Shady View Fire Protection Plan
Fire Behavior Report

Prepared For:
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and

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Chino Valley Fire District

Prepared By:
firesafe
::PLANNING SOLUTIONS

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Plant Palette Amended 051622

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Purpose of Report

Firesafe Planning Solutions performed an assessment of the risks related to wildland fire and to establish the appropriate criteria for a defensible space installation and maintenance program that will reduce the intensity of a wildfire approaching the Shady View residential community. This report will provide the results of the assessment and provide objective support of the defensible space installation and maintenance program for this community that is equal to or greater than the risk which would be encountered in a worst-case scenario. The study takes into consideration existing/future vegetative interface fuels, topography, and weather conditions during a fire. The report provides results of computer calculations that measured the fire intensity from a worst-case scenario wildfire in both the extreme (Santa Ana- NE and E winds) and the predominant (Onshore – W wind) conditions. The results of fire behavior calculations have been incorporated into the fire protection design for the Shady View development and are the genesis of a request for the size of the fuel modification zones on the east interface, the building exterior wall separations from any structure on an adjoining lot being less than thirty (30) feet as an alternate measures that achieve the same level of protection as a thirty (30) foot separation and the rationale for the secondary exit separation as designed into the project..

Geographic Description

The proposed project is located in the City of Chino Hills, in San Bernardino County, California. The general location is shown below.

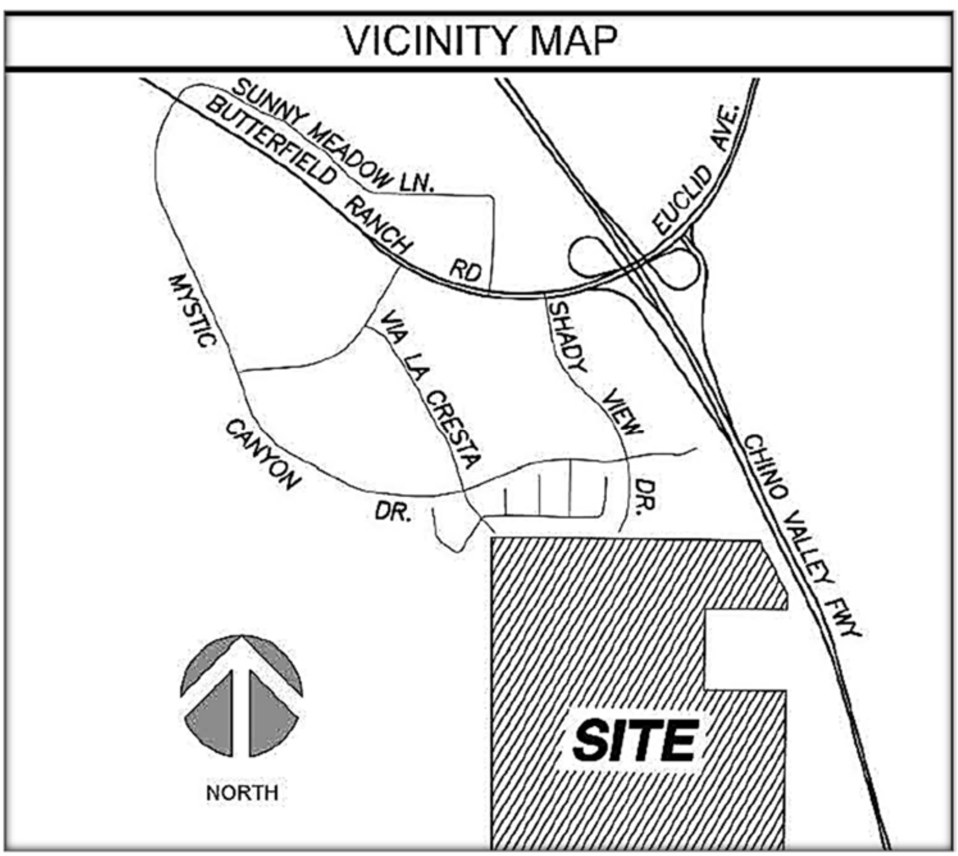


Figure 1

The project site is bordered by existing development to the north. Butterfield Ranch Road is north of the development State Route 71 (Chino Valley Freeway) run along the entire eastern edge. The area to the west and south are undeveloped. To the south and west are open space and agricultural lands. The project site is bordered by the county line (San Bernardino/Riverside) on the east side. This illustrated below in Figure 2

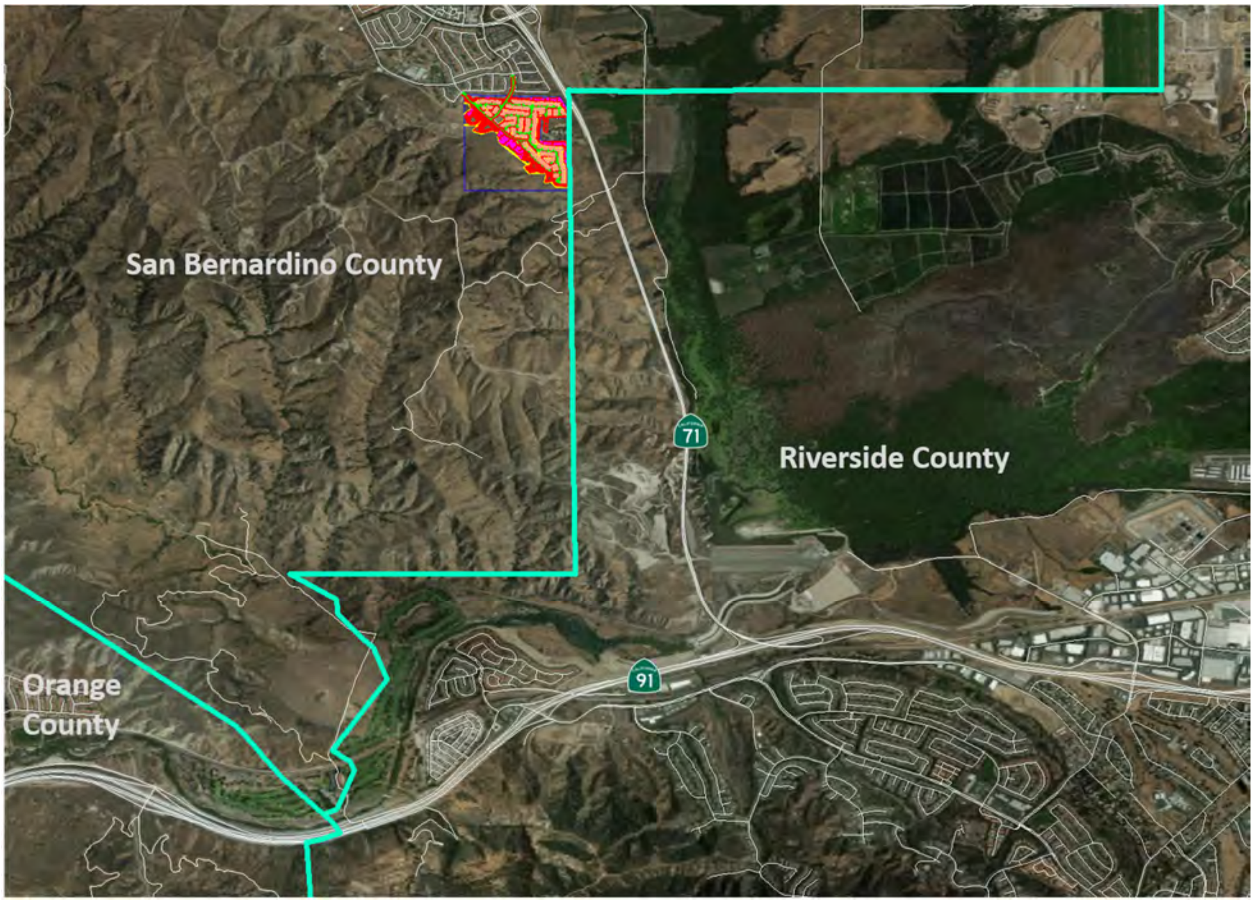


Figure 2

<u>Fire Hazard Zone Maps</u>

The Shady View project site is located in LRA (Local Responsibility Area) but is bordered by SRA (State Responsibility Area) and FRA (Federal Responsibility Area) as shown in Figure 3, on the next page. This is important in that these SRA and FRA areas will not be maintained as fuel modification zones or should not be expected to be. These areas will remain pristine and native, as they have been for decades.

While the project site is not located within a designated CalFire Fire Hazard Severity Zone, it is within the Fire Hazard Overlay District of the City of Chino Hills, as shown in Figure 5, on page 6. Inclusion in the Fire Hazard Overlay District requires adherence to specific portions of the Development Code (Title 16 of the Chino Hills Municipal Code) as provided in Appendix A.

The CalFire map is simply a recommendation provided to the city for adoption or amendment at its own discretion. The City Overlay District does not have zones (moderate, high, and very high) like the CalFire maps. All areas within the Overlay District are treated the same.

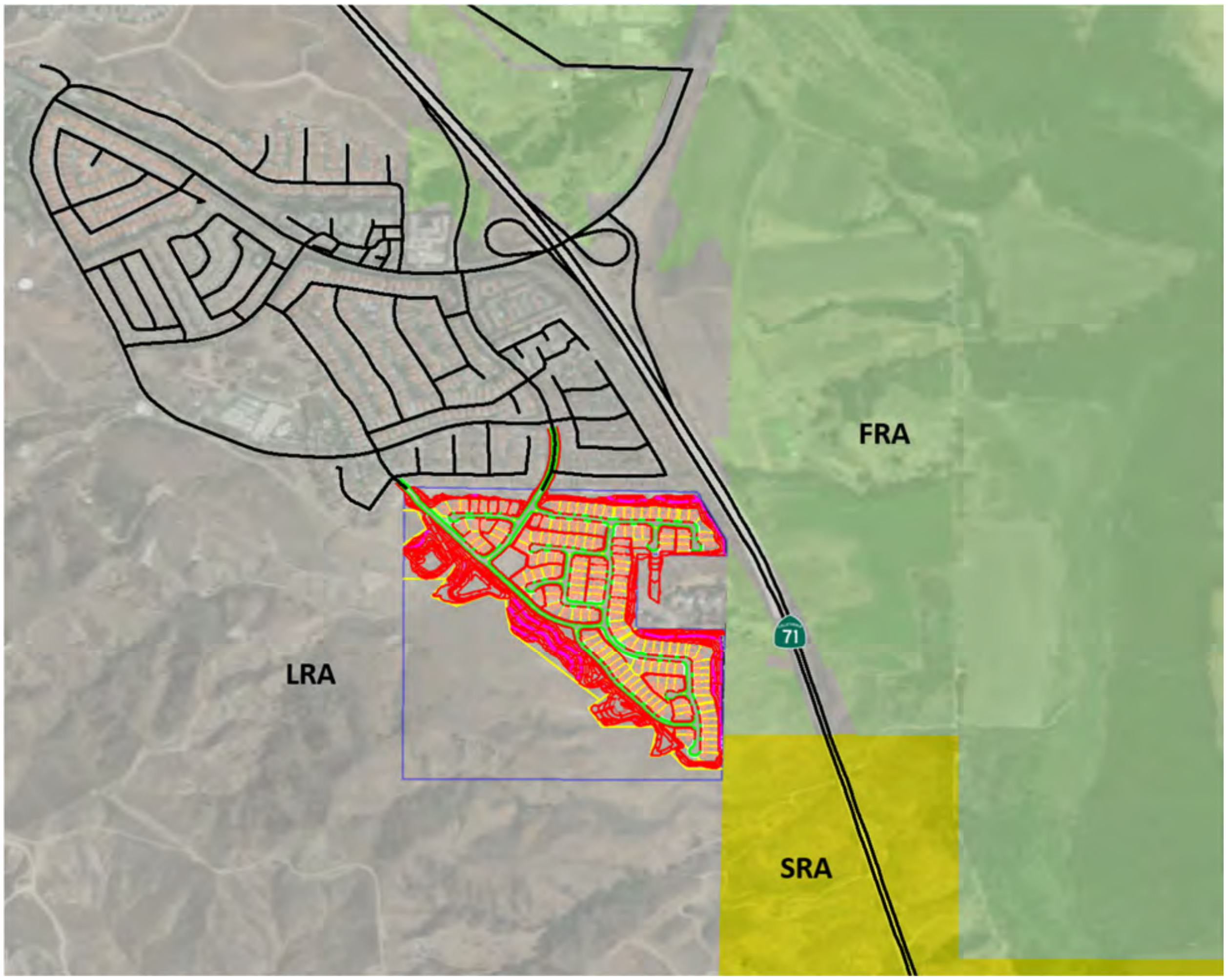


Figure 3
CalFire Fire Hazard Severity Zone Map (recommended)

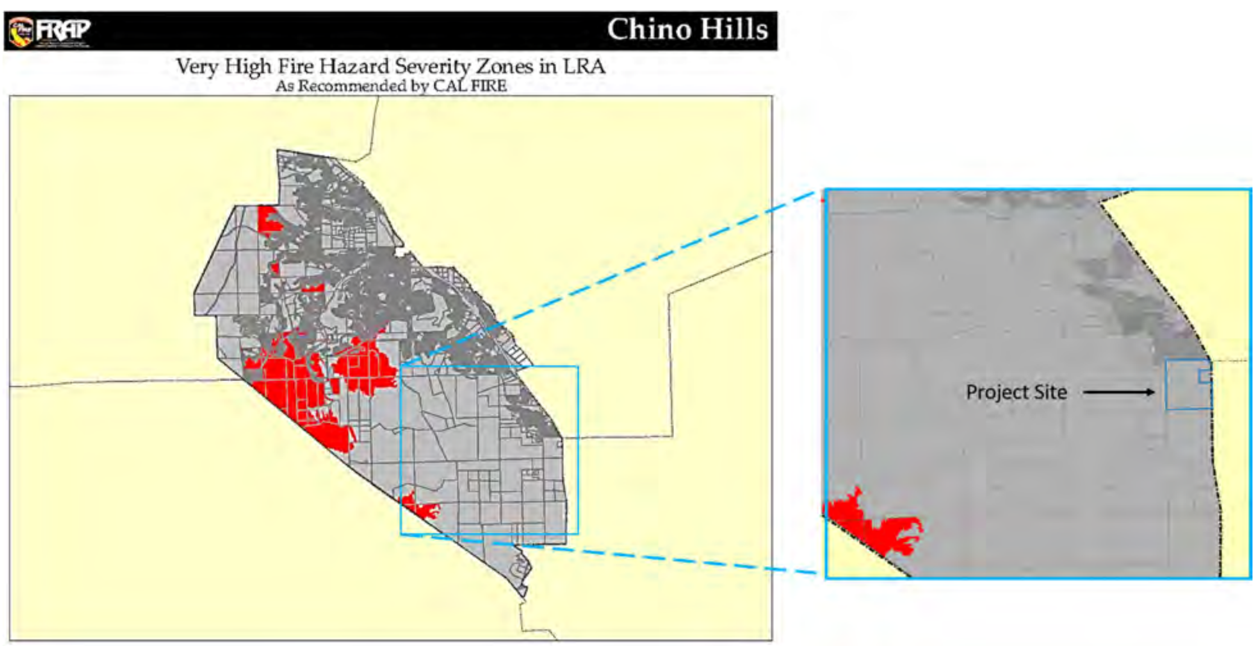


Figure 4

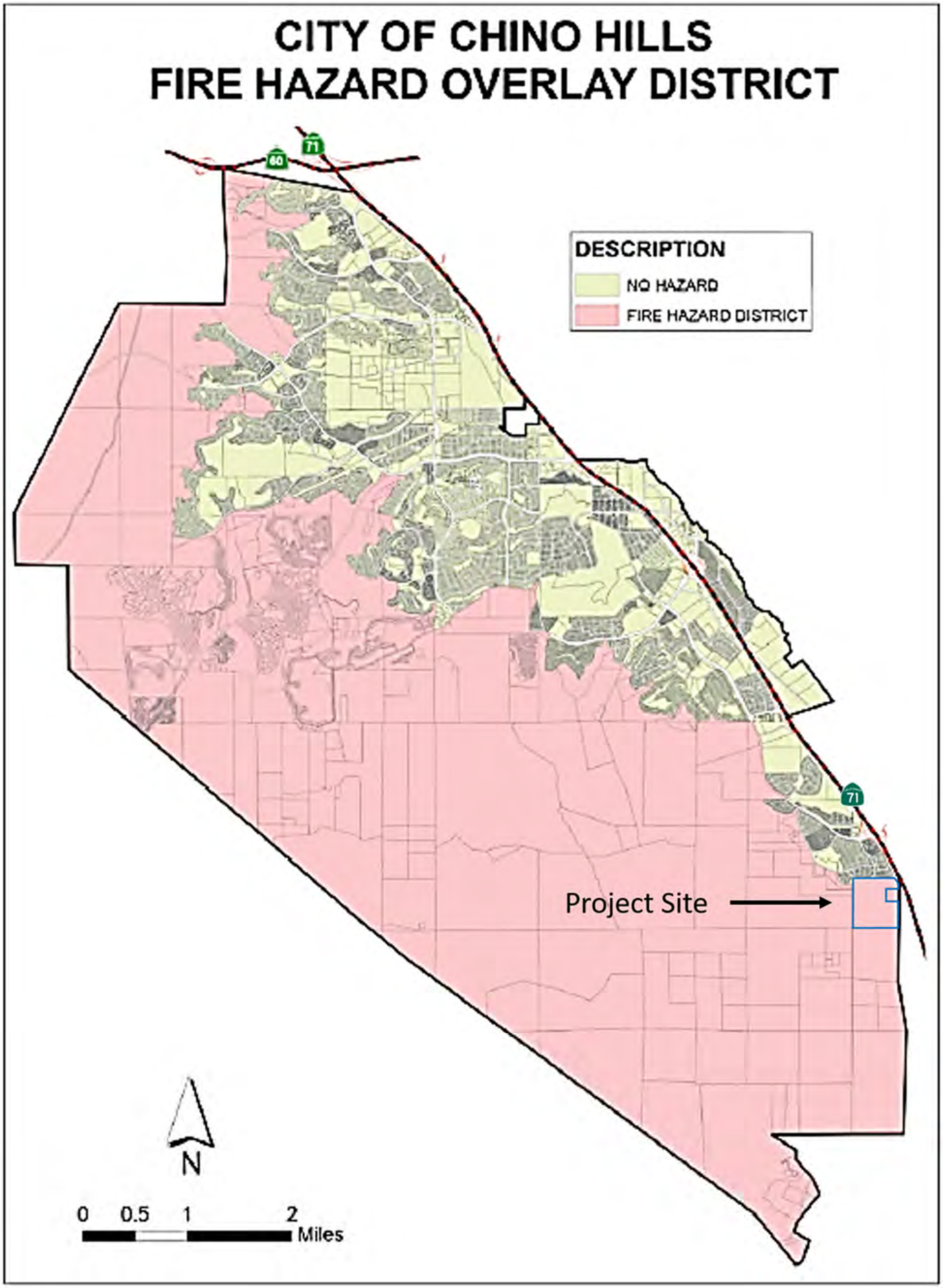
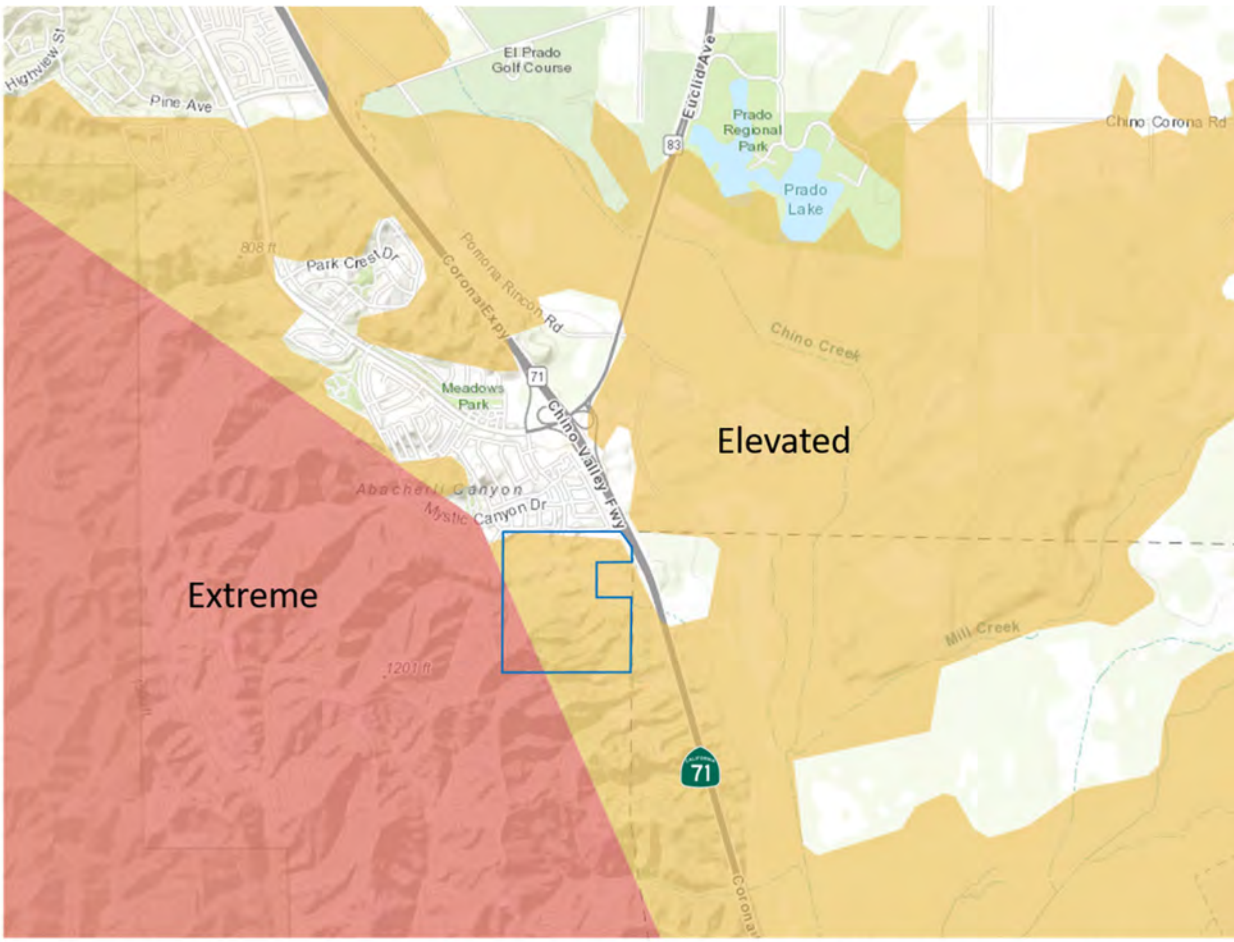

CITY OF CHINO HILLS
FIRE HAZARD OVERLAY DISTRICT
60
71
DESCRIPTION
NO HAZARD
FIRE HAZARD DISTRICT
71
Project Site
N
0
0.5
1
2
Miles

Figure 5

In addition to the CalFire recommendations for Fire Severity Zones, The CPUC (California Public Utilities Commission completed Fire-Threat maps In October 2007, wildfires driven by strong Santa Ana winds burned 1,000,000 acres in California. Several of the worst wildfires were reportedly ignited by overhead utility power lines and aerial communication facilities near power lines. In response to these wildfires, the California Public Utilities Commission (CPUC) initiated and adopted regulations to protect the public from potential fire hazards associated with overhead powerline facilities and nearby aerial communication facilities. One of the byproducts of this effort is the Fire-Threat Map (shown below in Figure 6). The adopted CPUC Fire-Threat Map, together with the map of Tier 1 High Hazard Zones (HHZs) on the U.S. Forest Service (USFS)-California Department of Forestry and Fire Protection's (CAL FIRE) joint map of tree mortality HHZs, comprise the HFTD Map where stricter fire-safety regulations apply. These factors have been considered in this report.



California Public Utilities Commission (CPUC) statewide Fire-Threat Map

Figure 6

<u>Fire History</u>

A review of the CalFire database (FRAP) which compiled this statewide spatial database of fire perimeters from BLM, NPS, and USFS fires 10 acres and greater in size and CAL FIRE fires 300 acres and greater in size shows a picture of the project site and the adjacent historic fire corridor to the west. It is depicted on the following page in Figure 7.

