DRAFT

City of Oakland, California
Vegetation Management Plan

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ACRONYMS AND ABBREVIATIONS

Acronym	Definition
BAAQMD	Bay Area Air Quality Management District
BMP	best management practice
CAL FIRE	California Department of Forestry and Fire Protection
CAL-IPC	California Invasive Plant Council
CEQA	California Environmental Quality Act
City	City of Oakland
CSSC	Chabot Space and Science Center
CWPP	The Alameda County Community Wildfire Protection Plan
EBMUD	East Bay Municipal Utility District
EBRPD	The East Bay Regional Park District
EIR	Environmental Impact Report
FHSZ	Fire Hazard Severity Zone
GIS	geographic information system
HCP	Habitat Conservation Plan
Horizon	Horizon Water and Environment
Intermix	Wildland Urban Intermix
OFD	Oakland Fire Department
PRC	California Public Resources Code
USFWS	U.S. Fish and Wildlife Service
VHFHSZ	Very High Wildfire Hazard Severity Zone
VMP	Vegetation Management Plan
VOC	volatile organic compound
WHR	California Wildlife Habitat Relationship System
WUI	Wildland Urban Interface

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1 INTRODUCTION

The Oakland Hills exhibits a complex wildfire environment that presents a significant risk to public and firefighter safety and the built and natural environment. This region has been subject to numerous damaging wildland fires, is influenced by local extreme wind and weather conditions (including Diablo wind events), has steep and varied terrain, and enjoys a complex mosaic of native and introduced vegetation. It is one of the highest risk areas in the country for devastating wildland urban interface (WUI) fires, including the state's most destructive wildfire, the 1991 Tunnel Fire, which destroyed 2,900 structures, injured more than 150 people, and killed 25 people (CAL FIRE 2017). The portion of the Oakland Hills within the City of Oakland (City) has been designated a Very High Wildfire Hazard Severity Zone (VHFHSZ).

Of the variables that comprise the wildland fire environment (weather, terrain, and fuels [vegetation]), vegetation is the only variable that can be managed. The goal of vegetation management, as identified in this Vegetation Management Plan (VMP), is not to remove all vegetation wholesale, but to target vegetation management activities to minimize the potential for ignitions, crown fires, and extreme fire behavior by reducing and maintaining fuel loads and altering the structure, composition, and spacing of retained vegetation. Conducted in strategic and prioritized locations, vegetation management enhances fuel/fire breaks, provides defensible space around structures and assets, provides space for staging areas, and enhances ingress and egress routes. Managing vegetation at City-owned parcels and along roadways also creates strategic fuel breaks. These fuel breaks function to compartmentalize wildfires, modify their progression patterns across the landscape, and improve the ability to control or combat wildfire once started.

This VMP outlines a framework for managing fuel loads and vegetation arrangements on City-owned properties and along roadways in the City's VHFHSZ and acknowledges that vegetation is a dynamic component to wildfire hazard necessitating an adaptive management approach. The goals, objectives, and recommendations identified in this plan are based on existing field conditions and the principles of vegetation management for fire hazard reduction and have been identified and prioritized to reduce and maintain lower fuel loads in high fire hazard areas (FEMA 1992). This VMP also identifies best management practices (BMPs) to be implemented during vegetation management activities to reduce or avoid impacts to natural resources present in the Plan Area. (A glossary of terms used in this VMP is provided in Appendix A.)

This VMP has been prepared with stakeholder input gained through a variety of outreach efforts including questionnaire responses, direct written comments, and stakeholder outreach meetings. Additionally, stakeholders will have the opportunity to review and comment on this Draft VMP and provide the City with feedback. This VMP also acknowledges that vegetation management is

one component of fire hazard reduction in the Oakland Hills and that the Oakland Fire Department (OFD) and other City departments are actively engaged in fire hazard reduction efforts being implemented through other plans and programs. Finally, the goals, objectives, and management recommendations in this VMP are consistent with Objective CO-10 and Policy CO-10.1 of the Open Space Conservation and Recreation Element of the City of Oakland General Plan (City of Oakland 1996), which call for managing vegetation to minimize the risk of catastrophic wildfire.

1.1 Purpose

The fire hazard condition present in the Oakland Hills necessitates a proactive hazard mitigation approach, a component of which is vegetation management. All vegetation will burn; however, vegetation can be managed to minimize the potential for ignition, facilitate suppression activities, and reduce the likelihood of extreme fire behavior. The biological, ecological, and community resources present in the Plan Area must also be considered in developing this VMP. Therefore, the purpose of this VMP is to evaluate the specific wildfire hazard factors in the Plan Area and provide a framework for managing vegetative fuel loads on City-owned properties and along roadways within the City's VHFHSZ such that wildfire hazard is reduced and negative environmental effects resulting from vegetation management activities are avoided or minimized. While this VMP is intended to be a stand-alone document, the information and recommendations presented herein will be used by OFD in evaluating vegetation management needs on an ongoing basis. This VMP will also be a critical component to the overall fire hazard mitigation effort being conducted by OFD in the Oakland Hills. Finally, nothing in this VMP shall be construed to create a duty for OFD to conduct fire inspections beyond what state and local law already require.

1.2 Plan Area Location

For the purposes of this VMP, the Plan Area encompasses City-owned parcels and the areas within 30 feet of the edge of roadsides located within the City's VHFHSZ, as defined in Section 4904.3 of the Oakland Fire Code (Oakland Municipal Code Chapter 15.12). Specifically, the Plan Area includes:

- 422 City-owned parcels, ranging in size from <0.1 acres to 235 acres and totaling 1,925 acres. Parcels have been categorized into the following categories, as described in Section 9.2: urban and residential, canyon areas, ridgetop areas, City park lands and open space, other areas, and medians.
- Roadside areas along 308 miles of road within the City's VHFHSZ, which includes surface and arterial streets, State Routes 13 and 24, and Interstate 580.

The City's VHFHSZ encompasses approximately 11,890 acres and extends along the western slope of the Oakland Hills. The extent of the City's VHFHSZ is presented in Figures 1 and 2, and a detailed description of the Plan Area is presented in Section 2. Table 1 summarizes the sizes and quantities of City-owned parcels in the Plan Area.

Table 1
City-Owned Parcels within the Plan Area

Parcel Category	Quantity	Total Acreage
Urban and Residential	191	59.2
Canyon Areas	85	185.7
Ridgetop Areas	11	130.2
City Park Lands and Open Space	90	1,522.8
Other Areas*	13	21.2
Medians	32	5.8
Total:	**422**	**1,924.9**

Note:
* Other Areas are developed City-owned properties in the Plan Area that include fire stations (nos. 21 and 25), City facilities (parking lots, police stations), and parks and playgrounds (e.g., Montclair Park).

1.3 Plan Scope and Timeframe

The scope of this VMP covers all existing and recommended vegetation management and appurtenant actions occurring on City-owned parcels or along the edge of public roads within the Plan Area. This VMP recognizes that vegetative fuels are one component of wildfire hazard. Vegetation management is a fundamental strategy to reducing fire risk in the Plan Area, and a single component within a multi-faceted approach that is necessary to comprehensively reduce wildfire risk in the Plan Area. Other critical components necessary to reduce wildfire risk include structural hardening through building codes and standards, providing and maintaining suitable access and egress routes, ensuring water availability, firefighter training, and establishment, maintenance, and inspection of defensible space on private properties. OFD and other City departments are addressing these other components of wildfire risk reduction through various plans and programs, including public outreach and fire prevention education and training, roving fire patrols, private property defensible space inspections, and adoption of codes for structures in VHFHSZs. Consequently, this VMP focuses exclusively on vegetation management in the Plan Area and is intended to complement other wildfire risk reduction plans and programs being planned or implemented by OFD and other City departments. Readers and stakeholders are directed to the City's other plans and programs to address other aspects of wildfire risk reduction in the Plan Area. The purpose and focus of this VMP is vegetation management.

The timeframe for this VMP is 10 years. The goals, objectives, methods, and recommendations contained herein should be reviewed at the end of the 10-year timeframe, following a re-evaluation of Plan Area's wildfire hazard conditions and the success of vegetation management actions implemented over the 10-year VMP timeframe. Following such a subsequent review, revisions to VMP goals, objectives, methods, or recommendations may be necessary to reflect wildfire hazard conditions within the Plan Area at a later time.

1.4 Vegetation Management Goals and Objectives

The OFD has identified four primary goals to guide preparation of this VMP and subsequent vegetation management actions implemented to follow this VMP intended to reduce wildfire hazard. The VMP goals provide a framework under which more specific management objectives and recommendations were developed, as presented in this VMP. The goals of the VMP are as follows:

- Reduce wildfire hazard on City-owned land and along critical access/egress routes within the City's designated VHFHSZ;
- Reduce the likelihood of ignitions and extreme fire behavior to enhance public and firefighter safety;
- Implement practices to avoid or minimize impacts to natural resources;
- Maintain an active role in regional efforts to reduce wildfire hazard in the Oakland Hills.

SOURCE: ESRI 2017; City of Oakland 2017

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0 5,000 10,000 Feet

FIGURE 1

Regional Map

Draft Vegetation Management Plan - City of Oakland, California

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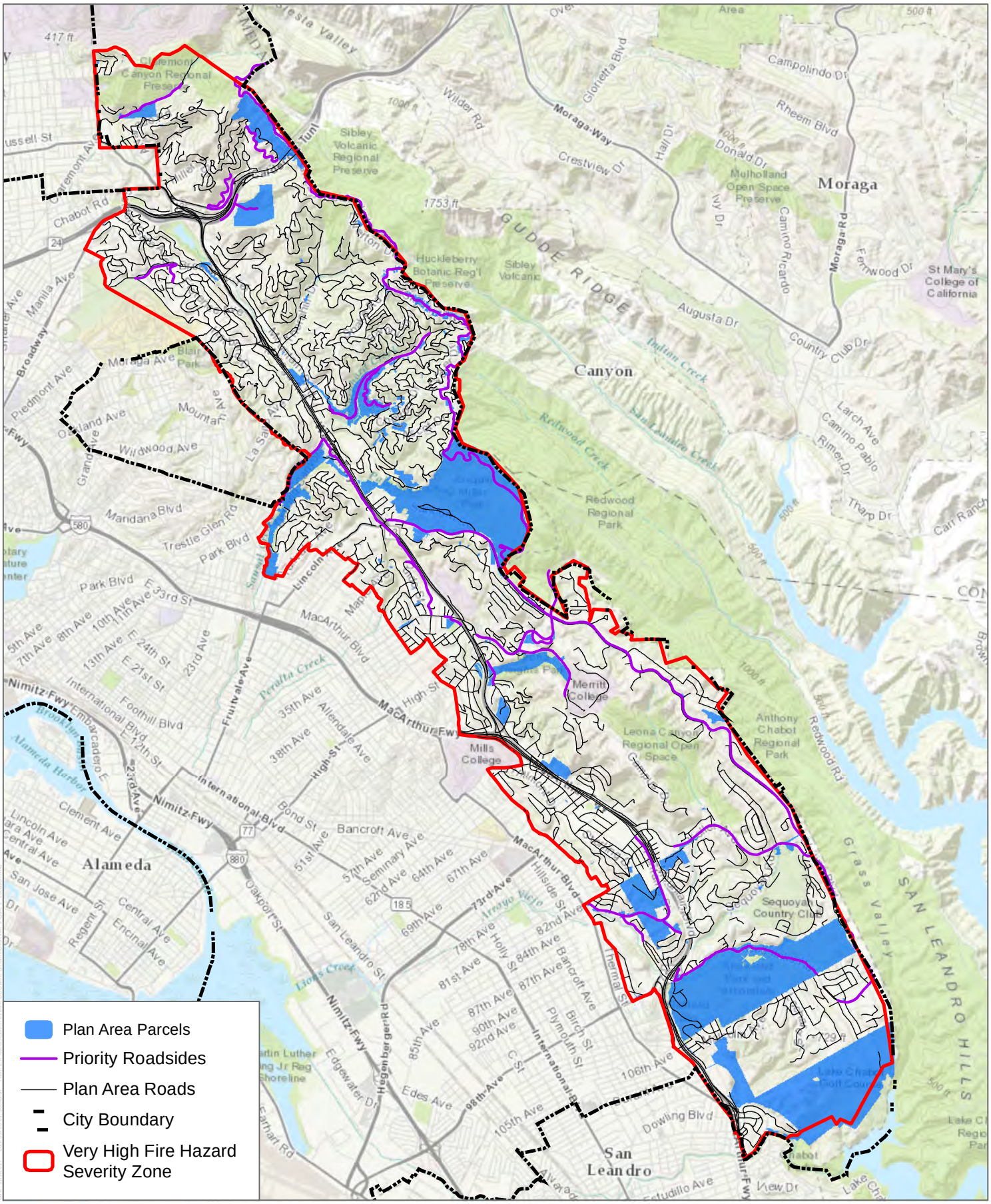

SOURCE: ESRI 2017; City of Oakland 2017

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FIGURE 2

Location Map

Draft Vegetation Management Plan - City of Oakland, California

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To achieve these vegetation management goals for the Plan Area and over the VMP timeframe, objectives were developed to achieve desired levels of wildfire hazard reduction, public and firefighter safety, and resource protection. The purpose of the objectives is to enable the OFD to make informed, adaptive decisions according to site-specific conditions and prepare annual vegetation management action plans that meet VMP goals over time. The objectives of the VMP are as follows:

- Reduce the likelihood of catastrophic wildfires by limiting ignition potential, reducing fuel loads, and modifying fuel arrangements on City-owned lands.
- Reduce the likelihood of extreme fire behavior within the Plan Area.
- Identify and define vegetation management actions that consider site-specific vegetation type, fuel hazard, treatment effectiveness, and ongoing maintenance requirements.
- Identify and prioritize fuel treatment areas based on fuel loads and arrangements, terrain, topographic exposure, and proximity to roads and structures.
- Retain vegetation where feasible to reduce wind exposure, retain soil and surface fuel moisture, and reduce the potential for soil erosion.
- Develop management recommendations that enable OFD to make informed, adaptive decisions on an annual basis (or more often as necessary) regarding vegetation management within the Plan Area, considering the benefits of treatment, potential environmental effects, and treatment costs.
- Avoid, minimize and/or reduce potential adverse effects of vegetation management on sensitive biological resources, water resources, aesthetics, soils, and slope stability.
- Increase the ability of OFD and other responding agencies to suppress wildfire in the Plan Area in order to minimize wildfire impacts to Plan Area resources.
- Routinely evaluate the effectiveness and implementation frequency of vegetation management actions within the Plan Area.

1.5 Summary of Plan and Hazard Assessment Methodology

Development of this VMP included an assessment of wildfire hazard within the Plan Area and an evaluation of variables that contribute to wildfire risk. The following components comprise the hazard assessment methodology conducted for this VMP:

- **Field Assessments:** Conducted to identify vegetative communities and land cover types, fuel characteristics, fuel models, terrain, and hazard conditions in the Plan Area.

- **Geographic Information Systems (GIS) Analysis:** Conducted to evaluate conditions in the Plan Area, including terrain, vegetative cover, land ownership, City-owned parcel distribution, the area of land within 100 and 300 feet of existing structures, and the extent and distances of Plan Area roads.
- **Fire Behavior Modeling:** Conducted in a GIS for selected larger parcels to identify areas that may be subject to extreme fire behavior, considering weather, fuels, and terrain variables.
- **Research:** Conducted to document existing vegetation management practices used by OFD and to identify anecdotal evidence of areas subject to high ignition potential.

This assessment allowed for the prioritization of vegetation treatment areas within the Plan Area, which was based on several factors, including proximity to structures (e.g., WUI), areas along critical access/egress routes, areas subject to increased ignition potential, and areas that exhibit the potential for extreme fire behavior. A more detailed discussion of the methodology is presented in Section 3.

2 PLAN AREA DESCRIPTION

The fire environment comprises several factors. Fires can occur in any environment where conditions are conducive to ignition and fire movement. The three major components of the fire environment are climate, topography, and vegetation/fuel. The state of each of these components and their interaction with each other determine the potential characteristics and behavior of a wildfire at any given moment. Understanding these existing conditions is necessary to understanding the potential for wildfire within the Plan Area.

Wildfires are a regular and natural occurrence in most of California. However, the numbers of fires and acres burned annually has increased in recent years. These wildfires are mostly human-triggered, suggesting that the historic fire interval has been artificially affected across large areas. In addition, wildfire suppression[1] efforts over the last several decades may have aided in the accumulation of fuels in some natural communities (Minnich 1983; Minnich and Chou 1997) resulting in larger and more intense wildfires. Large wildfires have had, and will continue to have, a substantial and recurring role in native California landscapes (Keeley and Fotheringham 2003), in part because (1) native landscapes become highly flammable each fall, (2) the climate in the region has been characterized by fire climatologists as the worst fire climate in the United States (Keeley 2004) with Diablo winds occurring during autumn after a 6-month drought period each year, and (3) ignitions via anthropogenic sources have increased or are increasing in many wildland or WUI areas.

Based on available information and an understanding of the fire environment, it is expected that wildfires will occur again and will burn within the Plan Area. In addition, the Plan Area is that which is classified by the City as a VHFHSZ (Chapter 49, Oakland Fire Code). The Very High Fire Hazard rating is based on a combination of relevant factors of fuel/vegetation, terrain, and climate/weather. Fire Hazard Severity zoning is discussed in more detail in Section 2.5.

2.1 Climate

The climate in the Plan Area is influenced by the maritime locale adjacent to the San Francisco Bay (Bay) and is frequently under the influence of a seasonal, migratory, subtropical high-pressure cell known as the Pacific High (WRCC 2017a). Wet winters and dry summers with mild seasonal changes generally characterize the San Francisco Bay climate. This climate pattern is

[1] The act of extinguishing a wildfire.

occasionally interrupted by heat waves, cold snaps, isolated thunderstorms, fog, or dry easterly (or northeasterly) winds (WRCC 2017a), known locally as "Diablo" winds.[2]

The great majority of precipitation in the Plan Area occurs during the winter months due to the migration of mid-latitude cyclonic storms (fronts) arriving to the California coast. Rainfall amounts generally increase with elevation along the East Bay Hills due to orographic lifting and cooling processes. Although not typically associated with increased fire risk due to the cooler seasonal temperatures and moister conditions, development of strong mid-winter high pressure conditions also results in off-shore Diablo-type winds in the winter season. Winter cold snaps can occur when frigid high latitude or arctic air masses descend to California.

Live fuel moisture content, a measure of the relative mass of water and indicator of ignitability, for most vegetation in the Oakland Hills reaches the driest point in the late summer, or early fall period. Seasonal drying of vegetation produces conditions that can result in fuel-driven wildfires and fire-associated climatic changes. This condition is referred to as a plume-dominated wildfire. Plume-dominated wildfires are fires where the energy produced by the fire in conjunction with atmospheric instability creates significant convective forces and increased wind speeds. Such fires are extremely unpredictable, spread in various directions simultaneously, and exhibit extreme fire behavior. These fires are extremely dangerous and are often large.

The average annual high temperature calculated from January 1948 to June 2016 for the Oakland area is approximately 65.0º Fahrenheit (F), with higher temperatures in summer and early fall (June through September) reaching up to an average of 73.4°F (WRCC 2017b). The average annual low temperature is 50.0°F, and winter low temperatures are routinely between 42°F and 50°F. The average annual precipitation for the area is 18.03 inches, with the most rainfall concentrated in the months of November (2.52 inches), December (3.11 inches), January (3.71 inches), February (2.71 inches), and March (2.57 inches) (WRCC 2017b). Rainfall is much less during summer months of June (0.18 inches), July (0.04 inches), and August (0.05 inches) (WRCC 2017b).

The regional prevailing wind pattern is from the west or northwest, but the presence of the Pacific Ocean causes a diurnal wind pattern known as the land/sea breeze system. During the day, onshore winds are from the west and travel from the Bay, up the hillslopes and canyons, to the ridgetop of the Oakland Hills. At night, gentler offshore winds, derived from cooler air masses moving downslope, are from the east, and travel from the ridgetop, down the hillslopes

[2] Diablo winds are warm, dry winds that flow downslope when stable, high-pressure air is forced across and down the lee slopes of a mountain/hill range (e.g., Oakland Hills). Diablo winds are similar to Santa Ana winds in Southern California.

and canyons, toward the Bay. During the summer season, the diurnal winds can be slightly stronger 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 varied topography of the Oakland Hills affects wind velocity and patterns. The highest wind velocities are typically associated with downslope, canyon, and Diablo winds.

Summer fog is an important element of the Bay Area and East Bay Hills microclimates. The generation of Bay fog involves a combination of local and regional atmospheric and topographic processes occurring at daily and seasonal cycles. Warming land surfaces in California's Central Valley during the summer season rise and create an on-shore, generally westerly, wind direction along the central California coastline. This wind carries marine air over the cool coastal waters (subject to the southerly California Current). The marine air masses are cooled to saturation, fog is formed, and by advection the fog moves inland, favoring gaps in the coast range where it can penetrate. The summer advective fog season in the Bay Area is most pronounced in June, July, and into August, but such fog may generate earlier in May and also into the later summer and fall weeks of September.

In the Plan Area, such summer fog typically arrives in the late afternoon or evening and persists through the mid to late morning before "burning off," which is essentially evaporation with the morning sun. Summer fog in the Plan Area is an important influence to local atmospheric, plant, and soil moisture (the water balance), and thereby directly influences the component of the fire risk due to climate. In the Plan Area, heavy fog is even known to generate measurable fog drip precipitation, when moisture coalesces along tree leaves, branches, and trunks.

During periods when the low-pressure gradient of the Central Valley ceases or reverses, the atmospheric pressure and wind gradients that drive the great San Francisco Bay "fog machine" described above stop. When this happens, on-shore flows are reversed to off-shore flows, potentially creating strong Diablo winds, with the overall effect that atmospheric, plant, and soil moisture rapidly decreases. This increased aridity in turn increases the fire risk. The reduction in summer fog and increase in local aridity and off-shore Diablo winds is most intense in the later summer and fall weeks of September, October, and early November when the Oakland Hills frequently experience clear skies and warmer temperatures.

The fire season in the Oakland Hills typically starts in September, as the fog recedes earlier in the day and vegetation begins to dry out from regular, dry, offshore winds. The fire season typically ends in November with the onset of winter rainfall, cooler temperatures, and higher relative humidity. Fires are less common between December and August. The highest fire danger for this area coincides with period when the Diablo winds are at their strongest. Diablo wind conditions are a reversal of the prevailing westerly onshore winds that usually occur on a region-

wide basis during late summer and early fall. These winds are warm, dry winds that flow from the warmer, drier inland area east, over the crest of the Oakland Hills, and down through canyons to the Bay. As the winds 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 the Bay. In extreme cases, wind speeds can exceed 60 miles per hour.

Micro-climates, the climate of a small, restricted area, also characterize the Oakland Hills due significant variations in topography. Micro-climates in the area range from low-elevation, wind-sheltered, and damp locations with northerly or easterly aspects (e.g., lower portions of Claremont Canyon, Shepherd Canyon, Sausal Creek), to high-elevation, wind-exposed and dry locations with southerly or westerly aspects (e.g., Grizzly Peak Open Space, North Oakland Regional Sports Field, lots along Skyline Boulevard). Microclimate conditions can greatly affect fire hazard, and should be considered when determining vegetation treatment priorities and implementation timing. Such conditions are often not captured in weather station datasets or recorded in easily referenced weather almanacs, but are usually well known to locals, land managers, and local agency fire personnel.

2.2 Topography

The Oakland Hills area is located in the steep coastal mountains to the east of the San Francisco Bay known as the East Bay Hills. The hillslopes and canyons meet the Bay plain to the west and slope upward to the northwest–southeast-oriented ridgeline to the east. The lowest elevations in the City's VHFHSZ are approximately 70 feet above mean sea level at the bottoms of Arroyo Viejo and San Leandro Creek (USGS 2013a, 2013b). The highest elevations are in the northern portion of the City's VHFHSZ (approximately 1,500 feet above mean sea level near Grizzly Peak (USGS 2013a, 2013b).

The City's VHFHSZ is characterized by multiple drainages that run generally east to west, or northeast to southwest, downward from the summit ridgeline that roughly parallels Grizzly Peak Boulevard and Skyline Drive. Listed in general north to south order, prominent watersheds and drainages include Claremont Canyon, Temescal Creek, Shepherd Creek, Palo Seco Creek, Sausal Creek, Horseshoe Creek, Rifle Range Branch (Creek), Country Club Creek, Arroyo Viejo, Grass Valley Creek, and San Leandro Creek. The creeks in the City's VHFHSZ generally converge into a few larger creeks in the lower Bay plain region, ultimately reaching the San Francisco Bay. The steepest slopes in the City's VHFHSZ have gradients up to 62 degrees (186%), although the majority of the area has slope gradients of less than 27 degrees (50%), and the mean slope gradient for the area is 16 degrees (29%) (USGS 2013a, 2013b).

All slope aspects are represented in the City's VHFHSZ, with a higher proportion of south-, southwest-, and west-facing slopes present. The effect of aspect on fire hazard is related to solar

exposure. South and west-facing slopes are subject to more thermal heating from the sun and consequently have higher temperatures and lower fuel moistures. These slope aspects are typically dominated by lighter fuels (brush, grasses). North- and east-facing slopes receive less solar exposure and are therefore cooler and typically have heavier fuel loads (trees).

Topography affects wildfire movement and spread. Steep terrain typically results in faster upslope fire spread due to pre-heating of uphill vegetation. Flat areas typically result in slower fire spread, absent of windy conditions. Topographic features such as saddles, canyons, and chimneys (land formations that collect and funnel heated air upward along a slope) may form unique circulation conditions that concentrate winds and funnel or accelerate fire spread. For example, fire generally moves slower downslope than upslope. Terrain may also buffer, shelter, or redirect winds away from some areas based on canyons or formations on the landscape. Saddles occurring at the top of drainages or ridgelines may facilitate the migration of wildfire from one canyon to the next.

The narrow drainage and sub-drainage topographic features of the Oakland Hills have the capability to funnel winds, increase wind speeds, erratically alter wind direction, and facilitate fire spread and promote extreme fire behavior. This is especially true during Diablo wind events, when strong easterly or northeasterly winds are aligned with the downslope direction of the canyons and watersheds of the Oakland Hills. The topography of the Oakland Hills is therefore capable of producing wind conditions that promote extreme wildfire behavior.

Various terrain features can also influence fire behavior, as summarized in Table 2. Plan Area terrain is graphically presented in Figures 3.1 through 3.10.

Table 2
Effects of Topographic Features on Fire Behavior

Topographic Feature	Effect
Narrow Canyon	Surface winds follow canyon direction, which may differ from prevailing wind; wind eddies/strong upslope air movement expected, which may cause erratic fire behavior; radiant heat transfer between slopes facilitates spotting/ignition on opposite canyon side.
Wide Canyon	Prevailing wind direction not significantly altered; aspect significant contributor to fire behavior. Wide canyons not as susceptible to cross-canyon spotting except in high winds.
Box Canyon/Chute	Air drawn in from canyon bottom; strong upslope drafts. No gaps or prominent saddles to let heated air escape. Fires starting at canyon bottom can move upslope very rapidly due to a chimney-like preheating of the higher-level fuels and upslope winds.

