APPENDIX D

Fire Fuel Load Modeling Report

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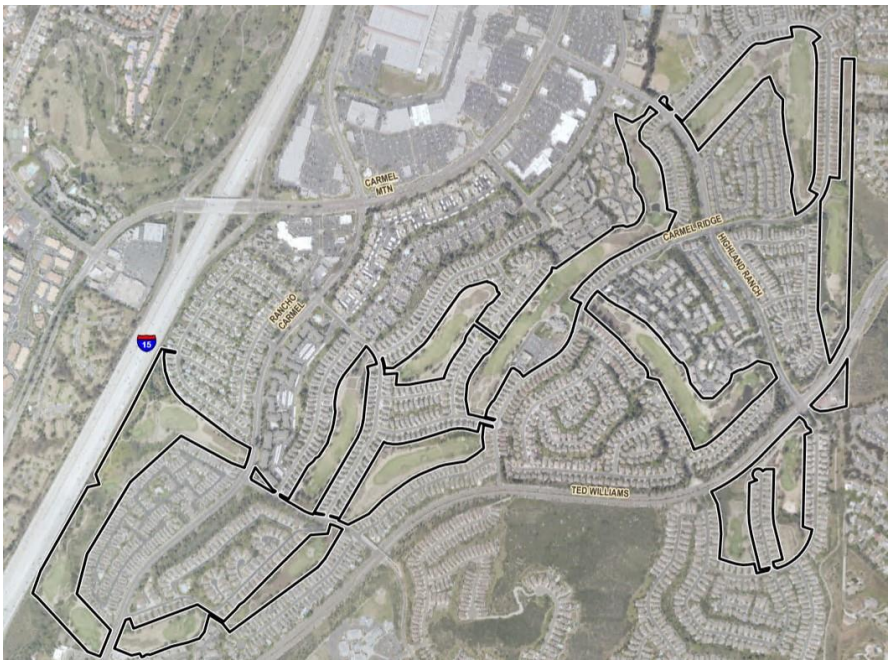
Trails at Carmel Mountain Ranch Project
Fire Fuel Load Modeling Report



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AUGUST 2020

Printed on 30% post-consumer recycled material.

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1 Introduction

In accordance with Section 142.0412 of the San Diego Municipal Code (Brush Management) and Section 104.9 of the 2019 California Fire Code (or then current edition), we are requesting an alternate method of fire protection for The Trails at Carmel Mountain Ranch Project (Project) in northeastern San Diego County. The Project Site, while interspersed between sections of an existing residential development, is generally defined by Ted Williams Parkway to the south, Carmel Mountain Road to the north, Pomerado Road to the east, and California Interstate 15 Expressway (I-15) directly adjacent to the west. The Project is within the City of San Diego's Subarea Plan (City of San Diego 1997). The Project area boundary is defined by the old Carmel Mountain Ranch Country Club property.

The majority of the Project Site area was previously a golf course and consists primarily of disturbed habitat. The majority of native habitat within the Project area is associated with Chicarita Creek along the western boundary of the Project Site area, and along the eastern boundary adjacent to a parcel owned by the City of Poway. Impacts to any areas of natural vegetation or habitat potentially suitable for special status plant species will be avoided. The Project Site currently includes ornamental plantings, and native habitat. Generally, land uses adjacent to the Project Site consist of single-family residential developments, neighborhood streets, a community park, and freeways. The Project site can be accessed via Carmel Mountain Road and Ted Williams Parkway.

This request is in response to our assessment of the site, the Project development footprint, off-site adjacent fuels, and the area's fire history and weather.

This Fire Fuel Load Modeling Report (FFLMR) discusses the Project site and its fire environment, fire risk assessment, including fire behavior modeling, and based on the results from this study, requests a variance from the standard brush management zone (BMZ) specifications with regard to the width of Zone 1 and Zone 2 for specific locations adjacent to existing residences. The existing condition in areas where former golf holes are located adjacent to existing residential structures includes protected riparian drainages. These drainages create a condition where it is not possible to achieve a standard BMZ. As such, the FFLMR provides an alternative approach that provides for an existing irrigation zone (existing rear or side yards) and a thinning BMZs that isolate the riparian drainages and minimize the potential for a vegetation fire to transition into a riparian tree crown fire, as explained in more detail in following sections. Per San Diego Municipal Code, the Fire Chief may modify standard requirements in consideration of the topography, existing and potential fuel load, and other characteristics of the site related to fire protection. As stated in the Municipal Code, (142.0412(i)), an applicant may request approval of alternative compliance for brush management in accordance with Process One if all of the following conditions exist:

1. The proposed alternative compliance provides sufficient defensible space between all structures on the premises and contiguous areas of native or naturalized vegetation as demonstrated to the satisfaction of the Fire Chief based on documentation that addresses the topography of the site, existing and potential fuel load, and other characteristics related to fire protection and the context of the proposed development.
2. The proposed alternative compliance minimizes impacts to undisturbed native or naturalized vegetation where possible while still meeting the purpose and intent of Section 142.0412 to reduce fire hazards around structures and provide an effective fire break.
3. The proposed alternative compliance is not detrimental to the public health, safety, and welfare of persons residing or working in the area.

This report provides Project information, a request for modification, and justifications for the modification.

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2 Project Information

The Project proposes to redevelop the previous Carmel Mountain Ranch Country Club and associated 18-hole golf course located in northeast San Diego County, in the Carmel Mountain Ranch Community within the City of San Diego (see Figure 1, *Project Location Map and* Figure 2, *Project Area Map*). The project site is located west of the City of Poway, east of the community of Rancho Peñasquitos, north of the community of Saber Springs, and south of the community of Rancho Bernardo. The project site is bounded by Ted Williams Parkway to the south; Carmel Mountain Road to the north; Interstate 15 (I-15) to the west; and the boundary with the City of Poway to the east. The Project, which totals approximately 164.5 acres, includes development of 1,200 multi-family homes and a mix of open space and recreational uses. Residential land uses would compose approximately 52.9 acres and would range in density from 12.9 to 37.43 dwelling units per acre. Open space uses would be composed of approximately 111.27 acres, which includes approximately 6 miles of publically accessible trails and 9.79 acres of publicly-accessible parkland. The Project Site is located within Section of Township 14 South, Range 2 West and Section 10 of Township 14 South, Range 2 West, of the Poway, California U.S. Geological Survey (USGS) 7.5-minute topographic quadrangle.

Site Address: The Trails at Carmel Mountain Ranch Project
14050 Carmel Ridge Road
San Diego, California 92128

Contact: **New Urban West**
Jonathan Frankel, Vice President, Forward Planning
925.708.3638

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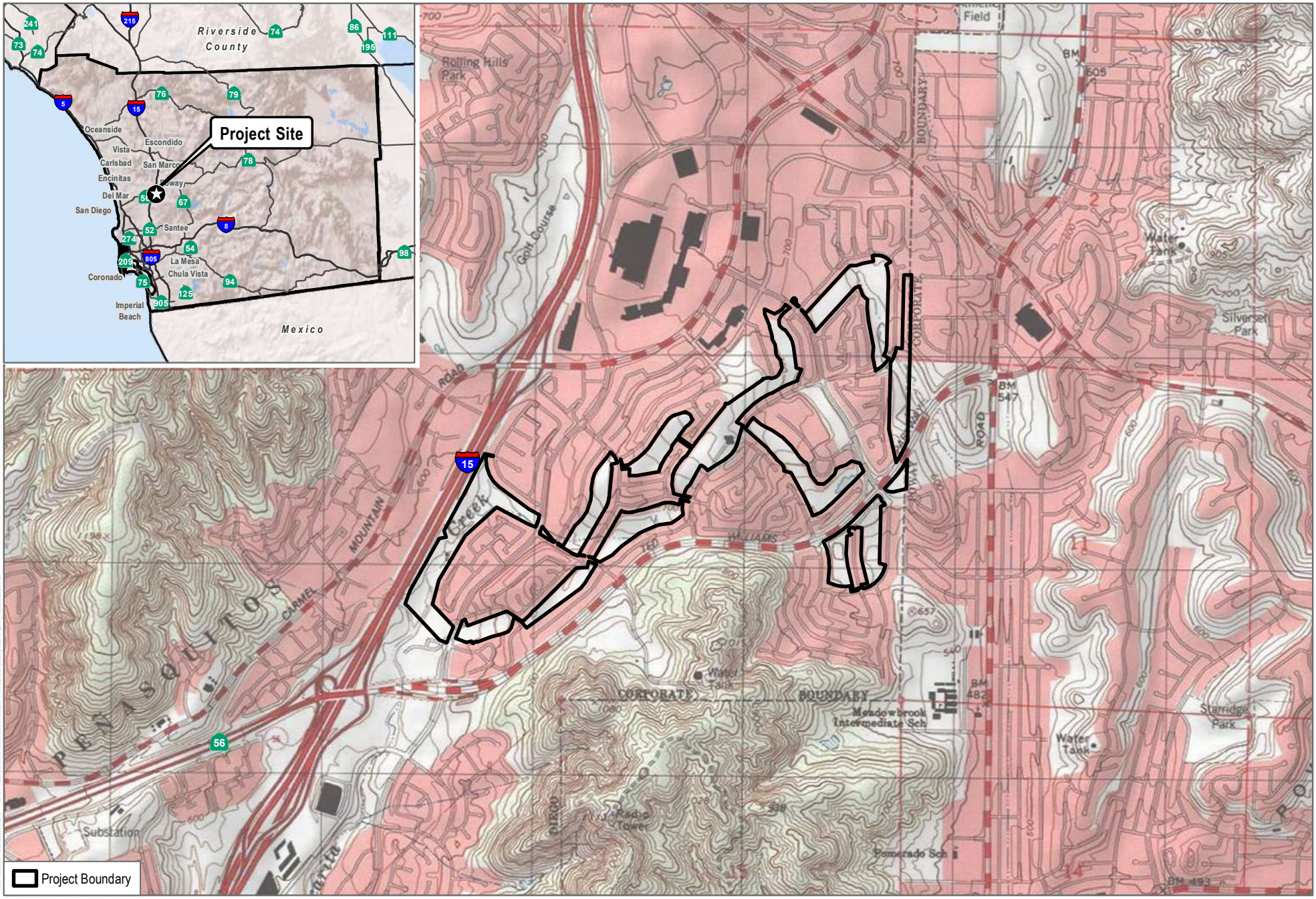

SOURCE: USGS 7.5-Minute Series Poway Quadrangle

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FIGURE 1

Project Location

The Trails at Carmel Mountain Ranch - Fire Fuel Load Modeling Report

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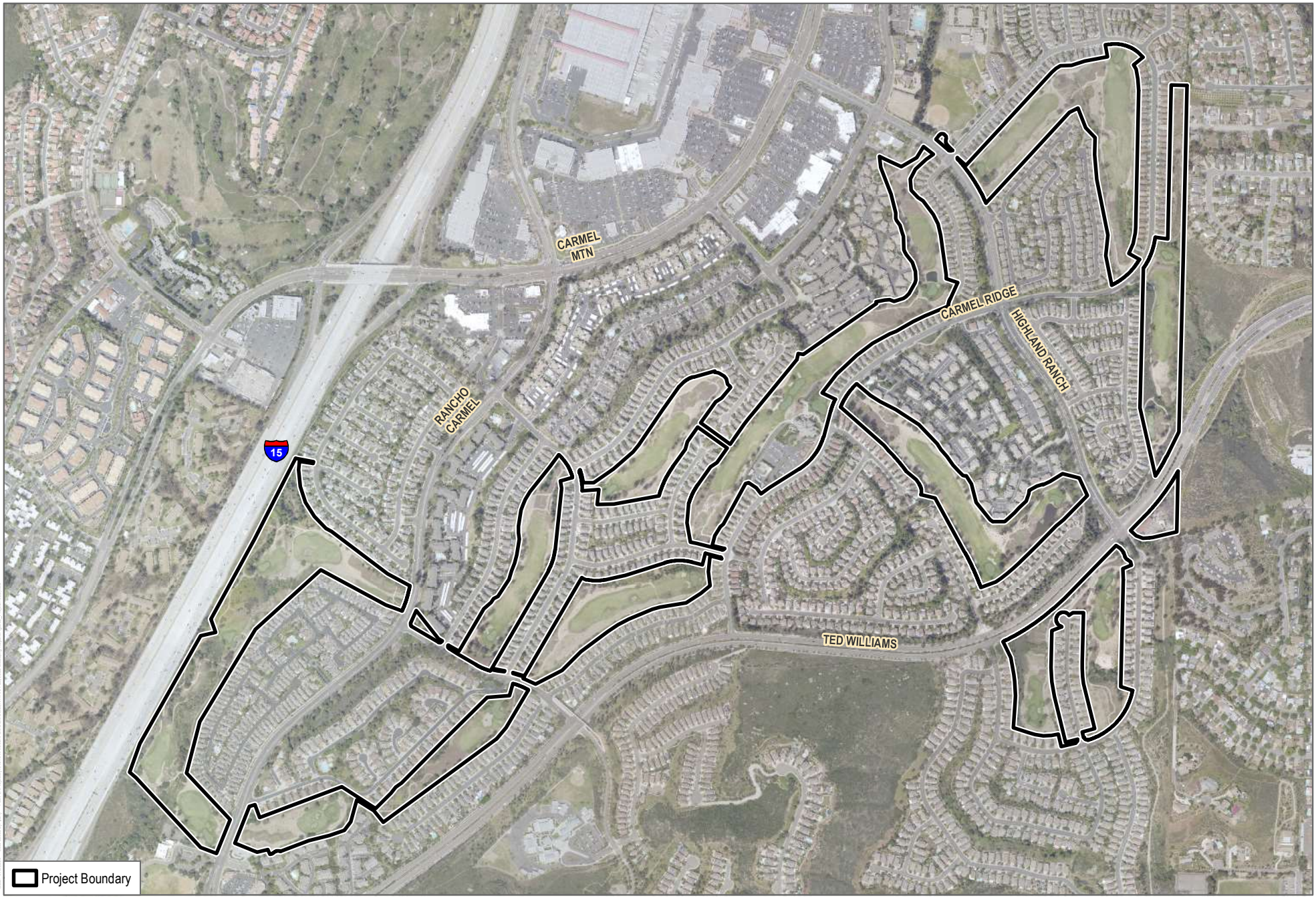

SOURCE: USGS 7.5-Minute Series Poway Quadrangle

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FIGURE 2

Project Area Map

The Trails at Carmel Mountain Ranch - Fire Fuel Load Modeling Report

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3 Project Description

The Project proposes to redevelop the Carmel Mountain Ranch Country Club and associated 18-hole golf course. The Project, which totals 164.5 acres, includes development of 1,200 multi-family homes and a mix of open space and recreational uses. Residential land uses would compose approximately 52.9 acres and would range in density from 12.94 to 37.43 dwelling units per acre. Open space uses would be composed of approximately 111.27 acres, which includes approximately 6 miles of publicly-accessible trails and 9.79 acres of publicly-accessible parkland.

The Project would develop distinct residential neighborhoods with a diversity of housing types and open space amenities and with a unique character and sense of place. Each neighborhood will provide an open space amenity, trail connection, recreation area and separate entrance. Gateways into the neighborhoods will be clearly marked and accentuated with distinct landscape features, building forms, enhanced paving, and direct pedestrian paths. Entrances to each neighborhood will lead residents and visitors directly to recreation areas and open space amenities in the neighborhood, providing a sense of place and arrival. Homes will be clustered and oriented around private open spaces and community amenities, providing a sense of neighborhood identity. Buildings will be oriented and relate directly to internal streets, paseos, greenways and common open space amenities and generally create an attractive presence and "eyes on the street."

Recreation and Trail System

Recreational amenities would include picnic pavilions, playgrounds, tot-lots, and trails for walking and biking. A multi-use trail system would circulate throughout the project site to provide mobility and recreational opportunities for pedestrians and bicyclists. The majority of the trail system would include decomposed granite or compacted earth trails with some concrete trails that would be repurposed from the previous golf cart path. Trails would connect to sidewalks along the proposed on-site roadways and along existing adjacent residential streets to maximize access and connectivity. Additionally, a trail staging area would provide bike racks, a trail map and rules kiosk, bike station, picnic tables, and shade areas. Trails would range from 5 to 8 feet in width and all trails would be publicly accessible.

Residential Land Use

Residential land uses would be developed as infill residential neighborhoods based on the standards in the Trails at Carmel Mountain Ranch Design Guidelines. The residential development would occur on approximately 52.9 acres ranging in density from 12.9 to 37.43 dwelling units per acre. The proposed project would allow for up to 1,200 residential dwelling units with heights ranging from 30 to 48 feet (inclusive of all building appurtenances such as solar panels, chimneys and mechanical equipment). All proposed new residential construction would be set back 50 feet from existing residential development.

The project would include 451 townhomes on approximately 26.23 acres, 543 market-rate apartments on approximately 19.14 acres, 78 affordable apartments on approximately 2.29 acres, and 128 mixed market rate and affordable apartments on approximately 3.42 acres.

A variety of building types (townhomes, garden walk-ups, stacked flats and apartments, among others) will be provided in the community, with a mix of for-sale, rental and age-restricted product to serve a diverse and mixed

population and household size. A variety of architectural styles will be allowed across the neighborhoods, so long as a consistency is established at each planning unit neighborhood to help define a sense of place. Building designs will establish a pattern and hierarchy of building massing and forms to help reduce the visual bulk of the development and will incorporate smaller-scale architectural elements, such as bay windows, porches, projecting eaves, awnings, and similar elements, to add visual interest and reduce the scale and mass of buildings.

These design features will help make the Trails at CMR a special place in the CMR Community and the greater San Diego region.

In addition, the project proposes a 12,000 square foot pad for future development of a community art gallery/studio located near the existing Carmel Mountain Ranch library. This gallery may include up to 6,000 sf in one or two buildings to house gallery space, studio space with an indoor kiln and bathroom/kitchen. In addition, this amenity could include up to 2,000 square foot outdoor open shed structure to house wood-burning ceramic kiln. Wood storage and a washing area. A 3,000 square foot café/restaurant/banquet area is proposed with 2,000 square foot of dining space and a 1,000 square foot kitchen. On additional caretaker unit up to 1,500 square feet would also be proposed. This gallery/studio would be privately owned by a non-profit, not for dedication to the City or homeowner's association. This Community Plan Land Use proposed is Community Commercial. It would be rezoned to be CC-2-1.

Maintenance and operation of the project would be financed through a new master homeowner's association (HOA) that would be responsible for all private roads, private utilities, and common amenities. The long-term maintenance and preservation of open space resources on the project site including the trail system may be the responsibility of the Carmel Mountain Ranch Maintenance Assessment District (MAD and/or the new Master HOA). The HOA would also be required to contract with qualified professionals for the long-term care and maintenance of the bioretention basins and brush management zones, which are described in more detail below. The HOA would also be responsible for enforcement of the project's Covenants, Conditions, and Restrictions.

Project Approvals

The project requires the following entitlements from the City, which would be processed concurrently unless otherwise noted:

- General Plan Amendment
- Community Plan Amendment
- Rezone
- Master Planned Development Plan
- Site Development Permit (for Environmentally Sensitive Lands)
- Neighborhood Development Permit for water easement vacation
- Vesting Tentative Map
- EIR Certification

Project Infrastructure

The Project site is surrounded by existing development, primarily residential land uses, with existing infrastructure. Any proposed new infrastructure needed to serve the project would be connected to existing vehicular access and circulation, water, sewer, drainage, and dry utilities such as gas, electricity, and telecommunications systems.

Connections will be made to existing City water and sewer infrastructure to provide service to the project as described below under Project Water System and Project Wastewater System.

Project Circulation

The project's circulation system is designed to interconnect with the existing adjacent public street system and discourage cut-through automobile traffic. The project's internal street network would consist of all private roadways designed as Complete Streets that accommodate automobiles, bicycles, pedestrians, low-speed vehicles, neighborhood electric vehicles, and golf carts. All private drives would include a minimum five-foot sidewalk along at least one side of the street. Motor courts would also be provided as a shared driveway (private drive) for two or more homes and common access roads would provide access from private drives to parking areas.

Project Water System

The City's Public Works Department would provide domestic water to the proposed project. The San Diego County Water Authority provides 99 percent of the City's water in the form of untreated water, with the remaining demand met through recycled water provided by the City or purchased from the Otay Water District. All imported water is treated locally at the City's water treatment plant and then distributed via a complex and comprehensive system of pumps and pipes.

Improvements to the public water system include a new 12-inch 793 Pressure Zone water line to serve Unit 5 and Unit 6, and the relocation of an existing 8-inch 1130 Pressure Zone water line through Unit 9/17.

Each Unit within the project is proposed to have a private domestic water system and a private fire protection system. In accordance with City of San Diego standards, private domestic water systems will include a meter and backflow preventer, and private fire protection systems will include backflow preventers.

Project Wastewater System

The project would connect to the City's sewer system. Wastewater collection and the City's sewage system are maintained and operated by the City's Public Works Department to ensure sufficient capacity is available for dry weather peak-flow conditions and storm or wet weather events.

The project site is divided into two sewer basins: the Chicarita Basin and the Poway Basin. The Chicarita Basin flows west to the existing Chicarita Trunk Sewer #90. The Poway Basin flows east to the City of Poway for transportation to the City's Municipal Wastewater System. Wastewater from the project, including that which goes to Poway, will ultimately be conveyed through the City's Municipal Wastewater System to the North City Water Reclamation Plant for treatment and disposal.

The project would construct new gravity sewer lines to connect the project site to the existing gravity sewer system. Unit 5 will require a lift station to serve the project. Onsite sewer systems will be private and will be designed to maintain a minimum of one (1) percent slope to meet state and local plumbing code standards. Alternatively, the private sewer systems within each Unit may be designed in accordance with the City of San Diego Sewer Design Guide.

Project Dry Utilities

Electrical power and natural gas would be provided by San Diego Gas & Electric. No major improvements to the local distribution networks are anticipated to be needed to support the growth facilitated by the proposed project. The applicant will work with dry utility providers to ensure utility systems have adequate capacity to serve the project. Telephone, cable TV, and internet service would be available from a variety of providers.

