



ORANGE COUNTY

HIGHWAY DESIGN MANUAL

**RESOURCES & DEVELOPMENT
MANAGEMENT DEPARTMENT**

COUNTY OF ORANGE
RESOURCES AND DEVELOPMENT MANAGEMENT DEPARTMENT
(RDMD)

SANTA ANA, CALIFORNIA

ORANGE COUNTY HIGHWAY DESIGN MANUAL

JUNE 2005



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ORANGE COUNTY HIGHWAY DESIGN MANUAL

June, 2005

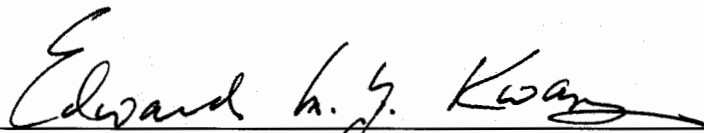
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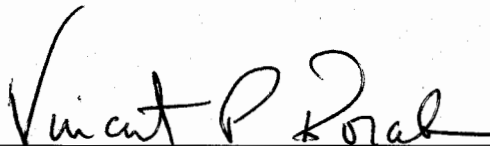
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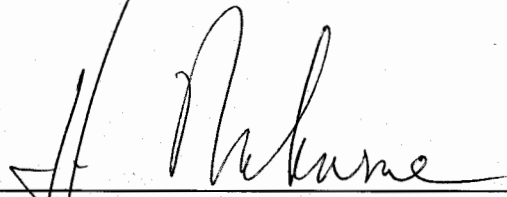
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POLICY STATEMENT

The Orange County Highway Design Manual was originally approved and adopted through Orange County Board of Supervisors Resolution No. 89-1380 on October 3, 1989. Said Resolution authorized the Director, Public Works to amend the Manual as he deems necessary to keep the Manual practical, reasonable and consistent with the technical state-of-the-art.

This Orange County Highway Design Manual provides updated design criteria, policies and procedures for use as a guide for Orange County RDMD engineers to exercise sound judgment in the design of streets and highways in Orange County. This manual is neither intended as, nor does it establish, a legal standard for these functions. The American Association of State Highway and Transportation Officials (A.A.S.H.T.O.) and the State of California Department of Transportation (Caltrans) have published policies and procedures on highway references to be used in conjunction with this manual.

This publication is intended to provide guidance in the design of new and major reconstruction projects. The fact that new minimum design values are presented does not imply that existing streets and highways are in any way inadequate; however certain roadway features may be upgraded where it is cost-effective to do so. The values contained herein will provide more satisfactory design for new street and highway facilities, as well as for major modification of existing facilities.

For all street and highway design, staff engineers shall exercise "Standard of Ordinary Care" as would be expected of members of the profession in carrying out assigned projects. The term "Standard of Ordinary Care" is not defined and is a matter to be considered with each specific highway design. However, it is RDMD policy that design may be considered to have a "Standard of Ordinary Care" if the design follows the Standard Plans, Highway Design Manual and/or other approved references, or has approved deviations from these documents which are supported by good engineering or safety logic.

In cases where strict adherence to the standards of design would be impractical or unreasonable, deviations may be approved providing they are in accordance with good engineering practice and the public health and safety, and conform to a plan that will, under the circumstances in such case, be practical and reasonable. Any deviations from the standards of design shall be identified by a note on the plans and approval of these plans shall constitute approval of these deviations. All deviations shall include supporting documentation and justification and shall be placed in appropriate County design file. Special circumstances which may be cited to justify deviation from the standards include, but are not limited to, the character of the community, alternative means of pedestrian circulation, environmental considerations, physical constraints, economic considerations and existing near-by uses.

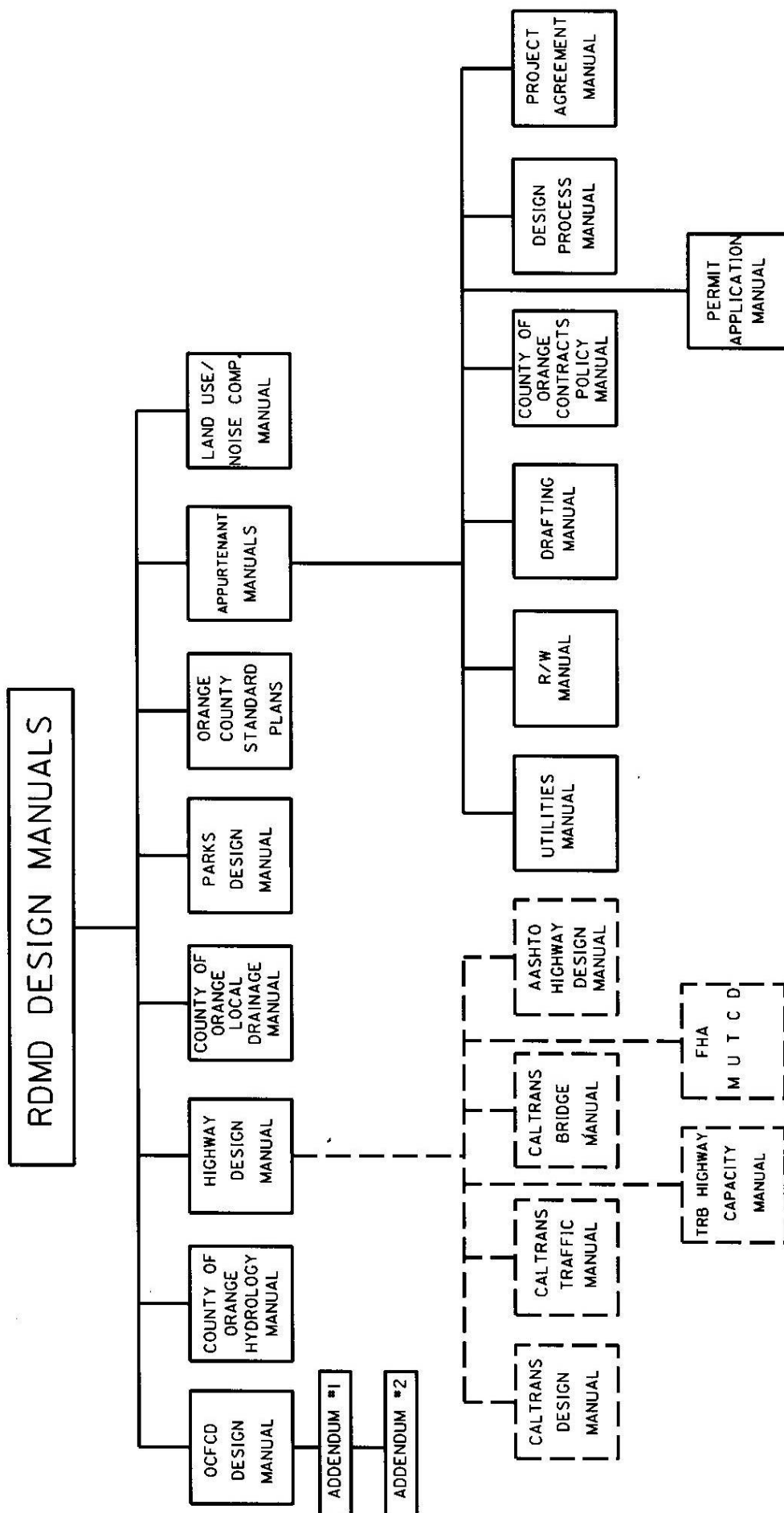
If there is a conflict between Design Policies, the policy highest in precedence shall control. The precedence of design documents shall be:

1. Codified Ordinances
2. Orange County Highway Design Manual
3. Orange County Standard Plans
4. Other Orange County Design Manuals

5. Caltrans Highway Design Manuals
6. A Policy on Geometric Design of Highways and Streets – American Association of State Highway and Transportation Officials
7. Manual of Uniform Traffic Control Devices for Streets and Highway – U. S. Department of Transportation Federal Highway Administration
8. Highway Capacity Manual – Special Report No. 209 – Transportation Research Board

When this manual references to specific APWA standard plans as modified by the County of Orange (e.g. 111-2-OC), the intent is to use the current adopted version.

This manual is not a textbook or a substitute for engineering knowledge, experience, or judgment. No attempt is made to detail basic engineering techniques; for these, standard textbooks should be used.



NOTE:
DASHED BOXES INDICATE ANOTHER FUTURE MANUAL OR ANOTHER AGENCY MANUAL
INCORPORATED BY REFERENCES.

ORGANIZATION STATEMENT

The organization of the Orange County Highway Design Manual closely follows the organization of the Caltrans Highway Design Manual. This format was chosen since the Caltrans Highway Design manual has traditionally been used for the design of streets and highways by the County of Orange.

The Orange County Highway Design Manual has the same Chapter headings, Topic headings and Section headings as the Caltrans Highway Design Manual. County policies are inserted into the Manual under the appropriate Chapter and Topic heading. Any policy found in the Orange County Highway Design Manual supersedes any corresponding policy found in the Caltrans Highway Design Manual. There are a few cases in the Manual where the titles used by Caltrans for a Topic or Section heading do not adequately introduce the County policy; in these cases a new title is used for the County heading followed by the Caltrans heading in parentheses.

EXAMPLE: 205.1 Access Openings on Transportation Corridors
(Access Openings on Expressways)

In those cases where the Caltrans Highway Design Manual does not have an appropriate Chapter for a particular County policy, that policy is included into this Manual beginning with Chapter 2000.

There are numerous cases in the Manual where Orange County does not have a policy under one of the Caltrans Topic headings. In these cases the Topic is left out of the Orange County Highway Design Manual which accounts for the gaps in the numbering sequence. If designers are unable to find a particular policy in the Manual they should consult the Policy Statement at the beginning of this Manual for the order of precedence of approved references.

The current 5th edition of the Caltrans Highway Design Manual is in “Metric” units; whereas the Orange County Highway Design Manual is in “English” units. In situations where Caltrans standard is to be used, convert measurements to rounded, rationalized “hard” numbers wherever possible.

All further breakdowns beyond the Section level do not necessarily parallel Caltrans content.

TRANSPORTATION CORRIDORS

Transportation Corridors are controlled access multimodal, multilane transportation facilities similar to freeways in their design standards (see definition under Topic 101). The planning and design of these facilities are a coordinated effort between the County and the Transportation Corridor Agencies, a joint powers agency made up of officials from the County and affected cities.

These facilities will be taken over by the State of California upon completion. For this reason, the design is closely coordinated with Caltrans. Generally, the design of Transportation Corridors shall be consistent with the design practices contained in the Caltrans Highway Design Manual for freeway design. However, there are some areas of design where the Orange County design criteria may be more desirable. In these cases, Corridor design criteria have been identified in the appropriate section(s) of the Orange County Highway Design Manual.

Specific Corridor design practices have been developed by the Transportation Corridor Agencies and will be used by the Transportation Corridor Agencies consultants responsible for preparing actual Transportation Corridor Agencies design plans. Designer shall coordinate design of adjacent street or highway with appropriate Local Agencies when street or highway is affected by a Corridor.

ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
AB	Aggregate Base
AC	Asphalt Concrete
ACP	Asphalt Concrete Pavement
ADT	Average Daily Traffic
ADA	American Disabilities Act
APWA	American Public Works Association
ARHM	Asphalt Rubber Hot Mix
ATPB	Asphalt Treated Permeable Base
BCO	Bonded Concrete Overlay
CEQA	California Environmental Quality Act
CF	Cubic Feet (Foot)
CFS	Cubic Feet per Second
CNEL	Community Noise Equivalent Level
CTB	Cement Treated Base
CTPB	Cement Treated Permeable Base
CY	Cubic Yard(s)
D	Minimum Tangent Distance
DGAC	Dense Graded Asphalt Concrete
e	Superelevation Rate (foot/foot)
e.g.	For Example
EP	Edge of Pavement
ESAL	Equivalent Single Axle Load
Etc	Etcetera
f	Friction Factor
FHWA	Federal Highway Administration
Ft	Feet (Foot)
GB	Grade Break
GE	Gravel Equivalent
GE _f	Gravel Equivalent Factor
H	Time Period (hour)
Hwy	Highway
i.e.	That Is (To Say)
L	Length of Vertical Curve
Lbs	Pounds
L _{dn}	Equivalent Day/Night Sound Level
L _{eq}	Equivalent Sound Level
LOS	Level of Service
LTS	Lime Treated Soil
K	Constant Coefficient
Max	Maximum
Min	Minimum
Misc.	Miscellaneous
MPAH	Master Plan of Arterial Highways
MPH	Miles Per Hour
MS&C	Mix, Spread and Compact
OCFCD	Orange County Flood Control District
OCTA	Orange County Transportation Authority
OGAC	Open Graded Asphalt Concrete

PCC	Portland Cement Concrete
PCCP	Portland Cement Concrete Pavement
PDS	Planning and Development Services
PMS	Pavement Management System
PRF	Pavement Reinforcing Fabric
Psi	Pounds Per Square Inch
Q-10	Peak Discharge (cfs) for 10 yr. Recurrence Interval
R	Radius (feet) (also Resistance Value)
RDMD	Resources and Development Management Department
RE	Roadway Excavation or Unclassified Excavation
Ref.	Reference
R-value	Resistance Value
R/W	Right of Way
S	Stopping Sight Distance, feet
SAMI	Stress Absorbing Membrane Interlay
SF	Square Feet (foot)
SP	Orange County RDMD Standard Plans
Specs.	Specifications
SY	Square Yard(s)
TI	Traffic Index
TMAC	Tire Modified Asphalt Concrete
Typ.	Typical
V	Velocity (speed) (mph)
W	Width of Transition

CHAPTER 100 – BASIC DESIGN POLICIES

Topic 101 – Design Speed

101.1 Selection of Design Speed

Design Speed is a speed selected to establish specific minimum geometric design elements for a particular section of street or highway. Design elements include things such as sight distance and horizontal and vertical alignment. Design Speed represents the maximum reasonable or prudent speed that can be maintained when conditions (weather, environment, traffic, etc.) are so favorable that the design elements of the street or highway govern.

The Design Speed for a street or highway is dependent upon the type of street or highway under design. Orange County has street and arterial highway classifications progressing from local streets, which are primarily to provide traffic access (with corresponding lower speeds) to principal arterial highways, which are primarily to provide traffic movement (with corresponding higher speeds).

101.2 Design Speed Standards and Definitions

(Design Speed Standards)

Listed below are the classifications and corresponding design speeds for streets and highways in Orange County.

<u>Classification</u>	<u>Minimum Design Speed (MPH)</u>	<u>Reference</u>
Transportation Corridor	70	Caltrans
Principal Arterial Highway	60	SP1100
Major Arterial Highway	60	SP1101
Primary Arterial Highway	55	SP1103
Secondary Arterial Highway	50	SP1105
Rural Secondary Highway	50	SP1108
Commuter Arterial Highway	45	SP1107
Industrial/Commercial Collector Street	35	SP1107
Rural Collector Street	35	SP1109
Residential Collector Street	35	SP1107
Industrial/Commercial Local Street	25	SP1107
Rural Local Street	25	SP1110
Residential Local Street	25	SP1107

(1) Transportation Corridor

A Transportation Corridor is a multimodal facility, having four to twelve lanes based on projected traffic volumes and a median of sufficient width to be utilized in the future for transit considerations such as fixed rail or high occupancy vehicles. Transportation Corridors will provide for high speed movement of vehicular traffic where projected volumes exceed Principal Arterial capacities. Transportation Corridors are depicted on the Circulation Plan and the Master Plan of Arterial Highways (MPAH) map as either conceptually proposed or established alignments. These routes will function similar to freeways and expressways and might eventually

be incorporated into the freeway and expressway system. Therefore, they are designed to meet minimum State and Federal standards.

(2) Arterial Highway

The MPAH serves primarily to indicate the general location and classification of all arterial highways and transportation corridors designed within Orange County. The purpose of these highways is to provide regional circulation which transcends city boundaries and provides an integrated roadway network serving the entire County and extending outside the County boundaries. In 1995, the Orange County Transportation Authority (OCTA) became the steward of the MPAH. OCTA's role is to coordinate with the cities to develop a consistent intercommunity highway system which will adequately serve existing and projected future land uses. The Transportation Corridors and Arterial Highways within the Unincorporated County of Orange are shown on the County of Orange Circulation Plan.

The typical sections shown on the Circulation Plan legend are simplified diagrams based upon adopted Orange County design standards. For more detailed typical sections refer to the Orange County Standard Plans. For definitions of Level of Service refer to topic 102. The following are definitions of highway classifications in Orange County:

- (a) A PRINCIPAL Arterial Highway is designated as a eight-lane divided roadway with a typical right of way width of 144 feet and a roadway width from curb to curb of 126 feet. A Principal has a planned capacity to accommodate between 45,000 to 60,000 vehicle trips per day at level of service C or better. Principal Arterials carry a large volume of regional through traffic not handled by the freeway system.
- (b) A MAJOR Arterial Highway is designed as a six-lane divided roadway, with a typical right of way width of 120 feet and a roadway width from curb to curb of 102 feet. A Major has a planned capacity to accommodate between 30,000 and 45,000 vehicle trips per day at level of service C or better. A Major Arterial's function is similar to that of a Principal Arterial. The principal difference is capacity.

A MODIFIED MAJOR Arterial Highway is designed to accommodate traffic volumes when a Major Arterial Highway is warranted in already developed areas, but a full 120 feet of right of way is not feasible due to existing structures or topography. The use of a MODIFIED MAJOR Arterial Highway and any deviation to the standards of design shall require Chief Engineer's approval.