Table 2
Effects of Topographic Features on Fire Behavior

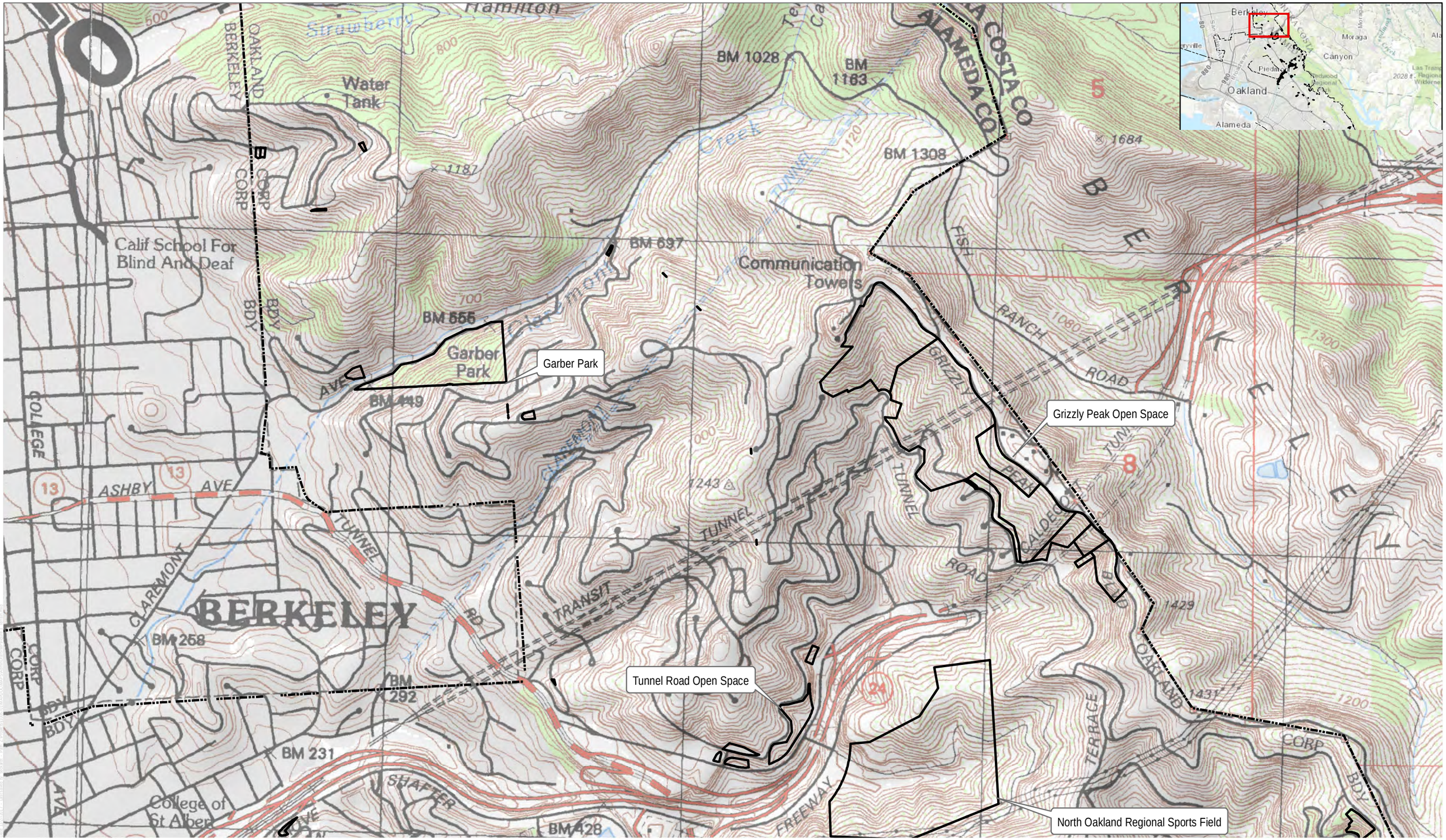
Topographic Feature	Effect
Ridge	Fires may change direction when reaching ridge/canyon edge; strong air flows likely at ridge point; possibility for different wind directions on different sides of ridge. Ridges experience more wind. Fires gain speed and intensity moving toward a ridge. Fires burning at a ridge can exhibit erratic fire behavior. Strong air flows can cause a whirling motion by the fire. As the wind crosses a ridge it usually has a leeward eddy where the wind rolls around and comes up the leeward side.
Saddle	Potential for rapid rates of fire spread; fires pushed through saddles faster during upslope runs. Winds can increase when blowing through saddles due to the funneling effect of the constricted pass. On the other side, winds will slow, but erratic winds potentially occur at the saddle due to eddies.

Sources: Teie 1994; Firewise 2013.

2.3.2 Vegetative Fire Hazard

The following sections summarize vegetative fire hazard according to the different vegetation types observed in the Plan Area. As stated, hazardous fuels include live and dead vegetation that exists in a condition that readily ignites; transmits fire to adjacent structures or ground, surface, or overstory vegetation; and/or is capable of supporting extreme fire behavior. All vegetation will burn; however, some plants exhibit characteristics that make them more flammable than others.[3] Flammability can be defined as a combination of ignitability, combustibility, and sustainability, where ignitability is the ease of or the delay of ignition, combustibility is the rapidity with which a fire burns, and sustainability is a measure of how well a fire will continue to burn with or without an external heat source (White and Zipperer 2010). Flammability is influenced by several factors, which can be classified into two groups: physical structure (e.g., branch size, leaf size, leaf shape, surface-to-volume ratio, and/or retention of dead material) and physiological elements (e.g., volatile oils, resins, and/or moisture content) (Moritz and Svihra 1996; UCCE 2016; UCFPL 1997; White and Zipperer 2010). Plants that are less flammable have low surface-to-volume ratios, high moisture contents, and minimal dead material or debris, while those that are more flammable have high surface-to-volume ratios, exhibit low moisture contents, contain volatile oils, and have high levels of dead material or debris (Moritz and Svihra 1996; UCFPL 1997; UCCE 2016; White and Zipperer 2010). Plant condition and maintenance is also an important factor in flammability. Some plants that have more flammable characteristics can become less flammable if well maintained and irrigated, but can also be explosively flammable when poorly maintained, or situated on south-facing slopes, in windy areas, or in poor soils (Moritz and Svihra 1996). In general, most vegetation within the Plan Area is not regularly irrigated or maintained for the purposes of promoting overall plant health.

[3] Highly flammable plants are also referred to as pyrophytes or pyrophytic.



SOURCE: USGS 2017; ESRI 2017; Oakland 2016

DUDEK

0 487.5 975 Feet

FIGURE 3.1

Plan Area Terrain

Draft Vegetation Management Plan - City of Oakland, California

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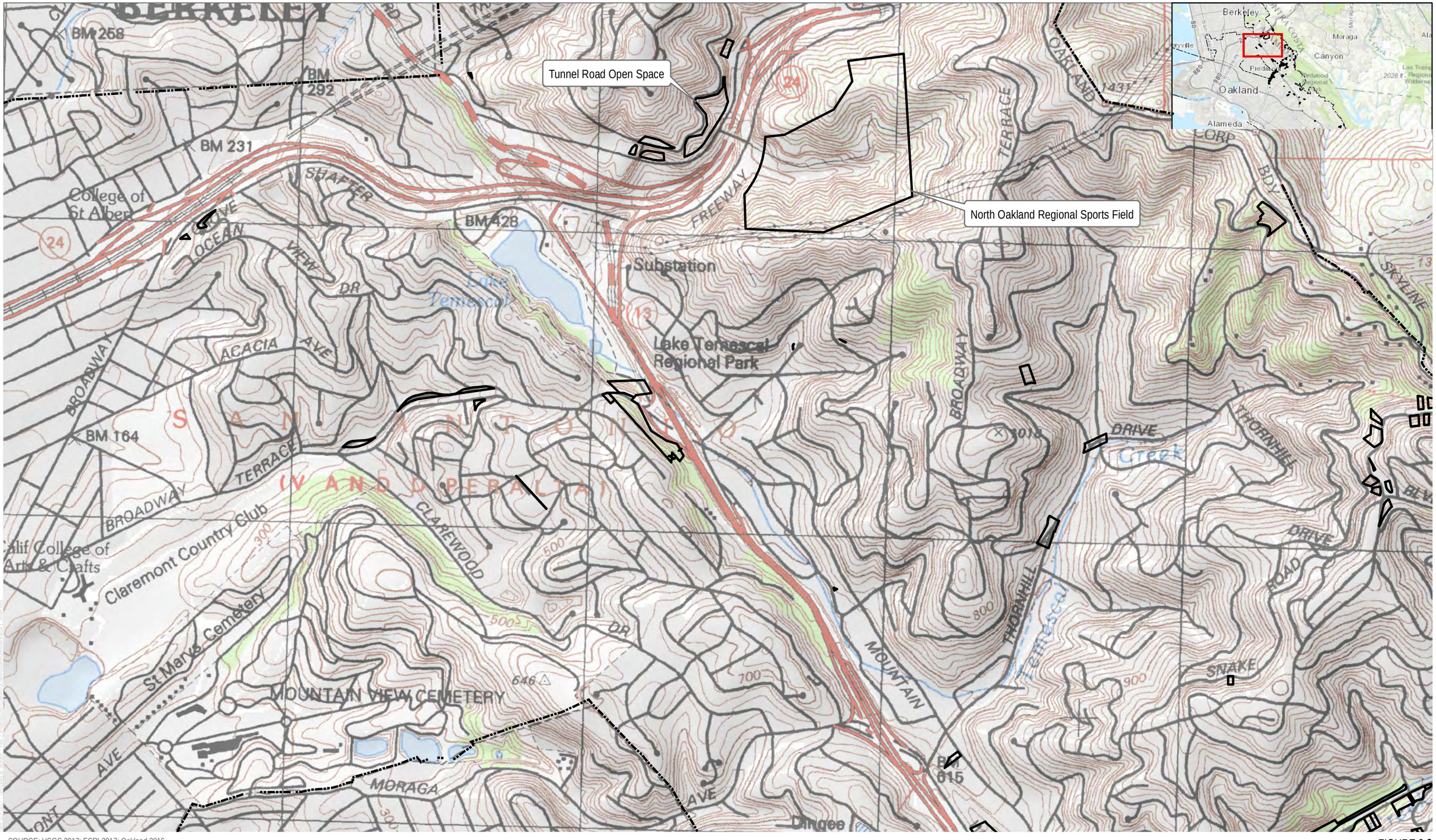

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 3.2

Plan Area Terrain

Draft Vegetation Management Plan - City of Oakland, California

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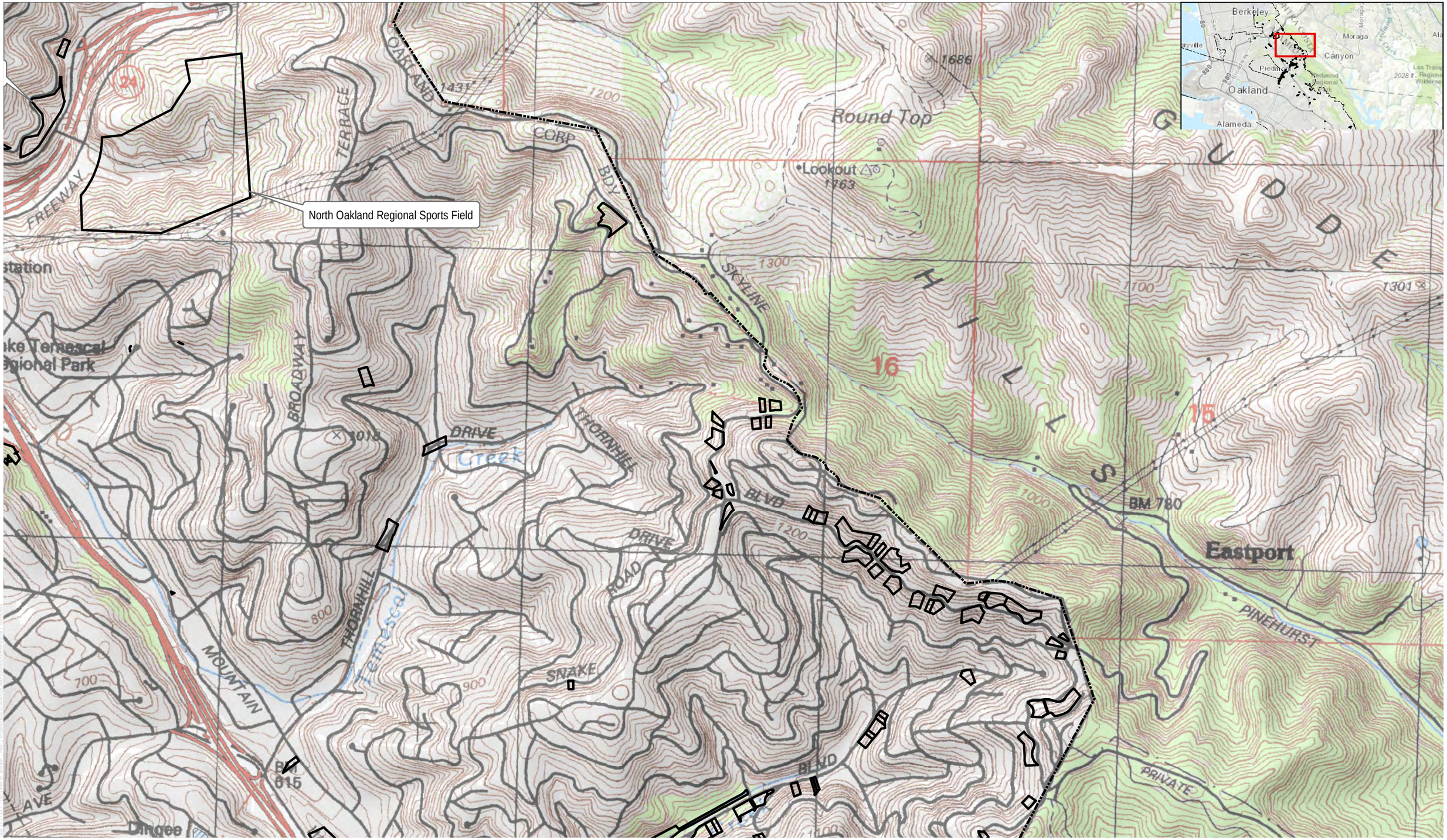

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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0 487.5 975 Feet

FIGURE 3.3

Plan Area Terrain

Draft Vegetation Management Plan - City of Oakland, California

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Shepherd Canyon Park

Beaconsfield Common

Sulphur Springs Park

Dimond Canyon Park

Joaquin Miller Park

City-owned Parcels

Oakland City Limits

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

DUDEK

0 487.5 975 Feet

FIGURE 3.4

Plan Area Terrain

Draft Vegetation Management Plan - City of Oakland, California

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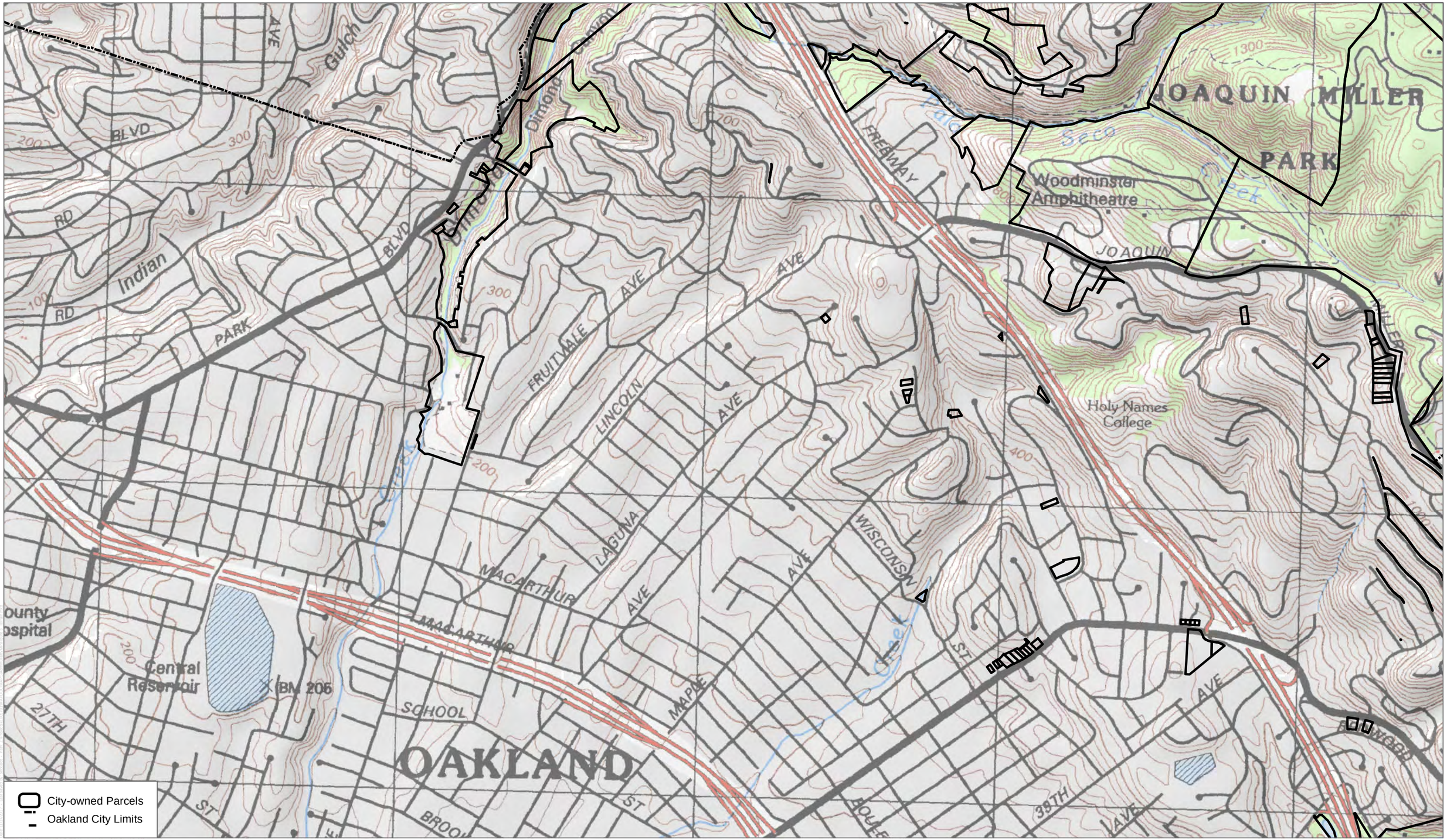

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

DUDEK

0 487.5 975 Feet

FIGURE 3.5

Plan Area Terrain

Draft Vegetation Management Plan - City of Oakland, California

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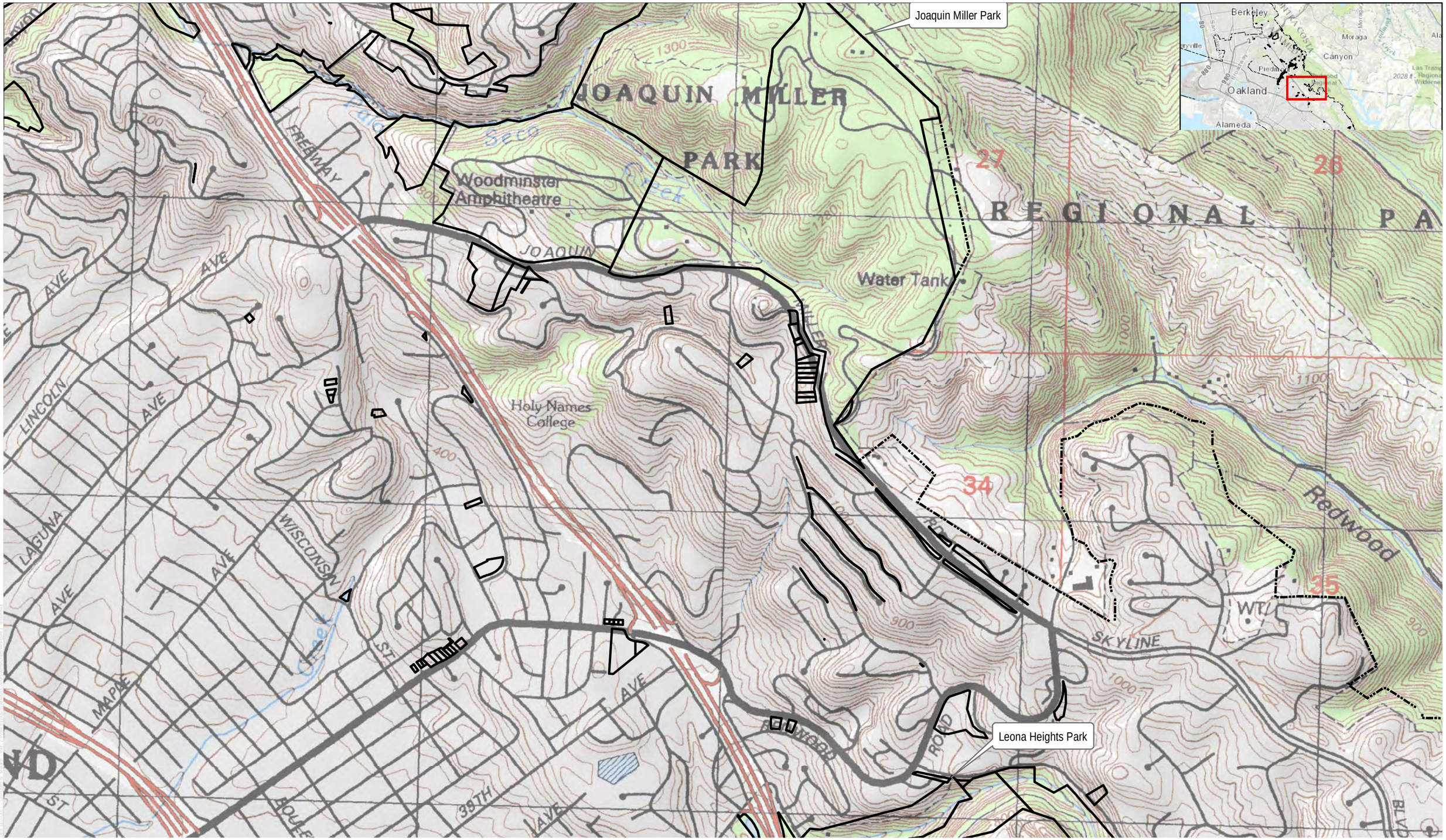

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 3.6

Plan Area Terrain

Draft Vegetation Management Plan - City of Oakland, California

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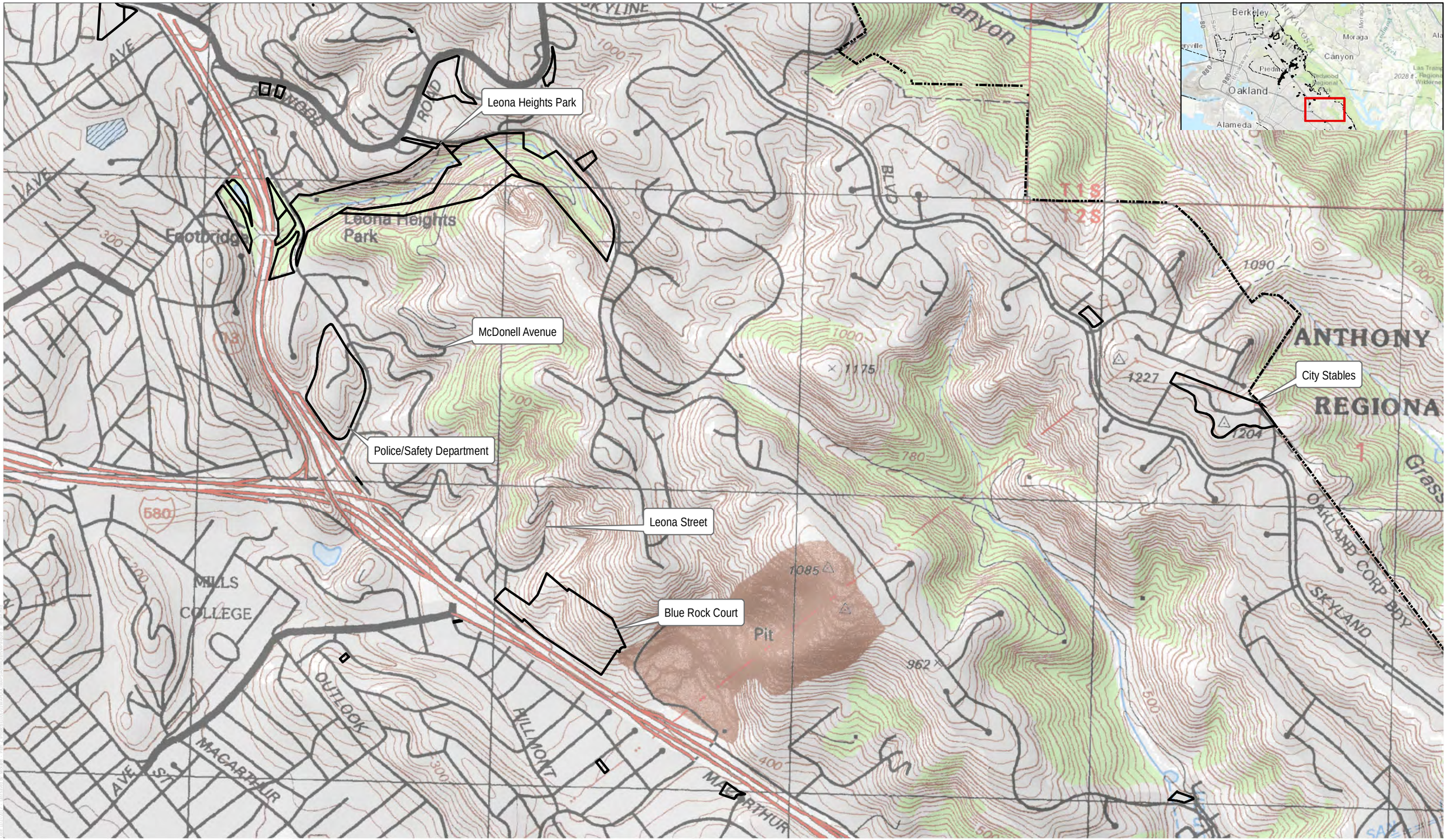