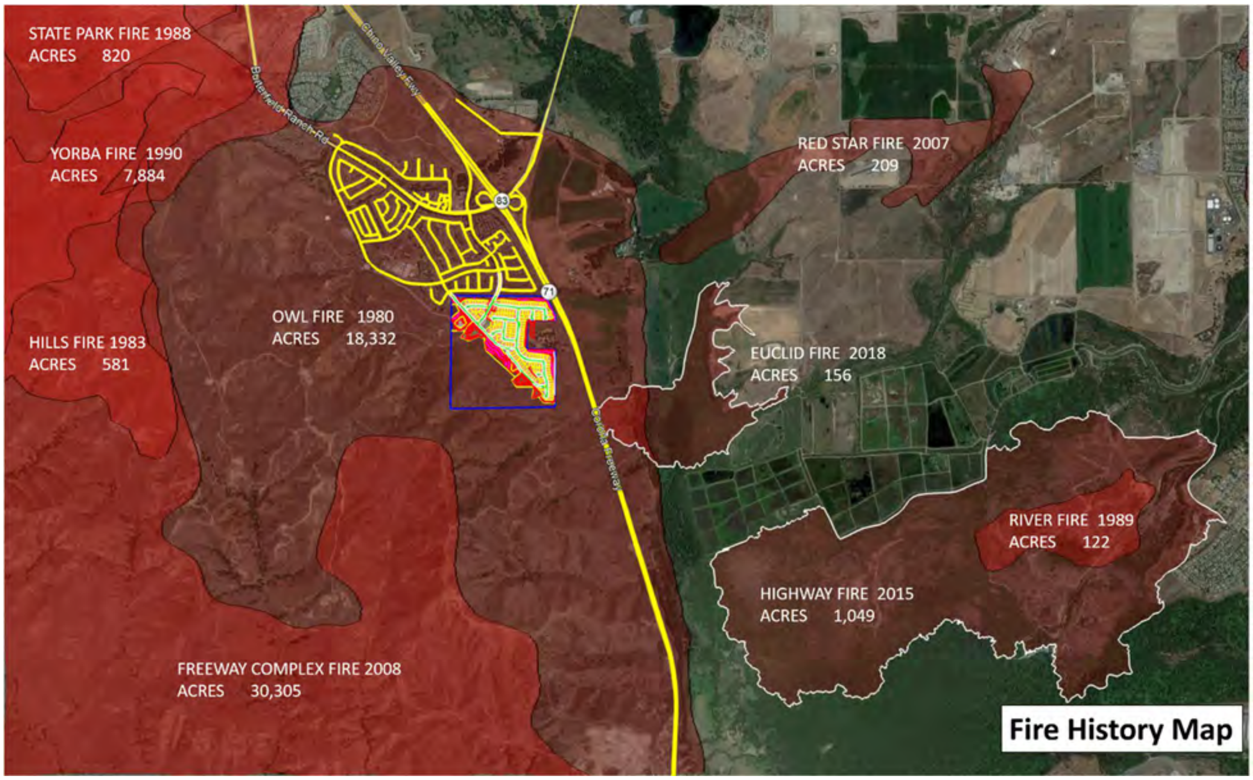


Figure 7

Note: Collection criteria for CAL FIRE fires changed in 2002 to include timber fires greater than 10 acres, brush fires greater than 50 acres, grass fires greater than 300 acres, fires destroying three or more structures, and fires causing $300,000 or more damage. In 2008 collection criteria for CAL FIRE fires eliminated the monetary criterion and redefined the definition of structures.

In the graphic above, the two fires outlined in white are the only fires to have burned in the area within the past ten years. Only the Owl Fire (1980) burned over the project site in the time that records have been kept for large fires. Figure 8, on the next page, provides a look at the fires that have occurred in the past 40 years.

The Freeway Complex (2008) approached the area but did not burn on the east side of the ridgeline near the project site. The Freeway Complex actually started along the 91 Freeway to the south and burned under Santa Ana wind conditions for the first few days of the fire before reversing direction when the offshore Santa Ana winds resided and the predominant onshore wind returned. This is a very typical condition with wildfires in southern California.

The fires to the east of State Route 71 show evidence of wind driven fires in the shape of the fire perimeters. The fires tend to be longer in the direction of travel and narrower overall. These fires align with the onshore and offshore winds, which will be covered in the next section (Fire Behavior). The fires to the west are generally larger fires and the perimeters seem to indicate that they burned along the topographic features dominated by fuel, slope, aspect, and available control points, more than the wind.

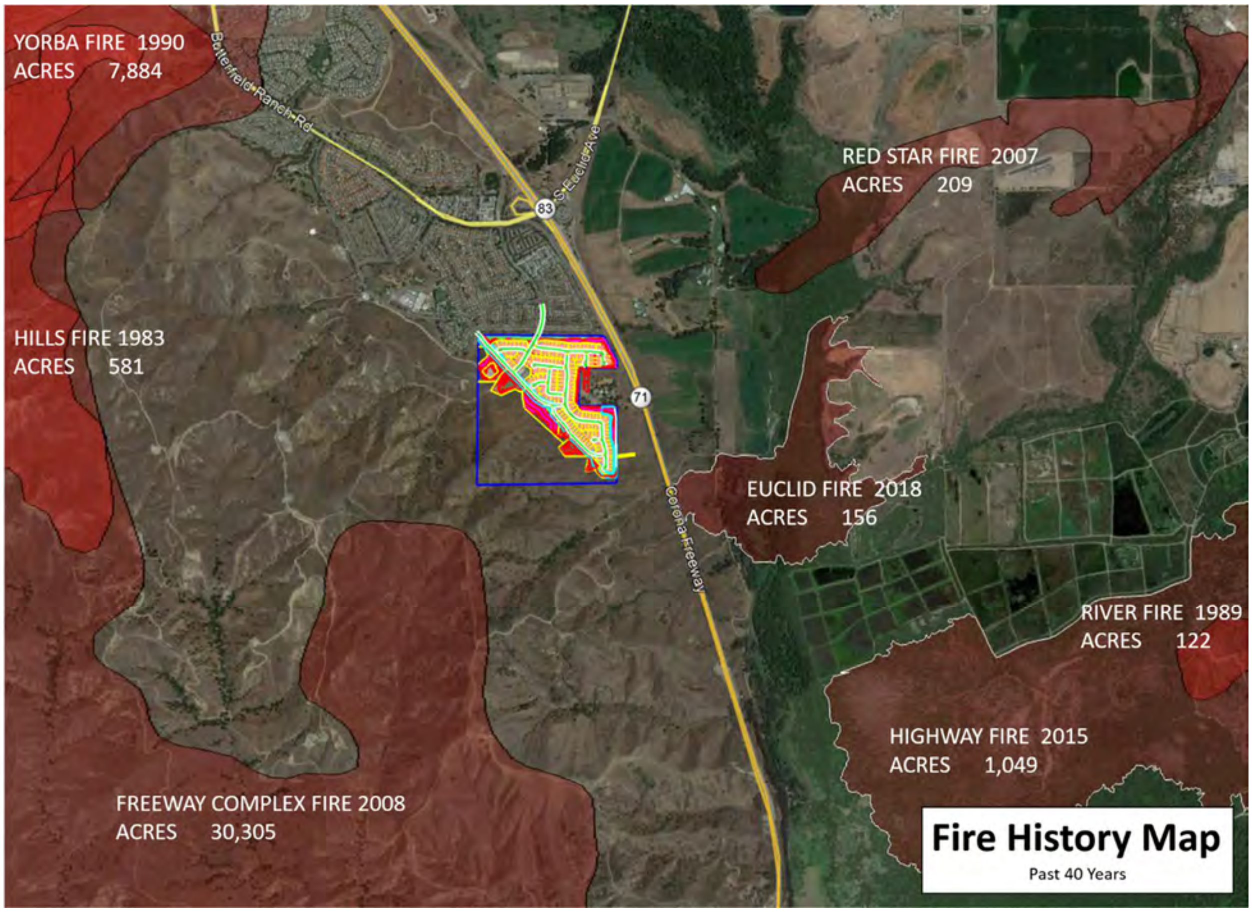


Figure 8

Fire Behavior

Firesafe Planning Solutions used “BehavePlus Fire Modeling System 5.0.5” to predict the level of wildfire intensity for a fire approaching the Shady View project site . BehavePlus, is a fire behavior prediction and fuel modeling system and is one of the most accurate methods for predicting wildland fire behavior in a static environment for a given scenario. The BehavePlus fire behavior computer modeling system is utilized by wildland fire experts nationwide. Vegetative fuels are recognized as fuel models within the BehavePlus program. The fuel models in the computer program are also referenced from the book titled, “Aids to Determining Fuel Models for Estimating Fire Behavior”. The fuel models were designed to aid in determining fuel types and are used in calculating and estimating fire behavior. Firesafe used BehavePlus to measure the intensity of a fire moving towards this development.

The fire model describes the fire behavior only within the flaming front of the fire. The primary moving force in the fire is dead fuel less than ¼” in diameter. These are the finest fuels that carry the fire. Fuels larger than ¼” contribute to fire intensity, but not necessarily to fire spread as much as the fine fuels. The BehavePlus fire model describes a wildfire spreading through surface fuels, which are the burnable materials within 6’ of the ground and contiguous to the ground. Behave modeling is static. It provides a snapshot of the fire behavior at a specific location under specific conditions. It is used as the worst-case software due to the fact that conditions for analysis can be inserted into the model which are not present with respect to the relationship of the wind, topography (slope and aspect), fuels and weather conditions.

This type of modeling can demonstrate the risk to the project site and does assist in the design of the best fire defense system for Shady View. The Modeling will provide data on the distances needed to insure that the structures are significantly further away than the most extreme flame lengths and intensity that would be produced. Instead of estimating with the exact fuel models for calculating fire behavior, Firesafe input worst case scenario factors and fuel models to ensure a further safety cushion in the computer fire behavior calculations and results analysis.

The FlamMap fire mapping and analysis system (Finney 2006) describes potential fire behavior for constant environmental conditions (weather and fuel moisture). Fire behavior is calculated for each pixel within the landscape file independently. Potential fire behavior calculations include surface fire spread, flame length, crown fire activity type, crown fire initiation, and crown fire spread. Dead fuel moisture and conditioning of dead fuels in each pixel based on slope, shading, elevation, aspect, and weather. With the inclusion of FARSITE, FlamMap can now compute wildfire growth and behavior with detailed sequences of weather conditions. Both have been used in the Firesafe analysis.

Fire Modeling Related References:

1. Standard Fire Behavior Fuel Models: A Comprehensive Set for Use with Rothemel's Surface Fire Spread Model , Joe H. Scott and Robert E. Burgan, .United States Department of Agriculture - Forest Service, Rocky Mountain Research Station, General Technical Report RMRS-GTR-153, June 2005.

2. BehavePlus: Fire Behavior Prediction and Fuel Modeling System - BURN Subsystem. General Technical Report INT-194. Patricia L. Andrews, United States Department of Agriculture - Forest Service, Intermountain Station, Ogden, Utah 84401

3. Finney, M. A. 2006. An overview of FlamMap fire modeling capabilities. In: Fuels management—how to measure success: conference proceedings. 2006 March 28-30; Portland, Oregon. Proceedings RMRS-P-41. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 213-220

Wildland Interface Fuel Types

For the purposes of modeling in the plan, the following fuel models were used:

Fuel Model GR1 (101) Dry Climate Grass is short, patchy, and possibly heavily grazed. Spread rate moderate, flame length low. Dynamic. Moisture of extinction is 15%. Fuel bed depth is 0.4 feet.

Fuel Model GR2 (102) Dry Climate - Moderately coarse continuous grass, average depth about 1 foot. Spread rate high; flame length moderate. Dynamic. Moisture of extinction is 15%. Fuel bed depth is 1.0 feet**.**

Fuel Model GS1 (121) Dry Climate - Shrubs are about 1 foot high, low grass load. Spread rate moderate; flame length low. Dynamic. Moisture of extinction is 15%. Fuel bed depth is 0.9 feet.

Fuel Model GS2 (122) Dry Climate - Shrubs are 1 to 3 feet high, moderate grass load. Spread rate high; flame length moderate. Dynamic. Moisture of extinction is 15%. Fuel bed depth is 1.5 feet.

Fuel Model SH1 (141) Dry Climate - Low shrub fuel load, fuelbed depth about 1 foot; some grass may be present. Spread rate very low; flame length very low. Dynamic. Moisture of extinction is 15%. Fuel bed depth is 1.0 feet.

Fuel **Model SH2** (142) Dry Climate - Moderate fuel load (higher than SH1), depth about 1 foot, no grass fuel present. Spread rate low; flame length low. Moisture of extinction is 15%. Fuel bed depth is 1.0 feet.

Fuel **Model SH5** (145) Dry Climate - Heavy shrub load, depth 4 to 6 feet. Spread rate very high; flame length very high. Moisture of extinction is 15%. Fuel bed depth is 6.0 feet.

Fuel **Model SH7** (147) Dry Climate - Very heavy shrub load, depth 4-6 feet. Spread rate lower than SH5, but flame length similar. Spread rate high; flame length very high. Moisture of extinction is 15%. Fuel bed depth is 6.0 feet.

The graphic below shows the fuels as recorded in the Landfire database for wildland fuel using the Scott and Bergan 40 fuel classifications. Numbers on graphic correspond to those detailed above. The project site is outlined in purple for the development area. Only the fuel listed above are within the project site and the area immediately adjacent.

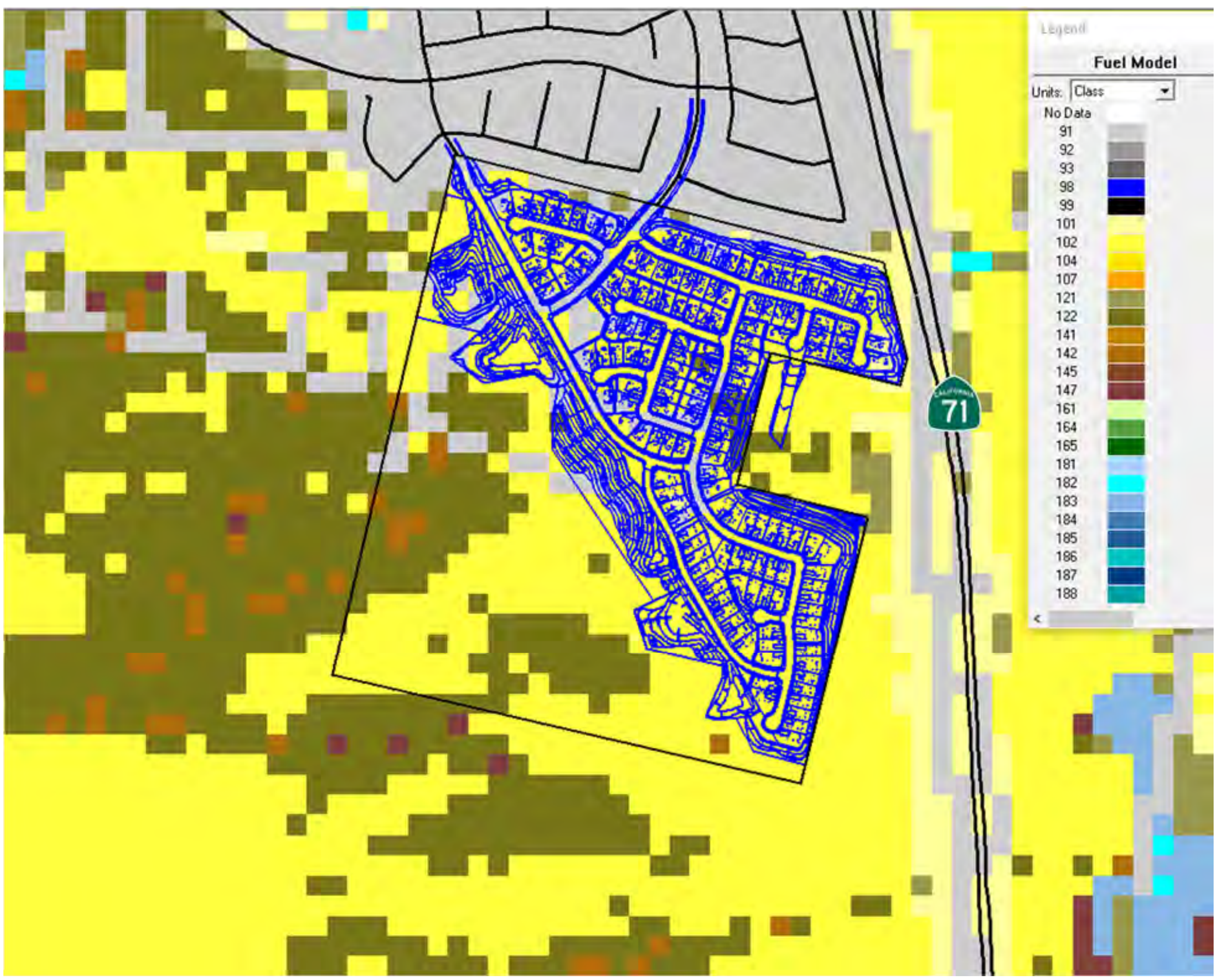


Figure 9

Fuels Summary

The predominant fuels in or near the project site are grasses, grass/scrub mixtures and small pockets of shrubs. Below and on the following pages, a series of photos are used to show the predominant vegetation on the site. More detailed photos are contained in Appendix C of this report. While all of the existing vegetation will be removed in the development areas, the drainages and areas adjacent to the project site to the south and west will be maintained as habitat/open space areas with no management of these areas other than possible grazing. The areas of sh5/sh7 fuels (dark orange and dark red respectively in Figure 9 on the previous page) are small and are far enough away so that they do not impact the project site. They have been modeled but are not in the interface exposure issue.

Below in Figure 10 the interfaces for the south half of the project site area labels. Moving west from the 71 Freeway the vegetation increases in mass as it moves up in elevation. The area between the project site and the freeway is mostly grasses while the area to west above and away from the project site is mostly shrubs on the north aspects but will mostly grasses on the south aspects. This is discussed more in the topography section.

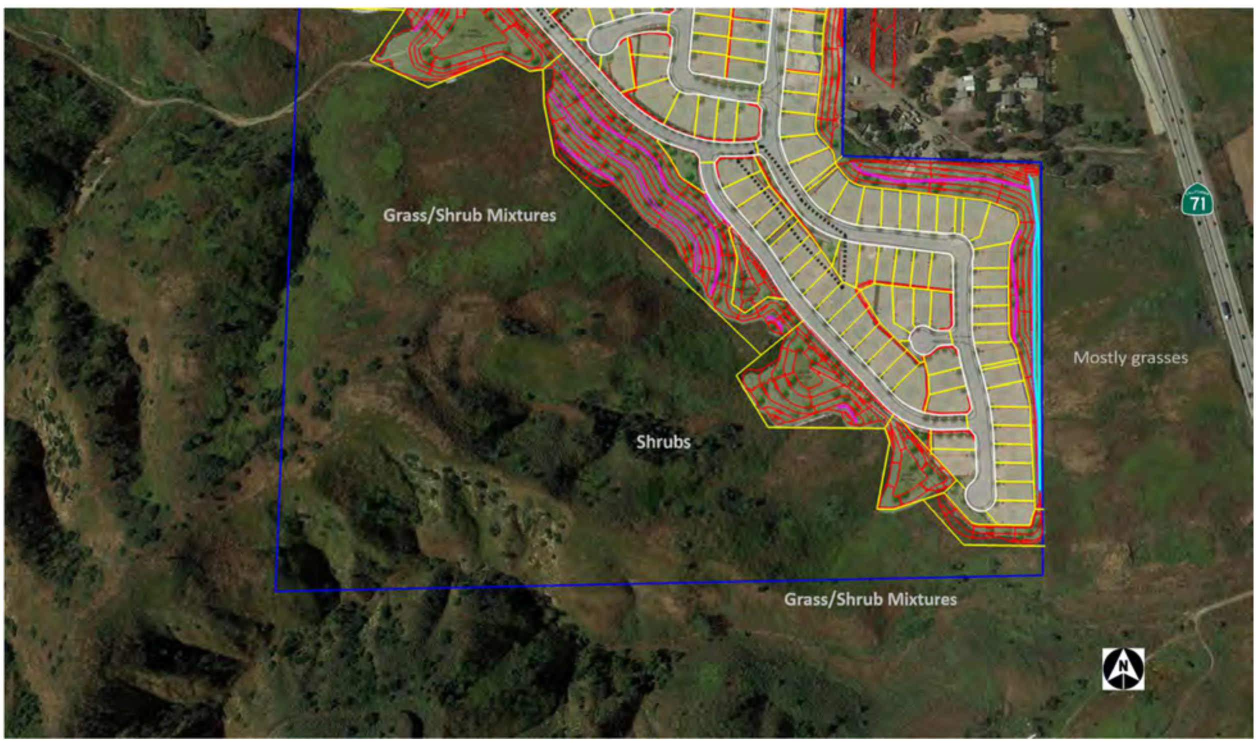


Figure 10

Photo 1 shows the typical west interface with grass fuels in the foreground, grass shrub mixtures in the middle of the picture and shrub fuels on the north aspect of the distant hills. Fuels here are gr2 and gs2. The fence is the edge of State Route 71 looking west over the south end of the project site.

Photo 1 –

Photo 2 shows typical fuels to the west of the project site. All are upslope (overall) and the north aspect of the deeper draws have more fuel loading. This interface transitions from a grass/shrub mixture to a shrub fuel as it moves up and away from the project site.

Photo 2 –

Photo 3 shows an example of the shrub fuels onsite. The shrub fuels are mostly on north aspects and are small pockets in areas within 200 feet of the development footprint.

Photo 3 –

Photo 4 shows the area between the existing homes to the north and the project site. This area will be maintained. Undesirable species will be removed.

Photo 4 –

Wind Patterns and Weather Inputs

After a review of the local AWOS (Automated Weather Observation Station) data (Station KAJO), the most extreme wind patterns and speeds relating to wildfires were entered into the modeling programs (Behave, Flammap, Farsight and Wind Ninja). All other lesser wind patterns and wind speeds normally produce less fire intensity based on a fire in wildland fuels. The Corona Airport AWOS is available SE of the project site (approximately 3.35 miles). The location of the AWOS relative to the project site is shown below.

Figure 11 **Project site**

On the next page, a wind rose and five-year summary of the weather for the AWOS provide the inputs that have been used for the modeling. The lowest relative humidity was 3%, the highest temperature was 115 degrees, the shows maximum sustained wind was 37 mph and the fastest wind gust was 52 mph.

The predominant wind direction is from the west, the strongest Santa Ana winds from the ENE. Winds of up to 15 mph can come from any direction but the stronger winds are either onshore (W) or offshore (NE or ENE). This fact is evident by the orientation of the runway at the corona airport (W/E). which are configured to fly into the wind on takeoff and with the wind on landing for the majority of the wind that is expected. This can be seen in Figure 11, above.

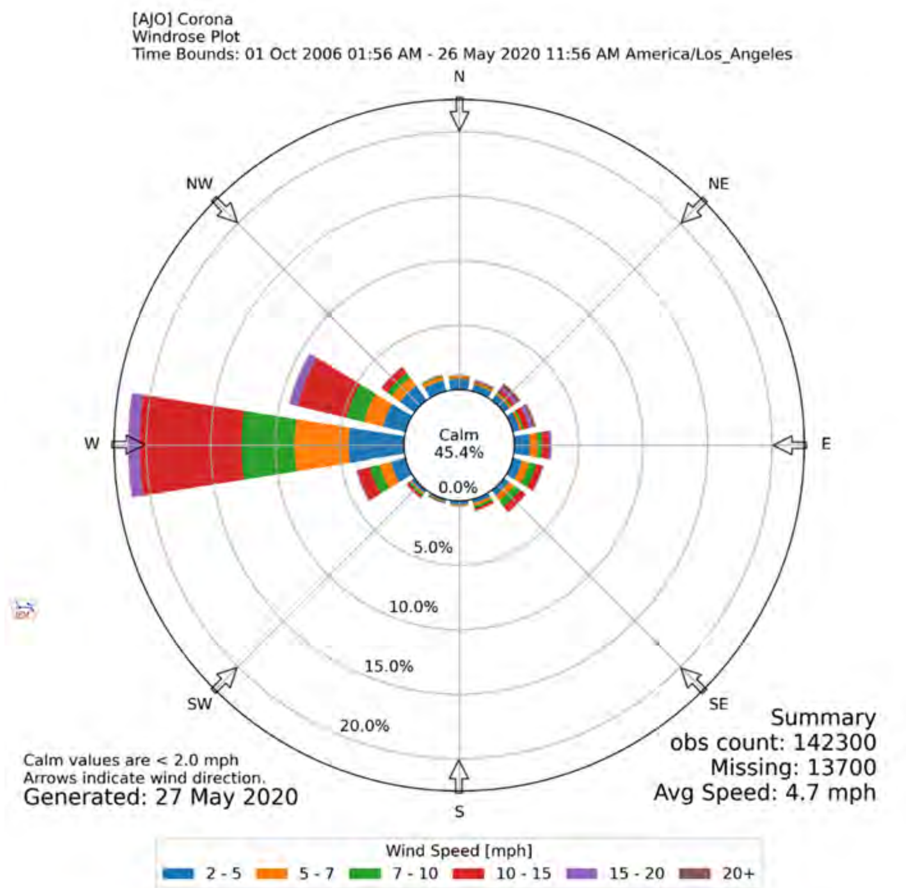


Figure 12

KAJO	Air Temp Fahrenheit	Relative Humidity Percentage	Wind Speed Miles/hour	Wind Direction Degrees	Wind Gust Miles/hour
2019					
Min	27	3	-	-	16
Max	102	100	31	360	40
Avg	63	68	5	150	21
2018					
Min	23	3	-	-	16
Max	115	100	33	360	44
Avg	65	62	6	153	21
2017					
Min	27	4	-	-	16
Max	109	100	33	360	45
Avg	65	63	5	150	22
2016					
Min	26	5	-	-	16
Max	109	100	37	360	52
Avg	67	63	5	150	22
2015					
Min	20	4	-	-	16
Max	104	100	32	360	48
Avg	63	66	4	99	21

Figure 13

Using the Wind Ninja software, the wind and the relationship to the topography has been determined to NOT be a factor with this development with respect to additional hazards. While wind channeling is present in the West interface, the impact on the development site in minor. The predominant wind (from the west) brings potential fire from areas which are above the project site and create wind sheltering (lower wind speeds) at the interface to the project site (blue arrows). The graphics on the next pages show wind from the west and from the east northeast as it intersects the project site development area.

