IV.G Wind

IV.G.1 Introduction

This section describes potential wind impacts associated with implementation of the Plan's height and bulk amendments and the likely future development under the Plan, including proposed street network changes and open space improvements. The analysis focuses on the potential for wind impacts on pedestrian areas such as sidewalks and plazas. The study area for the wind analysis is the entire Plan Area.

IV.G.2 Environmental Setting

San Francisco's Existing Climate and Wind Environment

Historic data collected at the old San Francisco Federal Building at 50 United Nations Plaza over a six-year period show that average wind speeds in the city are the highest in the summer and lowest in winter. However, the strongest peak wind speeds occur in winter (wind direction is also most variable in the winter). Wind speeds are diurnal and fluctuate throughout the day, with the highest average wind speeds occurring during the mid-afternoon and the lowest in the early morning. Based on over 40 years of recordkeeping, the highest mean hourly wind speeds (approximately 20 miles per hour [mph]) occur in July, while the lowest mean hourly wind speeds (in the range of 6 mph to 9 mph) occur in November.

In the city, westerly to northwesterly winds are the most frequent and strongest winds during all seasons.[320] Of the 16 primary wind directions, five have the greatest frequency of occurrence: the northwest (accounting for 10 percent of all winds), west-northwest (14 percent of all winds), west (35 percent of all winds), west-southwest (2 percent of all winds), and southwest (9 percent of all winds).[321] Over 90 percent of measured winds over 13 mph—the speed at which pedestrians begin to feel discomfort—blow from these directions.

Wind Effects on People

The comfort of pedestrians varies under different wind conditions.[322] Winds up to about 3.5 mph have no noticeable effect on pedestrian comfort. With speeds from 4 mph to 7 mph, wind is felt on the face. Winds from 8 mph to 12 mph will disturb hair, cause clothing to flap, and extend a light flag mounted on a pole. Winds from 13 mph to 18 mph will raise loose paper, dust, and dry soil, and will disarrange hair. For winds from 19 mph to 24 mph, the force of the wind will be felt on the body. With 25 mph to 31 mph winds,

[320] Wind directions are reported as directions from which the winds blow.
[321] The 16 primary wind directions, clockwise beginning with west winds, are west, west-northwest, northwest, north-northwest, north, north-northeast, northeast, east-northeast, east, east-southeast, southeast, south-southeast, south, south-southwest, southwest, and west-southwest.
[322] National Weather Service, "JetStream Max – Online School for Weather, Beaufort Wind Force Scale," webpage. Available at: http://www.srh.noaa.gov/jetstream/ocean/beaufort_max.htm, accessed on August 29, 2016; and Lawson, T.V. and A.D. Penwarden, "The Effects of Wind on People in the Vicinity of Buildings," Proceedings of the Fourth International Conference on Wind Effects on Buildings and Structures, London, 1975, Cambridge University Press, Cambridge, U.K., 605–622, 1976.

umbrellas are used with difficulty, hair is blown straight, there is difficulty in walking steadily, and wind noise is unpleasant. Winds over 31 mph cause noticeable inconvenience due to the effort expended during walking, while winds greater than 38 mph make it nearly impossible to walk into the wind, and gusts can blow people over.

Wind Effects from Buildings

Tall buildings and exposed structures can strongly affect the wind environment for pedestrians. A building that stands alone or is much taller than the surrounding buildings can intercept and redirect winds that might otherwise flow overhead and bring them down the vertical face of the building to ground level, where they create ground-level wind and turbulence (variability in wind speed and pressure). These redirected winds, or down-drafts, can be relatively strong and turbulent, and may in some instances be incompatible with the intended uses of nearby ground-level spaces. Conversely, a building with a height that is similar to the heights of surrounding buildings typically would cause little or no additional ground-level wind acceleration and turbulence. In addition to the localized effects from individual buildings, larger groups of buildings interact with and tend to slow the approaching winds, due to the friction and drag created by the many individual structures.

Thus, wind impacts are generally caused by large building masses extending substantially above their surroundings, and by buildings oriented so that a large wall catches a prevailing wind, particularly if such a wall includes little or no articulation. In general, new buildings less than 80 feet in height above ground surface are unlikely to result in substantial adverse effects on ground-level winds such that pedestrians would be uncomfortable. (Such winds may occur under existing conditions, but shorter buildings typically do not cause substantial changes in ground-level winds.)

Wind Patterns in the Plan Area Vicinity

Average wind speeds in San Francisco are the highest in the summer and lowest in winter; however, the strongest peak winds occur in winter. Throughout the year, the highest wind speeds occur in mid-afternoon and the lowest in the early morning. Prior experience with wind testing indicates that the Plan Area is windy, especially along Fourth Street south of Harrison Street, Third Street from Harrison to Brannan Streets, and Fifth Street from south of Bryant Street to Bluxome Street.

Both the upwind topography and the nearby buildings strongly influence wind conditions within the Plan Area. The wind patterns south of Market Street are strongly affected by the west, west-northwest, and northwest winds that approach over the street and building grid that exists north of Market Street. There, westerly winds, which are the most frequent and relatively strong, align with and are channeled into the east/west-oriented streets north of Market Street and approach Market Street relatively unimpeded at pedestrian level. Similarly, the west-northwesterly winds are also channeled into the east/west-oriented streets, but their speeds tend to be reduced due to their greater misalignment with the street grid. However, both the west and the west-northwest winds, which account for nearly half of the city's winds combined, contribute to the strong winds that flow along the east/west-oriented streets.

Northwest winds are impeded at the street level north of Market Street, due to their misalignment with the street grid, which is oriented nearly north/south and east/west; however, these winds continue to flow

overhead, toward the Plan Area. Southwest winds are similarly impeded at street level; they also continue to flow overhead, but they do not flow toward the South of Market (SoMa) area. Both northwest winds and southwest winds also contribute to winds along the east/west-oriented streets.

The street grid south of Market Street is offset from the North-of-Market Street grid by approximately 45 degrees. As a result, winds from the north and west either encounter the street wall (i.e., buildings) that redirects them along Market Street or they encounter an intersection with streets perpendicular to Market Street (i.e., the numbered streets) that lead into the Plan Area. In the latter case, the wind flow divides, with some wind flowing along the northwest/southeast street and some wind flowing along Market Street.[323]

Wind flows along each of the northwest/southeast (i.e., numbered) streets of the SoMa area are also directly generated by the northwest winds, which align with the grid south of Market Street and which can be brought to ground level and channeled into the numbered streets. Although misaligned with the street grid north of Market Street and diminished by passing through that area, the northwest winds are important in the Plan Area because they strike the faces of buildings on streets parallel to Market Street head-on and are brought down to the pedestrian level by those buildings.

Southwest winds also align with the Plan Area street grid, strike the faces of numbered-street buildings head-on, are directed down to the pedestrian level, and are channeled into southwest/northeast streets such as Mission, Howard, Folsom, Harrison, Bryant, and Townsend Streets, all of which are parallel to Market Street. Unlike the northwest wind, southwest winds approach the Plan Area relatively unimpeded over similar parallel blocks of low-rise buildings (mostly two- to four-stories, and no more than about 50 feet in height).