- (c) A PRIMARY Arterial Highway is designed as a four-lane divided roadway, with a typical right of way width of 100 feet and a roadway width from curb to curb of 84 feet. A Primary has a planned capacity to accommodate between 20,000 and 30,000 vehicle trips per day at level of service C or better. A Primary Arterial's function is similar to that of a Principal Arterial. The principal difference is capacity.

A MODIFIED PRIMARY Arterial Highway is designed to accommodate traffic volumes when a Primary arterial Highway is warranted in already developed areas, but a full 100 feet of right of way is not feasible due to existing structures or topography. The use of a MODIFIED PRIMARY Arterial Highway and any deviation to the standards of design shall require Chief Engineer's approval.

- (d) A SECONDARY Arterial Highway is designed as a four-lane undivided (no median) roadway, with a typical right of way width of 80 feet and a roadway width from curb to curb of 64 feet. A Secondary has a planned capacity to accommodate between 10,000 and 20,000 vehicle trips per day at level of service C or better. A Secondary Arterial serves as a collector, distributing traffic between local streets and Principal, Major and Primary Arterials. Although some Secondary Arterials serve as through routes, most provide more direct access from surrounding land uses than do Principal, Major or Primary Arterials.
- (e) A RURAL SECONDARY Arterial Highway is designed as a four-lane undivided (no median) roadway through a rural area, with a typical right of way width of 80 feet and roadway width from edge of pavement to edge of pavement of 64 feet. If asphalt concrete dikes (curbs) are placed at the edge of pavement, the 64 feet shall be measured from the front of dike. A Rural Secondary has a planned capacity to accommodate between 10,000 and 20,000 vehicle trips per day at level of service C or better. This highway is characterized by not having concrete curb, gutter and sidewalk. The drainage is handled by asphalt concrete dikes (curbs) or drainage ditch(es) at the side of the highway. This section shall only be used in approved areas.
- (f) A COMMUTER Arterial Highway is designed as a two-lane undivided, restricted access roadway, with a typical right of way width of 56 feet and a roadway width from curb to curb of 40 feet. A Commuter has a planned capacity to accommodate up to 10,000 vehicle trips per day at level of service C or better.

(3) Collector Streets

- (a) INDUSTRIAL/COMMERCIAL COLLECTOR Street – A non-arterial four-lane undivided highway with a planned capacity between 4,000 and 10,000 vehicle trips per day. This section is primarily used in industrial zoned areas but is also useful in some office and commercial areas.
- (b) RURAL COLLECTOR Street – A non-arterial street through a rural area, with a planned capacity between 500 and 6,000 vehicle trips per day. This street is characterized by not having concrete curb, gutter and sidewalk. The drainage is handled by asphalt concrete dikes (curbs) or drainage ditch(es) at the side of the street. This section shall only be used in approved areas.
- (c) RESIDENTIAL COLLECTOR Street – A non-arterial street, normally through a residential area, designed to collect traffic from local streets and distribute it onto arterials and with a planned capacity between 1,200 and 6,000 vehicle trips per day. Residential collectors shall not have residential frontage.

(4) Local Streets

- (a) INDUSTRIAL/COMMERCIAL LOCAL Street – A non-arterial street that may be striped for either four-lanes or two-lanes with parking lanes and a median lane having a planned capacity less than 4,000 vehicle trips per day. This section is used the same way as the industrial collector, except it is used for lower traffic volumes.

- (b) **RURAL LOCAL Street** – A non-arterial street through a rural area with a planned capacity of less than 500 vehicle trips per day. This street is characterized by not having concrete curb, gutter and sidewalk. The drainage is handled by asphalt concrete dikes (curbs) or drainage ditch(es) at the side of the street. This section shall only be used in approved areas.
- (c) **RESIDENTIAL LOCAL Street** – A non-arterial street with direct residential frontage having a planned capacity of less than 1,200 vehicle trips per day.

Topic 102 – Highway Capacity

102.1 Design Capacities

Design capacity is the maximum volume of traffic a highway is designed to carry at a selected level of service. In Orange County, the goal for design capacity is to provide a level of service C on arterial highway links (a link is the portion of the roadway between two arterial intersections) with the intent of maintaining a level of service D through intersections.

There are several factors that affect the capacity of a highway including the following:

- Grades.
- Width of lanes.
- Level of service selected.
- Number of lanes.
- Presence or absence of shoulders.
- Spacing and timing of traffic signals.
- Volumes of trucks, buses, and recreational vehicles.
- Side friction generated by parking, driveways, intersections, and interchanges.
- Operating speed.
- Lateral clearance.
- Sight distance.
- Pedestrian and bicycle traffic
- Horizontal and vertical alignment.

(1) Highway Capacity Values

Table 102.1 is used for planning the highway system at the General Plan level. In most cases it should also be adequate for design level work. If a more complete analysis of capacity is needed, see Section 102.2.

TABLE 102.1**HIGHWAY CAPACITY VALUES****Transportation Corridors**

<u>Lane Configuration</u>	<u>Levels of Service*</u> <u>D</u>
12 lanes divided	205,000
10 lanes divided	175,000
8 lanes divided	145,000
6 lanes divided	115,000
4 lanes divided	65,000

Arterial Highways

<u>Type of Arterial</u>	<u>Lane Configuration</u>	<u>Levels of Service*</u>					
		A	B	C	D	E	F
Principal	8 lanes divided	45,000	52,500	60,000	67,500	75,000	-
Major	6 lanes divided	33,900	39,400	45,000	50,600	56,300	-
Primary	4 lanes divided	22,500	26,300	30,000	33,600	37,500	-
Secondary	4 lanes undivided	15,000	17,500	20,000	22,500	25,000	-
Commuter	2 lanes undivided	7,500	8,800	10,000	11,300	12,500	-

*The volumes shown in the table above are daily two way traffic volumes and assume that the highways are built to their ultimate typical section as shown in the Standard Plans.

(2) Levels of Service

Levels of service are usually defined as A thru F. Beyond level of service E, capacity has been exceeded, and arriving traffic will exceed the ability of a given street to accommodate it. A description of the meaning of the six Levels of Service (LOS) follows:

- (a) Level of Service A indicates no physical restriction on operating speeds.
- (b) Level of Service B indicates stable flow with few restrictions on operating speed.
- (c) Level of Service C indicates stable flow and more restrictions on speed and lane changing due to higher volumes of traffic.
- (d) Level of Service D indicates approaching unstable flow conditions with little freedom to maneuver and which may be tolerable for short periods.
- (e) Level of Service E is the absolute capacity of the road. It is characterized by unstable flow, lower operating speeds than LOS D, and some momentary stoppages.
- (f) Level of Service F indicates forced flow operation (more traffic demand than there is capacity on the road) where the highway acts as a storage area and many stoppages occur.

102.2 References

More detailed data on design capacity are available in the Circulation Plan Component of the Orange County General Plan Transportation Element and in the “Highway Capacity Manual”, published by the Transportation Research Board in 1985.

Topic 103 – Design Designation

103.2 Design Period

Geometric Design of new facilities should normally be based on estimated build-out traffic (approximately 20 years). Any modification must be approved by the Traffic Engineer.

Topic 104 – Control of Access

104.1 General Policy

On Transportation Corridors, direct access from private property to the corridor is prohibited. As development of private property occurs along these corridors the County will acquire all access rights.

On arterial highways, direct access from private property is allowed but it is regulated by the County. As development of private property occurs along these arterials access rights will be acquired by the County except at approved locations.

On local and collector streets, direct access from private property is allowed but it too is regulated by the County. The difference between access to local and collector streets and access to arterial highways is the degree of control. More access is allowed on local and collector streets and access rights are not acquired.

104.2 Access Openings

The number of access openings on highways is a function of the highway’s classification. If a property has a choice of highways for access, then access should be taken from the highway with the lower classification (see Topic 205).

Topic 105 – Pedestrian Facilities

105.1 Sidewalks

The main purpose of sidewalks is to provide pedestrian circulation and to minimize pedestrian and vehicular conflict points. In general sidewalks should be constructed on both sides of all new highways. There are some exceptions to this: a) Sidewalks are not always required in residential areas on the side of the road without residential frontage unless they are needed for continuity. b) In rural areas sidewalks are often not required; refer to Standard Plans 1108 – 1110 and Subdivision Code Section 7-9-277 (Sidewalks and Pedestrian Ways).

- (1) General Criteria for the Location of Sidewalks
(Refer also to Standard Plans 1100 – 1111)

- (a) Required on both sides of all arterial highways per Standard Plans 1101 – 1106.

- (b) Required on both sides of collector streets except as in (d) below per Standard Plan 1107.
- (c) Required adjacent to all residential frontage on local streets except as in (d) below per Standard Plan 1107.
- (d) Subject to approval, standard sidewalks located in the parkway may not be required if other pedestrian walkways are provided which will adequately serve all pedestrian needs.
- (e) Sidewalks should be located so pedestrians do not have to cross a street in the middle of the block to get from one sidewalk to another.

(2) General Design Criteria for Sidewalks
(Refer also to Standard Plan 1205)

- (a) Sidewalks shall have a minimum unobstructed width of 4 feet around obstructions (see Standard Plan 1410).
- (b) Sidewalks immediately adjacent to bus stops shall be full parkway width, except in the following cases where they should be wider:
 - o If a bus bench or shelter exists or proposed and more width is needed to provide a minimum of 4 feet clear area in front of or behind each bench or shelter.
 - o If considerable pedestrian traffic is anticipated at a particular bus stop location such as a park and ride location.
- (c) Sidewalks adjacent to commercial, industrial and/or office facilities should be full parkway width.
- (d) Sidewalks adjacent to a school site should be full parkway width.
- (e) Sidewalks where heavy pedestrian activity is expected, such as adjacent to parks, libraries, etc. should be full parkway width.
- (f) Sidewalks on arterial highways and collector streets should generally be full parkway width. This provides an area to place signing and still maintain a minimum 4-foot clear area in the sidewalk. It also reduces maintenance costs of the parkway area. Subject to approval, sidewalks may be reduced to 5 feet (ADA compliance) with adequate provision for maintenance of remaining parkway and adequate provisions for meandering around obstructions (see Standard Plan 1205).
- (g) Curb ramps meeting ADA requirements shall be constructed at all intersections (see Standard Plan 1115).
- (h) Sidewalks on local residential streets should generally be full parkway width. Subject to approval, sidewalks may be reduced to 4 feet with passing spaces (5 feet x 5 feet) not to exceed every 200 feet (ADA compliance).

- (3) In addition to the sidewalk requirements listed above there may be a need for other sidewalks and/or pedestrian bridges if determined necessary for safe access to schools, recreation areas, or other public areas and determined to be physically and economically feasible.

Topic 108 – Coordination With Other Agencies

108.2 Bus Loading Facilities

All projects that involve design of an arterial highway should be reviewed by Traffic Engineering to determine if bus turn-outs or other transit facilities are needed. This should be done in the preliminary design stages in case additional right of way is needed. Traffic Engineering will coordinate its response with the OCTA in analyzing the proposed project.

CHAPTER 200 – GEOMETRIC DESIGN AND STRUCTURE STANDARDS

Topic 201 – Sight Distance

201.1 General

Sight distance is the continuous length of street/highway ahead of and visible to the driver. The Orange County Highway Design Manual shall be used to determine the design speed of a particular street or highway and the Caltrans Highway Design Manual shall be used to determine the minimum sight distance based on the design speed.

Topic 202 – Superelevation

202.2 Standards for Superelevation

The maximum superelevation rate for streets and highways in Orange County shall be 6% except through intersections where it shall be a maximum of 4%.

Topic 203 – Horizontal Alignment

203.2 Standards for Curvature

(1) Arterial Highways

The following list shows the minimum required curve radii for the various arterial highway classifications assuming normal crossfall (1.7%) with no superelevation. Designers should always try to exceed the minimum radii. If not possible or feasible to meet the minimum radii, then lesser radii (with appropriate superelevation) may be considered on a case-by-case basis. However, in every case the alignment shall meet or exceed the required design speed. The Caltrans Highway Design Manual shall be used to determine the correct superelevation (see Topic 202 for maximum superelevation).

<u>Classification</u>	<u>Design Speed (MPH)</u>	<u>Minimum Radius (feet)</u>
Transportation Corridor	70	3000
Principal Arterial Highway	60	2350
Major Arterial Highway	60	2350
Primary Arterial Highway	55	1800
Secondary Arterial Highway	50	1400
Rural Secondary Highway	50	1400
Commuter Arterial Highway	45	1100

(2) Collector and Local Streets

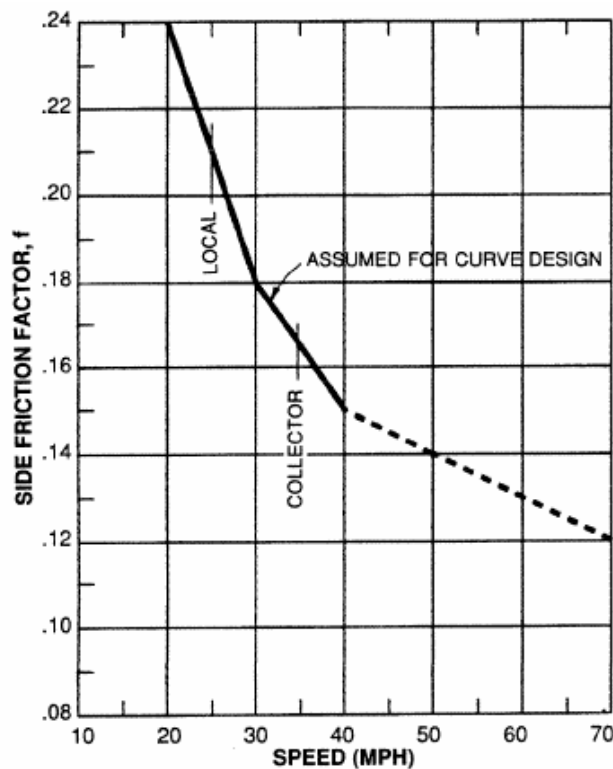
The following list shows the minimum required curve radii for the various street classifications assuming normal crossfall (1.7%) with no superelevation.

<u>Classification</u>	<u>Design Speed (MPH)</u>	<u>Minimum Radius (feet)</u>
Industrial/Commercial Collector Street	35	550
Rural Collector Street	35	550
Residential Collector Street	35	550
Industrial/Commercial Local Street	25	250
Rural Local Street	25	250
Residential Local Street	25	250

Superelevation is normally not practical or feasible on Residential Collector Streets or Residential Local Streets. However, it may be feasible on some Commercial Collector Streets and Commercial Local Streets. In cases where superelevation is used or in cases where it is necessary to determine a radius for a speed other than 25 or 35 MPH, use Figure 203.2 below.

FIGURE 203.2

**SIDE FRICTION FACTORS
FOR LOCAL AND COLLECTOR STREETS**



SPEED	*FRICTION FACTOR
20	0.24
30	0.18
40	0.15
50	0.14
60	0.13
70	0.12

* THESE FACTORS ARE THE VALUES AT WHICH COMFORT ENDS AND DISCOMFORT BEGINS FOR LOCAL AND COLLECTOR STREETS.

$$e + f = \frac{V^2}{15R}$$

e = SUPERELEVATION - FT./FT.

f = FRICTION FACTOR

V = SPEED IN MILES PER HOUR

R = RADIUS IN FEET

NOTE: FOR ARTERIAL HIGHWAYS REFER TO SECTION 203.2 (1).

Topic 204 – Grade

204.3 Standards for Grades

The maximum and minimum grades shall be as follows on County highways:

<u>Classification</u>	<u>Maximum (Percent)</u>	<u>Minimum (Percent)</u>
Transportation Corridors	Caltrans Standards	Caltrans Standards
Arterial Highways	6	1
Local and Collector Streets	10	1

204.4 Vertical Curves

The design of vertical curves in Orange County shall meet or exceed the Caltrans Highway Design Manual criteria. All vertical curves shall be of sufficient length to ensure adequate sight distance. Vertical curves are preferred to a series of grade breaks. If a grade break is used, the maximum allowable grade break along the centerline, without a vertical curve, is 0.5%. If a series of grade breaks is used in lieu of a vertical curve the rate of change of the grade shall be analyzed to insure adequate sight distance. A minimum length of centerline tangent prior to the grade break, before the beginning of a vertical curve or after the end of a vertical curve shall be provided as described below.

- (1) Series Grade Break Criteria for Arterial Highways and Collector Streets (and for Local Streets where $S < L$)

Grade breaks on arterial highways and collector streets shall have a minimum length of centerline tangent as derived from the following relationships:

- (a) $GB = 0.5\%$; $\implies D = K/2$
- (b) $GB > 0.5\%$; $\implies D = GB \times K$
- (c) $D = \text{'fixed value'}$; $\implies GB = D/K$, not to exceed 0.5%

GB = Grade Break (% change in grade)
D = Minimum Tangent Distance (feet)
K = found in Caltrans Fig. 201.4 and 201.5 (use K values
in Figures for $S < L$)
S = Stopping sight distance (feet)
L = Length of vertical curve (feet)

- (2) Series Grade Break Criteria for Local Streets (where $S > L$)

If a series of grade breaks on local streets are used, the centerline tangent length (where $S > L$) does not have to be based on the relationships in (1) above, but it does have to meet or exceed the minimum sight distance standards per the Caltrans Highway Design Manual.

Vertical profiles of all through travel lanes at warped intersections shall meet or exceed Caltrans minimum sight distance requirements.

Topic 205 – Road Connections and Driveways

205.1 Access Openings on Transportation Corridors

(Access Openings on Expressways)

Access to Transportation Corridors is allowed only at approved interchanges.