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 3.7

Plan Area Terrain

Draft Vegetation Management Plan - City of Oakland, California

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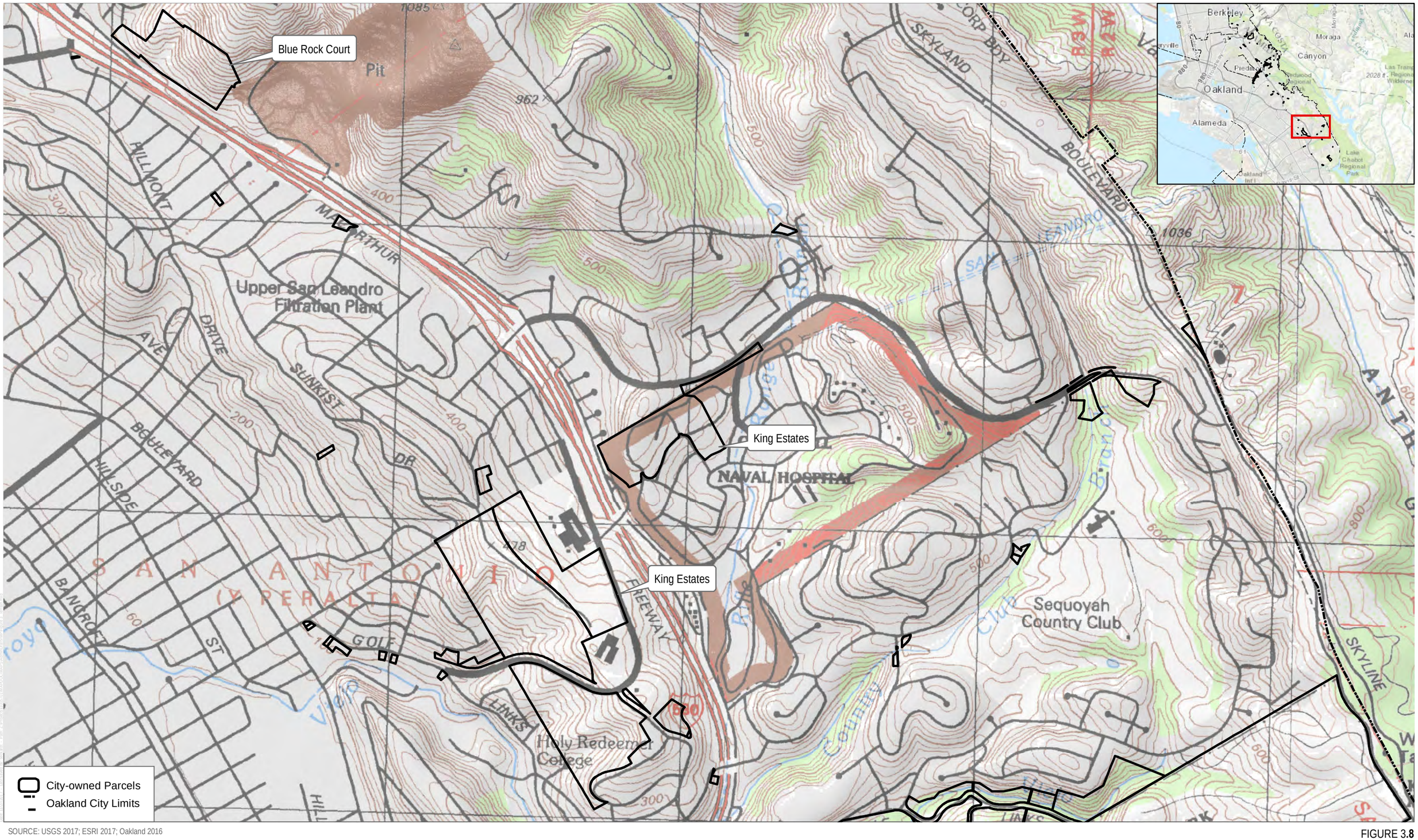

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 3.8

Plan Area Terrain

Draft Vegetation Management Plan - City of Oakland, California

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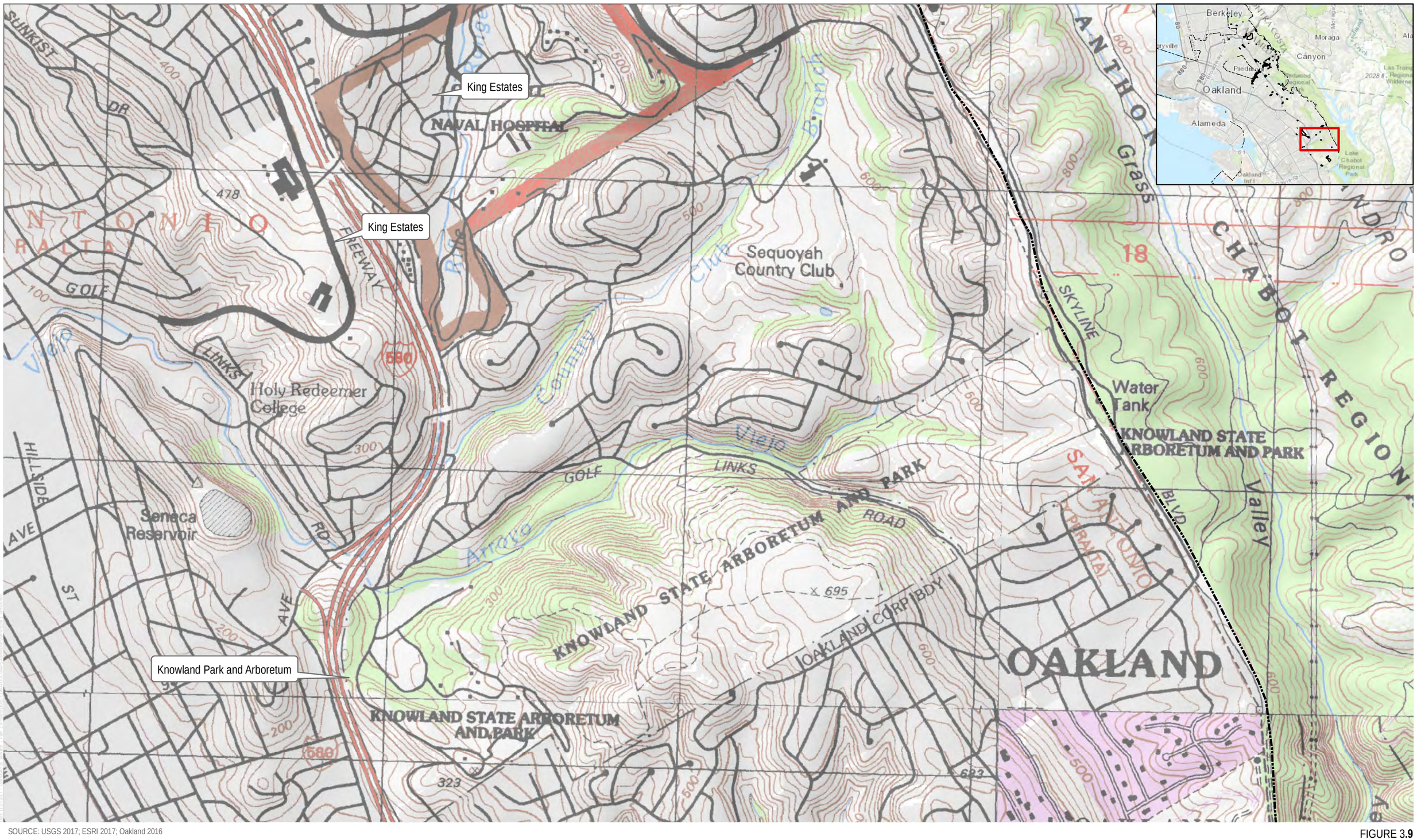

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 3.9

Plan Area Terrain

Draft Vegetation Management Plan - City of Oakland, California

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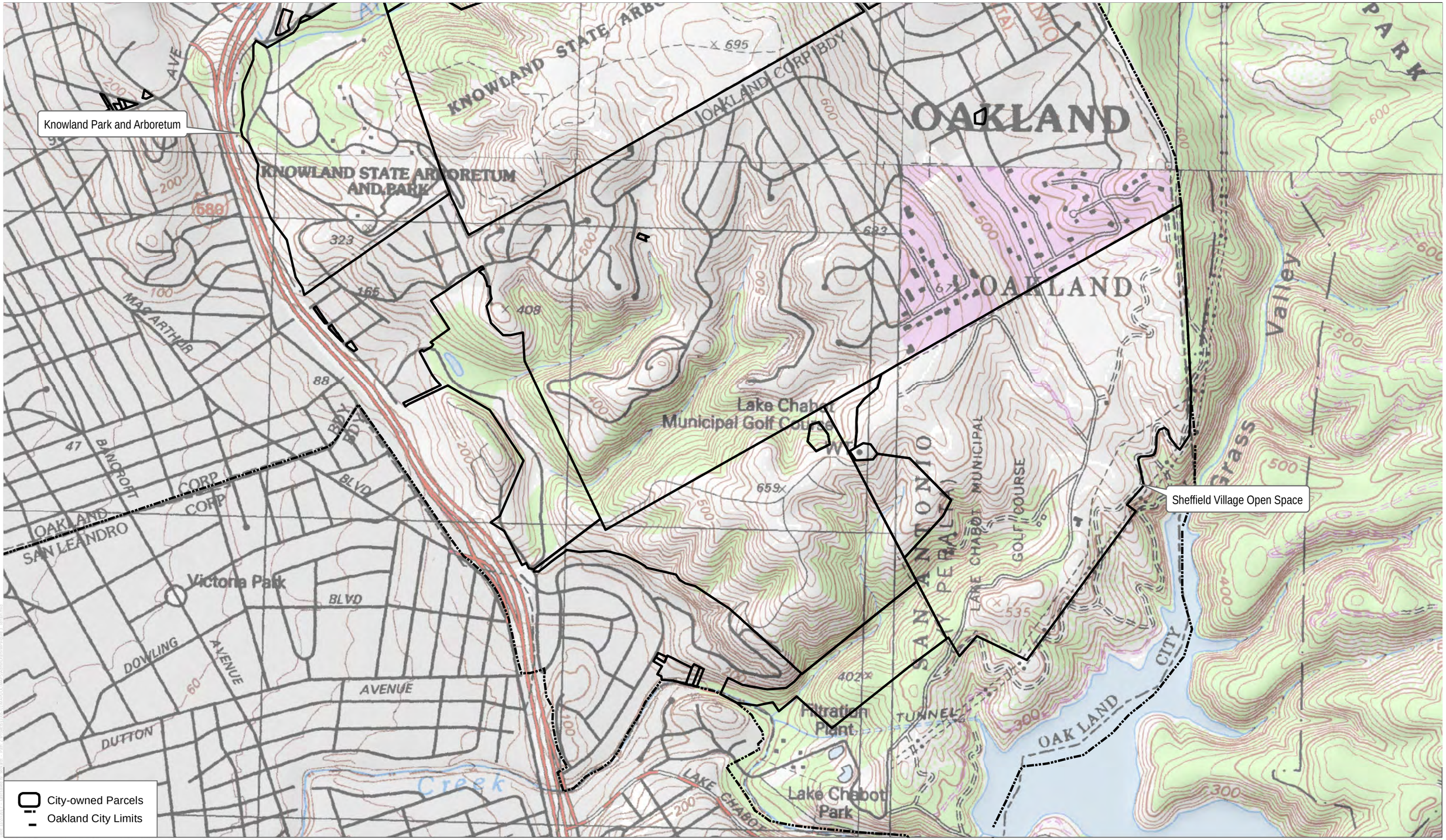

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 3.**10**

Plan Area Terrain

Draft Vegetation Management Plan - City of Oakland, California

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2.3 Vegetation and Fuels

This section summarizes the vegetation types (fuels) present in the Plan Area and their contribution to fire hazard. Hazardous fuels include live and dead vegetation that exists in a condition, which readily ignites; transmits fire to adjacent structures or ground, surface, or overstory vegetation; and/or is capable of supporting extreme fire behavior.

2.3.1 Field Assessments

Field assessments were conducted by Horizon Water and Environment (Horizon) to map and classify the existing vegetation communities and land cover types present in the Plan Area. Vegetation and land cover was classified using the California Wildlife Habitat Relationship (WHR) System. Vegetation and land cover types in the Plan Area include coast oak woodland, redwood, valley/foothill riparian, closed-cone pine-cypress, eucalyptus, coastal scrub, chamise-redshank chaparral, freshwater emergent wetland, perennial grassland, annual grassland, and urban land covers (Appendix B). The Biological Resources Report prepared for the Plan also identifies areas of high biological resource value within the Plan Area and is included in Appendix B. Table 3 summarizes the different vegetation communities and land covers identified and mapped in the Plan Area, and Figures 4.1 through 4.10 presents the distribution of vegetation communities and land covers across the Plan Area. Detailed vegetation community and land cover information, by parcel, is presented in Appendix C.

Table 3
Vegetation Communities and Associated Fuel Models in the Plan Area

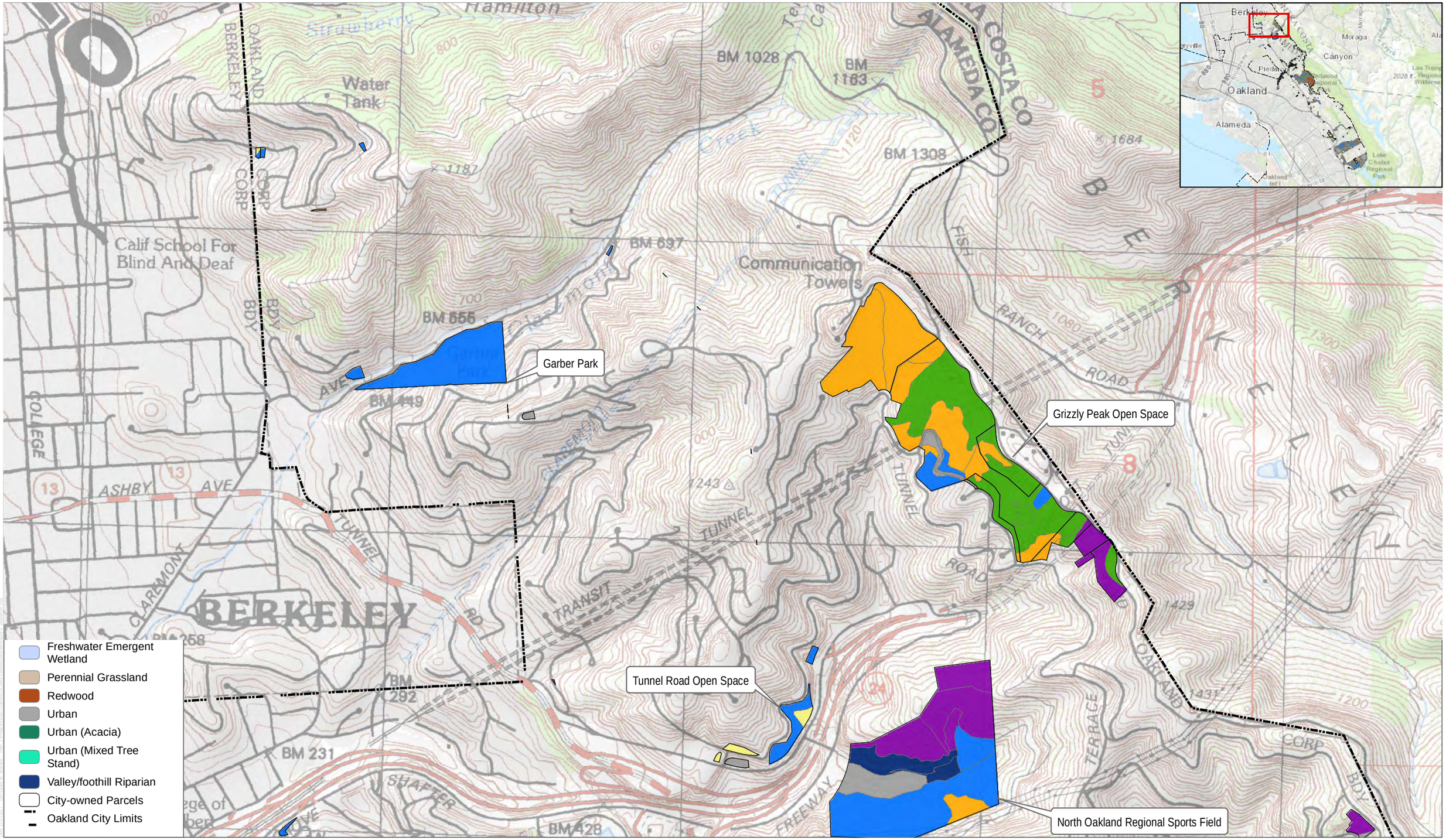
Vegetation Community/Land Cover	Fuel Models*	Acres	Percentage
Annual Grassland	GR1, GR4	254.5	13.22%
Chamise-Redshank Chaparral	SH5	8.1	0.42%
Coast Oak Woodland	GR1, GS2, TU1, TL2	604.6	31.41%
Coastal Scrub	GR1, GS2, SH1, SH5	169.7	8.82%
Closed-Cone Pine-Cypress	SH5, TU1, TU5, TL2, TL3, TL6	170.8	8.87%
Eucalyptus	GR1, SH5, TU1, TU5, TL2, TL3, TL6, TL9	152.1	7.90%
Freshwater Emergent Wetland	NB1	0.2	0.01%
Perennial Grassland	GR1	11.6	0.60%
Redwood	TU1, TL3	138.2	7.18%
Valley/Foothill Riparian	SH1, TU5	6.7	0.35%
Urban (Developed)	GR1, NB1	397.9	20.67%
Urban (Acacia)**	TU1	6.8	0.35%
Urban (Mixed Tree Stand)**	GR1	3.7	0.19%
	Total	**1,924.9**	**100.00%**

Notes:
* A discussion of fuel models is presented in Appendix D.

** The Urban WHR classification includes ornamental tree plantings in parks, and those dominated with acacia and mixed trees have been called out separately for this VMP for the purposes of evaluating fire behavior and fire hazard.

Field assessments were also conducted by Dudek to evaluate existing fuel load conditions and understand general fuel hazard conditions and current maintenance practices being conducted by OFD within the Plan Area. Field assessments of fuel conditions were conducted between December 2016 and August 2017. Site conditions were documented via photographs and in some cases noted on digital or hard-copy field maps.

Field assessments were also used to identify and classify vegetation community types into fuel models (Anderson 1982; Scott and Burgan 2005). Fuel model assignments are presented in Table 3 by vegetation community or land cover type. A discussion of fuel models and potential fire behavior is presented in Appendix D. Taken together, the (1) field assessment of existing vegetation and land cover conditions, (2) assessment of fuel load conditions, and (3) identification of how existing vegetation types align with existing fuel studies and models present an empirical on-the-ground (field-based) approach and basis for the treatments and approaches recommended in this VMP.



SOURCE: USGS 2017; ESRI 2017; Horizon 2017; Oakland 2016

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FIGURE 4.1

Plan Area Vegetation Distribution

Draft Vegetation Management Plan - City of Oakland, California

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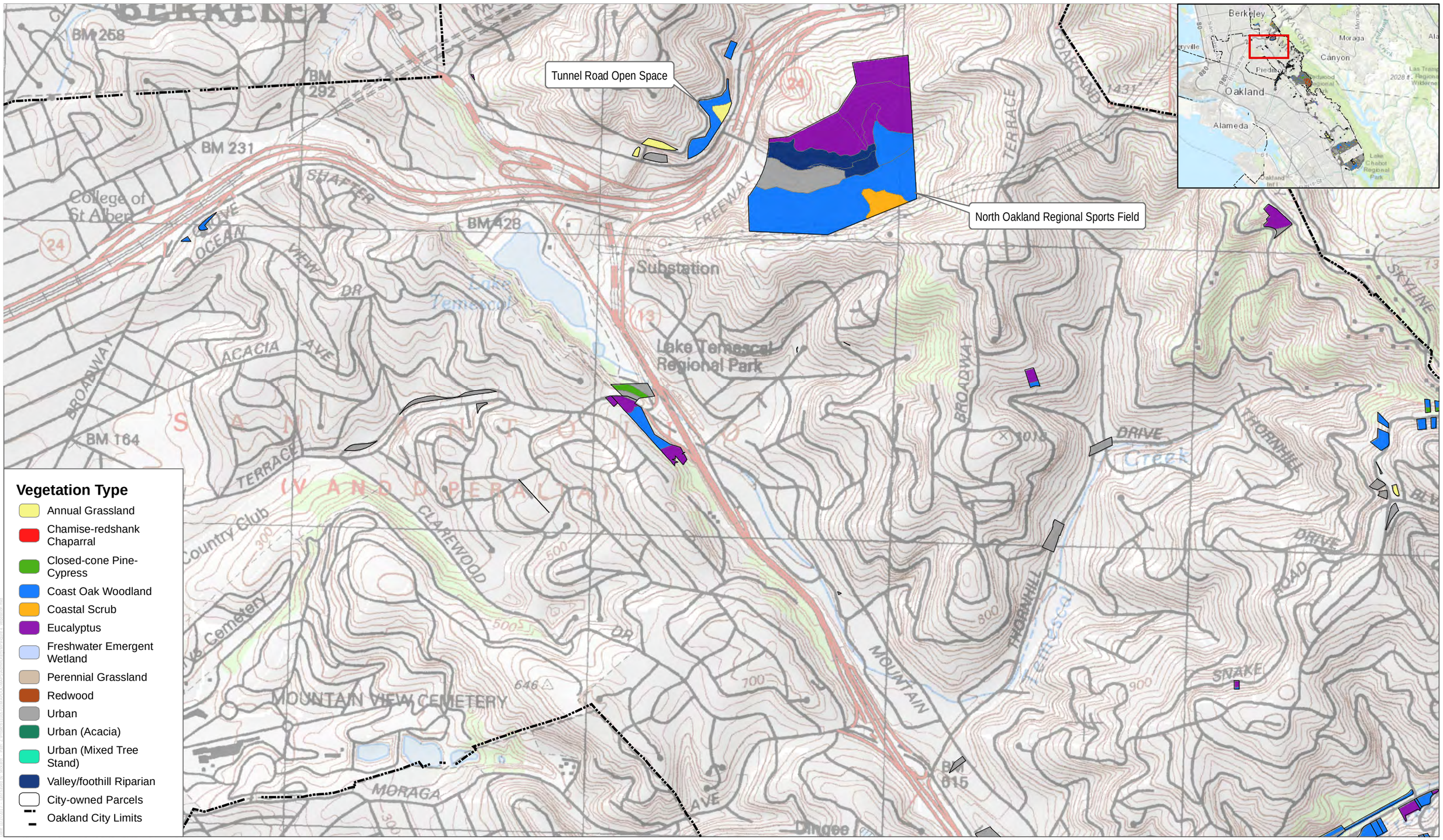

SOURCE: USGS 2017; ESRI 2017; Horizon 2017; Oakland 2016

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FIGURE 4.2

Plan Area Vegetation Distribution

Draft Vegetation Management Plan - City of Oakland, California

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North Oakland Regional Sports Field

Vegetation Type

- Annual Grassland
- Chamise-redshank Chaparral
- Closed-cone Pine-Cypress
- Coast Oak Woodland
- Coastal Scrub
- Eucalyptus
- Freshwater Emergent Wetland
- Perennial Grassland
- Redwood
- Urban
- Urban (Acacia)
- Urban (Mixed Tree Stand)
- Valley/foothill Riparian
- City-owned Parcels
- Oakland City Limits

SOURCE: USGS 2017; ESRI 2017; Horizon 2017; Oakland 2016

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FIGURE 4.3

Plan Area Vegetation Distribution

Draft Vegetation Management Plan - City of Oakland, California

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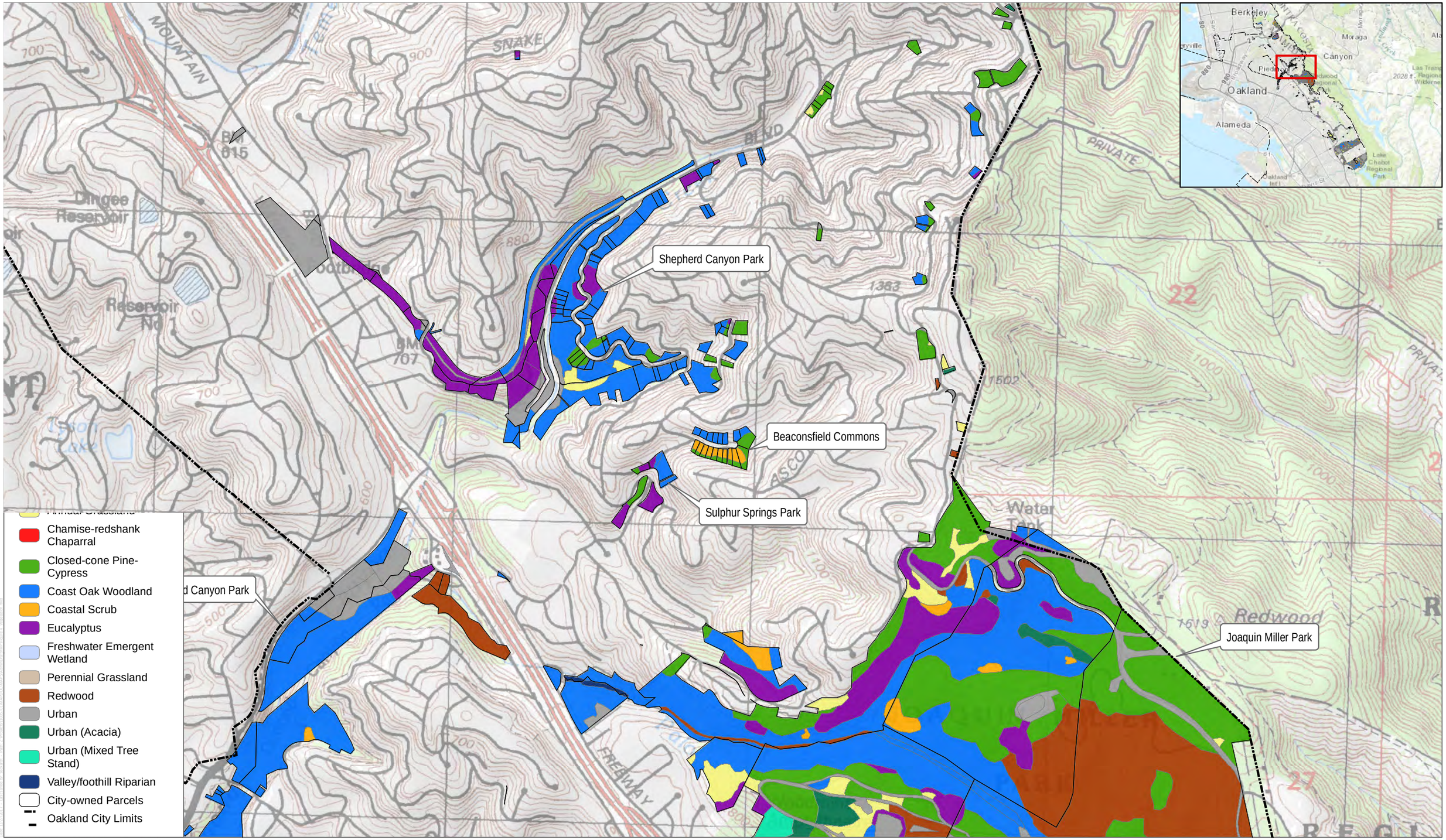

