

## Appendix H. Free Flow Speed Surveys

Floating car surveys were conducted on the Tier 2 network for the first time in 2012. However, in 2012 it was not possible to calculate the LOS without additional free flow speed information, which was needed in order to classify each arterial segment into a HCM arterial class. Therefore Alameda CTC also carried out free flow speed surveys in 2014. This section details the methodology and results of the free flow speed data collection and analysis.

The purpose of this section is to:

- Determine the hours of the day in which free flow speed surveys can occur for both floating car surveys and when using Inrix data;
- Describe the methodology used for analyzing the Free Flow Speed on Tier 2 network; and
- Present the free flow speed results and corresponding roadway class for CMP segments where INRIX data is used.

### H.1 | Background

Per the defined scope of work for 2014 LOS monitoring, performance data is being collected for Tier 2 network using both floating car surveys and INRIX data. Where INRIX data is utilized for LOS monitoring, INRIX data is also used to determine the free flow speed. Similarly, floating car run surveys would be conducted on the remaining Tier 2 CMP segments for both LOS monitoring and free flow analysis.

### H.2 | Determination of Hours for Free Flow Speed Measurements

Prior to free flow speed data collection, it was necessary to determine the hours in which free flow speed data can be collected.

The FHWA information guide<sup>4</sup> on speed concepts defines free flow speed as the speeds at which vehicles are operating during free flow conditions unimpeded by traffic control devices or by other vehicles. The 85th percentile of the distribution of observed speeds is the most frequently used measure of the operating speed. The 85th percentile speed is typically measured during hours when drivers can travel freely, but still perceive there is a chance of enforcement. Therefore hours of the day such as 2am are often excluded as speeding behavior is more prominent. This factor was kept in mind when analyzing Inrix data.

Distributions of speed for a sample of 24 CMP segments with INRIX data were reviewed to determine reasonable times for off peak speeds. This exploratory analysis was performed using both the weekday and weekend data for the sample segments. For weekend data, no evident peaks or patterns were noted and therefore weekend data was disregarded for the purposes of the free flow speed analysis. However the weekday data more evidently indicated a non-peak period in between the AM/PM peak periods. Note that some CMP segments had a nearly uniform speed distribution throughout the day.

Based on this exploratory analysis, majority of the CMP segments were observed to have free flow speeds spread during the following hours:

- Prior to 6:30 AM

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<sup>4</sup> Federal Highway Administration (FHWA). Speed Concepts: Information Guide. September 2009

- Between 9:30 AM and 12:00 PM
- After 8:00 PM

Lastly, these time periods were modified to account the local behavior in certain parts of the county. **Table H-1** summarizes the finalized time periods for conducting the free flow speed surveys utilizing the floating car survey method:

**Table H-1: Proposed Time Periods for conducting Free Flow Speed Surveys (Floating car method)**

| <b>For Oakland (CMPs north of 14th Av), Berkeley, Albany, Emeryville Area</b> | <b>For all other Tier 2 CMP segments:</b>                         |
|---|---|
| Prior to 6:30 AM<br>After 8:00 PM   | Prior to 6:30 AM<br>Between 9:30 AM and 12:00 PM<br>After 8:00 PM |

Note that while fields labelled in the INRIX data as 85<sup>th</sup> percentile speed were explored, they were disregarded as they were more similar to maximum speed.

Floating car surveys are conducted in accordance with the road rules (i.e. speed limit) and therefore it is only necessary to identify times of low traffic volumes so that the survey vehicle can travel unimpeded. This is the reason why overnight times can be utilized, even though many of the other vehicles could be speeding. This differs for commercial speed data as it captures the actual driving behavior of the population; however this free flow analysis should not include excessive speeding. The next section discusses the monitoring times periods for free flow analysis using Inrix data.

### H.2.1 | Monitoring Time Period & Days with Commercial Speed Data

Monitoring time periods for commercial speed data were also determined based on the analysis described in the previous section; however it was necessary to exclude times impacted by excessive speeding behavior.

Using INRIX data, it was possible to achieve an adequate sample size using the data obtained from the time periods between 6:00 am to 6:30 am and 8:00 pm to 9:00 pm for majority of the segments. Hence, the time periods prior to 6:00 AM, after 9:00 PM and in between 9:30 AM and 12:00 PM were excluded in INRIX data analysis. This ensures that the obtained results better represent the free flow speeds during off-peak hours. Refer to **Table H-2**.

**Table H-2: Time Periods for analyzing INRIX Data**

| <b>For all other Tier 2 CMP segments:</b> |
|---|
| 6:00 AM to 6:30 AM<br>8:00 PM to 9:00 PM  |

Additionally, the data for the free flow analysis was processed to include only the weekdays during the months of January to April during 2014. It may be noted that this includes additional months of January and February that are not used in the actual monitoring months for this project. Since, the objective of the free flow analysis is to categorize Tier 2 segments, it was deemed appropriate to include all the available months in 2014 to obtain better representative results that ensures accurate classification of Tier 2 segments.

### H.3 | Analysis

INRIX data was used to analyze and obtain free flow speed on 124 Tier 2 CMP segments. The processing and aggregation methods used were similar to those used for the normal LOS monitoring. Free flow speed measurements were obtained from floating car surveys on the remainder of the segments. These results are shown in **Table H-7**.

### H.4 | Defining the Arterial Class

#### H.4.1 | HCM 1985 and 2000 Guidelines

Arterial or urban street class is a key input to calculating the LOS using HCM 1985/2000 guidelines. In HCM these classes are designated using the numbers I, II, III and IV (IV applicable only to HCM 2000). HCM provides several guidelines to determine these classes. **Table H-3** and **Table H-4** provide two such preliminary guidelines available in HCM 1985 and HCM 2000.