West wind

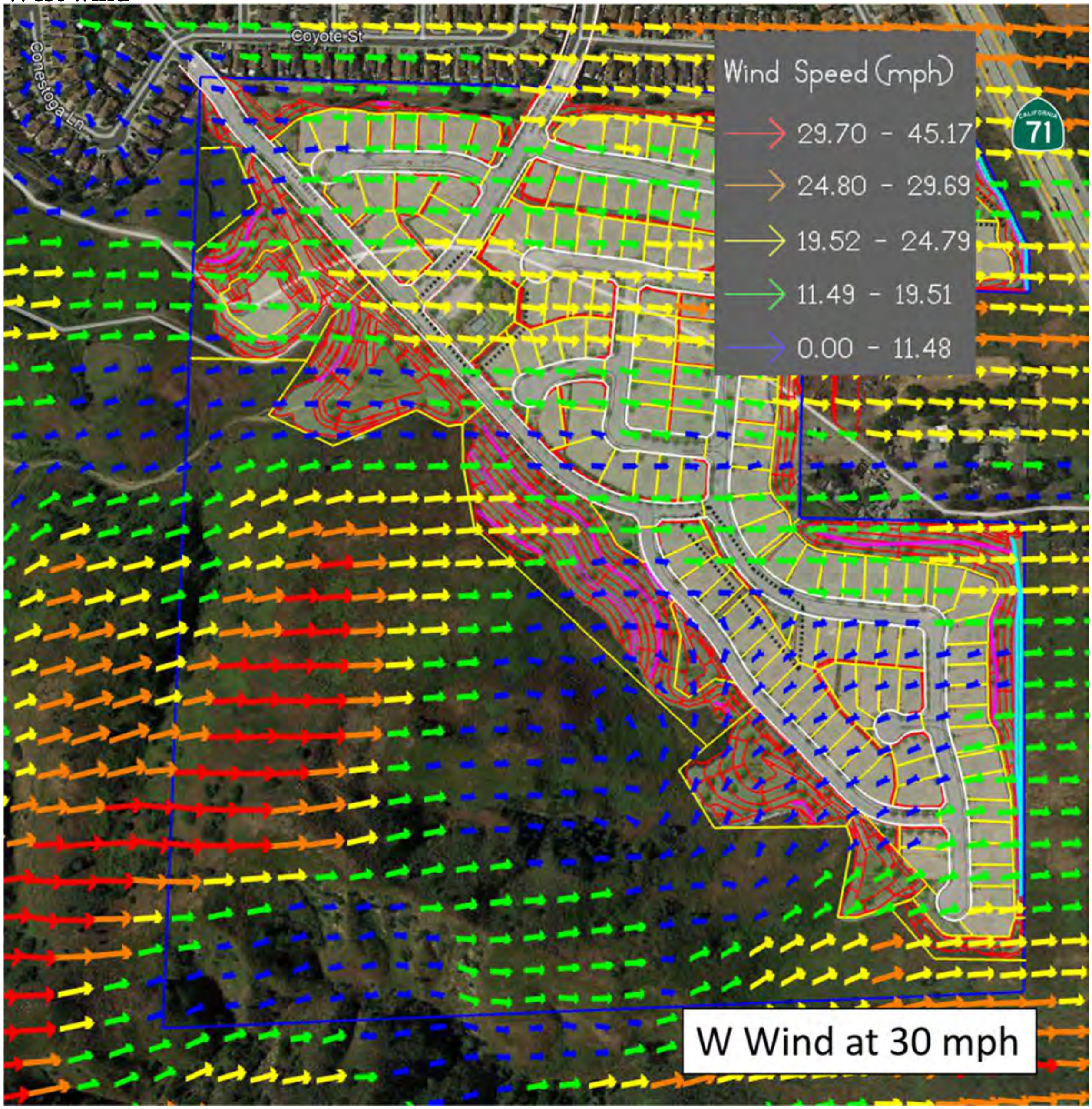


Figure 14

Yellow arrows represent winds of the speed modeled +/- about 10%; orange arrows are winds which are faster than the modeled winds; red arrows showing the extreme winds (normally only at the ridgetops) and green arrows are slightly wind sheltered areas and the blue are the most sheltered (normally at the bottom of steeper drainages or the leeward side of a steeper slope).

In Figure 15 (West Wind), below, the blue arrows not only indicate the slower wind speeds (under 12 mph) but in these areas, the wind changes direction, in some cases actually reverses direction. These areas are complicated fire behavior, but they are also, much less in severity and pose little risk to structures protected with 100' of fuel modification.

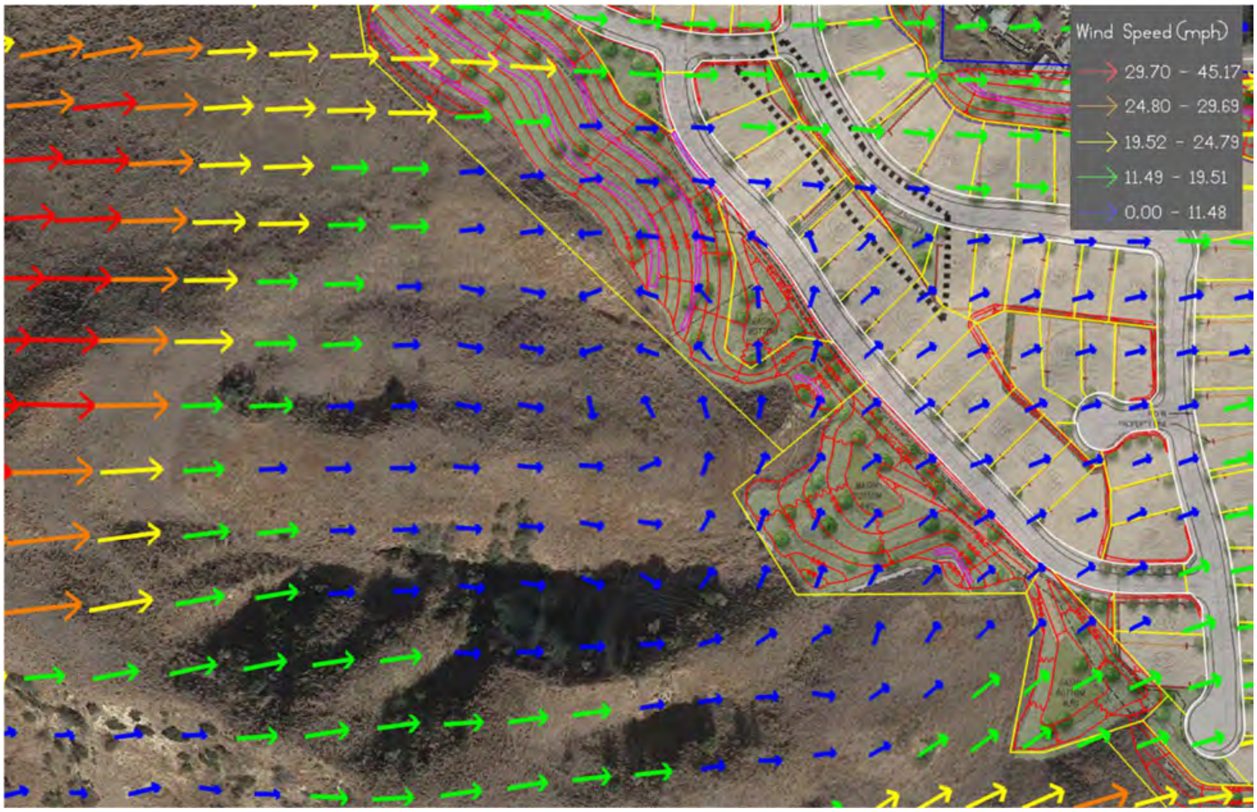


Figure 15

The ENE wind is less complicated. Little to no wind channeling occurs. Wind sheltering is also limited and the effect (reduction in wind speed) much less than the W wind scenario. The ENE wind limited acceleration on the east interface. In the area that does have acceleration, it does not occur in areas with large continuous fuel beds in line with the wind and slope. Nearly all of the native areas to the east of the project site have wind speeds at or lower than the domain average used in the modeling.

The area within the development footprint will be re-graded and will not produce the areas of increase or decrease shown on the model output here. The removal of native fuels, re-grading of the topography into homogenous forms and the irrigated planting that will occur remove the threat of the wildland continuing to burn into the community as a wildfire.

It should also be noted that the 71 Freeway provides a solid noncombustible fire break on the east interface. Any fire entering the community from the east, must originate from the area between the freeway and the project site or spot over the freeway from a fire to the east. The orientation of the wind to the freeway (perpendicular) provides the maximum safety effect to the project site. A line of fire cannot be blown into the community from the adjacent Prado Dam basin.

East Northeast wind.

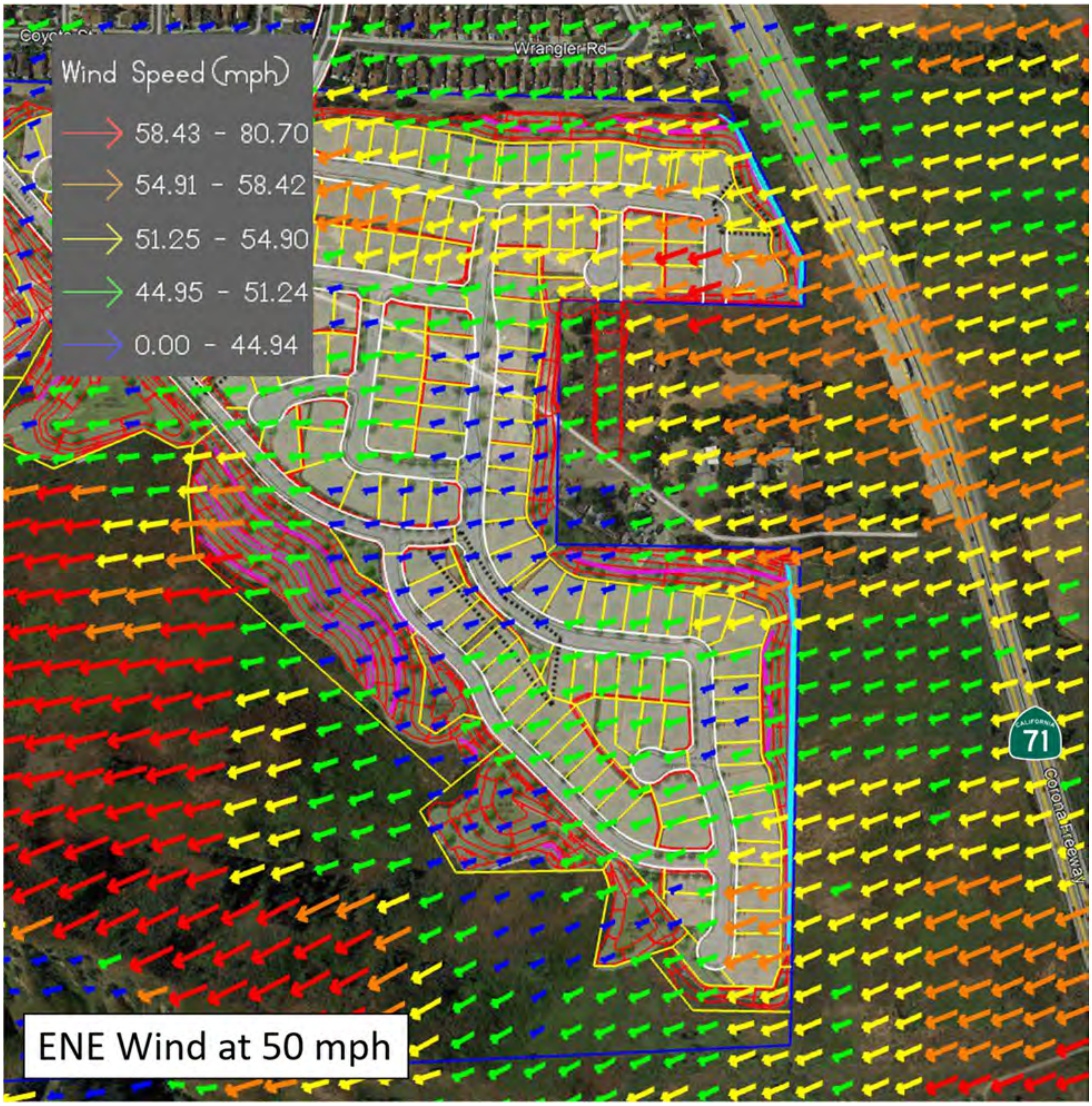


Figure 16

Topography/Terrain

Topography is an important input to the fire modeling software. Topography includes elevation, slope and aspect. Each has its own impacts on wildland fuels, wind impacts and fire behavior. First is elevation. Figure 17, on the next page, is a graphic representation of changes in elevation in and around the project site. The project site interfaces range from 500 feet to over 1,200 feet above sea level. Generally, the area rises from the east to the west, most dramatically west of the project site as shown in the graphic.

While the overall grade of the elevation/grade of the project site interface is important, the slope of the wildland fuel area is an important issue that drives the fire behavior. Slope can and does change on a regular basis in the native fuels. The analysis of the slope in the adjacent native fuels is in 30-meter grids within the dataset (Landfire Dataset), as are all Landfire datasets. The maximum slope in any grid within the immediate areas is 90% (42 degrees). While some small areas are likely steeper than 42 degrees, the overall average and impact on fire behavior does not exceed this level. All interface areas which will be regraded will be reestablished with slope not to exceed 50% (2:1 slope) unless they utilize retaining walls as is the case in much of the east interface.

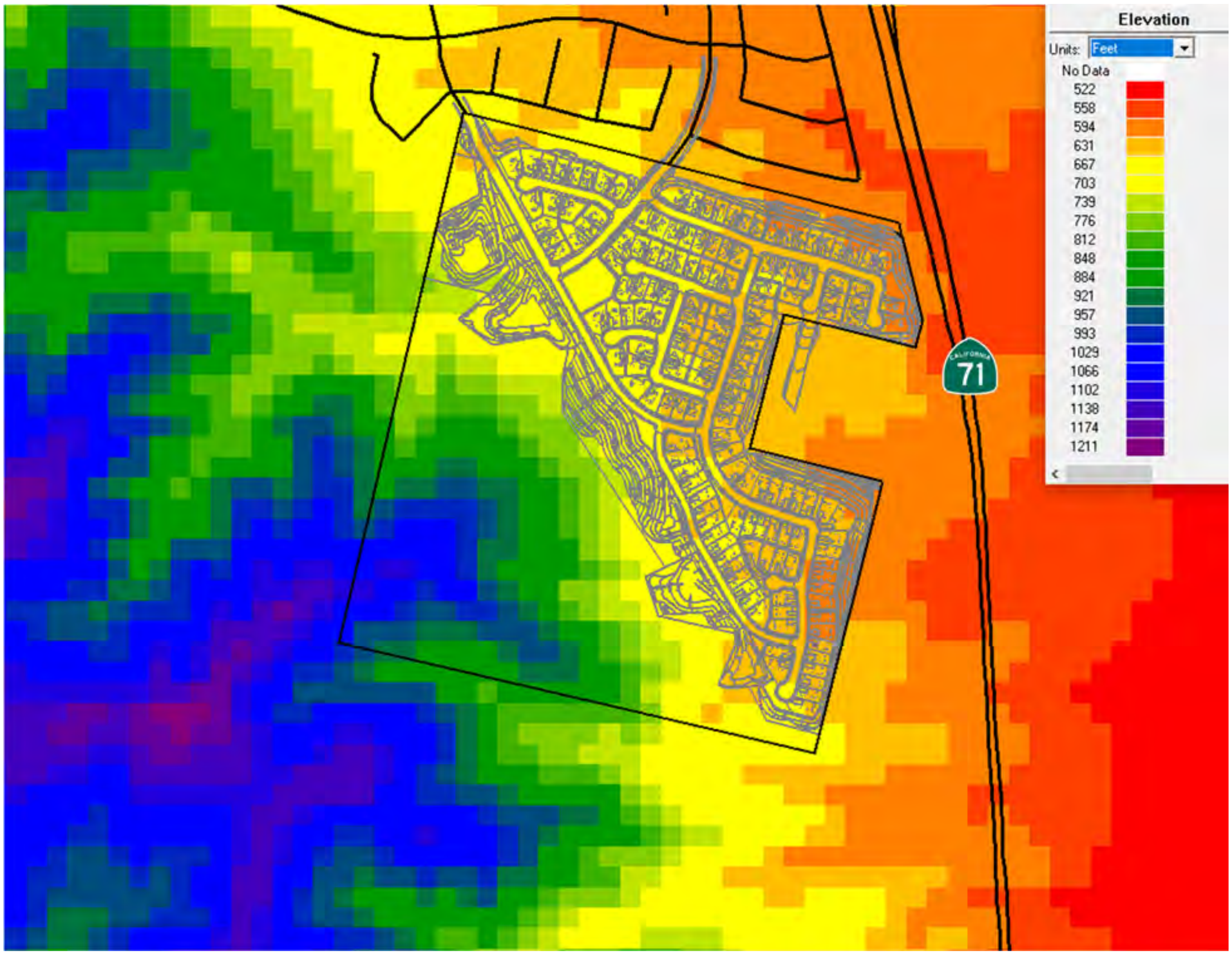


Figure 17 – Elevation Map from Landfire Database

The east interface (freeway side) is mostly gentle sloping areas (15% or less) where the west interface is much steeper and varied as it transitions into the hillside and up the ridgetops. When viewed along with the Aspect Map (Figure 19, on next page) a full understanding of the interface can be achieved.

The same 30-meter grids that are used for fuels, slope and elevation are used here for the aspect calculation. While accurate overall, some errors do exist. For example, if a grid were half north, and half south aspect, the algorithm would average the two values (north = 0 degrees and south = 180 degrees) into an east aspect (90 degrees). Ground truthing is needed to correct these. The aspect has been generally checked but not to the grid cell level.

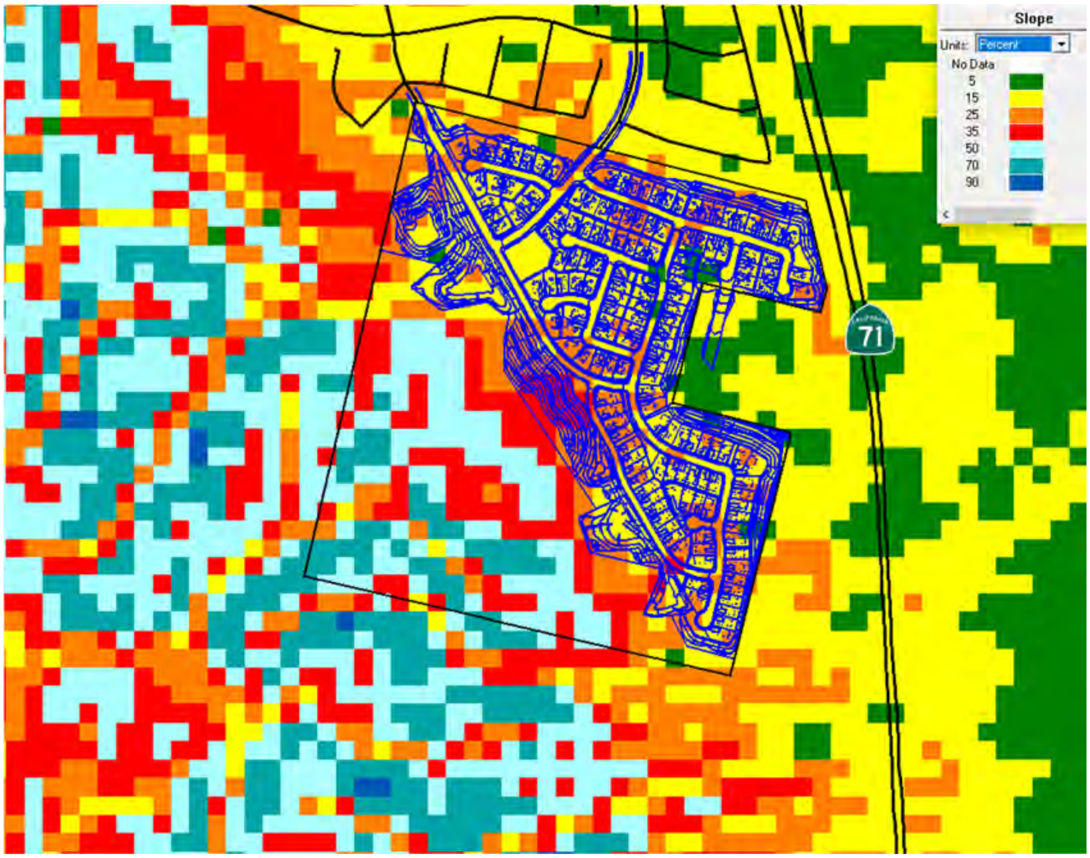


Figure 18 – Slope Analysis from Landfire Database

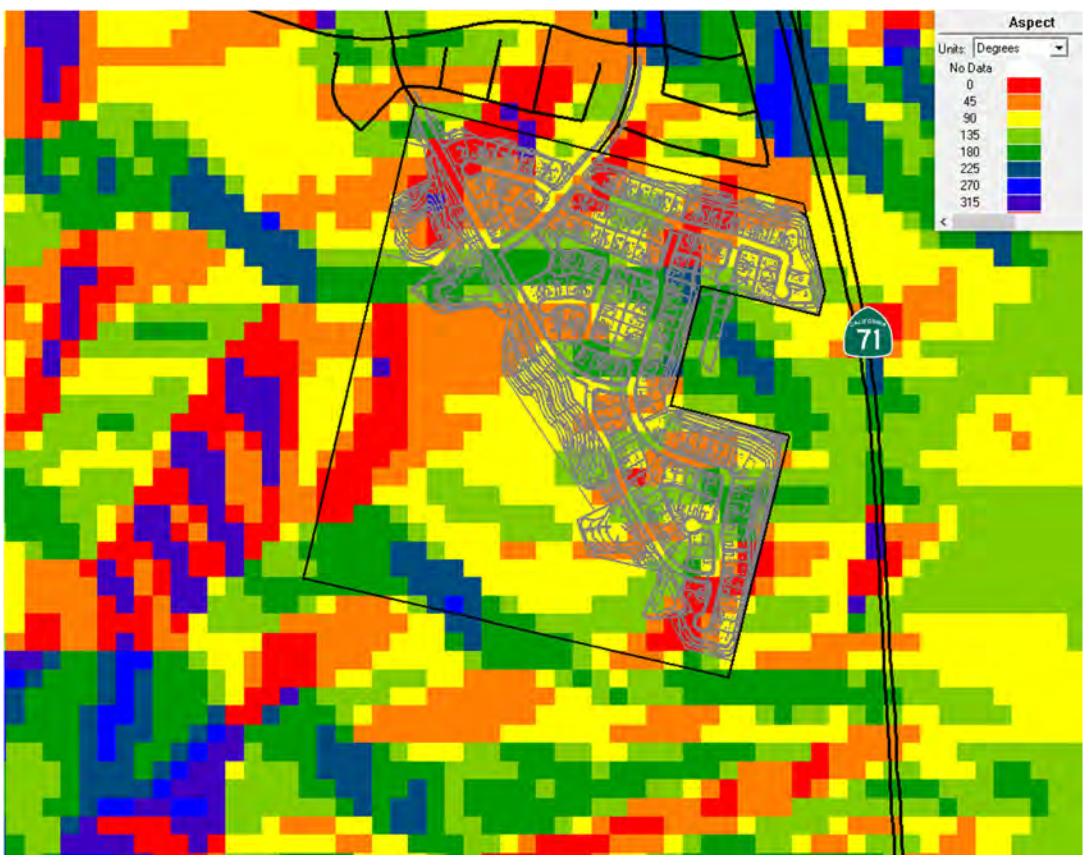


Figure 19 – Aspect Analysis from Landfire Database

Important to this discussion are the N, NE and NW aspects which tend to be protected from the sun for longer periods in the steeper slopes. This allows for more moisture to be retained and normally creates a higher fuel loading on these aspects. The opposite is true of the south aspects which tend to be lighter fuels at this elevation, in this part of southern California. This is illustrated below in Figure 20.

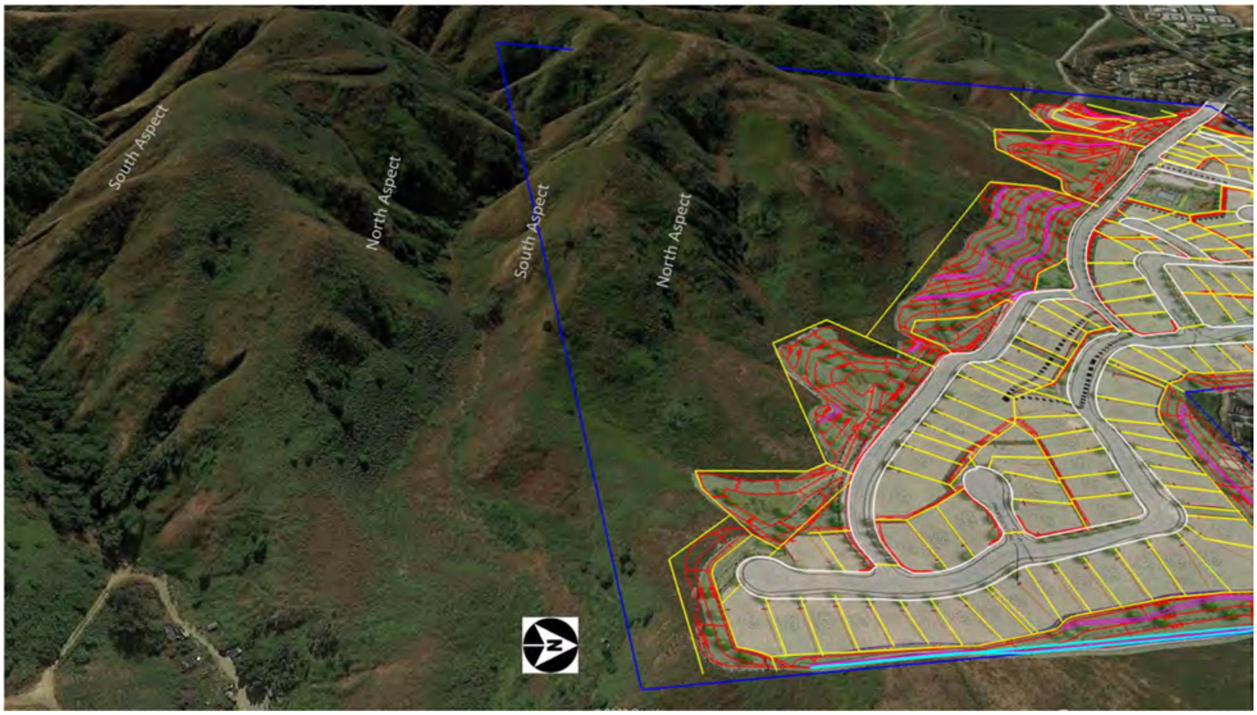


Figure 20

BehavePlus Fire Behavior Inputs and Results:

Inputs for the Behave Plus Fire Behavior Model were as follows:

- Moisture scenarios used are extreme.
- One-hour fuels at 3%, ten-hour at 4% and hundred-hour at 5%.
- Herbaceous live fuels are modeled at fully cured (30%) and woody fuels at 50%.
- Model runs have been completed with the wind running upslope, with the wind in "full alignment"

Behave runs have been completed for ENE Santa Ana wind event and the onshore W wind. The moisture scenario is unchanged to simulate the rear dry onshore that can occur when the Santa Ana winds break down and on shore flow is resumed but the air immediately offshore is the dry air that has been pushed out to sea by the NE or ENE wind event. This condition is rare and only lasts for a short period of time as the air further out to sea, will have increased moisture level when then returned to the land by the onshore breeze.