While the relatively frequent west and west-northwest winds are not aligned with the SoMa grid and their speeds are therefore reduced, they can be brought down to the pedestrian level by encountering taller buildings or simply by passing over vacant parcels of land. By both of these mechanisms, these winds directly and substantially contribute to winds at the pedestrian level in the Plan Area.

IV.G.3 Regulatory Framework

Planning Code Section 148, Reduction of Ground-Level Wind Currents in C-3 Districts, requires buildings to be shaped so as not to cause ground-level wind currents to exceed, more than 10 percent of the time, 11 mph in substantial pedestrian use areas, and 7 mph in public seating areas. The *Planning Code* comfort criteria are defined in terms of equivalent wind speed, which is an average wind speed (mean velocity), adjusted to include the level of gustiness and turbulence. Under procedures developed to implement Section 148, equivalent wind speed is defined as the mean wind velocity, multiplied by the quantity (one plus three times the turbulence intensity) divided by 1.45. This calculation magnifies the reported wind speed when turbulence intensity is greater than 15 percent. Throughout this analysis, unless otherwise stated, use of the term "wind speeds" in connection with the wind-tunnel tests refers to equivalent wind speeds that are exceeded 10 percent of the time. When a project would result in exceedances of a comfort criterion, an exception may be granted, pursuant to *Planning Code* Section 309, if the building or addition cannot be designed to meet the criteria.

[323] San Francisco convention, followed in this EIR, is to describe South of Market streets that are parallel to Market Street as east/west streets and streets perpendicular to Market Street as north/south streets. However, in discussing wind directions, true compass directions are used for clarity.

Section 148 also establishes a hazard criterion, which is an equivalent wind speed of 26 mph as averaged for a single full hour of the year.[324] This wind speed is equivalent to a one-minute average wind speed of 36 mph. Under Section 148, new buildings and additions may not cause wind speeds that meet or exceed this hazard criterion and no exception may be granted for buildings that result in winds that exceed the hazard criterion. In the Plan Area, Section 148 criteria apply only to a portion of the block bounded by Second and Third Streets and Folsom and Harrison Streets, which is in a C-3-O Use District.

Other sections of the *Planning Code* apply the same conditions of Section 148 to other areas of the city, including the Van Ness Avenue corridor (Section 243(c)10)) and Rincon Hill (Sections 249.1(b)(1)(A) and 825(d)). Furthermore, Section 148 conditions are used by the Planning Department to evaluate projects under CEQA.

IV.G.4 Impacts and Mitigation Measures

Significance Criteria

For the purposes of this EIR, implementation of the proposed Plan would have a significant effect with respect to the pedestrian wind environment if it would:

- Alter wind in a manner that substantially affects public areas.

For the purposes of CEQA review, the Planning Department has determined that an exceedance of the *Planning Code*'s wind hazard criterion is the standard for determining whether pedestrian winds would "substantially affect public areas" and therefore significant.

Approach to Analysis

The Plan is a regulatory program that would include *Planning Code* and Zoning Map and text amendments and new planning policies to further the Plan's primary objectives of accommodating additional jobs and housing in the Plan Area. Adoption of the Plan and its programmatic components would not directly alter the existing wind environment; over the long-term, however, implementation of the Plan could indirectly affect winds as a result of subsequent development projects that would be permitted under the Plan which could be taller than those currently permitted that may alter winds and cause hazardous conditions or otherwise substantially affect public areas.

Section 148 applies to approval of individual development projects within the C-3 use district, but not to area-wide plans such as the Central SoMa Plan. Because wind conditions in the Plan Area would be affected by the combination of building forms resulting from existing and future buildings, a program-level study is considered an appropriate methodology for evaluation of area-wide wind impacts.

[324] The wind hazard criterion is derived from the 26 mph hourly average wind speed that would generate a 3-second gust of wind at 20 meters per second, a commonly used guideline for wind safety. Because the original Federal Building wind data was collected at one-minute averages, the 26 mph hourly average is converted to a one-minute average of 36 mph, which is used to determine compliance with the 26 mph one-hour hazard criterion in the *Planning Code*. (Arens, E. et al., "Developing the San Francisco Wind Ordinance and its Guidelines for Compliance," Building and Environment, Vol. 24, No. 4, p. 297–303, 1989.)

The wind analysis evaluates wind effects associated with subsequent development that is anticipated to occur in the Plan Area over time, as compared to existing conditions. This analysis is based on wind tunnel testing of building models that reflect potential development that could reasonably be anticipated to occur under the Plan.

This analysis may also inform how winds under Plan conditions may affect certain public rights-of-ways where future open space improvements may be implemented.

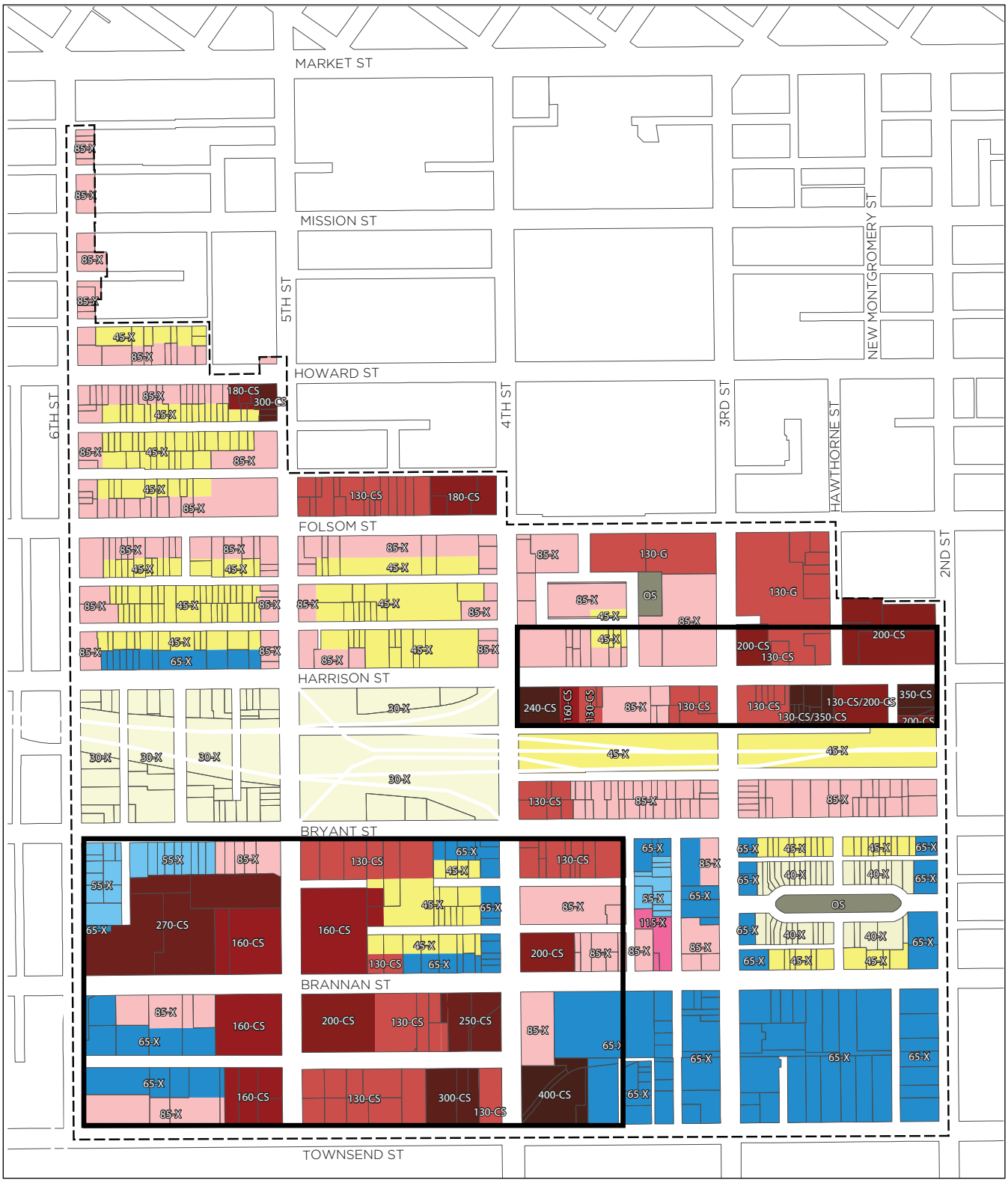
Proposed Street Network Changes and Open Space Improvements

