City of Belmont Stop Sign Warrant Policy

Prepared for

City of Belmont

By

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The following policy includes the recommended updates of the existing all-way stop policy, and the research findings of criteria and guidelines for establishing a stop sign warrant policy for the installation of single-stop signs, 2-way stop signs on minor streets, and 3-way stop signs at T-intersections within the City of Belmont.

Criteria for Establishing Stop-Sign Policies

The City of Belmont currently does not have adopted policies for the installation of single-stop signs, 2-way stop signs on minor streets, and stop-signs for T-intersections. The California Manual on Uniform Traffic Control Devices 2010 (CA-MUTCD) does not establish criteria for these types of installations but does provide standards for multi-way stop intersections as well as general applications for stop and yield signs.

DKS conducted a literature research of four (4) cities for their thresholds and criteria for these types of installations. City engineers from the Town of Danville, City of Dixon, City of Palo Alto, and City of San Mateo discussed stop sign installation issues in their cities and provided DKS with their installation policies and/or warrants.

Summary of Findings

The following table summarizes our findings about other cities' established stop-sign policies.

Danville	Caltrans Traffic Manual 2004[1]	Engineering Judgment[2]	Engineering Judgment[2]	Engineering Judgment[2]
Dixon	Warrants and standards adopted by the City of Dixon			
Palo Alto	Caltrans Traffic Manual 2004[1,3]	Engineering Judgment[2]	Engineering Judgment[2]	Engineering Judgment[2]
San Mateo	CA MUTCD 2006[4,5]	Engineering Judgment[2]	Engineering Judgment[2]	Engineering Judgment[2]

1 Chapter 4—Signs of the Caltrans Traffic Manual is superseded by the CA MUTCD 2006.
2 City engineers use engineering judgment on a case-by-case basis.
3 The City of Palo Alto has additional criteria from adopted warrants for traffic control devices near schools.
4 City of San Mateo has established a reduction factor for the CA MUTCD standards for residential areas.
5 The CA MUTCD 2006 is superseded by the CA MUTCD 2010.

Established Policies for All-Way Stops

All of the cities have established polices for all-way stop criteria, with the Town of Danville and the City of Palo Alto both retaining the 2004 Caltrans Traffic Manual criteria. The Caltrans warrant for multi-way stop sign analysis states that any of the following conditions may warrant a multi-way stop installation:

1. Where traffic signals are warranted and urgently needed, the multi-way stop may be an interim measure that can be installed quickly to control traffic while arrangements are being made for the signal installations.
2. An accident problem, as indicated by five or more reported accidents within a 12 month period of a type susceptible to correction by a multi-way stop installation. Such accidents include right-turn and left-turn collisions as well as right-angle collisions.
3. Minimum Traffic Volumes

a. The total vehicular volumes entering the intersections from all approaches must average at least 500 vehicles per hour for any 8 hours of an average day, and

b. The combined vehicular and pedestrian volumes from the minor street or highway must average at least 200 vehicles per hour from the same 8 hours, with an average delay to minor street vehicular traffic of at least 30 seconds per vehicle during the maximum hour, but

c. When the 85-percentile approach speed of the major street traffic exceeds 40 miles per hour, the minimum vehicular volume warrant is 70 percent of the above requirements

The criterion in the 2004 Caltrans Traffic Manual is superseded by the 2006 edition of the CA MUTCD. Criterion 1 and 2 are retained, while modifications have been made to Criterion 3. Notable changes to minimum vehicular and pedestrian volumes can be viewed in Section 2B.07-C:

Minimum Volumes

a. The vehicular volume entering the intersection from the major street approaches (total of both approaches) averages at least 300 vehicles per hour for any 8 hours of an average day, and

b. The combined vehicular, pedestrian, and bicycle volume entering the intersection from the minor street approaches (total of both approaches) averages at least 200 vehicles per hour for the same 8 hours, with an average delay to minor-street vehicular traffic of at least 30 seconds per vehicle during the highest hour, but

c. If the 85th-percentile approach speed of the major street traffic exceeds 40 miles per hour, the minimum vehicular volume warrants are 70 percent of the above values.

4. Where no single criterion is satisfied, but where Criteria 2, 3a, and 3b are all satisfied to 80 percent of the minimum values. Criterion 3c is excluded from this condition.

The all-way stop criterion for the City of San Mateo is consistent with the 2006 CA MUTCD, which has been superseded by the 2010 CA MUTCD. There were no updates to the criterion from the 2006 to the 2010 editions of the CA MUTCD.