The worst-case scenario used the ".5" adjustment factor for unsheltered fuels. The modeling was completed at 30 mph to represent the onshore condition and at 60 and 80 mph for the offshore condition. All assumed a 50% (2:1 slope) as the worst case. Aspects are shown on the scenarios running up hill with the wind and the maximum spread direction.

Inputs: SURFACE		
Description		Worst Case Fuels - SCAL
Fuel/Vegetation, Surface/Understory		
Fuel Model		1, 2, 4, 5, 6, gr1, gr2, gs1, gs2, sl
Fuel Moisture		
1-h Moisture	%	3
10-h Moisture	%	4
100-h Moisture	%	5
Live Herbaceous Moisture	%	30
Live Woody Moisture	%	50
Weather		
20-ft Wind Speed	mi/h	15, 30, 40, 60, 80
Wind Adjustment Factor		0.5
Wind Direction (from north)	deg	45
Terrain		
Slope Steepness	%	50
Aspect	deg	45
Fire		
Spread Direction (from north)	deg	225

Figure 21

The Behave outputs are attached in the Appendix C but have been summarized here for discussion purposes. The highlighted area provides the outputs for the existing vegetation and the radiant heat value at 50' and 100' for the 80-mph wind. The depth of the fuel bed is also provided.

Fuel Model	Wind Speed 15	30	40	60	80	Flame Length	Fuel Modification Distance (ft.) 50	100	Fuel bed depth (ft)
							2500	10000	
4	62,144	144,799	211,384	365,939	544,086	110.5	217.6	54.4	6.0
5	4,923	11,357	16,482	28,274	34,448	31.1	13.8	3.4	2.0
6	3,383	7,508	10,716	12,630	12,630	19.6	5.1	1.3	2.5
gr1	151	151	151	151	**151**	2.6	0.1	0.0	0.4
gr2	2,316	4,037	4,037	4,037	**4,037**	11.6	1.6	0.4	1.0
gs1	1,521	3,665	4,122	4,122	**4,122**	11.7	1.6	0.4	0.9
gs2	3,421	8,216	12,145	18,700	**18,700**	23.4	7.5	1.9	1.5
sh1	1,022	2,349	2,838	2,838	**2,838**	9.8	1.1	0.3	1.0
sh2	2,507	5,622	8,098	13,785	**20,273**	24.3	8.1	2.0	1.0
sh5	24,400	49,790	68,233	107,667	149,707	61.0	59.9	15.0	6.0
sh7	21,740	43,680	59,548	93,360	129,290	57.1	51.7	12.9	6.0
SCAL14	12,761	21,806	27,654	39,078	50,246	36.9	20.1	5.0	3.0
SCAL15	7,194	13,447	17,739	26,520	35,493	31.5	14.2	3.5	3.0
SCAL16	13,642	25,942	34,476	52,080	70,217	43.1	28.1	7.0	6.0
SCAL17	5,878	13,468	19,488	33,287	45,799	35.4	18.3	4.6	4.0
SCAL18	26,584	45,672	57,962	81,891	105,210	51.9	42.1	10.5	3.0
	Fireline Intensity kW/m²					(ft)	Fireline Intensity kW/m2		(ft)

Figure 22

Worst Case Fuels - SCAL
Flame Length (ft)

Fuel Model	20-ft Wind Speed mi/h				
	15	30	40	60	80
1	8.6	10.0	10.0	10.0	10.0
2	12.7	21.3	26.8	37.4	47.5
4	40.7	60.1	71.5	92.1	110.5
5	12.7	18.6	22.1	28.4	31.1
6	10.7	15.4	18.1	19.6	19.6
gr1	2.6	2.6	2.6	2.6	2.6
gr2	9.0	11.6	11.6	11.6	11.6
gs1	7.4	11.1	11.7	11.7	11.7
gs2	10.7	16.1	19.2	23.4	23.4
sh1	6.2	9.0	9.8	9.8	9.8
sh2	9.3	13.5	16.0	20.4	24.3
sh5	26.5	36.8	42.5	52.5	61.0
sh7	25.1	34.6	39.9	49.1	57.1
SCAL14	19.7	25.2	28.1	32.9	36.9
SCAL15	15.1	20.1	22.9	27.5	31.5
SCAL16	20.3	27.3	31.1	37.6	43.1
SCAL17	13.8	20.2	23.9	30.6	35.4
SCAL18	27.6	35.4	39.4	46.2	51.9

Worst Case Fuels - SCAL
Fireline Intensity (kW/m)

Fuel Model	20-ft Wind Speed mi/h				
	15	30	40	60	80
1	2122	2922	2922	2922	2922
2	4937	15169	25034	51555	86642
4	62144	144799	211384	365939	544086
5	4923	11357	16482	28274	34448
6	3383	7508	10716	12630	12630
gr1	151	151	151	151	151
gr2	2316	4037	4037	4037	4037
gs1	1521	3665	4122	4122	4122
gs2	3421	8216	12145	18700	18700
sh1	1022	2349	2838	2838	2838
sh2	2507	5622	8098	13785	20273
sh5	24400	49790	68233	107667	149707
sh7	21740	43680	59548	93360	129290
SCAL14	12761	21806	27654	39078	50246
SCAL15	7194	13447	17739	26520	35493
SCAL16	13642	25942	34476	52080	70217
SCAL17	5878	13468	19488	33287	45799
SCAL18	26584	45672	57962	81891	105210

Figure 23

The interface areas for the project site do not have large, dense and/or deep fuel beds. The majority of the fuel beds are under one foot on the east side and get more dense, continuous and have more depth on the west side as they move to the west. Fuel models are based on the Average Fuel Bed Depth as illustrated below in Figure 24. Occasional larger fuels are often balanced with areas of shorter or no fuels. For modeling, this is not realistic as every change in the fuel bed would need a separate input. This is solved by averaging the fuel that is present (the same thing is done for slope and aspect). The project site interface does not have any fuel beds that average over two feet within 200 feet of a proposed structure. For this reason, and after reviewing the configuration of the current fuels onsite, only the grass, grass/shrub mixtures and the shrub fuels less than two feet in depth were used for this analysis.

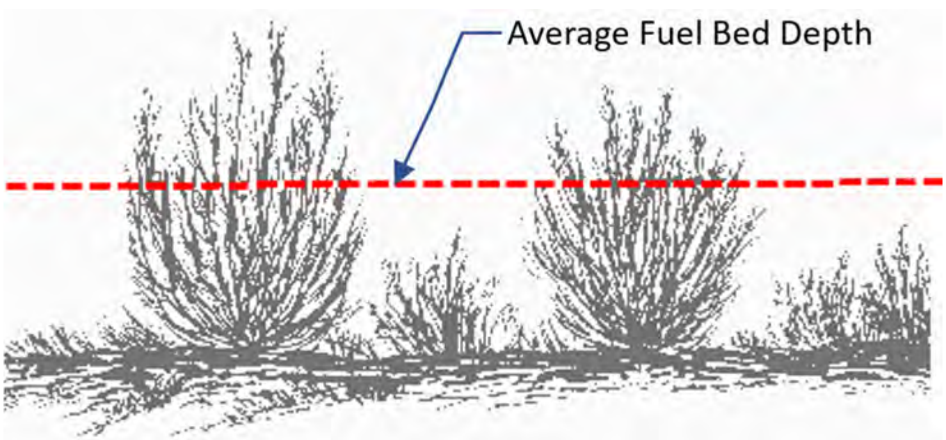


Figure 24

The project site risk needs to examine the potential for a fire within the adjacent native fuel to damage or ignite a structure within the project site. This can happen in one of four ways. First is direct contact with the fire. The maximum flame length is 24.3 feet under any scenario. Any distance greater than this will keep the flames off the structure.

Second is radiant heat. The laws of physics indicate that the decay of radiant heat is calculated by dividing the energy produced by the square of the distance from the heat source. Any structure two times the maximum flame length is expected to have a radiant flux value of less than 20 kW/m^2 on the exposed structure which will be acceptable given the residence time for the wind driven fire event based on Newton's Inverse Square Law. (Figure 25, below).

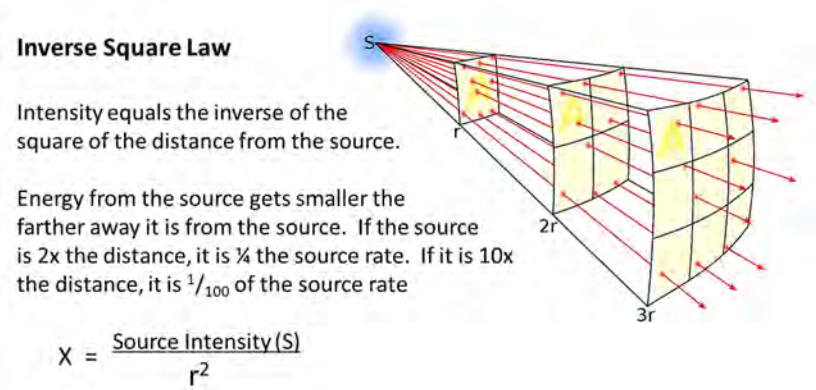


Figure 25 – Inverse Square Law

While this is simplified, it is overall accurate at a conceptual level. Several models exist for the calculation of the Radiant Heat Flux on a structure from various fire sources. Most are complicated and have a set of complex assumptions that must be made. The Inverse Square Law does not specify a unit of measure. The decay is relational between the distance and the source. The drop in heat from the source to distance r is relational to distant 2r and 3r. Firesafe uses a simple formula as a "yardstick" for generalized assumptions about radiant heat from fire. This formula is the FI (Fireline Intensity) from the Behave outputs over the distance in feet squared. Because Newton's Law is relational, it does not specify a unit of measure. Firesafe has derived its "rule of thumb" from the research done by several researchers to provide some rationale for why we use "two times the maximum flame length" rather than some other distance.

Making the calculation in meters and then converting the distances to feet means that the 93,360,779 kW/m from the 50-foot flame lengths in the sh7 fuel model provides a radiant heat flux of 9.3 kW/m^2 using the formula at 100 feet of separation from the native fuels to the structure. Firesafe uses the Fireline Intensity (FI) and divides this by the distance in feet squared and arrives at a value under 10 kW/m^2. This method will always overestimate the radiant heat flux by 17% over the meter formula which adds to the safety margin in the design criteria.

In nearly all cases, two times the maximum flame length will provide a radiant heat flux value of about 10 kW/m^2 or less. This stands to reason as flame length (LF) is a function of fireline intensity (I) in Byram's formula $LF=0.0775*I^{0.46}$ which most closely approximates the interchanges between these two values (fireline intensity and flame length) in the Behave program. We should be noticeably clear here; this is not the only factor of the amount of heat that might be subject to a specific structure. The real world is much more complicated than a simple formula. Most literature indicates that a hardened structure should be able to withstand 20 to 30 kW/m^2 for a period of 5 minutes or less and not ignite. Using the two times the maximum flame length on the worst-case fire should place the actual value much less than the ones calculated here when a fire actually burns in the interface.

Jack Cohen's SIAM (Structural Ignition Assessment Model) uses a radiant heat flux threshold of 20 kW/m^2 for 5.5 minutes as the baseline for structure ignition (Cohen, J.D., 1995. Structure Ignition Assessment Model (SIAM), USDA Forest Service Gen. Tech. Rep. PSW-GTR- 158). The residence time for a fire within the adjacent wildland would have a residence time of less than one minute under the worst-case scenario; far below the 5.5 minutes needed and would not have sufficient heat beyond the fuel modification zone to ignite any structures. The adjacent wildland areas simply lack the quantity of fuel necessary to burn at a high rate for a period long enough to create a radiant heat issue at the distances provided at two times the maximum flame length.

The third method of fire encroachment is convected heat. This impact area is generally about 75% of the radiant heat impact zone. While small pulses of convected heat may exceed the radiant heat zone and be a danger to the respiratory tracts of firefighters, these pulses are not sufficient in duration to cause ignition of structural materials. This factor can change when large fuels are below the subject property and burn for an extended duration prior to the flaming front impacting the interface. This would be a condition where the Model 4 fuel model would be more appropriate creating a separation distance of over 200 feet. This condition does not exist on the project site.

To be clear, the amount of radiant heat or convected heat that a structure can withstand and not ignite is far more than the human body can withstand. As indicated in Figure 26, below, a rate of 18 kW/m^2 is fatal to 50% of those exposed for 30 seconds while a structure can withstand 20 kW/m^2 for over 5 minutes without igniting. These are not interchangeable environments.

Btu/s/ft^2 Rate	kW/m^2 Rate	Time to Ignition seconds	Time to Ignition minutes	
17.3	60	10	0.17	
14.4	50	16	0.27	
11.6	40	28	0.47	
10.7	37			Damage to process equipment and collapse of mechanical structures
9.0	31	60	1.00	
8.7	30	66	1.10	
6.4	22	210	3.50	
5.8	20	337	5.50	Piloted wood ignition after 5.5 minutes
5.2	18			Death in 50% of victims after 30 seconds
4.6	16			Blistering of exposed skin after 5 seconds
3.6	12.5	1,200	20.00	20 minutes to ignition/2nd degree burn in 8 seconds
2.9	10			Pain on exposed skin after 3 sec/ death in 1% of victims after 40 seconds
2.0	7			Max exposure in PPE for 90 sec
1.8	6.4			Pain on exposed skin after 8 sec
1.4	5.0			2nd degree burns on exposed skin in 40 seconds
1.2	4.3	18,000	300.00	5 hours to ignition
1.2	4.0			First degree burns after 20 seconds
0.7	2.3			Pain on exposed skin after 2 minutes
0.6	2.1			Minimum to cause pain after 60 second
0.5	1.7			Minimum to cause pain
0.3	1.0			Equal to the maximum radiant heat transfer on a clear sunny day

Figure 26

The final method of fire encroachment would be embers and brands. These can and will travel great distances. The project site will be protected from this threat by compliance with California Residential Code Section R337. The project site will be susceptible to brands from both the onshore and offshore winds. Onshore winds will bring fire from the hilltops above the project site which will give the brands/embers more distance to travel before they land. The fuels to the east in the Prado Basin are of a nature that will produce a large number of brands/embers during a wind driven fire event within the basin.

The use of the Behave model for the structure protection calculation is enough information to make reasonable assumptions and decisions on distances, configuration, and acceptable risk. In order to validate the assumptions used for the Behave modeling, Firesafe used Flammap and Farsight modeling programs to run the fire across the topography see insure that the interactions of the slope, wind, fuel and aspect did not create a condition that was more serious than the assumptions used within the Behave model.

Three scenarios were used. A large vehicle fire on the 71 freeway, a line of fire on the west side of the 71 freeway and a line of fire coming from the west along the project site from above. The outputs from these scenarios are provided in the appendixes and the actual model runs will be made available to the fire department on request.

Figures 27-29 provide the flame length projects for the three scenarios. At no time, under these conditions do the flame lengths in the area adjacent to the project site exceed 25 feet. Up on the hillside and down in the Prado Basin, flame lengths of 47.3 feet are found in small areas. None within the project site.

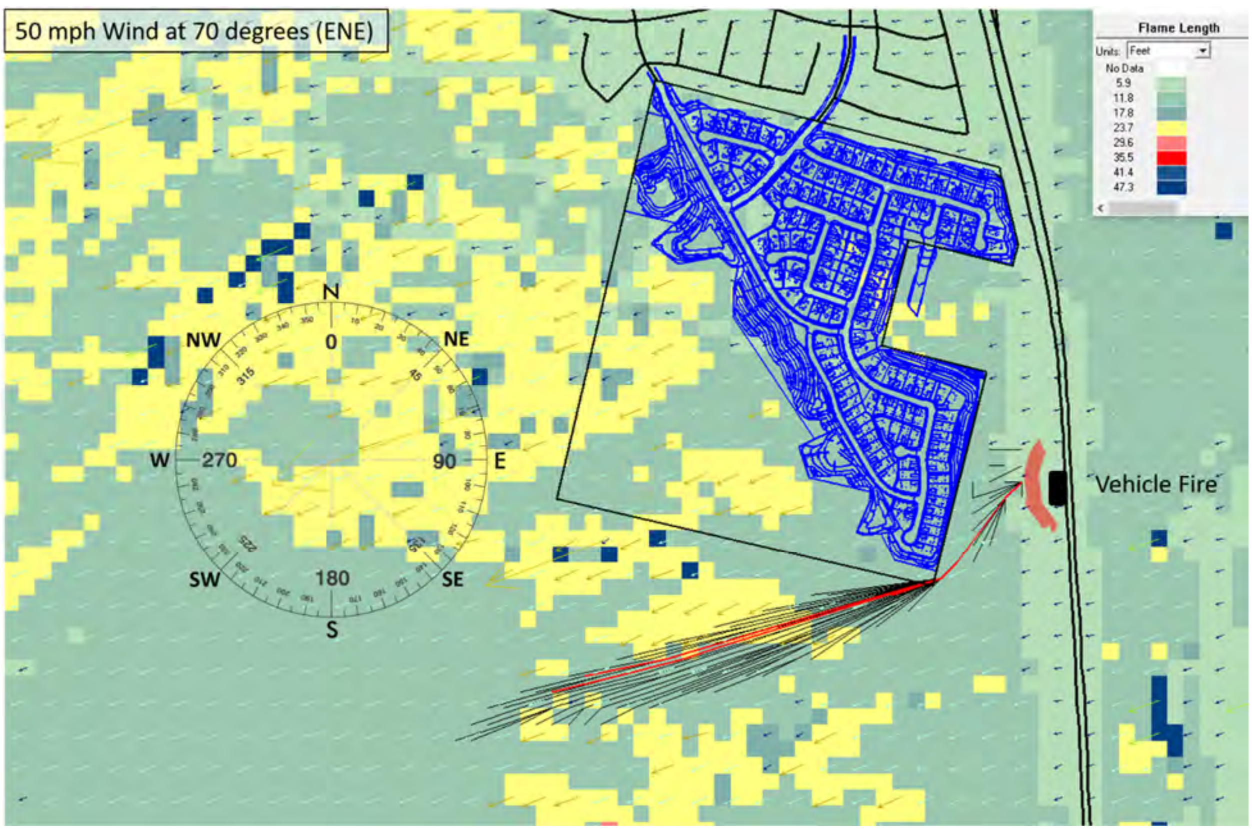


Figure 27

The major path of the fire travel is shown by the red line and the minor paths by black lines. The arrows indicate the spread direction for the fire in each 30-meter cell. A compass rose is provided for orientation.

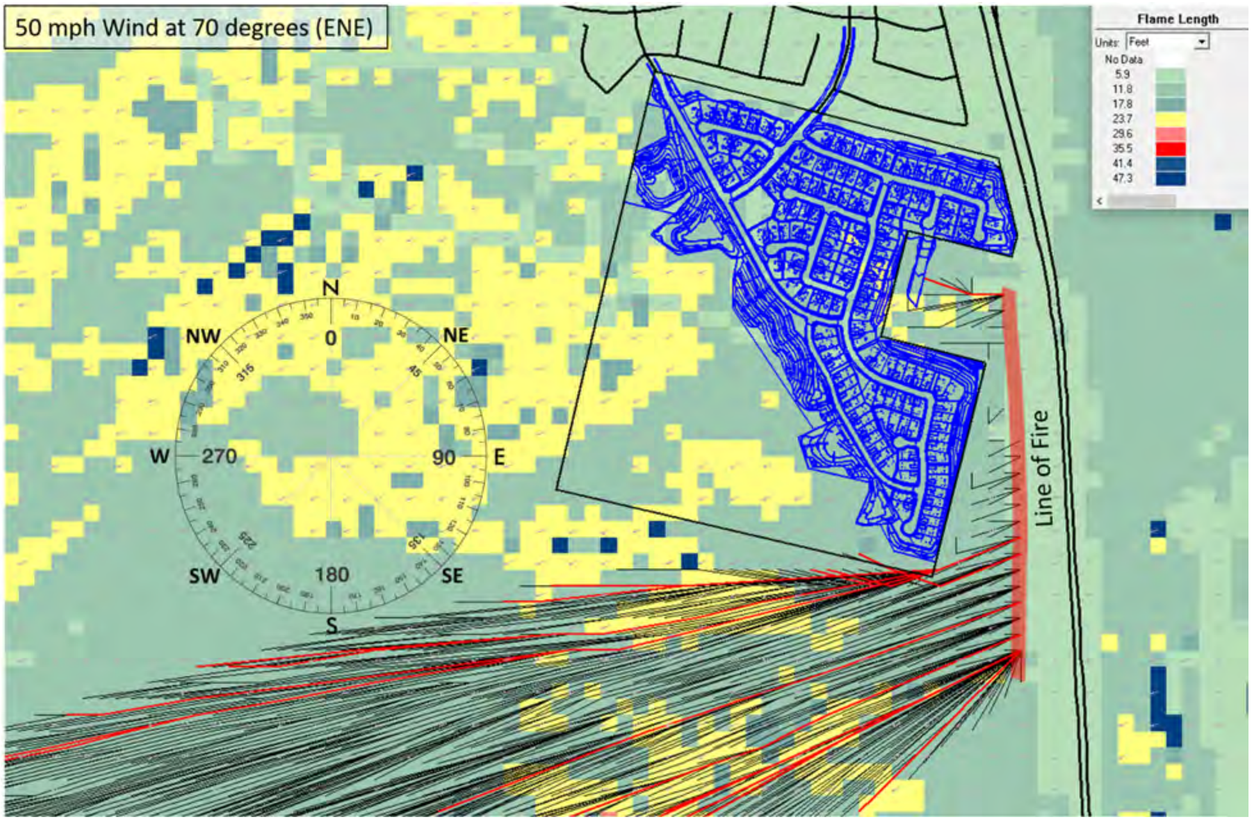


Figure 28

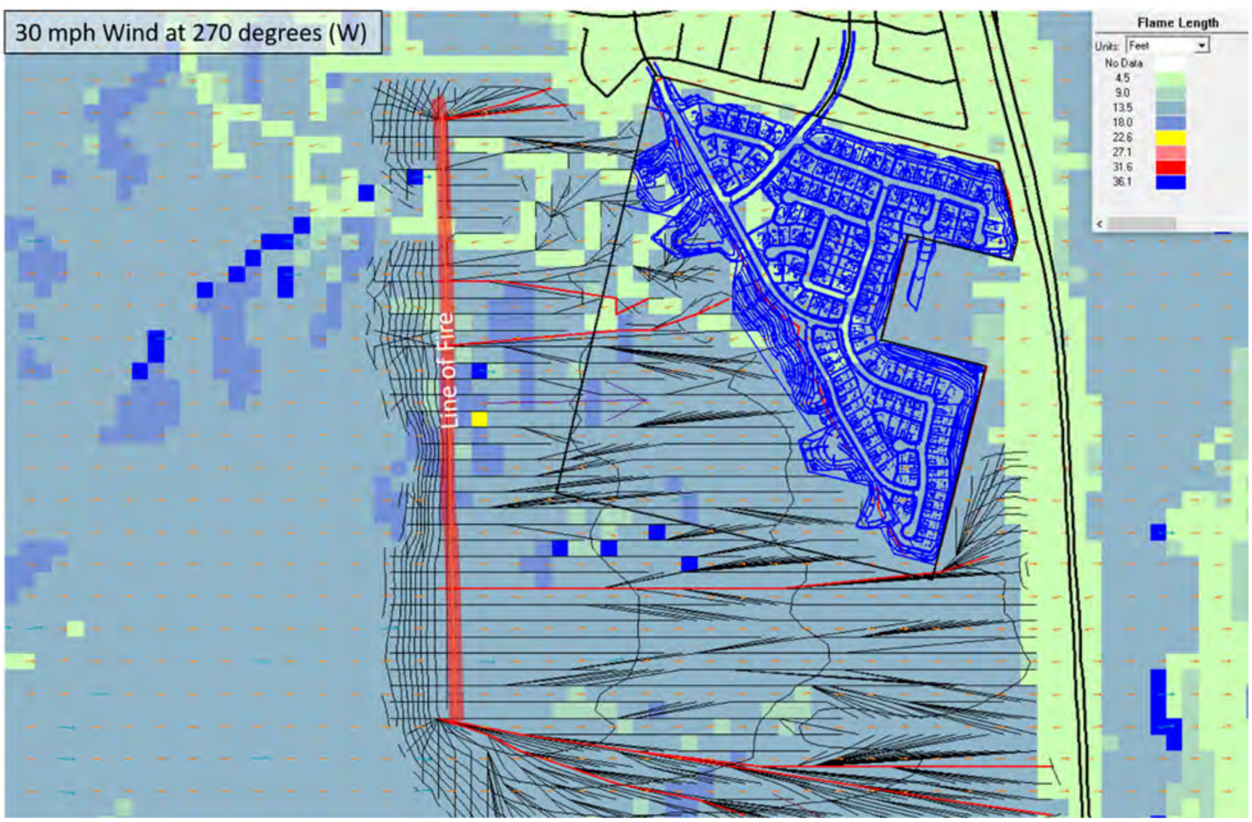


Figure 29

Fire Behavoir Summary

While the modeling indicates that flame lengths of under 25 feet are possible under perfect conditions, these perfect conditions do not exist on the project site currently. The area to the east is limited by the freeway and the project site. The amount of fuel within this area is mostly light or moderate. While these are flashy fuels and have a very fast rate of spread, they do not have the depth of fuel necessary to produce the extreme fire behavior that chaparral fuels (4-6 foot fuel bed depths) produce. In the graphic below you can see that in the gr1 fuel, the maximum fireline intensity is achieved at a 15 mph wind. All of the fuel is consumed so faster wind speed does not take it beyond the 151 kW/m^2. The gr2 fuel tops out at 30 mph (4,037 kW/m^2), the gs1 and gs2 by 80 mph. All of the fuel has reached their maximum by 80 mph. No fuel is left to burn, they are completely consumed. This is not the case for the heavier fuels.