SOURCE: USGS 2017; ESRI 2017; Horizon 2017; Oakland 2016

FIGURE 4.4

Plan Area Vegetation Distribution

Draft Vegetation Management Plan - City of Oakland, California

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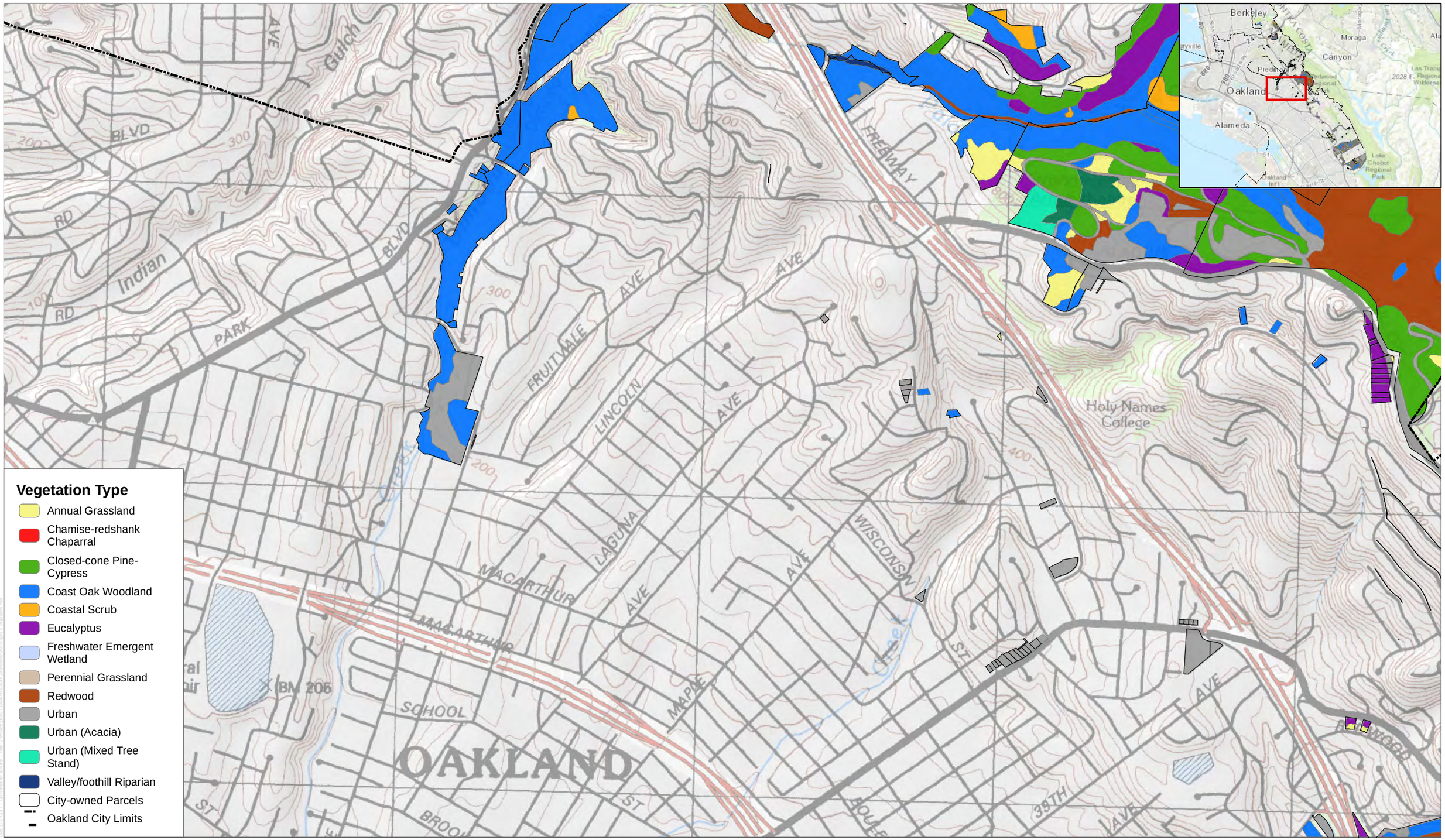

SOURCE: USGS 2017; ESRI 2017; Horizon 2017; Oakland 2016

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FIGURE 4.5

Plan Area Vegetation Distribution

Draft Vegetation Management Plan - City of Oakland, California

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Joaquin Miller Park

Leona Heights Park

Holy Names College

FREEWAY

SKYLINE

REGIONAL

Redwood

Berkeley

Moraga

Canyon

Oakland

Alameda

Vegetation Type

- Annual Grassland
- Chamise-redshank Chaparral
- Closed-cone Pine-Cypress
- Coast Oak Woodland
- Coastal Scrub
- Eucalyptus
- Freshwater Emergent Wetland
- Perennial Grassland
- Redwood
- Urban
- Urban (Acacia)
- Urban (Mixed Tree Stand)
- Valley/foothill Riparian
- City-owned Parcels
- Oakland City Limits

SOURCE: USGS 2017; ESRI 2017; Horizon 2017; Oakland 2016

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FIGURE 4.**6**

Plan Area Vegetation Distribution

Draft Vegetation Management Plan - City of Oakland, California

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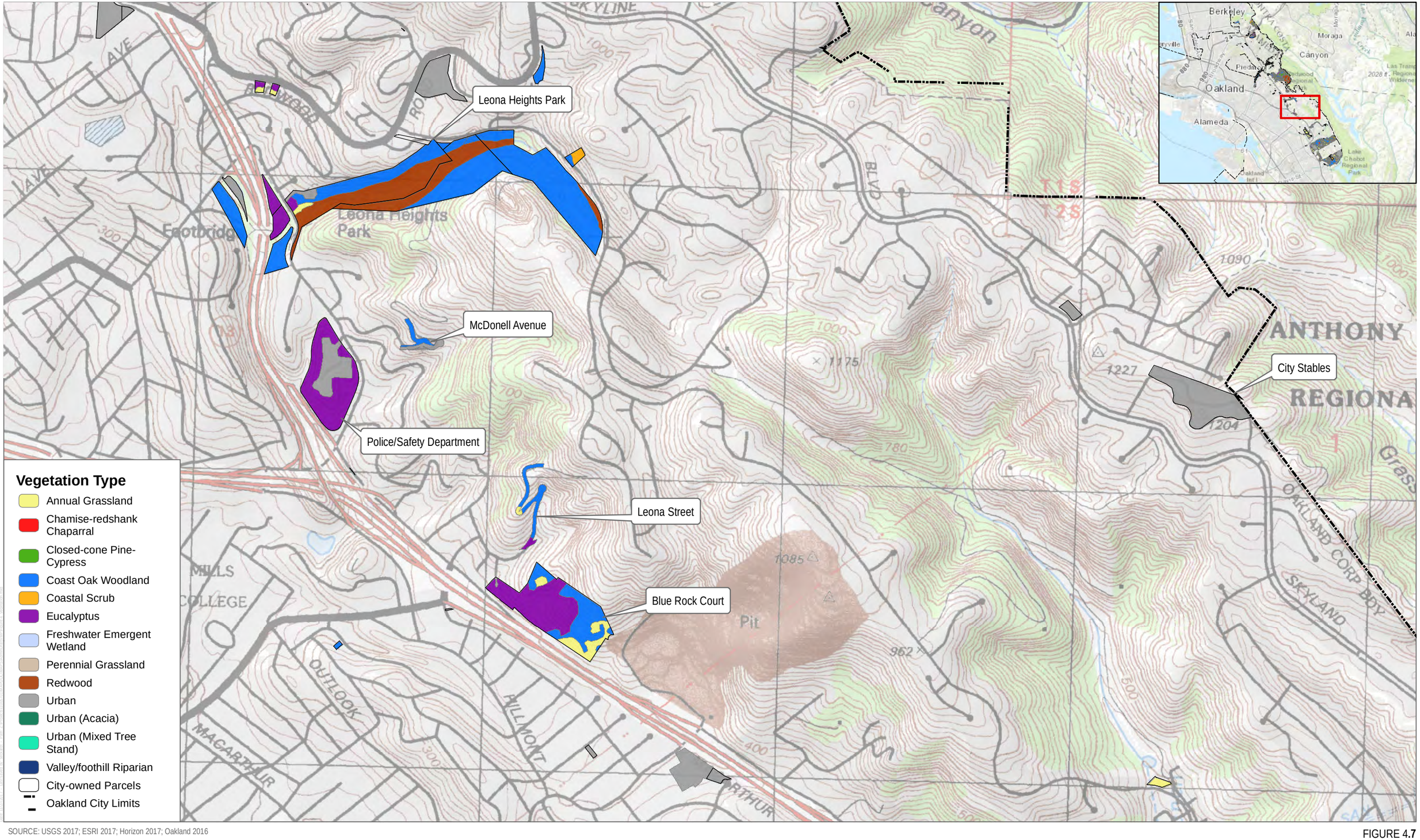

SOURCE: USGS 2017; ESRI 2017; Horizon 2017; Oakland 2016

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FIGURE 4.7

Plan Area Vegetation Distribution

Draft Vegetation Management Plan - City of Oakland, California

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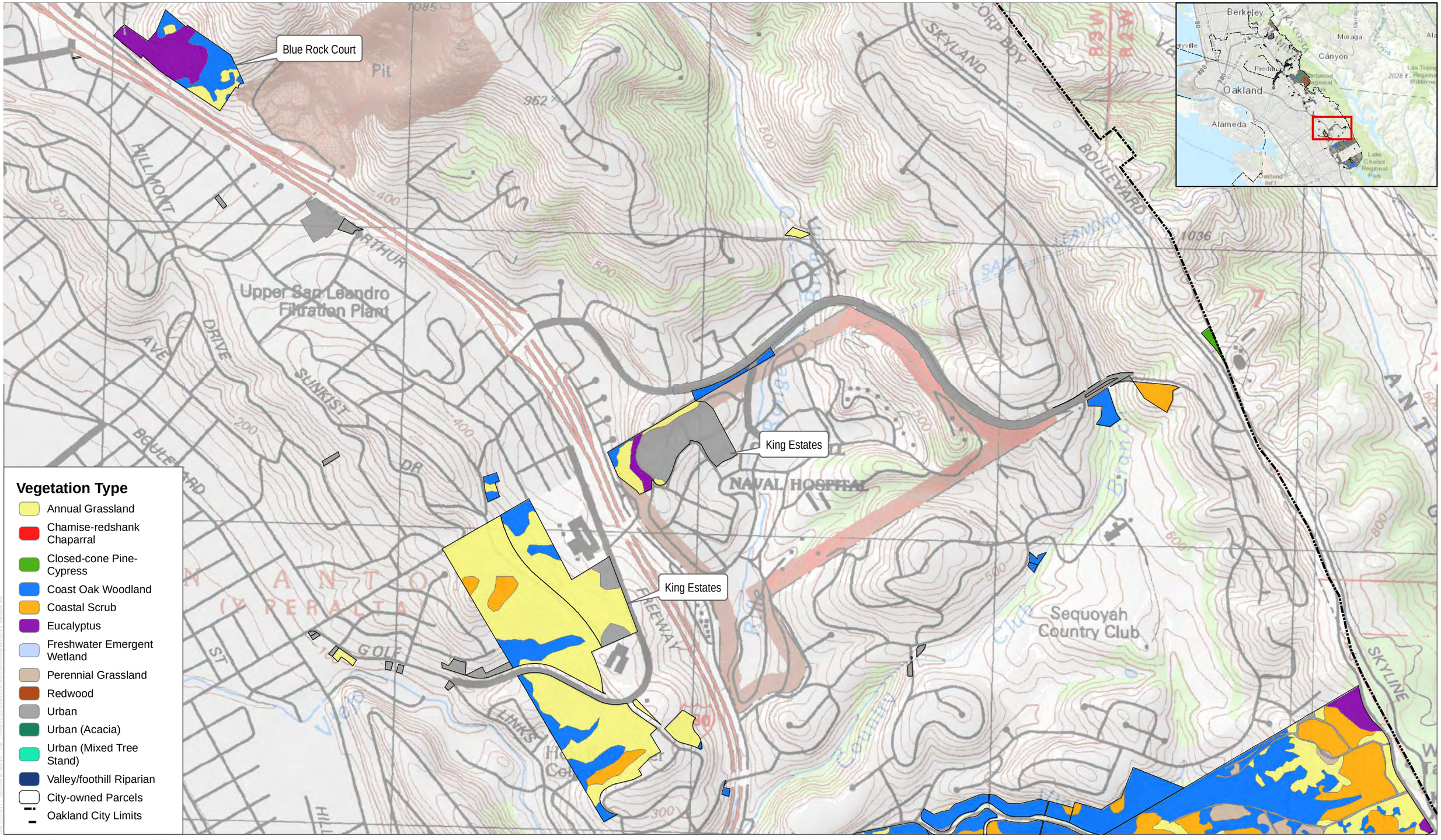

SOURCE: USGS 2017; ESRI 2017; Horizon 2017; Oakland 2016

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FIGURE 4.8

Plan Area Vegetation Distribution

Draft Vegetation Management Plan - City of Oakland, California

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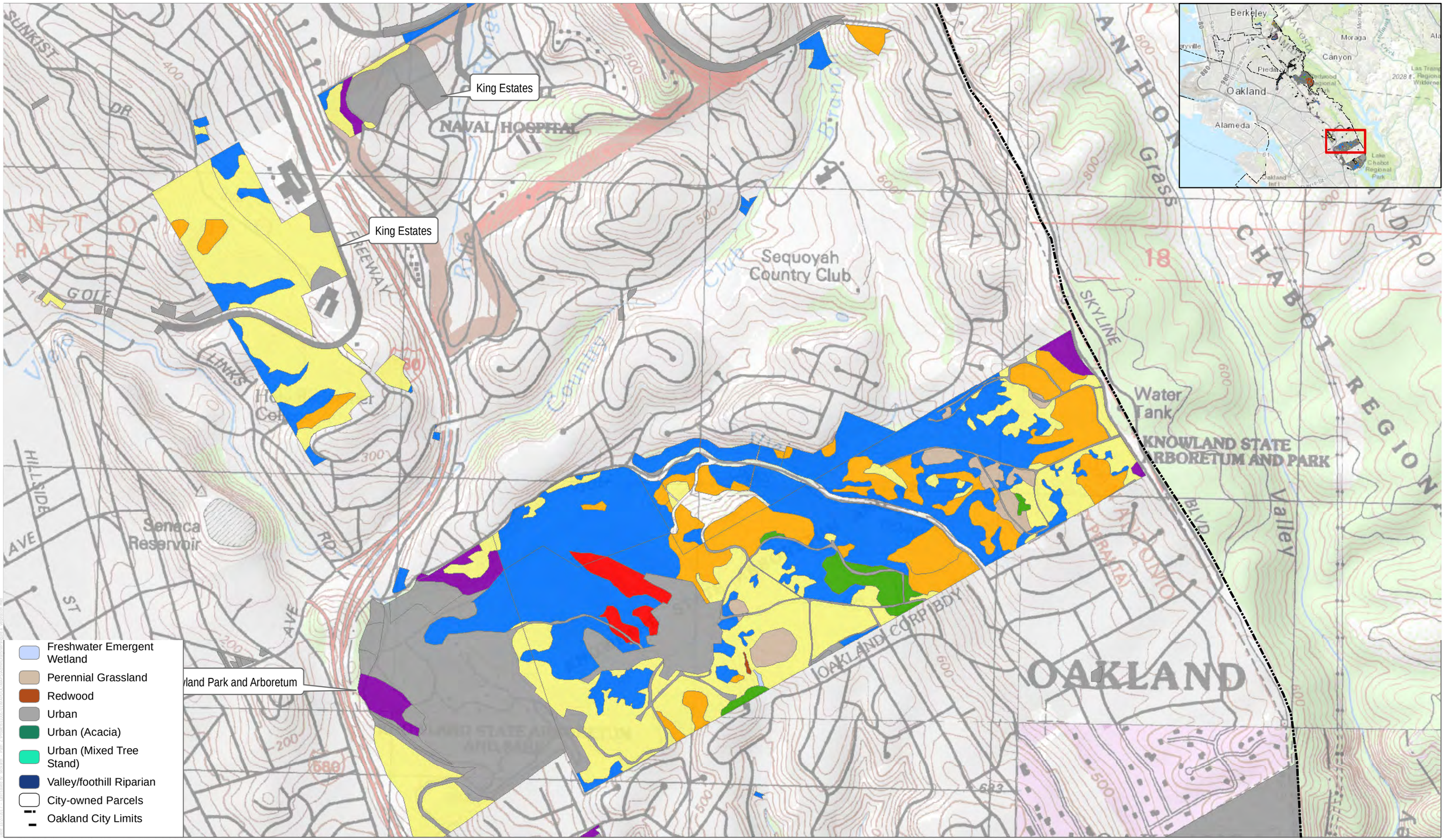

SOURCE: USGS 2017; ESRI 2017; Horizon 2017; Oakland 2016

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FIGURE 4.9

Plan Area Vegetation Distribution

Draft Vegetation Management Plan - City of Oakland, California

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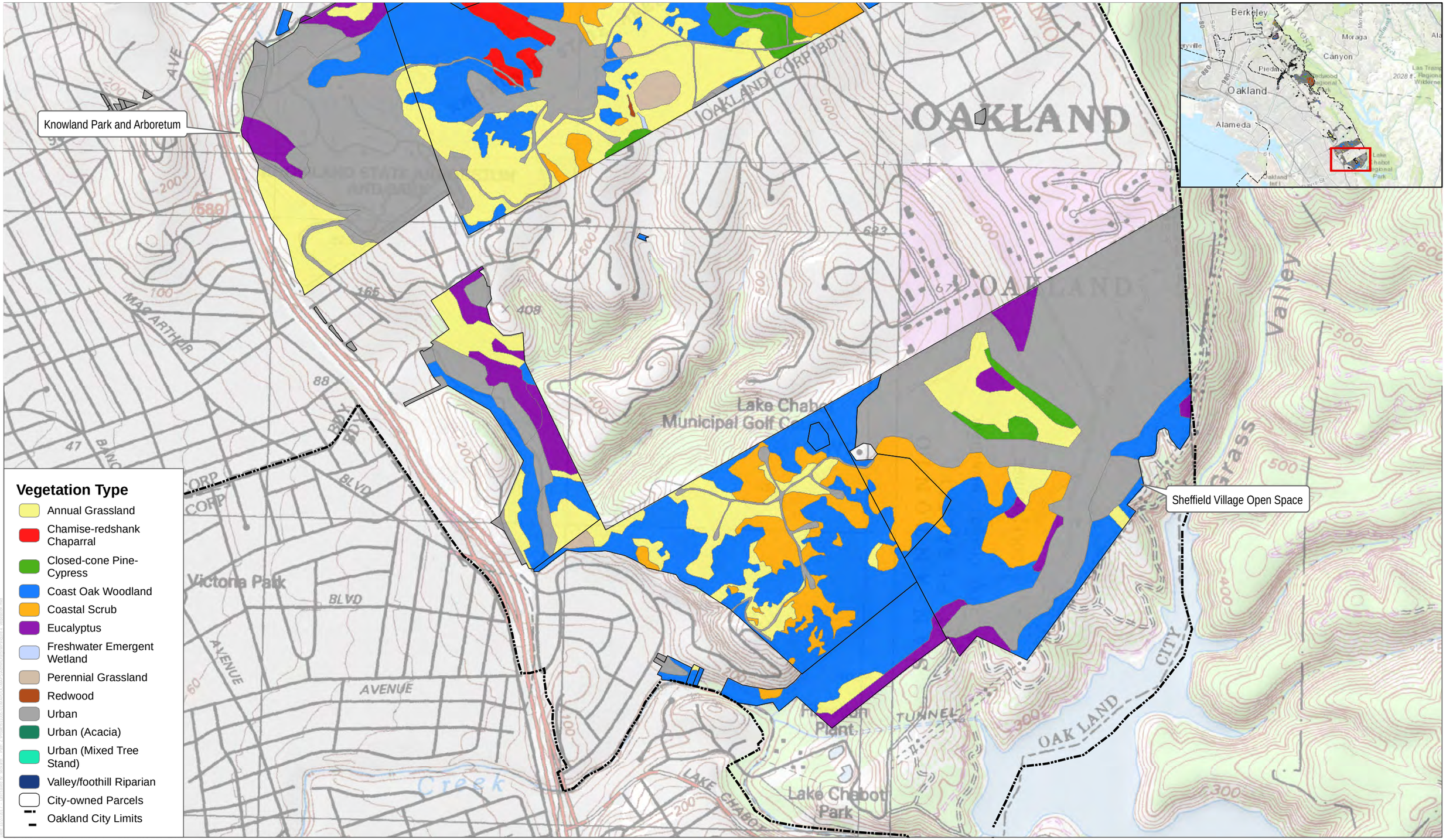

SOURCE: USGS 2017; ESRI 2017; Horizon 2017; Oakland 2016

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FIGURE 4.**10**

Plan Area Vegetation Distribution

Draft Vegetation Management Plan - City of Oakland, California

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Research into plant flammability has resulted in the development of plant lists in many California jurisdictions intended to promote the planting and retention of less flammable plants in defensible space zones, the WUI, or areas where vegetation management aims to reduce fire hazard (UCCE 2016; UCFPL 1997; Nader et al. 2007). Plant lists typically identify recommended low flammability (or firewise) plants and highly flammable plants that are not recommended for retention or planting. The City of Oakland has identified highly flammable plants (Table 4), some of which occur in the Plan Area (City of Oakland 2017a).

Table 4
Highly Flammable Plants in the City of Oakland

Trees		
Acacia	Douglas fir	Pine
Arbor-vitae	Fir	Spruce
Bald cypress	Hemlock	Sugar gum eucalyptus
Blue gum eucalyptus	Larch	Tamarix
Cedar	Manna gum eucalyptus	Yew
Cryptomeria	Palm	
Cypress	Pepper	
Shrubs		
Buckwheat	Coyote brush	Redshanks
California sagebrush	Hopseed bush	Scotch/French/Spanish broom
Chamise	Juniper	
Ground Covers		
Algerian ivy	Coyote brush	Juniper
Perennials		
Bamboo	Deer grasses	Grasses (Miscanthus)
Black sage	Fountain grasses	Pampas grass

Source: City of Oakland 2017a.

2.3.2.1 Grassland/Herbaceous

Grassland/herbaceous fuels in the Plan Area are represented by the annual grassland and perennial grassland vegetation community/land cover types. Grassland types may include scattered and widely spaced trees and/or shrubs, although grasses are the dominant cover type. Grasses are fine fuels that are loosely compacted with a low fuel load.[4] Grasses have a high surface area-to-volume ratio, requiring less heat to remove fuel moisture and raise fuel to ignition temperature. They are also subject to early seasonal drying in late spring and early

[4] The amount of available and potentially combustible material, usually expressed as tons/acre (SKCNP 2017).

summer. Live fuel moisture content in grasses typically reaches its low point in early summer, and grasses begin to cure soon after. Due to these characteristics, grasses have potential for a high rate of spread, rapid ignition, and facilitation of extreme fire behavior. Grasses are the vegetation type in the Plan Area with the highest risk for wildfire ignition. Their low overall fuel loads typically result in faster moving fires with lower flame lengths and heat output. Untreated grasses can help spread fire into other adjacent surface fuel types (e.g., shrubs) or facilitate surface to crown fire transition where they exist beneath tree canopies.

2.3.2.2 Brush/Scrub

Brush/scrub fuels in the Plan Area are represented by the chamise-redshank chaparral and coastal scrub vegetation community/land cover types. Brush/scrub types may include scattered and widely spaced trees, small patches of grass/herbaceous vegetation, or grass herbaceous vegetation occurring beneath shrub canopies, although shrubs are the dominant cover type.

Chaparral

Chaparral is considered a moderately fine fuel which is loosely compacted and has a moderate fuel load. Chaparral has a high surface area-to-volume ratio, requiring less heat to remove fuel moisture and raise fuel to ignition temperature. Chaparral is subject to early seasonal drying in the late spring and early summer, but does not fully cure in the way that grasses do. The live fuel moisture content reaches its low point in the late summer and early fall months. Dead fuels consist mainly of 1-hour and 10-hour fuel sizes, or twigs and small stems ranging from 0.25 inches to 1 inch in diameter. Chaparral has the potential for a high rate of spread, rapid ignition, and extreme fire behavior given its high content of volatile organic compounds (VOCs).

Coastal Scrub

Coastal scrub is considered a moderately fine fuel that is loosely compacted with a moderate fuel load. Coastal scrub has a high surface area-to-volume ratio, requiring less heat to remove fuel moisture and raise fuel to ignition temperature. It is subject to early seasonal drying in the late spring and early summer, but does not fully cure in the way that grasses do. Compared to chaparral, coastal scrub tends to have a lower content of VOCs. The live fuel moisture content reaches its low point in the late summer and early fall months. Dead fuels consist mainly of 1-hour and 10-hour fuel sizes, or twigs and small stems ranging from 0.25 inches to 1 inch in diameter. Coastal scrub has potential for a high rate of spread, rapid ignition, and extreme fire behavior.

2.3.2.3 Tree/Woodland/Forest

Tree/woodland/forest fuels in are the Plan Area represented by the coast oak woodland, eucalyptus, closed-cone pine-cypress, redwood, and valley/foothill riparian vegetation community/land cover types. Additionally, for the purposes of this VMP, the two tree-dominated urban land cover type designations (urban (acacia) and urban (mixed tree stand)) are considered within this general vegetation type. Tree/woodland/forest types may also include scattered shrubs or shrub groupings, small patches of grass/herbaceous vegetation, or shrub and grass herbaceous vegetation occurring beneath tree canopies, although trees are the dominant cover type.

Oak Woodland

Oak stands are composed of fuel structures ranging from fine to heavy. In closed canopy stands, a sparse understory of grass, leaves, twigs, branches, and bark litter may be present. In open stands, understory may include grass, shrubs, leaves, twigs, branches, and bark litter. Fuel buildup occurs very slowly in oak woodland stands in California (USFS 2015), and litter forms a thick, compacted mat resulting in very low surface fuel loads. Oak woodland understory fuel loads are low.

Oak trees are highly flame resistant as the leaves do not readily catch fire. Fires in oak stands tend to smolder in the duff, and consume surface fuels without generating enough heat to carry fire into the oak canopy (USFS 2015). Oak woodland litter does little to facilitate fire spread as it has a low surface area-to-volume ratio and requires high heat levels to remove fuel moisture and raise fuel to ignition temperature. Oak woodland litter is subject to seasonal drying in the late summer and early fall months, but fog drip, solar shading, and the windbreak provided by oak canopies can sustain high fuel moisture content throughout the year. Oaks have a low content of VOCs, and the lack of highly-combustible oils further reduces the fire hazard associated with oaks and oak woodlands.