**Table H-3: Arterial Class based on Free Flow Speed (Source: Table 11-1 HCM 1985)**

| Arterial Class                 | I        | II       | III      |
|--------------------------------|----------|----------|----------|
| Range of Free Flow Speed (mph) | 45 to 35 | 35 to 30 | 35 to 25 |
| Typical Free Flow Speed (mph)  | 40       | 33       | 27       |

**Table H-4: Arterial Class based on Free Flow Speed (Source: Exhibit 15-2 HCM 2000)**

| Arterial Class                 | I        | II       | III      | IV       |
|--------------------------------|----------|----------|----------|----------|
| Range of Free Flow Speed (mph) | 55 to 45 | 45 to 35 | 35 to 30 | 35 to 25 |
| Typical Free Flow Speed (mph)  | 50       | 40       | 35       | 30       |

Based on the free flow speed analysis results discussed in the previous section, **Table H-3** and **Table H-4** were used as the preliminary source of reference to classify arterials (Tier 2). As seen in these tables, Class I per HCM 1985 and Classes I and II per HCM 2000 were less ambiguous in their definition of speed bins. Classes II and III per HCM 1985 and Classes III and IV per HCM 2000 have speed bins that overlap each other. This implies that free flow speed between 30 mph to 35 mph could be classified under Class II/III per HCM 1985 or Class III/IV per HCM 2000. Further guidelines from HCM were reviewed to determine the arterials classes for such CMP segments with overlapping speed bins. These additional guidelines include the functional and design category definitions/criteria as shown in **Table H-5** and **Table H-6**. Such guidelines were also used to review CMP segments that have free flow speeds in the vicinity of the upper or lower limit of the bins (i.e., in the vicinity of 45 mph, 35 mph etc).

It may be noted that HCM definition of free flow speed excludes control delay. On the other hand, this delay may be captured in the free flow speed results from INRIX or floating car runs. Hence, speed alone may not be sufficient to determine the correct classification of the segments. To account for this, apart from using the function and design category guidelines, additional review was also undertaken as described in the next section.

**Table H-5: Function and Design Categories for Arterials (Source: Table 11-2 HCM 1985)**

| Criteria                 | Functional Category  |  |
|--------------------------|--|--|
|                          | Principal Arterials  | Minor Arterials  |
| Mobility function        | Very important   | Important  |
| Access function          | Very minor   | Substantial  |
| Points connected         | Freeways, important activity centers, major traffic generators   | Principal arterials  |
| Predominant trips served | Relatively long trips between above points and through trips entering, leaving, and going through the city | Trips of moderate lengths within relatively small geographical areas |

  

| Criteria                 | Design Category   |   |   |
|--------------------------|---|---|---|
|                          | Suburban Design   | Intermediate                                      | Urban Design                                  |
| Control of access        | Partial to almost full                                  | Partial   | Little or no control                          |
| Arterial type            | Multilane divided; undivided or two-lane with shoulders | Multilane divided or undivided; one-way; two-lane | Undivided one-way; two-way, two or more lanes |
| Parking                  | No parking  | Some parking                                      | Parking permitted                             |
| Separate left-turn lanes | Yes   | Some  | No  |
| Signals per mile         | 1 to 4  | 4 to 8  | 8 to 12                                       |
| Speed limits             | 40 to 45 mph  | 30 to 40 mph                                      | 25 to 35 mph                                  |
| Pedestrian interference  | None  | None  | Some  |
| Roadside development     | Low density   | Moderate  | High density                                  |

**Table H-6: Definitions for Arterial Classifications (Source: Table 11-3 HCM 1985)**

| Design Category                     | Functional Category |                |
|-------------------------------------|---------------------|----------------|
|                                     | Principal Arterial  | Minor Arterial |
| Typical Suburban Design and Control | I                   | II             |
| Intermediate Design                 | II                  | III            |
| Typical Urban Design                | III                 | III            |

#### H.4.2 | Additional Examination/Review

As a final step, Iteris used its professional judgment to review the classes for all the CMP segments. For this, virtual survey was performed using aerial imagery and the Google street view to understand the existing field conditions. Based on this survey coupled with local knowledge, classes were re-assigned to some of the CMP segments (based on **Table H-5** and **Table H-6**).

Following are several examples to illustrate the thought process and decisions in re-assigning the classes of some of the segments:

- Example 1: For the CMP segments T17/T24 along Broadway between College Ave and Grand Avenue in Oakland, the calculated free flow speed was around 21 mph based on INRIX data. If **Table H-3** and **Table H-4** were used, these segments would be classified as Class IV/Class III per HCM 2000/1985. However, these segments are not located in the

downtown district and also have a median with two or more lanes in each direction. The adjacent land use development is also generally less pedestrian-oriented than in downtown. Using these findings, the two CMP segments were re-classified to Class III/Class II per HCM 2000/1985.

- Example 2: Similar reasoning noted in Example 1 was used to re-classify the following CMPs along Foothill Boulevard in Oakland. The Classification for CMPs T53/T64, T57/T60, and T58/T65 was changed from Class IV/III to Class III/II.
- Example 3: For CMP segments T144 to T151 along Dublin Boulevard in Dublin, the calculated free flow speeds were between 24 mph to 34 mph. Per **Table H-3** and **Table H-4**, these segments would be classified as Class IV/Class III per HCM 2000/1985. However, most of these segments have two or more lanes in each direction divided by a median with adjacent auto-oriented development. Additionally, the speed limits are noted to be 45 mph/40 mph. Based on these findings T144/T151 and T145/T150 were re-classified to Class III/Class II, and T146/T149 and T147/T148 to Class II/I per HCM 2000/1985.

During this process, care was taken to ensure that same class was assigned to the adjacent CMP segments with similar characteristics along a corridor. Further, the same class was assigned to arterials which run between the same start and end points but travel in opposite directions. Adjustments were also made to a few CMP segments that are rural in nature. Unlike urban arterial segments, rural roadways segments do not have different categories per HCM 1985 and HCM 2000. These segments were simply classified as rural.

Based on this analysis, the final recommended classification for each CMP segment is included in **Table H-7** along with the free flow speed results.

Note that the free flow speeds for the following segments have been updated to use the AM peak period survey data: T43, T46, T132, T133, T135, T167, T168 and T172. This was based on additional review of the results that indicated free flow speeds to be lower than the AM peak period speeds. This could be due to non-recurring congestion during the free flow survey hours.