Additionally, the City of Palo Alto also has provisions for intersections near schools. This criteria state that the maximum delay a child should be expected to accept should not be greater than that which would be experienced if a traffic control signal, timed so as to provide an adequate crossing interval, were located at the crossing under study. Secondly, some form of device is essential when the number of adequate gaps in the traffic stream during the period the children are using the crosswalk is less than the number of minutes in the same period of time. That is, gaps less frequent than one per minute represent a situation that may require some form of warning or control device or measure.

One of these control devices is to turn the intersection to stop-controlled if the conditions of traffic for non-control measures are exceeded. These school pedestrian non-control measures include:

1. Types available: Signs and Markings, Flashing Signals, Pedestrian Walkways, Variable Speed Zones

2. The above devices will be installed at those school locations wherein the condition of traffic, i.e., speed, volume, street width and vehicle gap, having been reviewed by an engineering survey, are found to:

a. Produce frequent and adequate vehicle gaps such that pedestrians may safely cross the street without additional controls being present.

b. The unobstructed sight distance to the crosswalk is more than that shown for speeds indicated:

Speed (mph)	Unobstructed Sight Distance to Crosswalk (feet)
25	170
30	200
35	235
40	275

Source: City of Palo Alto.

It should be noted that this table is included in the City of Palo Alto's Multiway Stop Sign Evaluation Form. The vehicle speeds and corresponding unobstructed sight distance to crosswalk are based on engineering judgment form the City of Palo Alto. Given the sensitivity to a school zone area, the unobstructed sight distances to crosswalks are lower those provided in Exhibit 9-55 Design Intersection Sight Distance recommended in the AASHTO Geometric Design of Highways and Street 2004 manual.

The City of Dixon has 3 warrants for the evaluation of multi-way stop warrants. A stop sign installation may be considered if one or more of the following warrants are true.

1. Warrant 1 determines whether an intersection is in a residential or non-residential area based on speed limits, roadway width, and sight distances. The volume warrant for the corresponding land use is then completed.

	Residential Area Volume Warrant	Non-Residential Area Volume Warrant
Total Vehicular Volume from All Approaches[1]	180 vph[2] for any 8 hours of an average day[3]	300 vph[2] for any 8 hours of an average day
Vehicular Volume from Minor Street(s) [1]	72 vph[2] per the same 8 hours as above	120 vph[2] per the same 8 hours as above

1. The vehicular volumes used in the City of Dixon are based off of engineering judgment and experience in the field.
2. vph = vehicles per hour
3. Implies the 8 hours with the highest vph, consecutive or non-consecutive.

2. Warrant 2 is adopted from the accident warrant in the CA MUTCD for multi-way intersections and states that a minimum of 5 accidents have occurred within a 12 month period that are susceptible to correction by the installation of a multi-way stop.

3. Warrant 3 is based on the City's standards for stopping sight distance on the major street and states that the stopping distance on the major street approach(es) for vehicles of pedestrians crossing the street at the intersection is less than the standard used by the City of Dixon.

Established Policies for Single-Stop Sign and 2-Way Stop Signs on Minor Streets

The Town of Danville and the City of Palo Alto do not have criteria for the installation of a single-stop and 2-stop signs on minor streets and therefore use engineering judgment on a

case-by-case basis. This includes but is not limited to accident frequency, vehicular, pedestrian, and bicycle volume, sight distance, and intersection geometry.

The City of Dixon has criteria which are also reliant on engineering judgment but has more defined guidelines which state a stop sign may be warranted:

At the intersection of a minor street with a major street where application of the normal-right-of way rule is unduly hazardous; or

1. On a street entering an arterial or collector; or
2. An intersection where a combination of high speed, restricted view, and accident records indicates the need for control by the stop sign.

In these situations, the City of Dixon also considers the installation of yield signs instead of stop signs based on the criteria in the CA MUTCD Section 2B.09.

The City of San Mateo currently has a more defined criterion for single-stop installations on the minor leg of a T-intersection:

> Stop signs may be erected at the intersection of the minor leg of a three-legged intersection, or where a minor street meets a major arterial, or collector street. A minimum of 25 vehicles per hour shall be observed on the minor leg approach for this criterion to be satisfied.

Established Policies for Stop Signs for T-Intersection

None of the cities surveyed, with the exception of the City of Dixon, have criteria for the installation of stop signs for a T-intersection and therefore use engineering judgment on a case-by-case basis.

As mentioned in the Established Policies for All-Way Stops section, the City of Dixon has criterion for multi-way stop warrants. These three warrants evaluate the vehicular volume from minor approaches or all approaches for residential or non-residential areas, the number of accidents within a 12 month periods which would be susceptible to correction with the installation of a multi-way stop, and determine if the City's standards for stop distances are followed. The vehicular volumes in Warrant 1 are reduced for the case of a three-way intersection, but Warrants 2 and 3 are consistent with those of a multi-way stop. A stop sign installation may be considered if one or more of the three warrants are true.