Dead fuels consist of 1-hour (litter and duff < 0.25 inches in diameter), 10-hour (twigs and small stems 0.25 inches to 1 inch in diameter), 100-hour (branches 1 inch to 3 inches in diameter), and 1,000-hour (large stems and branches > 3 inches in diameter) sizes. Oak woodlands are mostly lacking in features that promote fire spread, but weather and topography have a strong influence on fire behavior. Given extreme fire weather and steep terrain, oak woodlands have the potential for a moderate rate of spread, torching and crown fire, and extreme fire behavior. Fire behavior in oak woodlands and forests is typically much less intense than wildfires burning in chaparral and coastal scrub communities. Low, compacted leaf litter understory, canopy shading of ground fuels, and wind velocity reduction from tree canopies significantly reduces the intensity and spread rates

of surface fires in oak woodlands. Transition from ground to canopy fire increases fire intensity, spotting, and tree mortality potential.

Eucalyptus

Eucalyptus stands and individual trees in the Plan Area are predominantly blue gum (*Eucalyptus globulus*). Eucalyptus stands are composed of fuel structures ranging from fine to heavy, and may include an understory of grass, brush, eucalyptus seedlings, saplings, and small trees, and eucalyptus leaf, twig, branch and bark litter. Eucalyptus litter is generally moderately compacted with heavy to very heavy fuel loads; fuel loads in eucalyptus stands can reach between 45 and 100 tons per acre (Agee et al. 1973). Fuel buildup in blue gum eucalyptus stands is very rapid, exceeding that of native tree species, and its litter (dead leaves and debris) is especially flammable (Agee et al. 1973; NPS 2006; Wolf and DiTomaso 2016). Fuel reduction programs in eucalyptus stands are typically recommended to maintain low fuel load levels (USFS 2013).

Blue gum eucalyptus is highly flammable; the bark catches fire readily, and deciduous bark streamers and lichen epiphytes tend to carry fire into the canopy, which tends to produce embers that can be carried by strong winds. These flying embers are carried downwind and result in the development of spot fires that have ignited in receptive fuel beds in advance of the fire's leading edge (Ashton 1981; USFS 2015). Peeling bark is typical of many other eucalyptus species and contributes to ground-based fuels (litter) when it falls. Peeling bark is also retained for a period of time on tree trunks, where it can facilitate ground to canopy fire transition (ladder fuel). Eucalyptus litter has a moderate surface area to volume ratio, requiring moderate heat to remove fuel moisture and raise fuel to ignition temperature. Eucalyptus litter is subject to seasonal drying in the late summer and fall, but fog drip, solar shading, and windbreaks provided by the eucalyptus canopy can sustain high fuel moisture content in the summer when fog is present.

Like chaparral, eucalyptus also has a higher content of VOCs. Eucalyptus leaves produce a volatile (Gabbert 2014), highly combustible oil, and flammable gasses may be released from trees at very high temperatures, further increasing fire hazard (Gross 2013). The live fuel moisture content reaches its low point in the late summer and early fall months. Dead fuels consist of 1-hour (litter and duff < 0.25 inches in diameter), 10-hour (twigs and small stems 0.25 inches to 1 inch in diameter), 100-hour (branches 1 inch to 3 inches in diameter), and 1,000-hour (large stems and branches > 3 inches in diameter) sizes. Features that promote fire spread include heavy litter fall, flammable oils in the foliage, and open crowns bearing pendulous (i.e., downward-hanging) branches, which encourage maximum updraft (USFS 2015). Given average

weather conditions and terrain, eucalyptus has potential for a high rate of spread, torching and crown fire,[5] and extreme fire behavior.

Closed-Cone Pine-Cypress

Closed-cone pine-cypress stands in the Oakland Hills is primarily comprised of Monterey pine (*Pinus radiata*) and Monterey cypress (*Hesperocyparis macrocarpa*). Large portions of the closed-cone pine-cypress stands the Project Area were established via plantings in the early 1900s (Nowak 1993). Closed-cone pine-cypress stands vary in surface fuel structures ranging from fine to heavy and may include an understory of grass, brush, pine needles, twigs, branches, and bark litter. Bark and leaf litter can accumulate rapidly beneath Monterey pine trees, resulting in significant fuel loads. Monterey pine litter is a fuel that is generally moderately compacted with a heavy fuel load reaching up to 100 tons per acre. Fuel buildup occurs very rapidly in unmanaged Monterey pine stands in California (USFS 2015). Monterey pine is highly flammable; the pine needles catch fire readily and tend to carry fire into the canopy and to disseminate fire via flying embers ahead of the main fire front (USFS 2015).

Monterey pine litter has a moderate surface area-to-volume ratio, requiring moderate heat to remove fuel moisture and raise fuel to ignition temperature. Monterey pine litter is subject to seasonal drying in the late summer and early fall months. The understory is more exposed than that of eucalyptus, although the fog drip, solar shading, and windbreak provided by the canopy can sustain high fuel moisture content in the summer when fog is present.

Like chaparral and eucalyptus, Monterey pine also has a higher content of VOCs and needles that produce a volatile (Gabbert 2014), highly combustible oil, and flammable gasses may be released from trees at very high temperatures, further increasing fire hazard (Gross 2013). The live fuel moisture content reaches its low point later in the late summer and early fall months. Dead fuels consist of 1-hour (litter and duff < 0.25 inches in diameter), 10-hour (twigs and small stems 0.25 inches to 1 inch in diameter), 100-hour (branches 1 to 3 inches in diameter), and 1,000-hour (large stems and branches > 3 inches in diameter) sizes. Features that promote fire spread include heavy litter fall, flammable oils in the foliage, and retention of dead needles that promote ignition within the canopy (USFS 2015). Given average weather conditions and terrain, Monterey pine has potential for a high rate of spread, torching and crown fire, and extreme fire behavior.

[5] A crown fire is a forest fire that advances often at great speed from tree top to tree top.

Redwood

Redwood stands are composed of fuel structures ranging from fine to heavy including a sparse understory vegetation typically consisting of ferns, grasses, leaves, twigs, branches, and bark litter. Bark and leaf litter tend to accumulate slowly beneath redwood trees, resulting in low fuel loads. Redwood litter is generally heavily compacted with a moderate fuel load reaching up to 100 tons per acre. Fuel buildup occurs very slowly in redwood stands in California (USFS 2015). Redwood is highly flame resistant, and the leaves do not catch fire readily. Fires tend to smolder in the duff, and consume surface fuels without generating enough heat to carry fire into the canopy (USFS 2015).

Redwood litter does little to facilitate the spread of fire. It has a low surface area-to-volume ratio and requires high heat to remove fuel moisture and raise fuel to ignition temperature. Redwood litter is subject to seasonal drying in the late summer and early fall months, but fog drip, solar shading, and windbreak provided by the redwood canopy can sustain high fuel moisture content throughout the year. Redwood has a low content of VOCs and lacks highly combustible oils, which further reduces the fire hazard associated with redwood.

Dead fuels consist of 1-hour (litter and duff < 0.25 inches in diameter), 10-hour (twigs and small stems 0.25 inches to 1 inch in diameter), 100-hour (branches 1 inch to 3 inches in diameter), and 1,000-hour (large stems and branches > 3 inches in diameter) sizes. Redwood stands are mostly lacking in features that promote fire spread, but weather and topography have a strong influence on fire behavior. Given extreme fire weather and steep terrain, redwood has potential for a moderate rate of spread, torching and crown fire, and extreme fire behavior.

Valley/Foothill Riparian

Valley/foothill riparian vegetation communities are concentrated within the drainages in the Plan Area and are characterized by willows (*Salix* spp.), white alder (*Alnus rhombifolia*), bigleaf maple (*Acer macrophyllum*), and red alder (*Alnus rubra*) (Appendix B). Riparian woodlands have a low fire hazard as their high moisture levels limit ignition potential and minimize the potential for wildfire spread. The vegetation within riparian woodlands responds slowly to changes in temperature and moisture, and significant surface shading from tree canopies limits fuel moisture loss. Surface fuels are relatively low in riparian woodlands; however, storm-related high water streamflow can deposit debris and contribute to fuel buildup as it dries out later in the season. During severe weather conditions, high fuel loads can result in high-intensity burning.

Urban

The urban vegetation community/land cover type typically represents noncombustible types (e.g., pavement) or developed and maintained landscapes (e.g., buildings, turf in parks), although some areas may be disturbed lands characterized by annual or perennial grass cover. Two of the vegetation communities/land cover types mapped as urban that include vegetation are urban (acacia) and urban (mixed tree stand). Both vegetation communities are primarily located in Joaquin Miller Park and Dimond Canyon. The areas mapped as urban (acacia) are acacia-dominated stands with little representation of other tree species. The one tree stand mapped as urban (mixed tree stand) is comprised of acacia, oak, pine, and redwood trees. Acacia stands and individual trees within the Plan Area consist of blackwood acacia (*Acacia melanoxylon*), silver wattle (*Acacia dealbata*), and black wattle (*Acacia mearnsii*). These trees or tree-form shrubs are moderately fast growing, invasive species that tend to shade out native trees, including alders and oaks. Blackwood acacia can grow as individual trees up to 40 feet tall. The other acacia species can grow as evergreen large shrubs in dense thickets. Acacias can be fire-stimulated with prolific regeneration from long-lived seed and sprouts after fire. In addition to the oils in the leaves or phyllods (i.e., expanded leaf stocks) and dried, curly seed pods, acacias are brittle and can break in high winds, increasing the buildup of downed debris and ladder fuels in the understory. Given their physical characteristics, acacia trees (in stands or intermixed with other tree species) contribute to increased fire hazard.

2.3.2.4 Invasive Species

Invasive species in the Plan Area may occur within any of the identified vegetation community/land cover types. Invasive plants can increase the frequency of fires by providing more continuous fuels that are more easily ignited (Brooks et al. 2004). Broom and pampas grass are of primary concern in the Plan Area, although others have been identified (as listed below). Some of the plants listed below are identified as invasive species by the California Invasive Plant Council (Cal-IPC; Cal-IPC 2017).

Broom

One of the primary invasive plant types of concern in the Plan Area is broom: French broom (*Genista monspessulana*), Scotch broom (*Cytisus scoparius*), and Spanish broom (*Spartium junceum*). All are identified as Cal-IPC invasive species. Dense broom infestations produce large amounts of dry matter, which can create a serious fire hazard (DiTomaso 1998). Broom spreads by prodigious seed production and may also sprout from the root crown (Bossard 2000) or upper stem (Boyd 1995) when aboveground parts are removed by cutting, freezing, or fire. A review by Bossard (2000) suggests that broom burns readily and carries fire to the tree canopy layer,

increasing both the frequency and intensity of fires in invaded areas. Similarly, Parsons and Cuthbertson (1992) suggest that broom causes concern in forest areas in Australia because it forms a flammable understory at the forest edge, where fires are most likely to start. Conversely, combustion of live, standing broom is difficult under conditions in which prescribed burns are typically conducted in California (cool, wet, low-wind days that provide lower risk of an escaped fire), unless fuel loads are artificially increased. Despite high temperatures and low humidity, researchers in Marin County, California, were unable to burn a mature, uncut broom stand, and a young uncut stand had only spotty combustion (Odion and Haubensak 2002).

Pampas Grass

Pampas grass (*Cortaderia selloana*) was also observed in the Plan Area. Pampas grass is a large, clumping grass, about 6 feet to 8 feet (1.8 meters to 2.4 meters) tall. It is an aggressive spreading, ornamental species that produces significant amounts of biomass, which is extremely flammable, thus increasing the potential for fire ignition and/or spread. This species produces an abundance of seed, which is light and can be windblown into the surrounding areas (Cal-IPC 2017). The Cal-IPC inventory categorizes pampas grass as having an overall rating of "high," and it is ranked as a high priority for removal/control within the Plan Area because of its ability to spread rapidly and contribute to the spread of wildfire.

Additional Plants

The following invasive plants occur in the Plan Area and contribute to increased fire hazard:

- Acacia species – silver wattle, blackwood acacia, and others (Cal-IPC invasive species)
- Blackberry (*Rubus discolor* and *R. ulmifolius*)
- Cotoneaster (*Cotoneaster franchetii, C. lacteus*, and *C. pannosus*) (Cal-IPC invasive species)
- Elm (*Ulmus* spp.)
- Eucalyptus species – blue gum and red gum (*E. camaldulensis*) (Cal-IPC invasive species)
- Gorse (*Ulex europaea*) (Cal-IPC invasive species)
- Hawthorn (*Crataegus monogyna*) (Cal-IPC invasive species)
- Holly (*Ilex aquifolium*) (Cal-IPC invasive species)
- Jubata grass (*Cortaderia jubata*) (Cal-IPC invasive species)
- Mayten (*Maytenus boaria*)
- Plum and cherry (*Prunus* spp.) (*Prunus cerasifera* is a Cal-IPC invasive species)

2.3.3 Wildfire Types and Potential Fire Behavior

Several wildfire types exist, as summarized below:

- **Ground Fire:** A fire burning on the ground or through understory vegetation and not reaching into the canopy (SKCNP 2017).
- **Surface Fire:** A fire burning along the surface without significant movement into understory or overstory vegetation, with low flame lengths, usually less than 1 meter (SKCNP 2017).
- **Crown Fire:** A fire that has burned upward from the ground and into the tree canopy. There are three types of crown fires:
    - **Passive Crown Fire:** A crown fire in which individual or small groups of trees torch out, but solid flaming in the canopy cannot be maintained except for short periods. Passive crown fire encompasses a wide range of crown fire behavior from the occasional torching of an isolated tree to a nearly active crown fire. Also called torching (Scott and Reinhardt 2001).
    - **Active Crown Fire:** A crown fire in which the entire fuel complex becomes involved, but the crowning phase remains dependent on heat released from the surface fuels for continued spread. Also called running and continuous crown fire (Scott and Reinhardt 2001).
    - **Independent Crown Fire:** A crown fire that spreads without the aid of a supporting surface fire (Scott and Reinhardt 2001).

Another component of fire behavior is spotting, the transfer of fire brands (embers) ahead of a fire front which can ignite smaller vegetation fires (SKCNP 2017). These smaller fires can burn independently or merge with the main fire. Spotting can also result in structural ignitions when transported embers reach a receptive fuel bed (e.g., combustible roofing), especially in wind-driven fires, such as those occurring during Diablo wind events in the Oakland Hills.

Each of the aforementioned fire types may occur within the Plan Area, depending on site-specific conditions. Fire behavior is the manner in which a wildland fire reacts to weather, fuels, and topography. The difficulty of controlling and suppressing a wildfire is typically determined by fire behavior characteristics, such as rate-of-spread, fireline intensity, torching, crowning, spotting, fire persistence, and by resistance to control (SKCNP 2017). Extreme fire behavior is that which precludes methods of direct control (e.g., flame lengths 8 feet and greater), behaves unpredictably and erratically, and typically involves high spread rates, crowning and/or spotting, the presence of fire whirls, and a strong convective column (NWCG 2017).

Fire behavior characteristics 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 et al. 2008). While it is a somewhat subjective and nonscientific measure of fire behavior, it is extremely important to fireline personnel when evaluating fireline intensity, and is worth considering as an important fire variable (Rothermel 1993). Fireline intensity is a measure of heat output from the flaming front and also affects the potential for a surface fire to transition to a crown fire. The information in Table 5 presents an interpretation of flame length and its relationship to fire suppression efforts.

Table 5
Fire Suppression Interpretation

Flame Length	Fireline Intensity	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 feet 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 feet to 11 feet	500–1,000 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 1,000 BTU/ft/s	Crowning, spotting, and major fire runs are probable. Control efforts at head of fire are ineffective.

Note: BTU/ft/s = British thermal units per foot per second.
Source: Roussopoulos and Johnson 1975.

2.4 Fire History and Ignitions

Fire history is an important component in understanding fire frequency, fire type, significant ignition sources, and vulnerable areas. The topography, vegetation, and climatic conditions associated with the Plan Area combine to create a unique situation capable of supporting large-scale, high-intensity, and sometimes damaging wildfires, such as the 1991 Tunnel Fire. The history of wildfires in the Plan Area is presented in Table 6.

Table 6
History of Wildfires in the Oakland Hills

Year	Month	Wind	Acres	Structures Lost	Location
1923	September	Diablo	130	584	North of UC Berkeley Campus
1931	November	Diablo	1,800	5	Leona Canyon
1933	November	Diablo	1,000	5	Joaquin Miller
1937	September	Westerly	700	4	Broadway Terrace

Table 6
History of Wildfires in the Oakland Hills

Year	Month	Wind	Acres	Structures Lost	Location
1940	September	Westerly	30	0	Broadway Terrace
1946	September	Diablo	1,000	0	Buckingham/Norfolk
1955	November	Westerly	10	0	Montclair
1960	October	Diablo	1,200	2	Leona Canyon
1961	November	South-Westerly	400	0	Briones Regional Park, Tilden Regional Park, Roberts Regional Recreation Area, Chabot Regional Park
1968	October	Westerly	204	0	North of Naval Hospital
1970	September	Diablo	204	37	Buckingham/Norfolk
1980	December	Diablo	2	5	Wildcat Canyon Road, Berkeley
1990	October	Westerly	200	0	Leona Canyon
1991	October	Diablo	1,700	3,000	Buckingham/Norfolk
2017	July	West/North	9	0	Grizzly Peak and South Park
2017	September	North	22	0	Leona Quarry
2017	October	Diablo	7	0	Elysian Fields and Gold Links Road
2017	December	Diablo	2.5	2	Snake Road and Colton Boulevard

Source: City of Oakland 2017b.

As presented in Table 6, nearly all significant wildfires have burned in the months of September, October, or November. This timeframe coincides with the end of the dry summer season, where vegetation has lower fuel moistures and Diablo winds return to the Plan Area. While not all the fires shown in Table 6 were associated with Diablo (easterly or northeasterly) winds, the largest and most damaging fires have occurred during such winds.

The history of wildfire ignitions in the Plan Area is directly related to human activity. Notable ignition locations include view spots along Grizzly Peak Boulevard or Skyline Boulevard that offer views of the San Francisco Bay and congregation areas within Joaquin Miller Park, along Skyline Boulevard near Sequoia Point. Stolen vehicle dump sites are another potential wildfire ignition source, with notable locations in Joaquin Miller Park (near Sequoia Point) and at the water tank on Skyline Boulevard, approximately 0.5 miles west of its intersection with Grass Valley Road. Mechanized and power equipment use (e.g., mowers) on private, residential parcels is another potential ignition source, one that was responsible for igniting the 1991 Tunnel Fire and the 1970 Diablo Fire. Fireworks present another potential ignition source in early summer on or near July 4, notably at King Estates Park (Crudele, pers. comm. 2017). Other potential ignition sources within the Plan Area include vehicle-originated fires along Plan Area roads, including State Routes 13 and 24 and Interstate 580.

2.5 Fire Hazard Severity Zoning

As noted, the Plan Area is located within the City's adopted VHFHSZ. Fire Hazard Severity Zones (FHSZs) are "geographical areas designated pursuant to California Public Resources Codes, Sections 4201 through 4204 and classified as Very High, High, or Moderate in State Responsibility Areas or as Local Agency Very High Fire Hazard Severity Zones designated pursuant to California Government Code, Sections 51175 through 51189" (California Building Standards Commission 2016). Oakland's VHFHSZ is a Local Agency VHFHSZ, as defined.

California Public Resources Code Sections 4201–4204 and Government Code Sections 51175–51189 direct California Department of Forestry and Fire Protection (CAL FIRE) to map areas of significant fire hazards based on fuels, terrain, weather, and other relevant factors. The resulting FHSZs define the application of various mitigation strategies to reduce risk associated with wildland fires (CAL FIRE 2016a). The model used to determine the extent of FHSZs is based on an analysis of potential fire behavior, fire probability predicated on frequency of fire weather, ignition patterns, expected rate of spread, ember (brand) production, and/or past fire history (CAL FIRE 2016a). Structures built in FHSZs are subject to more stringent fire hardening requirements than those that are not.

2.6 Wildland Urban Interface/Intermix

The pattern of development and land use within the City's VHFHSZ creates conditions that can be described as either a wildland urban interface or a wildland urban intermix. Urban areas are predominantly built-up environments with little or no exposure to vegetative fuels. Such areas are located primarily to the west of the City's VHFHSZ. The area where urban development abuts vegetative fuels is known as the wildland urban interface (WUI). This condition exists within the City's VHFHSZ where structures abut City parklands and open space. Areas where the density of housing units and structures is lower and/or the space between structures consists of vegetative fuels capable of propagating fire are more typically characterized as a wildland urban intermix (Intermix). This condition exists throughout the City's VHFHSZ, notably where smaller undeveloped lots consisting of vegetative fuels are situated between structures. Both conditions present advantages and disadvantages with respect to reducing wildfire hazard, as described below.

2.6.1 Wildland Urban Interface

WUI areas are those within the "vicinity" of wildland vegetation. The wildland fire risk associated with WUI areas includes propagation of fire throughout WUI communities via house-

to-house fire spread, landscaping-to-house fire spread, or ember intrusion. Advantages and disadvantages associated with WUI areas are as follows.

WUI Advantages

- Community water supply systems in place
- Multiple homes accessed by a single road
- Emergency equipment protects multiple assets at once
- Houses usually only exposed to flammable fuels on one side

WUI Disadvantages

- High housing density
- Congested roads during emergencies
- Limited options if the community water systems fail

2.6.2 Wildland Urban Intermix

Intermix areas are those where housing and vegetation intermingle. In the Intermix, wildland vegetation is continuous, and more than half of the land area is vegetated with combustible fuels. The wildland fire risk associated with Intermix areas includes vegetation-to-house fire spread or ember intrusion. Advantages and disadvantages associated with Intermix areas are as follow.

Intermix Advantages

- Low housing density
- Diversity in water supply systems

Intermix Disadvantages

- Increased risk to firefighters
- Emergency equipment can only protect single assets
- Delayed emergency equipment response times due to:
    - Rural roads (single lane, windy, heavy fuel loading)
    - Long driveways
- Congested roads during emergencies

- Diversity in water supply systems
- Houses surrounded by vegetation

3 WILDFIRE HAZARD ASSESSMENT

The wildfire hazard assessment conducted in support of this VMP involved an evaluation of field conditions, processing and analyzing spatial datasets in a GIS, conducting GIS-based modeling to identify areas that may be subject to extreme fire behavior, and identifying locations within the Plan Area that may present increased ignition potential or otherwise contribute to increase fire hazard. The assessment effort is presented in the following sections and was used to prioritize fuel treatment areas.

3.1 Field Assessments

As noted in Section 2.3.1, field assessments were conducted by Dudek between December 2016 and September 2017 in order to evaluate existing fuel load conditions and to gain an understanding of general fuel hazard conditions and current maintenance practices being conducted by OFD within the Plan Area. Field assessments were also used to identify and classify vegetation community and land cover types into fuel models, as presented in Table 3, and as discussed in more detail in Section 3.3 and Appendix D. During field assessments, site conditions were documented via photographs and, in some cases, noted on digital or hard-copy field maps. Photo-documentation of field conditions and corresponding fuel model assignments are presented in Appendix D.

3.2 GIS Analysis

Development of this VMP included assessment and processing of GIS datasets (in ArcGIS [version 10.5]), for variables influencing wildfire hazard in the Plan Area, as presented below:

- **Boundary:** The City's VHFHSZ boundary file was obtained from the City and formed the boundary for all analysis and mapping efforts conducted in support of this VMP.
- **Terrain:** Digital terrain data for the City's VHFHSZ was obtained (USGS 2013a, 2013b) and processed to develop slope and aspect datasets for use in project-related fire behavior modeling (Section 3.3 and Appendix D).
- **Vegetation/Land Cover:** Vegetation mapping data (Appendix B) was analyzed and used as the base for fuel model assignments (as described in Section 3.3 and Appendix D).
- **Land Ownership:** City-owned parcel data was obtained from the City and formed the mapping base for this VMP. Parcels were reviewed and classified into broad categories (e.g., canyon, urban/residential) for development of management recommendations. All additional mapping efforts performed in development of this VMP utilized the City-

owned parcel dataset as a base, and Assessor's Parcel Numbers for each parcel were retained in all subsequent GIS datasets.

- **Roads:** Road centerline data was obtained from the City and clipped to the City's VFHSZ boundary and road distances re-calculated based on clipped lengths.
- **Structures:** Structure footprint data in polygon format was obtained from the City and clipped to the VHFHZS boundary, plus a 200-foot buffer. This data was used in subsequent buffering efforts, as described below.

In addition to review of the aforementioned datasets, creation of buffering datasets was necessary to inform the prioritization recommendations included in this VMP, as some are related to distances from existing structures in the Plan Area. To determine the area of land within certain distances of structures, a GIS analysis was performed using buffering tools within ArcGIS (version 10.5). Using the Multiple Ring Buffer tool, 100-foot and 300-foot horizontal buffers around existing structure locations were calculated and mapped. Polygon data depicting structure footprints within the City's VHFHSZ was acquired from the City of Oakland. The structure footprint polygon data was used as the source data and buffers calculated outward. The resulting buffer polygon dataset included two distinct areas: the land area within 0 to 100 feet from structures and the land area within 100 feet to 300 feet from structures. All buffer dataset were clipped to the City-owned parcels within the Plan Area. Fire behavior modeling efforts were also conducted in a GIS environment, as described below.

3.3 Fire Behavior Modeling

Modeling of potential fire behavior was also conducted to support development of this VMP. Specifically, the FlamMap software package was used to identify portions of the Plan Area that may be subject to extreme fire behavior, considering weather, fuels, and terrain variables. FlamMap (version 5.0.3) (Finney et al. 2015) is a GIS-driven computer program that incorporates fuels, weather, and topography data in generating static fire behavior outputs, including values associated with flame length and crown fire activity, among others. It is a flexible system that can be adapted to a variety of specific wildland fire planning and management needs. The calculations that come from FlamMap are based on the BehavePlus fire modeling system algorithms but result in geographically distinct datasets based on GIS inputs. FlamMap model outputs allow wildland resource managers to evaluate anticipated fire behavior, which provides important insight about the characteristics of wildfire spread within management areas. Each of the input variables used in FlamMap remain constant at each location, meaning that the input variables are applied consistently to each grid cell and the fire behavior at one grid cell does not impact that at a neighboring grid cell. Essentially, the model presents a "snapshot" in time and does not account for temporal changes in fire behavior or the movement of fire across the

landscape. As such, the results of the models contained herein are best used as valuable information sources and tools to prioritize fuel treatments based on potential risk rather than used as a forecast tool of an exact representation of how a fire would behave in the Plan Area.

The following are the basic assumptions and limitations of FlamMap:

- The model output files describe fire behavior only in the flaming front. The primary driving forces in the predictive calculations are the dead fuels less than 0.25 inches in diameter. These are the fine fuels that carry fire. Fuels greater than 1 inch in diameter have little effect in carrying fire, and fuels greater than 3 inches in diameter have no effect.
- The model bases calculations and descriptions on a wildfire spreading through surface fuels that are within 6 feet of the ground and contiguous to the ground. Surface fuels are often classified as grass, brush, litter, or slash.
- The software assumes that fuel moisture conditions are uniform. However, because wildfires almost always burn under non-uniform conditions, length of projection period and choice of fuel must be carefully considered to obtain useful predictions.
- WindNinja software (version 2.1.0), which is incorporated into FlamMap, allows for the generation and incorporation of gridded wind data in the FlamMap simulation.