Table H-7: Free Flow Speed Results

| #   | Route  | From                              | To                                | Jurisdiction | Sample Size | Average Speed | HCM Class |      |
|-----|--|-----------------------------------|-----------------------------------|--------------|-------------|---------------|-----------|------|
|     |  |                                   |                                   |              |             |               | 1985      | 2000 |
| T1  | W.Grand Ave - Grand Ave -EB                      | I-80/Maritime St                  | San Pablo Ave                     | Oak          | 651         | 26.6          | 2         | 3    |
| T2  | W.Grand Ave - Grand Ave -EB                      | San Pablo Ave                     | Broadway                          | Oak          | 2235        | 19.9          | 3         | 4    |
| T3  | W.Grand Ave - Grand Ave -EB                      | Broadway                          | I-580                             | Oak          | 501         | 21.6          | 3         | 4    |
| T4  | W.Grand Ave - Grand Ave -WB                      | I-580                             | Broadway                          | Oak          | 409         | 21.5          | 3         | 4    |
| T5  | W.Grand Ave - Grand Ave -WB                      | Broadway                          | San Pablo Ave                     | Oak          | 868         | 20.8          | 3         | 4    |
| T6  | W.Grand Ave - Grand Ave -WB                      | San Pablo Ave                     | I-80/Maritime St                  | Oak          | 393         | 28.3          | 2         | 3    |
| T7  | 11th St - Lake Merritt Blvd - Lakeshore Ave-EB   | I-980 ON Ramp/Brush St            | Webster                           | Oak          | 4           | 14.4          | 3         | 4    |
| T8  | 11th St - Lake Merritt Blvd - Lakeshore Ave-EB * | Webster                           | East side of Lake Merritt Channel | Oak          | 4           | 14.7          | 3         | 4    |
| T9  | 11th St - Lake Merritt Blvd - Lakeshore Ave-EB   | East side of Lake Merritt Channel | MacArthur Blvd/I-580 ON Ramp      | Oak          | 4           | 16.7          | 3         | 4    |
| T10 | 12th St - Lake Merritt Blvd - Lakeshore Ave-WB   | MacArthur Blvd/I-580 ON Ramp      | East side of Lake Merritt Channel | Oak          | 4           | 16.8          | 3         | 4    |
| T11 | 12th St - Lake Merritt Blvd - Lakeshore Ave-WB * | East side of Lake Merritt Channel | Webster                           | Oak          | 4           | 15.9          | 3         | 4    |
| T12 | 12th St - Lake Merritt Blvd - Lakeshore Ave-WB   | Webster                           | I-980 OFF Ramp/Brush St           | Oak          | 4           | 17.4          | 3         | 4    |
| T13 | Telegraph Ave-NB *                               | 51st Street                       | Russell St                        | Oak, Berk    | 4           | 15.0          | 3         | 4    |
| T14 | Telegraph Ave-NB *                               | Russell St                        | Bancroft Way                      | Berk         | 4           | 13.5          | 3         | 4    |
| T15 | Telegraph Ave-SB *                               | Bancroft Way                      | Russell St                        | Berk         | 4           | 13.9          | 3         | 4    |
| T16 | Telegraph Ave-SB                                 | Russell St                        | 51st Street                       | Oak, Berk    | 4           | 18.5          | 3         | 4    |
| T17 | Broadway-SB                                      | Broadway/College Ave              | Grand Ave                         | Oak          | 480         | 20.8          | 2         | 3    |
| T18 | Broadway-SB                                      | Grand Ave                         | 14th St                           | Oak          | 506         | 18.2          | 3         | 4    |
| T19 | Broadway-SB                                      | 14th St                           | 5th St/Broadway                   | Oak          | 1060        | 17.9          | 3         | 4    |
| T20 | Broadway (Connection to I-880)-SB *              | 5th St/Broadway                   | I-880 ON Ramp                     | Oak          | 6945        | 62.9          | 1         | 1    |
| T21 | Broadway (Connection to I-880)-NB                | I-880 OFF Ramp                    | 5th St/Broadway                   | Oak          | 4           | 23.0          | 1         | 2    |
| T22 | Broadway-NB                                      | 5th St/Broadway                   | 14th St                           | Oak          | 1209        | 17.1          | 3         | 4    |
| T23 | Broadway-NB                                      | 14th St                           | Grand Ave                         | Oak          | 899         | 18.3          | 3         | 4    |
| T24 | Broadway-NB                                      | Grand Ave                         | Broadway/College Ave              | Oak          | 393         | 21.9          | 2         | 3    |
| T25 | Durant-EB  | Shattuck                          | College Ave.                      | Berk         | 4           | 16.0          | 3         | 4    |
| T26 | College Avenue-SB                                | Bancroft Way/College Ave          | Ashby Ave                         | Berk         | 573         | 16.8          | 3         | 4    |
| T27 | College Avenue-SB                                | Ashby Ave                         | Miles Ave/SR 24 OFF Ramp          | Oak, Berk    | 278         | 19.7          | 3         | 4    |
| T28 | College Avenue-SB                                | Miles Ave/SR 24 OFF Ramp          | Broadway/College Ave              | Oak          | 540         | 16.7          | 3         | 4    |
| T29 | College Avenue-NB                                | Broadway/College Ave              | Miles Ave/SR 24 OFF Ramp          | Oak          | 641         | 17.0          | 3         | 4    |
| T30 | College Avenue-NB                                | Miles Ave/SR 24 OFF Ramp          | Ashby Ave                         | Oak, Berk    | 574         | 18.3          | 3         | 4    |