205.2 Access Openings on Arterial Highways

(Private Road Connections)

Access openings on arterial highways are allowed only at locations approved by the County (see Section 104.1). Efforts should always be made on arterial highways to limit the access in order to improve the traffic carrying capacity and to reduce the number of conflict points. Traffic Engineering should review all access locations.

(1) General Criteria

- (a) Access points should be selected at locations with best possible sight distance and all access points shall provide adequate sight distance per Topic 405 of this Design Manual and Standard Plan 1117.
- (b) T-intersections are preferable to 4-way intersections, except as in (2) below.
- (c) When access to more than one street or highway is possible, access to lower classification street/highway is preferred. The impact of restricting access (partially or fully) on the higher classification street/highway should be considered.

(2) Signalized Access

- (a) When it is determined that an access location will need a signal, the access requiring the signal shall be located to provide a good signal progression with other existing and proposed signals along the same arterial.
- (b) When a signal is required, an effort should be made to locate a street/access on the opposite side of the arterial to also utilize this signal.

(3) Distance Between Access Points (See Figure 205.2)

- (a) Adjacent intersections/access points along the same arterial, but on opposite sides and having conflicting left turn ingress movements, shall have sufficient distance, centerline to centerline, to allow left turn pockets for both streets if left turn lanes are permitted or required (see also (3) (c) below). To determine turn pocket lengths, see Topic 405 and to determine median flare transition lengths, see Standard Plan 141-1-OC.
- (b) Adjacent intersections/access points along the same arterial, but on opposite sides and not having conflicting left turn ingress movements, shall have sufficient distance, centerline to centerline, to allow protected left turn out pockets on the arterial highway for both access points if these pockets are permitted or required (see also (3) (c) below). If protected left turn out pockets are not required then the minimum offset distance, centerline to centerline, should be 100 feet.
- (c) If a continuous raised median is existing or proposed on a Principal, Major or Primary Arterial Highway with no openings allowed for left turn movements, the offset distances specified in (3) (a) and (3) (b) above are not critical.

- (d) Adjacent intersections along the same highway, and on the same side of the highway, shall have sufficient distance, centerline to centerline, to avoid maneuvering conflicts between intersections (see Topic 405 for pocket lengths). The minimum distance between intersections should be 150 feet.
 - (e) Access shall be located far enough from any adjacent local or arterial intersection with controlled right of way (e.g. signal control or stop control) so the access will not be blocked by cars waiting at the intersection during periods of congestion. On an arterial this distance should be a minimum of 300 feet, when practical.
- (4) Limiting Access – Methods
- (a) In order to limit the number of access points on an arterial, internal reciprocal access easements between adjoining properties are preferred to reduce the total number of access points.
 - (b) When it is necessary to restrict certain access movements, raised medians should be considered on Principal, Major and Primary Arterials (see Standard Plans 1100, 1101 and 1103 for median policy, 1114 for “Landscaped Median Typical Section” and 1118 for “Left Turn In only Median Opening”). Consideration should be given to the adverse impacts imposed by access restrictions.

205.3 Access Openings on Local and Collector Streets (Urban Driveways)

Access openings on local streets are generally not restricted (see Section 104.2). Access is more restricted on collector streets than local streets (see Topic 101).

(1) General Criteria

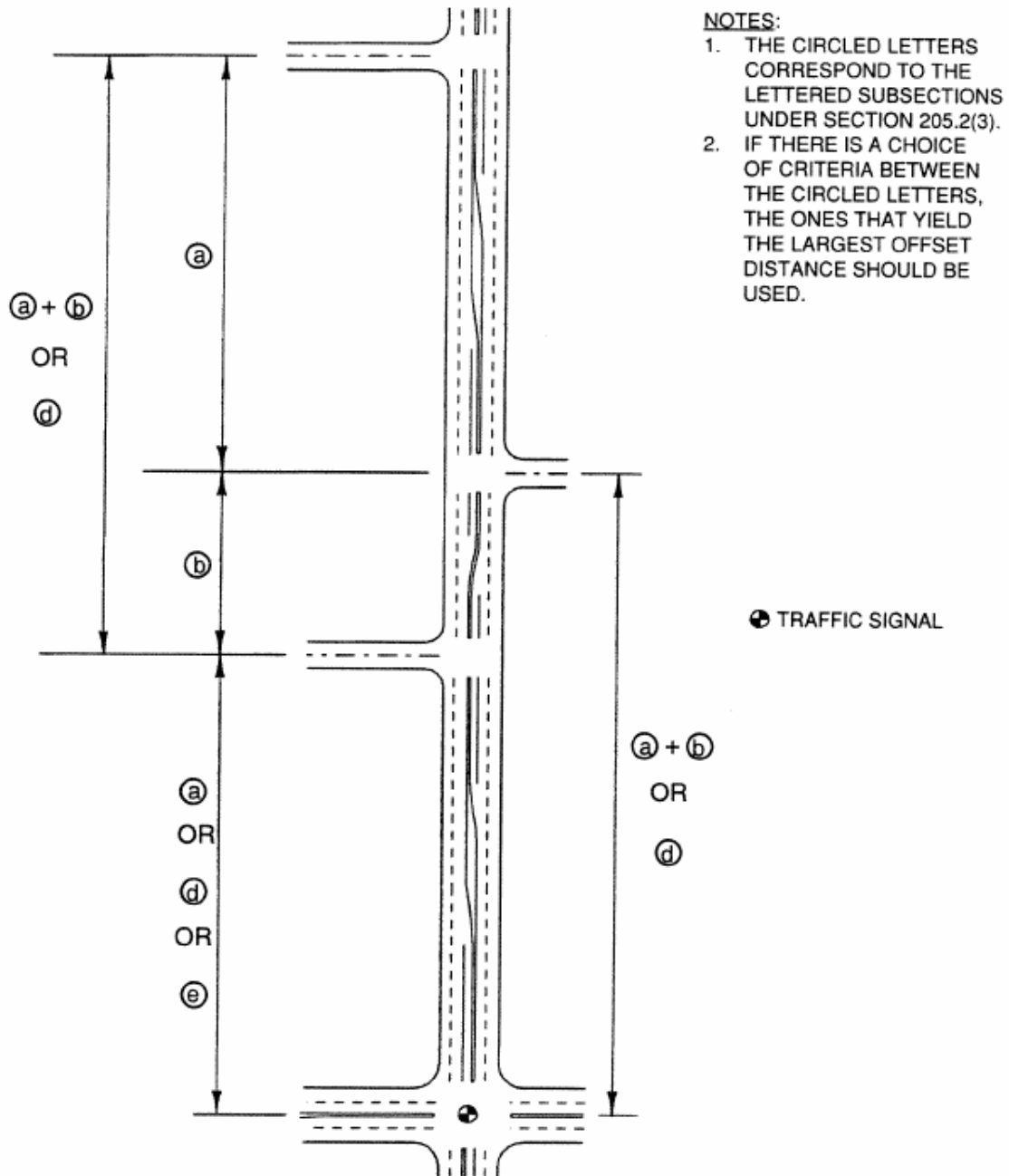
- (a) Access points should be selected at locations with best possible sight distance and all access points shall provide adequate sight distance per Topic 405 of this Design Manual and Standard Plan 1117.
- (b) T-intersections are preferable to 4-way intersections.
- (c) Collector streets shall not have any direct residential frontage.

(2) Distance Between Access Points

- (a) Adjacent intersections along the same street but on opposite sides and having conflicting left turn ingress movements shall have sufficient distance, centerline to centerline, to allow left turn pockets for both streets if left turn lanes are necessary.
- (b) Adjacent intersections along the same street but on opposite sides and not having conflicting left turn ingress movements should have a distance, centerline to centerline, of 150 feet.

FIGURE 205.2

ACCESS OPENINGS ON ARTERIAL HIGHWAYS



205.4 Design of Access Openings

(Driveways on Frontage Roads and in Rural Areas)

(1) Arterial Highway

Access openings with curb-return entries are required if the expected daily traffic volumes exceed 1000 vehicles. If less than 1000 vehicles, then a wide flared driveway entrance is acceptable. See Standard Plan 1210.

(2) Local and Collector Streets

Generally access openings for local and collector streets should be designed per Standard Plan 101-0-OC or Standard Plan 1210.

Topic 208 – Bridges and Grade Separation Structures

208.1 Bridge Width

Minimum bridge widths of various highways in Orange County are designated below:

<u>Highway Classification</u>	<u>Bridge Width (feet)</u>	<u>Reference</u>
Transportation Corridor	Caltrans	Caltrans
Principal Arterial Highway	128	SP1100
Major Arterial Highway	104	SP1102
Primary Arterial Highway	86	SP1104
Secondary Arterial Highway	76	SP1106

208.2 Cross Slope

Refer to Section 208.1 and the corresponding Standard Plans for details

208.3 Median

Refer to Section 208.1 and the corresponding Standard Plans for details.

208.4 Bridge Sidewalks

Refer to Section 208.1 and the corresponding Standard Plans for details.

Topic 209 – Curbs and Gutters

209.1 General Policy

Curbs and gutters shall be used on all County streets and highways except as listed below:

- (1) Rural Standards (See Standard Plans 1108-1110).
- (2) Interim construction.

Even with the exceptions listed above, curbs (and possibly gutters) may be necessary for drainage.

209.2 Types and Uses

Standard Plan 104-0-OC lists the standard types of curbs used in Orange County and Standard Plan 1201 shows Concrete Rolled Curb.

To determine the appropriate curb type and use refer to the following:

<u>Use</u>	<u>Curb Type</u>	<u>Reference</u>
Transportation Corridors	Caltrans	Caltrans
Arterial Highways	A2-200(8)	SP 1100, 1101 1103 & 1105
Arterial Highway Medians	A1-200(8)	SP 1114
Commuter Arterial Highways	A2-150(6)	SP 1107
Industrial/Commercial Collector Streets	A2-200(8)	SP 1107
Residential Collector, Industrial/Commercial and Residential Local Streets	A2-150(6)	SP 1107
Private Streets	A2-150(6) or Rolled Curb*	SP 1107, 1201*

* Concrete Rolled Curb may be used on private streets subject to approval.

209.3 Positions of Curbs

The positioning of curbs shall be consistent with the Standard Plans (see Section 209.2).

Topic 210 – Earth Retaining Systems

210.1 Types and Uses

For retaining walls up to 6 feet high, see Standard Plans 616-1-OC and 618-1-OC.

CHAPTER 300 – GEOMETRIC CROSS SECTION

Topic 301 – Pavement Standards

301.1 Pavement Width

Standard pavement and right of way widths of the various highways in Orange County are as follows:

<u>Classification</u>	<u>Pavement Width* (ft)</u>	<u>R/W Width (ft)</u>	<u>Reference</u>
Transportation Corridor	Caltrans Standards	Caltrans Standards	Caltrans
Principal Arterial Highway	126	144	SP 1100
Major Arterial Highway	102	120	SP 1101
Primary Arterial Highway	84	100	SP 1103
Secondary Arterial Highway **	64	80	SP 1105
Rural Secondary Highway **	64	80	SP 1108
Commuter Arterial Highway	40	56	SP 1107
Industrial/Commercial Collector Street	64	80	SP 1107
Rural Collector Street	40	60	SP 1109
Residential Collector Street	40	56	SP 1107
Industrial/Commercial Local Street	44	60	SP 1107
Rural Local Street	36	50	SP 1110
Residential Local Street	Var.	Var.	SP 1107

* Pavement widths represent the width measured from outside curb face to outside curb face. In the case of Major and Primary Arterial Highways, the width includes a fourteen foot median. In the case of rural streets/highways, the width is measured from the edge of pavement to the edge of pavement.

** Add ten feet to pavement and right of way width if a left turn pocket is required (see Standard Plan 1105 and Figure 405.2).

301.2 Crown Slopes

Crown slopes (crossfall) on Transportation Corridors shall comply with the Caltrans Highway Design Manual.

Crown slopes (crossfall) on streets/highways shall be 1.7%, except for sections of streets/highways with superelevation.

Topic 302 – Shoulder Standards

A shoulder as used in the Orange County Highway Design Manual is the portion of roadway contiguous with the traveled way for accommodation of stopped vehicles, for emergency use, for bike trails, etc.

302.1 Width

Shoulder width on Transportation Corridors shall comply with the Caltrans Highway Design Manual.

A shoulder on streets/highways with curb and gutter is the paved area between the edge of the outside travel lane and the curb face and is commonly referred to as the parking lane. The shoulder on streets/highways without curb and gutter is the area adjacent to the outside travel lane. For the standard widths refer to Topic 301 and the corresponding Standard Plans for more detail.

302.2 Slopes

Shoulder slopes on Transportation Corridors shall comply with the Caltrans Highway Design Manual.

Shoulder slopes on streets/highways with curb and gutter shall be the same as the adjacent travel lanes (see Section 301.2 and 302.1).

Shoulder slopes on streets/highways without curb and gutter shall be the same as the adjacent travel lanes except in the case of rural streets/highways where the shoulder slope shall be 5% (see Standard Plans 1108, 1109 and 1110).

302.3 Structural Section

Shoulder structural sections on Transportation Corridors shall comply with the Caltrans Highway Design Manual.

The paved portion of the shoulder shall have a structural section the same as the adjacent travel lanes.

Topic 303 – A. C. Dikes (Curbs) and Side Gutters

303.1 Asphalt Concrete Dikes (Curbs)

Asphalt Concrete Dikes (Curbs) on Transportation Corridors shall comply with the Caltrans Highway Design Manual.

Asphalt Concrete Dikes (Curbs) on Rural Secondary Arterial Highways shall comply with Standard Plan 1108.

Asphalt Concrete Dikes (Curbs) on Rural Local Streets shall comply with Standard Plans 1109 and 1110.

303.2 Longitudinal Drainage (Side Gutters)

Longitudinal drainage facilities on Transportation Corridors shall comply with the Caltrans Highway Design Manual.

Longitudinal drainage facilities on Rural Secondary Arterial Highways shall comply with Standard Plan 1108.

Longitudinal drainage facilities on Rural Local Streets shall comply with Standard Plans 1109 and 1110.

Topic 304 – Side Slopes

Side slope criteria have not been defined for Transportation Corridors. Consideration should be given to both local and State criteria when designing these slopes.

304.1 Side Slope Standards

The design of side slopes shall consider the specific recommendations of the Project Materials Report. Cut and fill slopes should normally be no steeper than 2:1 for streets/highways and 1 ½:1 for cut slopes with less than five feet in vertical height. In special circumstances where no evidence of previous instability exists and when recommended in the geotechnical report and approved by the County, cut slopes may be constructed steeper than 2:1. Recommendations in the geotechnical report for cut slopes to be steeper than 2:1 shall be accompanied by slope stability analysis considering both gross and surficial stability of the slope. Bedding planes flatter than 12 degrees from the horizontal need not normally be considered in a pseudostatic analysis.

Fill slopes shall not be constructed on natural slopes steeper than 2:1 or where the fill slope toes out within 13 feet horizontally of the top of existing or planned cut slopes, except in the case of slopes of minor height when approved by the County.

The minimum standards for slope stability for both cut and fill slopes are as follows: The minimum factor of safety for shear strength is 1.5 for static loads and 1.1 for pseudostatic (seismic) loads. The factor of safety for strength is defined as the ratio of the shearing resistance force to the actual driving force acting along the potential failure surface.

304.2 Clearance from Slope to Right of Way Line

Clearance distance from slope to right of way line on Transportation Corridors shall comply with the Caltrans Highway Design Manual.

Clearance distance from the right of way line to the hinge point of a cut or fill slope on an arterial highway shall be a minimum of two feet.

Clearance distance from the slope to right of way line on local and collector streets shall comply with Standard Plan 1107 and for Rural Street/highways, Standard Plans 1109-1110.

304.3 Slope Benches and Cut Widening

Slope benches at least 6 feet in width shall be established at not more than 30 feet vertical intervals on all cut and fill slopes to control surface drainage and debris, except where only one (1) terrace is required, it shall be at mid-height. For cut or fill slopes greater than 60 feet and up to 120 feet in vertical height, one bench at approximately mid-height shall be 12 feet in width.

Bench widths and spacing for cut and fill slopes greater than 120 feet in vertical height shall be designed by a Civil Engineer and approved by the County. Suitable access shall be provided to permit proper cleaning and maintenance.

Swales or ditches on 6 feet and 12 feet wide terraces shall have a minimum gradient of 6 percent and must be paved with reinforced concrete, or approved equal, not less than 3 inches in thickness. They shall have a minimum depth at the deepest point of 18 inches and a minimum paved width of 5 feet.

A single run of swale or ditch shall not collect runoff from a tributary area exceeding 13,500 square feet (projected) without discharging into a down drain.

Topic 305 – Median Standard

305.1 Width of Median

Median width on Transportation Corridors shall comply with the Caltrans Highway Design Manual.

Principal, Major, and Primary Arterial Highways shall normally have a median width of 14 feet with the same structural section as the adjacent lanes. If additional left turn lane(s) are needed, a corresponding increase in the median width is also necessary. A striped median is preferred and shall be used except as noted below (see also Standard Plans 1100, 1101 and 1103). Median width on bridges shall be a minimum of four feet.

- (1) The curbed median alternate may be acceptable under any of the following conditions (subject to approval):
 - (a) When it fills a gap on a stretch of roadway already built in adjacent areas with curbed median or when it provides a logical extension of an existing or proposed median.
 - (b) When it is a short section near an intersection for delineation and/or placing traffic control devices.
 - (c) When necessary to control turn movements and access on heavily traveled arterials with commercial frontage and multiple driveways.
 - (d) When it is to be landscaped.
 - (e) When it is required by a Planning Commission or Board of Supervisor action.
- (2) If the curbed alternate is approved, the following applies:
 - (a) Pave with 2 inches of asphalt concrete (AC) over approved soil sterilant unless landscaping or other paving is approved.
 - (b) If landscaping is approved:
 - See Standard Plan 1114 for Landscaped Median Detail.
 - Landscaped medians shall not be maintained with road funds; a method of funding maintenance shall be established prior to approval of street improvement plans.