New development within the project site would be required to comply with the California Energy Code (Title 24) and California Green Building Standards Code (CALGreen), as part of project conditions. Title 24 and CALGreen include the most stringent requirements for energy conservation in the country. To meet these requirements, all new development within the project site would include rooftop photovoltaic solar panels, energy-efficient lighting and appliances, cool roofs, energy-efficient windows, and other design features that significantly conserve energy.

Off-Site Improvements

Offsite improvements include the installation of a new traffic signal at the intersection of Carmel Ridge Road and Ted Williams Parkway. Adaptive signal timing would also be installed along Carmel Mountain Road between Rancho Carmel Drive and Conference Way.

Construction and Phasing

The proposed project would be developed in phases. Construction is anticipated to begin in February 2022, and end in October 2026.

Data regarding biological resources present within the project area were obtained through a review of pertinent literature and field reconnaissance, both of which are described in detail as follows. Survey areas were determined based on suitable habitat for the resource for which the survey was conducted.

4 Fire Risk Analysis

4.1 Field Assessment

A field assessment of the Project, including on-site and off-site adjacent areas, was conducted by Dudek on April 1, 2020 in order to document existing site conditions and determine potential actions for addressing the protection of the existing structures adjacent to the Carmel Mountain Ranch Country Club and associated 18-hole golf course site. Assessments of the area's topography, natural vegetation and fuel loading, assets, fire history, and general susceptibility to wildfire formed the basis of the site risk assessment. Among the field tasks that were completed are:

- Vegetation measurements and mapping refinements
- Fuel load analysis
- Topographic features documentation
- Photograph documentation
- Confirmation/Verification of office-based hazard assumptions.

Site photographs were collected (Attachment A) and the existing vegetation (fuel) communities were mapped (Attachment B) using 200-scale aerial images and project vegetation maps. Field observations were utilized to augment existing site data in generating the fire behavior models and formulating the recommendations detailed in this report.

4.2 Fire Environment

Fire environments are dynamic systems and include many types of environmental factors. Fires can occur in any environment where conditions are conducive to ignition and fire movement. Areas of naturally vegetated open space are typically comprised of conditions that may be favorable to wildfire spread. The three major components of fire environment are vegetation (fuels), climate and topography. The state of each of these components and their interactions with each other determines the potential characteristics and behavior of a fire at any given moment. It is important to note that wildland fire may transition to urban fire if structures are receptive to ignition. Structure ignition depends on a variety of factors and can be prevented through a layered system of protective features including fuel modification directly adjacent the structure(s), application of known ignition resistive materials and methods, and suitable infrastructure for firefighting purposes. Understanding the existing wildland vegetation and urban fuel conditions on and adjacent the site is necessary to understand the potential for fire within and around the Trails at Carmel Mountain Ranch Project.

4.3 Vegetation (Fuels)

Based on species composition and general physiognomy, the existing Trails at Carmel Mountain Ranch property supports a total of 13 vegetation communities (11 native and two (2) non-native) and two (2) land cover types were identified within the project area (see Tables 1a & 1b and Attachment B). In addition, two (2) land covers are located within the project area (Tables 1a & 1b). The golf course contains areas of hardscape such as golf cart pathways, along

with areas of landscaping and native habitat. The areas associated with the golf course (planted trees and other landscaping, fallowed greens, and hardscape) are all grouped under the category developed/disturbed habitat. Any area with native habitat was mapped according to Oberbauer et al. (2008). These vegetation communities/land cover types are described in detail in the Biological Technical Report (Dudek 2020) for the Project. In summary, native and non-native uplands vegetation communities and land covers present within the Project site included coastal sage scrub, coastal sage scrub (disturbed), coastal sage scrub (*Baccharis*-dominated), coastal and valley freshwater marsh, disturbed habitat, disturbed wetland, eucalyptus woodland, southern arroyo willow riparian forest, southern coast live oak riparian forest, southern cottonwood-willow riparian forest, southern sycamore-alder riparian woodland, southern willow scrub (disturbed), southern willow scrub, undifferentiated open woodland, developed land/disturbed habitat and an unvegetated channel. The site's vegetation fire risk is primarily determined by project-adjacent vegetation that will be preserved in the open space directly adjacent to the site's brush management zones. The growth of vegetation types/fuel models is influenced by aspect (orientation), soil constituents, soil depth, soil moisture, and weather. The vegetation occurring on the slopes adjacent the site represents the site's fuel load, an important component of the site's wildfire risk assessment. The photographs in Attachment 1 display the fuels on and adjacent the property.

Table 1a shows the acreages of upland vegetation communities while Table 1b displays wetland vegetation communities, all of which make up the entire project area which encompasses 164.52 acres.

Table 1a. Upland Vegetation Communities and Land Cover Types in the Project Area

Vegetation Community/ Land Cover Type	City of San Diego Biology Guidelines Vegetation Community	Acreage
Native Vegetation Communities		
Coastal Sage Scrub	Coastal Sage Scrub	3.35
Disturbed Coastal Sage Scrub	Coastal Sage Scrub	0.48
Coastal Sage Scrub (*Baccharis*-dominated)	Coastal Sage Scrub	1.79
Undifferentiated Open Woodland	Oak Woodland	0.42
Southern Sycamore-Alder Riparian Woodland*	Ornamental Plantings	0.16
Non-Native Vegetation Communities and Land Covers		
Developed Land/Disturbed Habitat	Disturbed Land	151.76
Eucalyptus Woodland	Eucalyptus Woodland	0.27
	Total	158.22

Note:
* This habitat type would normally be considered a Wetland in the City's Biology Guidelines (City of San Diego 2018a), however this is an artificially created wetlands in a historically non-wetland area. See Section 3.2.1.11 for further discussion.

Table 1b. Wetland Vegetation Communities and Land Cover Types in the Project Area

Vegetation Community/ Land Cover Type	City of San Diego Biology Guidelines Vegetation Community	Acreage
Native Vegetation Communities		
Coastal and Valley Freshwater Marsh	Freshwater Marsh	1.48
Southern Arroyo Willow Riparian Forest	Riparian Forest or Woodland	2.24
Southern Coast Live Oak Riparian Forest	Riparian Forest or Woodland	0.08
Southern Cottonwood-Willow Riparian Forest	Riparian Forest or Woodland	1.38
Disturbed Southern Willow Scrub	Riparian Scrub	0.19
Southern Willow Scrub	Riparian Scrub	0.47

Table 1b. Wetland Vegetation Communities and Land Cover Types in the Project Area

Vegetation Community/ Land Cover Type	City of San Diego Biology Guidelines Vegetation Community	Acreage
Unvegetated Channel	Natural Flood Channel	0.36
Non-Native Vegetation Communities and Land Covers		
Disturbed Wetland	Disturbed Wetlands	0.09
	Total	6.29

4.3.1 Coastal Sage Scrub (including disturbed variety)

Coastal sage scrub is a native vegetation community that, according to Oberbauer et al. (2008), is composed of a variety of soft, low, aromatic shrubs, characteristically dominated by drought-deciduous species—such as California sagebrush (*Artemisia californica*), California buckwheat (*Eriogonum fasciculatum*), and sages (*Salvia* spp.)—with scattered evergreen shrubs, including lemonade sumac (*Rhus integrifolia*) and laurel sumac (*Malosma laurina*).

Coastal sage scrub occupies a total of 3.83 acres within the project area. This vegetation community occurs primarily on the western side of the project area adjacent to riparian areas along Chicarita Creek. One area of disturbed coastal sage scrub was mapped along the southern boundary of the project area, and is largely comprised of coastal deerweed (*Acmispon glaber* var. *glaber*), California buckwheat, and heavy cover of black mustard (*Brassica nigra*). Coastal sage scrub (including disturbed forms) is considered a Tier II habitat by the City's Biology Guidelines

4.3.2 Coastal Sage Scrub (*Baccharis*-dominated)

Coastal sage scrub (*Baccharis*-dominated) is a native vegetation community that, according to Oberbauer et al. (2008), typically occurs in nutrient-poor soils and is composed primarily of broom baccharis (*Baccharis sarothroides*) or coyote bush (*Baccharis pilularis*). Other drought-deciduous species may also be sparsely intermixed—such as California sagebrush, California buckwheat, and saw toothed goldenbush (*Hazardia squarrosa*).

Coastal sage scrub (*Baccharis*-dominated) occupies a total of 1.79 acres within the project area. This community is found in patches along Chicarita Creek and a small area is mapped on the eastern edge of the project area and is associated with a larger area of coastal sage scrub located offsite. The City's Biology Guidelines (City of San Diego 2018a) do not distinguish between this variety and general coastal sage scrub, therefore it is considered a Tier II habitat.

4.3.3 Undifferentiated Open Woodland

According to Oberbauer et al. (2008), undifferentiated open woodland is characterized by a fairly open canopy including oak trees (*Quercus spp.*) and other plant species, where species composition is generally unknown but the structural characteristics of the vegetation is known.

Undifferentiated open woodland was mapped along a disturbed portion of Chicarita Creek and occupies 0.42 acres within the project area. The community contained coast live oaks, ornamental pines, California bay, eucalyptus trees and laurel sumac. The area could be a remnant of native habitat associated with Chicarita Creek and was therefore not

included in the developed land/disturbed category. Undifferentiated open woodland is not included in the City's Biology Guidelines. However, due to the presence of oak trees within this vegetation community, this area could be considered a Tier I habitat by the City's Biology Guidelines.

4.3.4 Urban/Developed Land and Disturbed Habitat

According to Oberbauer et al. (2008), urban/developed land represents areas that have been constructed upon or otherwise physically altered to an extent that native vegetation communities are not supported. This land cover type generally consists of semi-permanent structures, homes, parking lots, pavement or hardscape, and landscaped areas that require maintenance and irrigation (e.g., ornamental greenbelts). Typically, this land cover type is unvegetated or supports a variety of ornamental plants and landscaping. According to Oberbauer et al. (2008), disturbed land (disturbed habitat) refers to areas that are not developed yet lack vegetation, and generally are the result of severe or repeated mechanical perturbation.

Areas mapped as urban/developed land occupy 151.76 acres of the project area. Areas mapped as developed/disturbed habitat occupy a majority of the project area (92%), and consist of all graded and previously maintained areas of the golf course as well as ornamental plantings and landscaping associated with the golf course and adjacent housing. Since these two land covers overlap frequently throughout the project area, they were not mapped separately. Disturbed habitat (disturbed land) and development lands (ornamental plantings) are considered a Tier IV habitat per the City's Biology Guidelines (City of San Diego 2018a).

4.3.5 Eucalyptus Woodland

According to Oberbauer et al. (2008), eucalyptus woodland is a "naturalized" vegetation community that is fairly widespread in Southern California. It typically consists of monotypic stands of introduced Australian-introduced trees from the genus *Eucalyptus* that might consist of a variety of subspecies. The understory is either depauperate or absent due to high leaf litter, which restricts growth in understory as a result of high levels of allelochemicals. Although eucalyptus woodlands are of limited value to most native plants and animals, they frequently provide nesting and perching sites for several raptor species.

Areas mapped as eucalyptus woodland occupy 0.27 acres within the project area and are mapped in the western portion of the project area along Chicarita Creek. These stands of eucalyptus woodland were mapped because they are directly associated with Chicarita Creek. Eucalyptus trees also occur within the golf course but area mapped as developed/disturbed. Eucalyptus woodland is considered a Tier IV habitat per the City's Biology Guidelines (City of San Diego 2018a).

4.3.6 Coastal and Valley Freshwater Marsh

According to Oberbauer et al. (2008), coastal and Valley freshwater marsh is a wetland habitat type that develops where the water table is at or just above the ground surface, such as around the margins of lakes, ponds, slow-moving streams, ditches, and seepages. Due to being permanently flooded by fresh water, there is an accumulation of deep, peaty soils. It typically is dominated by species such as cattail (*Typha* spp.), sedge (*Carex* spp.), and bulrush (*Scirpus* sp.).

The areas mapped as coastal and valley freshwater marsh occupy 1.48 acres within the project area and are mapped along Chicarita Creek, and also in the east and southeast portions of the project area associated with unnamed stream channels. These areas are described in detail in the Aquatic Resource Delineation Report provided

in Appendix E of the Biological Technical Report (Dudek 2020). The City's Biology Guidelines (City of San Diego 2018a) do not distinguish between coastal and valley freshwater marsh and general freshwater marsh, therefore all marsh land is classified as a wetland habitat.

4.3.7 Disturbed Wetland

Disturbed wetlands are areas permanently or periodically inundated by water that have been substantially modified by human activity. Disturbed wetland (Palm-dominated) refers to a vegetation community that often consists of monotypic stands of palm species (*Arecaceae*) such as Washington fan palm (*Washingtonia robusta*) or canary date palm (*Phoenix canariensis*). Some other characteristic non-native species may also be sparsely intermixed including giant reed (*Arundo donax*), tamarisk (*Tamarix* spp.), pampas grass (*Cortaderia* spp.), and Bermuda grass (*Cynodon dactylon*).

The areas mapped as disturbed wetland occupy 0.09 acres within the project area and occur as a small pocket located on the eastern edge of the project area. This area is described in detail in the Aquatic Resource Delineation Report provided in Appendix E of the Biological Technical report. Per the City's Biology Guidelines (City of San Diego 2018a), disturbed wetland is classified as a wetland habitat.

4.3.8 Southern Willow Riparian Forest

Southern willow riparian forest is a vegetation community dominated by broad-leafed willow trees, often tall, with a closed or nearly closed canopy, which may have an understory of shrubby willows (Oberbauer et al. 2008). Dominant species are often arroyo willow (*Salix lasiolepis*) and Gooding's willow (*Salix gooddingii*). Other species besides willows that might also found in southern willow riparian forest communities include Douglas' sagewort (*Artemisia douglasiana*), mulefat (*Baccharis salicifolia*), manroot (*Marah macrocarpus*), California sycamore, Fremont cottonwood, black cottonwood (*Populus trichocarpa*), and narrowleaf willow (*Salix exigua*), (Oberbauer et al. 2008).

The area mapped as southern willow riparian forest occupies 2.24 acres within the project area and occurs primarily along Chicarita Creek, but also occurs along a small developing channel, and in isolated patches at holes 12 and 13. Within the project area, this vegetation community is dominated by arroyo willow and is mapped as southern arroyo willow riparian forest. This area is described in detail in the Aquatic Resource Delineation Report is provided in Appendix E of the Biological Technical Report. The City's Biology Guidelines (City of San Diego 2018a) do not distinguish between southern willow riparian forest and general riparian forest, therefore all forest land is classified as a wetland habitat.

4.3.9 Southern Coast Live Oak Riparian Forest

Southern coast live oak riparian forest is characterized as locally dense evergreen sclerophyllous riparian woodland dominated by coast live oak (*Quercus agrifolia*). This community is typically richer in herbaceous plants and poorer in shrubs than other riparian communities. Some other characteristic species that may occur include Douglas' sagewort, toyon (*Heteromeles arbutifolia*), manroot, and poison oak (*Toxicodendron diversilobum*), (Oberbauer et al. 2008).

The area mapped as southern coast live oak riparian forest occupies 0.08 acres within the project area and occurs in only one small area along the stretch of Chicarita Creek in the western section of the project area. This area is described in detail in the Aquatic Resource Delineation Report provided in Appendix E of the Biological Technical Report. The City's Biology Guidelines (City of San Diego 2018a) do not distinguish southern coast live oak riparian forest and general riparian forest, therefore all forest land is classified as a wetland habitat.

4.3.10 Southern Cottonwood-Willow Riparian Forest

Southern cottonwood-willow riparian forest is characterized as an open, broad-leafed, winter-deciduous riparian forest dominated by Fremont's cottonwood (*Populus fremontii*), and several tree willows. The understory is usually shrubby willows (Oberbauer et al. 2008). Other species that might also found in southern cottonwood-willow riparian forest communities include Douglas' sagewort, mulefat, manroot, California sycamore (*Platanus racemosa*), Gooding's willow, and arroyo willow (Oberbauer et al. 2008).

The area mapped as southern cottonwood-willow riparian forest occupies 1.38 acres within the project area and occurs in two areas, one associated with Chicarita Creek and the other associated with the unnamed channel along the eastern boundary of the project area. These areas are described in detail in the Aquatic Resource Delineation Report provided in Appendix E of the Biological Technical Report. The City's Biology Guidelines (City of San Diego 2018a) do not distinguish between southern cottonwood-willow riparian forest and general riparian forest, therefore all forest land is classified as a wetland habitat.

4.3.11 Southern Sycamore-Alder Riparian Woodland

Southern sycamore-alder riparian woodland is described by Oberbauer et al. (2008) as a tall, open, broad-leafed, winter-deciduous streamside woodland dominated by well-spaced western sycamore and often also white alder (*Alnus rhombifolia*). Seldom forming closed canopy forests, these stands may appear as trees scattered in a shrubby thicket of sclerophyllous and deciduous species and are subject to seasonally high-intensity flooding. Characteristic species of this habitat type include California mugwort, coast live oak, California blackberry (*Rubus ursinus*), California laurel (*Umbellularia californica*), and stinging nettle (*Urtica dioica*).

The area mapped as southern sycamore-alder riparian woodland occupies 0.16 acres within the project area and occurs within the eastern portion of the project area. This area consists primarily of western sycamore, is not associated with hydrologic indicators, and appears to have been planted as ornamental plantings in association with the golf course. The intent of the City's Biology Guidelines (City of San Diego 2018a) is not to regulate artificially created wetlands in historically non-wetland areas. Therefore, since the area mapped as sycamore-alder riparian woodland has not been delineated as a wetland by USACE or CDFW and was artificially created, it would not be considered a City wetland.

4.3.12 Southern Willow Scrub (including disturbed variety)

According to Oberbauer et al. (2008), southern willow scrub has been described as a dense, broad-leafed, winter-deciduous riparian thicket dominated by several species of willow (*Salix spp.*), with scattered emergent Fremont cottonwood and western sycamore. Most stands are too dense to allow much understory development. This habitat is considered seral due to repeated disturbance/flooding and is therefore unable to develop into the taller southern cottonwood willow riparian forest.

The areas mapped as southern willow scrub, including disturbed southern willow scrub, occupy 0.19 acres within the project area and occur in the southern portion and in one small drainage in the central portion of the project area. These areas are described in detail in the Aquatic Resource Delineation Report provided in Appendix E of the Biological Technical Report. The City's Biology Guidelines (City of San Diego 2018a) do not distinguish between this variety and general riparian scrub, therefore all riparian scrub is classified as a wetland habitat.

4.3.13 Unvegetated Channel

According to Oberbauer et al. (2008), unvegetated channel (or stream channel) refers to ephemeral and intermittent stream channels that are barren or sparsely vegetated, and thus do not fit into other wetland habitat categories. The lack of vegetation may be due to the scouring effects of floods, or man-caused vegetation removal for flood control, access, or other purposes.

The area mapped as unvegetated channel occupies 0.36 acres within the project area and includes one channel in the northwestern section of the project area; it is a part of Chicarita Creek, which occurs within the golf course. According to the City's Biology Guidelines (City of San Diego 2018a), since this channel appears to have been disturbed by golf course development and is likely lacking wetland dependent vegetation due to these activities, the channel would be considered a City wetland.

Each vegetation community corresponds to a designated fuel model (pre-determined vegetation type, densities, and structural characteristics) for fire behavior modeling purposes. Dudek has classified each of the cover types that will remain off-site and/or adjacent to the building footprints into fuel models, as discussed further below. Site-adjacent vegetation is important relative to wildfire as some vegetation, such as brush and grassland habitats are highly flammable while other vegetation, such as wetland communities or forest understory, are less flammable due to their higher plant moisture content, compact structure, and available shading from overstory tree canopies. The off-site, adjacent areas that will not be converted will represent the fire threat and were modeled (see section 5.7: Fire Behavior Modeling) to aid fire protection planning for this site.

4.4 Climate

North San Diego and the project area are influenced by the Pacific Ocean and are frequently under the influence of a seasonal, migratory subtropical high-pressure cell known as the "Pacific High." Wet winters and dry summers, with mild seasonal changes, characterize the Southern California climate. This climate pattern is occasionally interrupted by extreme periods of hot weather, winter storms, or dry, easterly Santa Ana winds. The average high temperature for the San Diego area is approximately 73°F, with average highs in the summer and early fall months (July–October) reaching 79°F. The average precipitation for the area is approximately 10 inches per year, with the majority of rainfall concentrated in the months of December (2.2 inches), January (1.7 inches), February (1.8 inches), and March (1.0 inches), while smaller amounts of rain are experienced during the other months of the year.

The prevailing wind pattern is from the west (on-shore), but the presence of the Pacific Ocean causes a diurnal wind pattern known as the land/sea breeze system. During the day, winds are from the west–southwest (sea) and at night winds are from the northeast (land), averaging 3 miles per hour (mph). During the summer season, the diurnal winds may average slightly higher (approximately 18 mph) than the winds during the winter season due to greater pressure gradient forces. Surface winds can also be influenced locally by topography and slope variations. The highest wind velocities are associated with downslope, canyon, and Santa Ana winds.

Typically, the highest fire danger is produced by the high-pressure systems that occur in the Great Basin which result in the Santa Ana winds of Southern California. Sustained wind speeds recorded during recent major fires in San Diego County exceeded 30 mph and may exceed 50 mph during extreme conditions. The Santa Ana wind conditions are a reversal of the prevailing southwesterly winds that usually occur on a region wide basis during late summer and early fall. Santa Ana winds are warm winds that flow from the higher desert elevations in the north through the mountain passes and canyons. As they converge through the canyons, their velocities increase.

Consequently, peak velocities are highest at the mouths of canyons and dissipate as they spread across valley floors or mesas. Santa Ana winds generally coincide with the regional drought period and the period of highest fire danger. The Carmel Mountain Ranch Project site is affected by Santa Ana winds. Winds funneled through mountains and onto the flat mesas dissipate and produce lower average wind conditions. The wind information used for fire behavior modeling for this site includes actual data from a Remote Automated Weather Station (RAWS) located in a similar inland location (latitude: 32.85917, longitude: -117.10556, elevation: 539 ft.) in San Diego County (Camp Elliott RAWS).

