45 FEET VERSUS 57 FEET AVAILABLE, THEREFORE, GUIDE RAIL NOT REQUIRED.

Barrier Curb Closure At Lighting Pole Base Installation

Figure-

Date:



FORM DC-30
REV. 1/9/67

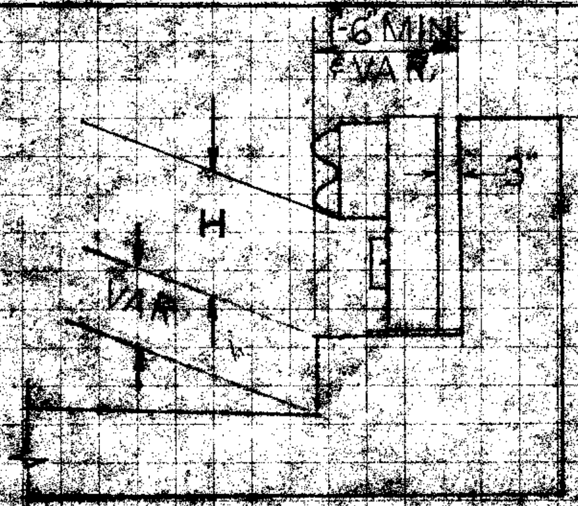
NEW JERSEY DEPARTMENT OF TRANSPORTATION

SHEET NO. ____ OF ____

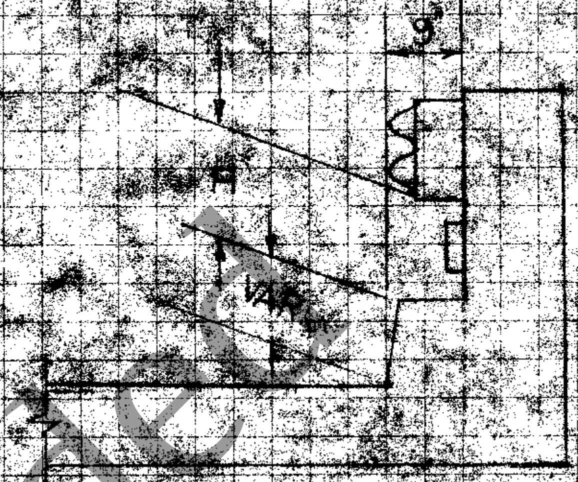
ROUTE (1927) ________ 1953 ________ SECTION ________ PROJECT ________

MADE BY ________ DATE ________ CHECKED BY ________ DATE ________

SUBJECT ________ F.A. NO. ________



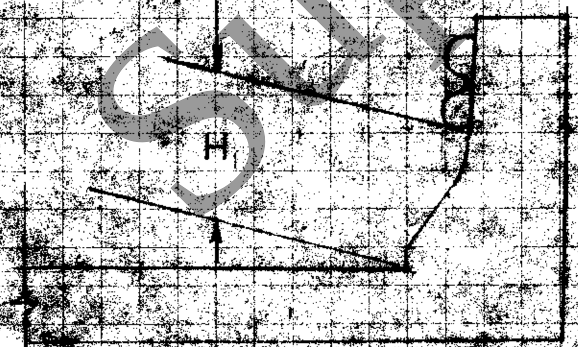
EXISTING
INTERSTATE OR FREEWAYS
GUIDE RAIL CARRIED
THRU STRUCTURE



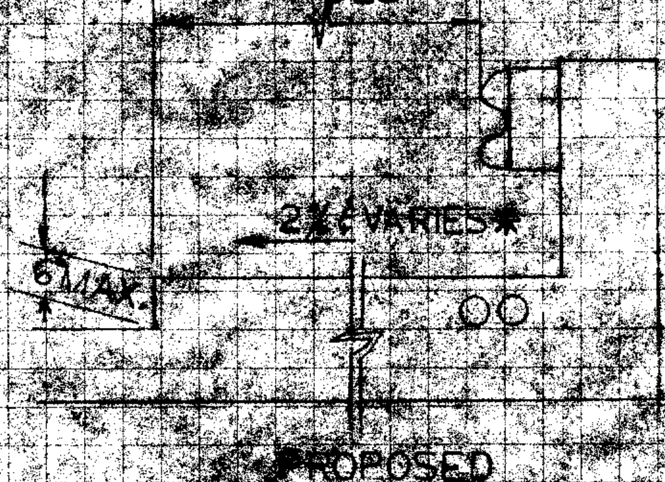
EXISTING
INTERSTATE OR FREEWAYS
GUIDE RAIL ATTACHED