## Appendix H. Free Flow Speed Surveys

**Table H-7: Free Flow Speed Results**

| #   | Route                             | From                                | To                                  | Jurisdiction | Sample Size | Average Speed | HCM Class |      |
|-----|-----------------------------------|-------------------------------------|-------------------------------------|--------------|-------------|---------------|-----------|------|
|     |                                   |                                     |                                     |              |             |               | 1985      | 2000 |
| T31 | College Avenue-NB                 | Ashby Ave                           | Bancroft Way/College Ave            | Berk         | 703         | 16.8          | 3         | 4    |
| T32 | Bancroft-WB                       | College Ave.                        | Shattuck                            | Berk         | 4           | 12.5          | 3         | 4    |
| T33 | 51st Street-EB *                  | SR 24 Off Ramp/52nd St              | Broadway                            | Oak          | 4           | 15.0          | 3         | 4    |
| T34 | 51st Street-WB *                  | Broadway                            | SR 24 Off Ramp/52nd St              | Oak          | 4           | 15.7          | 3         | 4    |
| T35 | Shattuck Avenue-NB                | 51 <sup>st</sup>                    | Alcatraz Ave.                       | Oak, Berk    | 4           | 22.8          | 3         | 4    |
| T36 | Shattuck Avenue-NB                | Alcatraz Ave.                       | Adeline St.                         | Berk         | 4           | 16.7          | 3         | 4    |
| T37 | Shattuck Avenue-SB                | Adeline St.                         | Alcatraz Ave.                       | Berk         | 4           | 17.1          | 3         | 4    |
| T38 | Shattuck Avenue-SB                | Alcatraz Ave.                       | 51 <sup>st</sup>                    | Oak          | 4           | 17.3          | 3         | 4    |
| T39 | Powel Street-Stanford Avenue-EB * | NB I-80 OFF Ramp                    | San Pablo Ave                       | Emery        | 4           | 15.5          | 2         | 3    |
| T40 | Powel Street-Stanford Avenue-EB   | San Pablo Ave                       | MLK Jr Way                          | Oak, Berk    | 4           | 17.0          | 2         | 3    |
| T41 | Powel Street-Stanford Avenue-WB * | MLK Jr Way                          | San Pablo Ave                       | Oak, Berk    | 4           | 19.1          | 2         | 3    |
| T42 | Powel Street-Stanford Avenue-WB   | San Pablo Ave                       | NB I-80 OFF Ramp                    | Emery, Oak   | 4           | 15.3          | 2         | 3    |
| T43 | 40thStreet-Shellmound Avenue-EB * | Shellmound Way (north of Powell St) | 40th St                             | Emery        | 7           | 24.6          | 2         | 3    |
| T44 | 40thStreet-Shellmound Avenue-EB * | 40th St                             | San Pablo Ave                       | Emery        | 4           | 16.5          | 3         | 4    |
| T45 | 40thStreet-Shellmound Avenue-WB * | San Pablo Ave                       | 40th St                             | Emery        | 4           | 22.0          | 3         | 4    |
| T46 | 40thStreet-Shellmound Avenue-WB * | 40th St                             | Shellmound Way (north of Powell St) | Emery        | 7           | 29.0          | 2         | 3    |
| T47 | International Boulevard-NB        | 42nd Ave                            | Fruitvale Ave                       | Oak          | 893         | 21.9          | 3         | 4    |
| T48 | International Boulevard-NB        | Fruitvale Ave                       | 14th Ave                            | Oak          | 365         | 22.9          | 3         | 4    |
| T49 | International Boulevard-NB        | 14th Ave                            | Lake Merritt Blvd                   | Oak          | 487         | 22.5          | 3         | 4    |
| T50 | International Boulevard-SB        | Lake Merritt Blvd                   | 14th Ave                            | Oak          | 336         | 21.5          | 3         | 4    |
| T51 | International Boulevard-SB        | 14th Ave                            | Fruitvale Ave                       | Oak          | 543         | 22.9          | 3         | 4    |
| T52 | International Boulevard-SB        | Fruitvale Ave                       | 42nd Ave                            | Oak          | 1053        | 21.4          | 3         | 4    |
| T53 | 73rd Ave -NB                      | International Blvd/73rd Ave         | 73rd Ave/Foothill Blvd              | Oak          | 414         | 28.1          | 2         | 3    |
| T54 | Foothill Boulevard-NB             | 73rd Ave/Foothill Blvd              | Seminary Ave                        | Oak          | 188         | 20.3          | 3         | 4    |
| T55 | Foothill Boulevard-NB             | Seminary Ave                        | High Street                         | Oak          | 514         | 21.5          | 3         | 4    |
| T56 | Foothill Boulevard-NB             | High Street                         | Fruitvale Ave                       | Oak          | 499         | 19.8          | 3         | 4    |
| T57 | Foothill Boulevard-NB             | Fruitvale Ave                       | 14th Ave                            | Oak          | 86          | 22.9          | 2         | 3    |
| T58 | Foothill Boulevard-NB             | 14th Ave                            | 1st Ave/Lake Shore Blvd             | Oak          | 285         | 20.5          | 3         | 4    |