4.5 Topography

Topography within the Carmel Mountain Ranch Project site consists of a relatively flat areas, with elevations within the project area ranging from approximately 532 feet above mean sea level (AMSL) in the southwest portion of the project area near I-15 Freeway to approximately 810 feet AMSL near the estate clubhouse near the center of the project area.

Topography affects wildfire movement and spread. Steep terrain typically results in faster fire spread due to pre-heating (and drying) of uphill vegetation. Flat areas typically result in slower fire spread, absent of windy conditions. Topography may form unique conditions which result in concentrated winds or localized fire funneling, such as saddles, canyons, and chimneys (land formations that collect and funnel heated air upward along a slope). Similarly, terrain may slow the spread of fire. For example, fire generally moves slower downslope than upslope. Terrain may buffer or redirect winds away from some areas based on canyons or formations on the landscape. The occurrences of terrain features that may affect fire behavior on the Carmel Mountain Ranch Project site were analyzed and incorporated into the risk assessment and in development of fire protection features.

4.6 Fire History

Fire history data provides valuable information regarding fire spread, fire frequency, ignition sources, and vegetation/fuel mosaics across a given landscape. Fire frequency, behavior, and ignition sources are important for fire response and planning purposes. One important use for this information is as a tool for pre-planning. It is advantageous to know which areas may have burned recently and, therefore, may provide a tactical defense position, or, what type of fire burned on the site, and how a fire may spread. According to available data from the California Department of Forestry and Fire Protection's (CAL FIRE) Fire and Resource Assessment Program (FRAP 2018), approximately 55 fires have burned within 5 miles of the project area since the beginning of the historical fire data record (Attachment C). These fires occurred between in 1910 and 2014 with some years including more than one fire. Three of the fires in the historical record burned onto the Trails at Carmel Mountain Ranch project site. These three fires that burned through the project site include the 1943 unnamed fire that burned roughly 40,000 total acres, the 1967 unnamed fire that burned roughly 29,000 total acres, and the 1980 Assist #138 Fire that burned roughly 1,200 total acres. These fires precede development of the site. The San Diego Fire and Rescue Department (SDFRD) may have data regarding smaller fires (less than 10 acres) that have occurred near the site that are not included in CAL FIRE's dataset.

Based on an analysis of this fire history data set, specifically the years in which the fires burned, the average interval between wildfires burning within a 5-mile radius of the project site was calculated to be approximately 2 years with intervals ranging between 0 (multiple fires in the same year) and 19 years. Based on this analysis, along with changes in the watershed over the last few decades that resulted in conversion of fuels to lower flammability urbanization, the project area is expected to be subject to wildfire that may include smaller fires during typical weather conditions and has the potential for larger wildfires during extreme weather conditions, but lacks consistent fuel beds to result in a large flaming front on the Project site.

4.7 Fire Behavior Modeling

4.7.1 Fire Behavior Modeling Background

Fire behavior modeling has been used by researchers for approximately 50+ years to predict how a fire will move through a given landscape given specified fuels, terrain, and weather (Linn 2003). The models have had varied complexities and applications throughout the years. One model has become the most widely used for predicting fire behavior on a given landscape. That model, known as "Behave," was developed by the U.S. Government (USDA Forest Service, Rocky Mountain Research Station) and has been in use since 1984. Since that time, it has undergone continued research, improvements, and refinement. The current version, BehavePlus 6.0, includes the latest updates incorporating years of research and testing. Numerous studies have been completed testing the validity of the fire behavior models' ability to predict fire behavior given site-specific inputs. One of the most successful ways the model has been improved has been through post-wildfire modeling (Brown 1972; Lawson 1972; Sneeuwjagt and Frandsen 1977; Andrews 2005; Brown 1982; Rothermel and Rinehart 1983; Bushey 1985; McAlpine and Xanthopoulos 1989; Grabner et al. 1994; Marsden-Smedley and Catchpole 1995; Grabner 1996; Alexander 1998; Granber et al. 2001; Arca et al. 2005). In this type of study, Behave is used to model fire behavior based on pre-fire conditions in an area that has recently burned. Real-world fire behavior, documented during the wildfire, can then be compared to the prediction results of Behave and refinements to the fuel models incorporated, retested, and so on.

Fire behavior modeling conducted on this site includes a relatively high-level of detail and analysis which results in reasonably accurate representations of how wildfire may move through available fuels on and adjacent the property. Fire behavior calculations are based on site-specific fuel characteristics supported by fire science research that analyzes heat transfer related to specific fire behavior. To objectively predict flame lengths, spread rates, and fireline intensities, this analysis incorporated predominant fuel characteristics, slope percentages, and representative fuel models observed on site. The BehavePlus fire behavior fuel modeling system was used to analyze anticipated fire behavior within and adjacent to key areas just outside of the proposed BMZs.

As Rothermel summarized, predicting wildland fire behavior is not an exact science. As such, the movement of a fire will likely never be fully predictable, especially considering the variations in weather and the limits of weather forecasting. Nevertheless, practiced and experienced judgment, coupled with a validated fire behavior modeling system, results in useful fire prevention and protection planning information. To be used effectively, the basic assumptions and limitations of BehavePlus must be understood.

- First, it must be realized that the fire model describes fire behavior only in the flaming front. The primary driving force in the predictive calculations is dead fuels less than one-quarter inch in diameter. These are the fine fuels that carry fire. Fuels greater than one inch have little effect while fuels greater than three inches have no effect on fire behavior.
- Second, the model bases calculations and descriptions on a wildfire spreading through surface fuels that are within six feet of the ground and contiguous to the ground. Surface fuels are often classified as grass, brush, litter, or slash.

- Third, the software assumes that weather and topography are uniform. However, because wildfires almost always burn under non-uniform conditions, length of projection period and choice of fuel model must be carefully considered to obtain useful predictions.
- Fourth, the BehavePlus fire behavior computer modeling system was not intended for determining sufficient fuel modification zone/defensible space widths. However, it does provide the average length of the flames, which is a key element for determining "defensible space" distances for minimizing structure ignition.

Although BehavePlus has some limitations, it can still provide valuable fire behavior predictions which can be used as a tool in the decision-making process. In order to make reliable estimates of fire behavior, one must understand the relationship of fuels to the fire environment and be able to recognize the variations in these fuels. Natural fuels are made up of the various components of vegetation, both live and dead, that occur on a site. The type and quantity will depend upon the soil, climate, geographic features, and the fire history of the site. The major fuel groups of grass, shrub, trees, and slash are defined by their constituent types and quantities of litter and duff layers, dead woody material, grasses and forbs, shrubs, regeneration, and trees. Fire behavior can be predicted largely by analyzing the characteristics of these fuels. Fire behavior is affected by seven principal fuel characteristics: fuel loading, size and shape, compactness, horizontal continuity, vertical arrangement, moisture content, and chemical properties.

The seven fuel characteristics help define the 13 standard fire behavior fuel models[1] and the five more recent custom fuel models developed for Southern California[2]. According to the model classifications, fuel models used in BehavePlus have been classified into four groups, based upon fuel loading (tons/acre), fuel height, and surface to volume ratio. Observation of the fuels in the field (on site) determines which fuel models should be applied in modeling efforts. The following describes the distribution of fuel models among general vegetation types for the standard 13 fuel models and the custom Southern California fuel models (SCAL):

- Grasses — Fuel Models 1 through 3
- Brush — Fuel Models 4 through 7, SCAL 14 through 18
- Timber — Fuel Models 8 through 10
- Logging Slash — Fuel Models 11 through 13

In addition, the aforementioned fuel characteristics were utilized in the development of 40 new fire behavior fuel models[3] developed for use in BehavePlus modeling efforts. These new models attempt to improve the accuracy of the standard 13 fuel models outside of severe fire season conditions, and to allow for the simulation of fuel treatment prescriptions. The following describes the distribution of fuel models among general vegetation types for the new 40 fuel models:

1 Anderson, Hal E. 1982. Aids to Determining Fuel Models for Estimating Fire Behavior. USDA Forest Service Gen. Tech. Report INT-122. Intermountain Forest and Range Experiment Station, Ogden, UT.

2 Weise, D.R. and J. Regelbrugge. 1997. Recent chaparral fuel modeling efforts. Prescribed Fire and Effects Research Unit, Riverside Fire Laboratory, Pacific Southwest Research Station. 5p.

3 Scott, Joe H. and Robert E. Burgan. 2005. Standard fire behavior fuel models: a comprehensive set for use with Rothermel's surface fire spread model. Gen. Tech. Rep. RMRS-GTR-153. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 72 p.

- Grass Models GR1 through GR9
- Grass Shrub Models GS1 through GS4
- Shrub Models SH1 through SH9
- Timber Understory Models TU1 through TU5
- Timber Litter Models TL1 through TL9
- Slash Blowdown Models SB1 through SB4

BehavePlus software was used in the development of this Carmel Mountain Ranch Fire Fuel Load Modeling Report in order to evaluate potential fire behavior for the Project site. Existing site conditions were evaluated, and local weather data was incorporated into the BehavePlus modeling runs.

4.7.2 Fire Behavior Modeling Approach

Dudek utilized the BehavePlus software package to analyze fire behavior potential for the Trails at Carmel Mountain Ranch Project site (refer to Figure 3, *Fire Behavior Modeling Map)* for fire modeling scenario locations and Appendices D and E for pre and post BMZ modeling results). As is customary for this type of analysis, six fire scenarios were evaluated, including one summer, onshore weather condition (west from former Golf Holes 4 and 5) and five extreme fall, offshore weather condition (north, south, northeast, and east of the Project Site).Fuels and terrain beyond that distance can produce flying embers that may affect the project, but defenses will be built into the Project's structures to prevent ember penetration and to extinguish fires that may result from ember penetration. It is the fuels next to the BMZs and within the BMZs that would have the potential to affect the project's and existing structures from a radiant and convective heat perspective as well as from direct flame impingement. BehavePlus software requires site-specific variables for surface fire spread analysis, including fuel type, fuel moisture, wind speed, and slope data. The output variables used in this analysis include flame length (feet), rate of spread (feet/minute), fireline intensity (BTU/feet/second), and spotting distance (miles). The following provides a description of the input variables used in processing the BehavePlus models for the Proposed Project site. In addition, data sources are cited and any assumptions made during the modeling process are described.

To support the fire behavior modeling efforts conducted for this FPP, the different vegetation types observed adjacent to the site were classified into the aforementioned numeric fuel models. As is customary for this type of analysis, the terrain and fuels directly adjacent to the property are used for determining flame lengths and fire spread. It is these fuels that would have the potential to affect the project's and existing structures from a radiant and convective heat perspective as well as from direct flame impingement.

4.7.2.1 Vegetation (Fuels)

Vegetation types were derived from The Biological Technical Report (Dudek, 2020) and a site visit that was conducted on April 1, 2020 by a Dudek Fire Protection Planner. Based on the site visit, three different fuel models were used in the fire behavior modeling effort presented herein. Fuel model attributes are summarized in Table 2. Modeled areas include Coast live oak, Southern Willow Scrub, and western sycamore Riparian with non-native chaparral and shrub understory (Fuel Model SH4 = Riparian Habitat (Timber-Shrub)) occur in a riparian drainage that runs along Former Golf Holes 3, 4, 5, 12, 13, and 15 of the old Carmel Mountain Ranch Golf Course). Mature tree canopies for coast live oak trees (*Quercus agrifolia)* and western sycamore trees (*Platanus racemosa*) are assumed

to have a canopy base height ranging from 20 to 30 feet off the ground. Canopy bulk density, the weight of canopy fuels per cubic foot of volume, is assumed to be the maximum allowable value in BehavePlus to represent broadleaf trees which, given canopy density and leaf size, have more weight per area than conifer trees (the standard for this value input in BehavePlus (Heinsch and Andrews 2010)). Foliar moisture, the moisture content of canopy foliage, is assumed to be 100%, a reasonable estimate in lieu of site-specific data (Scott and Reinhardt 2001).

Table 2. Existing Fuel Model Characteristics

Fuel Model Assignment	Vegetation Description	Location	Fuel Bed Depth (Feet)
GR1	Short, Sparse, Dry Climate Grass	BMZ fuel type will occur post development within thinning zone	1.0 ft.
GR2	Low Load, Dry Climate Grass	Located throughout each of the old Carmel Mountain Ranch Golf Course fairways	<2.0 ft.
GR4	Moderate Load, Dry Climate Grass	Located throughout each of the old Carmel Mountain Ranch Golf Course fairways	>3.0 ft.
SH4	Riparian Habitat (Timber Shrub)	Riverbed that runs along Holes 3, 4, 5, 12, 13, and 15 of the old Carmel Mountain Ranch Golf Course.	>8.0 ft.
SH5	High Load Dry Climate Shrub	The majority of this fuel type is concentrated on the western side of the project area (Holes 4 and 5)	>4.0 ft.
9	Southern Willow Scrub	Riverbed that runs along Holes 3, 4, 5, 12, 13, and 15 of the old Carmel Mountain Ranch Golf Course.	<2.0 ft.(duff layer)

The results of this analysis were utilized in generating the Brush Management Zone map presented in Figure 3. This analysis models fire behavior outside of proposed BMZs (off-site) as these areas would be the influencing wildfire areas post-development of the site. The following section presents the fire weather and fuel moisture inputs utilized for the fire behavior modeling conducted for this project.

4.7.2.2 Topography

Slope is a measure of angle in degrees from horizontal and can be presented in units of degrees or percent. Slope is important in fire behavior analysis as it affects the exposure of fuel beds. Additionally, fire burning uphill spreads faster than those burning on flat terrain or downhill as uphill vegetation is pre-heated and dried in advance of the flaming front, resulting in faster ignition rates. Slope values ranging from 3 to 5% were measured around the perimeter of the proposed project area from U.S. Geological Survey (USGS) topographic maps. These relatively low slope values result in a low influence on fire behavior leaving fuel and weather to have the biggest impact on fire spread.

4.7.2.3 Weather Analysis

Historical weather data for the Poway area was utilized in determining appropriate fire behavior modeling inputs for the Proposed Project area fire behavior evaluations. To evaluate different scenarios, data from both the 50th and 97th percentile moisture values were derived from Remote Automated Weather Station (RAWS) and utilized in the

fire behavior modeling efforts conducted in support of this report. Weather data sets from the Camp Elliott RAWS[4] Station were utilized in the fire modeling runs.

RAWS fuel moisture and wind speed data were processed utilizing the Fire Family Plus software package to determine atypical (97th percentile) and typical (50th percentile) weather conditions. Data from the RAWS was evaluated from August 1 through November 30 for each year between 1994 and 2018 (extent of available data record) for 97th percentile weather conditions and from June 1 through September 30 for each year between 1994 and 2018 for 50th percentile weather conditions.

Following analysis in Fire Family Plus, fuel moisture information was incorporated into the Initial Fuel Moisture file used as an input in BehavePlus. Wind speed data resulting from the Fire Family Plus analysis was also determined. Initial wind direction and wind speed values for the two BehavePlus runs were manually entered during the data input phase. The input wind speed and direction is roughly an average surface wind at 20 feet above the vegetation over the analysis area. Table 3 summarizes the wind and weather input variables used in the Fire BehavePlus modeling efforts.

Table 3. BehavePlus Fire Behavior Inputs

Input Name	50th Percentile	97th Percentile
1 h fuel moisture	8%	2%
10 h fuel moisture	9%	3%
100 h fuel moisture	15%	7%
Live herbaceous moisture	55%	30%
Live woody moisture	110%	60%
20 ft. wind speed (mph)	18 mph	19 mph sustained wind speed; 50 mph (expected gust speed)
Wind adjustment factor	0.4	0.4
Slope steepness	3%	3 to 5%

4.7.2.4 BehavePlus Fire Behavior Modeling Effort

As mentioned, the BehavePlus fire behavior modeling software package was utilized in evaluating anticipated fire behavior adjacent to the Proposed Project site. Four focused analyses were completed, each assuming worst-case fire weather conditions for a fire approaching the project site from the north, east, west, and south/southwest. The results of the modeling effort included anticipated values for surface fires (flame length (feet), rate of spread (mph), and fireline intensity (Btu/ft/s)) and crown fires (critical surface intensity (Btu/ft/s), critical surface flame length (feet), transition ratio (ratio: surface fireline intensity divided by critical surface intensity), transition to crown fire (yes or no), crown fire rate of spread (mph), critical crown rate of spread (mph), active ratio (ratio: crown fire rate of spread divided by critical crown fire rate of spread), active crown fire (yes or no), and fire type (surface, torching, conditional crown, or crowning)). The aforementioned fire behavior variables are an important component in understanding fire risk and fire agency response capabilities. Flame length, the length of the flame of a spreading surface fire within the flaming front, is measured from midway in the active flaming combustion zone to the average tip of the flames (Andrews, Bevins, and Seli 2008). Fireline intensity is a measure of heat output from the flaming

[4] https://raws.dri.edu/cgi-bin/rawMAIN.pl?caCCAE

front, and also affects the potential for a surface fire to transition to a crown fire. Fire spread rate represents the speed at which the fire progresses through surface fuels and is another important variable in initial attack and fire suppression efforts (Rothermel and Rinehart 1983). Spotting distance is the distance a firebrand or ember can travel down wind and ignite receptive fuel beds.

4.7.2.5 BehavePlus Fire Behavior Modeling Results

The results presented in Tables 4 and 5 depict values based on inputs to the BehavePlus software and are not intended to capture changing fire behavior as it moves across a landscape. Changes in slope, weather, or pockets of different fuel types are not accounted for in this analysis. For planning purposes, the averaged worst-case fire behavior is the most useful information for conservative fuel modification design. Model results should be used as a basis for planning only, as actual fire behavior for a given location will be affected by many factors, including unique weather patterns, small-scale topographic variations, or changing vegetation patterns.

Based on the BehavePlus analysis, worst-case fire behavior is expected in untreated, non-native grasses and surface shrub and chaparral fuels north and east of the proposed Project area under Peak weather conditions (represented by Fall Weather, Scenario 5). The fire is anticipated to be a wind-driven fire from the north/northeast during the fall. Under such conditions, expected surface flame lengths reach 41 feet with wind speeds of 50+ mph. Under this scenario, fireline intensities reach 18,349 BTU/feet/second with fast spread rates of 6.2 mph and could have a spotting distance up to 2.3 miles away.

Based on the BehavePlus analysis, post development fire behavior expected in the BMZs adjacent to the Project with 50% thinning of the existing grasses and shrubs outside of the Riparian area (BMZ Zone 2 - Gr2) under peak weather conditions (represented by Fall Weather, Scenario 2) is presented in Table 5. Under such conditions, expected surface flame length is expected to be significantly lower, with flames lengths reaching approximately 14 feet with wind speeds of 50+ mph. Under this scenario, fireline intensities reach 1,791 BTU/feet/second with relatively slow spread rates of 1.7 mph and could have a spotting distance up to 1.1 miles away. Therefore, the extended protective brush thinning zone proposed for the Trails at Carmel Mountain Ranch Project is approximately 5-times the flame length of the worst-case fire scenario under peak weather conditions and would provide adequate defensible space to augment a wildfire approaching the Riparian area before getting to the existing perimeter single-family residences adjacent to the proposed Project area.