LOCATION OF GUIDE RAIL AT EXISTING STRUCTURES ON LAND SERVICE ROADS WILL BE DETERMINED BY THE DESIGNER

*MAY BE ADJUSTED TO PROVIDE FOR UTILITIES



PROPOSED
INTERSTATE OR FREEWAYS
GUIDE RAIL ATTACHED



PROPOSED
LAND SERVICE ROADS
GUIDE RAIL ATTACHED

FORM DC-30
REV. 1/9/67

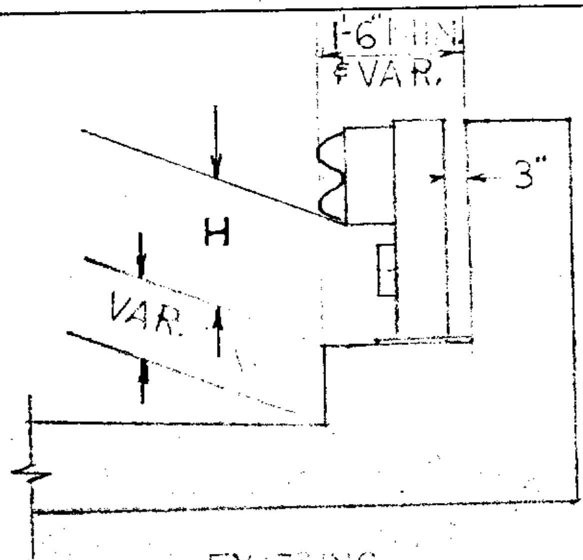
NEW JERSEY DEPARTMENT OF TRANSPORTATION

SHEET NO ____ OF ____

ROUTE (1927) ____________ 1953 ____________ SECTION ____________ PROJECT ____________

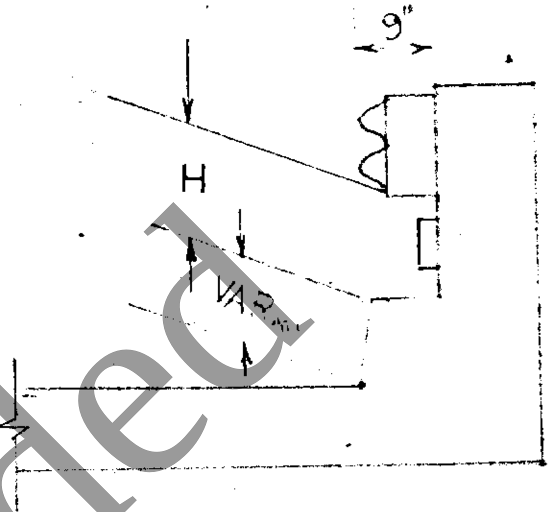
MADE BY ____________ DATE ________ CHECKED BY ____________ DATE ________