FlamMap was used to model flame length and crown fire activity for a portion of the Plan Area. A detailed discussion of the FlamMap modeling process conducted for this VMP is presented in Appendix D, which includes maps depicting the graphical outputs of the modeling runs. The results of the FlamMap modeling effort are summarized in Table 7, by location.

Table 7
Fire Behavior Modeling Results

Location	Flame Length	Crown Fire
Canyon Areas		
Garber Park	Flame lengths low (< 4 feet).	Surface fire only.
Dimond Canyon Park	Flame lengths high (> 8 feet) in coastal scrub and one coastal oak woodland area along Park Boulevard with grass/shrub understory. Flame lengths low to moderate (< 8 feet) in remaining areas of the property.	Primarily surface fire throughout the property, although small pockets of active crown fire occur the coastal oak woodland area along Park Boulevard with grass/shrub understory and in a few small areas within the drainage with high slope gradients.

Table 7
Fire Behavior Modeling Results

Location	Flame Length	Crown Fire
Shepherd Canyon Park	Flame lengths high (> 8 feet) in area along the western side of Shepherd Canyon Road where broom exists beneath eucalyptus tree canopies. Flame lengths moderate (< 8 feet) within eucalyptus stand along Escher Drive. Flame lengths low (< 4 feet) throughout the remainder of the property.	Active and passive crown fire concentrated along the western side of Shepherd Canyon Road where broom exists beneath eucalyptus tree canopies. Surface fire throughout the remainder of the property.
Leona Heights Park	Flame lengths high (> 8 feet) in coastal oak woodlands in upland areas in the eastern and northern portions of the park. Flame lengths low (< 4 feet) within redwood stands along the drainage bottom, with some isolated active crown fire in areas with steep slope gradients. Flame lengths low (< 4 feet) within the managed eucalyptus and oak stands at the park's western edge.	Active and passive crown fire in coastal oak woodlands in upland areas in the eastern and northern portions of the park. Primarily surface fire within redwood stands along the drainage bottom, with some isolated active crown fire in areas with steep slope gradients. Surface fire only in the managed eucalyptus and oak stands at the park's western edge.
Ridgetop Areas		
North Oakland Regional Sports Field	Flame lengths high (> 8 feet) throughout property.	Active crown fire throughout most of the property's tree-dominated vegetation (eucalyptus and coastal oak woodland). Surface fire concentrated in managed areas along dirt access road and in the area between ball field and eucalyptus stand.
Grizzly Peak Open Space	Flame lengths high (> 8 feet) throughout coastal scrub vegetation. Flame lengths low (< 4 feet) in coastal oak woodland. Variable flame lengths within pine and eucalyptus stands (low to high, dependent on canopy base heights and shading of surface fuels).	Torching of tree canopies along upper, northeastern portion of property and active crown fire along lower, southwestern portion of property.
City Stables	Flame lengths low (< 4 feet).	Surface fire only.
City Parklands and Open Space		
Sheffield Village Open Space	Flame lengths high (> 8 feet) in coastal scrub, oak stands with a heavy shrub understory, and isolated areas within oak woodlands with grass understory where slope gradients are high. Flame lengths moderate (< 8 feet) in pine and eucalyptus stands adjacent to the golf course. Flame lengths low (< 4 feet) throughout the remainder of the property.	Active crown fire in coastal scrub (where overstory trees are present), oak stands with a heavy shrub understory, and isolated areas within oak woodlands with grass understory where slope gradients are high. Surface fire only throughout the remainder of the property.
Knowland Park and Arboretum	Flame lengths high (> 8 feet) in the coastal scrub and chaparral stands in the central and eastern portions of the property. Flame lengths moderate (< 8 feet) in the eucalyptus stands in the western portion of the property. Flame lengths low (< 4 feet) throughout the remainder of the property.	Active crown fire in the coastal scrub and chaparral stands in the central and eastern portions of the property (where overstory trees are present) and in the eucalyptus stands in the western portion of the property. Surface fire only throughout the remainder of the property.

Table 7
Fire Behavior Modeling Results

Location	Flame Length	Crown Fire
Joaquin Miller Park	Flame lengths high (> 8 feet) throughout the northern and central portions of the park within nonmanaged oak, pine, eucalyptus, and acacia stands and within the acacia and mixed tree stands within the southern (lower) portions of the park. Flame lengths low to moderate (< 8 feet) in the lower, developed, and managed portions of the park and along the park's western edge where it abuts Castle Drive (except acacia and mixed tree stands).	Active and passive crown fire within the northern and central portions of the park within nonmanaged oak, pine, eucalyptus, and acacia stands. Active and passive crown fire also within the acacia and mixed tree stands within the southern (lower) portions of the park. Surface fire only within redwood stands and throughout the lower, developed and managed portions of the park (except acacia and mixed tree stands).
King Estates	Flame lengths low (< 4 feet) throughout the property's coastal oak woodlands and grasslands. Flame lengths moderate (< 8 feet) in the coastal scrub and eucalyptus stands on the property.	Isolated active crown fire only in coastal scrub where overstory trees are present. Surface fire only throughout the remainder of the property.
Other (Blue Rock Court)	Flame lengths high (> 8 feet) in the eucalyptus stand in the center of the property. Flame lengths low (< 4 feet) throughout the remainder of the property.	Active and passive crown fire in the eucalyptus stand in the center of the property. Surface fire only throughout the remainder of the property.
Other (Leona Street)	Flame lengths low (< 4 feet) in coastal oak woodland and annual grassland. Flame lengths high (> 8 feet) in eucalyptus stand at the property's southern end.	Surface fire only in coastal oak woodland and annual grassland. Active crown fire in eucalyptus stand at the property's southern end.
Other (McDonell Avenue)	Flame lengths low (< 4 feet).	Surface fire only.
Other (Police/Safety Department)	Flame lengths low (< 4 feet).	Surface fire only.
Other (Tunnel Road Open Space)	Flame lengths low (< 4 feet).	Surface fire only.
Other (Beaconsfield Common)	Flame lengths high (> 8 feet) in coastal scrub. Flame lengths low to moderate (< 8 feet) in coastal oak woodland and pine stands.	Active and passive crown fire in eucalyptus stands. Surface fire in coastal oak woodland and pine stands.
Other (Sulfur Springs Park)	Flame lengths high (> 8 feet) in eucalyptus stands. Flame lengths low to moderate (< 8 feet) in coastal oak woodland and pine stands.	Active and passive crown fire in coastal scrub (where overstory trees are present). Surface fire in coastal oak woodland and pine stands.

The results presented in Appendix D and summarized in Table 7 depict values based on inputs to the FlamMap software and are not intended to capture changing fire behavior as it moves across a landscape. For planning purposes, the worst-case fire behavior is the most useful information for prioritizing vegetation management activities. 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.

While other fire behavior modeling systems exist (BehavePlus, FARSITE), FlamMap was selected given its capabilities for mapping potential fire behavior in a GIS-based environment, a characteristic important in fire and vegetation management planning (Finney 2006). Another system utilized for modeling potential wildfire in Australia is Project VESTA, a comprehensive research project that investigated the behavior and spread of high-intensity brushfires in dry eucalyptus forests with different fuel ages and understory vegetation. Project VESTA was designed to quantify age-related changes in fuel attributes (eucalyptus stands between 2 years to 22 years old) and fire behavior in dry eucalypt forests in southern Australia. Research findings from Project VESTA (Gould et al. 2007) were used to assess fuel characteristics in different eucalyptus forest understories and to identify better fuel parameters to input into the FlamMap fire models conducted in support of this VMP.

3.4 Research and Documentation

Development of this VMP also included research to document existing vegetation management practices being conducted by OFD in the Plan Area and to identify anecdotal evidence of areas subject to high ignition potential. OFD has been actively managing vegetation since 2003 to minimize wildfire hazard in the Plan Area, utilizing various techniques (e.g., grazing, hand crews). The effort to document vegetation management efforts involved a thorough review and marking up of hard copy maps of the Plan Area by OFD, as well as a review of vegetation management contract documents provided by OFD. The current vegetation management activities being conducted by OFD at each City-owned parcel in the Plan Area were then recorded into the GIS data created for development of this VMP. A summary of current and past vegetation management activities is presented in Section 8, Vegetation Management Techniques, by management type.

Multiple conversations with OFD staff (Crudele, pers. comm. 2017) were also conducted to better understand locations within the Plan Area that may be subject to increased ignition potential, as such information is not typically recorded in map format. Identification of such areas is an important consideration for identifying and prioritizing fuel treatment recommendations. The effort to document such areas also involved a thorough review and marking up of hard copy maps of the Plan Area by OFD. The results of this effort are discussed in Section 2.4, Fire History and Ignition.

4 CODES AND STANDARDS

This section describes existing codes and standards relevant to vegetation management activity in the Plan Area or the City's VHFHSZ.

4.1 City of Oakland

4.1.1 Protected Trees

Oakland Municipal Code Chapter 12.36 (Protected Trees) was enacted to protect and preserve trees by regulating their removal, to prevent unnecessary tree loss and minimize environmental damage from improper tree removal, to encourage appropriate tree replacement plantings, to effectively enforce tree preservation regulations, and to promote the appreciation and understanding of trees. The code defines protected trees as California or coast live oak trees (*Quercus agrifolia*) measuring 4 inches in trunk diameter at breast height or larger, and any other tree (except eucalyptus and Monterey pine) measuring 9 inches diameter at breast height or larger on any property; and Monterey pine trees only on City property and in development-related situations where more than five Monterey pine trees per acre are proposed to be removed. Monterey pine trees are not protected in non-development-related situations, nor in development-related situations involving five or fewer trees per acre; however, public posting of such trees and written notice of proposed tree removal to the Office of Parks and Recreation is required per Section 12.36.070A and Section 12.36.080A. Except as noted above, eucalyptus and Monterey pine trees are not protected by this ordinance. To remove any protected trees, a tree removal permit is required.

4.1.2 Hazardous Trees

Oakland Municipal Code Chapter 12.40 (Hazardous Trees) defines a "hazardous tree" as any tree which poses an imminent threat to life or property, as determined by inspection using the criteria established by Section 12.40.030. The ordinance defines procedures for removal of hazardous trees for the purpose of preventing personal injury or damage to neighboring properties.

4.1.3 Stormwater Management

Oakland Municipal Code Chapter 13.16 (Creek Protection, Stormwater Management and Discharge Control) is intended to protect and enhance the water quality of watercourses, water bodies, and wetlands in a manner pursuant to and consistent with the federal Clean Water Act and National Pollutant Discharge Elimination System Permit No. CA0029831. The ordinance outlines measures to control discharges to storm sewers; reduces pollutants in storm water discharges; safeguards and preserves creeks, riparian corridors, creekside vegetation, and

wildlife; prevents activities that would contribute to flooding, erosion, or sedimentation; controls erosion and sedimentation; and protects drainage facilities.

4.1.4 Fire Code

Oakland Municipal Code Chapter 15.12 (Oakland Fire Code) and its amendments establish regulations regarding the hazard of fire and explosion arising from the storage, handling, or use of structures, materials or devices; conditions hazardous to life, property or public welfare in the occupancy of structures, or premises; fire hazards in the structure or on the premises from occupancy or operation; matters related to fire suppression or alarm systems; and conditions affecting the safety of firefighters and emergency responders during emergency operations.

The Oakland Fire Code also includes Chapter 49 (Wildland-Urban Interface Areas), which defines the City's VHFHSZ and outlines requirements for defensible space, hazardous vegetation management, electrical distribution line clearances, fire apparatus access, water supply, ignition source control, and combustible materials storage, among others. Specifically, Section 4906.3 of the Oakland Fire Code states that vegetation around all applicable buildings and structures within the VHFHSZ shall be maintained in accordance with California Public Resources Code Section 4291, California Code of Regulations Title 14 – Natural Resources, Division 1.5 – Department of Forestry and Fire Protection, "General Guideline to Create Defensible Space," and California Government Code Section 51182.

4.1.5 General Plan Open Space Conservation and Recreation Element

The Open Space Conservation and Recreation Element of the City's General Plan is the official policy document addressing the management of open land, natural resources, and parks in Oakland. It includes policies regarding topics such as flood control and discharge, creek maintenance, tree removal, wildlife corridors, and transportation management, among others. The element also discusses fire prevention measures, flammable vegetation control, fire-resistant landscape guidelines, and public education on fire suppression.

4.1.6 Comprehensive Plan Scenic Highways Element

The Scenic Highways Element, part of the Oakland Comprehensive Plan adopted in 1974 (City of Oakland 1074), addresses the preservation and enhancement of distinctively attractive roadways that traverse the City of Oakland and the visual corridors that surround them. It establishes a framework within which roads and highways can be identified as part of the Oakland Scenic Route System, enumerates policies regarding those routes, and complies with State Government Code Section 65302, which requires a Scenic Highways Element be prepared as part of the General Plan. The plan qualifies Interstate 580 as an Official California Scenic

Route and safeguards Skyline Boulevard/Grizzly Peak Boulevard/Tunnel Road as a uniquely scenic drive in the City.

4.1.7 General Plan Safety Element

The Safety Element of the General Plan was adopted in 2004 and amended in 2012. The purpose of a safety element is to reduce the potential risk of death, injuries, property damage, and economic and social dislocation resulting from large-scale hazards. By law, a safety element must address the following issues: seismically induced surface rupture, ground shaking, ground failure, tsunamis, seiches, and dam failure; slope instability leading to mudslides and landslides; subsidence, liquefaction, and other seismic and geologic hazards; flooding; wild-land and urban fires; and evacuation routes, military installations, peak-load water supply requirements and minimum road widths and clearances around structures, as those items relate to identified fire and geologic hazards. The fire hazards section of the Safety Element describes the City's unique fire risks, including structural fires and wildfires, as well as policies related to emergency response and fire prevention.

4.1.8 Pest Management Resolution

The City's Pest Management Resolution (No. 73968 C.M.S., 1997) identifies that pesticides shall not be used in or on City-owned properties or facilities, with specific exemptions. Exemptions include where use is required to preserve and/or protect human health and safety, around fire hydrants, and on public streets and rights-of-way maintained by the City, amongst others. Certain pesticides (e.g., pesticidal soaps, botanicals, horticultural oils) and also exempted.

4.2 Alameda County

4.2.1 General Plan Scenic Route Element

The Scenic Route Element of the Alameda County General Plan was adopted in 1966 and amended in 1994. It is intended to serve as a means of continuing coordination among the city and county planning functions of Alameda County and the State Division of Highways in the development of a county-wide system of scenic routes, appropriate portions of which would be adopted or expanded upon by each city and the state. The plan is also intended to serve as a guide for development of city and county legislation and programs that will protect and enhance the scenic values along routes.

4.3 State of California

4.3.1 California Public Resources Code

California Public Resources Code Section 4291 (PRC 4291) requires owners of property to create defensible space around structures on their property where firefighters can provide protection during a wildfire. PRC 4291 applies to areas of the state within the responsibility area of CAL FIRE. The defensible space distance is measured along the grade from the perimeter or projection of a building or structure. Under PRC 4291, defensible space is required up to 100 feet from a structure, or to the property limit, whichever is closer; however, the amount of vegetation management necessary may extend beyond 100 feet depending on the flammability of the structure, topography, and fuels. CAL FIRE's Guidelines for Creating Defensible Space as outlined in PRC 4291 can be found at: http://bofdata.fire.ca.gov/PDF/copyof4291final guidelines9_29_06.pdf.

5 MANAGEMENT PLANS AND PROGRAMS

This section describes existing land or resource management plans and programs relevant to vegetation management activity in the Plan Area or the City's VHFHSZ.

5.1 City of Oakland Management Plans and Programs

5.1.1 City of Oakland 2016–2021 Local Hazard Mitigation Plan

The Local Hazard Mitigation Plan, adopted June 7, 2016, is intended to assess the risks to the City and to the people of Oakland from natural and human-caused hazards. The Local Hazard Mitigation Plan reviews risks from hazards, including wildfire hazards, identifies mitigation measures to reduce those risks, and presents an implementation program for the next 5 years. The 2016–2021 Plan functions as an appendix to the 2004 Safety Element of the Oakland General Plan, is an update to the 2010–2015 Local Hazard Mitigation Plan, and complements the City's ongoing disaster, emergency, and resilience planning efforts. The City Administrator's office and the OFD's Emergency Management Services Division are responsible for monitoring mitigation measures and annual review of the Local Hazard Mitigation Plan in partnership with staff from the Planning and building Department.

The 2016–2021 Local Hazard Mitigation Plan can be accessed at:

http://www2.oaklandnet.com/government/o/PBN/OurOrganization/PlanningZoning/s/LocalHazardMitigationPlan/OAK058455.

The 2010–2015 Local Hazard Mitigation Plan can be accessed at:

http://www2.oaklandnet.com/oakca1/groups/ceda/documents/report/oak033052.pdf.

5.1.2 City of Oakland Wildfire Protection Assessment District 2011–2014 Vegetation Management Plan

The 2011–2014 Vegetation Management Plan describes the fire prevention codes and ordinances that pertain to WUI/Intermix areas of the City of Oakland, and provides educational information related to wildfire protection to the City's residents. The plan was prepared and enforced by the Wildfire Prevention Assessment District, a City-funded special assessment district active between 2004 and 2017. The District financed the costs and expenses related to vegetation management, yard waste disposal, community wildfire prevention education, and fire patrols in the Oakland Hills. The District has disbanded, and its final meeting was held in June 2017.

5.1.3 Oakland Fire Department Vegetation Inspection Program

OFD's Fire Prevention Bureau conducts approximately 26,000 public and private property inspections annually in the VHFHSZ portion of the City. Inspections are mandated by City of Oakland Ordinance No. 11640. The inspection area is divided into five districts (which differ from City Council Districts), each of which has an inspector.

On City-owned and private lots, fire companies and vegetation management inspectors annually inspect properties to identify and notice those that are out of compliance with the defensible space standards outlined in the City's Fire Code (Section 4907 of the Oakland Municipal Code Chapter 15.12). Repeat inspections are made until properties are brought to compliance. The overall annual compliance rate is typically 90%. Rarely does a property reach the level where the work is put out to bid for an independent contractor to complete the work.

The following summarizes the defensible space requirements included in the City's Fire Code:

Developed Lots (lots with a house or other structures):

- Keep a 30-foot minimum defensible space around all buildings (grass, weeds, brush to 6 inches or less).
- Keep 10-foot minimum clearances next to the roadside including street rights-of-way.
- Remove all portions of trees within 10 feet of chimneys or stovepipe outlets.
- Keep roof and gutters free of leaves, needles, or other dead/dying wood.
- Install a spark arrestor on chimneys or stovepipe outlets.
- Remove all tree limbs within six feet of the ground so as not to create fuel ladders.
- Remove dead/dying vegetation from the property.
- Maintain and irrigate all landscaping so it is green.

Vacant lots (if 0.5 acres or less, clear the entire property of flammable vegetation in accordance with fire hazard abatement requirements below. If greater than 0.5 acres, clear the perimeter with a minimum width of 30 feet around the property line or to the exterior boundary of the property):

- Clear entire lot of dry grass, weeds, and brush to a height of 6 inches or less.
- Maintain perimeter clearance of 30 feet within the property line to the exterior boundary.
- Provide a firebreak of l00 feet along the perimeter of property adjacent to neighboring structures.

- Maintain a 10-foot minimum clearance next to the roadside including street rights-of- way.
- Remove dead/dying vegetation from the property.
- Remove all tree limbs within 6 feet off the ground so as not to create fuel ladders.

5.2 Other Related Management Plans and Environmental Documents

5.2.1 Chabot Space and Science Center Vegetation Management Implementation Plan

The Chabot Space and Science Center Vegetation Management Implementation Plan (WRA 2013) was prepared for the City of Oakland to assist efforts in limiting fuel loads at the Chabot Space and Science Center (CSSC). The Plan also assists partial fulfillment of the Pallid Manzanita Habitat Enhancement and Conservation Plan prepared for the CSSC and includes recommendations that would reduce fuel loads and improve habitat conditions for pallid manzanita (*Arctostaphylos pallida*) a plant species federally listed as threatened and state listed as endangered, on the site. The Plan covers approximately 7.93 acres of land to the southwest of the CSSC, and is bounded by the CSSC driveways at the northwest and southeast and by Skyline Boulevard to the southwest.

5.2.2 Chabot Space and Science Center Pallid Manzanita Habitat Enhancement and Conservation Plan

The Pallid Manzanita Habitat Enhancement and Conservation Plan (CSSC 2015) was prepared to fulfill mitigation measures established in the Chabot Space and Science Center 1995 Environmental Impact Report. These mitigation measures were designed to avoid and minimize impacts to pallid manzanita located in the vicinity of the project site. The Plan discusses the existing conditions of the site and habitat for the pallid manzanita, then describes goals and performance standards and habitat enhancement and restoration measures to restore the species to previous numbers at a minimum and protect the plants into the future. The Plan sets forth a monitoring regimen to take place once a year during spring to document the success of habitat enhancement and restoration efforts and to plan future actions.

5.2.3 East Bay Regional Park District East Bay Hills Wildfire Hazard Reduction, Resource Management Plan, and Environmental Impact Report

The East Bay Regional Park District (EBRPD) East Bay Hills Wildfire Hazard Reduction and Resource Management Plan (LSA 2009) was prepared to provide long-term strategies for reducing fuel loads and managing vegetation within EBRPD's Study Area parks. The plan includes wildfire hazard reduction and resource management goals that are further supported by

objectives and guidelines to minimize the risk of Diablo wind-driven catastrophic wildfire along the WUI while maintaining and enhancing ecological habitat values within the EBRPD's jurisdiction. In order to achieve these goals, the EBRPD established a vegetation management plan, which describes vegetation types and characteristics within the EBRPD's Study Area, includes fire hazard reduction and resource management goals, and sets forth potential fuel treatment methods. The plan also discusses fuel reduction methods and plan implementation and allows for a feedback process to improve plan implementation.

The Environmental Impact Report (EIR) (LSA 2010) describes the potential environmental consequences that may result from implementation of EBRPD's Draft East Bay Hills Wildfire Hazard Reduction and Resource Management Plan. The EIR is designed to fully inform EBRPD's decision makers, other responsible agencies, and the general public of the plan and the potential consequences of its approval and implementation. The EIR also recommends a set of mitigation measures to reduce or avoid potentially significant impacts and examines various alternatives to the proposed project. The EIR was certified in 2010.

5.2.4 East Bay Municipal Utility District East Bay Watershed Fire Management Plan

East Bay Municipal Utility District (EBMUD) Fire Management Plan guides the implementation of fire protection and preparedness activities that meet key watershed management objectives. Using an integrated GIS-based fire-planning process, the Fire Management Plan can be updated to reflect current scientific information, federal or state regulations, and natural resource constraints. The plan provides a brief history of fire management in the East Bay, describes recent planning and management efforts to enable more proactive fire management practices, and presents fire assessment, fire reduction, and fire management implementation strategies and tactics (EBMUD 2000).

5.2.5 East Bay Municipal Utility District Low Effect East Bay Habitat Conservation Plan

Pursuant to Section 10 of the Endangered Species Act, the EBMUD Habitat Conservation Plan (HCP) specifies the potential impacts of activities associated with the take of listed species occurring in the HCP area. The HCP identifies general and species-specific biological goals, including managing maintenance of existing covered species habitat types and educating EBMUD personnel regarding identification and avoidance of sensitive species. Species goals include providing for covered species individuals and habitats on EBMUD watershed, and working toward general species recovery within the HCP area.

5.2.6 U.S. Fish and Wildlife Service, Recovery Plan for *Arctostaphylos pallida* (pallid manzanita)

Pallid manzanita was listed as endangered by the State of California in 1979, and was federally listed as threatened in 1998 under the authority of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.). At the time the species was listed, the U.S. Fish and Wildlife Service (USFWS) determined that designating critical habitat would not benefit the species. The USFWS has since determined that based on the highly restricted range within the San Francisco East Bay and threats unique to the species, a 5-year recovery plan is necessary. The Recovery Plan (USFWS 2015) describes the species, its setting, threats to the species, a recommendation to increase the species from threatened to endangered, and specific measures for recovery.

5.2.7 Alameda County Community Wildfire Protection Plan

The Alameda County Community Wildfire Protection Plan (CWPP) (Diablo Fire Safe Council 2015) provides an overview of wildfire hazards and risk in the WUI areas of Alameda County, California. The CWPP follows the format established by the federal Healthy Forest Restoration Act by identifying and prioritizing opportunities for fuel reduction within the County, addressing structural ignitability, and including collaboration with stakeholders. The CWPP aims to aid stakeholders in preventing and reducing the threat of wildfire in the County by producing recommendations to increase education about wildfires, reduce hazardous fuels and structural ignitability, and assist emergency preparedness and fire suppression efforts. In order to accomplish this, action plan summaries are provided that identify implementation steps, leaders and partners, timeframes, and funding needs that will occur over several years to facilitate the implementation of mitigation efforts.

5.2.8 CAL FIRE/Santa Clara Unit Strategic Fire Plan

The 2016 CAL FIRE/Santa Clara Unit Strategic Fire Plan (CAL FIRE 2016b) is produced on an annual basis for the coming fire season. The plan includes an assessment of the fire situation in the Santa Clara Unit (which includes Alameda County), stakeholder contributions and priorities, and strategic targets for pre-fire solutions developed by people who reside and work in the local fire problem area. The plan is also designed to achieve the goals and objectives of the 2010 Strategic Fire Plan for California under the direction of the Santa Clara Unit's pre-fire engineer. After identifying and evaluating existing wildfire hazards, the plan supports collaboration between stakeholders in the implementation and development of actions to reduce potential for a wildfire and ensure adequate response in the event of a wildfire.

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6 PUBLIC ENGAGEMENT

A robust public and stakeholder engagement effort was conducted to support development of this VMP and its forthcoming associated environmental review document under the California Environmental Quality Act (CEQA). To ensure meaningful input was incorporated into this VMP, public engagement activities were conducted to:

- Enable meaningful public input to the plan development process by providing easy access to comprehensive, clear, and timely information about the VMP development and EIR;
- Provide multiple opportunities through meetings and the project website for the public to participate; and
- Comply with the public involvement obligations as required by CEQA.