Topic 306 – Right of Way

306.1 General Standards

Right of way widths on Transportation Corridors shall comply with the Caltrans Highway Design Manual.

Right of way widths on arterial highways shall comply with the standard plans (see Section 301.1). Right of way on local and collector streets shall comply with Standard Plan 1107 (see Section 301.1). In addition to the above right of way requirements, other right of way may be required as follows:

- (a) Check the Master Plan of Scenic Highways and the Scenic Highway Element for additional right of way requirements for a particular arterial highway.
- (b) Check the Bikeways Plan for additional right of way requirements as a result of master planned bikeways on a particular highway.
- (c) Check the Master Plan of Riding and Hiking Trails for additional right of way requirements as a result of master plan riding and hiking trails on a particular highway.
- (d) When an arterial highway changes classification at an intersection the typical section of the higher classification shall be carried through the intersection (usually for a minimum distance of 300 feet plus necessary transitions). It is advisable to review design with Traffic Engineering.
- (e) Corner cut-offs at all curb return accesses require additional right of way (see Standard Plan 1111).
- (f) Bus stops require additional right of way if turnouts are required (see Topic 108 and Standard Plan 1120).
- (g) Additional turning lanes at intersections require additional right of way (check with Traffic Engineering for requirements).
- (h) When a private street intersects a public street the right of way on the public street shall be extended to include the full curb returns of the private street to maintain pedestrian travel within the public right of way. At signalized intersections, easements are needed on the private street for traffic signal loop detectors or other appurtenant traffic signal equipment.

If right of way acquisition is necessary on a street/highway design project it should be requested at the earliest opportunity since it may become the critical path for completing the project. If right of way is necessary the RDMD “Right-Of-Way Acquisition Procedure” manual should be consulted for the correct procedure.

In addition to right of way needed to construct a street or highway it is often necessary to acquire other easement or rights of entry on adjacent properties to facilitate the construction of the street or highway. These include slope easement, temporary construction easement, drainage easement, soundwall easement, right of entry and permit to enter. The RDMD “Right-Of-Way Acquisition Procedure” manual should be consulted to determine if these easements are needed and, if so, how to acquire them.

CHAPTER 400 – INTERSECTIONS AT GRADE

Topic 403 – Principles of Channelization

403.3 Angle of Intersection

Streets/highways shall intersect at right angles wherever possible and shall not intersect at greater than a 15 degree skew to a right angle.

Topic 405 – Intersection Design Standards

405.1 Sight Distance

Refer to Standard Plan 1117 for Intersection Sight Distance (Corner Sight Distance).

405.2 Left-turn Channelization (See Figure 405.2)

(2) Design Elements

- (a) Lane Width – A 10-foot turn lane width is standard in Orange County. On Major and Primary Arterial Highways, this 10-foot width is contained within the normal median width of 14 feet. The additional 4 feet is either striped or raised depending on the type of median.
- (b) Approach Taper – For a street/highway without a median, the approach taper provides space for a left-turn lane by moving traffic laterally to the right. The approach taper is unnecessary where a median is available for the full width of the left-turn lane. Length of the approach taper is given by the following formulas:
 - For 40 mph or less: Approach Taper Length = $(V \times V \times W)/60$
 - For greater than 40 mph: Approach Taper Length = $V \times W$

V = Design Speed (MPH)

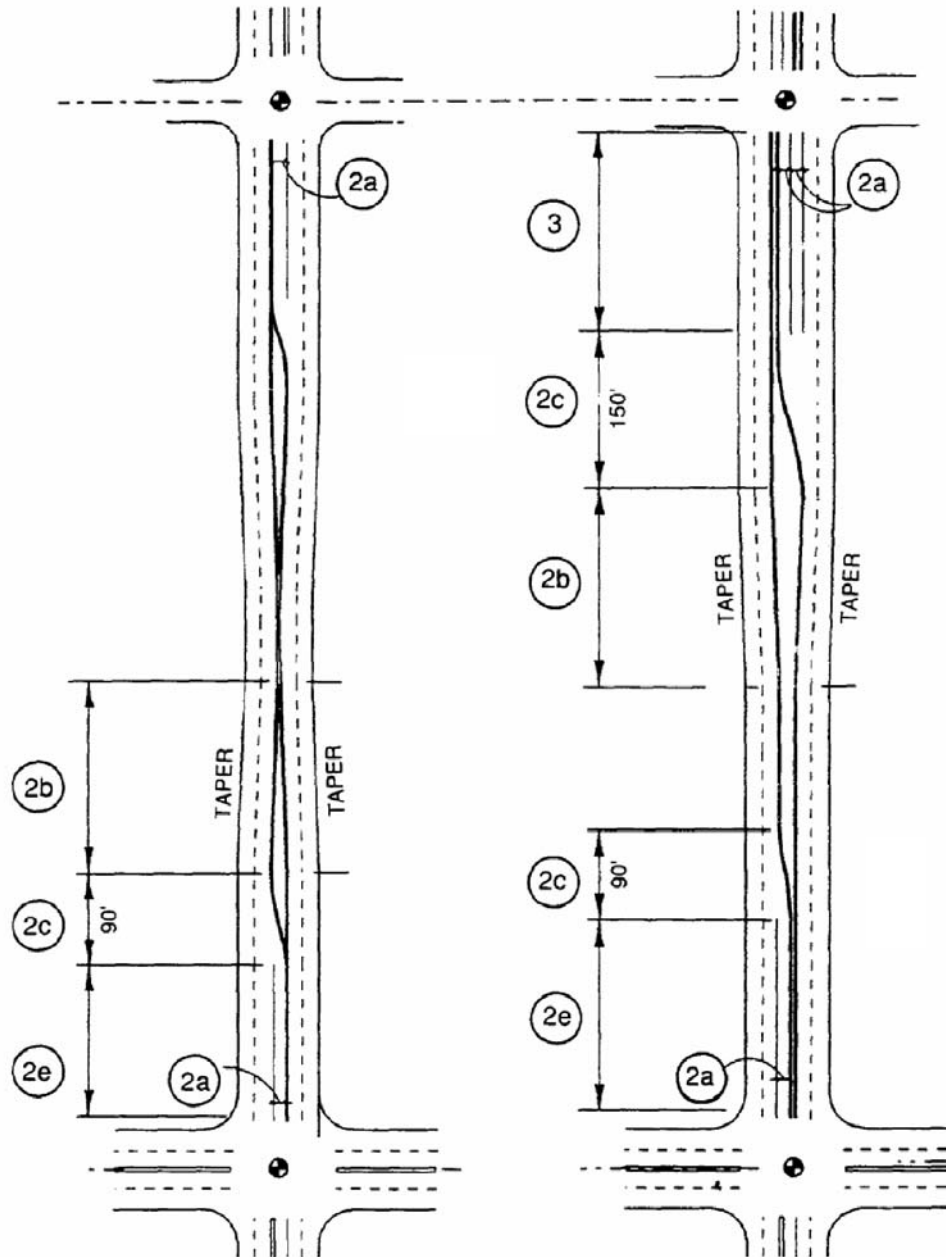
W = Width of transition (feet)

- (c) Bay Taper or Median Taper – A reversing curve along the left edge of the traveled way directs traffic into the left-turn lane. The length of this transition is 90 feet for a single left turn pocket and 150 feet for a dual left turn pocket. Refer to Standard Plan 140-2-OC for median taper design.
- (d) See Caltrans Highway Design Manual.
- (e) Storage Length – Storage length should be one foot for each car desiring to turn left during peak hour (minimum length = 100 feet). If left turn movements are unknown or cannot be accurately predicted, the following guidelines (see Table 405.2) may be used.

(3) Dual Left-turn Lanes

If the left turn demand requires a storage length of more than 300 feet (see Section 405.2 (2) (d)) dual left-turn lanes should be used (providing adequate right-of-way is available). When dual left turns are used, the length of each left-turn lane should equal half the total storage length required.

**FIGURE 405.2
LEFT-TURN CHANNELIZATION**



⊕ - TRAFFIC SIGNAL

NOTES:

1. THE CIRCLED NUMBERS CORRESPOND TO THE SUBSECTIONS UNDER SECTION 405.2.
2. SEE ALSO TOPIC 301.1.

TABLE 405.2**LEFT-TURN POCKET STORAGE LENGTH (FEET)**

TURNING FROM		TURNING TO			
		PRINCIPAL/ MAJOR	PRIMARY	SECONDARY	COMMUTER COLLECTOR LOCAL
PRINCIPAL/ MAJOR	60,000 ADT	350*	325*	275	225
	55,000 ADT	325*	300	250	200
	50,000 ADT	300	275	225	175
	45,000 ADT	275	250	200	150
	40,000 ADT	250	225	175	150
PRIMARY		250	250	200	150
SECONDARY		200	200	200	150

* See Topic 405.2(3)

NOTE: STORAGE LENGTH SHOULD BE INCREASED IF THERE IS KNOWN TO BE GREATER THAN AVERAGE TRUCK TRAFFIC.

405.5 Median Openings (See also Topic 305)

(3) Length of Median Opening

To determine length of median opening, determine the width of the cross street/highway and refer to Standard Plans 1118 & 1119.

405.6 Access Control

Refer to Topic 205.

405.8 Sidewalk Returns and Curb Radius (City Street Returns and Corner Radii)

For sidewalk returns and curb radii, refer to Standard Plan 1111.

CHAPTER 500 – TRAFFIC INTERCHANGES

Topic 501 – General

The Caltrans Highway Design Manual should be consulted for the design of Transportation Corridor interchanges or if other interchanges need to be designed.

CHAPTER 600 – DESIGN OF THE PAVEMENT STRUCTURAL SECTION

Topic 601 – General Consideration in Design of the Pavement Structural Section

601.1 Introduction

The California R-Value Method as outlined in Chapter 600 of the Caltrans Highway Design Manual is used with certain modifications for determining the pavement structural section. Orange County uses the following formula to calculate the Gravel Equivalent (GE) for all highways and streets.

$$GE = 0.0032 (TI) (100-R)$$

GE =Gravel Equivalent. The thickness of “Gravel” in feet required to support the expected traffic loads on the underlying material whose R-Value is used in the computation. The GE represents a base value to which all other pavement materials can be related (see Table 605.1A). By utilizing the relationship between these pavement materials and the GE, different combinations of pavement materials can be reviewed to determine the most desirable structural section.

TI = Traffic Index. A measure of the traffic loading on the street or highway. Precisely, it is a measure of the 18-kip equivalent single axle loads (ESAL) expected on the street or highway over the design life period.

R = R-Value or Resistance Value. A measure of the resistance value or supporting strength of the underlying material.

Topic 602 – Structural Section Design Responsibility

602.2 Design Responsibilities

The Orange County Materials Engineer is responsible for the design of all structural sections for unincorporated Orange County streets and highways. The County of Orange uses Asphalt Concrete Pavement (ACP) for the design of these structural sections in almost every case; however, in those few instances when we use Portland Cement Concrete Pavement (PCCP), we refer to the Caltrans Highway Design Manual.

Topic 603 – Traffic Data for Structural Section Design

603.1 Introduction

Traffic data for a particular street or highway may be obtained from RDMD/Traffic Engineering.

603.2 Design Period

A twenty year design period is used to calculate the pavement structural section for all arterial highways and for collector streets. A ten-year design period is used to calculate the pavement structural section for most local streets. See 603.4 Traffic Index.

603.3 Truck Traffic Projection

Truck traffic projections for a particular street or highway may be obtained from RDMD/Traffic Engineering.

603.4 Traffic Index

The Traffic Index (TI) for a particular street or highway may be obtained from RDMD/Planning and Development Services. When the calculated TI for a local street using a ten year design period exceeds 5.0, a design period of twenty years should be used to calculate the TI. For additional information on calculating a TI consult the current edition of the 'County Method of Calculating Traffic Indices' (available from RDMD/PDS).

Topic 604 – Basement Soils

604.1 Introduction

The R-Value of the basement soils is determined in accordance with California Test Method No. 301. The design R-Value by stabilometer is taken at 300 psi exudation pressure. When excessive moisture conditions are encountered in the basement soil, the designer should propose methods to mitigate these conditions. R-Values are determined from soils in the upper three feet of subgrade. Sampling locations are normally placed at 500 – foot intervals.

Topic 605 – Subbases and Bases

605.1 Introduction

The characteristics of various subbases and bases that may be used in structural sections (i.e., the capacities of these materials to resist the forces imposed by traffic, etc.) are discussed in the Caltrans Highway Design Manual. The specifications of these various subbases and bases are found in the Standard Specifications for Public Works Construction (Greenbook) and RDMD Standard Plan 1805. Generally, these subbases and bases, in addition to the asphalt concrete, may be used in various combinations to design the most desirable structural section for the specific project. For ease of discussion, subbases, bases and asphalt concrete will be referred to collectively as pavement material.

After the GE is calculated (see Section 601.1), the following table (Table 605.1A) can be used to determine the relationship of the various pavement materials with the GE. These relationships allow the designer to substitute various pavement materials in various thicknesses to achieve alternative sections that produce the same total GE. Then, by looking at the economics of the various alternatives or other factors, the final structural section can be determined. Notwithstanding the structural sections determined from the GE and the following table, there are minimum required thicknesses (see Table 605.1B).

TABLE 605.1A

GRAVEL EQUIVALENT FACTOR (GE_f) OF PAVEMENT MATERIALS

<u>Material</u>	<u>Gravel Equivalent Factor</u>
Asphalt Concrete	See Figures 605.1A and 605.1B
Aggregate Base	1.0
Crushed Misc. Material	1.0 (if Aggregate Base specs. are met)
Aggregate Subbase	0.8

<u>Treated Material</u>	<u>Gravel Equivalent Factor</u>
Cement Treated Base (Class A)	1.7
Cement Treated Pulverized Material	1.5 (typ.)
Cement-Treated Native Soil	1.4 (typ.)
Lime-Treated Pulverized Material	1.3 (typ.)
Lime-Treated Subbase	1.2 (typ.)

GE_f for treated materials = [7-day compressive strength (psi) / 1000 psi] + 0.9

TABLE 605.1B

MINIMUM THICKNESSES AND MINIMUM STRUCTURAL SECTIONS

Minimum thicknesses are used when the combination of R-value and TI results in a thinner structural section than shown in the table.

<u>Traffic Index</u>	<u>Composite Sections</u>		<u>Full-depth Sections</u>
	<u>Min. AC Component (ft)</u>	<u>Min. AC/AB (ft/ft)</u>	<u>Min. AC (ft)</u>
≤ 6.0	0.30	0.30/0.50	0.40
6.1-7.0	0.30	0.30/0.50	0.50
7.1-8.0	0.35	0.35/0.50	0.60
8.1-9.0	0.40	0.40/0.60	0.70
9.1-10.0	0.45	0.45/0.70	0.80
10.1-11.0	0.50	0.50/0.80	0.90

Note: AC/AB ratio should be greater than or equal to 0.25 (AC = Asphalt Concrete, AB = Aggregate Base)

EXAMPLE PROBLEM

Calculate unit cost of pavement components for estimating purposes.

The unit prices used below are for purposes of this example only. Actual prices may vary depending on availability of materials, quantity of materials needed, etc.

Abbreviations:

AC – Asphalt Concrete (also ARHM – Asphalt Rubber Hot Mix and TMAC – Tire Modified Asphalt Concrete)

AB – Aggregate Base

RE – Roadway Excavation or Unclassified Excavation

lb – Pounds

sf – Square Feet

cf – Cubic Feet

sy – Square Yards

cy – Cubic Yards

Note: All calculations are based on 95% relative compaction. Unit weight for 95% relative compaction of AC, ARHM, and TMAC is 140.6 lb/cf. Unit weight for 95% relative compaction of AB is 128.3 lb/cf.

Assumed Unit Prices:

AC: \$44.00/ton x 1 ton/2,000lb x 140.6lb/cf = \$3.09/cf

AC (ARHM): \$50.00/ton x 1 ton/2,000lb x 140.6lb/cf = \$3.52/cf

AC (TMAC): \$44.00/ton x 1 ton/2,000lb x 140.6lb/cf = \$3.09/cf

AB: \$15.00/ton x 1 ton/2,000lb x 128.3lb/cf = \$0.96/cf

RE: \$19.00/cy x 1 cy/27cf = \$0.70/cf

1. Assume design R-Value = 10 and Traffic Index = 9.1
 $GE = 0.0032 (TI) (100-R) = 0.0032 (9.1) (100-10) = 2.62'$
2. Calculate various equivalent sections:
 - a.) Full-depth AC: 1.10' AC (from Figure 605.1B)
 - b.) AC/AB:

AC:	0.45' AC min. (from Table 605.1B)
	GE=0.84 (from Fig. 605.1A)
AB:	GE=2.62 – 0.84 = 1.78
	1.78/1.0 (GE _f for AB = 1.78) (from Table 605.1A)
	Round to 1.80' AB
	Check AC/AB ratio: 0.45/1.80 = 0.250
	Structural Section: 0.45' AC/1.80' AB
3. Calculate cost of equivalent sections:

a.) AC: 1.10' x \$3.09/cf	= \$3.40/sf
RE: 1.10' x \$0.70/cf	= <u>\$0.77/sf</u>
Total	= <u>\$4.17/sf</u>
b.) AC: 0.45' x \$3.09/cf	= \$1.39/sf
AB: 1.80' x \$0.96/cf	= \$1.73/sf
RE: 2.25' x \$0.70/cf	= <u>\$1.58/sf</u>
Total	= <u>\$4.70/sf</u>

Full-depth AC structural sections can be more expensive for materials costs than composite structural sections but may be more economical or feasible when considering:

- cost of encountering shallow utilities
- reduced time of construction
- less inconvenience to public

Other equivalent sections such as cement-treated base and cement-treated pulverized existing pavement have proven to be the most economical section for certain situations; however, these alternatives require preliminary testing and field control testing by experienced personnel.