Table 4: RAWS BehavePlus Fire Behavior Model Results – Existing Conditions

Fire Scenario	Flame Length[1] (feet)	Spread Rate[1] (mph[5])	Fireline Intensity[1] (Btu/ft/s)	Spot Fire[1] (miles)	Surface Fire to Tree Crown Fire	Tree Crown Fire Rate of Spread (mph)	Crown Fire Flame Length (feet)
Scenario 1: 3% slope; Summer Onshore Wind (50th percentile) – Pre-BMZ (Holes 4 and 5)							
Long Needle, Hardwood Litter [2,3] (FM9)	3.5	0.2	85	0.2	Crowning [4]	0.5	78.9
Moderate Load, Dry Climate Grass (Gr4)	10.8	1.5	1,010	0.5	Crowning [4]	0.5	79.5
Moderate Load, Dry Climate Grass-Shrub (Gs2)	5.2	0.4	206	0.3	Crowning [4]	0.5	79.1

Table 4: RAWS BehavePlus Fire Behavior Model Results – Existing Conditions

Fire Scenario	Flame Length[1] (feet)	Spread Rate[1] (mph[5])	Fireline Intensity[1] (Btu/ft/s)	Spot Fire[1] (miles)	Surface Fire to Tree Crown Fire	Tree Crown Fire Rate of Spread (mph)	Crown Fire Flame Length (feet)
Riparian Habitat - Timber Shrub[2,3] (Sh4)	2.7	0.2	50	0.2	Crowning [4]	0.5	78.3
Sagebrush scrub (Sh5)	14.7	0.9	1,967	0.6	Crowning [4]	0.5	84.5
Scenario 2: 3% slope; Fall Offshore, Extreme Winds (97th percentile) – Pre-BMZ (Holes 3 and 4)							
Low Load, Dry Climate Grass (Gr2)	9.4 (14.1')[6]	1.7 (4.2)	736 (1,791)	0.4 (1.1)	Crowning [4]	1.1 (4.1)	134.9
Moderate Load, Dry Climate Grass (Gr4)	17.5 (33.3)	3.5 (13.9)	2,868 (11,561)	0.7 (2.0)	Crowning [4]	1.1 (4.1)	137.0
Low Load, Dry Climate Grass-Shrub (Gs1)	6.9 (12.1)	0.7 (2.4)	362 (1,283)	0.3 (1.0)	Crowning [4]	1.1 (4.1)	135.5
Riparian Habitat - Timber Shrub (Sh4)	12.6 (23.2)[6]	1.1 (4.1)	1,390 (5,260)	0.5 (1.5)	Crowning [4]	1.1 (4.1)	139.5
Scenario 3: 2% slope; Fall, Offshore, Extreme Winds (97th percentile) – Pre-BMZ (Hole 12)							
Low Load, Dry Climate Grass (Gr2)	9.4 (14.1')[6]	1.7 (4.2)	737 (1,791)	0.4 (1.1)	Crowning [4]	1.1 (4.1)	114.1
Moderate Load, Dry Climate Grass (Gr4)	17.5 (33.3)	3.5 (13.9)	2,872 (11,564)	0.7 (2.0)	Crowning [4]	1.1 (4.1)	116.5
Low Load, Dry Climate Grass-Shrub (Gs1)	6.9 (12.1)	0.7 (2.4)	373 (1,283)	0.3 (1.0)	Crowning [4]	1.1 (4.1)	114.8
Riparian Habitat - Timber Shrub (Sh4)	12.6 (23.2)[6]	1.1 (4.1)	1,392 (5,262)	0.5 (1.5)	Crowning [4]	1.1 (4.1)	119.2
Scenario 4: 4% slope; Fall, Offshore, Extreme Winds (97th percentile) – Pre-BMZ (Hole 13)							
Low Load, Dry Climate Grass (Gr2)	9.4 (14.1')[6]	1.7 (4.2)	736 (1,791)	0.4 (1.1)	Crowning [4]	1.1 (4.1)	114.1
Moderate Load, Dry Climate Grass (Gr4)	17.5 (33.3)	3.5 (13.9)	2,867 (11,559)	0.7 (2.0)	Crowning [4]	1.1 (4.1)	116.5
Low Load, Dry Climate Grass-Shrub (Gs1)	6.8 (12.1)	0.7 (2.4)	372 (1,283)	0.3 (1.0)	Crowning [4]	1.1 (4.1)	114.8
Riparian Habitat - Timber Shrub (Sh4)	12.6 (23.2)[6]	1.1 (4.1)	1,390 (5,260)	0.5 (1.5)	Crowning [4]	1.1 (4.1)	119.2

Table 4: RAWS BehavePlus Fire Behavior Model Results – Existing Conditions

Fire Scenario	Flame Length[1] (feet)	Spread Rate[1] (mph[5])	Fireline Intensity[1] (Btu/ft/s)	Spot Fire[1] (miles)	Surface Fire to Tree Crown Fire	Tree Crown Fire Rate of Spread (mph)	Crown Fire Flame Length (feet)
Scenario 5: 3% slope; Fall, Offshore, Extreme Winds (97th percentile) – Pre-BMZ (Hole 13)							
Low Load, Dry Climate Grass (Gr2)	9.4 (14.1')[6]	1.7 (4.2)	737 (1,791)	0.4 (1.1)	Crowning [4]	1.1 (4.1)	114.1
Moderate Load, Dry Climate Grass (Gr4)	17.5 (33.3)	3.5 (13.9)	2,872 (11,564)	0.7 (2.0)	Crowning [4]	1.1 (4.1)	116.5
Low Load, Dry Climate Grass-Shrub (Gs1)	6.9 (12.1)	0.7 (2.4)	373 (1,283)	0.3 (1.0)	Crowning [4]	1.1 (4.1)	114.8
Riparian Habitat - Timber Shrub (Sh4)	12.6 (23.2)[6]	1.1 (4.1)	1,392 (5,262)	0.5 (1.5)	Crowning [4]	1.1 (4.1)	119.2
Sagebrush scrub (Sh5)	24.4 (41.2)	2.0 (6.2)	5,905 (18,349)	0.8 (2.3)	Crowning [4]	1.1 (4.1)	128.8
Scenario 6: 3% slope; Fall, Offshore, Extreme Winds (97th percentile) – Pre-BMZ (Hole 15)							
Low Load, Dry Climate Grass (Gr2)	9.4 (14.1')[6]	1.7 (4.2)	736 (1,791)	0.4 (1.1)	Crowning [4]	1.1 (4.1)	114.1
Moderate Load, Dry Climate Grass (Gr4)	17.5 (33.3)	3.5 (13.9)	2,869 (11,561)	0.7 (2.0)	Crowning [4]	1.1 (4.1)	116.5
Low Load, Dry Climate Grass-Shrub (Gs1)	6.9 (12.1)	0.7 (2.4)	372 (1,283)	0.3 (1.0)	Crowning [4]	1.1 (4.1)	114.8
Riparian Habitat - Timber Shrub (Sh4)	12.6 (23.2)[6]	1.1 (4.1)	1,390 (5,260)	0.5 (1.5)	Crowning [4]	1.1 (4.1)	119.2

Notes:

1 Wind-driven surface fire.

2 Riparian overstory torching increases fire intensity. Modeling included canopy fuel over Sh4, which represents surface fuels beneath the tree canopies.

3 A surface fire in the mixed sycamore riparian forest would transition into the tree canopies generating flame lengths higher than the average tree height (25 feet). Viable airborne embers could be carried downwind for approximately 1.0 mile and ignite receptive fuels.

4 Crowning= fire is spreading through the overstory crowns.

5 MPH=miles per hour

6 Spotting distance from a wind driven surface fire; it should be noted that the wind mph in parenthesis represent peak gusts of 50 mph.

A crown fire with the modeled flame lengths listed in Table 5 would not be expected based on the BMZs being proposed, the ongoing maintenance of the BMZs, and the high moisture levels within the riparian zone areas. An active crown fire flame length modeled using the BehavePlus software is calculated from based on the active crown fire intensity, which assumes that the crown fire is fully active.

Table 5: RAWS BehavePlus Fire Behavior Model Results – Post BMZ Conditions

Fire Scenario	Flame Length (feet)	Spread Rate (mph)[5]	Fireline Intensity (Btu/ft./sec)	Spot Fire (Miles)[6]
Scenario 1: 3% slope; Summer Onshore Wind (50th percentile) – Pre-BMZ (Holes 4 and 5)				
BMZ Zone 1 (Gr1)	1.8	0.2	19	0.1
BMZ Zone 2 (Gr2)	5.8	0.7	257	0.3
Scenario 2: 3% slope; Fall Offshore, Extreme Winds (97th percentile) – Pre-BMZ (Holes 3 and 4)				
BMZ Zone 1 (Gr1)	3.1 (3.1)	0.5 (0.5)	67 (67)	0.2 (0.4)
BMZ Zone 2 (Gr2)	9.4 (14.1)	1.7 (4.2)	736 (1,791)	0.4 (1.1)
Scenario 3: 2% slope; Fall, Offshore, Extreme Winds (97th percentile) – Pre-BMZ (Hole 12)				
BMZ Zone 1 (Gr1)	3.1 (3.1)	0.5 (0.5)	67 (67)	0.2 (0.4)
BMZ Zone 2 (Gr2)	9.4 (14.1)	1.7 (4.2)	737 (1,791)	0.4 (1.1)
Scenario 4: 4% slope; Fall, Offshore, Extreme Winds (97th percentile) – Pre-BMZ (Hole 13)				
BMZ Zone 1 (Gr1)	3.1 (3.1)	0.5 (0.5)	67 (67)	0.2 (0.4)
BMZ Zone 2 (Gr2)	9.4 (14.1)	1.7 (4.2)	736 (1,791)	0.4 (1.1)
Scenario 5: 3% slope; Fall, Offshore, Extreme Winds (97th percentile) – Pre-BMZ (Hole 13)				
BMZ Zone 1 (Gr1)	3.1 (3.1)	0.5 (0.5)	67 (67)	0.2 (0.4)
BMZ Zone 2 (Gr2)	9.4 (14.1)	1.7 (4.2)	737 (1,791)	0.4 (1.1)
Scenario 6: 3% slope; Fall, Offshore, Extreme Winds (97th percentile) – Pre-BMZ (Hole 15)				
BMZ Zone 1 (Gr1)	3.1 (3.1)	0.5 (0.5)	67 (67)	0.2 (0.4)
BMZ Zone 2 (Gr2)	9.4 (14.1)	1.7 (4.2)	736 (1,791)	0.4 (1.1)

The following describes the fire behavior variables (Heisch and Andrews 2010) as presented in Tables 3 and 4:

Surface Fire:

- Flame Length (feet): The flame length of a spreading surface fire within the flaming front is measured from midway in the active flaming combustion zone to the average tip of the flames.
- Fireline Intensity (Btu/ft/s): Fireline intensity is the heat energy release per unit time from a one-foot wide section of the fuel bed extending from the front to the rear of the flaming zone. Fireline intensity is a function of rate of spread and heat per unit area and is directly related to flame length. Fireline intensity and the flame length are related to the heat felt by a person standing next to the flames.
- Surface Rate of Spread (mph): Surface rate of spread is the "speed" the fire travels through the surface fuels. Surface fuels include the litter, grass, brush and other dead and live vegetation within about 6 feet of the ground.

[5] mph = miles per hour
[6] Spotting distance from a wind driven surface fire; it should be noted that the wind mph in parenthesis represent peak gusts of 50 mph.

Crown Fire:

- Transition to Crown Fire: Indicates whether conditions for transition from surface to crown fire are likely. Calculation depends on the transition ratio. If the transition ratio is greater than or equal to 1, then transition to crown fire is Yes. If the transition ratio is less than 1, then transition to crown fire is No.
- Crown Fire Rate of Spread (mph): The forward spread rate of a crown fire. It is the overall spread for a sustained run over several hours. The spread rate includes the effects of spotting. It is calculated from 20-ft wind speed and surface fuel moisture values. It does not consider a description of the overstory.

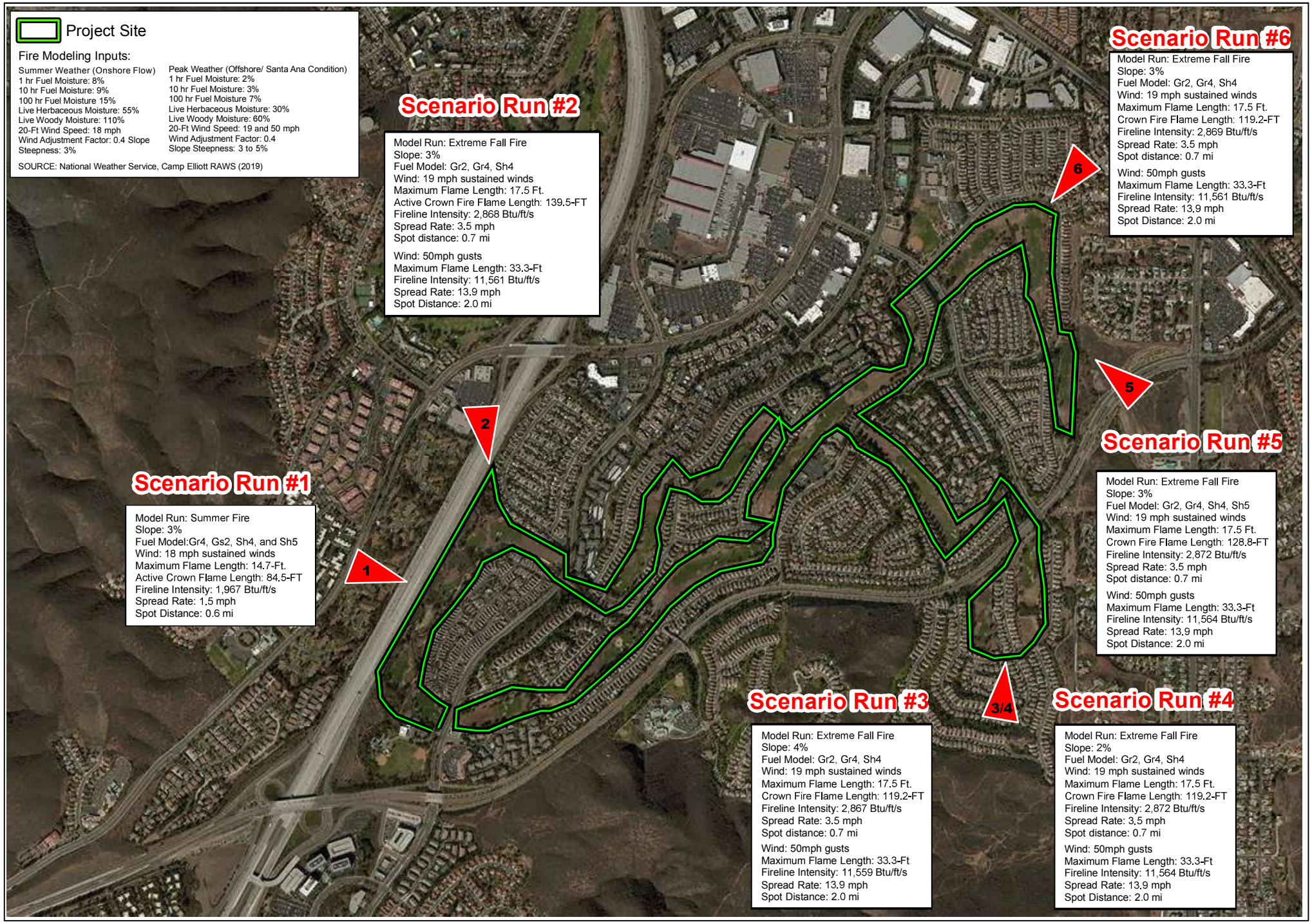
Fire Type:

Fire type is one of the following four types: surface (understory fire), torching (passive crown fire; surface fire with occasional torching trees), conditional crown (active crown fire possible if the fire transitions to the overstory), and crowning (active crown fire; fire spreading through the overstory crowns). Dependent on the variables: transition to crown fire and active crown fire.

The information in Table 6 presents an interpretation of the outputs for five fire behavior variables as related to fire suppression efforts. The results of fire behavior modeling efforts are presented in Tables 4 and 5. Identification of modeling run locations is presented graphically in Figure 3 of the Fire Fuel Load Modeling Report.

Table 6: Fire Suppression Interpretation

Flame Length (ft)	Fireline Intensity (Btu/ft/s)	Interpretations
Under 4 feet	Under 100 BTU/ft/s	Fires can generally be attacked at the head or flanks by persons using hand tools. Hand line should hold the fire.
4 to 8 feet	100-500 BTU/ft/s	Fires are too intense for direct attack on the head by persons using hand tools. Hand line cannot be relied on to hold the fire. Equipment such as dozers, pumpers, and retardant aircraft can be effective.
8 to 11 feet	500-1000 BTU/ft/s	Fires may present serious control problems -- torching out, crowning, and spotting. Control efforts at the fire head will probably be ineffective.
Over 11 feet	Over 1000 BTU/ft/s	Crowning, spotting, and major fire runs are probable. Control efforts at head of fire are ineffective.



AERIAL SOURCE: BING Maps, 2020

DUDEK

0 1,000 2,000 Feet

FIGURE 3

Fire Behavior Modeling Runs Map

The Trails at Carmel Mountain Ranch - Fire Fuel Load Modeling Report

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5 Brush Management Zones

As indicated in preceding sections of this report, an important component of a fire protection system is the Brush Management Zone (BMZ). BMZs are typically designed to gradually reduce fire intensity and flame lengths from advancing fire by strategically placing thinning zones and irrigated zones adjacent to each other on the perimeter of the WUI exposed structures. BMZs are arguably more important when situated adjacent to older structures that were built prior to the latest ignition resistant codes and interior sprinkler requirements.

Based on the modeled flame lengths for the Trails at Carmel Mountain Ranch Project, flame lengths under extreme fall weather conditions for sparse groupings of native shrubs on the eastern portion of the project area can reach approximately 41 feet or taller. However, many of the other fairways throughout the project area adjacent to Riparian fuels, include fuels of overgrown grasses and weed, as well as Southern willow scrub, Sycamore, and Coast Live Oak riparian pockets with exotic ornamentals, which lead to lower flame lengths, lower intensity fire with moderate spread rate. Note that these are not anticipated to be the average flame length across the project area, but could occur in some fuel pockets, with average flame lengths across the Riparian fuels of a lower value. As mentioned, the BMZs proposed for portions of this project are not standard SDFRD widths.

BMZs for the proposed project area include a standard BMZ for the proposed new structures and a modified irrigated existing Zone 1 condition, thinned Zone 2, and an extended protective brush thinning zone. The existing Zone 1 condition consists of a minimum 10-foot irrigated area within the rear yards of the existing single-family residential homes adjacent to the closed Carmel Mountain Ranch Country Club Golf Course, measured from the rear of the structure to the property line. The existing Zone 1 is not part of the Project and the Project would not have any responsibility to maintain it, maintenance is the responsibility of the existing single-family property owners. Zone 2 consists of a minimum 50-foot thinning zone, measured from the property line of the existing residences adjacent to the existing former fairways out as much as 90 feet into the project site. Portions of Zone 2 consist of existing undisturbed open space areas and City's required wetland buffers, that are to remain free of impacts. In order to mitigate for the inability to thin within the riparian wetland areas, an extended protective brush thinning zone is being recommended as additional brush management where Zone 2 does not extend beyond the riparian areas. The extended protective brush thinning zone consists of an additional minimum 20 feet and up to 50 feet of thinning around all sides of the riparian wetland area to create a buffer and reduce the potential of a ground fire transitioning into a crown fire. The extended protective brushing thinning zone around the riparian buffers are planned for areas on Unit 3 Lot 1, Unit 4 Lot 1, Unit 12 Lot 1, Unit 13 Lot 2, Unit 16 Lot 2, and Unit 16 Lot 5.

Table 7 summarizes the modified BMZ widths within the Trails at Carmel Mountain Ranch project area and Appendix E provides a graphic presentation of the BMZs. The adequacy of the provided BMZ widths is based on a variety of analysis criteria including predicted flame length, fire intensity (BTUs) and duration, site topography, extreme weather, position of roadways, adjacent fuels, and position of existing residential structures on neighboring communities relative to the proposed project.

Table 7. Trails at Carmel Mountain Ranch Brush Management Zones

Project Area	Existing Zone 1 Condition (feet)[1]	Zone 2 (feet)[2]	Extended Protective Brush Thinning Zone (feet)[3]	Total BMZ Width (feet)[4]
Unit 4 Lot 1 (Holes 4 and 5)[5]	Minimum 10 feet	90	20	90 to 110 feet

Table 7. Trails at Carmel Mountain Ranch Brush Management Zones

Project Area	Existing Zone 1 Condition (feet)[1]	Zone 2 (feet)[2]	Extended Protective Brush Thinning Zone (feet)[3]	Total BMZ Width (feet)[4]
Unit 3 Lot 1 (Holes 3 and 4)	Minimum 10 feet	50 to 90[6]	20	50 to 110 feet
Unit 7 Lot 2 (Hole 7)	Minimum 10 feet	90	0	90 feet
Unit 9 Lot 3 (Hole 18)	Minimum 10 feet	90	0	90 feet
Unit 12 Lot 1 (Hole 12)	Minimum 10 feet	90	50	90 feet
Unit 16 Lot 2 (Hole 15)	Minimum 10 feet	90	50	90 feet
Unit 16 Lot 5 (Hole 15)	Minimum 10 feet	90	20	90 to 110 feet

Notes:

1 The existing Zone 1 condition is the irrigated rear yards of the existing single-family residences adjacent to the fairways of the closed Carmel Mountain Ranch Country Club Golf Course. The existing Zone 1 condition is a minimum of 10 feet and extends from the rear of the existing structures to the property line. The existing Zone 1 is not part of the Project and the Project would not have any responsibility to maintain it, maintenance is the responsibility of the existing single-family property owners.

2 Zone 2 is a minimum 50-foot thinning zone that extends from the property line of the existing residence adjacent to the fairways out as much as 90 feet. It should be noted that some areas within Zone 2 include riparian wetland areas and an extended protective brush thinning zone is being recommended as additional brush management.

3 The extended protective brush thinning zone consists of an additional 20 feet of thinning around the riparian wetland area to reduce the likelihood of fire extending into the riparian area. An additional 50 feet of extended protective brush thinning zone is included as the 'wetland buffer' zone around the riparian areas on Unit 12 Lot 1, Unit 13 Lot 2, and Unit 16 Lot 2.

4 Total BMZ equals minimum 50 to 90-foot Zone 2 thinning area plus additional 20 to 50 feet of thinning around riparian wetland areas (extended protective brush thinning zone).

5 Fire prone vegetation (acacia species) directly adjacent to existing residential property lines will be removed and replanted with fire-resistive, low maintenance planting materials.

6 Zone 2 surrounding the riparian area within Unit 3 Lot 1 extends a minimum 50 feet but up to 90 feet from the rear of the existing Zone 1 condition area. Due to the property boundary being adjacent to I-15 in the northwestern portion of Unit 3 Lot 1, we are only able to achieve approximately 50 feet of combined Zone 2 around that portion of the riparian area; we are able to achieve the full 90 feet of Zone 2 around all other areas surrounding the riparian area.

A typical landscape/brush management installation in the City of San Diego consists of a 35-foot-wide, irrigated Zone 1 and a 65-foot-wide, non-irrigated Zone 2 for 100 total feet of BMZ. The Project would provide varying width BMZs as follows. Adjacent to existing, neighboring residential units, there would not be irrigated areas within the modified BMZs except for any existing rear or side yards. The Project would provide these existing residences with a Zone 2 thinning zone that extends outward from the rear or side yards between 50 and 90 feet. Due to the property boundary being adjacent to I-15 in the northwestern portion of Unit 3 Lot 1, we are only able to achieve approximately 50 feet of combined Zone 2 around that portion of the riparian area; we are however, able to achieve the full 90 feet of Zone 2 around all other riparian areas throughout the project site. The Zone 2 extends to within 5 feet of the riparian habitat areas and would not include maintenance within any protected riparian habitat delineated areas. In addition, a 20 to 50-foot extended protective brush thinning zone is being required around all sides of the riparian areas, including the side furthest from structures, even if it results in BMZ widths that exceeds 100 feet. This creates a buffer around the riparian areas to reduce the potential of a ground fire transitioning into a crown fire. Planting within Zone 2 will be consistent with SDFRD requirements and consist of low maintenance, fire-resistive plants that will be maintained on at least an annual basis.