Fuel Model	Wind Speed					Flame Length	Fuel Modification Distance (ft.)		Fuel bed depth (ft)
	15	30	40	60	**80**		50	100	
							2500	10000	
4	62,144	144,799	211,384	365,939	544,086	110.5	217.6	54.4	6.0
5	4,923	11,357	16,482	28,274	34,448	31.1	13.8	3.4	2.0
6	3,383	7,508	10,716	12,630	12,630	19.6	5.1	1.3	2.5
gr1	151	151	151	151	**151**	2.6	0.1	0.0	0.4
gr2	2,316	4,037	4,037	4,037	**4,037**	11.6	1.6	0.4	1.0
gs1	1,521	3,665	4,122	4,122	**4,122**	11.7	1.6	0.4	0.9
gs2	3,421	8,216	12,145	18,700	**18,700**	23.4	7.5	1.9	1.5
sh1	1,022	2,349	2,838	2,838	**2,838**	9.8	1.1	0.3	1.0
sh2	2,507	5,622	8,098	13,785	**20,273**	24.3	8.1	2.0	1.0

Figure 30

This is not to say that 25 foot flame lengths are not a risk to structures but a distance of 50' will provide a reasonable level of safety to the structures from direct flame impingement, radiant heat and convected heat risks. All structures within the project site will need to be protected against ember intrusion as this risk is present throughout.

The project site can be protected with 50' fuel modification zones. The project will use 100' on the west side in an abundance of caution where fuels have the ability to burn into the project as a line of fire which is well established but not with the Santa Ana winds pushing it. Vegeration to the south is not a significant risk as winds rarely come from this direction. In this area 50' is acceptable as well.

Alternative Fire Protection Features

The area between the structure and the native fuels (fuel modification zone) will need to be restricted to the approved plant palette to keep from providing a pathway for fire to enter the structure. This area will need to be irrigated and maintained as a "green zone" or a "Dry B zone" in order to make the fuel modification zone work as designed.

A block wall/radiant heat wall will be constructed when fuel modification zones are less than 100 feet in total between structures and native fuels. These walls will be either block or tempered glass over block similar to those shown on the next page.

These types of walls are extremely effective when used at the top of the slope in light to moderate fuels. The extreme fire behavior that can be produced by high winds also bends the fire over making it travel more parallel to the ground. The harder the wind, the more the flame angle will be and the more effective the radiant heat wall will become. The locations are shown on the fuel modification plan in red.

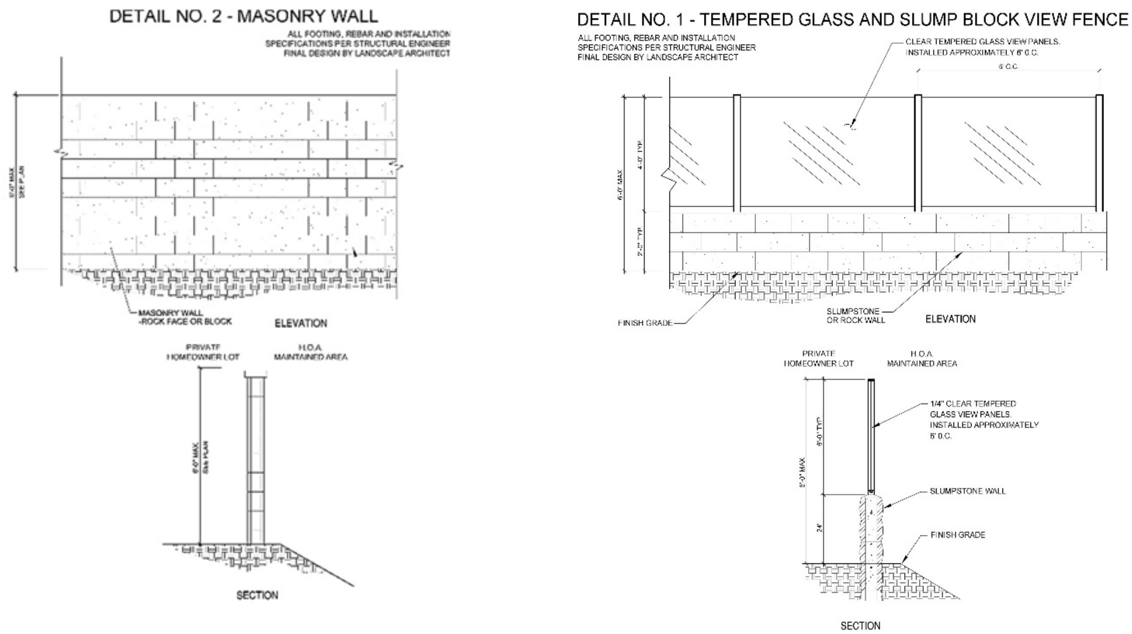


Figure 31

Alternate Measures that Achieve the Same Level of Protection

Two alternative measures are addressed in this report:

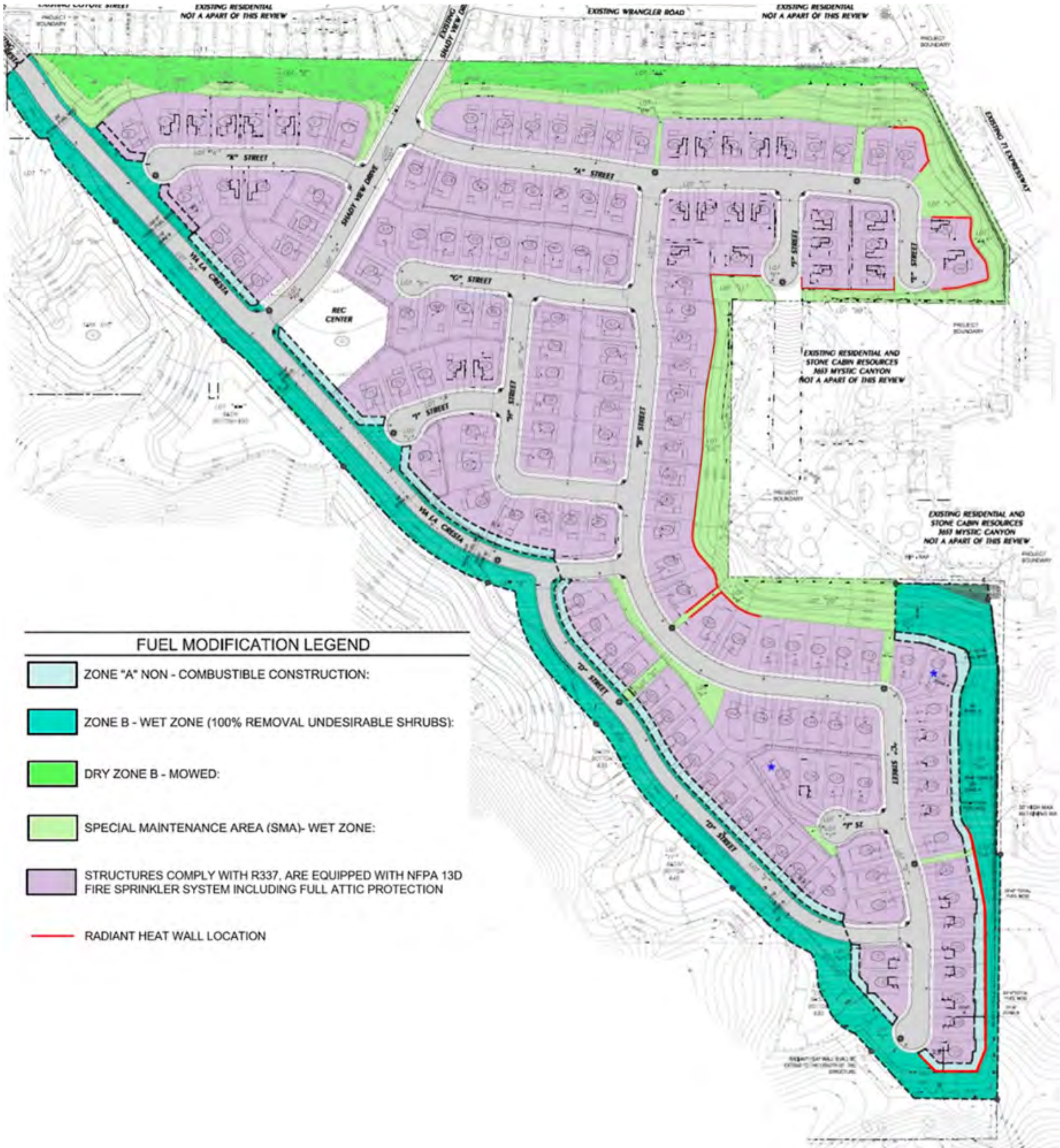
1. Spacing between structures
2. Secondary Access Separation

<u>Spacing Between Structures</u>

The Development Code calls for 30 feet between structures within the Fire Hazard Overlay District but allows for alternative measures that achieve the same level of protection. The project site, as configured, provides for a minimum separation between structures of 20 feet. For the Shady View project, the fire behavior modeling has shown that a 50 foot fuel modification zone (2x maximum flame length) is more than adequate; 100 foot of irrigated fuel modification has been provided on the west interface and much of the east interface. The west interface includes a roadway (hardscape) that further increases the protection of the adjacent structures for all but two of the building sites. This single loaded street with structures on the non-wildland side provides for a significant buffer and unlimited access for fire suppression activities.

The additional protection provided in place of the addition ten feet is as follows:

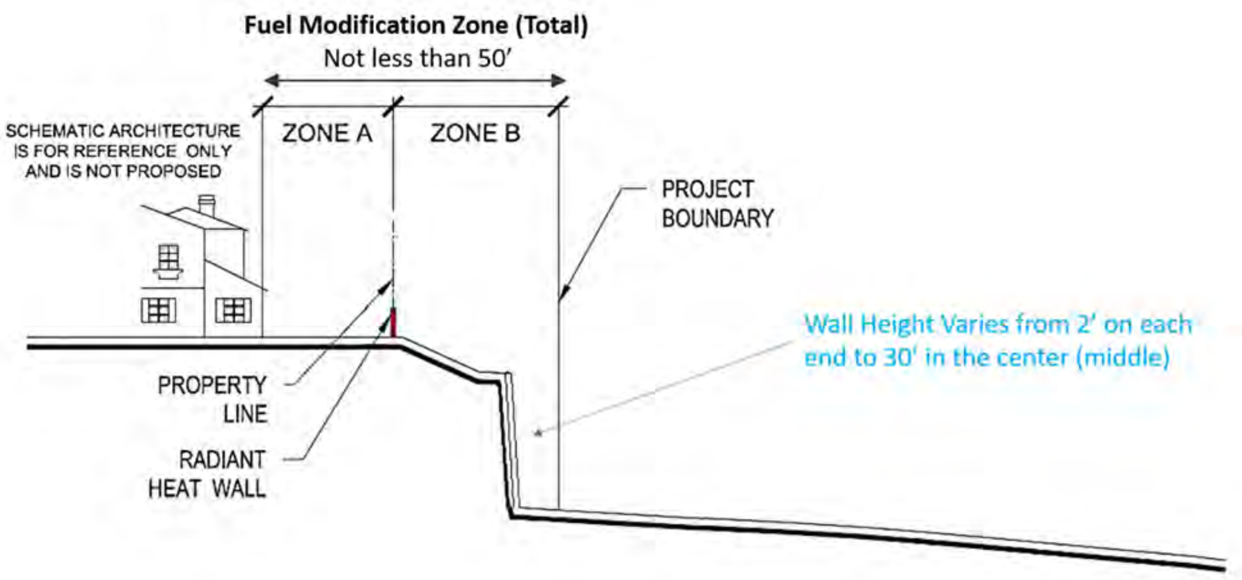
1. Extended the 100’ minimum to provide a 50’ Zone B for roadway protection along the southern side of Via La Cresta and “D” Street.



2. Radiant Heat Walls are provided for the areas less than 100’ (southern and eastern edges)
3. All interior Landscapes Areas have been designated as Special Maintenance Areas.
4. The project does not use Zone C (thinning zones with native vegetation). All fuel modification zones will comply with Zone A or Zone B requirement (more restrictive).
5. Attic protection will be provided for the deficient separation between the two points of access to the community and for the separation from structure to structure of 30-feet (all homes will be a minimum of 20-feet apart)
6. Lots 115 & 135 not meeting the 150’ hose pull access will be provided with Sprinkler protection to Attics and Small Spaces.
7. No trees will be allowed between structures. Ground cover only. Requirement will be stated in the CC&R’s

8. On all sides of the structure that does not have 30 feet distance to the next structure, the area below the windows (all levels) will not have planters or other spaces for vegetation within three feet of the structure. (in CC&R's)
9. Windows and doors on structures which are less than 30 feet apart shall be placed so that they are not directly adjacent to the windows/doors of the other structure.
10. All eaves shall be increased to one hour rated exterior.
11. All openings will be protected with listed devices or appliances. NO simple wire mesh.

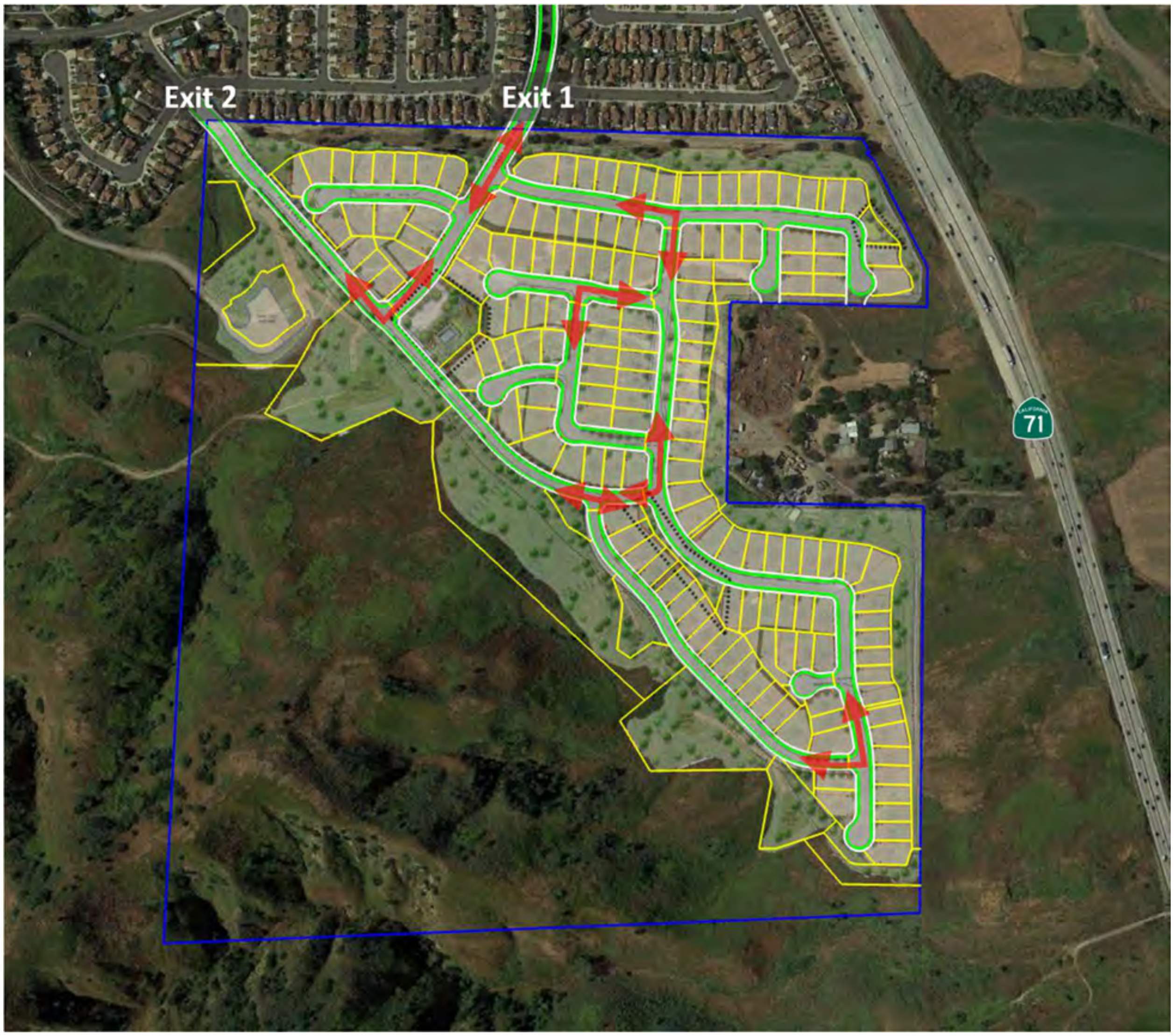
An additional feature of the east interface that increases protection is the retaining wall that encompasses more of this interface. At some points, the wall will be 30' in height from the native vegetation side. Some of these areas will have an additional radiant heat wall on top of the retaining wall. In most areas, the flame height will be less than the retaining wall.



Two Points of Egress

The Two Points of Egress for the project site were already established from the previous development in 1998 and 1990. These two points are approximately 1,000 feet apart (centerline to centerline at the project boundary). The diagonal of the area served is approximately 3,000 feet. The separation is existing, nonconforming and cannot be changed by the project site as the entire northern interface is covered with existing homes expect for these two access points.

Within the project site every intersection, except the two cul-de-sacs on the north east corner, have two possible travel paths with several possible routes to the two exit points. Only seven homes must travel more than 500' to a point where two travel paths are available. No home must travel more than 750' to a point with two choices. The homes in this area have limited exposure to wildland fire due to the very limited amount of vegetation between the homes and the freeway.



The project site structures will be protected with automatic fire sprinklers, including attic areas, they will have wildland fire resistive construction in accordance with Residential Code Section R337, the entire project site is surrounded by fuel modification/special maintenance areas to provide for defensible space. The west interface provides a single loaded street with very large irrigated slopes which provide a significant buffer to the egress roadway and the homes. This clearance (50’ minimum) is maintained throughout the exit pathway to both exits.

The combination of egress flow, safety buffers, multiple travel paths and a reasonable separation distance (1,000 feet) provides a secondary access within the project site that provides the same practical effect in establishing two distinct ways to exit so that if one of them is not usable, the other should be available. Firesafe believes the configuration as provided, which works with the existing nonconforming exit locations meets the criteria for an alternative method.

Report Summary

The Shady View project has been designed and will be protected by the most recently adopted codes and practices. Firesafe has used the BEHAVE model to measure the intensity of a fire moving towards this development to design a protection system that will ensure that the project will be safe from wildland fires even without fire department suppression activities. Flame lengths and fire intensity are ultimately reduced by the installation and maintenance of the fuel modification plan through the use of the irrigated Zone A and the possible use of radiant heat walls surrounding the homes on the perimeter in all locations where a 100 foot fuel modification zone cannot be accomplished.

Based on the scientific fire behavior analysis, exterior portions of future structures or attic spaces will not ignite from the exterior fire exposure from a wildland vegetation fire. This is primarily because the greatest fire energy is too far away from the structures due to the low plant densities within the defensible space zones and the construction feature requirements.

The codes enforced by the fire department for defensible space were developed to handle the exact type of fuels that are interfacing with this future development. We recommend approval of this Fire Protection Plan as an acceptable alternative to 30 foot spacing between structures (reducing this distance to the distance provided in the Development Code).

Principal
Fire Safe Planning Solutions

Fire Protection Analyst
Fire Safe Planning Solutions

Appendix A
Chapter 16.22 Fire Hazard Overlay District

Chapter 16 of the Chino Hills Municipal Code

16.22.010 - Intent and purpose.

A. The Fire Hazard Overlay District is established to mitigate against the threat of wildland fires. The standards set forth in this chapter provide additional opportunity for firefighting vehicles to have access into wildland interface areas. An additional intent of these standards is to prevent structures from becoming a barrier between firefighting equipment/personnel and wildland areas.

B. The Fire Hazard Overlay District shall be designated in the City's General Plan and updated as required based on information provided by California Department of Forestry and Fire (Cal Fire) or Chino Valley Fire District (CVFD).

C. Project design and structures located within the "Fire Hazard Overlay District" shall also meet the requirements of Chapter 16.06.160, Fire Resistive Design Requirements, unless the requirements of the Fire Hazard Overlay District are more restrictive, in which case the more restrictive requirements shall apply.

(Ord. No. 329, § 5, 6-12-2018)

16.22.020 - General provisions.

A. The provisions of this chapter shall apply to all new construction, and to existing structures where construction to an existing structure results in an increase in size of fifty (50) percent or more, within the Fire Hazard Overlay District.

B. All proposed development must meet all other applicable standards properly adopted by the Chino Valley Fire District.

C. The area of the City regulated by the Fire Hazard Overlay District has been adopted as Figure 5-10, Fire Hazard Overlay District of the City General Plan Safety Element, and is depicted in Figure 16.22-1

(Ord. No. 329, § 5, 6-12-2018)

16.22.030 - Regulations for the Fire Hazard Overlay District.

A. Construction Requirements.

1. All construction shall comply with the requirements of Section 7A of the Building Code.

B. Building Separations Standards.

a. Structures on separate lots shall have exterior wall separations from any structure on an adjoining lot of at least thirty (30) feet. This separation shall be clear to sky with no roof or overhang obstructing the separation. Alternate measures that achieve the same level of protection as a thirty (30) foot separation may be substituted in lieu of the thirty (30) foot separation, subject to approval by the Chino Valley Fire District and the Community Development Director. For the purposes of this section, structure is "a walled or covered building that is principally above ground and subject to a building permit."

(Ord. No. 329, § 5, 6-12-2018)

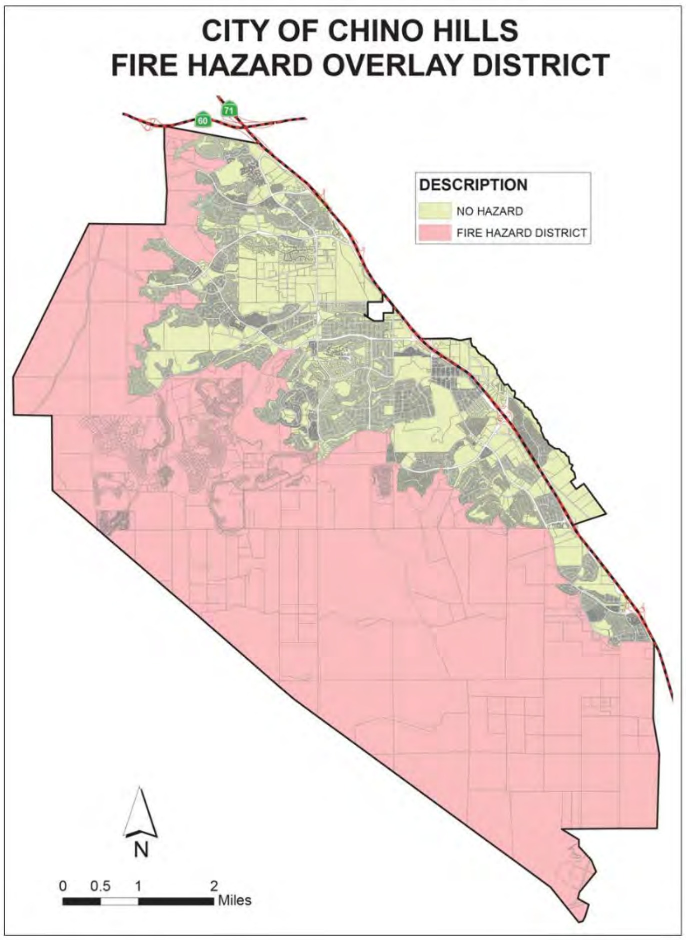


Figure 16.22-1 Fire Hazard Overlay District

16.22.040 - Regulations for the fuel modification areas.

A. A permanent fuel modification area is required around development projects or portions of such projects for the purpose of fire protection. The required width of the fuel modification area shall be determined by the Chino Valley Fire District as deemed necessary to mitigate fire hazards, but in no case shall it be less than one hundred (100) feet in width as measured from the development perimeter. The width of the fuel modification area shall be determined based upon:

1. The natural ungraded slope of the land within the project and in the areas adjacent to the project.

2. Fuel loading.

3. Access to the project and access directly to the fuel-modified area.

4. The on-site availability of water that can be used for firefighting purposes.

B. Adequate provisions shall be made for the continual maintenance of such areas, and such areas shall be designated as common open space rather than private open space.

C. Fuel modification areas shall also incorporate soil erosion and sediment control measures to alleviate permanent scarring and accelerated erosion.

D. When development projects are phased, required fuel modification areas shall be in place prior to the first certificate of occupancy.

E. Perimeter Access to Fuel Modification Area.

1. Development projects shall provide for adequate vehicular access for firefighting vehicles to the development perimeter of the project along the portion of the development perimeter that is adjacent to either an existing or proposed fuel-modification area. The development shall provide for the continual maintenance of the areas intended to provide such access ensuring that the access ways are unobstructed and maintained in good condition. Perimeter access shall be provided through one of the following two measures unless otherwise approved by the Chino Valley Fire District:

a. The provision of an existing or proposed road along the development perimeter, or portion thereof that is exposed to a wildland urban interface, open space, or fuel-modified area, and which is accessible to firefighting equipment. Such a road shall be paved with all-weather material and capable of supporting firefighting equipment, shall be at least twenty (20) feet in width and shall not exceed a grade of twelve (12) percent unless otherwise approved by the Chino Valley Fire District.

b. Development projects shall provide access ways, at least twelve (12) feet in width, with grade not to exceed twelve (12) percent, and capable of supporting firefighting vehicles, between the development perimeter and proposed or existing streets. Access ways shall be spaced at intervals of no more than an average of three hundred fifty (350) feet along each street.