Table H-7: Free Flow Speed Results

| #   | Route                         | From                                 | To                                   | Jurisdiction | Sample Size | Average Speed | HCM Class |      |
|-----|-------------------------------|--------------------------------------|--------------------------------------|--------------|-------------|---------------|-----------|------|
|     |                               |                                      |                                      |              |             |               | 1985      | 2000 |
| T60 | Foothill Boulevard-SB         | 14th Ave                             | Fruitvale Ave                        | Oak          | 210         | 21.8          | 2         | 3    |
| T61 | Foothill Boulevard-SB         | Fruitvale Ave                        | High Street                          | Oak          | 404         | 20.8          | 3         | 4    |
| T62 | Foothill Boulevard-SB         | High Street                          | Seminary Ave                         | Oak          | 513         | 20.2          | 3         | 4    |
| T63 | Foothill Boulevard-SB         | Seminary Ave                         | 73rd Ave/Foothill Blvd               | Oak          | 441         | 21.2          | 3         | 4    |
| T64 | 73rd Ave -SB                  | 73rd Ave/Foothill Blvd               | International Blvd/73rd Ave          | Oak          | 444         | 26.9          | 2         | 3    |
| T65 | E. 15th Street-SB             | 1st Avenue                           | 14th Avenue                          | Oak          | 4           | 14.8          | 3         | 4    |
| T66 | High Street-EB                | Otis Drive                           | Central Ave                          | Ala          | 4           | 19.7          | 3         | 4    |
| T67 | High Street-EB                | Central Ave                          | Fernside Blvd                        | Ala          | 4           | 19.3          | 3         | 4    |
| T68 | High Street-EB                | Fernside Blvd                        | NB I-880 OFF Ramp                    | Ala, Oak     | 4           | 14.8          | 2         | 3    |
| T69 | High Street-EB                | NB I-880 OFF Ramp                    | Foothill Blvd                        | Oak          | 4           | 16.3          | 3         | 4    |
| T70 | High Street-EB                | Foothill Blvd                        | MacArthur Blvd/WB I-580 OFF Ramp     | Oak          | 4           | 20.9          | 3         | 4    |
| T71 | High Street-WB                | MacArthur Blvd/WB I-580 OFF Ramp     | Foothill Blvd                        | Oak          | 4           | 21.2          | 3         | 4    |
| T72 | High Street-WB                | Foothill Blvd                        | NB I-880 OFF Ramp                    | Oak          | 4           | 16.9          | 3         | 4    |
| T73 | High Street-WB                | NB I-880 OFF Ramp                    | Fernside Blvd                        | Ala, Oak     | 4           | 21.6          | 2         | 3    |
| T74 | High Street-WB *              | Fernside Blvd                        | Central Ave                          | Ala          | 4           | 16.8          | 3         | 4    |
| T75 | High Street-WB                | Central Ave                          | Otis Drive                           | Ala          | 4           | 24.5          | 3         | 4    |
| T76 | Crow Canyon Road/Grove Way-NB | A Street/Redwood Road                | EB I-580 ON Ramp/Grove Way           | Ala Cnty     | 623         | 29.0          | 2         | 3    |
| T77 | Crow Canyon Road/Grove Way-NB | EB I-580 ON Ramp/Grove Way           | Cull Canyon                          | Ala Cnty     | 687         | 32.1          | 1         | 2    |
| T78 | Crow Canyon Road-NB           | Cull Canyon                          | Cold Water Dr                        | Ala Cnty     | 816         | 42.3          | 1         | 2    |
| T79 | Crow Canyon Road-NB           | Cold Water Dr                        | 0.43 miles north of Norris Canyon Rd | Ala Cnty     | 2717        | 42.0          | Rural     |      |
| T80 | Crow Canyon Road-NB           | 0.43 miles north of Norris Canyon Rd | County Line                          | Ala Cnty     | 2717        | 42.0          | Rural     |      |
| T81 | Crow Canyon Road-SB           | County Line                          | 0.43 miles north of Norris Canyon Rd | Ala Cnty     | 3447        | 41.4          | Rural     |      |
| T82 | Crow Canyon Road-SB           | 0.43 miles north of Norris Canyon Rd | Cold Water Dr                        | Ala Cnty     | 3447        | 41.4          | Rural     |      |
| T83 | Crow Canyon Road-SB           | Cold Water Dr                        | Cull Canyon                          | Ala Cnty     | 1216        | 41.6          | 1         | 2    |
| T84 | Crow Canyon Road/Grove Way-SB | Cull Canyon                          | EB I-580 ON Ramp/Grove Way           | Ala Cnty     | 732         | 36.1          | 1         | 2    |



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**Table H-7: Free Flow Speed Results**

| #    | Route                                  | From                                 | To                                   | Jurisdiction  | Sample Size | Average Speed | HCM Class |      |
|------|--|--------------------------------------|--------------------------------------|---------------|-------------|---------------|-----------|------|
|      |  |                                      |                                      |               |             |               | 1985      | 2000 |
| T85  | Crow Canyon Road/Grove Way-SB          | EB I-580 ON Ramp/Grove Way           | A Street/Redwood Road                | Ala Cnty      | 729         | 30.7          | 2         | 3    |
| T86  | Winton Avenue - D Street-EB            | Hesperian Blvd.                      | SB I-880 ON Ramp                     | Hay           | 5529        | 25.7          | 2         | 3    |
| T87  | Winton Avenue - D Street-EB            | SB I-880 ON Ramp                     | Santa Clara St                       | Hay           | 4151        | 33.5          | 2         | 3    |
| T88  | Winton Avenue - D Street-EB            | Santa Clara St                       | Soto Rd                              | Hay           | 4542        | 24.1          | 2         | 3    |
| T89  | Winton Avenue - D Street-EB            | Soto Rd                              | Foothill Boulevard/D St              | Hay           | 478         | 24.5          | 2         | 3    |
| T90  | Winton Avenue - D Street-WB            | Foothill Boulevard/D St              | Soto Rd                              | Hay           | 690         | 27.2          | 2         | 3    |
| T91  | Winton Avenue - D Street-WB            | Soto Rd                              | Santa Clara St                       | Hay           | 2510        | 23.0          | 2         | 3    |
| T92  | Winton Avenue - D Street-WB            | Santa Clara St                       | SB I-880 ON Ramp                     | Hay           | 1394        | 34.7          | 2         | 3    |
| T93  | Winton Avenue - D Street-WB            | SB I-880 ON Ramp                     | Hesperian Blvd.                      | Hay           | 4771        | 24.1          | 2         | 3    |
| T94  | A Street-EB                            | Foothill Boulevard/A St              | Redwood Rd/Grove Way                 | Hay, Ala Cnty | 4           | 23.6          | 2         | 3    |
| T95  | A Street-EB                            | Redwood Rd/Grove Way                 | EB I-580 ON Ramp/Grove Way           | Ala Cnty      | 4           | 18.5          | 2         | 3    |
| T96  | A Street-WB                            | EB I-580 ON Ramp/Grove Way           | Redwood Rd/Grove Way                 | Ala Cnty      | 4           | 28.8          | 2         | 3    |
| T97  | A Street-WB *                          | Redwood Rd/Grove Way                 | Foothill Boulevard/A St              | Ala Cnty      | 4           | 15.8          | 2         | 3    |
| T98  | Hesperian Boulevard-Union City Blvd-NB | Union City/Alvarado Blvd             | Whipple Rd                           | Uni Cty       | 4           | 26.5          | 1         | 2    |
| T99  | Hesperian Boulevard-Union City Blvd-NB | Whipple Rd                           | Hesperian/Union City Blvd/overbridge | Uni Cty       | 4           | 32.9          | 1         | 2    |
| T100 | Hesperian Boulevard-Union City Blvd-NB | Hesperian/Union City Blvd/overbridge | Industrial Blvd                      | Hay           | 4           | 26.4          | 1         | 2    |
| T101 | Hesperian Boulevard-Union City Blvd-NB | Industrial Blvd *                    | Tennyson/Hesperian                   | Hay           | 4           | 25.2          | 2         | 3    |
| T102 | Hesperian Boulevard-Union City Blvd-SB | Tennyson/Hesperian                   | Industrial Blvd                      | Hay           | 4           | 26.8          | 2         | 3    |
| T103 | Hesperian Boulevard-Union City Blvd-SB | Industrial Blvd                      | Hesperian/Union City Blvd/overbridge | Hay           | 4           | 19.3          | 1         | 2    |
| T104 | Hesperian Boulevard-Union City Blvd-SB | Hesperian/Union City Blvd/overbridge | Whipple Rd                           | Uni Cty       | 4           | 22.1          | 1         | 2    |
| T105 | Hesperian Boulevard-Union City Blvd-SB | Whipple Rd                           | Union City/Alvarado Blvd             | Uni Cty       | 4           | 29.5          | 1         | 2    |
| T106 | Alvarado Blvd.-NB                      | NB I-880 ON Ramp                     | Deep Creek Rd/SB I-880 OFF Ramp      | Fre           | 904         | 30.6          | 1         | 2    |
| T107 | Alvarado Blvd.-NB                      | Deep Creek Rd/SB I-880 OFF Ramp      | Fair Ranch Rd                        | Uni Cty, Fre  | 507         | 32.4          | 1         | 2    |
| T108 | Alvarado Blvd.-NB                      | Fair Ranch Rd                        | Union City/Alvarado Blvd             | Uni Cty       | 766         | 28.5          | 1         | 2    |
| T109 | Alvarado Blvd.-SB                      | Union City/Alvarado Blvd             | Fair Ranch Rd                        | Uni Cty       | 885         | 28.1          | 1         | 2    |
| T110 | Alvarado Blvd.-SB                      | Fair Ranch Rd                        | Deep Creek Rd/SB I-880 OFF Ramp      | Uni Cty, Fre  | 753         | 31.2          | 1         | 2    |
| T111 | Alvarado Blvd.-SB                      | Deep Creek Rd/SB I-880 OFF Ramp      | NB I-880 ON Ramp                     | Fre           | 1171        | 31.6          | 1         | 2    |