SUBJECT ____________ F.A. NO. ____________



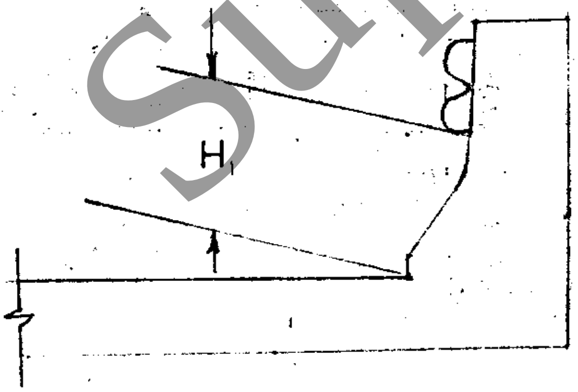
EXISTING
INTERSTATE OR FREEWAYS

GUIDE RAIL CARRIED
THRU STRUCTURE



EXISTING
INTERSTATE OR FREEWAYS

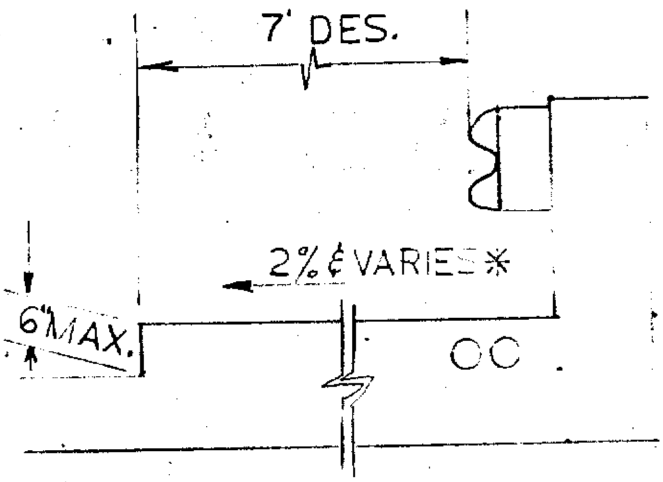
GUIDE RAIL ATTACHED



PROPOSED
INTERSTATE OR FREEWAYS
GUIDE RAIL ATTACHED

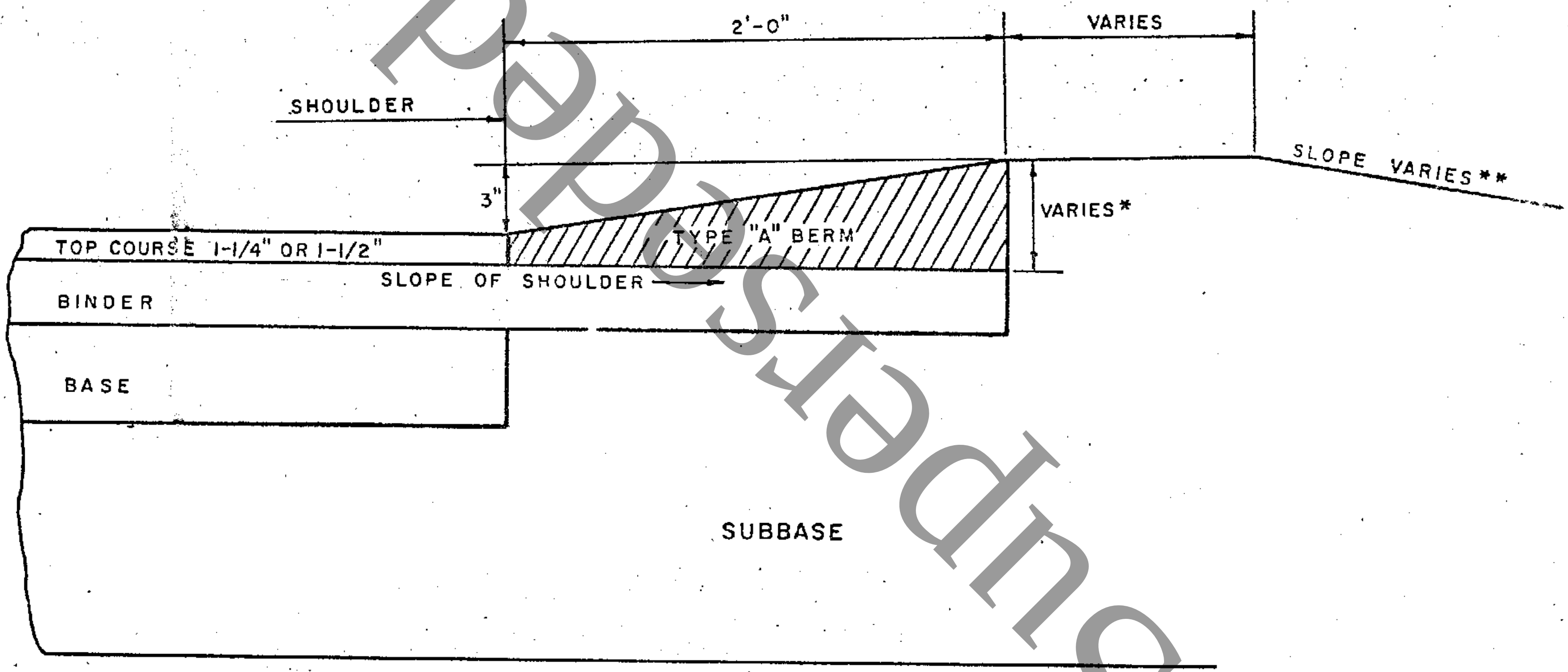
LOCATION OF GUIDE RAIL AT EXISTING STRUCTURES ON LAND SERVICE ROADS WILL BE DETERMINED BY THE DESIGNER