The modified BMZ widths are considered appropriate for this project because the extended protective brush thinning zone around the riparian areas will create a fuel reduction buffer, reducing the potential of a ground fire transitioning into a crown fire. Additionally, providing a thinned zone and removing fire prone plant species adjacent to existing residential structures and replanting them with low maintenance, fire-resistive plant material, reduces the fire intensity and flame lengths significantly. BMZs are delineated on the Trails at Carmel Mountain Ranch Project Brush Management Plan (Appendix F).

5.1 Fuel Modification Area Vegetation Maintenance

In addition to the proposed brush management zones, it is also recommended the existing Eucalyptus trees that line the fairway adjacent to the rear property fences of the existing residential properties within the proposed Unit 7 development area, be properly maintained by creating vertical separation from the ground cover vegetation below the tree's crown. This will include a combination of raising tree crowns through branch removal and maintaining understory fuels so they would not transmit fire into the tree crowns. If routine maintenance of the Eucalyptus trees and the understory fuels cannot be provided on at least an annual basis, the Eucalyptus trees should be removed as part of an overall fire hazard reduction approach to the site's landscaping.

All fuel modification area vegetation management shall occur as-needed for fire safety, compliance with the BMZ requirements detailed in this report, and as determined by the SDFRD. The Trails at Carmel Mountain Ranch HOA or similar, funded entity shall be responsible for all vegetation management throughout the project area, in compliance with the requirements detailed herein and SDFRD requirements. The HOA or similar entity shall be responsible for ensuring long-term funding and ongoing compliance with all provisions of this report. The HOA will be responsible for enforcing the landscape maintenance at least annually and prepare a report for submittal to the SDFRD.

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6 Justification for Reduced Brush Management Zones

As presented in this Fire Fuel Load Modeling Report, the BMZs provided for the existing residences adjacent the Trails at Carmel Mountain Ranch Project are not standard BMZs. Rather, the BMZs provided include a modified BMZ approach with an existing irrigated rear yard Zone 1 area (minimum 10 feet in width to be maintained by existing single-family property owners) and Zone 2 areas that vary from 50 to 90 feet in width. To compensate for the areas within Zone 2 that consist of existing undisturbed open space areas and City of San Diego Wetland buffers, a 20- to 50-foot extended protective brush thinning zone around all sides of the riparian/wetland areas adjacent to existing residential structures was evaluated to provide acceptable protection for existing residential structures located adjacent to the project area.

Based on the fire behavior modeling results, maximum flame lengths anticipated in untreated, surface fuels, including non-native grasses, could range between 15 and 41 feet in height with a relatively fast rates of spread between 5 and 14 mph under extreme weather conditions, represented by Santa Ana winds blowing at gusts of 50 mph. These numbers represent an extreme wildland fire burning in large open space areas, however, the project area itself is not a typical wildland urban interface area and an extreme wildland fire wouldn't be anticipated for this area. Instead, the project area would anticipate a relatively fast-moving fire for a short period of time due to the small fuel beds and fast vegetation burn time. By thinning and maintaining the grasses and other fuels within the project area, much lower flame lengths and slower rate of spread would be anticipated. Based on fire behavior modeling results performed for post BMZ thinning, the rate of fire spread was reduced to between 1.7 and 4.2 mph, with reduced flame lengths to 14 feet, and much lower intensity. Should ignition in grasses extend beyond the extended protective brush thinning zone and into the riparian understory, it could potentially burn aggressively due to the presence of large amounts of biomass from dense stands of shrubby willows, palms, and eucalyptus and the presence of ladder fuels. Modeling outputs indicate a transition to crown fire would be possible from a fire burning in the riparian understory, since the canopy heights to lowest branch are roughly 3 feet above ground in some areas. Under such conditions, expected surface flame lengths in peripheral riparian surface fuels could reach up to 29 feet and ignite the tree canopies with flame lengths in excess of 35 feet, and potentially up to 100 feet. Embers could be generated from both surface and crown fires resulting in ignition of receptive fuel beds 1.1 to 2 miles downwind. With that said, the riparian wetland areas within the Trails at Carmel Mountain Ranch Project site contain a high amount of moisture content which would reduce the intensity and flame lengths before a ground fire could transition into a crown fire. Additionally, the proposed 20- to 50-foot wide extended protective brush thinning zone around the riparian drainages is designed to reduce fuels, separate fuels, create lower overall fuel heights, and minimize the potential for ignition of riparian area fuels. Therefore, the application of the proposed BMZs would reduce the duration, size, and intensity of a wildfire and create the separation between the existing homes and the adjacent fuels that is desired for structure protection and defensible space.

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7 Conclusion

The goal of the brush management zones provided for the Trails at Carmel Mountain Ranch Project is to minimize the likelihood that a vegetation fire burns aggressively into riparian areas (source of largest fuels) and results in high intensity fire. This will provide the existing adjacent residential structures with the ability to survive a vegetation fire on this site with little intervention of firefighting forces. Preventing ignition to structures results in reduction of the exposure of firefighters and residents/visitors to hazards that threaten personal safety and will reduce property damage and losses. Mitigating ignition hazards and fire spread potential reduces the threat to structures and can help the fire department optimize the deployment of personnel and apparatus during a wildfire. The analysis in this Fire Fuel Load Modeling Report provides support and justifications for acceptance of a proposed BMZ for this project based on the site-specific fire environment and varying ignition-resistance of the existing residential structures. As presented in this report, the alternative measures proposed for the proposed project's BMZ supplement the standard requirements and provide at least functional equivalency.

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8 Limitations

This Fire Fuel Load Modeling Report does not provide guarantee that residents and visitors will be safe at all times because of the fire protection features it requires. There are many variables that may influence overall safety. This report provides requirements and recommendations for implementation of the latest fire protection features that have proven to result in reduced wildfire-related risk and hazard.

For maximum benefit, The Trails at Carmel Mountain Ranch residents and visitors, contractors, engineers, and architects are responsible for proper implementation of the concepts and requirements set forth in this report. Adjacent homeowners are responsible for maintaining their structures and lots as required by the applicable fire code and the SDFRD, which further helps protect against catastrophic loss as a result of a wildland fire.

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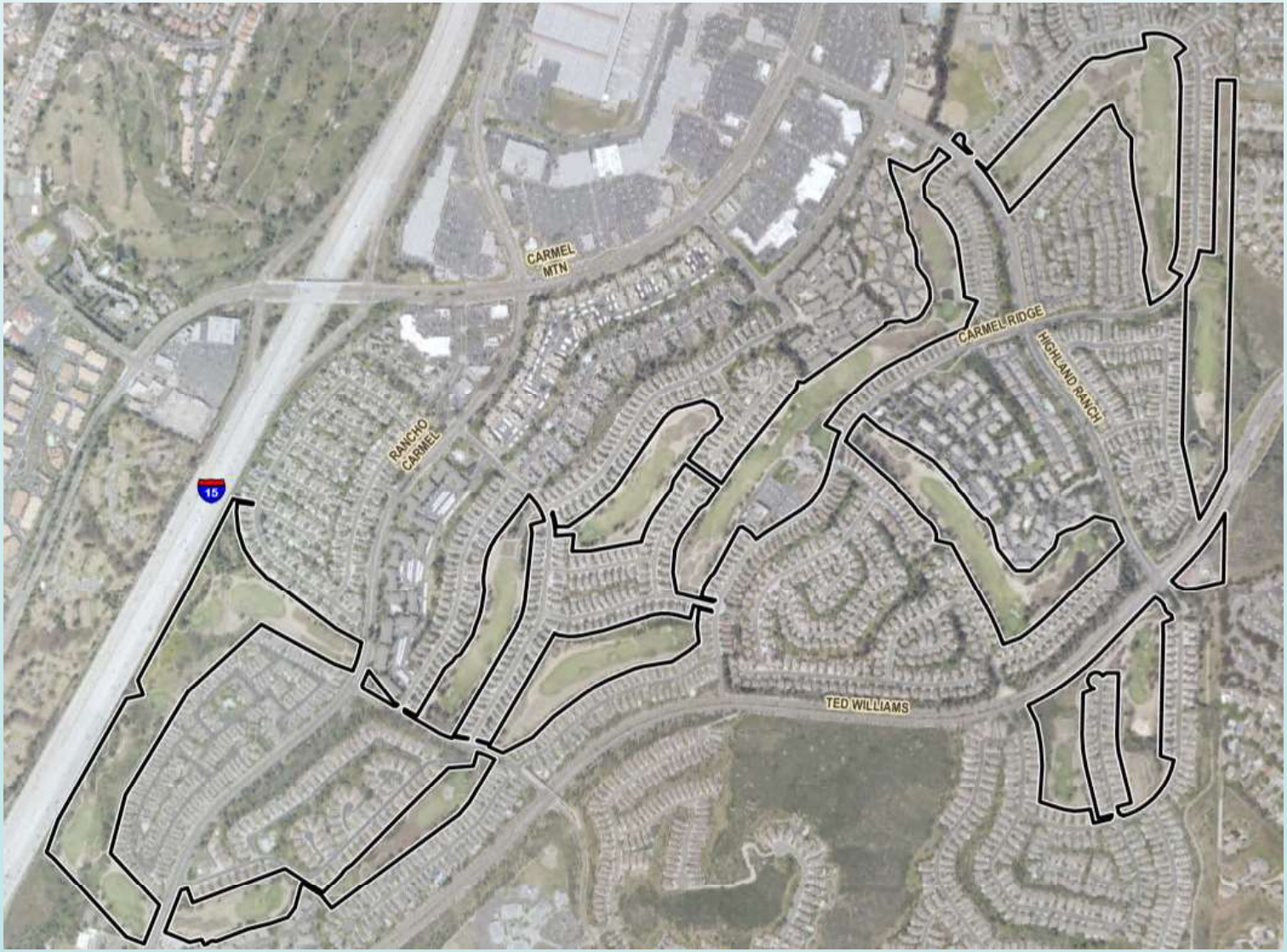
Appendix A

The Trails at Carmel Mountain Ranch Photograph Log

The Trails at Carmel Mountain Ranch Photograph Log



Trails at Carmel Mountain Ranch Photograph Log
Unit 4, Lot 1 (Holes 4 and 5)

Photograph 1. View looking northwest towards existing vegetation in the southwest portion of the project area. Note the existing community (red arrow) and unmaintained grasses and weeds in the once fairway of Hole 5.

Photograph 2. Photograph of riparian area west of existing community adjacent to once Hole 5 fairway. Photograph taken facing west.

Photograph 3. View looking northeast along the existing overgrown pathway that separates existing residential community from riparian area along the once hole 5 fairway.

Photograph 4. View looking north at unmaintained grasses on the western side of riparian area that lines the once 5th hole fairway in the western portion of the project area.

Trails at Carmel Mountain Ranch Photograph Log
Unit 4, Lot 1 (Holes 4 and 5)

Photograph 5. View looking southwest along the existing overgrown pathway that separates existing residential community from riparian area along the once hole 5 fairway. Note acacia shrubs that are proposed to be removed (red arrow).

Photograph 6. View looking north/northwest at unmaintained grasses on the western side of riparian area that lines the once 5th hole fairway in the western portion of the project area.

Photograph 7. View looking southwest along the existing overgrown pathway that separates existing residential community from riparian area along the once hole 5 fairway. Note acacia shrubs that are proposed to be removed (red arrow).

Photograph 8. View looking southwest along the existing overgrown pathway that separates existing residential community from riparian area along the once hole 5 fairway. Note acacia shrubs that are proposed to be removed (red arrow).

Trails at Carmel Mountain Ranch Photograph Log
Unit 4, Lot 1 (Holes 4 and 5)

Photograph 9. Photograph of riparian area northwest of existing residential community adjacent to once Hole 5 fairway. Photograph taken facing southwest standing on bridge separating holes 4 and 5.

Photograph 10. Photograph of riparian area northwest of existing residential community adjacent to once Hole 4 fairway. Photograph taken facing north standing on bridge separating holes 4 and 5.

Photograph 11. View looking southwest towards hole 4 fairway and unmaintained grasses between the I-15 Freeway and the riparian area. Photograph taken standing in hole 3 fairway.

Photograph 12. Photograph of riparian area directly adjacent to existing residential community on southern side of hole 3. Photograph taken facing south.

Trails at Carmel Mountain Ranch Photograph Log
Unit 3, Lot 1 (Holes 3 and 4)

Photograph 13. Photograph of riparian area adjacent to existing residential community along Chicarita Creek Road. Photograph taken facing north.

Photograph 14. Photograph of the once hole 3 fairway that separates two existing residential communities. Photograph taken facing east.

Photograph 15. Photograph of riparian area adjacent to existing residential community along Chicarita Creek Road. Photograph taken facing northwest.

Photograph 16. Photograph of riparian area adjacent to existing residential community along Chicarita Creek Road. Photograph taken facing west.

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Trails at Carmel Mountain Ranch Photograph Log
Unit 12, Lot 1 (Hole 12)

Photograph 17. Photograph of a riparian area near the once hole 12 teebox that separates two existing residential communities. Photograph taken facing west. Note Ted Williams Parkway north of this area.

Photograph 18. Photograph of existing vegetation along hole 12 that separates two existing residential communities. Photograph taken facing south.

Photograph 19. Photograph of existing vegetation along hole 12 that separates two existing residential communities. Photograph taken facing south.

Photograph 20. Photograph of a riparian area near the once hole 12 teebox that separates two existing residential communities. Photograph taken facing northwest. Note Ted Williams Parkway north of this area.

Trails at Carmel Mountain Ranch Photograph Log
Unit 13, Lot 2 (Hole 13)

Photograph 21. Photograph of a riparian area near the once hole 13 teebox that separates two existing residential communities. Photograph taken facing north.

Photograph 22. Photograph of a riparian area near the once hole 13 teebox that separates two existing residential communities. Photograph taken facing north looking up eastern side of fairway.

Photograph 23. Photograph of a riparian area near the once hole 13 teebox that separates two existing residential communities. Photograph taken facing northwest at existing structures along western side of fairway.

Photograph 24. Photograph of a riparian area near the once hole 13 teebox that separates two existing residential communities. Photograph taken facing east.

Trails at Carmel Mountain Ranch Photograph Log
Unit 13, Lot 2 (Hole 13)

Photograph 25. Photograph of a riparian area near the once hole 13 teebox that separates two existing residential communities. Photograph taken facing east.

Photograph 26. Photograph of existing vegetation along hole 13 that separates two existing residential communities. Photograph taken facing northeast.

Photograph 27. Photograph of existing vegetation along hole 13 that separates two existing residential communities. Photograph taken facing south. Note riparian area (red arrow).

Photograph 28. Photograph of existing vegetation along hole 13 that separates two existing residential communities. Photograph taken facing east standing near hole 13 green.

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Trails at Carmel Mountain Ranch Photograph Log
Unit 16, Lot 5 (Hole 15)

Photograph 29. Photograph of a riparian area near the once hole 15 teebox that separates two existing residential communities. Photograph taken facing northeast.

Photograph 30. Photograph of a riparian area near the once hole 15 teebox that separates two existing residential communities. Photograph taken facing northeast.

Photograph 31. Photograph of a riparian area near the once hole 15 teebox that separates two existing residential communities. Photograph taken facing south.

Photograph 32. Photograph of existing vegetation along hole 15 that separates two existing residential communities. Photograph taken facing north.

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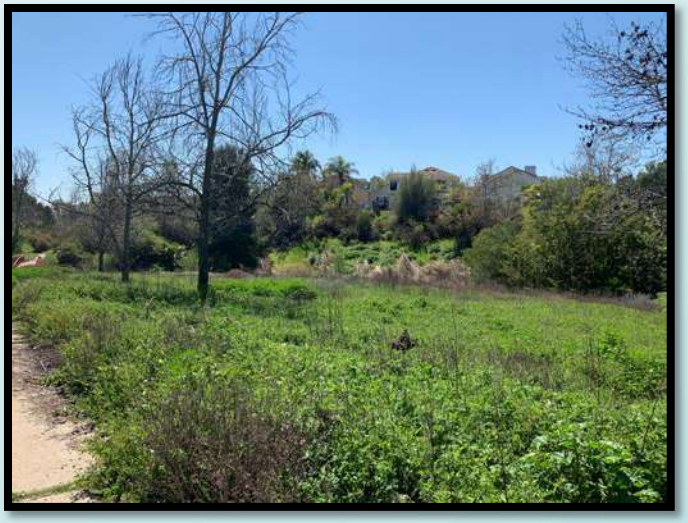
Trails at Carmel Mountain Ranch Photograph Log
Unit 16, Lot 5 (Hole 15)

Photograph 33. Photograph of riparian area north of existing residential community adjacent to once Hole 15 fairway. Photograph taken facing south standing on bridge crossing riparian area.

Photograph 34. Photograph of a riparian area on western side of the once hole 15 fairway that runs north adjacent to existing residential community. Photograph taken facing northwest.

Photograph 35. Photograph of a riparian area on western side of the once hole 15 fairway that runs north adjacent to existing residential community. Photograph taken facing west towards hole 16 fairway..



Photograph 36. Photograph of a riparian area on western side of the once hole 15 fairway that runs north adjacent to existing residential community. Photograph taken facing south.

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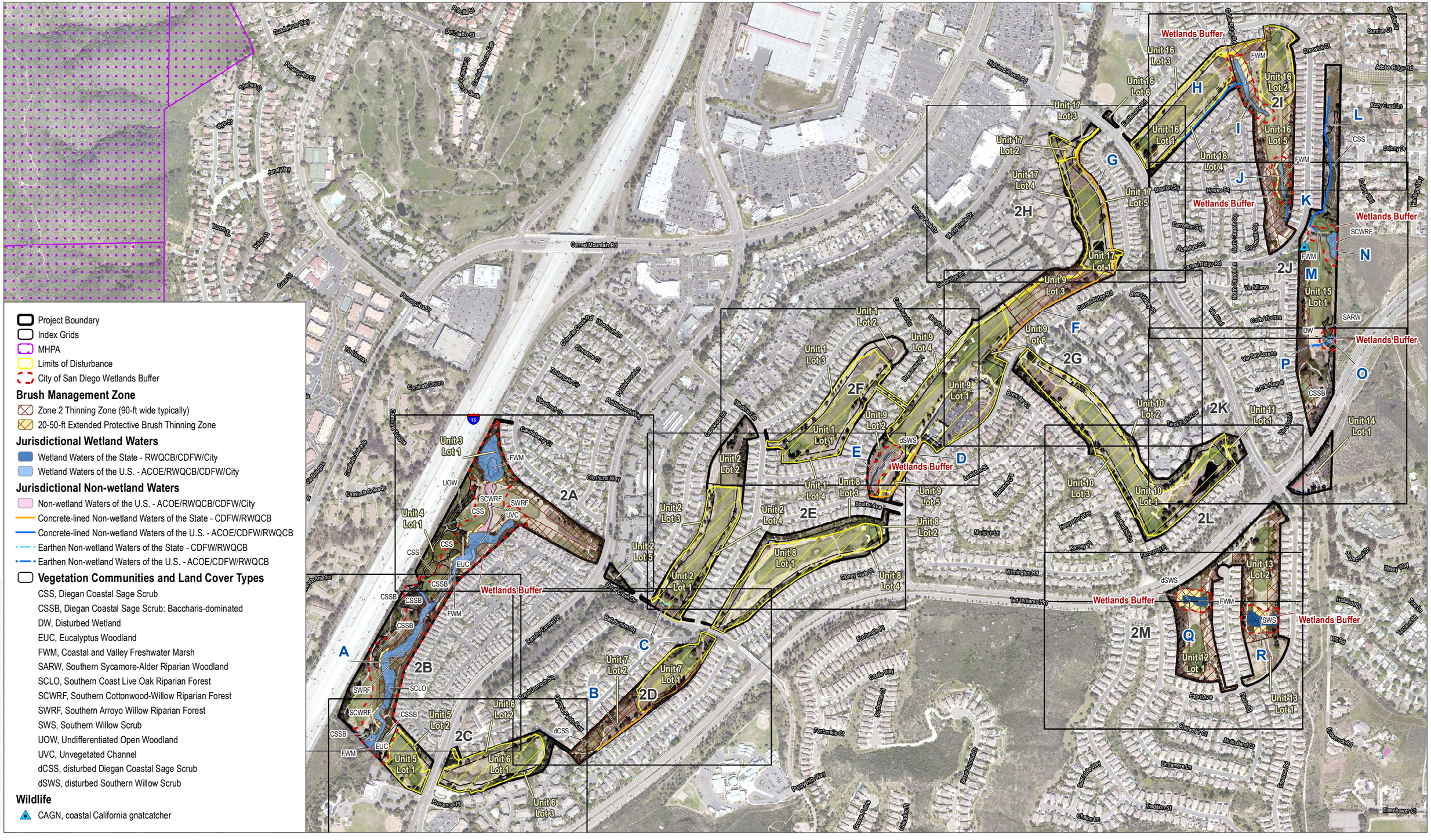
Appendix B