Some other considerations in pavement design include:

- Controlling shrinkage cracking of cement-treatment.
- Practical minimum and maximum thickness for AB, CTB (Cement Treated Base), etc.
- Pavement widenings – is adjacent section rigid?
- AC mix design – gradation and asphalt content

Generally, the engineer using this manual for estimating purposes or to design a small area of pavement should use only the AC/AB or full-depth AC section and reference the Orange County RDMD Standard Plans.

Topic 608 – Asphalt Concrete Pavement Structural Section Design

608.2 Asphalt Concrete Pavement Material Types.

Refer to Topic 605 and Table 605.1A for determining the Gravel Equivalence of Asphalt Concrete Pavement (ACP).

FIGURE 605.1A

GRAVEL EQUIVALENT CHART FOR COMPOSITE ASPHALT
CONCRETE PAVEMENT SECTION

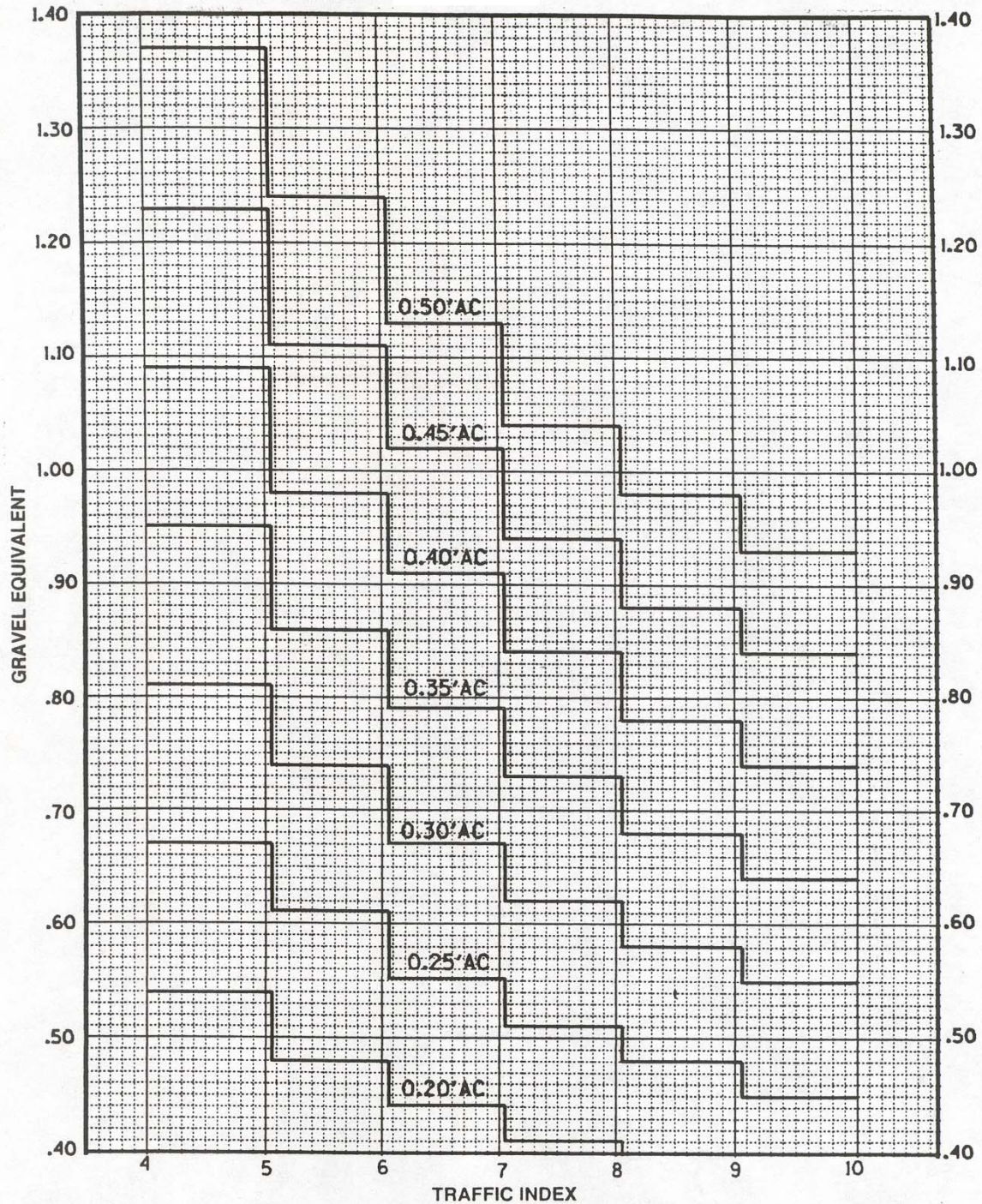
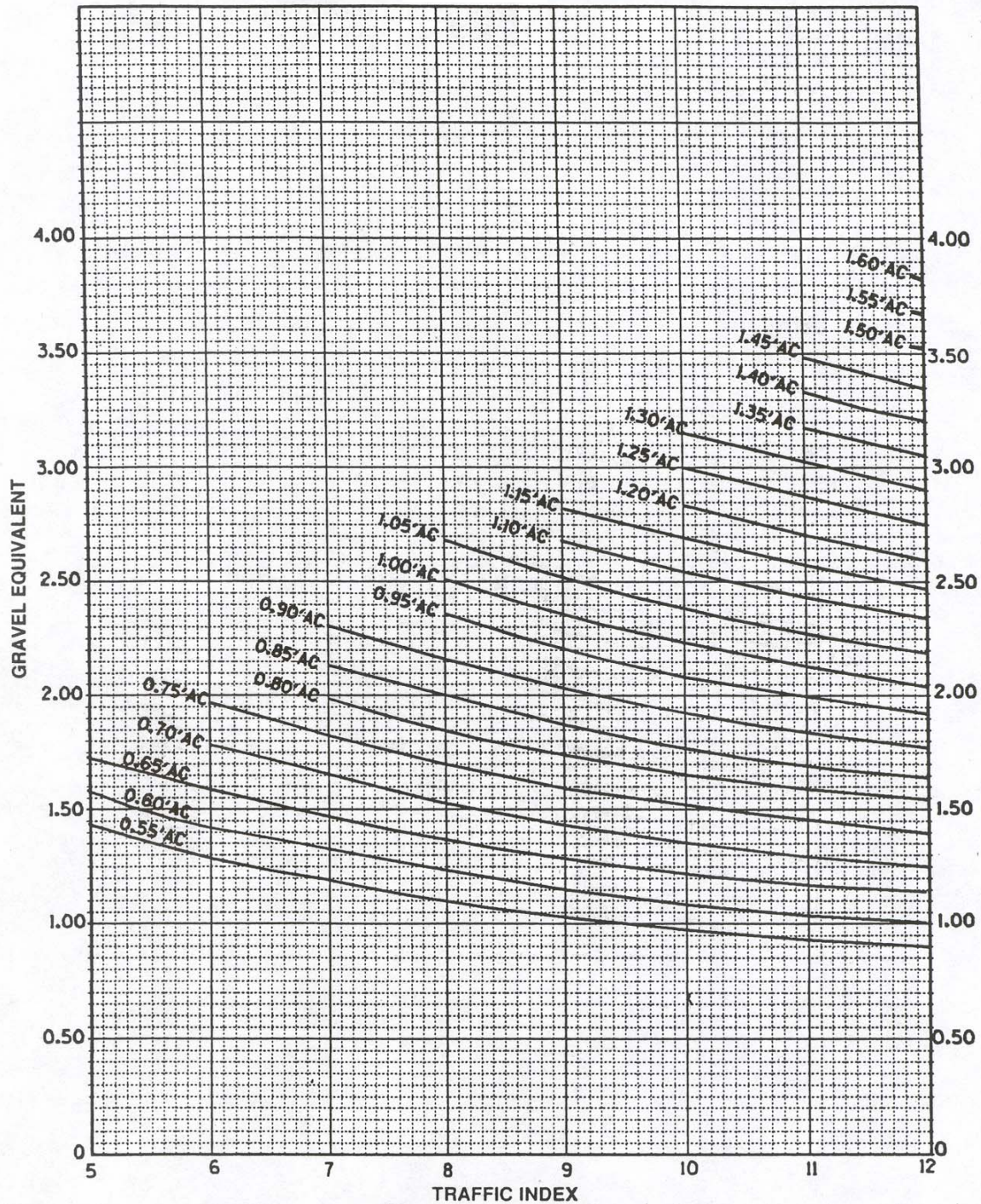


FIGURE 605.1B

GRAVEL EQUIVALENT CHART FOR FULL-DEPTH ASPHALT
CONCRETE PAVEMENT SECTION



Topic 611 – Pavement Structural Section Rehabilitation

611.1 Introduction

The Materials Laboratory is continually researching and evaluating new rehabilitation materials, methods, and strategies for pavement maintenance and rehabilitation.

The County's review process involves investigation by the Materials Laboratory Geotechnical Investigation/Pavement Design Section and the final approval of the Materials Engineer. The investigations use historical data, non-destructive testing and sampling to produce alternatives for preventative and corrective maintenance and rehabilitation of existing pavements. The final decision for a recommendation for maintenance or repair draws on the past success of a product or technique and its application to the current need of a pavement.

611.2 Pavement Management System

- (1) General. The County contracted a consultant to develop a customized Pavement Management System (PMS) in the early 1980's. This system emphasizes an engineered approach to pavement rehabilitation and a structured systems approach for the system-wide management of existing pavements.

The Orange County Pavement Management System (OCPMS) is the primary tool used in determining where repairs are needed and how available funds will be apportioned within the unincorporated county. It involves the following step-by-step processes.

- Inventorying pavement conditions.
- Analyzing the extent and severity of pavement distress.
- Developing a full-cycle (7-year) plan for annual maintenance. This includes candidate lists for each year based upon last maintenance, current priority and similar proximity.
- Identifying potential cost effective repair strategies and potential alternatives for candidate projects.

The OCPMS is managed by the Operations and Maintenance Engineering Section and is used to assist in programming and scheduling improvements according to the 7-year cycle. The PMS reports are used by the project manager and the Materials Engineer as a starting point in the determination of the appropriate repair strategy for rehabilitation and Capital Improvement Projects, (CIP) projects.

- (2) PMS Reports. The OCPMS uses data gathered every two years in a countywide pavement condition survey. This survey of the physical condition of all streets and highways within the unincorporated County is fully documented.

The information obtained during the pavement inventory survey is compiled into various user reports. These reports identify where rehabilitation should be considered, indicate a potential repair strategy, provide repair unit cost, quantify rehabilitation costs support program funding levels, and aid in determining program and project priorities for programming improvements. The basic reports for analysis are:

- (a) Category Condition Report: Assigns a rating from 0-100 for each street segment and separates them into four categories.
- (b) Priority Report: Prioritizes the streets in order of need based upon traffic volumes, extended life and cost to life ratio.
- (c) Proposed Improvement Report: Separates streets by the system-generated improvement based upon type of distress.

611.4 General Pavement Structural Section Failure Types

Engineering judgment, based primarily on experience in pavement design, construction, materials, and maintenance, is required to identify pavement failure types and to determine the primary source of failure.

In asphalt concrete pavement (ACP), base or subbase failure may be visually indicated by the rutting of the AC surface in the wheel paths or by alligator cracking of the AC. On the other hand, deep rutting may also indicate a lack of stability in the AC. Meandering cracks and differential settlement of the surface most likely indicates a subsurface problem.

There are many variables in materials and environment as well as other factors that affect the performance of pavement structural sections. This makes it impossible to develop hard and fast rules for the rehabilitation of pavements. Therefore, the Materials Engineer makes recommendations based on his experience and judgment and the guidance of engineers who are familiar with the design, construction, materials, and maintenance of pavement in the geographical area of the project. Deflection testing of ACP, coring of ACP, coring of PCCP and other tests can be used to confirm judgments that are made.

The following discussion of pavement failure types primarily includes those encountered in Orange County on asphalt concrete pavement. Brief definitions of these are also included in Topic 612. The failure type terminology shown below is generally the same as that included in the pavement distress descriptions of the Operations Manual and the Distress Identification Manual developed by the Strategic Highway Research Program (SHRP). This manual is available through the Operations and Maintenance Division.

611.6 ACP Failure Types

- (1) *Alligator Cracking.* Alligator Cracks are cracks which form multi-sided, interconnecting blocks, ranging from a few square inches to up to 2 square feet in size, and may be accompanied by a depression. The most prevalent cause is moisture, which softens the base material or subgrade and causes the pavement to move and break under traffic loads. Alligator cracking is categorized into the three severities as outlined below.
 - (a) Low – The block patterns are formed with visible hairline cracks, and the pavement is not spalled.

- (b) Moderate – There is the development of spalled cracking into a pattern or network of cracks.
 - (c) Severe – The cracked pieces are well defined and spalled on the edges. Some of the pieces may be missing or may move under traffic.
- (2) *Block Cracking.* Block cracks are a pattern of cracks that divides the pavement into approximately rectangular pieces. These cracks are generally due to hardening and shrinkage of the asphalt and/or reflection cracking from CTB. The blocks may range in size from approximately 1 square foot to 25 square feet. This type of distress is not load-associated, although load can increase the severity of individual cracks. Block cracking normally occurs over a large portion of the pavement area, but sometimes occurs only in nontraffic areas. The three severity levels of block cracking are given below.
- (a) Low – Cracks with a mean width of $< \frac{1}{4}$ " or sealed cracks with sealant material in good condition and with a width that cannot be determined.
 - (b) Moderate – Cracks with a mean width of $> \frac{1}{4}$ " and $< \frac{3}{4}$ " and adjacent low severity random cracking.
 - (c) Severe – Cracks with a mean width $> \frac{3}{4}$ " and adjacent moderate to severe severity cracking.
- (3) *Transverse Cracking.* Transverse cracks are cracks that occur approximately at right angles to the pavement centerline. They may be caused by shrinkage or differential thermal stress of the AC surface or hardening of the asphalt or may be reflective cracks caused by breaks beneath the surface course, i.e., shrinkage cracks in CTB or underlying PCC. The three severity levels of transverse cracking are outlined below.
- (a) Low – The cracking is a single hairline crack.
 - (b) Moderate – The cracks are $> \frac{1}{4}$ ", but not fully separated.
 - (c) Severe – The cracks are separated with fractured or spalled edges.
- (4) *Longitudinal Cracking.* Longitudinal cracks are approximately parallel to the pavement centerline. They may be caused by:
- (a) Poorly constructed paving lane joints,
 - (b) Shrinkage of the AC surface due to low temperatures or hardening of the asphalt,
 - (c) A reflective crack caused by cracks beneath the surface course.
- The severity levels for longitudinal cracks are the same as those given for transverse cracks in 611.6(3) above.
- (5) *Edge Cracking.* Crescent-shaped cracks or fairly continuous cracks which intersect the pavement edge and are located within 2 feet of the pavement edge, adjacent to the shoulder.

Includes longitudinal cracks outside of the wheel path and within 2 feet of the pavement edge. The three severity levels of edge cracking are given below.

- (a) Low – Cracks with no breakup or loss of materials.
 - (b) Moderate – Cracks with some breakup and loss of material for up to 10% of the length of the affected portion of the pavement.
 - (c) Severe – Cracks with considerable breakup and loss of materials for more than 10% of the length of the affected portion of pavement.
- (6) *Rutting.* Rutting is a longitudinal depression in the wheel tracks and may include longitudinal hairline cracks in the bottom of the rut and run parallel to the depression. Rutting stems from a permanent deformation in any of the pavement layers or in the subgrade, usually resulting from consolidation or lateral movement of the layer due to traffic loads. Rutting may be caused by plastic movement in the AC during hot weather or inadequate compaction during construction. Significant rutting can lead to major structural failure of the pavement and hydroplaning potential. Low, moderate and high severity rutting levels are described below.
- (a) Low – A depression is beginning to form in the wheel path which can be barely felt during driving.
 - (b) Moderate – The depression becomes defined in the wheel path and noticeably affects the vehicle's lateral movement.
 - (c) Severe – There is a well-defined depression in the wheel path that seriously affects the vehicle's lateral movement.
- (7) *Raveling.* Raveling is the progressive loss of pavement material (aggregate) from the surface downward (including slurry sealed pavements). Raveling is the result of traffic abrading and loosening the aggregate or the lack of sufficient asphalt binder or coated asphalt in the plant mix. The hardening of the pavement over time can also weaken the bonding of the asphalt with the aggregate. The severity levels are outlined below.
- (a) Low - The outline of the aggregate is beginning to appear.
 - (b) Moderate – The aggregate is beginning to protrude and the surface is rough and noisy to ride.
 - (c) Severe – The aggregate is protruding and is loose or missing and the surface may have depressions or potholes.
- (8) *Drip Track Ravel.* Drip track ravel is the progressive disintegration of the surface between wheel paths. This disintegration is caused by the dripping of oil and gas from vehicles. These petroleum products soften and weaken the bitumen causing the loss of the aggregate and binder. Ravel due to the leaching of asphalt binder by gas and oil, is primarily a

condition which occurs at intersections where vehicles must come to a stop before proceeding.