(Ord. No. 329, § 5, 6-12-2018)

Appendix B

Fuel Modification Zone Configurations

Zone B will have vegetation spacing requirements based on the type of zone to be used. Irrigated zones will be allowed to have more vegetation in them than dry zones. Figure 32, below, provides the spacing requirements for each (wet and dry).

Dry Zone B configuration can only be used if approved by the fire department for the specific location based on adjacent vegetation and the specific topography of the site. Three examples of alternative Zone B configurations are provided in Figures 33-35 on the following pages. Each represents an equal alternative from a fire modeling perspective but must be evaluated to the specific location at the time of fire department approval of the specific interface.

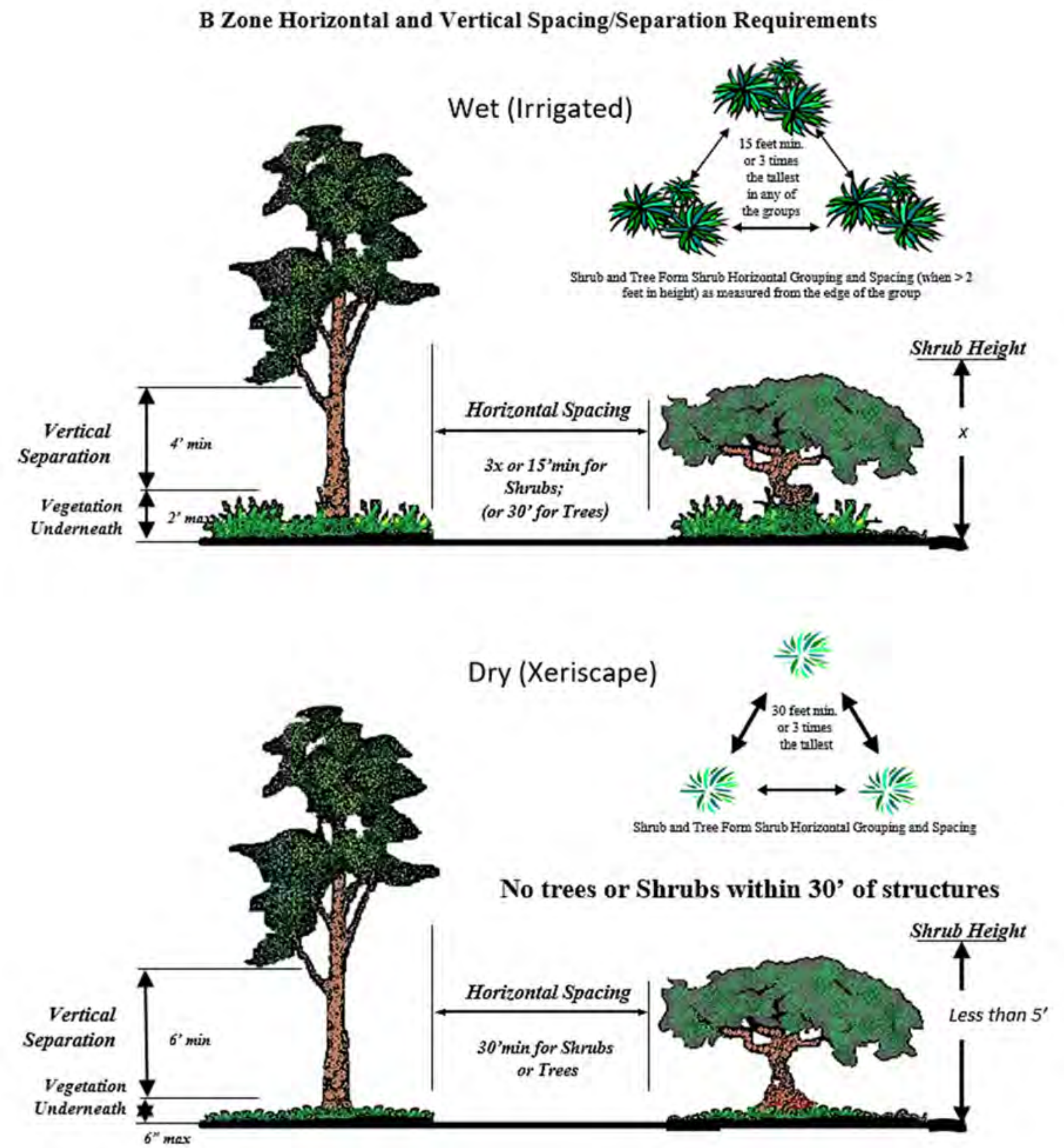


Figure 32

Low maintenance and reduced water requirements must be considered in the evaluation of the project perimeter fire protection needs. While lush irrigated fuel modification zones look nice, they are expensive to maintain and require regular maintenance to be 100% effective in their design. Lower amounts of fuel within the fuel modification zone is always better from a fire defense perspective. Succulents are a good choice for fuel modification zones; noncombustible materials are even better.

Mow B Zone

a. Completed annually before May 1st
b. Remaining vegetation less than 4 inches in height
c. Supplemental irrigation at a minimum; likely regular irrigation
d. Slope erosion issues may not allow this option in some areas
e. Use of specialty grasses which are native and/or drought tolerant
f. Not for areas over 2:1 slope

Figure 33 – Zone B Alternative Configuration - Mow

Hardscape B Zone

a. Noncombustible ground cover
   1) Rock
   2) Concrete/asphalt
   3) Pavers
   4) Gravel
   5) Boulder blankets

Figure 34 – Zone B Alternative Configuration - Hardscape

Succulent B Zone

a. All surface fuels are succulents (approved palette)
b. Trees are 40 foot or greater from any structure and are limbed up four feet.
c. Spaces between succulents must be cut to less than four inches, hardscape or other noncombustible configuration.
d. Grasses are allowed but are not recommended due to maintenance requirement in an area that will be very low maintenance without grasses
e. Supplemental water system is recommended to protect investment in succulents

Figure 35 – Zone B Alternative Configuration - Succulent

The following is a list of plants are NOT allowed in defensible space zones.

Ornamental Grasses:

Green Fountain Grass- *Pennisetum Setaceum*
This plant grows in dense stands and alters native habitats. It is an extreme fire hazard.
Pampas Grass- *Cortaderia Selloana, Cortaderia Jubata*
This plant accumulates large amounts of litter and harbors vermin. It is a serious fire hazard.

Shrubs:

Broom (Bridal, French, Portuguese, Scotch, and Spanish)- *Retama Monopserma, Genista Monspessulana, Cytisus Striatus, Cytisus Scoparius* and *Spartium Junceum*
This plant grows rapidly, creating an extreme increase in fuel accumulation and fire danger.

Native Shrubs/Target Fuels: These plants contain high oils and resins and retain low moisture. They are highly flammable and emit toxic gasses when burned. It is recommended to clear this brush from around structures and not to plant these shrubs if they are not already present.

Chamise- *Adenostoma Fasciculatum*
California Sagebrush- *Artemisia Californica*
Juniper Bush- *Juniperus communis*
Common Buckwheat- *Ergonum Fasciculatum*

Trees:

Palms: Although palms are extremely prevalent in San Bernardino County, they are considered a fire hazard when they are not pruned and maintained properly. They create dead fronds and harbor vermin.

Desert Fan Palm- *Washingtonia Filifera*
Canary Island Palm- *Phoenix Canariensis*
Mexican Fan Palm- *Washingtonia Robusta*

Italian Cypress- *Cypressus Sempervirens*
Heavy litter from this tree creates a serious fire hazard. This tree also harbors extreme vertical fire spread hazards.

Eucalyptus (Blue Gum, Common Eucalyptus, Red Gum)- *Euclyptus Globulus*
This tree creates abundant litter and creates a thick covering of duff. The debris is extremely flammable. Also, when ignited, the stringy bark has a potential to be carried away into unburned fuels and cause spot fires.

Pine Trees

The following are the approved plant palette for Chino Valley Fire District approval:

Ref#	Code	Botanical Name	Common Name	Plant Form
1.	W	Abelia x grandiflora	Glossy Abelia	Shrub
3.	–	Acer macrophyllum	Big Leaf Maple	Tree
4.	X	Achillea millefolium	Common Yarrow	Low shrub
5.	W	Achillea tomentosa	Wolly Yarrow	Low shrub
6.	X	Aeonium decorum	Aeonium	Ground cover
7.	X	Aeonium simsii	Aeonium	Ground cover
8.	W	Agaave attenuata	Century Plant	Succulent
9.	W	Agave shawii	Shaw’s Century Plant	Succulent
10.	N	Agave victoriae-reginae	Agave	Ground cover
11.	X	Ajuga reptans	Carpet Bugle	Ground cover
14.	N	Aloe aborescens	Torch Aloe	Shrub
15.	N	Aloe aristata	Dwarf Aloe	Ground cover
16.	N	Aloe brevifolia	Aloe	Ground cover
17.	W	Aloe Vera	Medicinal Aloe	Succulent
18.	W	Alyogyne huegelii	Blue Hibiscus	Shrub
19.	–	Ambrosia chamissonis	Beach Bur-Sage	Perennial
20.	–	Amoroha fruticosa	Western False Indigobush	Shrub
21.	W	Anigozanthus flavidus	Kangaroo Paw	Perennial Accent
22.	–	Antirrhinum nuttalianum ssp. Nuttatianum	Beard Tongue	Subshrub
23.	X	Aptenia cordifolia x ‘Red Apple’	Red Apple Aptenia	Ground cover
24.	W	Arbutus unedo	Strawberry Tree	Tree
25.	W	Arctostaphylos ‘Pacific Mist’	Pacific Mist Manzanita	Ground cover
26.	W	Arctostaphyis edmundsil	Little Sur Manzanita	Ground cover
27.	–	Arctostaphylos glandulosa	Eastwood Manzanita	Shrub
28.	W	Arctostaphylos hookeri ‘Monterey Carpet’	Monterey Carpet Manzanita	Low shrub
29.	N	Arctostaphylos pungens	Heather	Shrub
30.	N	Arctostaphylos refugioensis	Refugio Manzanita	Shrub
31.	W	Arctostaphylos uva-ursi	Bearberry	Ground cover
32.	W	Arctostaphylos x ‘Greensphere’	Greensphere Manzanita	Shrub
33.	N	Atemisia caucasia	Caucasian Artemisia	Ground cover
34.	N	Artemisia pycnocephaia	Beach Sagewort	Perennial
35.	X	Atriplex canescens	Four-Wing Saltbush	Shrub
36.	X	Atriplex lentiformis ssp. Breweri	Brewer Saltbush	Shrub
41.	N	Baileys Multiradiata	Desert Marigold	Ground cover
42.	W	Beaucarnea recurvata	Bottle Palm	Shrub/Small tree
43.	N	Bougainvillea spectabilis	Bougainvillea	Shrub
44.	N	Brahea armata	Mexican Blue Palm	Palm
45.	N	Brahea brandegeei	San Jose Hesper Palm	Palm
46.	N	Brahea edulis	Guadalupe Palm	Palm
47.	–	Brickellia californica	Hoary Nettle	Subshrub
48.	W	Bromus carinatus	California Brome	Grass
49.	–	Camissionia cheiranthifolia	Beach Evening Primrose	Perennial subshrub
50.	N	Carissa macracarpa	Green Carpet Natal Plum	Ground cover/shrub
51.	X	Carpibrotus chilensis	Sea Fig Ice Plant	Ground cover
60.	W	Cerastium tomentosum	Snow-in-summer	Ground cover/shrub
61.	W	Ceratonia siliqua	Carob	Tree

Ref#	Code	Botanical Name	Common Name	Plant Form
62.	**W**	Cercis occidentalis	Western redbud	Tree/Shrub
63.	**X**	Chrysanthemum leucanthemum	Oxeye Daisy	Groundcover
64.	**W**	Cistus hybridus	White Rockrose	Shrub
65.	**W**	Cistus incanus	Mauve Rockrose	Shrub
66.	**W**	Cistus incanus salviafolius	Sageleaf Rockkrose	Shrub
67.	**W**	Cistus purpureus	Orchid Rockrose	Shrub
69.	**–**	Clarkia bottae	Showy Fairwell to Spring	Annual
70.	**–**	Cneoridium dumosum	Bushrue, Pt. Reyes Ceanothus	Shrub
71.	**–**	Collinsia heterophylla	Chinese Houses	Annual
72.	**W**	Comarostaphylis diversifolia	Summer Holly	Shrub
73.	**N**	Convolvulus cneorum	Bush Morning Glory	Shrub
74.	**W**	Coprosma kirkii	Creeping Coprosma	Ground
75.	**W**	Coprosma pumila	Prostrate Coprosma	Low Shrub
76.	**–**	Coreopsis californica	California coreopsis	Annual
77.	**W**	Coreopsis lanceolata	Coreopsis	Ground cover
78.	**N**	Correa pulchella	Australian Fushia	Ground cover
81.	**X**	Crassula lactea	Taylor's Parches	Ground cover
82.	**X**	Crassula ovata	Jade Tree	Shrub
83.	**X**	Crassula tetragona	Jade Plant	Shrub
84.	**W**	Croton californicus	California Croton	Ground cover
85.	**X**	Delosperma ‘alba’	White Trailing Ice Plant	Ground cover
86.	**–**	Dendromecon rigida	Bush Poppy	Shrub
87.	**–**	Dichelostemma capitatum	Blue Dicks	Herb
88.	**N**	Distictis buccinatoria	Blood-Red Trumpet Vine	Vine/Climbing vine
89.	**N**	Dodonaea viscosa	Hopseed Bush	Shrub
90.	**X**	Drosanthemum floribundum	Rosea Ice Plant	Ground cover
91.	**X**	Drosanthemum hispidum	Ice Plant, Showy Dewflower	Ground cover
92.	**–**	Dudleya lanceolat	Lance Leaved Dudleya	Succulent
93.	**–**	Dudleya pulverulenta	Chalk Dudleya	Succulent
95.	**–**	Encelia californica	California Encelia	Small shrub
96.	**–**	Epilobium canum (Zauschneria californica)	Hoary California Fushia	Shrub
97.	**–**	Eriastrum sapphirinum	Mojave Wolly Star	Annual
98.	**N**	Eriobotrya japonica	Loquat	Tree
99.	**–**	Eriodictycon crassifolium	Thick-Leaf Yerba Santa	Shrub
100.	**–**	Eriodictycon trichocalyx	Mojave Wooly Star	Annual
101.	**W**	Eriophyllum confertiflorum	Golden Yarrow	Shrub
102.	**W**	Erythrina species	Coral Tree	Tree
103.	**W**	Eschscholzia californica	California Poppy	Flower
104.	**X**	Eschscholzia mexicana	Mexican Poppy	Herb
106.	**N**	Fiejoa sellowiana	Pineapple Guava	Shrub/Tree
107.	**N**	Fragaria chiloensis	Wild Strawberry/ Sand	Ground cover
108.	**–**	Frankenia salina	Alkali Heath	Ground cover
109.	**W**	Fremontodendron californicum	California Flannelbush	Shrub
110.	**X**	Gaillardiaa x grandiflora	Blanketflower	Ground cover
111.	**W**	Galvezia speciosa	Bush Snapdragon	Shrub
112.	**W**	Garrya ellipta	Silktassel	Shrub
113.	**X**	Gazania hybrids	South African Daisy	Ground cover
114.	**X**	Gazania rigens leucolaena	Trailing Gazania	Ground cover

Ref#	Code	Botanical Name	Common Name	Plant Form
115.	**–**	Gilia capitata	Globe Gilia	Perennial
116.	**W**	Gilia lepthantha	Showy Gilia	Perennial
117.	**W**	Gilia tricolor	Bird's Eyes	Perennial
118.	**W**	Ginko biloba	Maidenhair Tree	Tree
119.	**–**	Gnaphalium californicum	California Everlasting	Annual
120.	**W**	Grewia occidentalis	Starflower	Shrub
121.	**–**	Grindelia stricta	Gum Plant	Ground cover
122.	**N**	Hakea suaveolens	Sweet Hakea	Shrub
123.	**W**	Harde bergia comptoniana	Lilac Vine	Shrub
124.	**N**	Helianthemum mutabile	Sunrose	Ground
125.	**–**	Helianthemum scoparium	Rush Rose	Shrub
126.	**–**	Heliotropium curassavicum	Salt Heliotrope	Ground cover
127.	**X**	Helix canariensis	English Ivy	Ground cover
128.	**W**	Hesperaloe parviflora	Red Yucca	Perennial
129.	**–**	Heteromeles arbutifolia	Toyon	Shrub
133.	**–**	Isocoma menziesii	Coastal Goldenbush	Small shrub
134.	**–**	Isomeris arborea	Bladderpod	Shrub
135.	**W**	Iva hayesiana	Poverty Weed	Ground cover
136.	**N**	Jublans californica	California Black Walnut	Tree
137.	**–**	Juncus acutus	Spiny Rush	Perennial
138.	**–**	Keckiella antirrhinoides	Yellow Bush Penstemon	Subshrub
139.	**–**	Keckiella cordifolia	Heart Leaved Penstemon	Subshrub
140.	**–**	Keckiella ternata	Blue Stemmed Bush Penstemon	Subshrub
141.	**W**	Kniphofia uvaria	Red Hot Poker	Perennial
142.	**W**	Lagerstroemia patersonii	Crape Myrtle	Tree
143.	**X**	Lampranthus aurantiacus	Bush Ice Plant	Ground cover
144.	**X**	Lampranthus filicaulis	Redondo Creeper	Ground cover
145.	**X**	Lampranthus spectabilis	Trailing Ice Plant	Ground cover
146.	**W**	Lantana camara cultivars	Yellow Sage	Shrub
147.	**W**	Lantana montevidensis	Trailing Lantana	Shrub
148.	**–**	Lasthenia californica	Dwark Goldfields	Annual
149.	**W**	Lavandula dentataq	French Lavendar	Shrub
150.	**W**	Leptospermum laevigatum	Australian Tea Tree	Shrub
151.	**W**	Leucophyllum frutescens	Texas Ranger	Shrub
152.	**–**	Leymus condensatus	Giant Wild Rye	Large grass
154.	**X**	Limonium perezii	Sea Lavender	Shrub
155.	**W**	Liquidambar styraciflua	American Sweet Gum	Tree
156.	**W**	Liriodendron tulipifera	Tulip Tree	Tree
159.	**X**	Lotus corniculatus	Bird's Foot Trefoil	Ground Cover
160.	**–**	Lotus Heermanii	Woolly Lotus	Perennial
161.	**–**	Lotus Scoparius	Deerweed	Shrub
162.	**W**	Lupinus arizonicus	Desert Lupine	Annual
163.	**W**	Lupinus benthamil	Spider Lupine	Annual
164.	**–**	Lupinus bicolor	Sky Lupine	Flowering annual
165.	**–**	Lupinus sparsiflorus	Coulter's Lupine	Annual
166.	**W**	Lyonothamnus floribundus ssp.	Fernleaf Ironwood	Tree
167.	**W**	Macademia Integrifolia	Macadamia Nut	Tree
168.	**W**	Mahonia aquifolium 'Golden Abundance'	Golden Abundance, Oregon	Shrub

Ref#	Code	Botanical Name	Common Name	Plant Form
169.	**W**	Mahonia nevinii	Nevin Mahonia	Shrub
170.	**–**	Malacothamnus fasciculatus	Chaparral Marrow	Shrub
171.	**X**	Makephora luteola	Trailing Ice Plant	Ground cover
172.	**W**	Maytenus boaria	Mayten Tree	Tree
173.	**W**	Melaleuca nesophila	Pink Melaleuca	Shrub
174.	**N**	Metrosideros excelsus	New Zealand Christmas Tree	Tree
175.	**–**	Mimulus species	Monkeyflower	Flower
176.	**–**	Mirabilis californica	Wishbone Bush	Perennial
177.	**N**	Myoporum debile	Trailing Myoporum	Shrub
178.	**N**	Myoporum insulare	Boobialla	Shrub
179.	**W**	Myoporum parvifolium	Creeping Boobialla	Ground cover
180.	**W**	Myoporum ‘Pacificum’	Trailing Myoporum	Shrub
181.	**–**	Nassella [stipa] lepida	Foothill Needlegrass	Ground cover
182.	**–**	Nassella stipa] pulchra	Purple Needlegrass	Ground cover
183.	**–**	Nemophila menziesii	Baby Blue Eyes	Annual
185.	**–**	Oenothera hookeri	California Evening Primrose	Flower
186.	**W**	Oenothera speciosa	Showy Evening Primrose	Perennial
187.	**X**	Ophiopogon japonicus	Mondo Grass	Ground cover
188.	**–**	Opuntia littoralis	Prickly Pear	Cactus
189.	**–**	Opuntia oricola	Oracle Cactus	Cactus
190.	**–**	Opuntia prolifera	Coast Cholla	Cactus
192.	**X**	Osteospermum fruticosum	Trailing African Daisy	Ground cover
193.	**X**	Parkinsonia aculeata	Mexican Palo Verde	Tree
194.	**W**	Pelargonium peltatum	Ivy Geranium	Ground cover
195.	**X**	Penstemon species	Beard Tongue	Shrub
196.	**W**	Photinia Fraseri	Red Robin	Shrub
197.	**W**	Pistacia chinensis	Chinese pistache	Tree
199.	**–**	Plantage erecta	California Plantain	Annual
200.	*****	Plantago insularis	Woolly Plantain	Annual
201.	**X**	Plantago sempervirens	Evergreen Plantain	Ground cover
202.	**W**	Platanus racemosa	California Sycamore	Tree
203.	**W**	Plumbago auriculate	Plumbago Cape	Shrub
204.	**–**	Populus fremontii	Western Cottonwood	Tree
205.	**X**	Portulacaria afra	Elephant’s Foot	Shrub
206.	**–**	Potentilla glandulosa	Sticky Cinquefoil	Subshrub
207.	**X**	Potentilla tabernaemontanii	Spring Cinquefoil	Ground cover
212.	**W**	Puya species	Puya	Succulent/shrub
213.	**W**	Pyracantha species	Firethorn	Shrub
214.	**–**	Quercus agrifolia	Coast Live Oak	Shrub
215.	**–**	Quercus berberdifolia	California Scrub Oak	Shrub
216.	**–**	Quercus dumosa	Coastal Scrub Oak	Shrub
217.	**X**	Quercus engelmannii	Engelmann Oak	Tree
218.	**X**	Quercus suber	Cork Oak	Tree
223.	**N**	Rhaphiolepis species	Indian Hawthorn	Shrub
224.	**–**	Rhus integrifolia	Lemonade Berry	Shrub
225.	**N**	Rhus lancea	African Sumac	Tree
226.	**–**	Rhus ovataa	Sugarbush	Shrub
231.	**–**	Romneya coulteri	Matilija Poppy	Shrub

Ref#	Code	Botanical Name	Common Name	Plant Form
232.	**X**	Romneya coulteri 'White Cloud'	White Cloud Matilija Poppy	Shrub
234.	**W**	Salvia greggii	Autumn Sage	Shrub
235.	**W**	Salvia sonomensis	Creeping Sage	Ground cover
239.	**–**	Satureja chandleri	San Miguel Savory	Perennial
240.	**–**	Scirpus acutus	Hard-Stem Bulrush	Perennial
241.	**–**	Scirpus californicus	California Bulrush	Perennial
242.	**X**	Sedum acre	Goldmoss Sedum	Ground cover
243.	**X**	Sedum album	Green stonecrop	Ground cover
244.	**X**	Sedum confusum	Stonecrop	Ground cover
245.	**X**	Sedum x rubrotinctum	Pork & Beans	Ground cover
246.	**X**	Senecio serpens	Dusty Miller	Ground cover
247.	**–**	Sisyrinchium bellum	Blue-Eyed Grass	Ground cover
248.	**–**	Solanum douglasii	Douglas Nightshade	Shrub
249.	**–**	Solanum xantii	Purple Nightshade	Perennial
250.	**W**	Stenocarpus sinuatus	Firewheel Tree	Tree
251.	**W**	Strelitzia nicolai	Giant Bird of Paradise	Perennial
252.	**W**	Strelitzia reginae	Bird of Paradise	Perennial
254.	**W**	Tecoma stans [stenolibium stans]	Yellow Bells	Shrub/small tree
255.	**X**	Tecomaria capensis	Cape Honeysuckle	Ground cover
256.	**N**	Teucrium chamaedrys	Germander	Ground cover
257.	**N**	Thymus serpyllum	Lemon Thyme	Ground cover
259.	**–**	Trichostems lanatum	Wolly Blue-Curls	Shrub
260.	**X**	Trifolium hirtum 'Hyron'	Hyron Rose Clover	Ground cover
261.	**X**	Trifolium fragiferum 'O'Connor's'	O'Connor's Legume	Ground cover
262.	**–**	Umbellularia californica	California Laurel	Tree
263.	**–**	Verbena Lasiostachys	Western Vervain	Perennial
264.	**N**	Verbena peruviana	Peruvian Verbena	Ground cover
265.	**X**	Verbena species	Verbena	Ground cover
267.	**–**	Vitis Girdiana	Desert Wild Grape	Vine
268.	**X**	Vulpia myuros 'Zorro'	Zorro Annual Fescue	Grass
269.	**W**	Westringia fruticosa	Coast Rosemary	Shrub
270.	**W**	Xanthorrhoea species	Grass Tree	Perennial / shrub
271.	**W**	Xylosma congestum	Shiny Xylosma	Shrub

X = Plant Species prohibited in wet and dry fuel modification zones adjacent to native open space lands. Acceptable in all other fuel modification zones and locations.