The proposed street network changes would be implemented entirely within existing public rights-of-way and would not involve construction of any buildings or other structures of a height or bulk great enough to result in adverse effects related to wind. As disclosed in the Initial Study (see Appendix B), the proposed street network changes were found not to affect wind conditions in a substantial manner. Because wind impacts related to street network changes would be less than significant, no further analysis is required. Likewise, the proposed open space improvements, while not currently designed or programmed in detail, would not include construction of buildings or other structures of a height or bulk great enough to result in adverse effects related to wind (generally above 80 feet). Therefore, the proposed open space improvements were found not to affect wind conditions in a substantial manner and, therefore, no further analysis is required.

Methodology

As discussed above, a significant wind impact would result if individual buildings that could be developed under the Plan would have exposure, orientation, or massing that would cause new exceedances (violations) of the hazard criterion of 26 mph for a single hour of the year as established in *Planning Code* Section 148. For CEQA purposes, the Planning Department considers an exceedance of the wind hazard criterion to substantially affect the use of publically accessible open spaces, and result in a significant impact. Exceedances of the wind comfort criterion are presented for informational purposes, and to demonstrate compliance with other *Planning Code* requirements.

For portions of the Plan Area where the greatest changes in building height limits would occur under the Plan, a wind-tunnel test was performed in February 2014 and updated in December 2015 to generally define the pedestrian wind environment that currently exists, and would exist with Plan implementation, on sidewalks and open spaces around the Plan Area. Wind-tunnel testing and analysis was conducted for two discrete zones (study areas) within the Plan Area that are proposed to undergo the most extensive increases in height limits—the approximately four-block area between Bryant and Townsend Streets from the west side of Fifth Street to the east side of Fourth Street, and Harrison Street between Second and Fourth Streets (just north of the I-80 freeway) (see **Figure IV.G-1, Wind Tunnel Test Areas**). One-inch-to-50-foot scale models of Study Area and vicinity buildings were constructed in order to simulate the existing and with-Plan wind conditions.



Plan Area

Wind Tunnel Test Areas (approximate)

Numbers indicate height limit in feet
Letters indicate bulk district
OS - Open Space District

SOURCE: San Francisco Planning Department

Case No. 2011.1356E: Central SoMa Plan

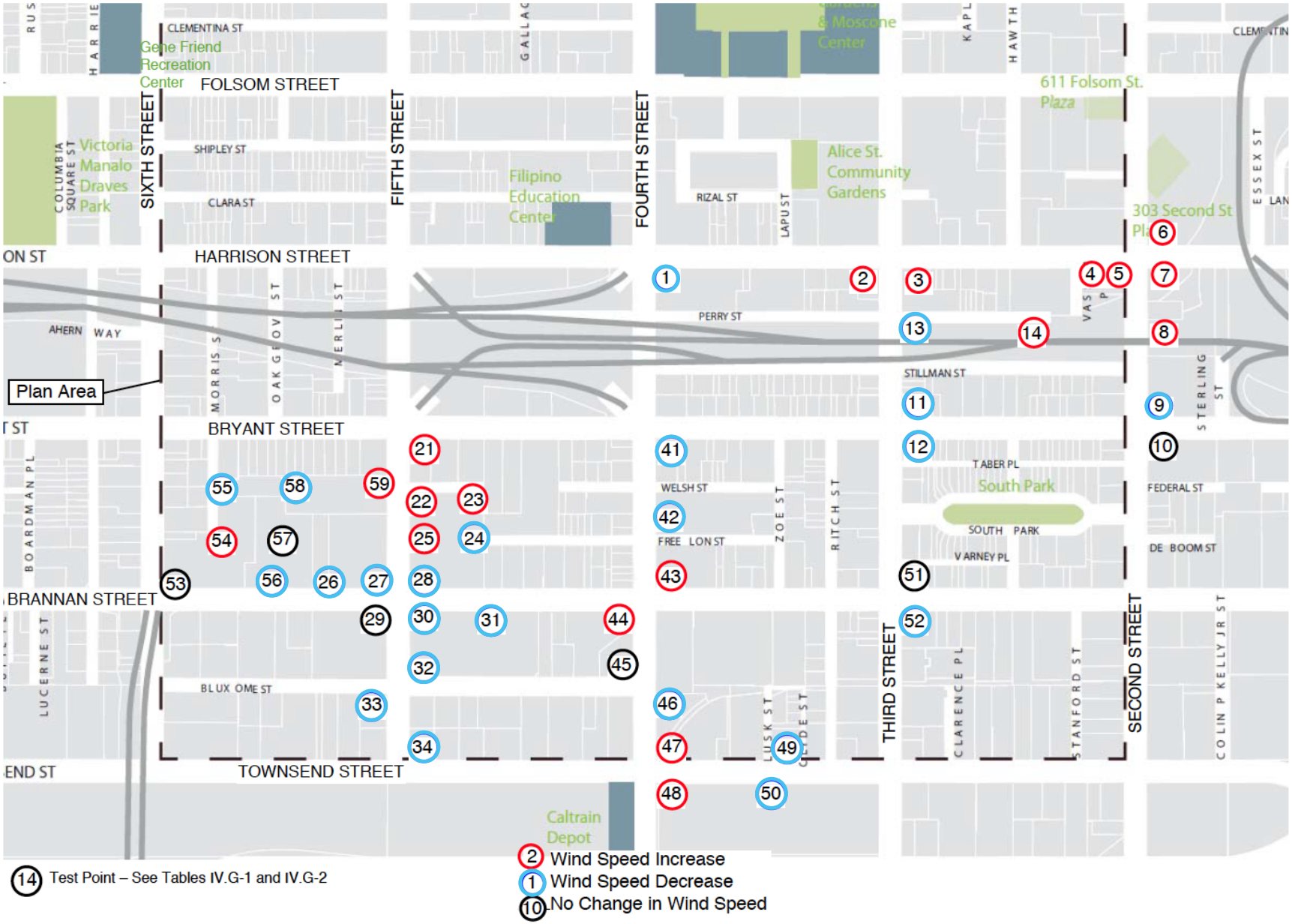
Figure IV.G-1
Wind Tunnel Test Areas

Wind speeds were measured for the existing scenario and the with-Plan scenario. The with-Plan scenario would, in general, permit increased building height limits, from 65 to 85 feet along much of Fourth, Harrison, and Bryant Streets. The Plan would also allow for eight towers of between 200 feet and 400 feet in height on certain sites south of Bryant Street, including potentially three towers of between about 220 feet and 270 feet in height on the site of the existing San Francisco Flower Mart at Sixth and Brannan Streets), and for five 160-foot buildings and about half a dozen buildings of 130 feet in height in much of the area south of Harrison Street, as well as a 115-foot-tall building on the northwest corner of Brannan and Ritch Streets, between Third and Fourth Streets.