- (9) *Bleeding*. Bleeding is when excessive binder is occurring on the pavement surface. It may create a shiny, glass-like, reflective surface that may be tacky to the touch and is usually found in the wheel path. The severities are as follows:
- (a) Low – An area of pavement is discolored relative to the remainder of the pavement, by excess asphalt.
 - (b) Moderate – An area of pavement surface is losing surface texture due to excessive asphalt.
 - (c) Severe – Excess asphalt gives the pavement surface a shiny appearance; the aggregate may be obscured by excess asphalt; tire marks may be evident in warm weather.
- (10) *Utility Patch Distress*. Patch distresses are areas of pavement which have been removed and repaired by the placement of new bituminous material. In the case of a utility patch, the new bituminous material replaces the existing pavement. All types of distress can occur in a patched area. Utility patch distress has the following severities:
- (a) Low – The patch is in good condition.
 - (b) Moderate – The patch is slightly depressed and beginning to crack and separate along the edges.
 - (c) Severe – the patch is depressed and badly cracked and raveled.

611.7 General Pavement Rehabilitation Strategies

Pavement service life is affected by many factors. Each rehabilitation project should, therefore, be analyzed carefully to develop the most appropriate corrective action. The reliability of such an analysis depends on numerous variables such as: design and construction records; in-depth evaluation of current conditions; and field and laboratory testing based on findings from records and observation, to name just a few.

Factors which should be considered in determining appropriate corrective action include the following:

- Type, degree, extent and cause of deterioration
- Rate of deterioration
- Comparative lane deterioration
- Base condition and underlying support

- Retention or trapping of surface water in the structural section
- Shoulder condition
- Vertical Controls
- Pavement Deflection (ACP)
- Traffic handling alternatives
- Conservation of materials and energy
- Availability of new materials
- Cost

During the service life of a pavement structural section, preventive maintenance should be performed at the appropriate time to preserve the pavement structural section and thus postpone or minimize the magnitude of the pavement rehabilitation work that eventually will be required. Rehabilitation is designed to provide an additional twenty years of service.

611.9 ACP Rehabilitation Strategies

There are several kinds of problems or failures that AC pavements can experience. The fact that these failures can occur individually or in combinations is somewhat responsible for the broad range of treatments that are available to repair AC.

Some of the treatments that are used in these programs are:

- Cracking filling
- Patching
- Digout and patch
- Strip patch
- Heater scarify
- Grinding
- Milling
- Seal coats
- Recycle

- Overlay
- Removal and replace (reconstruction)

The cost effective repair of pavement (pavement management) is more of an art than science. A great deal of research and experimentation has been done, and is continuing, but there is no accepted formula or textbook solution for many of the problem types. The County of Orange uses “designed” overlays and reconstruction, because the most predictable results are obtained from this method.

Thus, engineers have several options for pavement rehabilitation. Choosing from among these alternatives depends on informed evaluation of numerous factors such as pavement requirements and cost, to name but a few.

Caltrans Topic 611 provides general guidelines for pavement structural section rehabilitation; however, materials used for rehabilitation of county roads should meet the minimum requirements of the Greenbook. Recommendations and materials for rehabilitation shall be approved by the Materials Engineer.

611.10 Traffic Handling and Safety

RDMD/Traffic Engineering should be consulted for guidance on all traffic handling and safety issues.

Topic 612 - Pavement Structural Section Definitions

The following list of definitions includes a number of terms that are common in pavement design:

Alligator Cracking. Interconnected or interlaced load associated (fatigue) cracks in asphalt concrete pavement forming a series of small polygons that resemble the typical pattern of an alligator’s skin.

Asphalt Treated Permeable Base (ATPB). A highly permeable open-graded mixture of crushed coarse aggregate and asphalt binder placed as the base layer to assure adequate drainage of the structural section, as well as structural section support.

Base. A layer of selected, processed, and/or treated aggregate material of planned thickness and quality placed immediately below the pavement and above the subbase or basement soil to support the pavement.

Basement Material. The material in excavation or embankments underlying the lowest layer of subbase, base, pavement surfacing or other specified layer which is to be placed.

Basement Soil. See Basement Material.

Bleeding. When excessive binder works its way to the surface of AC pavement, it obscures the aggregate and reduces friction.

Block Cracking. Interconnected cracks on flexible pavement that are not load associated, which form a series of large polygons, usually with sharp corners or angles.

Borrow. Natural soil obtained from sources outside the roadway prism to make up a deficiency in excavation quantities.

Cement Treated Permeable Base (CTPB). A highly permeable open-graded mixture of coarse aggregate, portland cement, and water placed as the base layer to provide adequate drainage of the structural section, as well as structural support.

Chip Seal. A high viscosity asphaltic emulsion surface coat which incorporates rolled-in rock screenings (chips) over an asphalt concrete pavement, as preventive maintenance, to extend the service life.

Cold Recycling. The rehabilitation of asphalt concrete pavement without the application of heat by milling and mixing with new binder and/or rejuvenating agents in place.

Composite Pavement. A pavement structure or structural section composed of an asphalt concrete wearing surface or overlay and portland cement concrete slab.

Condition Rating. An OCPMS value that is derived by subtracting the pavement distress values, as recorded from the field evaluation of a street segment, from 100. The Condition Rating is the County's equivalent to other systems rating acronyms of PCR or PMI or PSI.

Construction Joint. A joint made necessary by a prolonged interruption in the placing of concrete.

Dense Graded Asphalt Concrete (DGAC). A uniformly graded asphalt concrete mixture (aggregate and paving asphalt) containing a small percentage of voids, used primarily as a surface layer to provide the structural strength needed to distribute loads to underlying layers of the structural section. Most roads are surfaced with dense graded bituminous pavements. They consist of aggregates graded from coarse to dust and intimately mixed with bituminous binder before being placed and compacted.

Design Period. The period of time that an initially constructed or rehabilitated pavement structural section is designed to perform before reaching a condition that requires major rehabilitation or reconstruction.

Drip Track Ravel. Progressive disintegration of the surface between wheel paths on asphalt concrete pavement, caused by oil and fuel dripping from vehicles. This is most prevalent adjacent to intersections where vehicles slow and stop.

Edge Cracking. Crescent-shaped cracks or fairly continuous cracks which intersect the pavement edge and are located within 2 feet of the pavement edge, adjacent to the shoulder. Includes longitudinal cracks outside of the wheel path and within 2 feet of the pavement edge.

Edge Drain System. A drainage system, consisting of a slotted plastic collector pipe encapsulated in treated permeable material and a filter fabric barrier, with unslotted plastic pipe vents, outlets, and cleanouts, designed to drain the structural section of both rigid and flexible pavements.

Embankment. A prism of earth fill that is constructed from excavated or borrowed natural soil and/or rock, extending from original ground to the grading plane, and designed to provide a stable support for the pavement structural section.

Equivalent Single Axle Loads (ESAL's). Summation of equivalent 18,000 pound single axle loads used to convert mixed traffic to design traffic for the design period.

Flexible Pavement. A traffic load carrying system that is made up of one or more layers that are designed to transmit and distribute that loading to the underlying roadbed material. The highest quality layer is the surface course, (generally asphalt concrete) which is usually underlaid by a lesser quality base, and in turn a subbase. It is called flexible because it can tolerate deflection bending under heavy loads.

Fog Seal. A combination of mixing-type asphaltic emulsion and water which is applied to the surface of asphalt concrete pavement to seal the surface, primarily used for local street pavement maintenance.

Grading Plane. The surface of the basement material upon which the lowest layer of subbase, base, pavement surfacing, or other specified layer is placed.

Hot Recycling. The use of reclaimed asphalt concrete pavement which is combined with virgin aggregates, asphalt, and sometimes rejuvenating agents at a central hot-mix plant and placed in the structural section in lieu of all new materials.

Joint Seals. Pourable, or extrudable, or premolded materials that are placed primarily in transverse and longitudinal joints in or along the edge of concrete pavement to deter the entry of water and incompressible materials.

Lean Concrete Base. Mixture of aggregate, portland cement, water, and optional admixtures primarily used as a base for portland cement concrete pavement.

Leveling Course. The layer, generally of AC or other treated or processed material, that is placed over the rough or undulating surface of an existing pavement, structure deck, or other surface to improve the surface profile or ride quality before placement of subsequent layers.

Lime treatment. The mixing of lime with native or embankment materials to increase the strength (R-value) of the material which supports the pavement structural section.

Longitudinal Cracking. Cracks or breaks in flexible or rigid pavement which are approximately parallel to the pavement center line.

Maintenance. The preservation of the entire roadway, including pavement surface and structural section, shoulders, roadsides, structures, and such traffic control devices as are necessary for its safe and efficient utilization.

Open Graded Asphalt Concrete (OGAC). An open graded mixture of aggregate and a relatively high asphalt content which provides good skid resistance and a high permeability. OGAC is designed to accommodate rapid surface drainage and minimize the potential of hydroplaning while at the same time providing an effective seal of the underlying asphalt concrete pavement. Open graded AC and plant mix differ from dense graded AC in that they contain little fine aggregate or dust. It is common to stipulate that aggregate for open mixes be tougher than aggregate for dense graded mixes, since the coarse particles of open graded mixtures are not protected by a matrix of fine particles.

Overlay. A layer, usually of asphalt concrete, placed on existing asphalt or portland cement concrete pavement to restore ride quality, to increase structural strength (load carrying capacity), and to extend the service life.

Panel Length. The distance between adjacent transverse joints in a traffic lane.

Pavement. The surface layer of the structural section that carries traffic. Except for special or experimental surface layers, the pavement is either portland cement concrete or asphalt concrete. The asphalt concrete layer may include up to a 0.10 foot layer of OGAC.

Pavement Management System (PMS). A management system which was developed by the County to assess the condition of pavement on unincorporated streets and highways annually and to prioritize and program the rehabilitation of pavement consistent with available funding.

Pavement Rehabilitation. Work undertaken to extend the service life of an existing facility. This includes placement of additional surfacing and/or other work necessary to return an existing roadway, including shoulders, to a condition of structural or functional adequacy, for a minimum period of 20 years. This might include the partial or complete removal and replacement of portions of the pavement structural section.

Pavement Reinforcing Fabric (PRF). A nonwoven, bonded-fiber, engineering grade synthetic fabric that is, as used by Caltrans, placed as an interlayer in asphalt concrete overlays primarily to minimize surface water infiltration and retard reflection cracking through the overlay, from cracks or joints in the existing pavement.

Pavement Structure. See Structural Section.

Pavement Surfacing. See Surface Course.

Prepared Roadbed. In-place soils compacted or stabilized according to provisions of applicable specifications.

Prime Coat. The application of a low viscosity liquid bituminous material to an absorbent surface (preparatory to placing subsequent structural section layers or PRF) for the

- purpose of hardening or toughening the surface and promotion adhesion between it and the superimposed constructed layer or PRF interlayer.
- Pumping.* The ejection of foundation material either wet or dry, through joints or cracks or along edges of rigid slabs resulting from vertical movements of the slab under traffic. This phenomena is especially pronounced with saturated structural sections.
- Raveling.* Progressive disintegration of the surface downward on asphalt concrete pavement by the dislodgement of aggregate particles and binder. Stripping usually precedes raveling.
- Reflection Cracking.* Cracking in asphalt concrete layers caused by movement of cracked or jointed pavement in the layer below.
- Resurfacing.* A supplemental surface layer or replacement layer placed on an existing pavement to restore its riding qualities or to increase its structural (load carrying) strength.
- Rigid Pavement.* Primarily portland cement concrete pavement which distributes the superimposed axle loads over a relatively wide area of underlying structural section layers and soil because of its rigidity and high modulus of elasticity.
- Roadbed.* The roadbed is that area between the intersection of the upper surface of the roadway and the side slopes or curb lines. The roadbed rises in elevation as each increment or layer of subbase, base, surfacing or pavement is placed. Where the medians are so wide as to include areas of undisturbed land, a divided highway is considered as including two separate roadbeds.
- Roadbed Material.* Also referred to as basement soil or basement material, the material below the grading plane in cuts and embankments, extending to such depths as affect the support of the pavement structure or structural section.
- Rubberized Asphalt.* A mixture of paving asphalt combined with specified percentages of granulated reclaimed rubber for use as the binder in asphalt concrete and in stress absorbing membrane interlayers within or under asphalt concrete overlays. Primary applications where benefits appear to be significant are for providing more resilient and more durable wearing surface for overlays, and to retard reflection cracking. Rubberized asphalt joint sealant is used to keep incompressible materials out of joints in concrete pavement and retard surface water infiltration in concrete pavement.
- Rutting.* Longitudinal depressions that develop in the wheel paths of flexible pavement under traffic. This permanent and sometimes progressive deformation is most often caused by unstable asphalt concrete pavement or inadequate strength of the underlying foundation.
- R-value.* Resistance value of treated or untreated soil or aggregate as determined by the stabilometer test (California Test 301). This is a measure of the supporting strength of the basement soil and subsequent layers used in the design of pavement structural sections.
- Seal Coat.* A bituminous coating, with or without aggregate, applied to the surface of a pavement for the purpose of waterproofing, preserving, or rejuvenating a cracked or raveling

bituminous surface, or to provide increased skid resistance or resistance to abrasion by traffic.

Selected Material. A suitable native material obtained from a specified source such as a particular roadway cut or borrow area, or a suitable material having specified characteristics to be used for a specific purpose.

Serviceability. The ability at time of observation of a pavement to service traffic (autos and trucks) which use the facility.

Settlement. Localized vertical displacement of the pavement structural section due to slippage or consolidation of the underlying foundation, often resulting in pavement cracking, poor ride quality and deterioration.

Shoulder Backing. A material that is placed adjacent to the outside edge of the shoulder surfacing to protect the edge from spalling, and to provide edge support.

Single Axle Load. The total load transmitted by all wheels whose centers may be included between two parallel transverse vertical planes 40 inches apart, extending across the full width of the vehicle.

Slurry Seal. A mixture of mixing-type asphaltic emulsion, fine mineral aggregate and water proportioned, mixed and spread primarily on asphalt concrete pavement for maintenance purposes.

Spalling. Cracking, breaking, or chipping of a rigid pavement along joints, edges, or cracks in which small portions of the slab are dislodged. Spalling is caused primarily by incompressibles confined in the opening or nonuniform slab support in conjunction with vertical movement due to wheel load impact.

Stress Absorbing Membrane Interlay (SAMI). An interlayer placed within or at the bottom of an asphalt concrete overlay or layer to retard reflective cracking. It does not add to the structural strength. Examples of SAMI's include: a rubberized chip seal interlayer or pavement reinforcing fabric.

Stripping. The loss of the adhesive bond between asphalt cement and aggregate, most often caused by the presence of water in asphalt concrete, which may result in raveling, loss of stability and load carrying capacity of the asphalt concrete pavement or treated base.

Structural Section. The planned engineering design of layers of specific materials (normally consisting of subbase, base, and pavement surface) placed over the basement soil to support the traffic loads anticipated to be accumulated and applied during the design period. The structural section is also commonly called the pavement structural section.

Structural Section Drainage System. A drainage system used for both asphalt and portland cement concrete pavements consisting of a treated permeable base layer and a collector system which includes a slotted plastic pipe encapsulated in treated permeable material

and a filter fabric barrier with unslotted plastic pipe as vents, outlets and cleanouts to rapidly drain the pavement structural section.

Subbase. A layer of aggregate of designed thickness and specified quality placed on the basement soils as the foundation for a base.

Subgrade. That portion of the roadbed on which pavement surfacing, base, subbase, or a layer of any other material is placed.

Surface Course. The top layer of AC pavement. It is also sometimes called the “wearing course”.

Surface Polish. The loss of the original pavement surface texture due to traffic wear.

Surface Recycling. In-place heating of the surface of asphalt concrete pavement followed by scarification, remixing, and compaction, generally to a depth of about $\frac{3}{4}$ inches. This is considered to be a maintenance procedure.

Tack Coat (Paint Binder). The application of bituminous material to an existing surface to provide bond between the superimposed construction and the existing surface.

Tandem Axle Load. The total load transmitted to the road by two consecutive axles whose centers may be included between parallel vertical planes spaced more than 40 inches and not more than 96 inches apart, extending across the full width of the vehicle.

Thin Bonded Concrete Overlays (BCO). An overlay of existing concrete pavement which is designed to improve ride and structural condition. Generally BCOs are about three inches thick, consisting of conventional low slump portland cement concrete or concrete containing polymers, or latex, or magnesium phosphate, or other additives designed to accommodate placement, improve bonding, and improve durability. Bonding is accomplished by epoxy or other types of adhesives.

Thin Bonded Wearing Course. A $\frac{5}{8}$ inch thick overlay of the existing pavement using a “gap-graded,” high quality aggregate matrix combined with a polymer modified binder. Considered to be a non-structural combination of preventative and corrective maintenance, this process can be used to improve the ride quality, correct minor deviations in the road surface, and provide a new wearing course that reduces the amount of rain water on the road surface.

Transverse Cracking. Cracks in asphalt concrete pavement approximately at right angles to the center line, most often created by thermal forces exceeding the tensile strength of the asphalt concrete. (Transverse cracks also occur in PCCP but are more often caused by live load stresses combined with uneven base support.)

Utility Patch Distress. Patch distresses are areas of pavement which have been removed and repaired by the placement of new bituminous material. In the case of a utility patch, the new bituminous material replaces the existing pavement.