W = Plant species appropriate for use in wet fuel modification zones adjacent to native open space lands. Acceptable in all other wet and irrigated dry (manufactured slopes) fuel modification zones and locations.

– = Plant species native to San Bernardino, Orange and San Diego Counties. Acceptable in all fuel modification (wet or dry zones) in all locations.

N = Plant species acceptable on a limited basis (maximum 30% of the area at time of planting) in wet fuel modification zones adjacent to native open space reserve lands. Acceptable in all other fuel modification zones and locations.

***** = If seed collected from local seed source.

****** = Not native plant species but can be used in all fuel modification zones.

Succulents (Allowed All Zones)

Scientific Name	Common Name	Plant Type	Plant Form
Aeonium simsii	Aeonium	succulent	shrub
Aeonium ‘Atropurpurea’	Aeonium	succulent	
Aeonium ‘Sunburst’	Aeonium	succulent	
Aeonium arboreum	Aeonium	succulent	
Aeonium haworthii 'Pinwheel'	Aeonium	succulent	
Aeonium 'Kiwi'	Aeonium	succulent	
Aeonium 'Zwartkop'	Aeonium	succulent	
Agave americana 'Alba Picata'	Century plant	succulent	shrub
Agave victoriae-reginae	Agave	succulent	shrub
Agave angustifolia	Agave	succulent	
Agave attenuata	Agave	succulent	
Agave 'Blue Flame'	Agave	succulent	
Agave 'Blue Glow'	Agave	succulent	
Agave bovicornuta ‘Reggae Time’	Agave	succulent	
Agave brevifolia	Agave	succulent	
Agave celsii 'Nova'	Agave	succulent	
Agave desmettiana	Agave	succulent	
Agave desmettiana ‘Variegata’	Agave	succulent	
Agave 'El Montevideo'	Agave	succulent	
Agave geminiflora	Agave	succulent	
Agave guiengola	Agave	succulent	
Agave lophantha ‘Quadricolor’	Agave	succulent	
Agave mediopicta 'Alba'	Agave	succulent	
Agave parryi	Agave	succulent	
Agave potatorum	Agave	succulent	
Agave salmiana ferox	Agave	succulent	
Agave 'Sharkskin'	Agave	succulent	
Agave shawii	Agave	succulent	
Agave tequilana	Agave	succulent	
Agave titanota	Agave	succulent	
Agave vilmoriniana	Agave	succulent	
Agave weberi	Agave	succulent	
Aloe arborescens	Torch aloe	succulent	shrub
Aloe aristata	Aloe, Dwarf aloe	succulent	shrub
Aloe brevifolia	Aloe	succulent	shrub
Aloe ‘Fire Ranch’	Aloe	succulent	
Aloe africana	Aloe	succulent	
Aloe bainesii	Aloe	succulent	
Aloe 'Black Beauty'	Aloe	succulent	
Aloe 'Blue Elf'	Aloe	succulent	

Scientific Name	Common Name	Plant Type	Plant Form
Aloe ferox	Aloe	succulent	
Aloe 'Grassy Lassie'	Aloe	succulent	
Aloe 'Hercules'	Aloe	succulent	
Aloe 'Johnson's Hybrid'	Aloe	succulent	
Aloe maculata	Aloe	succulent	
Aloe marlothii	Aloe	succulent	
Aloe nobilis	Aloe	succulent	
Aloe striata	Aloe	succulent	
Aloe transvaalensis	Aloe	succulent	
Aloe vera	Aloe	succulent	
Aloe x 'Pink Blush'	Aloe	succulent	
Calandrina spectabilis			
Calandrinia grandiflora			
Carpobrotus edulis	Ice plant, Hottentot fig, Sea fig	succulent	groundcover
Cotyledon macrantha			
Cotyledon orbiculata			
Crassula arborescens 'Silver Dollar'			
Crassula argentea	Jade plant	succulent	groundcover
Crassula lactea	Crassula	succulent	groundcover
Crassula multiclava	Crassula	succulent	groundcover
Crassula tetragona	Crassula	succulent	groundcover
Crassula capitella ‘Campfire’	Crassula	succulent	
Crassula falcata	Crassula	succulent	
Crassula ovata	Crassula	succulent	
Crassula ovata arborescens 'Baby Jade'	Crassula	succulent	
Crassula ovata 'Gollum'	Crassula	succulent	
Crassula ovata 'Hobbit'	Crassula	succulent	
Crassula ovata 'Variegata'	Crassula	succulent	
Crassula pagoda	Crassula	succulent	
Crassula pellucida	Crassula	succulent	
Crassula radicans	Crassula	succulent	
Crassula 'Springtime'	Crassula	succulent	
Crassula tetragona	Crassula	succulent	
Dasylirion longissima			
Dasylirion wheeleri			
Delosperma alba	White trailing ice plant	succulent	groundcover
Dracaena draco			
Dudleya brittonii			
Dudleya pulverulenta			
Echeveria ‘Perle Von Nuremberg’			
Echeveria 'Black Prince'			
Echeveria deranosa			

Scientific Name	Common Name	Plant Type	Plant Form
Echeveria elegans 'Gray Red'			
Echeveria haagii tolimanensis			
Echeveria imbricata			
Echeveria prolifica			
Echeveria pulidonis			
Euphorbia 'Ascot Rainbow'			
Euphorbia 'Blackbird'			
Euphorbia 'Diamond Frost'			
Euphorbia milii			
Euphorbia tirucalli			
Euphorbia tirucalli ‘Sticks on Fire’			
Euphorbia x martinii 'Tiny Tim'			
Furcraea foetida 'Mediopicta Sport'			
Furcraea sellowiana			
Hesperaloe parviflora			
Kalanchoe beharensis			
Kalanchoe luciae			
Kalanchoe tomentosa			
Lampranthus aurantiacus	Trailing ice plant, bush gold, bush ice plant	succulent	groundcover
Lampranthus filicaulis	Redondo creeper	succulent	groundcover
Lampranthus spectabilis	Trailing ice plant	succulent	groundcover
Malephora crocea	Ice plant, Croceum ice plant	succulent	groundcover
Malephora luteola	Yellow trailing ice plant	succulent	groundcover
Opuntia ficus-indica			
Pachyveria glauca			
Pachyveria hookeri			
Portulacaria afra	Purslane tree, Elephant's food	succulent	groundcover
Sedum acre	Goldmoss sedum	succulent	creeper
Sedum album	Green stonecrop	succulent	creeper
Sedum brevifolium	Stonecrop	succulent	groundcover
Sedum burrito			
Sedum confusum	Stonecrop, Sedum	succulent	groundcover
Sedum guatalamense			
Sedum lineare 'Variegata'			
Sedum nussbaumerianum			
Sedum rubrotinctum (S. guatemalense)	Brown bean, Pork and beans	succulent	groundcover
Sedum spathulifolium	Stonecrop	succulent	groundcover
Sedum spurium			

Scientific Name	Common Name	Plant Type	Plant Form
Sedum tricolor			
Senecio mandraliscae	Blue ice plant	succulent	shrub
Senecio serpens (Kleinia repens)	Senecio, Dusty miller, Blue-chalksticks	succulent	shrub
Senecio vitalis			
Yucca ‘Bright Edge’			
Yucca aloifolia			
Yucca elata			
Yucca gloriosa			
Yucca rostrata			
Yucca whipplei			

Appendix C

Site Photos
Shady View Chino Hills

Photo locations are shown on the map above as reference points. Several photos were taken from each general location and are within a few feet of each other. For simplicity, these photo site have been grouped in the locations are shown above.

Photo Site 1 – Looking West

Photo Site 2 – Looking West

Photo Site 3 – Looking West

Looking Southwest

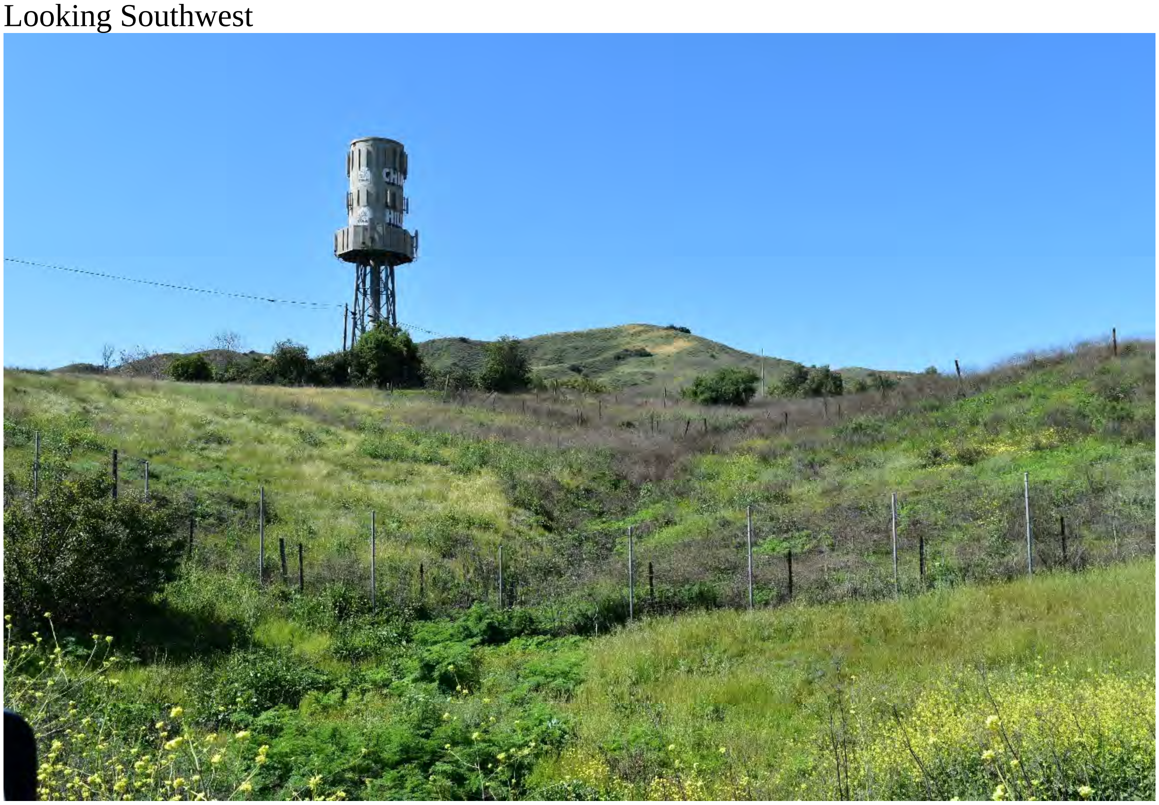


Photo Site 4 – Looking West

Looking Southwest

Photo Site 5 – Looking South

Looking Northeast

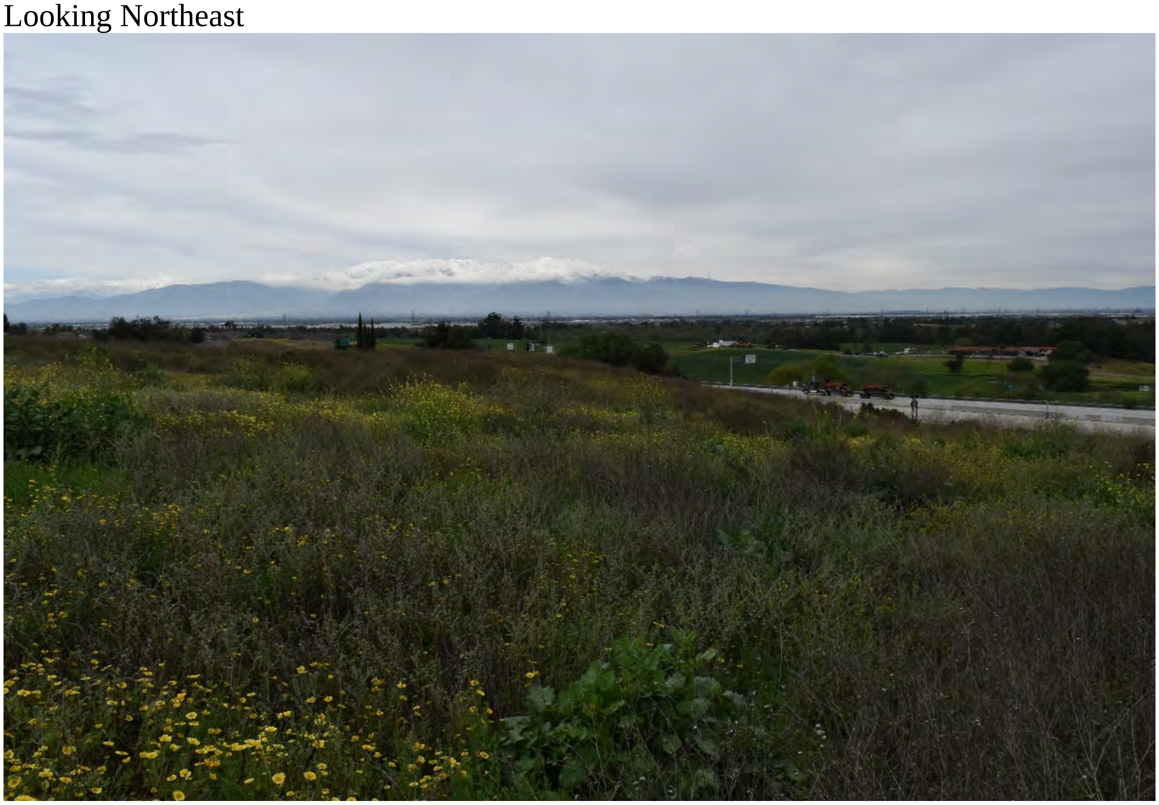


Photo Site 6 – Looking East

Looking West

Photo Site 7 – Looking West

Looking Southwest

Photo Site 8 –Looking West

Photo Site 9–Looking Northwest

Photo Site 9 (cont.) –Looking North

Looking Northeast

Photo Site 10 – Looking Northwest

Looking East

Photo Site 11 – Looking South

Looking West

Photo Site 12 – Looking East

Looking Southwest

Photo Site 13 – Looking Northwest

Looking East

Photo Site 13 (cont.) –Looking Southeast

Looking Southwest

Appendix D
Modeling Results

Inputs: SURFACE

Description		Worst Case Fuels - SCAL

Fuel/Vegetation, Surface/Understory

Fuel Model		1, 2, 4, 5, 6, gr1, gr2, gs1, gs2, sh

Fuel Moisture

1-h Moisture	%	3
10-h Moisture	%	4
100-h Moisture	%	5
Live Herbaceous Moisture	%	30
Live Woody Moisture	%	50

Weather

20-ft Wind Speed	mi/h	15, 30, 40, 60, 80
Wind Adjustment Factor		0.5
Wind Direction (from north)	deg	45

Terrain

Slope Steepness	%	50
Aspect	deg	45

Fire

Spread Direction (from north)	deg	225

Run Option Notes

Maximum reliable effective wind speed limit IS imposed [SURFACE].

Calculations are for the specified spread directions [SURFACE].

Fireline intensity, flame length, and spread distance are always for the direction of the spread calculations [SURFACE].

Wind and spread directions are degrees clockwise from north [SURFACE].

Wind direction is the direction from which the wind is blowing [SURFACE].

Output Variables

Surface Rate of Spread (ft/min) [SURFACE]

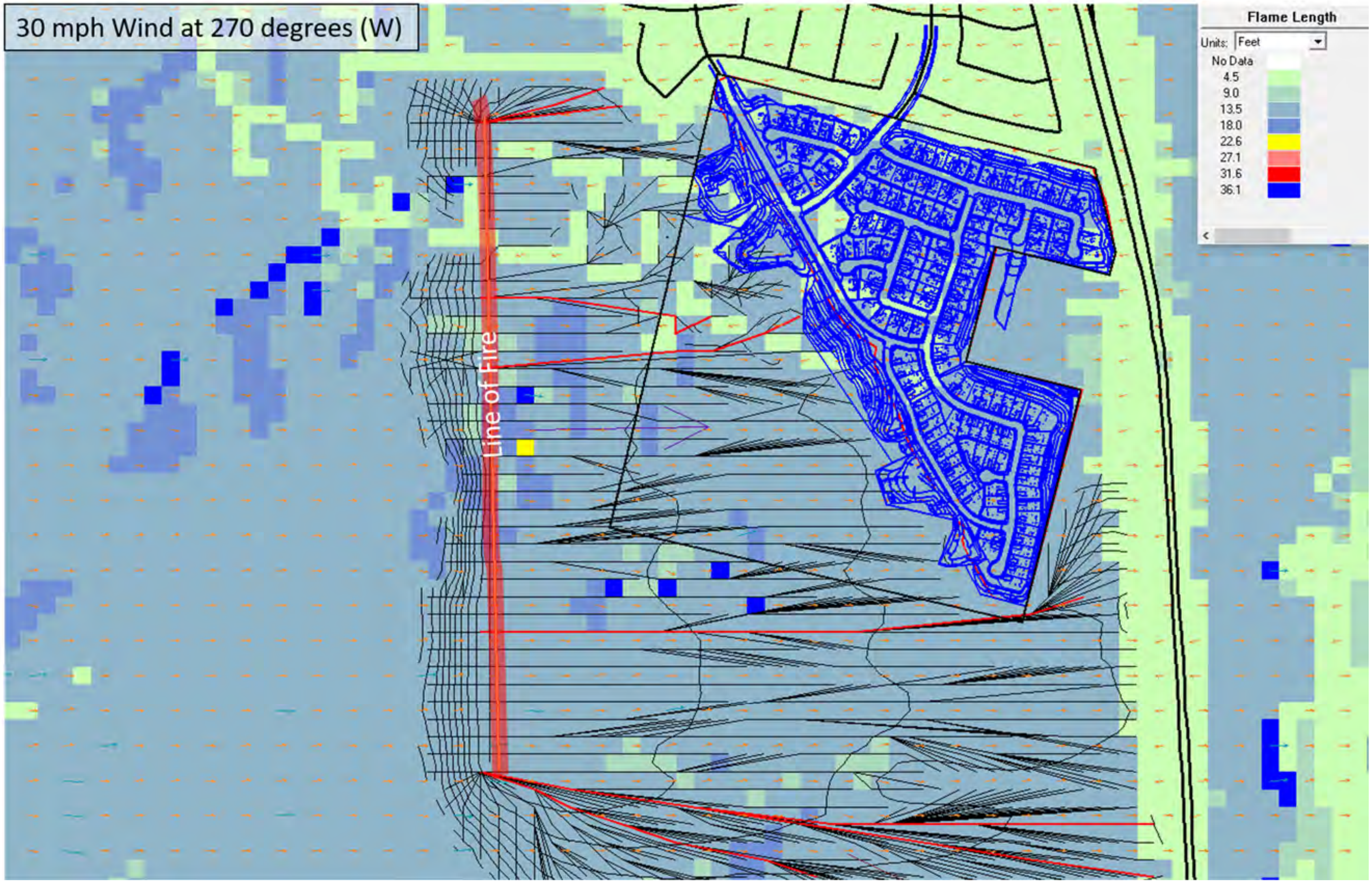
Fireline Intensity (kW/m) [SURFACE]

Flame Length (ft) [SURFACE]

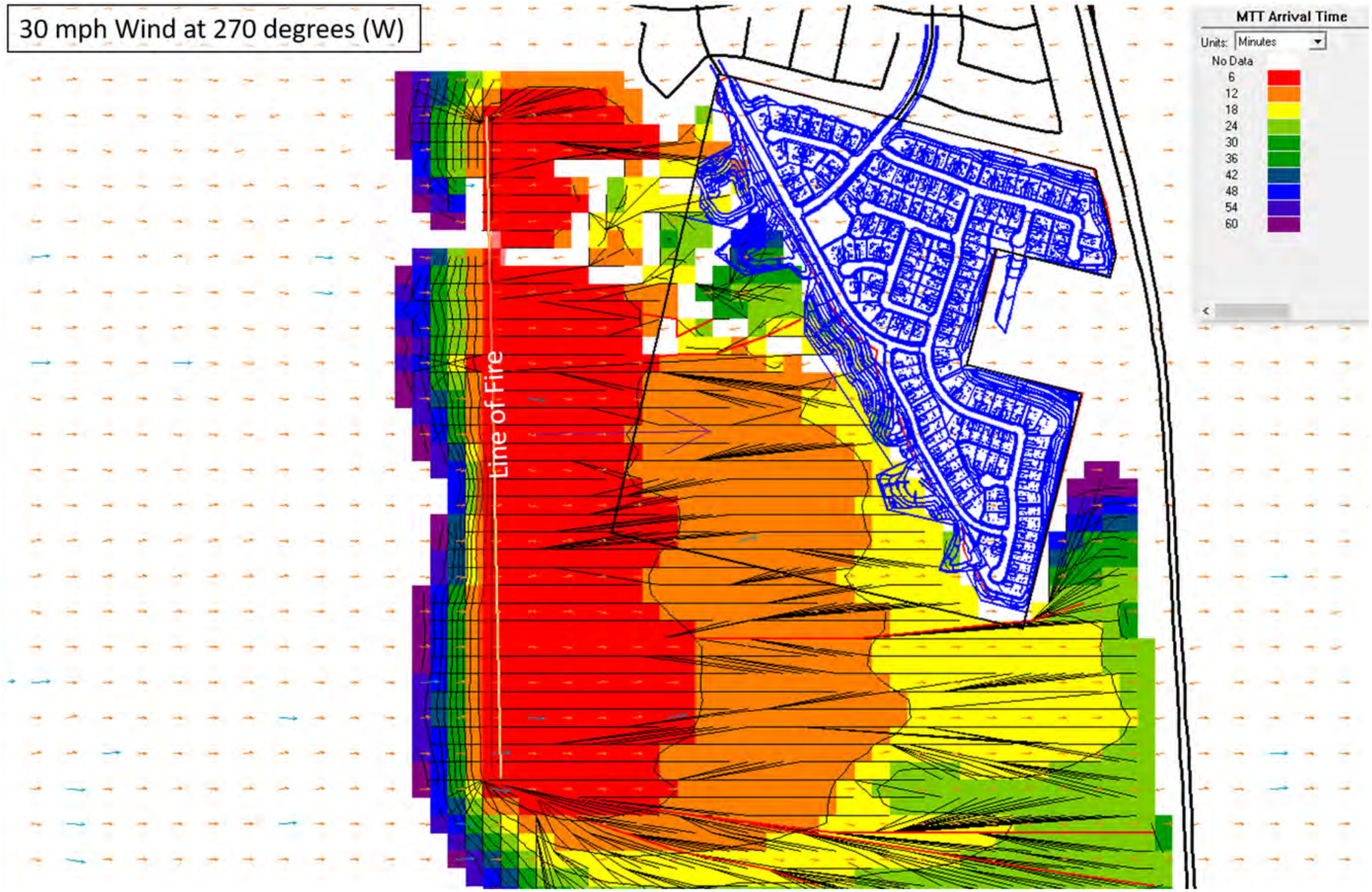
Direction of Maximum Spread (from north) (deg) [SURFACE]

(continued on next page)

Flammap/Farsight Selected Outputs

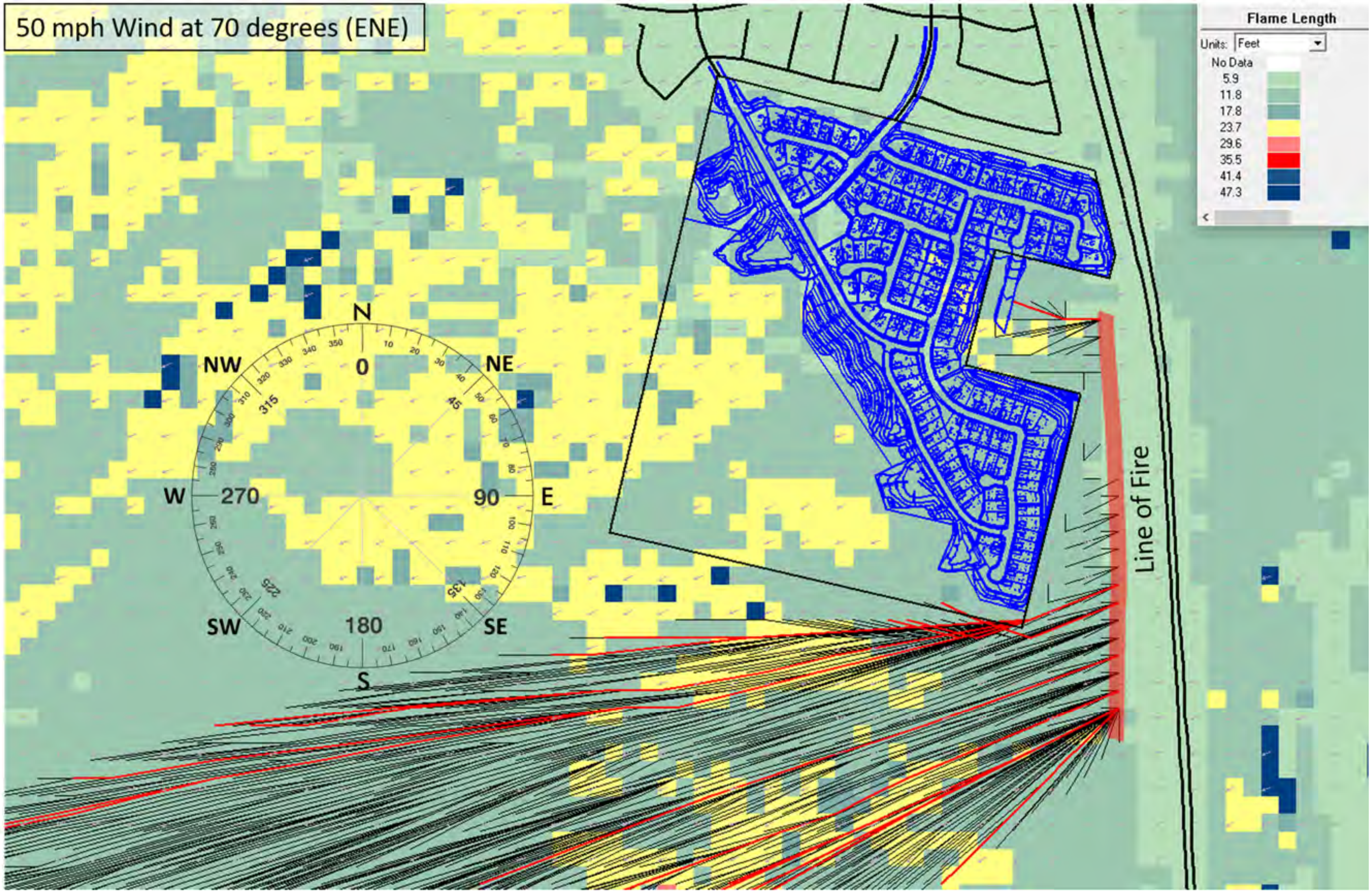


Line of Fire from the West – Flame Length *Red Lines are Major Fire Travel Path/Black are Minor Path*