The Plan, as analyzed in this EIR, also allows for four towers of 200 feet, 240 feet, 350 feet, and 350 feet in height on the south side of Harrison Street between Second and Fourth Streets, a tower of 200 feet on the northeast corner of Third and Harrison Streets, and 180 feet at the northwest corner of Fourth and Folsom Streets, as well as a tower on the southeast corner of Fifth and Howard Streets, with a maximum potential height of 300 feet. To allow for a conservative but realistic model of Plan conditions, development assumptions formulated by the Planning Department are reflected in the wind model by extruding parcel lines to a base height of 85 feet. For parcels with proposed allowable heights taller than 85 feet, building setbacks were built into the model along with reasonable assumptions for limited tower floor plates and tower siting on larger parcels. These assumptions generally reflect the policy direction in Goal VIII of the Plan to "ensure that the overall development pattern is complementary to the skyline" (Objective 8.2) and "Limit the distribution and bulk of new towers and focus them at important nodes" (Policy 8.3.4). However, the assumptions used in the wind-tunnel testing do not take into account the specific controls in Goal VIII that would modulate building setbacks further than the assumptions used in this analysis. Therefore, the analysis can be considered to be conservative (i.e., worst case).

Pedestrian-level wind speeds were measured at 47 locations selected within the study areas to quantify resulting pedestrian-level winds on sidewalks and in other public spaces where implementation of the Plan would be expected to have the most effect on winds (see **Figure IV.G-2, Wind Tunnel Test Points and Wind Speed Changes with Plan Implementation**). Locations for wind speed sensors, or test points, were selected to indicate how the general flow of winds would be directed around the new taller buildings. The locations of interest for the *Planning Code* are those public "areas of substantial pedestrian use," where the pedestrian comfort criterion applies. For this reason, test points were concentrated along sidewalks at intersections, at locations where taller buildings could be built pursuant to the Plan's proposed increases in height limits (shown in Figure IV.G-1), and near proposed open space improvements (depicted in Figure IV.G-2). All test points were also compared against the 11 mph pedestrian comfort criterion.

It is noted that the number and location of test points, while suitable for a Plan-level analysis that lacks details of specific project designs, would not typically be sufficient for wind-tunnel testing of an individual development project, for which a comparable number of test points would be used but for which the points would be concentrated around the project site itself, rather than spread over an area of several blocks, as was the case for this area-wide test. Moreover, the pedestrian-level wind environment around a specific building is highly dependent on the building design (e.g., location and size of setbacks, whether a tower is placed atop a podium, the height of the street wall, etc.). As noted in the Approach to Analysis section above, the Plan is a regulatory program and would not result in direct physical changes to existing wind environment. Therefore, this analysis evaluates potential increase in building heights but does not consider any building designs. Accordingly, it is



SOURCE: ESA

Case No. 2011.1356E: Central SoMa Plan

Figure IV.G-2

Wind Tunnel Test Points and Wind Speed Changes with Plan Implementation

anticipated that most individual subsequent development projects that are proposed at heights greater than 100 feet would undergo project-specific wind-tunnel testing, consistent with Planning Department protocols. Such project-specific analysis would be based on actual building designs and would entail more test points near a particular project site than were employed in this Plan-level analysis.

In accordance with the protocol for wind tunnel testing under Section 148 of the *Planning Code*, configurations were tested for each of four prevailing wind directions: northwest, west-northwest, west, and southwest. These winds are the most common in the city and most important for sites south of Market Street, and are therefore most representative for evaluation of possible wind effects from subsequent development under the Plan.

For the remainder of the Plan Area, where height limits would remain the same as under existing conditions or be increased to a much lesser degree than the areas tested in the wind tunnel (and, in a few instances, would decrease), wind conditions are addressed qualitatively.

Impact Evaluation

Impact WI-1: Subsequent future development anticipated under the Plan could alter wind in a manner that substantially affects public areas. (Significant and Unavoidable)

The results of the wind-tunnel test, performed to generally define the pedestrian wind environment that currently exists, and would exist with Plan implementation, on sidewalks and open spaces around the Plan Area, are discussed below. A qualitative discussion of the remainder of the Plan Area is also provided below.

Table IV.G-1, Pedestrian-Comfort Analysis, presents the Pedestrian-Comfort Analysis results, namely the wind speeds exceeded 10 percent of the time and the percentage of time that the comfort criterion is exceeded for each test location and test scenario. **Table IV.G-2, Hazard Analysis**, presents the Wind Hazard Analysis results, the equivalent wind speed, and the number of hours per year of exceedance of the hazard criterion for each test location and test scenario. Figure IV.G-2 presents the test point locations and indicates whether wind speeds would increase or decrease with Plan implementation. **Figure IV.G-3, Greatest Increases in Wind Speed**, p. IV.G-14, shows locations of exceedances of the *Planning Code* wind hazard criterion under with-Plan conditions.

Existing Conditions

The existing average of wind speeds exceeded 10 percent of the time for all 47 test points is 12.5 mph. Wind speeds in these pedestrian areas range from 4 mph to 20 mph. The windiest areas are generally along Fourth and Fifth Streets south of Bryant Street.

Existing Comfort Criterion Conditions

Wind speeds at 29 of the 47 locations (62 percent) currently exceed the *Planning Code*'s 11 mph pedestrian-comfort criterion. The highest wind speed in the vicinity (20 mph) was measured at Fourth Street and Freelon Street (between Bryant and Brannan Streets) (test point #42).