Table H-7: Free Flow Speed Results

| #    | Route                  | From                        | To                               | Jurisdiction | Sample Size | Average Speed | HCM Class |      |
|------|------------------------|-----------------------------|----------------------------------|--------------|-------------|---------------|-----------|------|
|      |                        |                             |                                  |              |             |               | 1985      | 2000 |
| T112 | Fremont Boulevard-NB * | NB I-880 OFF Ramp           | Automall Parkway                 | Fre          | 419         | 34.7          | 1         | 2    |
| T113 | Fremont Boulevard-NB * | Automall Parkway            | Blacow Rd                        | Fre          | 863         | 34.2          | 1         | 2    |
| T114 | Fremont Boulevard-NB * | Blacow Rd                   | Adams Ave                        | Fre          | 3417        | 28.0          | 1         | 2    |
| T115 | Fremont Boulevard-NB * | Adams Ave                   | Stevenson Rd                     | Fre          | 1953        | 27.9          | 2         | 3    |
| T116 | Fremont Boulevard-NB * | Stevenson Rd                | Mowry Ave                        | Fre          | 1080        | 30.2          | 2         | 3    |
| T117 | Fremont Boulevard-NB * | Mowry Ave                   | Peralta Blvd                     | Fre          | 1460        | 30.0          | 2         | 3    |
| T118 | Fremont Boulevard-NB * | Peralta Blvd                | Thornton Ave                     | Fre          | 1012        | 30.9          | 2         | 3    |
| T119 | Fremont Boulevard-NB * | Thornton Ave                | Decoto Rd                        | Fre          | 363         | 32.0          | 1         | 2    |
| T120 | Fremont Boulevard-NB * | Decoto Rd                   | Paseo Padre Pkwy                 | Fre          | 685         | 31.0          | 1         | 2    |
| T121 | Fremont Boulevard-NB * | Paseo Padre Pkwy            | NB I-880 OFF Ramp                | Fre          | 668         | 31.0          | 1         | 2    |
| T122 | Fremont Boulevard-SB * | NB I-880 OFF Ramp           | Paseo Padre Pkwy                 | Fre          | 658         | 32.0          | 1         | 2    |
| T123 | Fremont Boulevard-SB * | Paseo Padre Pkwy            | Decoto Rd                        | Fre          | 504         | 29.7          | 1         | 2    |
| T124 | Fremont Boulevard-SB * | Decoto Rd                   | Thornton Ave                     | Fre          | 504         | 30.2          | 1         | 2    |
| T125 | Fremont Boulevard-SB * | Thornton Ave                | Peralta Blvd                     | Fre          | 1402        | 29.3          | 2         | 3    |
| T126 | Fremont Boulevard-SB * | Peralta Blvd                | Mowry Ave                        | Fre          | 627         | 29.4          | 2         | 3    |
| T127 | Fremont Boulevard-SB * | Mowry Ave                   | Stevenson Rd                     | Fre          | 653         | 32.3          | 2         | 3    |
| T128 | Fremont Boulevard-SB * | Stevenson Rd                | Adams Ave                        | Fre          | 1538        | 27.8          | 2         | 3    |
| T129 | Fremont Boulevard-SB * | Adams Ave                   | Blacow Rd                        | Fre          | 3592        | 27.9          | 1         | 2    |
| T130 | Fremont Boulevard-SB * | Blacow Rd                   | Automall Parkway                 | Fre          | 527         | 33.1          | 1         | 2    |
| T131 | Fremont Boulevard-SB * | Automall Parkway            | NB I-880 OFF Ramp                | Fre          | 370         | 34.9          | 1         | 2    |
| T132 | Automall Parkway-EB    | NB I-880 OFF Ramp           | Fremont Blvd                     | Fre          | 6           | 23.1          | 1         | 2    |
| T133 | Automall Parkway-EB    | Fremont Blvd                | NB I-680 ON Ramp                 | Fre          | 6           | 29.5          | 1         | 2    |
| T134 | Automall Parkway-WB    | NB I-680 ON Ramp            | Fremont Blvd                     | Fre          | 4           | 21.5          | 1         | 2    |
| T135 | Automall Parkway-WB *  | Fremont Blvd                | NB I-880 OFF Ramp                | Fre          | 7           | 27.1          | 1         | 2    |
| T136 | Vasco Road-NB          | WB I-580 OFF Ramp           | Scenic Ave                       | Liv          | 2668        | 36.3          | 1         | 2    |
| T137 | Vasco Road-NB          | Scenic Ave                  | Dalton Ave/City-County Line      | Liv          | 3357        | 37.4          | 1         | 2    |
| T138 | Vasco Road-NB          | Dalton Ave/City-County Line | N. Vasco Rd/Vasco Rd             | Liv          | 4059        | 53.0          | Rural     |      |
| T139 | Vasco Road-NB          | N. Vasco Rd/Vasco Rd        | Local Road underpass/County Line | Liv          | 4059        | 53.0          | Rural     |      |