Vegetation Community Map



SOURCE: SANGIS 2017; Project Design 2019

DUDEK

0 350 700 Feet

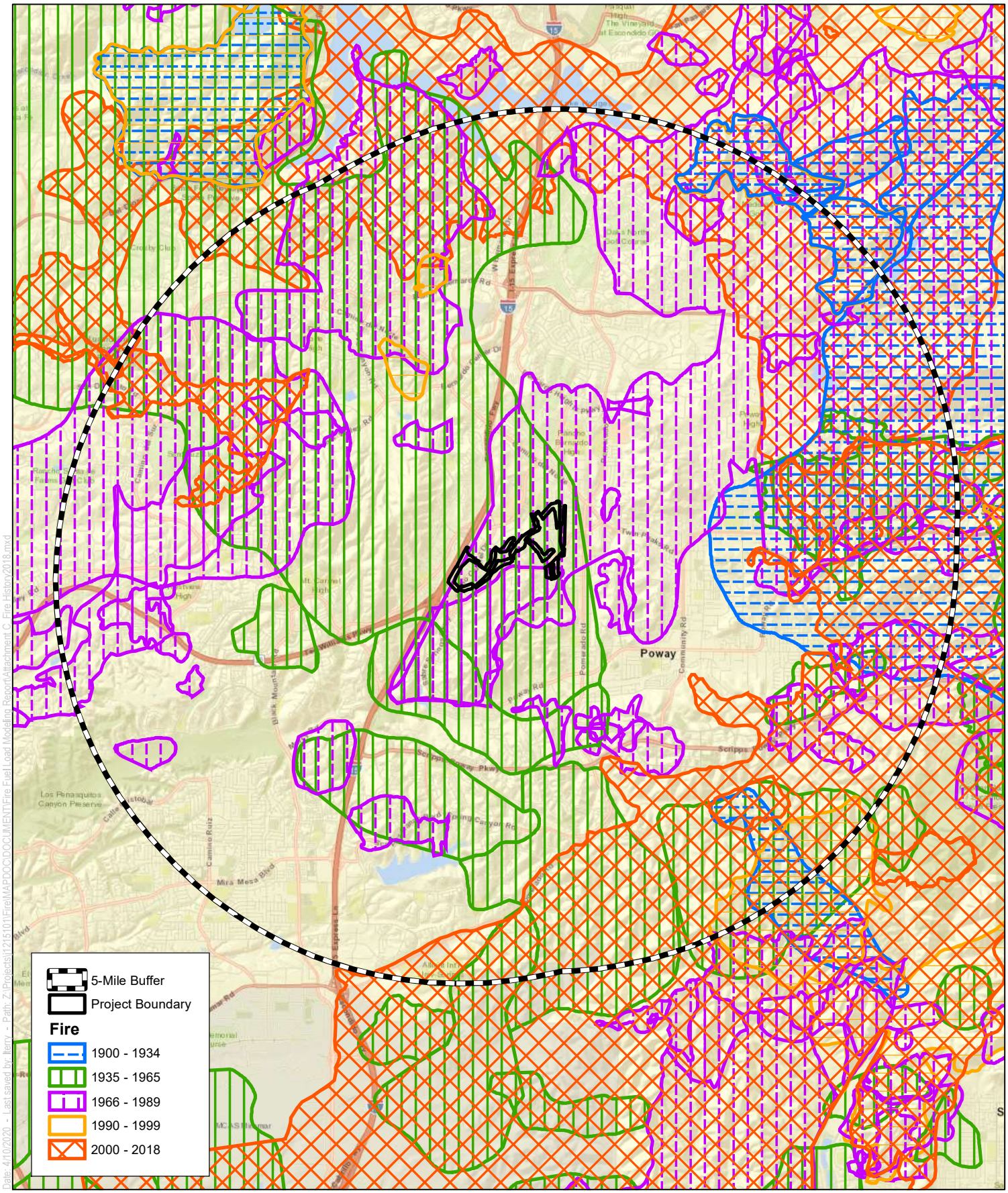
FIGURE 2

Biological Resources Overview Map

Trails at Carmel Mountain Ranch

Appendix C

Fire History Map



SOURCE: AERIAL- BING MAPPING SERVICE; FIRE DATA-CALFIRE 2018

DUDEK

0 1 2 Miles

APPENDIX **C**

Fire History Map

The Trails at Carmel Mountain Ranch - Fire Fuel Load Modeling Report

Appendix D

Fire Behavior Modeling Results – Pre BMZ Results

Inputs: SURFACE, CROWN, SPOT

Description		Scenario 1: Summer On-shore Wind(Pre BMZ)-Holes 4 & 5

Fuel/Vegetation, Surface/Understory

Fuel Model		9, gr4, gs2, sh4, sh5

Fuel/Vegetation, Overstory

Canopy Height	ft	25
Downwind Canopy Height	ft	4
Downwind Canopy Cover		Open
Canopy Base Height	ft	4
Canopy Bulk Density	lb/ft3	0.062

Fuel Moisture

1-h Fuel Moisture	%	8
10-h Fuel Moisture	%	9
100-h Fuel Moisture	%	15
Live Herbaceous Fuel Moisture	%	55
Live Woody Fuel Moisture	%	110

Weather

20-ft Wind Speed	mi/h	18
Wind Adjustment Factor		0.4
Wind Direction (from north)	deg	90

Terrain

Slope Steepness	%	3
Site Aspect	deg	0
Ridge-to-Valley Elevation Difference	ft	55
Ridge-to-Valley Horizontal Distance	mi	0.1
Spotting Source Location		VB

Run Option Notes

Maximum effective wind speed limit IS imposed [SURFACE].

Fire spread is in the HEADING direction only [SURFACE].

Wind is in specified directions [SURFACE].

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

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

Crown fire method uses Rothermel (1991) [CROWN].

(continued on next page)

Input Worksheet (continued)

Output Variables

Surface Fire Rate of Spread (mi/h) [SURFACE]
Surface Fireline Intensity (Btu/ft/s) [SURFACE]
Surface Fire Flame Length (ft) [SURFACE]
Active Crown Fire Rate of Spread (mi/h) [CROWN]
Active Crown Fireline Intensity (Btu/ft/s) [CROWN]
Active Crown Fire Flame Length (ft) [CROWN]
Spot Dist from a Wind Driven Surface Fire (mi) [SPOT]

Notes

Scenario 1: Summer On-shore Wind(Pre BMZ)-Holes 4 & 5

Head Fire

Fuel Model	Surface Fire Rate of Spread mi/h	Surface Fireline Intensity Btu/ft/s	Surface Flame Length ft	Active Crown ROS mi/h	> > >
9	0.2	85	3.5	0.5	
gr4	1.5	1010	10.8	0.5	
gs2	0.4	206	5.2	0.5	
sh4	0.2	50	2.7	0.5	
sh5	0.9	1967	14.7	0.5	

Scenario 1: Summer On-shore Wind(Pre BMZ)-Holes 4 & 5

Head Fire

< Fuel Model	Active Crown FLI Btu/ft/s	Active Crown FL ft	Surface Fire Spot Dist mi
9	7837	78.9	0.2
gr4	7919	79.5	0.5
gs2	7870	79.1	0.3
sh4	7744	78.3	0.2
sh5	8682	84.5	0.6

Discrete Variable Codes Used
Scenario 1: Summer On-shore Wind (Pre Construction)

Fuel Model

9	9	Long needle or hardwood litter
104	gr4	Moderate load, dry climate grass (D)
107	gr7	High load, dry climate grass (D)
122	gs2	Moderate load, dry climate grass-shrub (D)
144	sh4	Low load, humid climate timber-shrub (S)

Downwind Canopy Cover

Open	Open

Spotting Source Location

VB	Valley Bottom

Inputs: SURFACE, CROWN, SPOT

Description		Scenario 2: Extreme Fall Wind (Pre construction)

Fuel/Vegetation, Surface/Understory

Fuel Model		gr2, gr4, gs1, sh4

Fuel/Vegetation, Overstory

Canopy Height	ft	25
Downwind Canopy Height	ft	3
Downwind Canopy Cover		Open
Canopy Base Height	ft	3
Canopy Bulk Density	lb/ft3	0.062

Fuel Moisture

1-h Fuel Moisture	%	2
10-h Fuel Moisture	%	3
100-h Fuel Moisture	%	7
Live Herbaceous Fuel Moisture	%	30
Live Woody Fuel Moisture	%	60

Weather

20-ft Wind Speed	mi/h	19, 50
Wind Adjustment Factor		0.4
Wind Direction (from north)	deg	180

Terrain

Slope Steepness	%	3
Site Aspect	deg	0
Ridge-to-Valley Elevation Difference	ft	55
Ridge-to-Valley Horizontal Distance	mi	0.1
Spotting Source Location		VB

Run Option Notes

Maximum effective wind speed limit IS imposed [SURFACE].

Fire spread is in the HEADING direction only [SURFACE].

Wind is in specified directions [SURFACE].

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

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

Crown fire method uses Rothermel (1991) [CROWN].

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Input Worksheet (continued)

Output Variables

Surface Fire Rate of Spread (mi/h) [SURFACE]
Surface Fireline Intensity (Btu/ft/s) [SURFACE]
Surface Fire Flame Length (ft) [SURFACE]
Active Crown Fire Rate of Spread (mi/h) [CROWN]
Active Crown Fireline Intensity (Btu/ft/s) [CROWN]
Active Crown Fire Flame Length (ft) [CROWN]
Spot Dist from a Wind Driven Surface Fire (mi) [SPOT]

Notes

Scenario 2: Extreme Fall Wind (Pre construction)

Head Fire

Surface Fire Rate of Spread (mi/h)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	1.7	4.2
gr4	3.5	13.9
gs1	0.7	2.4
sh4	1.1	4.1

Scenario 2: Extreme Fall Wind (Pre construction)

Head Fire

Surface Fireline Intensity (Btu/ft/s)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	736	1791
gr4	2868	11561
gs1	372	1283
sh4	1390	5260

Scenario 2: Extreme Fall Wind (Pre construction)

Head Fire

Surface Fire Flame Length (ft)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	9.4	14.1
gr4	17.5	33.3
gs1	6.9	12.1
sh4	12.6	23.2

Scenario 2: Extreme Fall Wind (Pre construction)

Head Fire

Active Crown Fire Rate of Spread (mi/h)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	1.1	4.1
gr4	1.1	4.1
gs1	1.1	4.1
sh4	1.1	4.1

Scenario 2: Extreme Fall Wind (Pre construction)

Head Fire

Active Crown Fireline Intensity (Btu/ft/s)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	17508	67109
gr4	17936	68750
gs1	17627	67567
sh4	18424	70619

Scenario 2: Extreme Fall Wind (Pre construction)

Head Fire

Active Crown Fire Flame Length (ft)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	134.9	330.3
gr4	137.0	335.6
gs1	135.5	331.8
sh4	139.5	341.7

Scenario 2: Extreme Fall Wind (Pre construction)

Head Fire

Spot Dist from a Wind Driven Surface Fire (mi)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	0.4	1.1
gr4	0.7	2.0
gs1	0.3	1.0
sh4	0.5	1.5

Discrete Variable Codes Used
Scenario 2: Extreme Fall Wind (Pre construction)

Fuel Model

102	gr2	Low load, dry climate grass (D)
104	gr4	Moderate load, dry climate grass (D)
121	gs1	Low load, dry climate grass-shrub (D)
144	sh4	Low load, humid climate timber-shrub (S)

Downwind Canopy Cover

Open	Open

Spotting Source Location

VB	Valley Bottom

Inputs: SURFACE, CROWN, SPOT

Description		Scenario 3: Extreme Fall Wind (Pre construction)

Fuel/Vegetation, Surface/Understory

Fuel Model		gr2, gr4, gs1, sh4

Fuel/Vegetation, Overstory

Canopy Height	ft	20
Downwind Canopy Height	ft	3
Downwind Canopy Cover		Open
Canopy Base Height	ft	3
Canopy Bulk Density	lb/ft3	0.062

Fuel Moisture

1-h Fuel Moisture	%	2
10-h Fuel Moisture	%	3
100-h Fuel Moisture	%	7
Live Herbaceous Fuel Moisture	%	30
Live Woody Fuel Moisture	%	60

Weather

20-ft Wind Speed	mi/h	19, 50
Wind Adjustment Factor		0.4
Wind Direction (from north)	deg	0

Terrain

Slope Steepness	%	2
Site Aspect	deg	0
Ridge-to-Valley Elevation Difference	ft	50
Ridge-to-Valley Horizontal Distance	mi	0.09
Spotting Source Location		VB

Run Option Notes

Maximum effective wind speed limit IS imposed [SURFACE].

Fire spread is in the HEADING direction only [SURFACE].

Wind is in specified directions [SURFACE].

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

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

Crown fire method uses Rothermel (1991) [CROWN].

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Input Worksheet (continued)

Output Variables

Surface Fire Rate of Spread (mi/h) [SURFACE]
Surface Fireline Intensity (Btu/ft/s) [SURFACE]
Surface Fire Flame Length (ft) [SURFACE]
Active Crown Fire Rate of Spread (mi/h) [CROWN]
Active Crown Fireline Intensity (Btu/ft/s) [CROWN]
Active Crown Fire Flame Length (ft) [CROWN]
Spot Dist from a Wind Driven Surface Fire (mi) [SPOT]

Notes

Scenario 3: Extreme Fall Wind (Pre construction)

Head Fire

Surface Fire Rate of Spread (mi/h)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	1.7	4.2
gr4	3.5	13.9
gs1	0.7	2.4
sh4	1.1	4.1

Scenario 3: Extreme Fall Wind (Pre construction)

Head Fire

Surface Fireline Intensity (Btu/ft/s)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	737	1791
gr4	2872	11564
gs1	373	1283
sh4	1392	5262

Scenario 3: Extreme Fall Wind (Pre construction)

Head Fire

Surface Fire Flame Length (ft)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	9.4	14.1
gr4	17.5	33.3
gs1	6.9	12.1
sh4	12.6	23.2

Scenario 3: Extreme Fall Wind (Pre construction)

Head Fire

Active Crown Fire Rate of Spread (mi/h)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	1.1	4.1
gr4	1.1	4.1
gs1	1.1	4.1
sh4	1.1	4.1

Scenario 3: Extreme Fall Wind (Pre construction)

Head Fire

Active Crown Fireline Intensity (Btu/ft/s)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	13632	52254
gr4	14060	53894
gs1	13752	52712
sh4	14548	55763

Scenario 3: Extreme Fall Wind (Pre construction)

Head Fire

Active Crown Fire Flame Length (ft)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	114.1	279.5
gr4	116.5	285.4
gs1	114.8	281.2
sh4	119.2	291.9

Scenario 3: Extreme Fall Wind (Pre construction)

Head Fire

Spot Dist from a Wind Driven Surface Fire (mi)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	0.4	1.1
gr4	0.7	2.0
gs1	0.3	1.0
sh4	0.5	1.5

Discrete Variable Codes Used
Scenario 3: Extreme Fall Wind (Pre construction)

Fuel Model

102	gr2	Low load, dry climate grass (D)
104	gr4	Moderate load, dry climate grass (D)
121	gs1	Low load, dry climate grass-shrub (D)
144	sh4	Low load, humid climate timber-shrub (S)

Downwind Canopy Cover

Open	Open

Spotting Source Location

VB	Valley Bottom

Inputs: SURFACE, CROWN, SPOT

Description		Scenario 4: Extreme Fall Wind (Pre construction)

Fuel/Vegetation, Surface/Understory

Fuel Model		gr2, gr4, gs1, sh4

Fuel/Vegetation, Overstory

Canopy Height	ft	20
Downwind Canopy Height	ft	3
Downwind Canopy Cover		Open
Canopy Base Height	ft	3
Canopy Bulk Density	lb/ft3	0.062

Fuel Moisture

1-h Fuel Moisture	%	2
10-h Fuel Moisture	%	3
100-h Fuel Moisture	%	7
Live Herbaceous Fuel Moisture	%	30
Live Woody Fuel Moisture	%	60

Weather

20-ft Wind Speed	mi/h	19, 50
Wind Adjustment Factor		0.4
Wind Direction (from north)	deg	180

Terrain

Slope Steepness	%	4
Site Aspect	deg	0
Ridge-to-Valley Elevation Difference	ft	55
Ridge-to-Valley Horizontal Distance	mi	0.09
Spotting Source Location		VB

Run Option Notes

Maximum effective wind speed limit IS imposed [SURFACE].

Fire spread is in the HEADING direction only [SURFACE].

Wind is in specified directions [SURFACE].

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

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

Crown fire method uses Rothermel (1991) [CROWN].

(continued on next page)

Input Worksheet (continued)

Output Variables

Surface Fire Rate of Spread (mi/h) [SURFACE]
Surface Fireline Intensity (Btu/ft/s) [SURFACE]
Surface Fire Flame Length (ft) [SURFACE]
Active Crown Fire Rate of Spread (mi/h) [CROWN]
Active Crown Fireline Intensity (Btu/ft/s) [CROWN]
Active Crown Fire Flame Length (ft) [CROWN]
Spot Dist from a Wind Driven Surface Fire (mi) [SPOT]

Notes

Scenario 4: Extreme Fall Wind (Pre construction)

Head Fire

Surface Fire Rate of Spread (mi/h)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	1.7	4.2
gr4	3.5	13.9
gs1	0.7	2.4
sh4	1.1	4.1

Scenario 4: Extreme Fall Wind (Pre construction)

Head Fire

Surface Fireline Intensity (Btu/ft/s)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	736	1791
gr4	2867	11559
gs1	372	1283
sh4	1390	5260

Scenario 4: Extreme Fall Wind (Pre construction)

Head Fire

Surface Fire Flame Length (ft)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	9.4	14.1
gr4	17.5	33.3
gs1	6.8	12.1
sh4	12.6	23.2

Scenario 4: Extreme Fall Wind (Pre construction)

Head Fire

Active Crown Fire Rate of Spread (mi/h)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	1.1	4.1
gr4	1.1	4.1
gs1	1.1	4.1
sh4	1.1	4.1

Scenario 4: Extreme Fall Wind (Pre construction)

Head Fire

Active Crown Fireline Intensity (Btu/ft/s)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	13632	52254
gr4	14060	53894
gs1	13752	52712
sh4	14548	55763

Scenario 4: Extreme Fall Wind (Pre construction)

Head Fire

Active Crown Fire Flame Length (ft)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	114.1	279.5
gr4	116.5	285.4
gs1	114.8	281.2
sh4	119.2	291.9

Scenario 4: Extreme Fall Wind (Pre construction)

Head Fire

Spot Dist from a Wind Driven Surface Fire (mi)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	0.4	1.1
gr4	0.7	2.0
gs1	0.3	1.0
sh4	0.5	1.5

Discrete Variable Codes Used
Scenario 4: Extreme Fall Wind (Pre construction)

Fuel Model

102	gr2	Low load, dry climate grass (D)
104	gr4	Moderate load, dry climate grass (D)
121	gs1	Low load, dry climate grass-shrub (D)
144	sh4	Low load, humid climate timber-shrub (S)

Downwind Canopy Cover

Open	Open

Spotting Source Location

VB	Valley Bottom

Inputs: SURFACE, CROWN, SPOT

Description		Scenario 5: Extreme Fall Wind (Pre construction)

Fuel/Vegetation, Surface/Understory

Fuel Model		gr2, gr4, gs1, sh4, sh5

Fuel/Vegetation, Overstory

Canopy Height	ft	20
Downwind Canopy Height	ft	3
Downwind Canopy Cover		Open
Canopy Base Height	ft	3
Canopy Bulk Density	lb/ft3	0.062

Fuel Moisture

1-h Fuel Moisture	%	2
10-h Fuel Moisture	%	3
100-h Fuel Moisture	%	7
Live Herbaceous Fuel Moisture	%	30
Live Woody Fuel Moisture	%	60

Weather

20-ft Wind Speed	mi/h	19, 50
Wind Adjustment Factor		0.4
Wind Direction (from north)	deg	310

Terrain

Slope Steepness	%	3
Site Aspect	deg	0
Ridge-to-Valley Elevation Difference	ft	60
Ridge-to-Valley Horizontal Distance	mi	0.09
Spotting Source Location		VB

Run Option Notes

Maximum effective wind speed limit IS imposed [SURFACE].

Fire spread is in the HEADING direction only [SURFACE].

Wind is in specified directions [SURFACE].

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

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

Crown fire method uses Rothermel (1991) [CROWN].

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Input Worksheet (continued)

Output Variables

Surface Fire Rate of Spread (mi/h) [SURFACE]
Surface Fireline Intensity (Btu/ft/s) [SURFACE]
Surface Fire Flame Length (ft) [SURFACE]
Active Crown Fire Rate of Spread (mi/h) [CROWN]
Active Crown Fireline Intensity (Btu/ft/s) [CROWN]
Active Crown Fire Flame Length (ft) [CROWN]
Spot Dist from a Wind Driven Surface Fire (mi) [SPOT]

Notes

Scenario 5: Extreme Fall Wind (Pre construction)

Head Fire

Surface Fire Rate of Spread (mi/h)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	1.7	4.2
gr4	3.5	13.9
gs1	0.7	2.4
sh4	1.1	4.1
sh5	2.0	6.2

Scenario 5: Extreme Fall Wind (Pre construction)

Head Fire

Surface Fireline Intensity (Btu/ft/s)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	737	1791
gr4	2872	11564
gs1	373	1283
sh4	1392	5262
sh5	5905	18349

Scenario 5: Extreme Fall Wind (Pre construction)

Head Fire

Surface Fire Flame Length (ft)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	9.4	14.1
gr4	17.5	33.3
gs1	6.9	12.1
sh4	12.6	23.2
sh5	24.4	41.2

Scenario 5: Extreme Fall Wind (Pre construction)

Head Fire

Active Crown Fire Rate of Spread (mi/h)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	1.1	4.1
gr4	1.1	4.1
gs1	1.1	4.1
sh4	1.1	4.1
sh5	1.1	4.1

Scenario 5: Extreme Fall Wind (Pre construction)

Head Fire

Active Crown Fireline Intensity (Btu/ft/s)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	13632	52254
gr4	14060	53894
gs1	13752	52712
sh4	14548	55763
sh5	16339	62629

Scenario 5: Extreme Fall Wind (Pre construction)

Head Fire

Active Crown Fire Flame Length (ft)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	114.1	279.5
gr4	116.5	285.4
gs1	114.8	281.2
sh4	119.2	291.9
sh5	128.8	315.4

Scenario 5: Extreme Fall Wind (Pre construction)

Head Fire

Spot Dist from a Wind Driven Surface Fire (mi)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	0.4	1.1
gr4	0.7	2.0
gs1	0.3	1.0
sh4	0.5	1.5
sh5	0.8	2.3

Discrete Variable Codes Used
Scenario 5: Extreme Fall Wind (Pre construction)

Fuel Model

102	gr2	Low load, dry climate grass (D)
104	gr4	Moderate load, dry climate grass (D)
121	gs1	Low load, dry climate grass-shrub (D)
144	sh4	Low load, humid climate timber-shrub (S)
145	sh5	High load, dry climate shrub (S)

Downwind Canopy Cover

Open	Open

Spotting Source Location

VB	Valley Bottom

Inputs: SURFACE, CROWN, SPOT

Description		Scenario 6: Extreme Fall Wind (Pre BMZ)-Hole 15

Fuel/Vegetation, Surface/Understory

Fuel Model		gr2, gr4, gs1, sh4

Fuel/Vegetation, Overstory

Canopy Height	ft	20
Downwind Canopy Height	ft	3
Downwind Canopy Cover		Open
Canopy Base Height	ft	3
Canopy Bulk Density	lb/ft3	0.062

Fuel Moisture

1-h Fuel Moisture	%	2
10-h Fuel Moisture	%	3
100-h Fuel Moisture	%	7
Live Herbaceous Fuel Moisture	%	30
Live Woody Fuel Moisture	%	60

Weather

20-ft Wind Speed	mi/h	19, 50
Wind Adjustment Factor		0.4
Wind Direction (from north)	deg	200

Terrain

Slope Steepness	%	3
Site Aspect	deg	0
Ridge-to-Valley Elevation Difference	ft	32
Ridge-to-Valley Horizontal Distance	mi	0.07
Spotting Source Location		VB

Run Option Notes

Maximum effective wind speed limit IS imposed [SURFACE].