The target audience for the public engagement effort included City of Oakland and Alameda County elected officials, local stakeholder organizations, landowners, immediate neighbors, and the general public. Project fact sheets and presentations were developed to explain the project purpose, need, scope, and location. Project information was distributed via direct emails, letters, social media (Twitter, Facebook), a dedicated project website (https://oaklandvegmanagement .org/), and several public meetings/workshops. Public feedback was collected via email, an online comment form, an online survey, and hand-written and verbal comments provided at public meetings. X workshops were conducted during VMP development, as identified below:

- March 29, 2017: Dunsmuir Estate
- March 30, 2017: Trudeau Center
- June 29, 2017: Trudeau Center
- To be updated with Spring 2018 Meeting Information

All stakeholder and public comments received were catalogued and summarized. Many constructive comments and recommendations helped guide development of this VMP, including, but not limited to:

- Retention of trees and vegetation in treatment areas;
- Prioritization of treatment areas;
- Treatment of weeds, brush, and dead trees;
- Utilization of grazing as a management tool;
- Treatment of vegetation in defensible space areas; and
- Protection of natural resources (e.g., streams).

Following public feedback, and in an effort to refine the prioritization of treatment areas presented in this VMP, additional analysis and fire behavior modeling was conducted to determine which portions of the Plan Area would be subject to extreme fire behavior and thus should be prioritized for treatment. A summary of survey results and key issues raised during VMP development are included in Appendix E.

7 PLAN AREA RESOURCES

This section summarizes biological, ecological, and community resources found in the Plan Area. Potential impacts to plan area resources were considered during development of the vegetation treatment recommendations, BMPs, and the impact avoidance/minimization measures included in this VMP.

7.1 Biological Resources

7.1.1 Vegetation Communities

As presented in Section 2.3.1, existing vegetation communities and land cover types present in the Plan Area were mapped and classified using the California WHR System (Appendix B). As presented in Table 3, there are 13 vegetation and land cover types mapped in the Plan Area, including coast oak woodland, redwood, valley/foothill riparian, closed-cone pine-cypress, eucalyptus, coastal scrub, chamise-redshank chaparral, freshwater emergent wetland, perennial grassland, annual grassland, and urban land covers (Appendix B). As the urban WHR classification includes ornamental tree plantings in parks, areas dominated with acacia and mixed trees have been called out separately for this VMP as urban (acacia) and urban (mixed tree stand). Figure 4 presents the distribution of vegetation communities and land covers across the Plan Area and detailed vegetation community and land cover information, by parcel, is presented in Appendix C.

Urban land cover is present mainly along roads and roadside clearing areas. The Oakland Zoo and Lake Chabot Golf Course are categorized within the urban land cover type. Given the mapping standards under the WHR system, the urban land cover type also includes two vegetated types: acacia tree stands and one acacia/oak/pine/redwood stand that occur in Joaquin Miller Park. These two are noted separately in Table 3. Coast oak woodland is present throughout the Plan Area and is generally located in canyons and on hill slopes. The largest areas of annual grassland are located in the southern portion of the Plan Area, mainly Kings Estates, Knowland Park, and Sheffield Village Open Space. Perennial grassland is intermixed with annual grassland in some areas. Closed-cone pine-cypress vegetation is found in Joaquin Miller Park and surrounding areas, as well as the southern portion of Grizzly Peak Open Space. Eucalyptus vegetation is found in patches throughout the Plan Area, with large areas of this vegetation in the North Oakland Sports Field, Shepard Canyon, Joaquin Miller Park, and in smaller parcels and roadside clearing areas along Skyline Boulevard. The location of the closed-cone pine-cypress and eucalyptus vegetation types is largely the result of large-scale tree planting that occurred in the Oakland hills between 1880 and 1920 (Nowak 1993). Coastal scrub is located on slopes throughout the Plan Area, with large portions in Grizzly Peak Open Space,

Knowland Park, and Sheffield Village Open Space. Redwood vegetation is mainly located in Joaquin Miller Park and nearby Dimond Canyon and Leona Heights Park. Valley/foothill riparian is located along drainages in North Oakland Sports Field and Joaquin Miller Park. Chamise-redshank chaparral is located in Knowland Park, near the Oakland Zoo. Finally, a small area of freshwater emergent wetland is located in Knowland Park.

7.1.2 Special-Status Plant Species

As identified in the Biological Resources Report (Appendix B), the following special-status plant species are known to occur in the Plan Area:

- Pallid manzanita (*Arctostaphylos pallida*)
- Oakland star-tulip (*Calochortus umbellatus*)
- Presidio clarkia (*Clarkia franciscana*)
- Western leatherwood *(Dirca occidentalis*)
- Tiburon buckwheat (*Eriogonum luteolum* var. *caninum*)
- Bristly leptosiphon (*Leptosiphon acicularis*)

There are other special-status plants with the potential to occur within the Plan Area but that have not been documented. These plants are presented in the Biological Resources Report (Appendix B). Practices to avoid and/or minimize impacts to sensitive plant species are included in Section 10.

7.1.3 Special-Status Animal Species

As identified in the Biological Resources Report (Appendix B), the following special-status wildlife species have the potential to occur in the Plan Area:

- Western pond turtle (*Emys marmorata*)
- Alameda whipsnake (*Masticophis lateralis euryxanthus*)
- California red-legged frog (*Rana draytonii*)
- White-tailed kite (*Elanus leucurus*)
- Golden eagle (*Aquila chrysaetos*)
- Yellow warbler (*Setophaga petechial*)
- Western red bat (*Lasiurus blossevillii*)

- Pallid bat (*Antrozous pallidus*)
- Western mastiff bat (*Eumops perotis californicus*)
- San Francisco dusky-footed woodrat (*Neotoma fuscipes annectens*)

Practices to avoid and/or minimize impacts to special-status animal species are included in Section 10.

7.2 Streams and Water Resources

The City of Oakland includes many creeks, several flood control channels, and a few lakes, and borders the San Francisco Bay along much of its western edge. Flood control measures and urbanization have altered the hydrologic function and ecology of many of these surface water features. Lake Merritt, Lake Temescal, and Lake Chabot are Oakland's three major lakes, though technically Lake Merritt is a tidal basin with connectivity to the Bay. The San Francisco Bay and Estuary waters provide an important water resource and habitat for marine and terrestrial life, along with other benefits such as scenic and recreational value. The City is committed to the protection of its surface waters and has established several policies to ensure conservation of these resources by retaining creek vegetation, maintaining creek setbacks, controlling bank erosion, and managing City lakes and pollution in the Bay and Estuary (City of Oakland 1996). About 95% of Oakland's drinking water supply comes from Sierra Nevada sources and is managed by the EBMUD. Runoff within local watersheds provides the remainder of the City's supply.

Vegetation in local watersheds and along streams and water courses provides many important functions in protecting water resources and water quality in the watershed. Vegetated riparian corridors may provide water quality buffering benefits to the adjacent streams. Vegetation removal or treatment in riparian corridor areas must be conducted in consideration of potential effects on water quality and ecological function. Riparian vegetation provides habitat for terrestrial and aquatic wildlife species, provides streambank stability, reduces erosion, shades the water surface thereby affecting water temperature (which affects aquatic habitat), and is a source for large woody debris, which falls into streams and watercourses providing habitat and affecting flow patterns and pool development (Kocher and Harris 2007). However, when a watershed is catastrophically burned in an expansive wildfire, many of these functions and roles are lost or severely reduced until the vegetation recovers. Following a catastrophic watershed-wide fire, hillslope erosion and sediment yields through watershed tributary channels typically increase by an order of magnitude (or greater) over non-fire average conditions (Neary et al. 2008). Therefore, sound vegetation management that reduces the extent and frequency of watershed-wide extreme fires also helps avoid and minimize potential sediment and water quality impacts

in the watershed. Vegetation management activities seek to maintain the water resource and water quality benefits of watershed vegetation while reducing the hazard and fire risk. Practices to avoid and/or minimize impacts to streams and water resources associated with vegetation management activities are included in Section 10.

7.3 Slopes and Soil Stability

Soil erosion along hillslopes and sediment transport through waterways naturally occurs in the Oakland Hills. These geomorphic processes can be exacerbated and can lead to hazards if aggravated by severe or indiscriminate vegetation removal, increases in impervious surface, alterations of the drainage system, or widespread grading that affects slope stability. The City sets forth policies to protect soils from degradation and misuse due to development. These include soil management practices such as soil enrichment, drainage improvements, covering or creating drainage ditches around exposed slopes during the rainy season, and planting of exposed soils to control erosion (City of Oakland 2012). More than half of the City consists of sloping or hilly land and about one-quarter of the city includes slopes greater than 15%. The Plan Area is entirely within the hill lands of the City. Most of Oakland's soils are considered to have "severe" limitations for development by the U.S. Department of Agriculture. These limitations include steep slopes, shrink-swell potential, and low strength. The presence of three seismically active faults in the vicinity of the City also creates a high risk for earthquakes and landslides within the City. The state's seismic hazard zone maps designate most of the upper Oakland Hills and scattered areas of the lower hills as being susceptible to earthquake-induced landslides. One-quarter of the City has moderate to high potential for landslides. Most landslide activity within the area has been caused by heavy rains, creek channel modifications, and development on steep terrain rather than from earthquakes. The City has established policies to minimize risks associated with landslides and to disseminate outreach and educational materials on measures to reduce slide hazards. Seismic hazard zone maps for the City designate most of West Oakland, North Oakland, and East Oakland as being prone to liquefaction, along with large parts of central Oakland. Subsidence is of low concern within the City (City of Oakland 2012).

Vegetation helps stabilize slopes and minimize soil erosion by providing root strength and by absorbing soil moisture. Plant roots can anchor into bedrock or more stable soils and can bind weaker soils through fibrous root development. Excessive, haphazard, or indiscriminate vegetation removal can result in the loss of root strength in the soil and their decay can increase soil moisture levels, increasing the potential for erosion and slope failure (Ziemer 1981). Vegetation also reduces stormwater runoff by capturing and storing rainfall in the canopy and releasing it releasing it through evapotranspiration. Vegetation also minimizes promotes infiltration of rainfall into the soil (Center for Watershed Protection and USFS 2008). Practices to avoid and/or minimize impacts to slopes and soil stability are included in Section 10.

7.4 Community Resources

The City of Oakland includes a unique array of community resources which include buildings, districts, and other features that have significant historic, cultural, educational, architectural or aesthetic interest or value. The City is committed to protecting these resources through policies, goals, and objectives outlined in its General Plan Historic Preservation Element. These resources represent Oakland's rich and multicultural past and include Ohlone archaeological sites, buildings dating from the Spanish-Mexican settlement period, structures from the City's pioneer communities of the early 1860's, Italiante Victorian houses, and development from the 1906 post-earthquake boom. Oakland boasts a diversity of architectural styles including Victorian, Beaux Arts, International, New Brutalist, and modernist styles. The National Register of Historic Places lists 38 properties in the City as historic places, and the Landmarks Preservation Advisory Board designates 113 properties as Oakland landmarks. Oakland includes five preservation districts: Preservation Park, Victorian Row, Preservation Park Extension, Downtown Brooklyn-Clinton, and Portions of the 1900, 2000, and 2100 blocks of 10th Avenue.

Other community resources within the City include the Claremont Hotel and Resort, UC Botanical Garden, Oakland Zoo, CSSC, and Merritt Community College. The Oakland Zoo is within the Plan Area, on City-owned property Knowland Park. The CSSC is in the Plan Area and adjacent to Joaquin Miller Park, and the Claremont Hotel is immediately southwest of Garber Park. Merritt Community College is also within the Plan Area and is adjacent to Leona Heights Park.

The City also includes more than 20 Federal Emergency Management Agency-designated "critical facilities," including fire stations, temporary evacuation shelters, transportation and infrastructure facilities, and other emergency response facilities utilized by the entire San Francisco Bay Area region. The City seeks to preserve these resources by designating eligible properties as historic resources, preserving all City-owned historic properties, and specifying guidelines for alteration to historic properties (City of Oakland 1998).

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8 VEGETATION MANAGEMENT TECHNIQUES

Vegetation management for fire hazard mitigation is the practice of thinning, pruning, removing, or otherwise altering vegetation in order to reduce the potential for ignitions and modify fire behavior. Different vegetation management techniques can be utilized, depending on vegetation type, location, condition, and configuration. Given the dynamic nature of vegetation, a single treatment technique or management prescription may not be appropriate for one site over time. Therefore, an adaptive approach that allows for selection of management techniques is needed to achieve the vegetation management standards outlined in this VMP. Vegetation management techniques will be identified by OFD personnel during annual work plan development and will be dictated by site-specific conditions and effort needed to meet identified vegetation management standards.

In general, vegetation management techniques can be classified into four categories:

- Biological (e.g., grazing)
- Hand Labor (e.g., hand pulling, cutting)
- Mechanical (e.g., mowing, masticating)
- Chemical (e.g., herbicide)

The following sections present a discussion of each of the vegetation management techniques that may be implemented in the Plan Area, including information regarding equipment, application, timing, limiting factors, special considerations and BMPs. Selection of a qualified and trained contractor, appropriate training, scheduling, and supervision to carry out vegetation management treatments and any associated BMPs are also key components of an effective vegetation management program.

8.1 Biological Techniques

8.1.1 Grazing

Grazing is a method of using livestock to reduce the fine fuel loading of live herbaceous growth, shrubs, and new growth of trees. Livestock, such as cattle, goats, horses, or sheep, browse on grasses, forbs, shrubs, and fresh growth of young trees, thereby removing, over time, any consumed vegetation from the overall fine fuel load of the site. Grazing is effective in managing fine fuels and preventing the expansion of brush/scrub into grasslands. Livestock each have different grazing habits and not all livestock are ideally suited for grazing treatments in all areas. Most livestock, with the exception of goats, do not consume live or dead, tough, woody plant

material in any significant quantity as this material is generally unpalatable. Additionally, livestock do not effectively create fuel breaks, but are well-suited to maintain new annual vegetative growth within them. In the Oakland Hills, goat grazing has been successfully used for reducing fine fuel loads in grasslands, brushlands, and beneath tree canopies.

Goat grazing in Grizzly Peak Open Space

To achieve fine fuel reduction standards, grazing typically begins in the late spring, when growth of annual grasses has slowed, and continues through the summer in order to reduce fine fuels prior to the onset of peak fire season. Development of site-specific grazing management plans should be completed for proposed grazing treatments and should include goals and implementation actions to ensure that timing of grazing treatment meets vegetation management standards but minimizes potential negative effects. Grazing management plans should also identify the optimal stocking rate and grazing duration, typically measured in pounds per acre of residual dry matter. Optimal residual dry matter levels should be determined by overall management objectives, such as suppression of weeds, fuel load reduction, or minimizing erosion potential. As a fuel reduction technique, grazing does not need to be conducted each year if the intent is to control shrubs or maintain understory fuels; however, if the intent is to reduce grass or other flashy fuels, grazing should be conducted annually.

Grazing can be a relatively inexpensive and effective treatment method and can even generate revenue when cattle grazing is contracted for large areas. Control of livestock movements and preventing overgrazing is critical for successful implementation. Using professional herders or portable fences may be an alternative to fixed fencing where the treatment is ephemeral. Additional controls may also be needed for protection of retained plants, riparian zones, and sensitive resources areas, and to minimize erosion potential.

8.1.1.1 Grazing Management

Although the concept of grazing is the same regardless of which type of animal is used, how each animal type conducts its grazing varies significantly. As a result, not all animals will be ideally suited for grazing treatments in all areas. Animal selection should be determined by the fuel management standard trying to be reached. As noted, development of site-specific grazing management plans should be completed considering site-specific conditions and identified management standards. The plan should specify management objectives and standards, animal stocking rates and use levels, grazing season (turn-out and turn-in dates), and monitoring

requirements and performance criteria. Stocking rates are determined by a range analysis, which calculates the number of animals required for a given period to attain the desired use level, which generally ranges from 600 to 1,000 pounds per acre of residual dry matter, depending on site-specific conditions.

Fencing installed along roadway for grazing management

Timely movement of livestock to the next treatment area or other available pastures once identified standards have been met is important to minimize potential adverse effects, including soil compaction, overgrazing, and resource damage. Fencing is an important component to grazing management efforts to prohibit livestock from leaving the identified treatment area or gaining access to riparian zones, wetlands, or other sensitive resource areas. Finally, water sources are necessary for livestock and need to be provided if insufficient water is available at the treatment site.

8.1.1.2 Goat Grazing

Specific operational techniques need to be considered for effective fuel reduction by goat grazing. Proper grazing techniques can minimize root impacts. With proper management, goats dramatically reduce the density of brush, but do not eliminate the core plant, which remains alive and viable. Management of goat herd population density is necessary to limit impacts. Maintaining a light population density for a shorter period of time, as well as avoiding localized concentrations of goats helps to reduce soil compaction, retain sufficient plant cover to minimize erosion potential, and reduce animal waste concentrations. Goat grazing also reduces the need for other treatment techniques, although grazing can also be used in combination with such techniques to achieve desired fuel standards. Goats also have the ability to access steeper slopes in an efficient manner. Access to such areas by hand crew increases costs and time necessary for fuel treatment.

Unlike other livestock, goats prefer to browse on woody vegetation (e.g., tree leaves, twigs, vines, and shrubs) and will consume materials up to 6 feet above the ground. This grazing pattern makes goats a desirable choice for fuel reduction treatments as they can effectively create and maintain vertical separation between surface vegetation and the lower limbs of overstory trees (EBMUD 2001). Additionally, substantial amounts of invasive plant seed can effectively be removed from the landscape by the use of time-controlled, short-duration, high-intensity grazing in early spring (Menke 1992). However, since goats will indiscriminately damage most plants,

their use in areas with desired shrub and tree retention should be minimized as goats can girdle shrubs and trees by browsing on bark. Alternatively, portable electric fences can be effectively used to control goat herds and more effectively guide the outcome of the grazing effort.

Utilization of goats for achieving the vegetation management standards outlined in this VMP should include development of a grazing management plan for areas selected for grazing during annual work plan development. The plan should provide a range analysis to determine the optimum stocking rate and duration and should include requirements for monitoring to determine when vegetation management standards are attained. Since duration and timing are significant factors in controlling grazing impacts on sensitive plants, goats should be moved once treatment standards are met.

8.1.1.3 History of Grazing in the Plan Area

OFD has historically used goat grazing in portions of the Plan Area to manage vegetation for fire hazard reduction purposes. Approximately 3,000 goats have been utilized annually (typically between May and August) to manage fine fuels on approximately 600 acres to 700 acres of City-owned property, typically on larger City park land and open space. Goats have been used in large treatment areas where manual labor would be cost-prohibitive, to treat vegetation in areas that are inaccessible to mowing equipment, or in areas too steep for hand crews. Areas, such as steep bare hillsides that are prone to erosion, are avoided, and plants identified for retention are protected from goat grazing damage.

Goats are typically used in the following portions of the Plan Area:

- King Estates (approximately 88 acres)
- Joaquin Miller Park (approximately 150 acres)
- Knowland Park (approximately 350 acres)
- Dunsmuir Estates (Sheffield Village Open Space) (approximately 75 acres)
- Shepherd Canyon (approximately 9 acres)
- London Road (approximately 10 acres)

8.1.1.4 Best Management Practices for Grazing

Riparian Zones

Streams and watercourses within proposed grazing areas should be identified and assessed prior to turn-out. Creek protection zones should be avoided. Limiting exposure of goat herds to water

and riparian habitats through temporary exclusion fencing can minimize water contamination risk. The primary concern regarding nutrient and pathogen contamination of water is direct deposit. Unless feces are deposited in or immediately adjacent to a streambed (on the order of a meter or so), there is little danger of significant bacterial contamination from overland flow (Swanson et al. 1994; Buckhouse and Gifford 1976). The creation and use of riparian buffers zones can filter pollutants on slopes up to about 20% and can filter 50% to 90% of the sediment, nitrogen and phosphorus, and bacterial concentrations in surface runoff (EBMUD 2001).

If treatment within the creek protection zone is necessary, those with bank stabilization issues, or associated with unstable side slopes, should be addressed in the grazing plan, and provided additional protection measures. Where creek protection zones are not excluded from the grazing area, the grazing plan should consider the need for retention of streamside vegetation to promote bank stabilization and would require a Creek Protection Permit under Oakland Municipal Code Chapter 13.16 (Creek Protection, Stormwater Management and Discharge Control). The grazing plan should include monitoring the condition of the residual streamside vegetation during grazing activities, and thresholds that trigger turn-in and cessation of grazing prior to denuding the streambank. The grazing plan should also consider the placement location of minerals, such as salt licks, in relation to the watercourse. Specifying a minimum distance from the watercourse to the mineral location can help prevent herds from concentrating within the sensitive streamside area.

Sensitive Biological and Cultural Resource Areas

Grazing areas should be assessed for presence of sensitive biological and cultural resources prior to turn-out. Areas with special-status plants, animals, historic or pre-historic resources, and other areas or items of cultural significance, may warrant exclusion from the grazing area, or other protection measures, such as adjusted timing and reduced use levels. Where these areas are not excluded from the grazing area, the grazing plan should identify these areas and the associated protection measures. When special-status biological resources are present, or when management objectives aim to favor a specific biological resource, the timing and use level of grazing practices can often be adjusted to promote plant recruitment. For example, grazing can be timed to occur prior to seed set of annual grasses, which promotes perennial grasses.

Soil Stabilization

Soil types and unstable areas should be identified and assessed prior to turn-out. Grazing areas with soils sensitive to grazing, or with known unstable areas, may warrant exclusion from the grazing area or additional protection measures to enhance soil stability. Where these areas are not excluded from the grazing area, the grazing plan should identify these areas and the associated protection measures, such as adjusted timing and reduced use levels. In areas where sensitive soils or unstable

areas are present, timing can be adjusted to avoid grazing during saturated soil conditions, and the use level can be reduced in order to retain additional ground cover.

Invasive Plants and Pathogens

Measures to prevent the movement and introduction of invasive plants and diseases should be addressed in the grazing plan, and grazing practices should follow the "Arrive Clean, Leave Clean" approach. The grazing plan should specify requirements for holding areas and quarantine periods for animals prior to turn-out to the grazing area. Stock water should come from an approved source specified in the grazing plan. Additionally, the grazing plan should address sanitation requirements for personnel, equipment, and vehicles.

Other Best Management Practices

Additional BMPs include routine monitoring, proper selection of qualified contractors, inclusion of BMPs in grazing contracts, and properly addressing safety concerns regarding use of electric fences in public spaces.

8.2 Hand Labor Techniques

Hand labor treatments involve pruning, cutting, or removal of trees, shrubs, and grasses by hand or using hand-held equipment. Other hand labor treatments involve bark pulling, removing dead wood and litter, and mulching. Hand labor is most effective for spot application on small areas or areas with difficult access, such as hand-pulling French broom on a small lot, where heavy equipment move-in costs may be high or where topographic or environmental constraints preclude the use of heavy equipment. Hand labor also allows for selective management or removal of targeted vegetation and is typically used in conjunction with other techniques. Hand labor may be dangerous for workers when use of sharp tools is required on steep and/or unstable terrain, or where poison oak, rattlesnakes, or bees are abundant.

Hand labor generates debris when pulling, pruning, and cutting vegetation. If not removed, debris can be chipped or cut down and scattered on site, as long as fuel load standards are met. Requirements for cutting materials into smaller size, known as lopping, does add additional time (and therefore costs) to hand labor techniques. Hand labor techniques typically have lower potential for adverse environmental effects, although large volumes of foot traffic, specifically in areas with steep slopes, can result in surface soil compaction and increase erosion potential.

Hand labor is a treatment technique in which volunteers can assist in hazard reduction activities; required expertise and manual skills vary, however, depending upon the materials treated and

equipment required, and appropriate supervision and adequate training is always necessary to ensure desired results.

Hand tools include, but are not limited to, shovels, Pulaski hoes, McLeod fire tools, weed whips (potentially using different blades according to materials being treated) and "weed wrenches" (tools that pull both shrub and root system out), chain saws, hand saws, machetes, pruning shears, and loppers. Personal protection equipment typically includes long pants and long-sleeved shirts, gloves, safety goggles, hard hats, and sturdy boots. Chippers are often used in conjunction with hand labor to process cut materials into mulch for on-site disposal. More common hand labor techniques to reduce fuel loads are described in the following sections.

8.2.1 Line Trimming

Line trimming grass/herbaceous fuels

Line trimming is one of the most common and successful methods for reducing light fuel, flashy loads. This technique uses a hand-held tool (normally gas-powered) that cuts grass, herbaceous vegetation, ground covers, and very small shrubs with a plastic line or cutting blade. Line trimming is typically used after grasses have dried or cured to prevent regrowth in the same year. This technique reduces fuel height and retains the cut material in a compacted layer on the ground surface, minimizing the potential for bare soil. On steep slopes or in areas with retained shrubs/trees, line trimming is more feasible than using mowers. Implementation of this technique should avoid direct contact of the cutting line or blade with the soil surface to minimize disturbance. Trees or shrubs retained within the treatment area should be fenced or otherwise protected from contact with the cutting line or blade to minimize damage to stem tissue.

8.2.2 Branch Pruning/Removal

Hand labor can involve the use of handsaws, chainsaws, pruners, and other equipment to prune shrub or tree branches, remove dead limbs, stems, and branches, and lop larger material into smaller sizes. Fallen branches and cut material can then be further broken into compact mulch and distributed across the site or removed for disposal. While the use of saws and other tools can be a time-efficient option for fuel reduction, pointed stems and branches left behind as a result of tool use may be unsafe in more heavily trafficked areas. Implementation of this technique should avoid cutting and breakage to trees or shrubs retained within the treatment area to minimize damage to stem tissue.

8.2.3 Hand-Pulling and Gathering

Hand pulling weeds

Pulling weeds and gathering downed woody debris, and collecting other combustible materials by hand offers the greatest amount of control among hand labor techniques, prohibits resprouting of weeds by removal of the root system, requires no tools and minimal skill, but is also very time-intensive. Hand pulling weeds is easiest when soils are near field capacity[6] and roots readily pull out of the ground. Most weeds pulled can be left on site as mulch; however, larger weeds, such as French broom, should be removed. To limit the spread of seeds, care should be taken to bag weeds securely if viable seeds are present. Woody debris may can be staged on site to be chipped, burned, or removed. Other combustible material or trash may be gathered on site for transport to an appropriate disposal facility.

8.2.4 Clearance Pruning

Clearance pruning entails removing understory shrubs, small trees, and small lower tree limbs to create vertical separation between surface fuels and the bottom of the tree canopy. Pruning lower branches of trees can be done with a hand-held pole saw or pole chainsaw. Lower branches on shorter trees may be pruned with loppers. It is recommended that an International Society of Arboriculture-Certified Arborist conduct all pruning according to American National Standards Institute A300 standards (ANSI 2017). Clearance pruning removes fuel ladders and therefore decreases the potential for crown fire transition.

8.2.5 Mosaic Thinning and Dripline Thinning

Mosaic thinning is a treatment technique where trees and shrubs are retained throughout the treatment area in non-uniform patterns. Individual trees and shrubs and/or tree and shrub groupings are thinned to create a mosaic with horizontal spacing established between plants and plant groupings. Dripline thinning is a technique that involves removing shrubs and/or smaller trees beneath tree canopies to prevent torching and minimize the potential for crown fire transition. Treatment is typically accomplished with chain saws, pruning saws, or loppers.