Weathering. Gradual degradation of asphalt concrete due to oxidation and hardening, especially of the surface layer resulting in transverse cracking and surface raveling.

Wearing Course. See Surface Course.

CHAPTER 700 – MISCELLANEOUS STANDARDS

Topic 701 – Fences

The general policy of the County is to not provide fences within County street/highway right of way. Where special circumstances suggest a need for fencing, see Standard Plan 600-1-OC for Chain Link Fence and Gates and Standard Plan 1413 for Guard Cable Fence.

Topic 702 – Miscellaneous Traffic Items

702.1 References

- (1) Guardrail and Crash Cushions

See Caltrans July 2002 Standard Plans A77A through A77N (Standard Plans for Construction of Local Streets and Roads) for Metal Beam Guard Railing.

- (2) Markers

See Standard Plan 1402 for Markers.

- (3) Mailboxes

See Standard Plan 1211 for Single Unit Mailbox Detail and Standard Plan 1212 for Multi-Unit Mailbox Detail.

- (4) Other traffic related standards as found in the RDMD Standard Plans.

Topic 705 – Materials and Color Selection

In areas where improvements are designated for special treatment by the Board (e.g. Specific Plan, Scenic Highway Plan, etc.) the design of these improvements shall comply with Board policy.

See Standard Plan 1114 for Landscaped Median Typical Section. This plan discusses the use of pattern stamped colored concrete or interlocking concrete pavers in the median design. See Topic 305 for the policy on medians.

Topic 706 – Roadside Treatment

In areas designated for special treatment by the Board (e.g. Specific Plan, Scenic Highway Plan, etc.) the design shall comply with Board policy.

See Standard Plan 1700 for Street Tree List which discusses the trees acceptable for use in the street/highway right of way. See Topic 900 for landscape and planting requirements.

CHAPTER 800 – HIGHWAY DRAINAGE DESIGN

Topics 801-891 – General

801.1-891.1 Introduction

For Highway Drainage Design on streets/highways in Orange County, refer to the following:

- (1) Orange County Design Manual
 - (a) Orange County Flood Control District Design Manual.
 - (b) Orange County Hydrology Manual.
 - (c) County of Orange Local Drainage Manual.
- (2) Other references as listed in the Policy Statement of the Highway Design Manual.
- (3) Caltrans Highway Design Manual Chapters 800-890

CHAPTER 900 – LANDSCAPE ARCHITECTURE

Topic 901 – General

In areas designated for special treatment by the Board (e.g. Specific Plan, Scenic Highway Plan, etc.) the design shall comply with Board policy.

The general policy of Orange County is not to provide landscaping with street or highway construction. Landscaping, when approved, shall not be maintained with road funds. A method of funding landscape maintenance shall be established prior to approval of street improvement plans.

An exception to the above policy is to provide erosion control planting on cut and fill slopes for street or highway construction. All slopes in excess of five feet in height should be considered for erosion control planting. Other water quality best management practices may be also required.

Topic 902 – Planting Design Standards

902.2 Sight Distance and Safety Requirements

(1) Basic Requirements

Refer to Topic 201 and Standard Plan 1117 for sight distance requirements.

902.3 Trees

(2) Trees Planted Along Streets or Highways

See Standard Plan 1700 for placement and list of trees which are acceptable for use in the street or highway right of way. Trees are unacceptable in the Limited Use Area (see Standard Plan 1117).

902.4 Planting Guidelines

If planting is required (see Topic 901), Harbors, Beaches and Parks Design Division should be consulted for recommendations on planting material.

CHAPTER 1000 – BIKEWAY PLANNING AND DESIGN

Topic 1002 – General Planning Criteria

OCTA Commuter Bikeways Strategic Plan (Bikeways Plan) should be consulted to determine if a master plan bikeway is planned on the highway being designed. If so, the design of the highway should conform to the Bikeways Plan, as well as, the Circulation Plan.

Additional right of way may be required for a Class I bikeway.

Topic 1003 – Design Criteria

1003.1 Class I Bikeways

(1) Widths

The minimum paved width for a two-way Class I Bikeway as shown on the Bikeways Plan shall be 10 feet. A minimum 2-foot wide graded area measured from edge of pavement to hinge point shall be provided adjacent to each side of the trail pavement (see Figures 1003.1A and 1003.1B). Where the sideslope adjacent to the graded shoulder is steeper than 4:1, the downslope side shall have a 4-foot wide graded area measured from edge of pavement to hinge point adjacent to the trail pavement. For Master Plan Bikeways, where a deviation is allowed for widths less than 10 feet, a 3-foot wide graded area measured from edge of pavement to hinge point adjacent to each side of the trail pavement shall be provided. Paving is allowed within the graded area to reduce the maintenance costs or to provide for drainage facilities; e.g. curb and gutter (see Section 1003.1(14)).

Where heavy bicycle volumes are anticipated and/or significant pedestrian traffic is expected, the paved width of a two-way path should be greater than 10 feet, preferably 12 feet or more. Dual use by pedestrians and bicycles is undesirable, and the two should be separated wherever possible.

Additional pavement widening on the inside of horizontal curves may be required where the horizontal design speed criteria can't be met.

(2) Clearance to Obstructions

A minimum 2-foot horizontal clearance to obstructions shall be provided adjacent to the pavement (see Section 1003.1(14)). A 3-foot clearance is recommended. The minimum overhead clearance shall be 10 feet to account for the "shy factor" (e.g. bridge under crossings). Where a bike path doubles as a maintenance roadway, or where equestrians are present, overhead clearance shall be sufficient to accommodate the anticipated maintenance vehicles or equestrian use. Minimum vertical clearance for equestrian use and for maintenance vehicles shall be 12 feet.

FIGURE 1003.1A

**CLASS I BIKEWAY ON SEPARATE RIGHT OF WAY
TYPICAL SECTION**

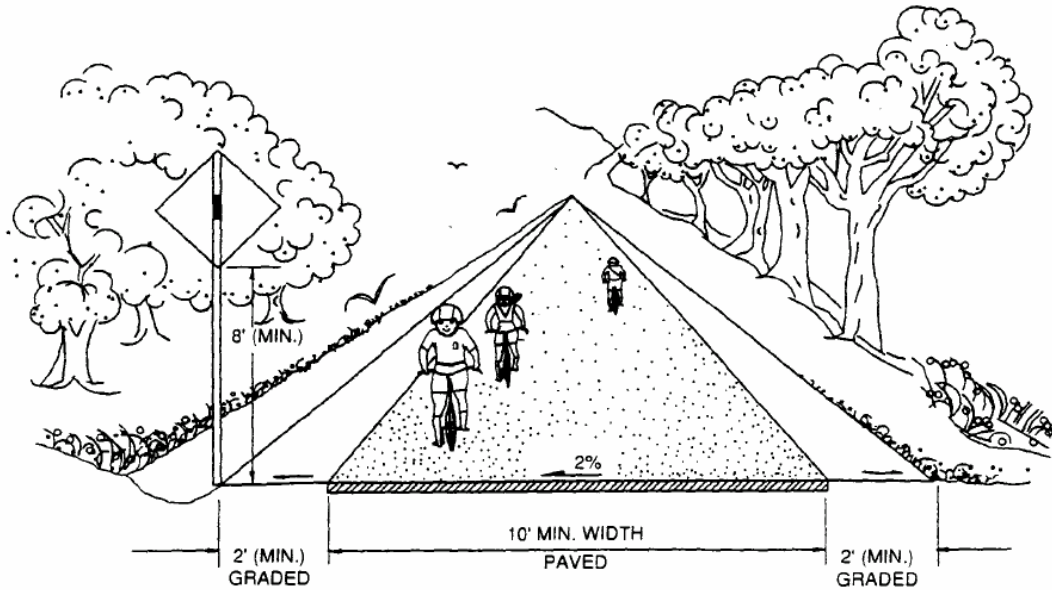
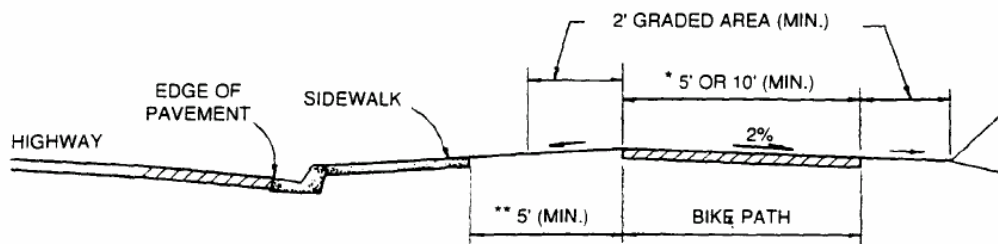


FIGURE 1003.1B

**CLASS I BIKEWAY ALONG HIGHWAY
TYPICAL SECTION**



- * ONE-WAY: 5' MINIMUM WIDTH
TWO-WAY: 10' MINIMUM WIDTH
- ** 5' SHALL BE MEASURED FROM CURB
FACE, IF NO SIDEWALK REQUIRED

(3) Striping and Signing

A 4-inch yellow centerline stripe shall be placed to separate opposing directions of travel at bridge undercrossings or at other dips where bike trail gradient exceeds 5%. A 6-inch white edge stripe shall be placed for all trails with adjacent down slopes steeper than 4:1.

Yellow painted word or symbol warning markings on the pavement and/or signs shall be used to alert bicyclists where caution is warranted, such as substandard horizontal or vertical alignment, barrier posts, etc. The size of work and symbol markings shall conform to the stencil size used by RDMD/Operations and Maintenance Division.

(6) Bike Paths in the Median of Highways

Bikeways shall not be permitted in any median.

(7) Design Speed

The proper design speed for a bike path is dependent on expected type of use and on the terrain. The minimum design speed for bike paths should be 20 mph. In the case of bike paths on long downgrades (steeper than 4% and longer than 500 ft.) the minimum design speed should be 30 mph.

(12) Grades

<u>Maximum Desirable Sustained Grade (Percent)</u>	<u>Maximum Desirable Length (Feet)</u>
10.0 (use only in very extraordinary situations)	70
7.0 (maximum for ramps)	120
5.0 (maximum for normal situations)	170
4.5	330
4.0	600
3.5	850
3.0	1000
2.5	1300
2.0	1700

Where grades steeper than 7% cannot be avoided, signs indicating "Steep Grade" shall be provided.

(13) Structural Section

The structural section of the bikeway shall be determined by the Orange County Materials Engineer. Portland Cement Concrete (PCC) shall be used where adequate drainage is not provided and/or high moisture content is known to be present, or anticipated, in the subgrade (subdrains should be provided in these areas). Asphalt concrete (AC) shall conform to the requirements of Standard Plan 1805.

(14) Drainage

The bikeway shall have a cross slope of 2% to facilitate drainage of the trail. In addition, the graded shoulders adjacent to the bikeway shall slope away from the trail at 2% minimum, 5% maximum.

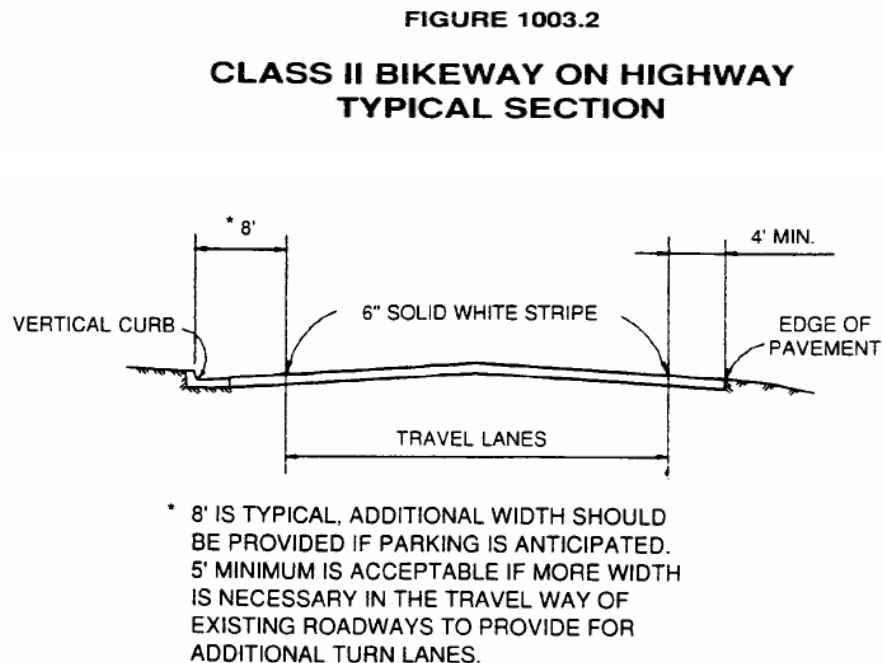
Minor drainage facilities are allowed in the graded area (graded area is described in (1) above); for example a curb and gutter to convey drainage would be allowed but the curb face shall be located no closer than the outside edge of the graded area (this actually requires extending the graded area further out in order to construct the curb). Drainage ditches shall not be located within this graded area unless the sideslope(s) of the ditch within the graded area is 5% or less.

Drainage from areas adjacent to bikeways shall not be permitted to flow across the bikeway. Drainage ditches of suitable dimension shall be provided to intercept such drainage. Where necessary to carry intercepted water across the bikeway, catch basins with drains (designed for "Q-10") shall be provided where a bike path crosses any drainage course.

1003.2 Class II Bikeways

(1) Widths

The width for a bike lane on a curbed street shall typically be 8 feet measured from the curb face, or 4 feet measured from the edge of pavement if there is no curb and gutter (see Figure 1003.2). A reduction in the bike lane width to a minimum of 5 feet, measured from the curb face, to facilitate restriping of an existing roadway for added lanes, is acceptable. Bike lanes shall be one-way facilities.



CHAPTER 1100 – HIGHWAY TRAFFIC NOISE ABATEMENT

Topic 1101 - General Requirements

1101.1 Introduction

The County of Orange policies and standards related to noise are specified in the “Noise Element” of the Orange County General Plan. The “Land Use/Noise Compatibility Manual” has been adopted by the Board of Supervisors as the implementation mechanism of the Noise Element.

The highway project must address noise impacts in accordance with the County planning policy summarized below from the “Objectives and Policies” section of the Noise Element. The three general types of noise-impact and noise-mitigation situations can be identified and related to the noise environment as follows:

(1) Situations where a new land use is being proposed that is impacted by an existing noise source such as an arterial highway. “New” in this context refers both to the initial development of land and when one use is replaced by another (any use requiring a building permit or grading permit would be considered a new land use). This is the most common situation and is typified by residential tract adjacent to, and impacted by, noise from an arterial highway. An arterial highway, as shown on the Circulation Plan, may exist in its ultimate form, may exist in a partial configuration or may only be planned. Designation of the arterial highway on the plan and the traffic and noise projections which accompany this designation are, in this context, the “existing noise source”. In this instance, the tract developer would be required to mitigate the highway noise to comply with the Noise Element standards specified in Tables 1102.1A and 1102.1B.

(2) Situations where an existing use is impacted by a new or expanded source of noise. This situation is typified by general planning of a new transportation facility (new transportation facility is one that was added to the Master Plan of Arterial Highways or Circulation Plan or one that has been upgraded after the Noise Element was adopted in 1975) close enough to existing uses to have noise impacts on them, or the expansion of such a facility beyond currently planned levels. In this situation, the project proponent of the new or expanded noise source is obliged to mitigate the impacts of the new source of noise to comply with the Noise Element standards specified in Tables 1102.1A and 1102.1B (see the following paragraph for exception to this). Furthermore, regardless of the Noise Element, compliance with CEQA may also require noise mitigation measures. The usual measure of mitigation will be to assume impacts are adequately mitigated if the residential noise level after the project meets Noise Element standards.

(3) Situations where land uses (e.g. building) and noise sources (e.g. streets/highways) were established prior to adoption of noise policies and standards (prior to 1975). In this situation, everything is in place; i.e. buildings and streets/highways exist or have been planned (planned prior to 1975). If there is no change in these existing uses, then there is no obligation to mitigate noise impacts, even if the existing uses are not currently in conformance with the Noise Element Standards (Tables 1102.1A and 1102.1B). However, if a change is proposed to an existing building, then the project is evaluated under the criteria in (1) above. If a change (e.g. road widening, etc.) is proposed to the street/highway there is no obligation to address noise impacts as long as the change is consistent with its pre-1975

planned use. If a change is proposed to the street/highway that is not consistent with its pre-1975 planned use, the project is evaluated under the criteria in (2) above.

The preferred method of mitigating noise impacts on County highway projects is to construct a noise barrier. “Noise barrier,” in this case, refers to walls, earthen berms, or some combination of the two. A less preferred alternative is to offer payment to the adjoining property owners to retrofit their property with noise proofing measures. Where retrofit payments are to be made, payment shall be pursuant to a contract (including noise easement) obtained by RDMD Real Estate Services which ties the payment to mitigation and holds County harmless from further claims. The offer of payment is a voluntary program. The County should make a reasonable effort to offer payment which the property owner has no obligation to accept. If the property owner does not accept the offer, the County has no further obligation to pursue this matter and may proceed with the project. The payment to the property owner for retrofit should be based on an estimate of the cost of the work.

If the project proponent (County) deems that mitigation is infeasible when the environmental document is transmitted to the Board, it should clearly recommend no mitigation. The transmittal to the Board should fully explain the infeasibility of alternatives for mitigation, provide information regarding benefits of the proposed project which may outweigh the unavoidable adverse impacts (Section IX.B of the Environmental Analysis Procedures adopted by the Board), and request the Board to make a finding that mitigation is infeasible.