Fire spread is in the HEADING direction only [SURFACE].

Wind is in specified directions [SURFACE].

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

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

Crown fire method uses Rothermel (1991) [CROWN].

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Input Worksheet (continued)

Output Variables

Surface Fire Rate of Spread (mi/h) [SURFACE]
Surface Fireline Intensity (Btu/ft/s) [SURFACE]
Surface Fire Flame Length (ft) [SURFACE]
Active Crown Fire Rate of Spread (mi/h) [CROWN]
Active Crown Fireline Intensity (Btu/ft/s) [CROWN]
Active Crown Fire Flame Length (ft) [CROWN]
Spot Dist from a Wind Driven Surface Fire (mi) [SPOT]

Notes

Scenario 6: Extreme Fall Wind (Pre BMZ)-Hole 15

Head Fire

Surface Fire Rate of Spread (mi/h)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	1.7	4.2
gr4	3.5	13.9
gs1	0.7	2.4
sh4	1.1	4.1

Scenario 6: Extreme Fall Wind (Pre BMZ)-Hole 15

Head Fire

Surface Fireline Intensity (Btu/ft/s)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	736	1791
gr4	2869	11561
gs1	372	1283
sh4	1390	5260

Scenario 6: Extreme Fall Wind (Pre BMZ)-Hole 15

Head Fire

Surface Fire Flame Length (ft)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	9.4	14.1
gr4	17.5	33.3
gs1	6.9	12.1
sh4	12.6	23.2

Scenario 6: Extreme Fall Wind (Pre BMZ)-Hole 15

Head Fire

Active Crown Fire Rate of Spread (mi/h)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	1.1	4.1
gr4	1.1	4.1
gs1	1.1	4.1
sh4	1.1	4.1

Scenario 6: Extreme Fall Wind (Pre BMZ)-Hole 15

Head Fire

Active Crown Fireline Intensity (Btu/ft/s)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	13632	52254
gr4	14060	53894
gs1	13752	52712
sh4	14548	55763

Scenario 6: Extreme Fall Wind (Pre BMZ)-Hole 15

Head Fire

Active Crown Fire Flame Length (ft)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	114.1	279.5
gr4	116.5	285.4
gs1	114.8	281.2
sh4	119.2	291.9

Scenario 6: Extreme Fall Wind (Pre BMZ)-Hole 15

Head Fire

Spot Dist from a Wind Driven Surface Fire (mi)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr2	0.4	1.1
gr4	0.7	2.0
gs1	0.3	1.0
sh4	0.5	1.5

Discrete Variable Codes Used
Scenario 6: Extreme Fall Wind (Pre BMZ)-Hole 15

Fuel Model

102	gr2	Low load, dry climate grass (D)
104	gr4	Moderate load, dry climate grass (D)
121	gs1	Low load, dry climate grass-shrub (D)
144	sh4	Low load, humid climate timber-shrub (S)

Downwind Canopy Cover

Open	Open

Spotting Source Location

VB	Valley Bottom

Appendix E

Fire Behavior Modeling Results – Post BMZ Results

Inputs: SURFACE, SPOT

Description		Scenario 1: Summer On-shore Wind(Post BMZ)-Holes 4 & 5

Fuel/Vegetation, Surface/Understory

Fuel Model		gr1, gr2, gs1, sh1

Fuel/Vegetation, Overstory

Downwind Canopy Height	ft	4
Downwind Canopy Cover		Open

Fuel Moisture

1-h Fuel Moisture	%	8
10-h Fuel Moisture	%	9
100-h Fuel Moisture	%	15
Live Herbaceous Fuel Moisture	%	55
Live Woody Fuel Moisture	%	110

Weather

20-ft Wind Speed	mi/h	18
Wind Adjustment Factor		0.4
Wind Direction (from north)	deg	90

Terrain

Slope Steepness	%	3
Site Aspect	deg	0
Ridge-to-Valley Elevation Difference	ft	55
Ridge-to-Valley Horizontal Distance	mi	0.1
Spotting Source Location		VB

Run Option Notes

Maximum effective wind speed limit IS imposed [SURFACE].

Fire spread is in the HEADING direction only [SURFACE].

Wind is in specified directions [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 Fire Rate of Spread (mi/h) [SURFACE]

Surface Fireline Intensity (Btu/ft/s) [SURFACE]

Surface Fire Flame Length (ft) [SURFACE]

(continued on next page)

Input Worksheet (continued)

Spot Dist from a Wind Driven Surface Fire (mi) [SPOT]

Notes

Scenario 1: Summer On-shore Wind(Post BMZ)-Holes 4 & 5

Head Fire

Fuel Model	Surface Fire Rate of Spread mi/h	Surface Fireline Intensity Btu/ft/s	Surface Flame Length ft	Surface Fire Spot Dist mi
gr1	0.2	19	1.8	0.1
gr2	0.7	257	5.8	0.3
gs1	0.1	16	1.6	0.1
sh1	0.0	2	0.6	0.1

Discrete Variable Codes Used

Scenario 1: Summer On-shore Wind(Post BMZ)-Holes 4 & 5

Fuel Model

101	gr1	Short, sparse, dry climate grass (D)
102	gr2	Low load, dry climate grass (D)
121	gs1	Low load, dry climate grass-shrub (D)
141	sh1	Low load, dry climate shrub (D)

Downwind Canopy Cover

Open	Open

Spotting Source Location

VB	Valley Bottom

Inputs: SURFACE, SPOT

Description		Scenario 2: Extreme Fall Wind (Post BMZ)-Holes 3 and 4

Fuel/Vegetation, Surface/Understory

Fuel Model		gr1, gr2

Fuel/Vegetation, Overstory

Downwind Canopy Height	ft	3
Downwind Canopy Cover		Open

Fuel Moisture

1-h Fuel Moisture	%	2
10-h Fuel Moisture	%	3
100-h Fuel Moisture	%	7
Live Herbaceous Fuel Moisture	%	30
Live Woody Fuel Moisture	%	60

Weather

20-ft Wind Speed	mi/h	19, 50
Wind Adjustment Factor		0.4
Wind Direction (from north)	deg	180

Terrain

Slope Steepness	%	3
Site Aspect	deg	0
Ridge-to-Valley Elevation Difference	ft	55
Ridge-to-Valley Horizontal Distance	mi	0.1
Spotting Source Location		VB

Run Option Notes

Maximum effective wind speed limit IS imposed [SURFACE].

Fire spread is in the HEADING direction only [SURFACE].

Wind is in specified directions [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 Fire Rate of Spread (mi/h) [SURFACE]

Surface Fireline Intensity (Btu/ft/s) [SURFACE]

Surface Fire Flame Length (ft) [SURFACE]

(continued on next page)

Input Worksheet (continued)

Spot Dist from a Wind Driven Surface Fire (mi) [SPOT]

Notes

Scenario 2: Extreme Fall Wind (Post BMZ)-Holes 3 and 4

Head Fire

Surface Fire Rate of Spread (mi/h)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr1	0.5	0.5
gr2	1.7	4.2

Scenario 2: Extreme Fall Wind (Post BMZ)-Holes 3 and 4

Head Fire

Surface Fireline Intensity (Btu/ft/s)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr1	67	67
gr2	736	1791

Scenario 2: Extreme Fall Wind (Post BMZ)-Holes 3 and 4

Head Fire

Surface Fire Flame Length (ft)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr1	3.1	3.1
gr2	9.4	14.1

Scenario 2: Extreme Fall Wind (Post BMZ)-Holes 3 and 4

Head Fire

Spot Dist from a Wind Driven Surface Fire (mi)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr1	0.2	0.4
gr2	0.4	1.1

Discrete Variable Codes Used

Scenario 2: Extreme Fall Wind (Post BMZ)-Holes 3 and 4

Fuel Model

101	gr1	Short, sparse, dry climate grass (D)
102	gr2	Low load, dry climate grass (D)

Downwind Canopy Cover

Open	Open

Spotting Source Location

VB	Valley Bottom

Inputs: SURFACE, SPOT

Description		Scenario 3: Extreme Fall Wind (Post BMZ)-Hole 12

Fuel/Vegetation, Surface/Understory

Fuel Model		gr1, gr2

Fuel/Vegetation, Overstory

Downwind Canopy Height	ft	3
Downwind Canopy Cover		Open

Fuel Moisture

1-h Fuel Moisture	%	2
10-h Fuel Moisture	%	3
100-h Fuel Moisture	%	7
Live Herbaceous Fuel Moisture	%	30
Live Woody Fuel Moisture	%	60

Weather

20-ft Wind Speed	mi/h	19, 50
Wind Adjustment Factor		0.4
Wind Direction (from north)	deg	0

Terrain

Slope Steepness	%	3
Site Aspect	deg	0
Ridge-to-Valley Elevation Difference	ft	50
Ridge-to-Valley Horizontal Distance	mi	0.09
Spotting Source Location		VB

Run Option Notes

Maximum effective wind speed limit IS imposed [SURFACE].

Fire spread is in the HEADING direction only [SURFACE].

Wind is in specified directions [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 Fire Rate of Spread (mi/h) [SURFACE]

Surface Fireline Intensity (Btu/ft/s) [SURFACE]

Surface Fire Flame Length (ft) [SURFACE]

(continued on next page)

Input Worksheet (continued)

Spot Dist from a Wind Driven Surface Fire (mi) [SPOT]

Notes

Scenario 3: Extreme Fall Wind (Post BMZ)-Hole 12

Head Fire

Surface Fire Rate of Spread (mi/h)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr1	0.5	0.5
gr2	1.7	4.2

Scenario 3: Extreme Fall Wind (Post BMZ)-Hole 12

Head Fire

Surface Fireline Intensity (Btu/ft/s)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr1	67	67
gr2	737	1791

Scenario 3: Extreme Fall Wind (Post BMZ)-Hole 12

Head Fire

Surface Fire Flame Length (ft)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr1	3.1	3.1
gr2	9.4	14.1

Scenario 3: Extreme Fall Wind (Post BMZ)-Hole 12

Head Fire

Spot Dist from a Wind Driven Surface Fire (mi)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr1	0.2	0.4
gr2	0.4	1.1

Discrete Variable Codes Used
Scenario 3: Extreme Fall Wind (Post BMZ)-Hole 12

Fuel Model

101	gr1	Short, sparse, dry climate grass (D)
102	gr2	Low load, dry climate grass (D)

Downwind Canopy Cover

Open	Open

Spotting Source Location

VB	Valley Bottom

Inputs: SURFACE, SPOT

Description		Scenario 4: Extreme Fall Wind (Post BMZ)-Hole 13

Fuel/Vegetation, Surface/Understory

Fuel Model		gr1, gr2

Fuel/Vegetation, Overstory

Downwind Canopy Height	ft	3
Downwind Canopy Cover		Open

Fuel Moisture

1-h Fuel Moisture	%	2
10-h Fuel Moisture	%	3
100-h Fuel Moisture	%	7
Live Herbaceous Fuel Moisture	%	30
Live Woody Fuel Moisture	%	60

Weather

20-ft Wind Speed	mi/h	19, 50
Wind Adjustment Factor		0.4
Wind Direction (from north)	deg	180

Terrain

Slope Steepness	%	4
Site Aspect	deg	0
Ridge-to-Valley Elevation Difference	ft	55
Ridge-to-Valley Horizontal Distance	mi	0.09
Spotting Source Location		VB

Run Option Notes

Maximum effective wind speed limit IS imposed [SURFACE].

Fire spread is in the HEADING direction only [SURFACE].

Wind is in specified directions [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 Fire Rate of Spread (mi/h) [SURFACE]

Surface Fireline Intensity (Btu/ft/s) [SURFACE]

Surface Fire Flame Length (ft) [SURFACE]

(continued on next page)

Input Worksheet (continued)

Spot Dist from a Wind Driven Surface Fire (mi) [SPOT]

Notes

Scenario 4: Extreme Fall Wind (Post BMZ)-Hole 13

Head Fire

Surface Fire Rate of Spread (mi/h)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr1	0.5	0.5
gr2	1.7	4.2

Scenario 4: Extreme Fall Wind (Post BMZ)-Hole 13

Head Fire

Surface Fireline Intensity (Btu/ft/s)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr1	67	67
gr2	736	1791

Scenario 4: Extreme Fall Wind (Post BMZ)-Hole 13

Head Fire

Surface Fire Flame Length (ft)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr1	3.1	3.1
gr2	9.4	14.1

Scenario 4: Extreme Fall Wind (Post BMZ)-Hole 13

Head Fire

Spot Dist from a Wind Driven Surface Fire (mi)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr1	0.2	0.4
gr2	0.4	1.1

Discrete Variable Codes Used
Scenario 4: Extreme Fall Wind (Post BMZ)-Hole 13

Fuel Model

101	gr1	Short, sparse, dry climate grass (D)
102	gr2	Low load, dry climate grass (D)

Downwind Canopy Cover

Open	Open

Spotting Source Location

VB	Valley Bottom

Inputs: SURFACE, SPOT

Description		Scenario 5: Extreme Fall Wind (Post BMZ)-Hole 15

Fuel/Vegetation, Surface/Understory

Fuel Model		gr1, gr2

Fuel/Vegetation, Overstory

Downwind Canopy Height	ft	3
Downwind Canopy Cover		Open

Fuel Moisture

1-h Fuel Moisture	%	2
10-h Fuel Moisture	%	3
100-h Fuel Moisture	%	7
Live Herbaceous Fuel Moisture	%	30
Live Woody Fuel Moisture	%	60

Weather

20-ft Wind Speed	mi/h	19, 50
Wind Adjustment Factor		0.4
Wind Direction (from north)	deg	310

Terrain

Slope Steepness	%	3
Site Aspect	deg	0
Ridge-to-Valley Elevation Difference	ft	60
Ridge-to-Valley Horizontal Distance	mi	0.09
Spotting Source Location		VB

Run Option Notes

Maximum effective wind speed limit IS imposed [SURFACE].

Fire spread is in the HEADING direction only [SURFACE].

Wind is in specified directions [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 Fire Rate of Spread (mi/h) [SURFACE]

Surface Fireline Intensity (Btu/ft/s) [SURFACE]

Surface Fire Flame Length (ft) [SURFACE]

(continued on next page)

Input Worksheet (continued)

Spot Dist from a Wind Driven Surface Fire (mi) [SPOT]

Notes

Scenario 5: Extreme Fall Wind (Post BMZ)-Hole 15

Head Fire

Surface Fire Rate of Spread (mi/h)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr1	0.5	0.5
gr2	1.7	4.2

Scenario 5: Extreme Fall Wind (Post BMZ)-Hole 15

Head Fire

Surface Fireline Intensity (Btu/ft/s)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr1	67	67
gr2	737	1791

Scenario 5: Extreme Fall Wind (Post BMZ)-Hole 15

Head Fire

Surface Fire Flame Length (ft)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr1	3.1	3.1
gr2	9.4	14.1

Scenario 5: Extreme Fall Wind (Post BMZ)-Hole 15

Head Fire

Spot Dist from a Wind Driven Surface Fire (mi)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr1	0.2	0.4
gr2	0.4	1.1

Discrete Variable Codes Used
Scenario 5: Extreme Fall Wind (Post BMZ)-Hole 15

Fuel Model

101	gr1	Short, sparse, dry climate grass (D)
102	gr2	Low load, dry climate grass (D)

Downwind Canopy Cover

Open	Open

Spotting Source Location

VB	Valley Bottom

Inputs: SURFACE, SPOT

Description		Scenario 6: Extreme Fall Wind (Post BMZ)-Hole 15

Fuel/Vegetation, Surface/Understory

Fuel Model		gr1, gr2

Fuel/Vegetation, Overstory

Downwind Canopy Height	ft	3
Downwind Canopy Cover		Open

Fuel Moisture

1-h Fuel Moisture	%	2
10-h Fuel Moisture	%	3
100-h Fuel Moisture	%	7
Live Herbaceous Fuel Moisture	%	30
Live Woody Fuel Moisture	%	60

Weather

20-ft Wind Speed	mi/h	19, 50
Wind Adjustment Factor		0.4
Wind Direction (from north)	deg	200

Terrain

Slope Steepness	%	3
Site Aspect	deg	0
Ridge-to-Valley Elevation Difference	ft	32
Ridge-to-Valley Horizontal Distance	mi	0.07
Spotting Source Location		VB

Run Option Notes

Maximum effective wind speed limit IS imposed [SURFACE].

Fire spread is in the HEADING direction only [SURFACE].

Wind is in specified directions [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 Fire Rate of Spread (mi/h) [SURFACE]

Surface Fireline Intensity (Btu/ft/s) [SURFACE]

Surface Fire Flame Length (ft) [SURFACE]

(continued on next page)

Input Worksheet (continued)

Spot Dist from a Wind Driven Surface Fire (mi) [SPOT]

Notes

Scenario 6: Extreme Fall Wind (Post BMZ)-Hole 15

Head Fire

Surface Fire Rate of Spread (mi/h)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr1	0.5	0.5
gr2	1.7	4.2

Scenario 6: Extreme Fall Wind (Post BMZ)-Hole 15

Head Fire

Surface Fireline Intensity (Btu/ft/s)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr1	67	67
gr2	736	1791

Scenario 6: Extreme Fall Wind (Post BMZ)-Hole 15

Head Fire

Surface Fire Flame Length (ft)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr1	3.1	3.1
gr2	9.4	14.1

Scenario 6: Extreme Fall Wind (Post BMZ)-Hole 15

Head Fire

Spot Dist from a Wind Driven Surface Fire (mi)

Fuel Model	20-ft Wind Speed mi/h	
	19	50
gr1	0.2	0.4
gr2	0.4	1.1

Discrete Variable Codes Used
Scenario 6: Extreme Fall Wind (Post BMZ)-Hole 15

Fuel Model

101	gr1	Short, sparse, dry climate grass (D)
102	gr2	Low load, dry climate grass (D)