*MAY BE ADJUSTED TO PROVIDE FOR UTILITIES



PROPOSED
LAND SERVICE ROADS
GUIDE RAIL ATTACHED

BITUMINOUS CONCRETE BERM — TYPE "A"



*THIS DIMENSION VARIES WITH THE THICKNESS OF THE TOP COURSE AND SLOPE OF SHOULDER
**SEE TYPICAL SECTIONS FOR PROJECT

NOTE:
ALLOWANCES FOR THE SLOUGHING OF THE BASE AND BINDER MATERIAL FOR ESTIMATING PURPOSES ARE TO BE MADE AS INDICATED ON D2.97.0

New Jersey Department of Transportation

MEMORANDUM

TO ALL DESIGN UNITS

FROM Mr. Frank S. Parker

Chief Engineer, Design

SUBJECT Curb Ramps for the Handicapped

DATE February 25, 1976

A preliminary Design standard and guide lines for Curb Ramps, subject to the approvals required by statute, is attached heréto.

All future projects where sidewalks are to be constructed or reconstructed will provide ramps for the handicapped.

Every effort shall be made to provide the most desirable ramp configuration.

Frank S Parker

FSP:RAP:wc

(1) Wheel chair ramps through traffic islands.

(2) Where ramps are to be deleted

GUIDE LINES AND SPECIFICATIONS FOR

CURB CUT RAMPS FOR THE PHYSICALLY HANDICAPPED

The requirements shown on the attached sketch are the desirable and the acceptable minimum dimensions for the barrier free ramps. The designer should keep in mind that existing conditions at an intersection may present special problems. It is not our intent to dictate specific locations for the ramps, since each situation is different, but to insure a design that will provide the best service to its users. The agency having jurisdiction in each case should make every effort to insure a safe usable facility.

A sight distance study is recommended and utilities should be relocated, if possible, to insure that curb cuts are not placed in such a location that motorists find it difficult to perceive the low profile of wheelchair occupants where they cross the roadway. Utilities should be kept clear of the curb cut area to give maximum visibility of and for ramp users.

Ramps must be designed to accommodate everyone, thus, transitions from the sidewalk to the ramp or to the landing area must be gradual. Curb cut ramps will be placed at all intersections. The best location is adjacent to the normal sidewalk (at the P.C. of the curb).

Two ramps will be constructed on each corner, one on each street within the crosswalk area. However, where field conditions prohibit this design, one ramp at the center of the curb return or ramping the sidewalk itself is acceptable.

Relocation of the sidewalk at the intersection is permissible and in some cases necessary, in order to obtain the required slope.

The ramp surface shall be constructed in accordance with New Jersey Department of Transportation specifications, except that a stiff broom, approved by the engineer, shall be substituted for the wet soft hair brush.