The complexities of noise mitigation decisions are such that they can best be described by the “Noise Mitigation Decision Tree for County Projects” illustrated on Figure 1101.1.

1101.4 Procedures for Assessing Noise Impacts

The County uses the Federal Highway Administration’s (FHWA) methodology for predicting vehicular noise. This method is based on predicting the noise generated by constant speed highway traffic. The basis of the model is the equivalent sound level, L_{eq} , although an adjustment for conversion to L_{10} is provided. The method incorporates three classes of vehicles – automobiles, medium trucks, and heavy trucks. Adjustments for absorptive ground covers and finite length barriers are also included. Certain special topics such as non-uniform highway sites and determination of equivalent day-night levels, L_{dn} , are also included. The design engineer is referred to Appendix B of the County of Orange “Land Use/Noise Compatibility Manual” for more information on these topics.

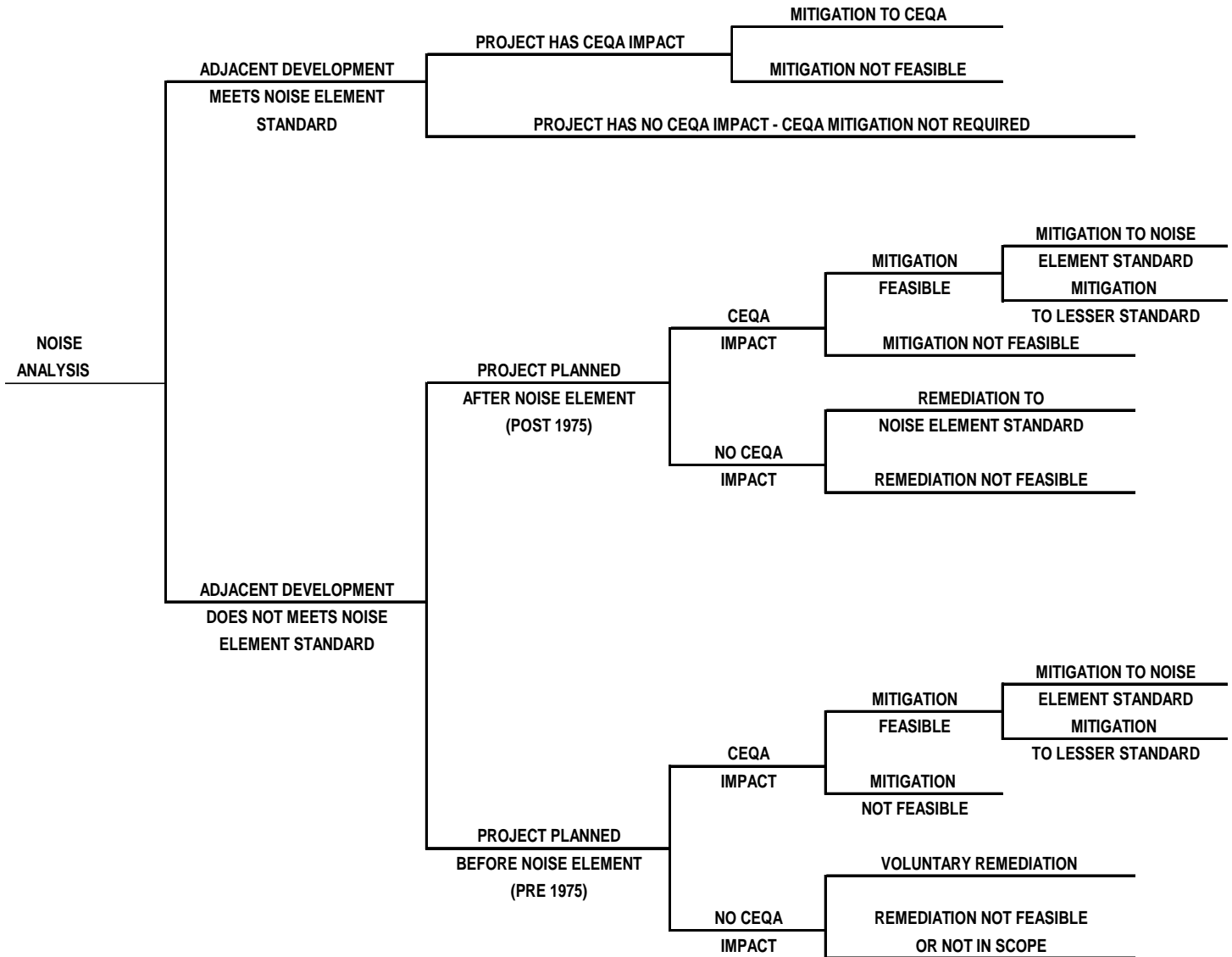
Topic 1102 – Design Criteria

1102.1 General

Noise abatement criteria levels used by the County of Orange are shown in Table 1102.1A “Compatibility Matrix for Land Uses and Community Noise Equivalent Levels” and explained in Table 1102.1B “Explanations and Definitions”. The information in these Tables has been excerpted from Tables II-3 and II-4 in Chapter II “Noise Element Policies” of the County of Orange “Land Use/Noise Compatibility Manual,” adopted September 18, 1984 and amended December 14, 1993. The information in these Tables shall not be used without first verifying its’ accuracy and completeness with the latest approved version of the Noise Element.

FIGURE 1101.1

NOISE MITIGATION DECISION TREE FOR COUNTY PROJECTS



1102.2 Noise Barrier Location

Noise Barriers used to mitigate County highway projects are typically located within County road Right of Way. An alternative when highway widening and Right of Way acquisition impacts adjacent building setbacks is to locate the Noise Barrier within a separate easement to the County.

Notwithstanding the above requirements, Noise Barriers near intersections shall not be constructed within the “limited use area” as defined on Standard Plan 1117.

1102.3 Noise Barrier Heights

Noise barrier heights shall be determined by conducting a noise study for the project. This type of study will usually be conducted by an expert in the field of noise. The County Planning and Development Services, Building Permit Section maintains a list of approved Acoustical Consultants certified by PDS for work in Orange County.

There is not a specific height limit for Noise Barriers (either walls, berms or a combination) within County highway right of way although zoning requirements place specific height limits for walls built adjacent to County highway right of way on private property. It is a good practice to use the height limitations of the adjacent private properties as the limit for the walls within the County highway right of way. Using this criterion, walls within County highway right of way where access rights have been dedicated should be limited to a maximum height of six feet measured from the base of the wall (reference Zoning Code Sec. 7-9-137.5). The zoning on the adjacent property should be checked to determine if greater heights are permissible. If it is necessary to exceed the wall height limitation, there are some options available. One option is to combine the wall with an earthen berm; the wall height should still be limited to six feet. However, by putting the wall on top of a berm, the overall height can be increased. The problem with this solution is the additional right of way required to construct the berm since it will need side slopes of at least 2:1. Another solution is to attempt to mitigate the noise impact by noise proofing the impacted properties (see Section 1101.1).

If none of the above solutions are possible or feasible, then consideration should be given to either constructing the wall higher than the maximum listed above, or requesting the Board of Supervisors find mitigating the noise impact is infeasible (see Section 1101.1(2)).

If constructing a wall higher than the maximum listed above is the preferred solution, this alternate should be reviewed with the Zoning Administration section of Current Planning Services; however, their approval is not mandatory if it's a project within the County highway right of way or other County easement. Section 7-9-20(h) of the Zoning Code exempts walls/fences in public road right of way from provisions of the Zoning Code if walls/fences are maintained by a public agency.

TABLE 1102.1A

**COMPATIBILITY MATRIX FOR LAND USES AND
COMMUNITY NOISE EQUIVALENT LEVELS
(excerpted from Table II – 3, Land Use/Noise Compatibility Manual)**

<u>TYPE OF USE</u>	<u>65+ DECIBELS CNEL</u>	<u>60 TO 65 DECIBELS CNEL</u>
<u>Residential</u>	3a, b, e	2a, e
<u>Commercial</u>	2c	2c
<u>Employment</u>	2c	2c
<u>Open Space</u>		
Local	2c	2c
Community	2c	2c
Regional	2c	2c
<u>Educational Facilities</u>		
Schools (K thru 12)	2c, d, e	2c, d, e
Preschool, College	2c, d, e	2c, d, e
Other		
<u>Places of Worship</u>	2c, d, e	2c, d, e
<u>Hospitals</u>		
General	2a, c, d, e	2a, c, d, e
Convalescent	2a, c, d, e	2a, c, d, e
<u>Group Quarters</u>	1a, b, c, e	2a, c, e
<u>Hotels/Motels</u>	2a, c	2a, c
<u>Accessory Uses</u>		
Executive Apartments	1a, b, e	2a, e
Caretakers	1a, b, c, e	2a, c, e

Note: See Table 1102.1B for definitions of the entries

TABLE 1102.1B

EXPLANATIONS AND DEFINITIONS ON TABLE 1102.1A

**ACTION REQUIRED TO ENSURE COMPATIBILITY
BETWEEN LAND USE AND NOISE FROM EXTERNAL SOURCES**

1= Allowed if interior and exterior community noise levels can be mitigated.

2 = Allowed if interior levels can be mitigated.

3 = New residential uses are prohibited in areas within the 65-decibel CNEL contour from any airport or air station; allowed in other areas if interior and exterior community noise levels can be mitigated. The prohibition against new residential development excludes limited “infill” development within an established neighborhood.

STANDARDS REQUIRED FOR COMPATIBILITY OF LAND USE AND NOISE

a = Interior Standard: CNEL of less than 45-decibels (habitable rooms only).

b = Exterior Standard: CNEL of less than 65-decibels in outdoor living areas.

c = Interior Standard: $L_{eq}(h)$ = 45 to 65-decibels interior noise level, depending on interior use.

<u>TYPICAL INTERIOR USE (non-residential)</u>	<u>$L_{eq}(h)$</u>
Private Office, Church Sanctuary, College, Preschool, Schools (Grade K-12), Board Room Conference Room, etc.	45
General Office, Reception, Clerical, etc.	50
Schools (Grade K-12)	52
Bank Lobby, Retail Store, Restaurant, Typing Pool, etc.	55
Manufacturing, Kitchen, Warehousing, etc.	65

d = Exterior Standard: $L_{eq}(h)$ of less than 65-decibels in outdoor living areas.

e = Interior Standard: As approved by the Board of Supervisors for sound events of short duration such as aircraft flyovers or individual passing railroad trains.

-continue-

TABLE 1102.1B
-continued-

EXPLANATIONS AND DEFINITIONS ON TABLE 1102.1A

KEY DEFINITIONS

Habitable Room – Any room meeting the requirements of the Uniform Building Code or other applicable regulations which is intended to be used for sleeping, living, cooking or dining purposed, excluding such enclosed spaces as closets, pantries, bath or toilet rooms, service rooms, connecting corridors, laundries, unfinished attics, foyers, storage spaces, cellars, utility rooms and similar spaces.

Interior – Spaces that are covered and largely enclosed by walls.

$L_{eq}(h)$ – The A-weighted equivalent sound level averaged over a period of “h” hours. An example would be $L_{eq}(12)$, where the equivalent sound level is the average over a specified 12-hour period (such as 7:00 a.m. to 7:00 p.m.). Typically, time period “h” is defined to match the hours of operation of a given type of use.

Outdoor Living Area - Outdoor living is a term used by the County of Orange to define spaces that are associated with residential land uses typically used for passive private recreational activities or other noise-sensitive uses. Such spaces include patio areas, barbecue areas, Jacuzzi areas, etc., associated with residential uses; outdoor patient recovery or resting areas associated with hospitals, convalescent hospitals, or rest homes; outdoor school facilities routinely used for educational purposes which may be adversely impacted by noise. Outdoor areas usually not included in this definition are: front yard areas, driveways, greenbelts, maintenance areas, and storage areas associated with residential land uses; exterior areas at hospitals that are not used for patient activities; outdoor areas associated with places of worship and principally used for short-term social gatherings; and outdoor areas associated with school facilities that are not typically associated with educational uses prone to adverse noise impacts (for example, school play yard areas).

CHAPTER 2000 – STREET LIGHTING

Topic 2001 – Lighting Standards

2001.1 Lighting Policy

(1) Non-County Lead – New Development

Street Lighting conforming to adopted County standards is required on streets constructed in conjunction with new private land development projects.

(2) County Constructed Street Improvements

Street Lighting is required only at intersections and as needed for traffic safety purposes. In areas without standard Street Lighting, intersection/safety lighting is only provided based on the recommendation of the Orange County Traffic Committee.

2001.2 Lighting Design Criteria

Street Lighting, where required, shall be provided in accordance with Standard Plan 1411.

REFERENCE CHART OF DESIGN STANDARDS FOR DIFFERENT STREET/HIGHWAY CLASSIFICATIONS

		ARTERIAL HIGHWAYS						COLLECTOR STREETS			LOCAL STREETS			
		PRINCIPAL ARTERIAL HWY.	MAJOR ARTERIAL HWY.	PRIMARY ARTERIAL HWY.	SECONDARY ARTERIAL HWY.	RURAL SECONDARY HWY.	COMMUTER ARTERIAL HWY.	COMM/IND COLLECTOR ST.	RURAL COLLECTOR ST.	RESIDENTIAL COLLECTOR ST.	COMMERCIAL LOCAL ST.	RURAL LOCAL ST.	RESIDENTIAL LOCAL ST.	
ORANGE COUNTY RDMD STANDARD PLAN REF. (UNLESS OTHERWISE NOTED)		1100	1101	1103	1105	1108	1107	1107	1109	1107	1107	1110	1107	
PLANNED CAPACITY (ADT) /LOS		40,000 TO 60,000/C	30,000 TO 45,000/C	20,000 TO 30,000/C	10,000 TO 20,000/C	10,000 TO 20,000/C	4,000 TO 10,000/C	4,000 TO 10,000	1,200 TO 6,000	1,200 TO 6,000	<4,000	<1,200	<1,200	
DESIGN SPEED (MPH)		60	60	55	50	50	45	35			25			
HORIZONTAL ALIGNMENT	MINIMUM CURVE RADIUS¹ (FEET)	2350	2350	1800	1400	1400	1100	550			250			
	MAXIMUM SUPERELEVATION (%)	6						6	6	NOT RECOM- MENDED	6	NOT RECOM- MENDED	NOT RECOM- MENDED	
	SIDE FRICTION FACTOR	0.12	0.12	0.13	0.14	0.14	0.15	0.17			0.17			
	MINIMUM STOPPING SIGHT DISTANCE² (FEET)	580	580	500	430	430	360	250			150			
	MINIMUM LENGTH OF VERTICAL CURVE (FEET)	200						SEE TOPIC 204.4			SEE TOPIC 204.4			
VERTICAL ALIGNMENT	GRADE	BREAK (%)	0.5 MAXIMUM³						0.5 MAXIMUM³			0.5 MAXIMUM³		
		MAX. (%)	6						10			10		
		MIN. (%)	1						1			1		
		NUMBER OF LANES (UNDIVIDED UNLESS OTHERWISE NOTED)	8 DIVIDED	6 DIVIDED	4 DIVIDED	4	4	2	4	2	2	2 OR 4	2	2
CROSS SECTION ELEMENTS	RIGHT OF WAY WIDTH (FEET)	144	120	100	80⁵	80⁵	56	80	60	56	60	50	VARIES	
	PAVEMENT WIDTH⁶ (FEET)	126	102	84	64⁵	(EP-EP)⁶	40	64	49 (EP-EP)⁶	40	44	36 (EP-EP)⁶	VARIES	
	STANDARD MEDIAN WIDTH⁷	14	14	14	NONE	NONE	NONE	NONE			NONE			
	BRIDGE WIDTH (FEET)	128 (SP1100)	104 (SP1102)	86 (SP1104)	76 (SP1104)	—	—	—			—			
	PARKWAY WIDTH (FEET)	9	9	8	8	8	8	8			8	6	VARIES	
	SIDEWALK WIDTH (FEET) (WITHIN PARKWAY)	9	9	8	8	NONE	8	8	NONE	8	8	NONE	FULL PKWY.⁸	
	CURBS & GUTTERS⁹	A2-8	A2-8	A2-8	A2-8	NONE	A2-6	A2-8	NONE	A2-6	A2-6	NONE	A2-6	
	ELECTROLIER SPACING (FEET) (SEE S.P. 1411)	200¹⁰	200¹⁰	200	200	200	200	200			300			

1. WITHOUT SUPERELEVATION.
2. MINIMUM STOPPING SIGHT DISTANCE APPLIES TO BOTH HORIZONTAL AND VERTICAL CURVES.
3. FOR VARIATIONS IN GRADE BREAKS AND MINIMUM TANGENT DISTANCES SEE TOPIC 204.4 OF ORANGE COUNTY HIGHWAY DESIGN MANUAL.
4. SEE STANDARD PLANS AND CIRCULATION PLAN FOR VARIATIONS.
5. INCREASE BY 10' FOR TURN POCKET AT INTERSECTION WITH ARTERIALS.
6. MEASURED FROM OUTSIDE CURB FACE TO OUTSIDE CURB FACE EXCEPT RURAL HIGHWAYS WHICH ARE FROM EDGE OF PAV'T TO EDGE OF PAV'T.
7. RAISED MEDIANS, WHILE NOT PREFERRED, SHOULD CONFORM TO TOPIC 305 OF ORANGE COUNTY HIGHWAY DESIGN MANUAL.
8. 4' MINIMUM CLEAR DISTANCE (DOES NOT INCLUDE WIDTH OF CURB).
9. RAISED MEDIANS ON ARTERIAL HIGHWAYS, USE TYPE A1-8 CURB.
10. 180' WITH RAISED MEDIAN.