## Appendix H. Free Flow Speed Surveys

**Table H-7: Free Flow Speed Results**

| #    | Route               | From                                 | To                                   | Jurisdiction | Sample Size | Average Speed | HCM Class |      |
|------|---------------------|--------------------------------------|--------------------------------------|--------------|-------------|---------------|-----------|------|
|      |                     |                                      |                                      |              |             |               | 1985      | 2000 |
| T140 | Vasco Road-SB *     | Local Road underpass/County Line     | N. Vasco Rd/Vasco Rd                 | Liv          | 4024        | 46.8          | Rural     |      |
| T141 | Vasco Road-SB *     | N. Vasco Rd/Vasco Rd                 | Dalton Ave/City-County Line          | Liv          | 4024        | 46.8          | Rural     |      |
| T142 | Vasco Road-SB       | Dalton Ave/City-County Line          | Scenic Ave                           | Liv          | 3796        | 34.3          | 1         | 2    |
| T143 | Vasco Road-SB       | Scenic Ave                           | WB I-580 OFF Ramp                    | Liv          | 2832        | 32.0          | 1         | 2    |
| T144 | Dublin Blvd.-EB     | San Ramon Road                       | Village Parkway                      | Dub          | 424         | 26.5          | 2         | 3    |
| T145 | Dublin Blvd.-EB     | Village Parkway                      | Dougherty Rd                         | Dub          | 1393        | 29.5          | 2         | 3    |
| T146 | Dublin Blvd.-EB     | Dougherty Rd                         | Hacienda Dr                          | Dub          | 1280        | 34.1          | 1         | 2    |
| T147 | Dublin Blvd.-EB     | Hacienda Dr                          | Tassajara Dr                         | Dub          | 540         | 30.2          | 1         | 2    |
| T148 | Dublin Blvd.-WB     | Tassajara Dr                         | Hacienda Dr                          | Dub          | 1922        | 29.1          | 1         | 2    |
| T149 | Dublin Blvd.-WB     | Hacienda Dr                          | Dougherty Rd                         | Dub          | 459         | 32.8          | 1         | 2    |
| T150 | Dublin Blvd.-WB     | Dougherty Rd                         | Village Parkway                      | Dub          | 2574        | 29.5          | 2         | 3    |
| T151 | Dublin Blvd.-WB     | Village Parkway                      | San Ramon Road                       | Dub          | 891         | 24.5          | 2         | 3    |
| T152 | San Ramon Road-NB   | WB I-580 OFF ramp                    | Silvergate Dr                        | Dub          | 684         | 30.8          | 1         | 2    |
| T153 | San Ramon Road-NB   | Silvergate Dr                        | Alcosta Blvd/Westside Dr/County Line | Dub          | 1362        | 35.1          | 1         | 2    |
| T154 | San Ramon Road-SB   | Alcosta Blvd/Westside Dr/County Line | Silvergate Dr                        | Dub          | 1664        | 35.8          | 1         | 2    |
| T155 | San Ramon Road-SB   | Silvergate Dr                        | WB I-580 OFF ramp                    | Dub          | 509         | 32.7          | 1         | 2    |
| T156 | Dougherty Road-NB * | WB I-580 OFF ramp                    | Amador Valley Blvd on SB             | Dub          | 1809        | 35.4          | 1         | 2    |
| T157 | Dougherty Road-NB * | Amador Valley Blvd on SB             | Fallcreek Rd on SB/County Line       | Dub          | 1987        | 44.1          | 1         | 2    |
| T158 | Dougherty Road-SB * | Fallcreek Rd on SB/County Line       | Amador Valley Blvd on SB             | Dub          | 1915        | 43.1          | 1         | 2    |
| T159 | Dougherty Road-SB * | Amador Valley Blvd on SB             | WB I-580 OFF ramp                    | Dub          | 1404        | 33.1          | 1         | 2    |
| T160 | Tassajara Road-NB   | WB I-580 OFF ramp                    | Central Parkway                      | Dub          | 4           | 24.7          | 1         | 2    |
| T161 | Tassajara Road-NB   | Central Parkway                      | Somerset Ln/N Dublin Ranch Dr        | Dub          | 4           | 34.3          | 1         | 2    |
| T162 | Tassajara Road-NB   | Somerset Ln/N Dublin Ranch Dr        | Fallon Rd                            | Dub          | 4           | 38.4          | 1         | 2    |
| T163 | Tassajara Road-NB   | Fallon Rd                            | County Line                          | Ala Cnty     | 4           | 35.2          | 1         | 1    |
| T164 | Tassajara Road-SB   | County Line                          | Fallon Rd                            | Ala Cnty     | 4           | 45.2          | 1         | 1    |
| T165 | Tassajara Road-SB   | Fallon Rd                            | Somerset Ln/N Dublin Ranch Dr        | Dub          | 4           | 38.7          | 1         | 2    |
| T166 | Tassajara Road-SB * | Somerset Ln/N Dublin Ranch Dr        | Central Parkway                      | Dub          | 4           | 33.8          | 1         | 2    |
| T167 | Tassajara Road-SB * | Central Parkway                      | WB I-580 OFF ramp                    | Dub          | 6           | 25.7          | 1         | 2    |