TABLE IV.G-1 PEDESTRIAN-COMFORT ANALYSIS

Test Location Number	Wind Comfort Criterion Speed (mph)	Existing Conditions: Equivalent Wind Speed Exceeded 10% of Time (mph)	Existing Conditions: % Time Wind Speed Exceeds Criterion	Existing Conditions: Source	Existing plus Plan Conditions: Equivalent Wind Speed Exceeded 10% of Time (mph)	Existing plus Plan Conditions: % Time Wind Speed Exceeds Criterion	Existing plus Plan Conditions: Speed Change Relative to Existing (mph)	Existing plus Plan Conditions: Source
1	11	15	27	e	10	8	-5	—
2	11	6	0		10	5	3	
3	11	7	1		10	5	3	
4	11	9	4		13	16	4	p
5	11	7	3		17	32	10	p
6	11	6	0		9	2	3	
7	11	7	2		14	22	7	p
8	11	9	2		12	12	3	p
9	11	13	17	e	10	8	-2	—
10	11	8	2		8	2	0	
11	11	16	29	e	11	12	-4	—
12	11	13	18	e	12	14	-1	e
13	11	13	17	e	10	8	-4	—
14	11	6	1		13	14	7	p
21	11	11	9		12	14	1	p
22	11	18	37	e	24	48	6	e
23	11	4	0		14	24	10	p
24	11	15	27	e	5	0	-10	—
25	11	16	27	e	20	39	4	e
26	11	15	28	e	14	24	-2	e
27	11	16	29	e	7	1	-8	—
28	11	18	38	e	13	19	-5	e
29	11	18	34	e	17	35	0	e
30	11	14	22	e	13	17	-2	e
31	11	11	11		10	6	-1	
32	11	15	25	e	13	17	-2	e
33	11	11	10		7	0	-4	
34	11	12	13	e	11	11	-1	—
41	11	19	38	e	16	30	-2	e
42	11	20	42	e	13	19	-7	e
43	11	13	16	e	20	42	7	e
44	11	14	20	e	16	29	3	e
45	11	10	5		10	5	0	
46	11	16	29	e	10	5	-7	—
47	11	8	2		16	30	8	p
48	11	9	3		12	13	4	p
49	11	9	4		8	3	-1	
50	11	15	25	e	10	7	-5	—
51	11	14	22	e	14	23	0	e
52	11	11	11		11	9	-1	
53	11	19	37	e	19	41	1	e
54	11	12	12	e	13	18	1	e
55	11	15	18	e	12	13	-3	e
56	11	15	23	e	14	21	-1	e
57	11	12	12	e	12	12	0	e
58	11	15	23	e	14	24	-1	e
59	11	14	24	e	23	47	9	e
Ave. of 10%	***Percent:***	***12.5 mph***	***17%***		***12.9 mph***	***17%***	***0.3 mph***	
	Total Exceedances:	**Total:**	**29**			**Total:**	**29**	
	Subtotals by type:	*Existing*	*29*	*E*		*Existing:*	*20*	*e*
						New, due to Plan:	*9*	*p*
						New location:	*0*	*n*
						Elim. by Plan:	*9*	—

TABLE IV.G-2 HAZARD ANALYSIS

Test Location Number	Wind Hazard Criterion Speed, (mph)	Existing Conditions: 1-hour/year Equivalent Wind Speed, (mph)	Existing Conditions: Wind Hazard Criterion Exceeded (hrs./yr.)r	Existing Conditions: Source	Existing plus Plan Conditions: 1-hour/year Equivalent Wind Speed, (mph)	Existing plus Plan Conditions: Wind Hazard Criterion Exceeded (hrs./yr.)r	Existing plus Plan Conditions: Hours Change Relative to Existing	Existing plus Plan Conditions: Source
1	36	26			18			
2	36	15			17			
3	36	18			18			
4	36	29			25			
5	36	28			29			
6	36	14			16			
7	36	26			27			
8	36	19			29			
9	36	25			25			
10	36	19			23			
11	36	33			22			
12	36	24			24			
13	36	25			23			
14	36	22			33			
21	36	24			22			
22	36	36			44	47	47	p
23	36	17			29			
24	36	27			11			
25	36	32			42	19	19	p
26	36	26			32			
27	36	28			16			
28	36	32			23			
29	36	36	1	e	30		-1	—
30	36	27			22			
31	36	21			18			
32	36	30			25			
33	36	19			17			
34	36	27			22			
41	36	32			32			
42	36	37	1	e	28		-1	—
43	36	24			37	2	2	p
44	36	23			29			
45	36	18			18			
46	36	31			17			
47	36	17			30			
48	36	17			23			
49	36	21			19			
50	36	26			19			
51	36	33			26			
52	36	23			20			
53	36	37	2	e	37	2	0	e
54	36	27			29			
55	36	32			24			
56	36	27			24			
57	36	28			26			
58	36	28			29			
59	36	32			38	15	15	p
Avg. 1 hr	***Total Hours:***	***26 mph***	***4 hrs.***		***25 mph***	***85 hrs.***	***81 hrs.***	
	Total Exceedances:	**Total:**	**3**			**Total:**	**5**	
	Subtotals by type:	*Existing:*	*3*	*e*		*Existing:*	*1*	*e*
						New or incr. time:	*4*	*p*
						New location:	*0*	*n*
						Elim. by Plan:	*2*	*—*

Existing Hazard Conditions

The average of wind speeds exceeded one hour per year at the 47 test points is 26 mph under existing conditions. The *Planning Code*'s wind hazard criterion of 26 mph is exceeded at three of the existing setting test locations.[325] One existing wind hazard condition exists at the same location as the highest measured wind speeds—Fourth and Freelon Streets (#42; one hour per year), while the other two locations are at the southwest corner of Fifth and Brannan Streets (#29; one hour per year) and at the northeast corner of Sixth and Brannan Streets (#53; two hours per year). The total duration of the existing exceedances was measured to be four hours per year.

With-Plan Scenario

Given that landscape features in open areas and building articulation beyond basic required setbacks were not modeled in detail, test results are likely to indicate higher wind speeds than may actually occur. With the addition of subsequent Plan development, as described above, the average of the wind speeds exceeded 10 percent of the time for the 47 test point locations would increase by 0.4 mph, from 12.5 mph to 12.9 mph. Wind speeds in pedestrian areas would range from 5 mph to 24 mph. Wind speeds would continue to generally be greatest on Fourth and Fifth Streets south of Bryant Street.

With-Plan Comfort Criterion Conditions

Implementation of the Plan would alter wind speeds conditions at individual test points but would not result in an overall substantial change in wind speed in the study areas; that is, wind speeds would increase at some locations and decrease at other locations, but the overall wind environment, based on the average of wind speeds at all test points, would remain similar to that under existing conditions. The with-Plan scenario would create nine new pedestrian-comfort criterion exceedances and eliminate the same number of pedestrian-comfort criterion exceedances, resulting in 29 of the 47 locations with wind speeds in excess of the *Planning Code*'s 11 mph pedestrian-comfort criterion, the same number as under existing conditions. Two of four existing exceedances along Third Street would be eliminated (#13 and 11) along with one on Second Street (#9), two on Fourth Street (#1 and 46), two on Fifth Street (#27 and 34), one on Townsend Street (#50), and one at the western end of Freelon Street, between Bryant and Brannan and Fourth and Fifth Streets—the location of the potential new park (#24). However, another test location just to the north within this potential park space (#23) would newly exceed the 11 mph pedestrian criterion (and the 7 mph seating criterion). This test point is at the northeast corner of a massing model representing a potential project at 598 Brannan Street. It is noted that this potential project would undergo project-specific wind-tunnel testing prior to being considered for approval, and that design articulation could result in reduced ground-level wind speeds, compared to those reported here for the testing of massing-only models.