Downwind Canopy Cover

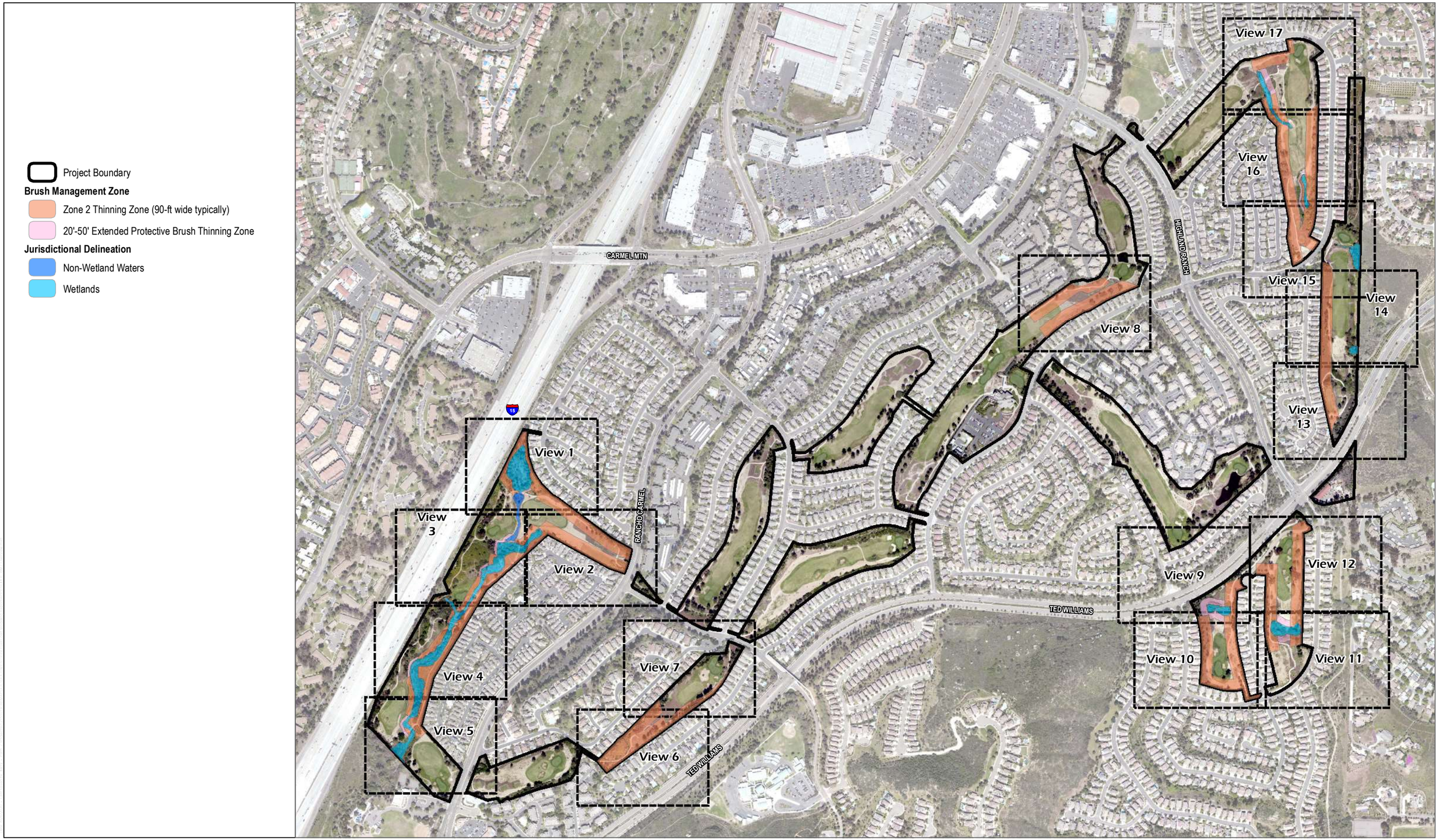
Open	Open

Spotting Source Location

VB	Valley Bottom

Appendix F

Brush Management Plan



SOURCE: AERIAL-SANGIS 2017

DUDEK

0 355 710 Feet

APPENDIX F

Brush Management Plan Overview

The Trails at Carmel Mountain Ranch - Fire Fuel Load Modeling Report

SOURCE: AERIAL-SANGIS 2017

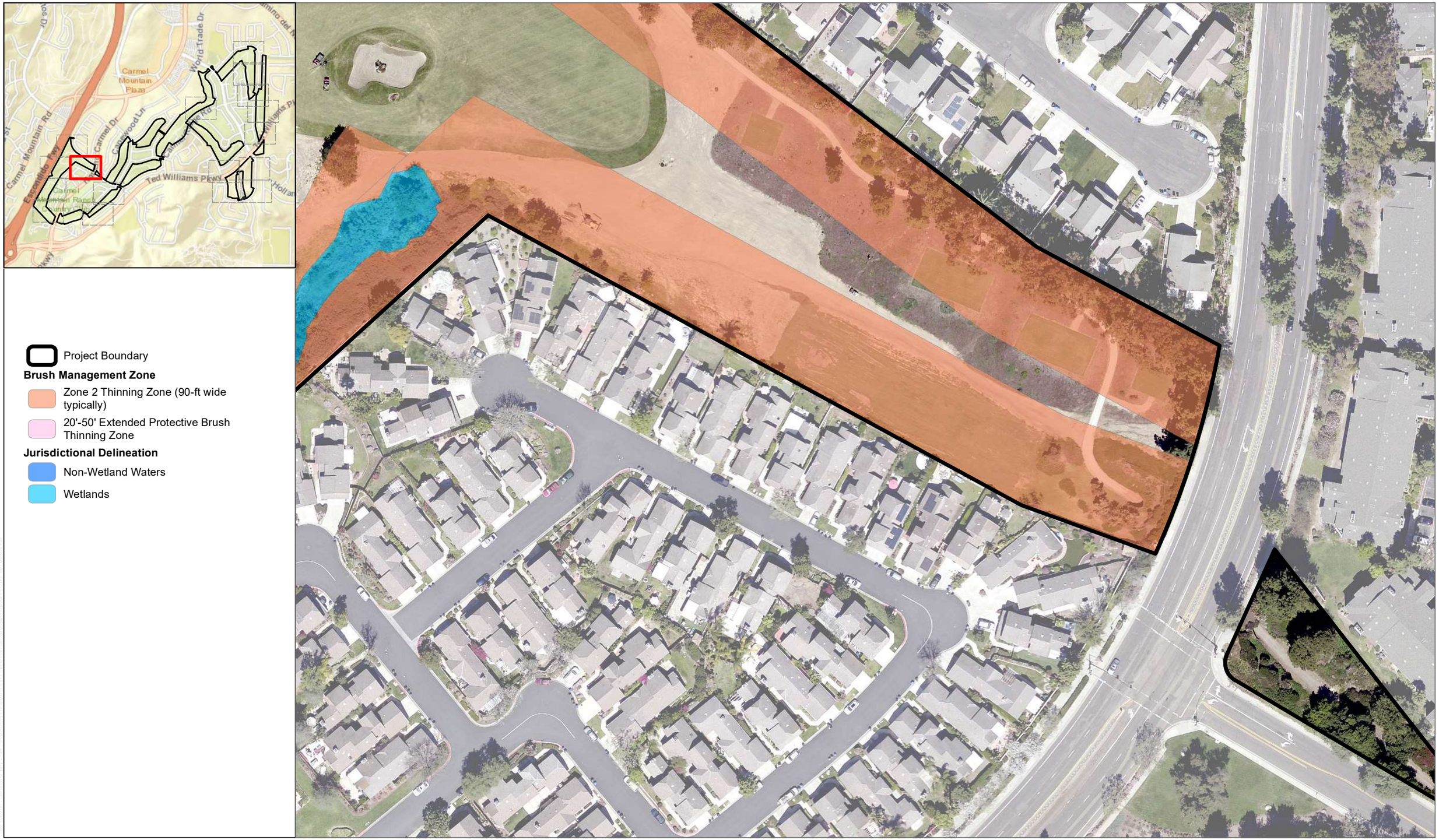
DUDEK

0 40 80 Feet

APPENDIX F - View 1

Brush Management Plan

The Trails at Carmel Mountain Ranch - Fire Fuel Load Modeling Report



SOURCE: AERIAL-SANGIS 2017

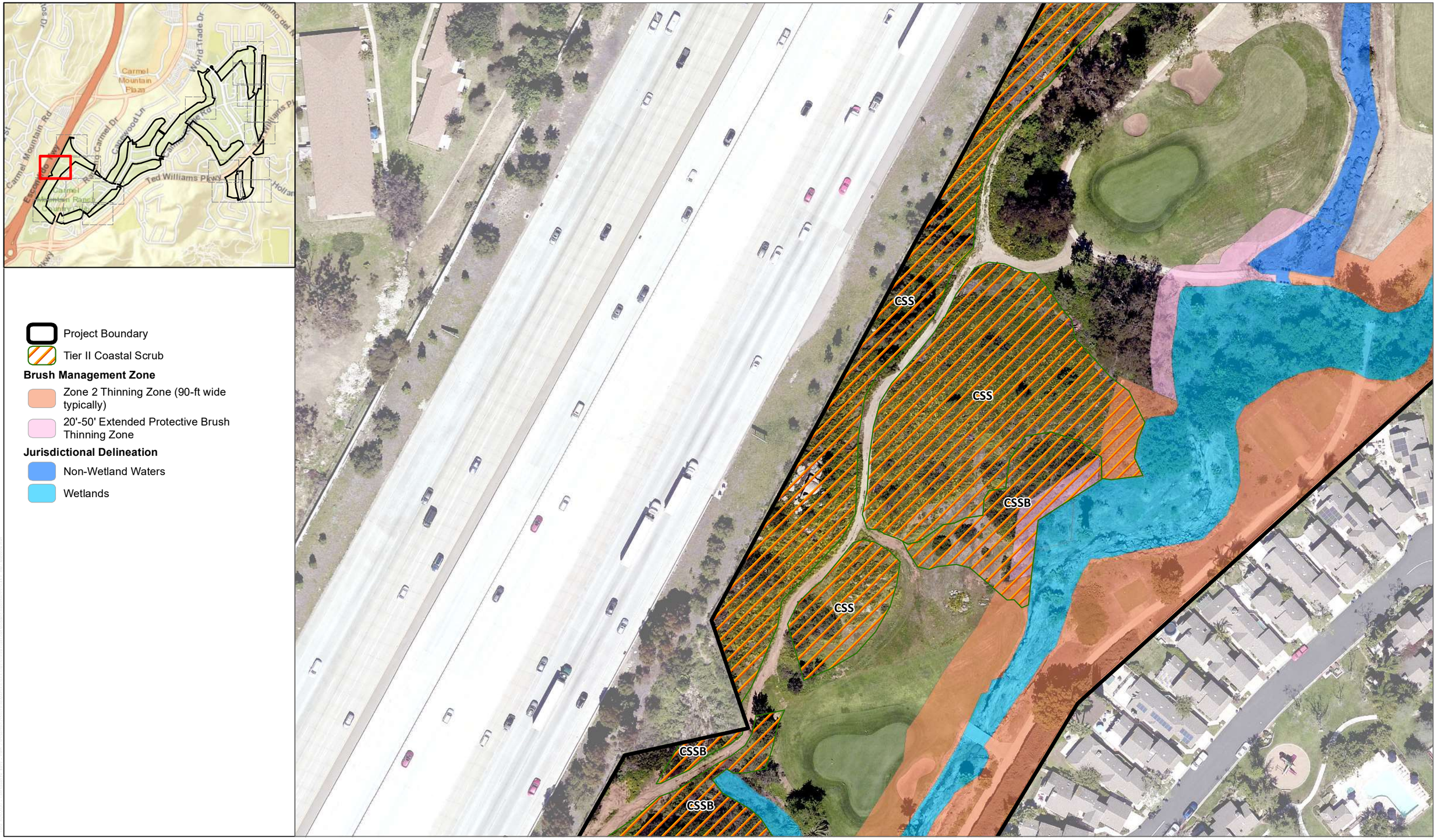
DUDEK

0 40 80 Feet

APPENDIX F - View 2

Brush Management Plan

The Trails at Carmel Mountain Ranch - Fire Fuel Load Modeling Report



SOURCE: AERIAL-SANGIS 2017

DUDEK

0 40 80 Feet

APPENDIX F - View 3

Brush Management Plan

The Trails at Carmel Mountain Ranch - Fire Fuel Load Modeling Report

SOURCE: AERIAL-SANGIS 2017

DUDEK

0 40 80 Feet

APPENDIX F - View 4

Brush Management Plan

The Trails at Carmel Mountain Ranch - Fire Fuel Load Modeling Report

SOURCE: AERIAL-SANGIS 2017

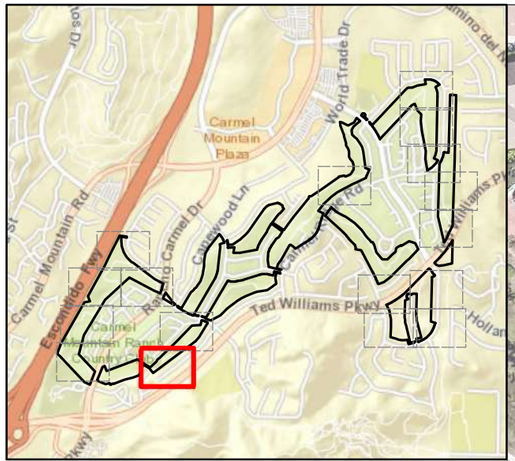
DUDEK

0 40 80 Feet

APPENDIX F - View 5

Brush Management Plan

The Trails at Carmel Mountain Ranch - Fire Fuel Load Modeling Report



Project Boundary

Tier II Coastal Scrub

Brush Management Zone

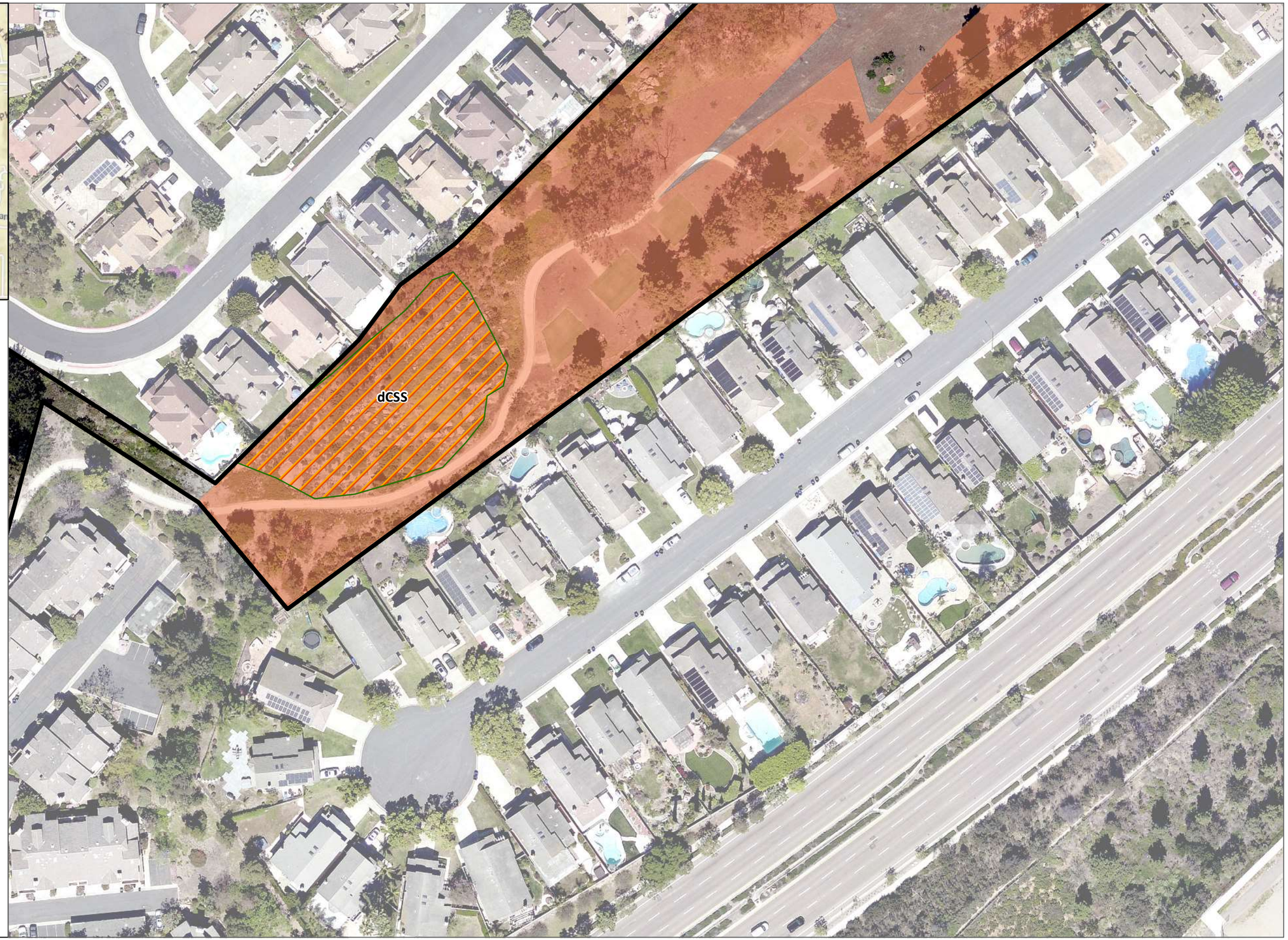
Zone 2 Thinning Zone (90-ft wide typically)

20'-50' Extended Protective Brush Thinning Zone

Jurisdictional Delineation

Non-Wetland Waters

Wetlands



SOURCE: AERIAL-SANGIS 2017

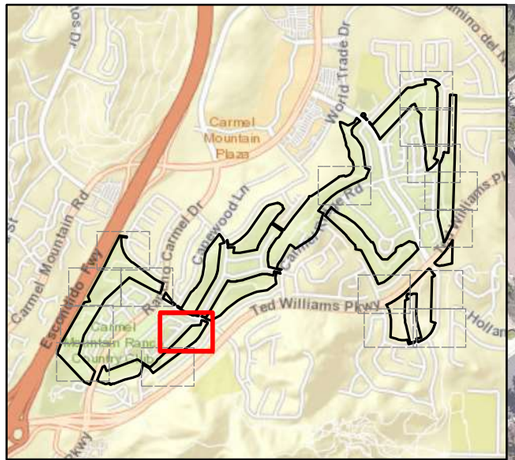
DUDEK

0 40 80 Feet

APPENDIX F - View 6

Brush Management Plan

The Trails at Carmel Mountain Ranch - Fire Fuel Load Modeling Report



Project Boundary

Brush Management Zone

- Zone 2 Thinning Zone (90-ft wide typically)
- 20'-50' Extended Protective Brush Thinning Zone

Jurisdictional Delineation

- Non-Wetland Waters
- Wetlands

SOURCE: AERIAL-SANGIS 2017

DUDEK

0 40 80 Feet

APPENDIX F - View 7

Brush Management Plan

The Trails at Carmel Mountain Ranch - Fire Fuel Load Modeling Report

SOURCE: AERIAL-SANGIS 2017

DUDEK

0 40 80 Feet

APPENDIX F - View 8

Brush Management Plan

The Trails at Carmel Mountain Ranch - Fire Fuel Load Modeling Report

SOURCE: AERIAL-SANGIS 2017

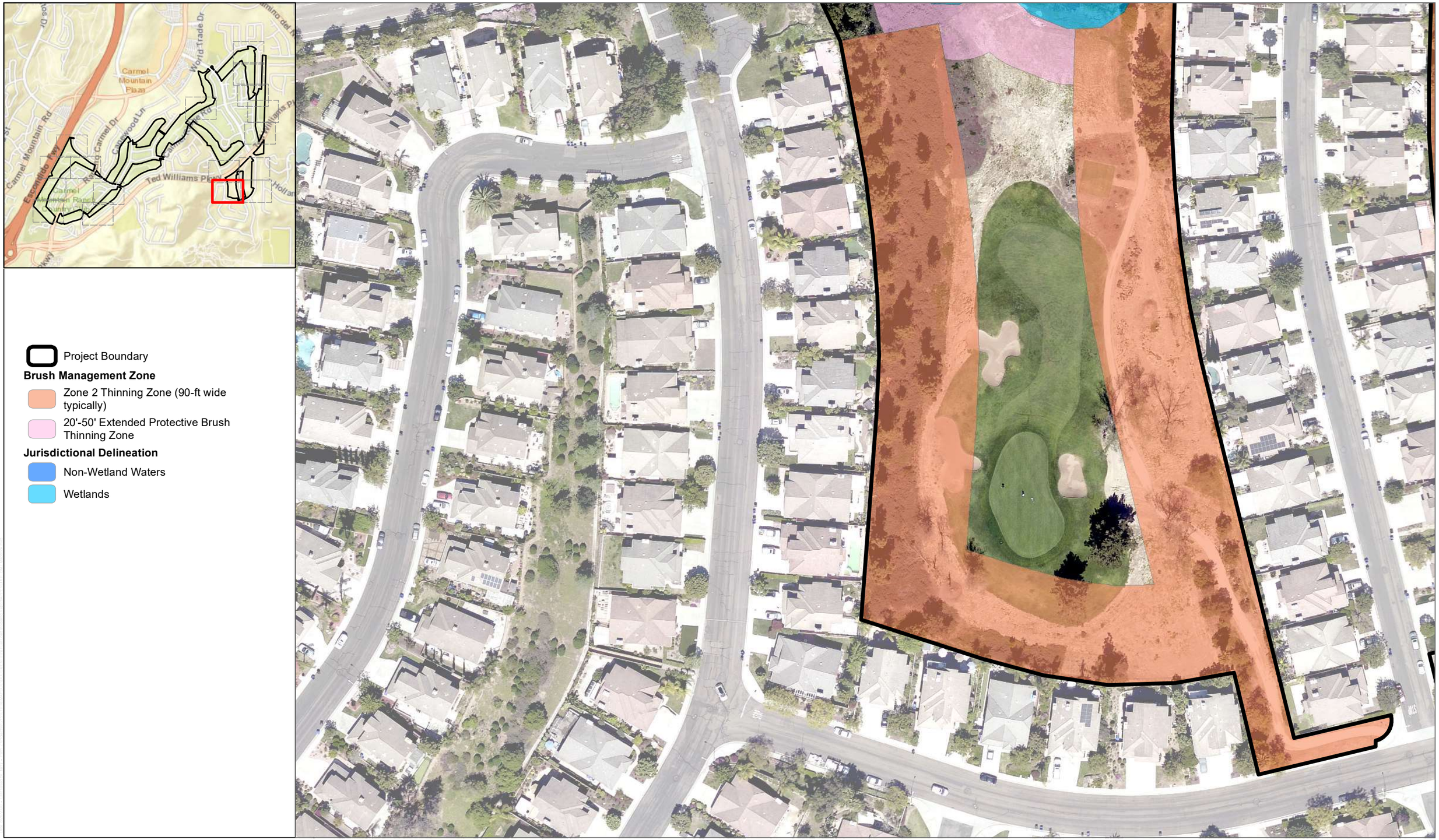
DUDEK

0 40 80 Feet

APPENDIX F - View 9

Brush Management Plan

The Trails at Carmel Mountain Ranch - Fire Fuel Load Modeling Report



SOURCE: AERIAL-SANGIS 2017

DUDEK

0 40 80 Feet

APPENDIX F - View 10

Brush Management Plan

The Trails at Carmel Mountain Ranch - Fire Fuel Load Modeling Report

SOURCE: AERIAL-SANGIS 2017

DUDEK

0 40 80 Feet

APPENDIX F - View 11

Brush Management Plan

The Trails at Carmel Mountain Ranch - Fire Fuel Load Modeling Report

SOURCE: AERIAL-SANGIS 2017

DUDEK

0 40 80 Feet

APPENDIX F - View 12

Brush Management Plan

The Trails at Carmel Mountain Ranch - Fire Fuel Load Modeling Report

SOURCE: AERIAL-SANGIS 2017

DUDEK

0 40 80 Feet

APPENDIX F - View 13

Brush Management Plan

The Trails at Carmel Mountain Ranch - Fire Fuel Load Modeling Report

SOURCE: AERIAL-SANGIS 2017

DUDEK

0 40 80 Feet

APPENDIX F - View 14

Brush Management Plan

The Trails at Carmel Mountain Ranch - Fire Fuel Load Modeling Report

SOURCE: AERIAL-SANGIS 2017

DUDEK

0 40 80 Feet

APPENDIX F - View 15

Brush Management Plan

The Trails at Carmel Mountain Ranch - Fire Fuel Load Modeling Report

SOURCE: AERIAL-SANGIS 2017

DUDEK

0 40 80 Feet

APPENDIX F - View 16

Brush Management Plan

The Trails at Carmel Mountain Ranch - Fire Fuel Load Modeling Report

SOURCE: AERIAL-SANGIS 2017

DUDEK

0 40 80 Feet

APPENDIX F - View 17

Brush Management Plan

The Trails at Carmel Mountain Ranch - Fire Fuel Load Modeling Report