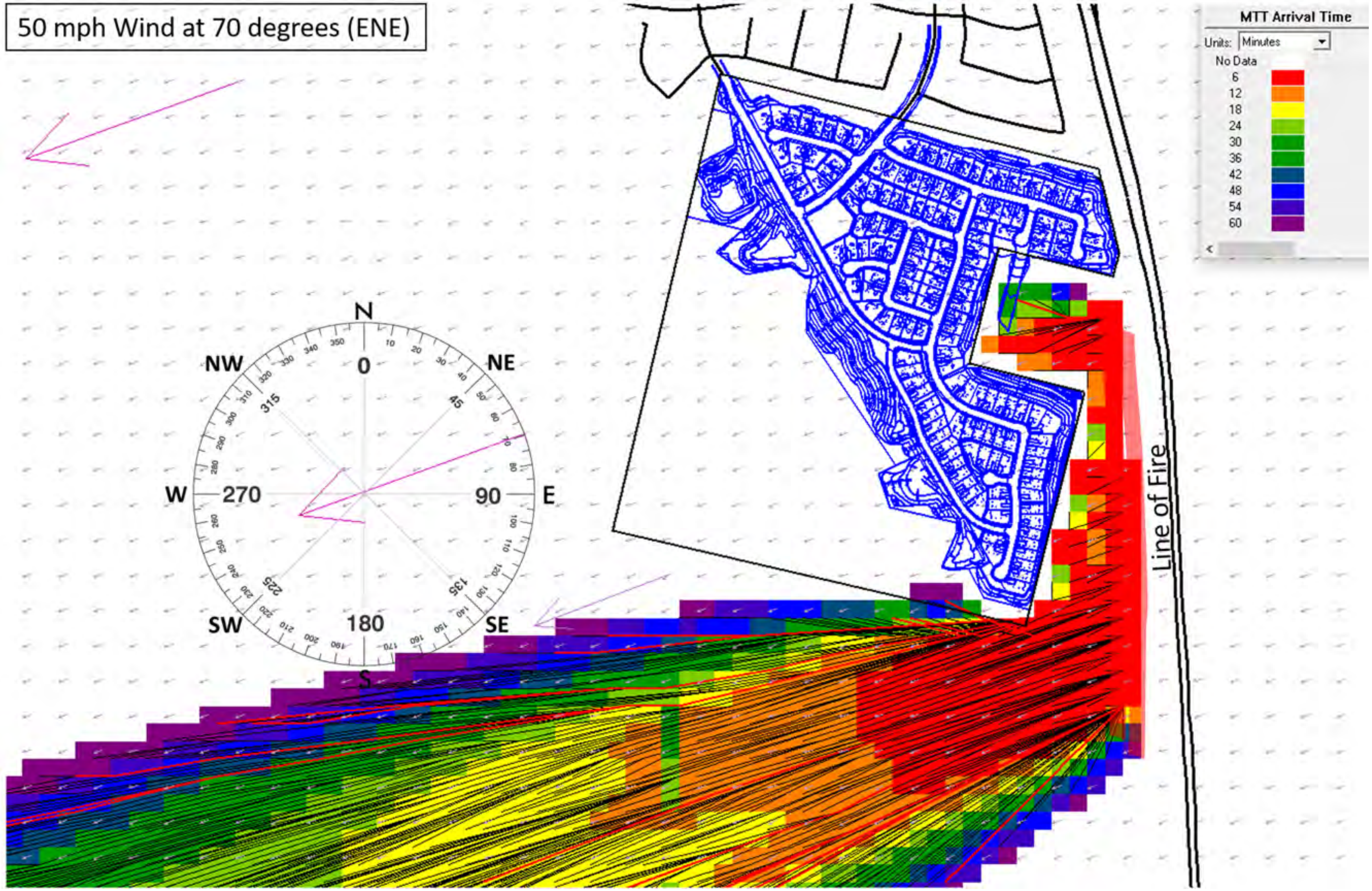


Line of Fire from the West – Arrival Time

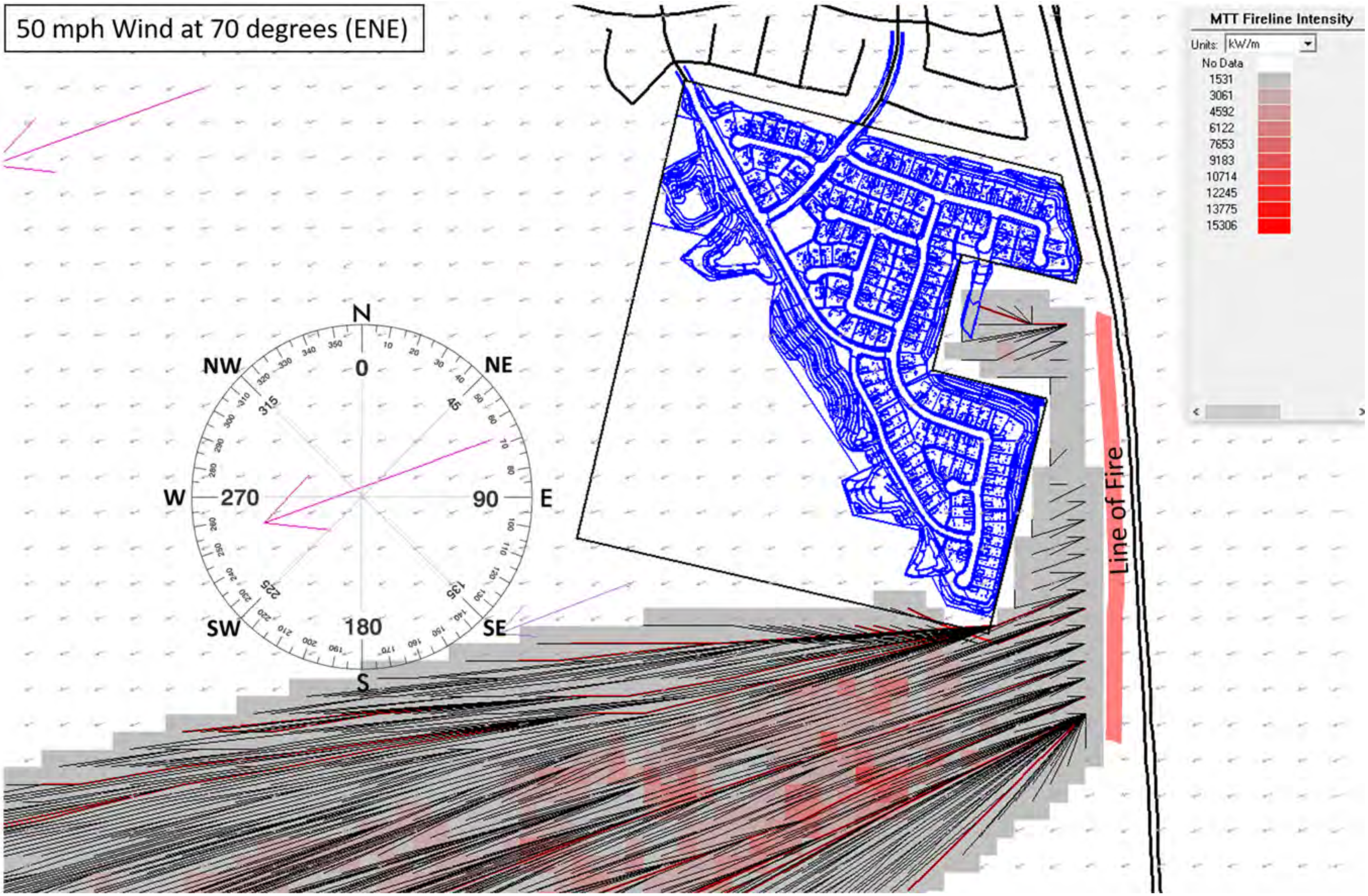
Red Lines are Major Fire Travel Path/Black are Minor Path



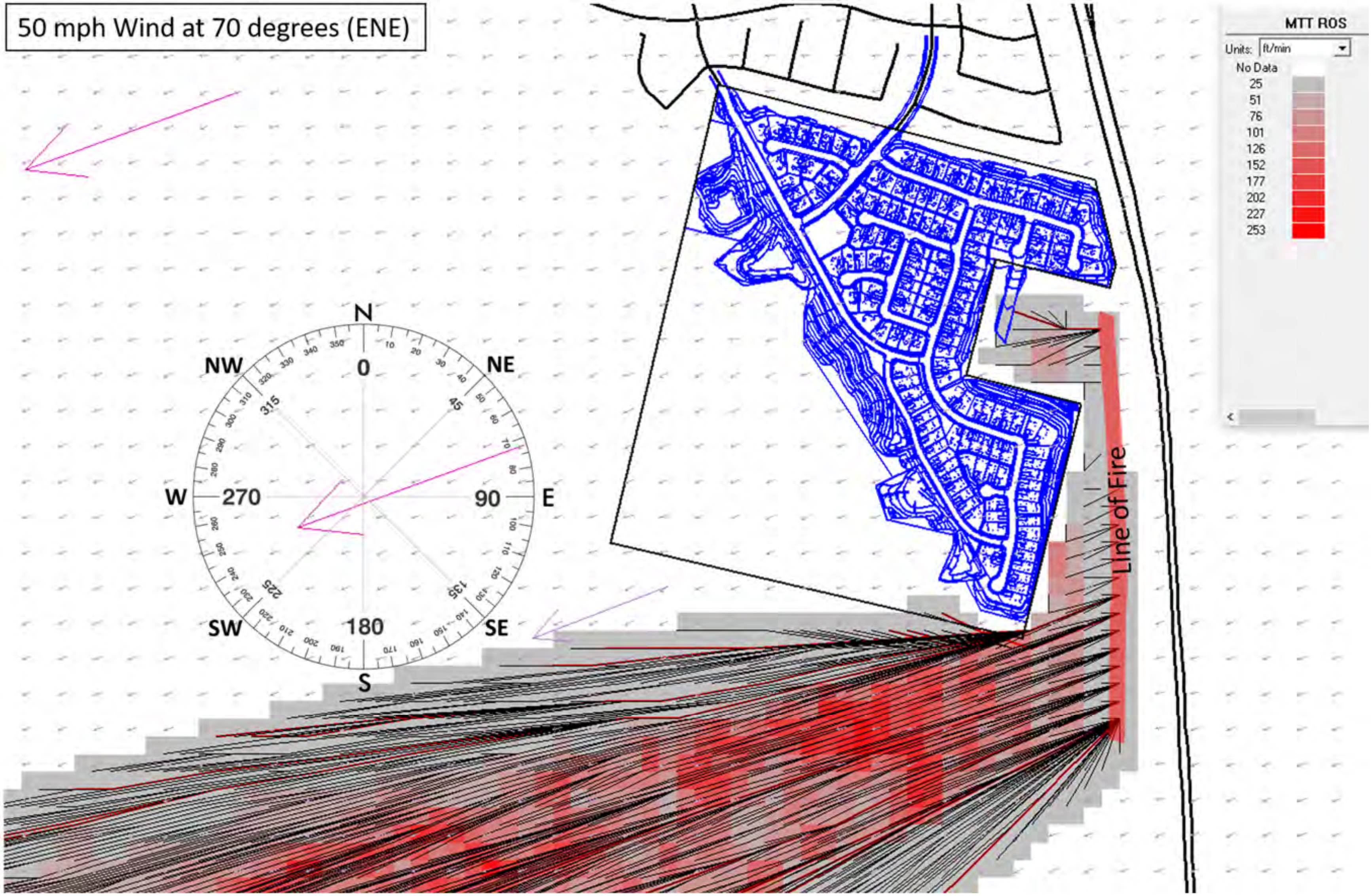
Line of Fire from the East – Flame Length *Red Lines are Major Fire Travel Path/Black are Minor Path*



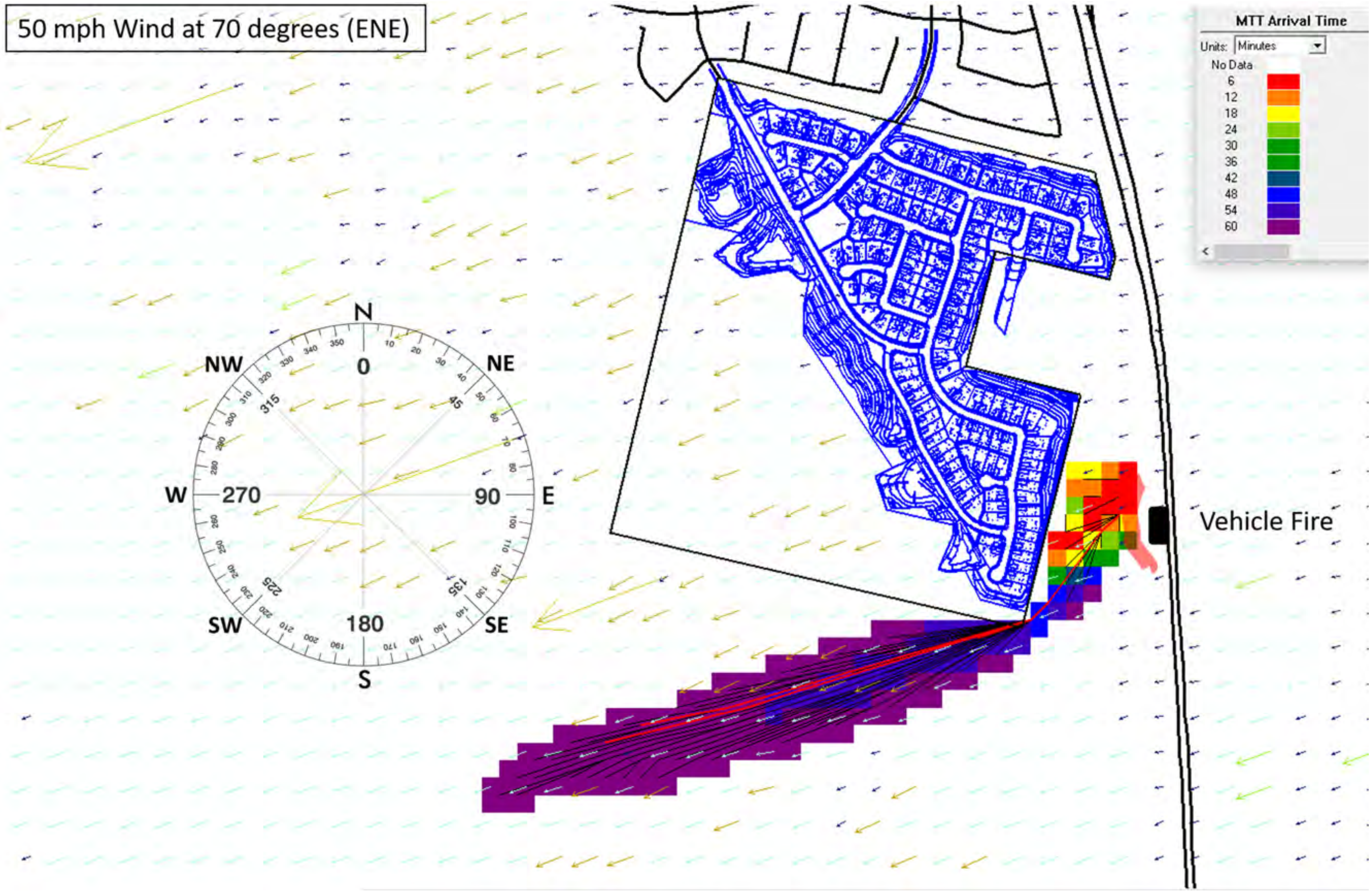
Line of Fire from the East – Arrival Time *Red Lines are Major Fire Travel Path/Black are Minor Path*



Line of Fire from the East – Fireline Intensity *Red Lines are Major Fire Travel Path/Black are Minor Path*



Line of Fire from the East – Rate of Spread *Red Lines are Major Fire Travel Path/Black are Minor Path*



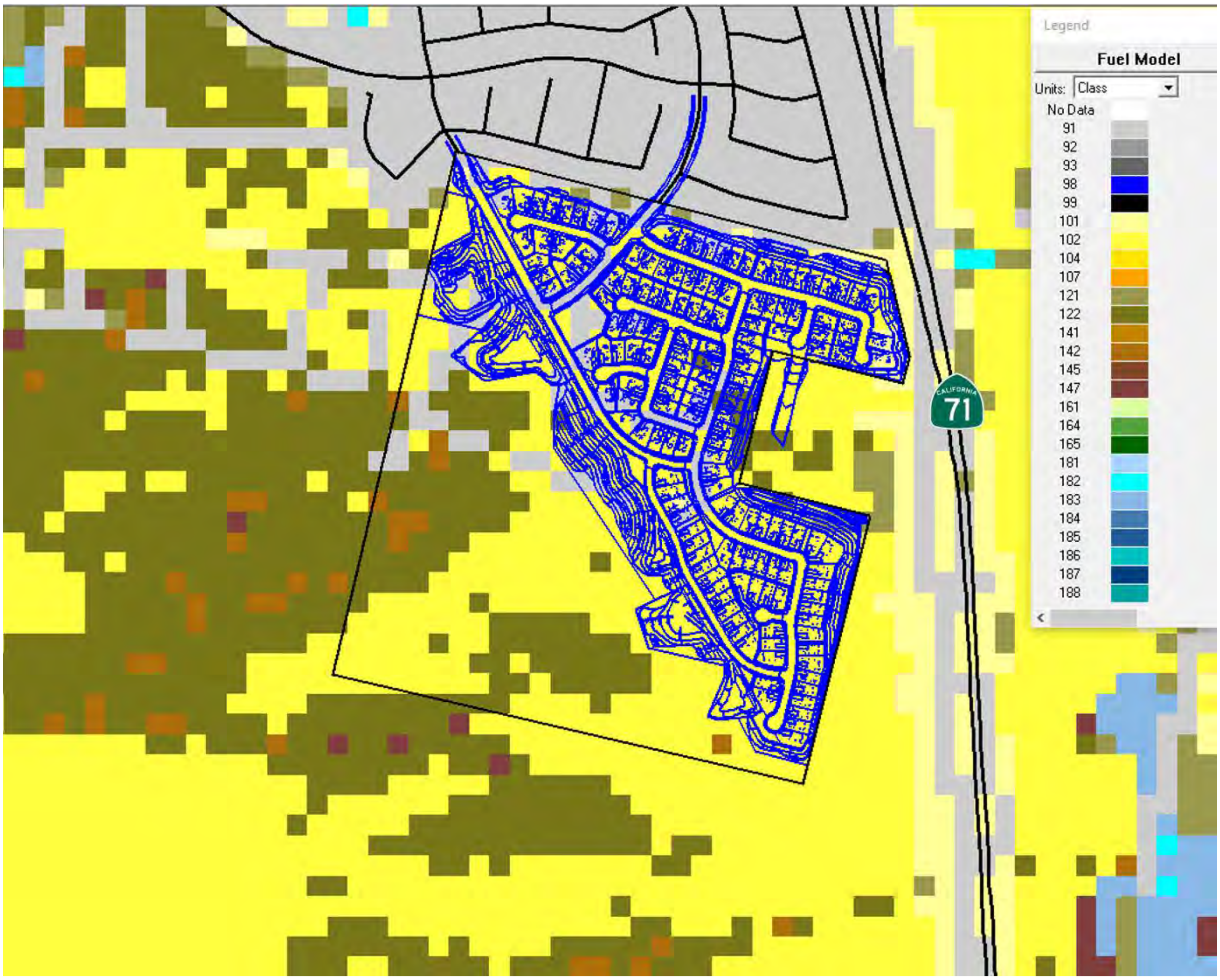
Large Vehicle Fire from the East – Arrival Time

Red Lines are Major Fire Travel Path/Black are Minor Path

Large Vehicle Fire from the East – Flame Length *Red Lines are Major Fire Travel Path/Black are Minor Path*

Input Worksheet (continued)

Notes



Worst Case Fuels - SCAL

Surface Rate of Spread (ft/min)

Fuel Model	20-ft Wind Speed mi/h				
	15	30	40	60	80
1	356.6	491.1	491.1	491.1	491.1
2	151.7	465.9	769.0	1583.6	2661.4
4	330.0	768.8	1122.4	1943.0	2888.9
5	108.1	249.3	361.8	620.7	756.2
6	103.2	229.1	327.0	385.4	385.4
gr1	30.0	30.0	30.0	30.0	30.0
gr2	154.2	268.7	268.7	268.7	268.7
gs1	75.0	180.8	203.3	203.3	203.3
gs2	103.4	248.3	367.1	565.2	565.2
sh1	43.3	99.5	120.2	120.2	120.2
sh2	29.3	65.8	94.7	161.2	237.1
sh5	219.0	446.8	612.4	966.3	1343.6
sh7	144.4	290.1	395.5	620.1	858.8
SCAL14	57.8	98.7	125.2	176.9	227.5
SCAL15	71.8	134.2	177.0	264.6	354.1
SCAL16	109.0	207.3	275.5	416.2	561.2
SCAL17	116.4	266.7	385.9	659.2	907.0
SCAL18	112.6	193.5	245.5	346.9	445.6

Worst Case Fuels - SCAL

Fireline Intensity (kW/m)

Fuel Model	20-ft Wind Speed mi/h				
	15	30	40	60	80
1	2122	2922	2922	2922	2922
2	4937	15169	25034	51555	86642
4	62144	144799	211384	365939	544086
5	4923	11357	16482	28274	34448
6	3383	7508	10716	12630	12630
gr1	151	151	151	151	151
gr2	2316	4037	4037	4037	4037
gs1	1521	3665	4122	4122	4122
gs2	3421	8216	12145	18700	18700
sh1	1022	2349	2838	2838	2838
sh2	2507	5622	8098	13785	20273
sh5	24400	49790	68233	107667	149707
sh7	21740	43680	59548	93360	129290
SCAL14	12761	21806	27654	39078	50246
SCAL15	7194	13447	17739	26520	35493
SCAL16	13642	25942	34476	52080	70217
SCAL17	5878	13468	19488	33287	45799
SCAL18	26584	45672	57962	81891	105210

Worst Case Fuels - SCAL

Flame Length (ft)

Fuel Model	20-ft Wind Speed mi/h				
	15	30	40	60	80
1	8.6	10.0	10.0	10.0	10.0
2	12.7	21.3	26.8	37.4	47.5
4	40.7	60.1	71.5	92.1	110.5
5	12.7	18.6	22.1	28.4	31.1
6	10.7	15.4	18.1	19.6	19.6
gr1	2.6	2.6	2.6	2.6	2.6
gr2	9.0	11.6	11.6	11.6	11.6
gs1	7.4	11.1	11.7	11.7	11.7
gs2	10.7	16.1	19.2	23.4	23.4
sh1	6.2	9.0	9.8	9.8	9.8
sh2	9.3	13.5	16.0	20.4	24.3
sh5	26.5	36.8	42.5	52.5	61.0
sh7	25.1	34.6	39.9	49.1	57.1
SCAL14	19.7	25.2	28.1	32.9	36.9
SCAL15	15.1	20.1	22.9	27.5	31.5
SCAL16	20.3	27.3	31.1	37.6	43.1
SCAL17	13.8	20.2	23.9	30.6	35.4
SCAL18	27.6	35.4	39.4	46.2	51.9

Worst Case Fuels - SCAL

Direction of Maximum Spread (from north) (deg)

Fuel Model	20-ft Wind Speed mi/h				
	15	30	40	60	80
1	225	225	225	225	225
2	225	225	225	225	225
4	225	225	225	225	225
5	225	225	225	225	225
6	225	225	225	225	225
gr1	225	225	225	225	225
gr2	225	225	225	225	225
gs1	225	225	225	225	225
gs2	225	225	225	225	225
sh1	225	225	225	225	225
sh2	225	225	225	225	225
sh5	225	225	225	225	225
sh7	225	225	225	225	225
SCAL14	225	225	225	225	225
SCAL15	225	225	225	225	225
SCAL16	225	225	225	225	225
SCAL17	225	225	225	225	225
SCAL18	225	225	225	225	225

Discrete Variable Codes Used
Worst Case Fuels - SCAL

Fuel Model	
1	Short grass (S)
2	Timber grass and understory (S)
4	Chaparral (S)
5	Brush (S)
6	Dormant brush, hardwood slash (S)
gr1	Short, sparse, dry climate grass (D) (101)
gr2	Low load, dry climate grass (D) (102)
gs1	Low load, dry climate grass-shrub (D) (121)
gs2	Moderate load, dry climate grass-shrub (D) (122)
sh1	Low load, dry climate shrub (D) (141)
sh2	Moderate load, dry climate shrub (S) (142)
sh5	High load, dry climate shrub (S) (145)
sh7	Very high load, dry climate shrub (S) (147)
SCAL14	Manzanita
SCAL15	Chamise 1
SCAL16	North Slope Ceanothus
SCAL17	Chamise 2
SCAL18	Sage / Buckwheat