[325] As stated in footnote 324, the wind hazard criterion is derived from the 26 mph hourly average wind speed that would generate a 3-second gust of wind at 20 meters per second, a commonly used guideline for wind safety. Because the original Federal Building wind data was collected at one-minute averages, the 26 mph hourly average is converted to a one-minute average of 36 mph, which is used to determine compliance with the 26 mph one-hour hazard criterion.

Two other new exceedances would occur at the intersection of Fourth and Townsend Streets (#47 and 48), near the southwestern corner of a potential 400-foot-tall building, and five new exceedances would occur near, and south of, the intersection of Second and Harrison Streets (#4, 5, 7, 8, and 14), in proximity to a site at 400 Second Street that would have height limits permitting three towers at heights of 200 feet, 350 feet, and 350 feet. The final new pedestrian exceedance would occur at Fifth and Bryant Streets (#21), although the actual increase in wind speed would be only 1 mph, from 11 mph to 12 mph, and thus would not likely be perceptible by persons at that location.[326]

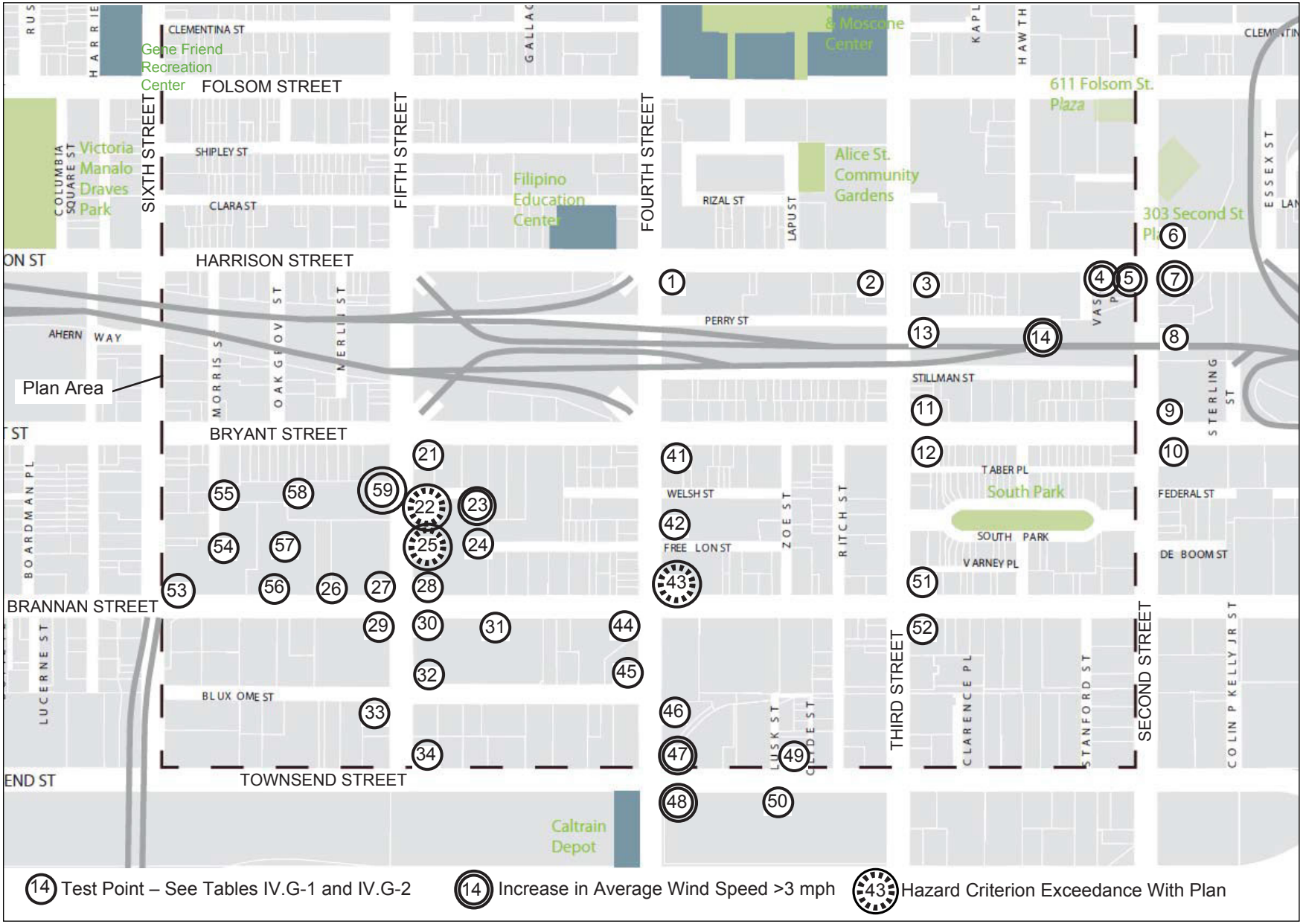
As indicated on **Figure IV.G-3, Greatest Increases in Wind Speed**, and Table IV.G-1, the relatively larger (greater than 3 mph) increases in wind speed would occur near, and south of, the intersection of Second and Harrison Streets, along Fourth Street, and on the northwest corner of the potential new mid-block public open space noted above, on the block bounded by Bryant, Fourth, Brannan, and Fifth Streets. The greatest increases in wind speeds—10 mph—would occur at Second and Harrison Streets (#5) and at the northwest corner of the potential new park (#23). Conversely, the greatest decrease in wind speed—also 10 mph—would occur at the southwest corner of the potential new park (#24).

Other notable increases in wind speeds would occur on Fifth Street south of Bryant Street (#59; 9 mph); at Fourth and Townsend Streets (#47; 8 mph); another location at Second and Harrison Streets (#7; 7 mph); a location south of the same three-tower project at 400 Second Street (#14; 7 mph); Fourth and Brannan Streets (#43; 7 mph); and on Fifth Street at Welsh Street (#22; 6 mph). Notable decreases in wind speed would occur at Fifth and Brannan Streets (#27; -8 mph); Fourth and Freelon Streets (#42; -7 mph); Fourth and Bluxome Streets (#46; -7 mph); Fourth and Harrison Streets (#1; -5 mph); and Townsend Street between Third and Fourth Streets (#50; -5 mph).

Results indicate development of relatively taller buildings could shift the locations of where higher pedestrian-level winds would occur, but would not necessarily result in overall increases in ground-level wind speeds: several pairs of adjacent test points (#23 and #24; #42 and #43; #46 and #47) reveal generally comparable increases and decreases at different corners of the same potential development site. More detailed project-specific wind-tunnel testing would be necessary to determine the full extent of such subsequent development projects' effects.

Overall, the average of wind speeds exceeded 10 percent of the time would increase from 12.5 mph to 12.9 mph, a change that would not result in a perceptible difference at any given point. Therefore, while localized conditions might improve or worsen, there would not be a substantial change in overall pedestrian-level wind speeds in the study areas.

[326] All of the other new pedestrian comfort exceedances would also result in increases in equivalent wind speed of more than 3 mph.