	Residential Area Volume Warrant	**Non-Residential Area Volume Warrant**
Total Vehicular Volume from All Approaches[2]	135 vph[1] for any 8 hours of an average day	225 vph[1] for any 8 hours of an average day
Vehicular Volume from Minor Street(s) [2]	54 vph[1] per the same 8 hours as above	90 vph[1] per the same 8 hours as above

1 vph = vehicles per hour
2 The vehicular volumes used in the City of Dixon are based off of engineering judgment and experience in the field.

Final Stop-Sign Policy for City of Belmont

The following outlines the proposed criteria for the installation of all-way stop signs, 3 stop signs at T-intersections, 2-way stop signs on minor streets, and single-stop locations. Updates to the existing all-way stop sign policy are indicated in bold. Stop sign installations may be considered if ANY of the following conditions exist:

1. **Traffic and Pedestrian Volumes**

   a. The minimum hourly average (for any eight hours) vehicular volume entering the intersection from all approaches on an average day and the vehicular volume entering the intersection from the minor street or streets for the same eight hours must meet the following criterion:

	Minimum Hourly Average (vehicles per hour) [1]	**Vehicular Volume from Minor Street(s) (fraction of total volume per hour minimum)**
All-Way Stop Signs	300	1/3
3-Way Stop Signs on T- Intersections	225	1/4
2-Way Stop Signs on Minor Streets	300	1/5
Single-Stop Signs on Minor Streets	225	1/4

1. The minimum hourly average is for any eight hours, consecutive or non-consecutive.

   b. The minimum hourly average (for any eight hours) vehicular volume entering the intersection on the major approach and the pedestrian volume per hour crossing during the same eight hours must meet the following criterion.

	Minimum Hourly Average (vehicles per hour)	**Pedestrian Volume (pedestrians per hour)**
All-Way Stop Signs	150	75 crossing the major approach
3-Way Stop Signs on T-Intersections	60	30 crossing the major approach
2-Way Stop Signs on Minor Streets	40	30 crossing the minor approach
Single-Stop Signs	100	30 crossing the minor approach

2. **Accident History**

   3 or more types susceptible to correction by stop signs within a 12-month period, with satisfactory observance and enforcement of less restrictive control.

3. **Sight Distances**

   The straight line sight distance (the length of roadway in a straight line that is visible to the driver) of one or more approaches of the major street for vehicles or pedestrians crossing the intersection is less than 150 feet, or if the stopping sight distance (the distance traveled when a vehicle driver is required to stop) for roadways with

approach grades of +/- 3% for vehicles on one or more approaches of the major street does not meet the 2004 edition of the American Association of State Highway and Transportation Officials' (AASHTO) *A Policy on Geometric Design and Highways and Streets*.

Speed (mph)	15	20	25	30	35	40	45
Stopping Distance (ft)	80	115	155	200	250	305	360

Source: Exhibit 9-55: Design Intersection Sight Distance – Case B1 – Left Turn from Stop
These design speeds and design stopping distances are for roadways with grades between -3% and 3%, but guidelines for roadways on steeper grade are also included in AASHTO and can be calculated by adjusting the time gap for the design vehicle and the resulting intersection site distance.

For approach grades steeper than +/- 3%, the following table provides adjustment factors with respect to the appropriate approach grade.

	Speed (mph)						
Approach Grade (%)	15	20	25	30	35	40	45
-6	1.1	1.1	1.1	1.1	1.1	1.1	1.1
-5	1.0	1.0	1.1	1.1	1.1	1.1	1.1
-4	1.0	1.0	1.0	1.1	1.1	1.1	1.1
-3 to +3	1.0	1.0	1.0	1.0	1.0	1.0	1.0
+4	1.0	1.0	1.0	1.0	1.0	0.9	0.9
+5	1.0	1.0	1.0	1.0	0.9	0.9	0.9
+6	1.0	1.0	0.9	0.9	0.9	0.9	0.9

Source: Exhibit 9-53: Adjustment Factors for Sight Distance Based on Approach Grade
Note: Based on ratio of stopping sight distance on specified approach grade to stopping sight distance on level terrain

4. **High–Pedestrian Generators**

   High concentrations of pedestrian traffic in areas such as in the vicinity of schools, playgrounds, and shopping centers.

5. **Visible Signs of Traffic Issues**

   Skid marks, fixed object collisions, and other potential traffic problems.

6. **Traffic Volume Equilibrium**

   The intersection approach volumes for the major and minor streets near equilibrium as determined by the City of Belmont staff. Typically, intersection equilibrium for an intersection is reached when approach volumes for the minor/major legs reach 45%/55% of the total intersection volume.