Table H-7: Free Flow Speed Results

| #    | Route   | From                          | To                    | Jurisdiction   | Sample Size | Average Speed | HCM Class |      |
|------|---|-------------------------------|-----------------------|----------------|-------------|---------------|-----------|------|
|      |   |                               |                       |                |             |               | 1985      | 2000 |
| T168 | E. Stanley Blvd - Railroad Avenue - 1st Street-NB * | SR 84/Isabel Ave              | Murrita Blvd          | Liv            | 6           | 31.5          | 1         | 2    |
| T169 | E. Stanley Blvd - Railroad Avenue - 1st Street-NB * | Murrita Blvd                  | S Livermore Ave       | Liv            | 4           | 23.4          | 2         | 3    |
| T170 | E. Stanley Blvd - Railroad Avenue - 1st Street-NB * | S Livermore Ave               | Inman St              | Liv            | 4           | 21.7          | 2         | 3    |
| T171 | E. Stanley Blvd - Railroad Avenue - 1st Street-SB   | Inman St                      | S Livermore Ave       | Liv            | 4           | 20.1          | 2         | 3    |
| T172 | E. Stanley Blvd - Railroad Avenue - 1st Street-SB   | S Livermore Ave               | Murrita Blvd          | Liv            | 6           | 26.6          | 2         | 3    |
| T173 | E. Stanley Blvd - Railroad Avenue - 1st Street-SB   | Murrita Blvd                  | SR 84/Isabel Ave      | Liv            | 4           | 21.9          | 1         | 2    |
| T174 | Stoneridge Drive-EB                                 | SB I-680 OFF Ramp             | Hopyard Rd            | Plea           | 2024        | 33.2          | 1         | 2    |
| T175 | Stoneridge Drive-EB                                 | Hopyard Rd                    | Hacienda Dr           | Plea           | 813         | 29.8          | 1         | 2    |
| T176 | Stoneridge Drive-EB                                 | Hacienda Dr                   | W. Las Positas Blvd   | Plea           | 640         | 31.1          | 1         | 2    |
| T177 | Stoneridge Drive-EB                                 | W. Las Positas Blvd           | Santa Rita Road       | Plea           | 744         | 30.0          | 1         | 2    |
| T178 | Santa Rita Road-EB                                  | Stoneridge Dr/Santa Rita Road | W. Los Positas Blvd   | Plea           | 2402        | 31.1          | 1         | 2    |
| T179 | Santa Rita Road-EB                                  | W. Los Positas Blvd           | WB I-580 OFF Ramp     | Plea           | 2454        | 30.3          | 1         | 2    |
| T180 | Santa Rita Road-WB                                  | WB I-580 OFF Ramp             | W. Los Positas Blvd   | Plea           | 1595        | 31.3          | 1         | 2    |
| T181 | Santa Rita Road-WB                                  | W. Los Positas Blvd           | Santa Rita Road       | Plea           | 2590        | 31.5          | 1         | 2    |
| T182 | Stoneridge Drive-WB                                 | Santa Rita Road               | W. Las Positas Blvd   | Plea           | 752         | 31.8          | 1         | 2    |
| T183 | Stoneridge Drive-WB                                 | W. Las Positas Blvd           | Hacienda Dr           | Plea           | 879         | 33.8          | 1         | 2    |
| T184 | Stoneridge Drive-WB                                 | Hacienda Dr                   | Hopyard Rd            | Plea           | 894         | 28.8          | 1         | 2    |
| T185 | Stoneridge Drive-WB                                 | Hopyard Rd                    | SB I-680 OFF Ramp     | Plea           | 725         | 32.9          | 1         | 2    |
| T186 | Sunol Blvd.- 1st Street- Stanley Blvd.-NB           | NB I-680 OFF                  | Bernal Ave            | Plea           | 724         | 31.2          | 1         | 2    |
| T187 | Sunol Blvd.- 1st Street- Stanley Blvd.-NB           | Bernal Ave                    | Ray/Vineyard          | Plea           | 1788        | 26.1          | 3         | 4    |
| T188 | Sunol Blvd.- 1st Street- Stanley Blvd.-NB           | Ray/Vineyard                  | Bernal Ave/Valley Ave | Plea           | 728         | 32.1          | 2         | 3    |
| T189 | Sunol Blvd.- 1st Street- Stanley Blvd.-NB *         | Bernal Ave/Valley Ave         | SR 84/Isabel Ave      | Plea, Ala Cnty | 1151        | 44.9          | 1         | 1    |
| T190 | Sunol Blvd.- 1st Street- Stanley Blvd.-SB           | SR 84/Isabel Ave              | Bernal Ave/Valley Ave | Plea, Ala Cnty | 2634        | 51.0          | 1         | 1    |
| T191 | Sunol Blvd.- 1st Street- Stanley Blvd.-SB           | Bernal Ave/Valley Ave         | Ray/Vineyard          | Plea           | 1867        | 34.6          | 2         | 3    |
| T192 | Sunol Blvd.- 1st Street- Stanley Blvd.-SB           | Ray/Vineyard                  | Bernal Ave            | Plea           | 2574        | 25.4          | 3         | 4    |
| T193 | Sunol Blvd.- 1st Street- Stanley Blvd.-SB           | Bernal Ave                    | NB I-680 OFF          | Plea           | 1838        | 35.6          | 1         | 2    |

\* Alameda CTC may refine HCM arterial class in 2016 LOS Monitoring Study as these segments were impacted by construction or performed slower in free flow surveys than in peak period.