SOURCE: ESA

Case No. 2011.1356E: Central SoMa Plan

Figure IV.G-3
Greatest Increases in Wind Speed

With-Plan Hazard Conditions

With regard to wind hazard conditions, the average of the wind speeds exceeded one hour per year would decrease by 1 mph, to 25 mph, which represents an incremental improvement from existing conditions. However, both the number of hazard exceedances and the hours per year during which the hazard criterion would be exceeded would increase substantially. Two new hazard exceedances would occur on the east side of Fifth Street between Bryant and Brannan Streets (#22 and #25); winds at these locations would exceed the hazard criterion by 47 hours and 19 hours per year, respectively. A third new hazard exceedance would occur on the west side of Fifth Street (#59, 15 hours per year). These three points are immediately downwind of the Flower Mart site, where a project is proposed that would develop three buildings at heights of 220 feet to 270 feet. As with other potential development included in the wind-tunnel testing, the Flower Mart buildings were tested as basic rectilinear massing models, without articulation that would likely be part of any actual project-specific design. Like all subsequent development projects that propose high-rise buildings, this project would be subject to more detailed project-specific wind-tunnel testing, which would be based on detailed, articulated project designs rather than the simple massing models tested for this Plan analysis.

Elsewhere, the existing exceedance of the wind hazard criterion at the corner of Fourth and Freelon Streets (#42) would be eliminated and shifted southward to a new exceedance at the corner of Fourth and Brannan Streets (#43). While this does not represent a substantial change in wind hazard conditions, it should be noted that the eliminated exceedance (#42) occurs for one hour per year while the new exceedance (#43) would occur for a duration of two hours per year. The new exceedance of the hazard criterion would occur at the southwestern corner of a 200-foot-tall massing model of a potential tower that could be developed under the Plan's proposed height limits. However, as was stated previously with respect to comfort criteria exceedances, any subsequent development project greater than 100 feet in height would undergo project-specific wind-tunnel testing prior to being considered for approval, consistent with Planning Department protocols. Finally, an existing one-hour per year exceedance of the hazard criterion at the southwest corner of Fifth and Brannan Streets (#29) would be eliminated, while an existing hazard exceedance at the northeast corner of Sixth and Brannan Streets (#53; two hours per year) would remain unchanged. The net effect at all 47 test points would be an increase of 77 hours per year in the duration of the wind hazard condition in the Plan Area (from 4 hours under existing conditions to 81 hours under Plan conditions), a significant impact. In general, it can be expected that project-specific building articulation and/or other changes in project design could be employed to reduce ground-level wind speeds, compared to those reported here for the testing of massing-only model. **Mitigation Measure M-WI-1, Wind Hazard Criterion for the Plan Area**, has been identified to reduce this significant impact.

Other Portions of the Plan Area

Other parts of the Plan Area are generally less windy than the Study areas tested. One exception is the northeast corner of Fifth and Howard Streets, location of the Intercontinental Hotel. This 340-foot-tall tower is the westernmost tall building in the SoMa area, and as such, it intercepts prevailing west, west-northwest, and northwest winds that are uninterrupted by other high-rise development. As a result, winds that hit the tower are re-directed downward to street level and around the southwest corner of the building as they seek a path around the structure. Accordingly, and as was predicted by the project wind-tunnel test, relatively high wind speeds occur at the corner and along the Howard Street frontage of the building.

Outside the areas tested in the wind-tunnel test, height limits in the Plan Area would remain mostly as under existing conditions. The three locations where height limits would increase—along the north side of Folsom Street between Fourth and Fifth Streets and at the northwest corner of Fourth and Harrison Streets and the northeast corner of and Fifth and Harrison Streets—would be subject under the Plan to limitations on lot mergers. This would effectively limit the height that could be achieved at these locations because it is typically the case that a relatively taller building requires a larger development site than a shorter building, given that, once a building exceeds a height of 70 feet, elevator(s) and other vertical improvements (utilities, etc.) are required that are not necessary for a shorter structure, thereby reducing the usable floor area of the building by a certain amount. At the southeast corner of Fifth and Howard Streets, where a height of 300 feet is proposed, pedestrian-level wind speeds could be adversely affected.

Accordingly, the Plan would result in minimal, if any, potential for future increases in pedestrian-level wind speeds in the portions of the Plan Area not tested in the wind tunnel where heights would increase under the Plan. Construction to existing height limits of 85 feet could occur; however, pedestrian-level increases in winds would be minimal because buildings lower than about 100 feet typically do not result in substantial increases in ground-level winds that would exceed the hazard criterion.

Conclusion

As noted above, for program-level wind testing, wind tunnel models did not include detailed landscape features in open areas or specific building articulation beyond basic setbacks. Because these details have not been developed and cannot be known at this time, it is not possible to assess the effects that future buildings may have on winds in the Plan Area and vicinity. However, the program-level wind testing of the massing model indicates that the Plan could result in 4 new exceedances of the 26 mph hazard criterion, resulting in a ***significant*** impact. Building designs can be developed (podium setbacks, awnings, terraces, and other articulations) that avoid tall flat surfaces square to prevailing winds. These structural features would be expected to reduce ground-level wind speeds and turbulence. In addition, the presence of large street trees and, potentially, street furniture could further reduce general wind speeds and would improve wind conditions in the Plan Area. Without these features included in the wind tunnel model, the test results reported are conservative and likely to indicate higher wind speeds than would actually occur. In conclusion, the landscaping features and building articulation would be expected to eliminate the five hazard criterion exceedances that were identified in the Plan condition.

Outside the areas of greatest potential change that were evaluated in the wind-tunnel, the potential for adverse changes to pedestrian-level winds would be minimal due to the existing relatively low height limits in the western portion of the Plan Area that would remain relatively unchanged.

Mitigation Measures

Mitigation Measure M-WI-1: Wind Hazard Criterion for the Plan Area. In portions of the Central SoMa Plan area outside the C-3 Use Districts, projects proposed at a roof height greater than 85 feet shall be evaluated by a qualified wind expert as to their potential to result in a new wind hazard exceedance or aggravate an existing pedestrian-level wind hazard exceedance (defined as the one-hour wind hazard criterion of 26 miles per hour equivalent wind speed). If the qualified expert determines that wind-tunnel testing is required due to the potential for a new or worsened wind

hazard exceedance, the following requirements for reduction of ground-level wind speeds in areas of substantial pedestrian use shall apply:

- New buildings and additions to existing buildings shall be shaped (e.g., include setbacks, or other building design techniques), or other wind baffling measures shall be implemented, so that the development would result in the following with respect to the one-hour wind hazard criterion of 26 miles per hour equivalent wind speed:
    - No net increase, compared to existing conditions, in the overall number of hours during which the wind hazard criterion is exceeded (the number of exceedance locations may change, allowing for both new exceedances and elimination of existing exceedances, as long as there is no net increase in the number of exceedance locations), based on wind-tunnel testing of a representative number of locations proximate to the project site; OR
    - Any increase in the overall number of hours during which the wind hazard criterion is exceeded shall be evaluated in the context of the overall wind effects of anticipated development that is in accordance with the Plan. Such an evaluation shall be undertaken if the project contribution to the wind hazard exceedance at one or more locations relatively distant from the individual project site is minimal and if anticipated future Plan area development would substantively affect the wind conditions at those locations. The project and foreseeable development shall ensure that there is no increase in the overall number of hours during which the wind hazard criterion is exceeded.
    - New buildings and additions to existing buildings that cannot meet the one-hour wind hazard criterion of 26 miles per hour equivalent wind speed performance standard of this measure based on the above analyses, shall minimize to the degree feasible the overall number of hours during which the wind hazard criterion is exceeded.