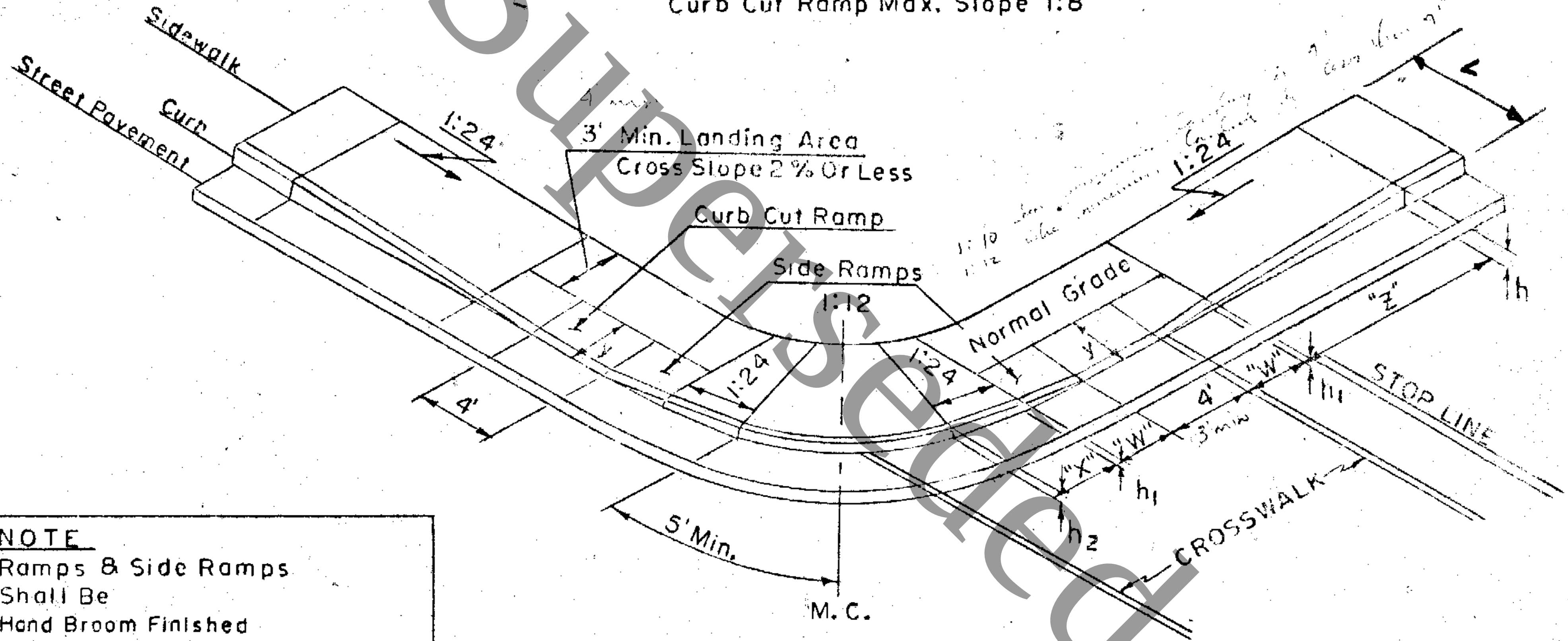
$y = W$

$y = h_1 (12)$

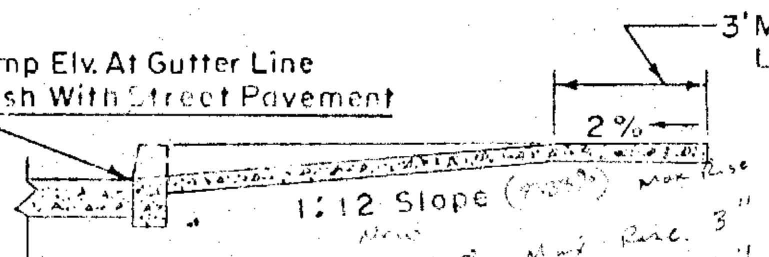
$h_1 = h - \frac{Z}{24}$

$h_2 = h_1 + \frac{X}{24}$

NOTE: Curb Cut Ramp Desirable Slope 1:12
Curb Cut Ramp Max. Slope 1:8



NOTE
Ramps & Side Ramps
Shall Be
Hand Broom Finished



N. J. D. O. T.

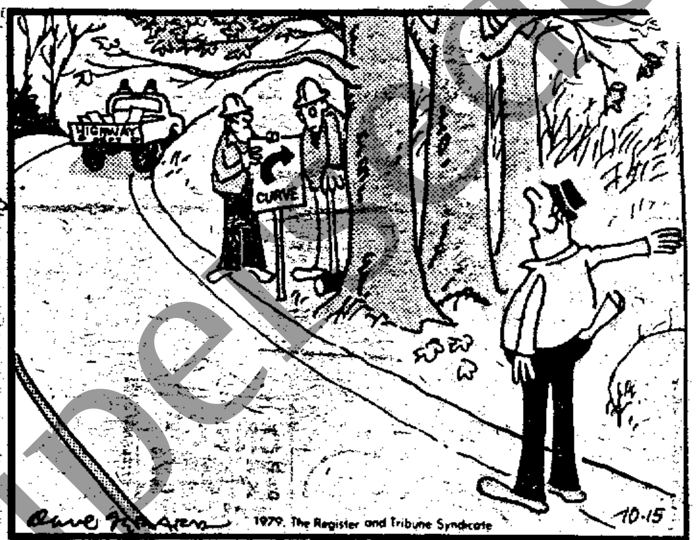
Recommended Treatment

For

Curb Cut Ramps For The Physically Handicapped

DESIGN STANDARDS

SIGN PLACEMENT



"A little more to the right — I can still see it!"