Significance after Mitigation: Implementation of Mitigation Measure M-WI-1 would reduce the potential for a net increase in wind hazard exceedances and the hours of wind hazard exceedances. However, it cannot be stated with certainty that each subsequent development project would be able to meet the one-hour wind hazard criterion of 26 miles per hour equivalent wind speed performance standard without substantial modifications to the project's design and program such that the project would not be able to be developed to allowable building heights proposed by the Plan. Therefore, this impact would remain ***significant and unavoidable***. This determination does not preclude the finding that specific development projects would result in less than significant wind impacts depending on the design and site conditions.

IV.G.5 Cumulative Impacts

Impact C-WI-1: Development under the Plan, combined with past, present, and reasonably foreseeable future projects, would not result in cumulative significant impacts related to wind. (Less than Significant)

Based on an evaluation of proposed, approved, and under-construction buildings within four blocks upwind and two blocks crosswind of the Plan Area, it was determined that no specific buildings that could be developed under the cumulative scenario would combine with the wind effects of the Plan to result in a substantial cumulative impact related to wind, beyond those identified for the Plan, above. Cumulative projects 100 feet and taller near the Plan Area could result in localized wind effects that could be adverse. However, with the exception of the recently approved 5M project along Fifth Street between Mission and

Howard Streets, none of these cumulative projects is located near areas where the Plan would result in major increases in height limits. Therefore, minor changes in wind patterns shown to result from development under the Plan, as described above, are not anticipated to interact with localized wind effects from cumulative development. Therefore, no separate cumulative wind-tunnel test was performed.

A review of wind studies for the tallest recently approved projects near the Plan Area—the 706 Mission Street project (currently under construction), the recently built San Francisco Museum of Modern Art (SFMOMA) expansion project, the 222 Second Street project (also newly built), and the 5M project approved in late 2015, reveals that these cumulative projects would incrementally alter (increase or decrease) localized wind speeds at individual locations but would result in either similar wind conditions (i.e. no substantial changes) or slightly improved wind conditions. These tests are summarized below.

The 706 Mission Street project will include a new structure with a 550-foot-tall tower adjacent to a rehabilitation of the existing Aronson Building on the northwest corner of Mission and Third Streets and relocation to the project site of the Mexican Museum. The wind study for this project concluded that the addition of the project in the existing and cumulative settings would improve wind hazard conditions, reducing the number of wind hazard exceedances from four under existing conditions to three with the project, and reducing the number of hours per year during which the hazard criterion is exceeded from 127 to 37. Under cumulative conditions, the number of hours of exceedance was further reduced to 26.[327] The SFMOMA Expansion project developed a 220-foot-tall structure south of Minna Street in the middle of the block between Third and Second Streets, adjacent to the existing SFMOMA. The project wind study concluded that the addition of the project in the existing setting would not significantly alter wind conditions (pedestrian or hazard) and would slightly improve wind conditions (pedestrian comfort and hazard) when added to the cumulative setting, with three of four existing hazard exceedances eliminated.[328] The 222 Second Street project constructed a 350-foot-tall tower at the southwest corner of Second and Howard Streets. That project's wind study concluded that the addition of the project in the existing and cumulative settings would not substantially alter pedestrian wind conditions, with no hazard exceedances reported in any of the test scenarios.[329]

The 5M project would demolish surface parking lots and several existing buildings (926 Howard Street, 912 Howard Street, 409–411 Natoma Street, and 190 Fifth Street); retain the existing Chronicle Building at 901 Mission Street, existing buildings at 447–449 Minna Street, 430 Natoma Street/49 Mary Street, and a portion of the building at 110 Fifth Street (Examiner Building); and construct three new towers with occupied building heights ranging from 200 feet to 450 feet. The project includes 821,300 square feet of residential uses (690 units), 807,600 square feet of office uses (including active office uses at or below the ground floor), and 68,700 square feet of other active ground floor uses (a mix of retail establishments, recreational and arts facilities, restaurants, workshops, and educational uses). The wind study for this project concluded that the

[327] City and County of San Francisco, *706 Mission Street – The Mexican Museum and Residential Tower Project Environmental Impact Report (Case No. 2008.1084E) Final EIR*, certified March 21, 2013 with certification upheld by Board of Supervisors, May 7, 2013. Available at: http://www.sf-planning.org/index.aspx?page=1828, accessed on August 29, 2016.
[328] City and County of San Francisco, *San Francisco Museum of Modern Art/Fire Station Relocation and Housing Project Environmental Impact Report* (Case Nos. 2009.0291E and 2010.0275E), Final EIR certified November 10, 2011. Available at: http://www.sf-planning.org/index.aspx?page=1828, accessed on August 29, 2016.
[329] City and County of San Francisco, *222 Second Street Office Project Environmental Impact Report* (Case No. 2006.1106E), Final EIR certified August 12, 2010. Available at: http://www.sf-planning.org/index.aspx?page=1828, accessed on August 29, 2016.

addition of the 5M project in the existing setting would result in relatively modest degradation of wind comfort conditions but would improve wind hazard conditions by reducing the number of wind hazard exceedances from three under existing conditions to two with the project, and reducing the number of hours per year during which the hazard criterion is exceeded from 79 to 32.[330] With the exception of the site at Fifth and Howard Streets, discussed above, implementation of the Plan would not change height limits on the parcels surrounding the 5M project site, and there are relatively few other locations with height limits greater than 85 feet in this portion of the Plan Area. Based on the 5M Project results and prevailing wind patterns in the area, the wind study concluded that implementation of the Plan, which would occur generally to the south and east of the 5M Project site, would not be expected to change wind conditions at the 5M Project site as the majority of Plan Area development would be situated downwind, and relatively far removed, from the 5M Project site. Therefore, the potential effects from this project would not combine with development under the Plan to cause a substantial cumulative impact beyond those impacts described above in Impact WI-1. As was stated previously, any subsequent development project greater than 80 feet would be required to be evaluated for wind impacts and projects proposing building heights greater than 100 feet in height would undergo project-specific wind-tunnel testing prior to being considered for approval. In general, it can be expected that project-specific building articulation and/or other changes in project design could be employed to reduce ground-level wind speeds, compared to those reported above for the testing of massing-only model. As described above, there are no cumulative projects (besides those that could be accommodated under the Plan) that could combine with other development outside of the plan area to result in cumulative wind impacts. Therefore, the cumulative impact would be ***less than significant***.

Mitigation: None Required.

[330] City and County of San Francisco, *5M Project Environmental Impact Report* (Case No. 2011.0409E), Final EIR certified September 17, 2015 with certification upheld by Board of Supervisors, November 17, 2015. Available at http://www.sf-planning.org/index.aspx?page=1828, accessed August 29, 2016.

[THIS PAGE INTENTIONALLY LEFT BLANK]