[6] The amount of soil moisture or water content held in the soil after excess water has drained away and the rate of downward movement has decreased.

Treated material typically needs to be removed, piled and burned, or chipped and distributed on site. Thinning can reduce fuel continuity and loading by selective removal of vegetation to reach spacing standards. Dead, dying, and pyrophytic plants are prioritized for removal. This technique is most useful in WUI or Intermix areas and/or around high-value resources, such as cultural sites or park management facilities.

8.2.6 Black Plastic Coverage

As an alternative to herbicide use, securing black plastic over cut or treated tree stumps can prevent sprouting by blocking sunlight and thereby preventing latent buds in the remaining tree tissue to germinate. For this treatment type, a 5-millimeter or thicker black plastic sheet is fixed to the top and sides of a cut stump. The plastic can be installed as late as 2 weeks after cutting and requires removal, typically2 years after application. If the plastic is cut, damaged, or torn, reinstallation or other repair and maintenance may be necessary.

Black plastic applied to eucalyptus stumps

Black plastic can also be placed over larger surface areas to prevent germination of weeds; however, this technique also prevents germination of other vegetation. To prevent weed growth, the plastic should be applied prior to active growth, but can be installed after germination. Covering stumps is typically feasible for small areas and treated areas should be checked two to three times a year to make sure that sprouts have not emerged through the plastic or around the edge. Cut stumps may require up to a year or more of covering to prevent resprouting (Holloran et al. 2004).

8.2.7 Mulch Application

The application of mulch, including on-site treated and chipped material, can inhibit weed growth, protect bare soil from rainfall impact, provide soil nutrients during the decomposition process, and help retain soil moisture. For applications where mulch or other chipped material is transported to a site, care should be taken to minimize the spread of plant pathogens (e.g., sudden oak death) or invasive weed seeds that may be present in the material. While mulches can function to reduce weed growth thereby reducing flashy fuels, it should be noted that mulches do burn, although slowly and with low flame lengths; however, they may burn for a longer period of time in one location.

8.2.8 History of Hand Labor Treatment in the Plan Area

OFD has historically used hand labor for managing vegetation throughout the Plan Area, primarily on urban and residential parcels, but elsewhere as needed (e.g., roadsides, small treatment areas within larger parks or open space areas). OFD annually contracts with private contractors to manage vegetation on urban and residential parcels. The use of hand labor is focused on reducing ladder fuels, controlling invasive species (e.g., broom), reducing surface fuels (e.g., grasses, weeds, down material), thinning vegetation, maintaining fuel loads, and pruning tree canopies. Hand labor is also used in concert with mechanical treatment efforts, when implemented. Areas such as steep bare hillsides that are prone to erosion are avoided, and plants identified for retention are protected.

8.2.9 Best Management Practices for Hand Labor

The following BMPs should be implemented, where feasible, when utilizing hand labor vegetation management techniques. In all circumstances, tools and equipment should be utilized only for their intended use. Additional BMPs are provided in Section 10.

Tool and Equipment Use

- Ensure equipment operators and project personnel are properly trained in equipment use;
- Ensure that vehicles and equipment arrive at the treatment area clean and weed-free;
- Prune trees according to International Society of Arboriculture and American National Standards Institute A300 standards;
- To minimize soil disturbance, leave stumps from removed trees and shrubs intact, with stump heights not exceeding 6 inches, as measured from the uphill side;
- Protect retained trees and vegetation from tool and equipment damage;
- Service and fuel tools only in areas that will not allow grease, oil, fuel, or other hazardous materials to pass into streams or retained vegetation; and
- Remove from the site and properly dispose of all refuse, litter, trash, and non-vegetative debris resulting from vegetation treatment operations, and other activity in connection with vegetation treatment operations.

Fire Safety

During operations that involve the use of any vehicle, machine, tool, or equipment powered by an internal combustion engine operated on hydrocarbon fuels, provide and maintain suitable and

serviceable tools for firefighting purposes. Equipment should be located at a point accessible in the event of a fire and should include one backpack pump-type fire extinguisher filled with water, two axes, two McLeod fire tools, and a sufficient number of shovels so that each employee at the operation can be equipped to fight fire. Also ensure that all tools with an internal combustion engine using hydrocarbon fuels is equipped with a spark arrestor, as defined in California Public Resources Code Section 4442.

8.3 Mechanical Techniques

Mechanical techniques include all fuel reduction methods that employ motorized heavy equipment to remove or alter vegetation. Mechanical techniques can be employed to treat grass/herbaceous material (e.g., mowers, diskers), or woody material (e.g., masticators, feller-bunchers). Mechanical treatment techniques rearrange vegetation structures, compact or chip/shred material, and move material to landings, staging areas, or burn piles. Mechanical equipment is usually equipped with either rubber tires or tracks, although skids and cables are also used. In some instances, two or more pieces of heavy equipment will work in concert to achieve the fuel treatment standard. One piece of equipment, such as a feller-buncher, may be responsible for cutting material, while another piece of equipment moves the cut material to a landing or staging area where it can then be further treated or transported off site. Alternatively, one piece of heavy equipment may work independently. For example, mowers leave cut material on the ground surface and masticators shred/chip brush and heavier woody vegetation leaving treated material in a compacted chip layer on the ground surface.

Mechanical equipment is generally used in more uniform fuels where its use more efficiently reaches treatment standards. Constraints to mechanical equipment use include steep slopes, dense tree cover that prohibits travel, saturated soils, and dry, high-fire-hazard weather conditions where equipment use could result in ignition. In addition, selective plant removal is typically not achievable with mechanical equipment (e.g., mosaic thinning) due to equipment size, although equipment can be guided around avoidance areas. Use of mechanical equipment may also result in damage to retained vegetation.

Use of mechanical equipment needs to consider the terrain, access, vegetation type, and treatment standard of the treatment area to effectively treat vegetation and minimize impact potential. Supervision and specialized training are also necessary. The use of mechanical equipment is often done in conjunction with other treatment techniques, particularly hand labor (prior to mechanical treatment) and prescribed fire (following mechanical treatment). As noted below within the description of individual mechanical treatment techniques, the appropriate timing of the treatments plays a large part in determining treatment success. More common mechanical techniques to treat or reduce fuel loads are described in the following sections.

8.3.1 Grading

Grading is typically used to create or maintain firebreaks, creating a strip of land absent of fuel. A tractor with an attached blade can effectively produce a firebreak 8 feet to 12 feet wide with one to two passes. Treatment should be done in the spring months after the ground is dry but before grass is entirely cured. This is done to minimize the potential for equipment-caused ignitions. Grading can have negative effects on surface water drainage where the side banks of the graded area interrupt cross-slope flow. Grading may also accelerate water flow across the graded area. The disturbance created by graded firebreaks can result in establishment of invasive weeds, which should be considered prior to implementing this technique.

8.3.2 Mowing

Mower attachment on a tractor

Mowing tools, such as rotary mowers on wheeled tractors or other equipment, or straight-edged cutter bar mowers, or flails, can be used to cut herbaceous and woody vegetation above the ground. Mowing results in shorter, more compacted fuels, which reduces potential flame length and fire spread rates. Under ideal conditions, approximately 5 acres can be mowed per day, depending on the treatment area's slope and accessibility. Timing of mowing has an impact on the type of grasses promoted. Mowing after annual grasses have cured enhances growing conditions for perennial native grasses, provided mowing does not occur during seed production. Mowing at the appropriate time to a height of approximately 4 inches minimizes weed and brush encroachment and reduces the amount of manual work needed to maintain the site. Mowing of weeds is typically required annually. Mowing may be used in conjunction with other techniques, such as disking, to require a thinner strip of disked area.

8.3.3 Disking

Disked grassland area (foreground)

Disking is a fuel reduction technique where plant material is cut and mixed with surface soil to create a barrier of discontinuous fuel and bare earth to stop fire spread. This practice is typically used along the perimeter of open spaces, ranches, and roadways. A tractor with disk attachment is used and can typically disk a 15-foot-wide swath in a single pass, disking approximately 2 acres per day. Disking is typically done annually once grass has cured to prevent regrowth during that growing season. Disking creates an uneven surface that reduces water velocity; however, erosion can result, especially in areas with steep slopes. While this treatment is an effective barrier to surface fire spread, it can promote weed growth.

8.3.4 Mechanical Cutting/Crushing

A tractor or similar equipment may be used to crush vegetation using a blade that is kept slightly off the ground. A variety of attachments may also be used, including rollers (e.g., brush hog), a horizontal cutting blade (which operates similar to a large mower), or a set of chains to flail the material being treated. The blade cuts or breaks off the shrub tops, knocks down larger shrubs, and compacts the treated material, which is left to dry so that it can be subsequently scattered or piled and burned. Under this treatment technique, soil is disturbed where the equipment travels and where some shrubs are uprooted. Flailing treatment involves the use of tractors with affixed or towed mowing heads that cut or flail small diameter material, especially grasses. Some attachments include an articulated arm or boom that can reach 10 feet to 15 feet from a vehicle (Tiger mower).

Masticator attachment on a bobcat

Masticating equipment installed on Bobcats, wheeled or crawler-type tractors, excavators, or other specialized vehicles, is used to cut or shred shrubs and trees into small pieces that are then scattered across the ground, where they act as mulch. Shrubs and sapling-size trees are typically masticated with Bobcats and crawler-type tractors, while excavators are often used when larger trees are removed. Bobcats typically operate on slopes with gradients less than 20%, while excavators and tractors can operate on slopes with gradients up to 45%.

Other attachments to tractors and equipment have been developed that use a gravity roller to crush vegetation into mulch. The attachment is held by cables that can be rolled down and winched up a hillside, allowing for some degree of directional aiming through the use of cables at each end. The gravity roller is filled with water to provide the weight necessary to crush the vegetation, and cutting surfaces are arranged on the roller to resemble tire tread. The "Brontosaurus" is a type of grinding machine with an articulated arm that tends to grind off woody material, and in some cases shattering roots of shrubs, more than cutting them.

8.3.5 Chipping

Chipping is often used following other treatment techniques to treat larger cut material and reduces the size of materials by passing them through a series of high-speed blades. The result is chips or mulch, which is deposited into a truck bed or on the ground in a pile or broadcast near the equipment. If retained on site, spreading and redistribution of chipped material is necessary. Spread chipped material on the ground surface results in a compacted fuel structure that is less likely to ignite and carry fire. Larger grinders, such as tub grinders, can chip logs up to 24 inches in diameter.

Chipper

8.3.6 Tree Removal

Tree removal is typically accomplished using chain saws, but may be accomplished with feller-bunchers. Yarding equipment (described below) is then used for transporting cut material to a landing or staging area. Tree removal can be selective (removing individual trees within a stand and retaining others) or broad (removing all trees in a stand or portion thereof). Selective tree removal is used to reduce vertical and horizontal continuity between retained trees and in shaded fuel breaks. The created spacing minimizes the potential for crown fire transition (upward movement of fire from the ground into tree canopies) and crown fire spread (horizontal movement of fire from tree canopy to tree canopy). Broad tree removal is used where a conversion of vegetation types is desired (e.g., from forested to grassland).

Tree being removed in segments

Chain saws are typically used to cut and drop trees to the ground and then de-limb and cut (buck) them into smaller lengths. Feller-bunchers are mechanized pieces of equipment used to harvest or remove trees in a short period of time. Because they tend to be less selective in their application, they are typically not used in areas where tree retention is identified as a treatment standard. While feller-bunchers typically have a 24-inch- to 30-inch-diameter limit for the size of trees that they can remove and can create a large amount of debris requiring removal for further treatment, they generally reduce the amount of skidding and on-site soil disturbance. Following their use, treatment of residual material is typically performed using hand labor techniques.

Tree removal activities require the establishment of a flat landing area, which is an area of land used during operations to sort, store, and load logs onto trucks or to chip them into mulch. Material is yarded to the landing(s), as described below.

8.3.6.1 Yarding

Yarding is the process of transporting cut trees, or portions thereof, from their cut location to a landing or staging area for subsequent treatment or transport off site. Tractor-based yarding involves the use of tractors to pull logs to a landing area where they can be reduced to debris and distributed, or sorted, stacked, and hauled away as logs or chips. Tractor-based yarding on steep slopes can leave significant scars where chains and logs drag along the ground surface, increasing the potential for erosion and compaction and requiring additional treatment to remediate the soil surface. Tractor-based yarding is best suited for flatter areas to minimize the potential for erosion. The use of a feller-buncher in combination with tractor yarding may be appropriate in larger treatment areas; however, the mobilization costs with such equipment may preclude its use on treatment areas less than 5 acres in size.

Cable yarding involves the use of cables to move cut and felled trees to a landing or staging area. Equipment is set up on flat areas and cables strung up or down slopes to transport materials along skid trails. This technique results in less soil disturbance/compaction and therefore less potential for erosion and sedimentation. Cable yarding is preferable on steeper slopes (greater than 35%). The technical layout and machinery used in cable yarding has a sizable effect on the system capabilities. The yarder used should have drums and an interlock system, and should include a mechanical slack pulling carriage, where feasible. These are means by which good control of the logs can be gained. Tractor systems, as described above, may be needed to reduce

potential ground disturbance where deflection is insufficient. While compaction and ground disturbance overall should be reduced when using a cable yarding system, there may be spots requiring post-treatment remediation to fill in cuts and gouges in the ground surface to minimize soil erosion potential.

Helicopter yarding uses helicopters to lift and transport trees from the treatment area to landings/staging areas. Helicopter yarding allows for increased selectivity of targeted materials as ground-based crews identify which trees are removed. This technique is suitable in areas with significant slopes. Helicopter yarding requires very large landing areas and equipment and personnel costs can be expensive. Noise impacts resulting from this technique should be evaluated prior to use.

8.3.7 Fire and Fuel Breaks

Firebreaks are areas of land where all vegetation has been removed and bare soil remains, thereby creating a non-burnable area to stop fire spread or facilitate firefighting operations (e.g., backfiring). Responding agencies typically attempt to minimize impacts to sensitive resources when fighting fires in wildlands, and where feasible, fires are allowed to run to natural firebreaks, including trails and roads. These locations may serve as a defensive position for firefighting. Creating firebreaks can have impacts to soil stability, drainage, and weed establishment, as described previously in Section 8.3.1, Grading.

Fire break between oak woodland and chaparral

Fuel breaks, including shaded fuel breaks, are areas of land where vegetation has been treated to slow the spread of a fire or reduce the likelihood of crown fire transition. For fuel breaks in shrub-dominated vegetation types, mosaic thinning is applied to provide horizontal spacing between retained shrubs or shrub groupings. For fuel breaks in tree-dominated vegetation types (shaded fuel breaks), clearance pruning and dripline thinning are applied to provide horizontal and vertical spacing between retained trees and tree groupings and understory vegetation.

8.3.8 Prescribed Fire

Prescribed fires reduce the volume of fuel through combustion and are conducted under specific regulations when conditions permit both adequate combustion and proper control. This technique can be used to burn piles of cut vegetation (pile burns), or over a designated prepared area (broadcast burn). Both broadcast and pile burning are often implemented in conjunction with

hand labor and mechanical treatment methods as a means of removing vegetative debris, or in advance of an herbicide treatment to enhance the effectiveness of the application.

Broadcast burns are usually done in larger areas where a maximum amount of fuel treatment can take place and can be used to control invasive and noxious weeds and treat cut material (slash) on the ground surface in areas treated by other techniques, or reduce surface and/or ladder fuels beneath tree canopies in shaded fuel breaks. Treatment boundaries are often roads, trails, or other non-burnable features, reducing the number of firebreaks that need to be created. This approach reduces labor costs and preparation time, and minimizes soil disturbance and the potential for soil erosion. Prescribed burns can be used in all vegetation types, where conditions allow for effective control.

Prescribed burning can be a cost-effective way to quickly reduce a large volume of woody material remaining after other fuel treatment operations. A broadcast burn produces more uniform treatment and minimizes areas of great burn intensity. Alternatively, tractors or hand crews can create piles of material on flat or gently sloping ground that can be burned during very wet conditions (pile burn), although the volume of fuel in the piles can produce localized heat which may impact adjacent retained vegetation.

Prescribed fire in grass/shrub vegetation (NPS 2013)

Broadcast burning may occur throughout the year; however, it is usually conducted during the late spring months when the ground is still wet or during fall or winter after plants have completed their yearly growth cycle and their moisture content has declined. Spring burns are sometimes preferred to ensure a greater measure of public safety; however, there may be impacts to animal and plant reproduction. Fall burns are more closely aligned with the natural fire cycle found in California. Piles of vegetation may be burned any time after the vegetation has dried. “Cool” burn prescriptions, using techniques such as backfiring, chevron burning, and flank firing, as well as timing the fires during periods of high humidity and high fuel moisture content, typically results in incomplete combustion; therefore, existing vegetation is partially retained.

Hand held tools, such as drip torches, propane torches, diesel flame-throwers, and fuses (flares), may be used for igniting prescribed fires. Mass ignition techniques may include the use of terra-torches and heli-torches. These types of ignition devices release an ignited, gelled fuel mixture onto the area to be treated. Helicopters may also be used to drop hollow polystyrene spheres

containing potassium permanganate that are injected with ethylene glycol immediately before ignition. The sphere ignition method is best used for spot-firing projects in light fuels.

Prescribed burns must be conducted by trained fire protection personnel. Utilizing personnel and equipment from neighboring fire districts provides the added benefit of joint training under prescribed rather than emergency conditions. Timing is critical to the use of this treatment technique due to variances in weather conditions and the necessity to time treatments to minimize impacts to plant and animal species. Fuel moisture content must be determined to assess if the treatment area is safe to burn. There are typically more appropriate burn days in the spring and early summer months when there is a greater chance of atmospheric conditions conducive to smoke dilution and dispersion.

Prescribed burning requires proper planning and the development and approval of a prescription or burn plan, which is typically developed by the local fire protection district in consideration of fuel reduction requirements, local weather conditions, and available resources for fire management. The following sections summarize the planning needs for implementing prescribed burns.

8.3.8.1 Prescribed Fire Tasks

The following describes the steps that must be completed prior to initiating prescribed fire activities.

Burn Plan/Prescription

Working with a fire management specialist, a site-specific prescription and burn plan is developed that establishes goals and procedures for the prescribed burn. This plan takes into account the site characteristics and the likely behavior of the fire, including the heat output, length of burn, best ignition sources and points, and optimal fire control methods. Each characteristic is closely tied to the type, age, density, and condition of vegetation; the site's terrain; solar exposure; and local and prevailing wind patterns. The prescription identifies the limits of the burn area, locations of control lines, acceptable fuel moisture ranges and weather conditions, and required personnel and equipment.

Smoke Management Plan

Local and regional regulating agencies need to review the burn plan to identify potential environmental impacts and develop mitigation measures. The Bay Area Air Quality Management District (BAAQMD) also requires preparation of a smoke management plan detailing the location of sensitive receptors and measures to be implemented to maximize smoke dilution and minimize smoke production. Current air quality regulations within the jurisdiction of the BAAQMD limit open burning; however, burning to reduce fire hazards, for management of

forest and rangelands, and to train fire protection personnel receives special accommodation under BAAQMD Regulation 5 (BAAQMD 2013). In addition to the preparation and approval of a smoke management plan, the BAAQMD requires notification of the burn and that burning is conducted on a permissive burn day. The BAAQMD selects burn days based on air quality, weather conditions, and wind patterns; provides the burn's acreage allocation the morning of the burn; and provides the "all clear" designation prior to initiation of the burn.

Pre-burn Site Preparation

Hand labor or mechanical treatment techniques are often required prior to initiation of a prescribed burn to remove and treat larger material (trees, shrubs, slash). Treatment of larger material is done to reduce its size and spatial arrangement and to remove ladder fuels that may allow for crown fire transition. Site preparation also includes the establishment of fire lines needed to control the fire if they do not already exist. These fire lines are typically constructed using bulldozers or by hand using scraping tools. Occasionally they are "burned in" with a strip of fire under conditions that limit fire spread.

Burn Notification

Notifying the local or surrounding communities, local fire departments, media, and BAAQMD is an essential component to avoid potential misinterpretation of the prescribed burn as a wildfire. Notification to interested and affected parties and the media are also repeated the day of the prescribed burn. Printed materials or interpretive signs are made available at the site and distributed to neighboring communities explaining the reason for the prescribed burn, the type of burn being conducted, and the intended result of the prescribed burn. Prescribed fires generate high levels of public safety concerns over the chance of fire escape from control lines, and the rapid distribution rate of smoke, ash, and particulate matter may raise additional concerns from the public many miles downwind from the actual burn site.

Post-Burn Follow-up and Evaluation

Following completion of the prescribed burn, the results are evaluated to determine if the need exists for additional treatment based on established goals. Additional treatment methods may include hand labor or mechanical treatment of unburned or partially burned materials. Follow-up and evaluation efforts may occur from 1 to 2 years after the burn to identify needs for additional vegetation treatment or site-remediation needs.

8.3.9 History of Mechanical Treatment Use in the Plan Area

OFD has historically used some of the mechanical techniques identified in the previous sections in portions of the Plan Area to manage vegetation for fire hazard reduction purposes. Mechanical equipment is used on an as-needed basis to grade or disk fire trails, reduce ladder fuels (e.g., small tree removal), control invasive species, reduce surface fuels (e.g., mowing grasses), chip and spread trimmings and down material, thin vegetation, and maintain fuel loads. OFD has not use prescribed fire (broadcast or pile burning) in the Plan Area due to smoke/air quality permitting requirements. Mechanical techniques are also used in concert with hand labor treatment efforts. Due to mechanical equipment limitations, areas such as steep bare hillsides that are prone to erosion are avoided, and plants identified for retention are protected.

8.3.10 Best Management Practices for Mechanical Techniques

The following BMPs should be implemented, where feasible, when utilizing mechanical vegetation management techniques. In all circumstances, equipment should be utilized only for its intended use. Additional BMPs are provided in Section 10.

Heavy Equipment Use

The following practices should be implemented when using heavy equipment for vegetation management activities:

- Utilize low ground-pressure equipment, to the extent feasible;
- Ensure equipment operators and project personnel are properly trained in equipment use;
- Install waterbreaks as described in Section 10.1 for graded or disked areas that are not otherwise stabilized;
- Ensure that vehicles and equipment arrive at the treatment area clean and weed-free;
- Control fugitive dust resulting from equipment use by watering disturbed areas;
- Protect retained trees and vegetation from potential damage resulting from heavy equipment use;
- To minimize soil disturbance, leave stumps from removed trees and shrubs intact, with stump heights not exceeding 6 inches, as measured from the uphill side;
- Limit the size and quantity of equipment to that which is necessary to meet the identified vegetation management standard;
- Regrade or recontour any areas subject to soil disturbance from heavy equipment, including dragging or skidding of trees or other material;

- Avoid heavy equipment use on unstable slope areas, slopes with gradients exceeding 65%, slopes with gradients between 50% and 65% where the erosion hazard rating is high or extreme, or slopes with gradients over 50% that lead without flattening to sufficiently dissipate water flow and trap sediment before reaching a stream or other water resource. The procedure for determining erosion hazard rating is presented in Section 10.1;
- Service and fuel heavy equipment only in areas that will not allow grease, oil, fuel, or other hazardous materials to pass into streams or retained vegetation;
- Remove from the site and properly dispose of all refuse, litter, trash, and non-vegetative debris resulting from vegetation treatment operations, and other activity in connection with vegetation treatment operations;
- Ensure that hazardous materials spill kits are available on all heavy equipment.

Yarding

For cable yarding, install, operate, and maintain cable lines so that retained trees will not incur unreasonable damage. Retained trees should not be used for rub trees, corner blocks, rigging, or other cable ties unless effectively protected from damage.

Tree Removal

To the fullest extent possible and with due consideration given to topography, lean of trees, utility lines, local obstructions, and safety factors, trees should be felled away from streams, sensitive biological resources areas, and retained trees. Cabling, sectional removal, or other felling techniques should also be employed, where feasible, to minimize impacts to streams, sensitive biological resource areas, and retained trees.

Fire Safety

During operations that involve the use of any vehicle, machine, tool, or equipment powered by an internal combustion engine operated on hydrocarbon fuels, provide and maintain suitable and serviceable tools for firefighting purposes. Equipment should be located at a point accessible in the event of a fire and should include one backpack pump-type fire extinguisher filled with water, two axes, two McLeod fire tools, and a sufficient number of shovels so that each employee at the operation can be equipped to fight fire. Also, ensure that all equipment with an internal combustion engine using hydrocarbon fuels is equipped with a spark arrestor, as defined in California Public Resources Code Section 4442.

8.4 Chemical Techniques

Chemical techniques involve the use of herbicides to kill vegetation or prevent growth and are typically used in combination with other types of fuel reduction treatments. Herbicides do not remove any vegetation from a treatment area; therefore, dead plant material remains unless otherwise treated. Application of herbicides and other chemicals is typically performed by hand, and can include sponging, spraying, or dusting chemicals onto undesirable vegetation. Hand application provides flexibility in application and is ideally suited for small treatment areas. Roadside application of herbicides may employ a boom affixed to or towed behind a vehicle.

Herbicide application requires specific storage, training, and licensing to ensure proper and safe use, handling, and storage. Only personnel with the appropriate license are allowed to use chemicals to treat vegetation. Herbicide application is also only applied per a prescription prepared by a licensed pest control advisor. Personal protection equipment is essential to limit personnel exposure to chemicals, and includes long pants and long-sleeved shirts, gloves, safety goggles, hard hats, sturdy boots, face masks, and, in some instances, respirators.

8.4.1 Herbicides

The application of herbicides may be used on its own or as a secondary vegetation treatment technique following manual (hand labor) or mechanical removal for controlling sprout growth and regeneration. The advantage of herbicide treatments is that they typically result in high kill rates, and can prevent treated plants from setting seed. Thus, in the long run, targeted plants are eliminated as their "seed bank" is eventually eliminated. Some disadvantages include the necessity of applicators to be trained and then licensed by the State of California, the cost of application and safety equipment, the cost of the herbicide itself, the potential to affect non-target vegetation, and the social stigma associated with the use of chemical controls, particularly in wetlands situations. In spite of these disadvantages, herbicides, or herbicides in combination with hand/mechanical removal, are the most widely used and effective techniques for controlling certain types of vegetation.

Herbicides are broadly classified into two basic types: pre-emergent and post-emergent. Pre-emergent herbicides are sprayed directly onto the ground and prevent plants from germinating and/or growing. As such, they have a larger potential to impact native seeds remaining in the soil, and often have longer persistence times in the environment. Post-emergent herbicides are applied directly onto the plants, often during the early phases of their growth, killing them before they have the chance to mature and set seed. With proper equipment and training, herbicides can be applied selectively, minimizing impacts to native seeds residing in the soil. However, should

the target vegetation be intermixed with growing desired vegetation, the chance of affecting desired vegetation would be increased.

Different plants vary in their response to any particular herbicide, and can also vary in their response depending upon in which stage of their life cycle the herbicide is applied. Herbicides applied during the "bolting" phase (when flowing stalks are being produced) may have greater kill rates than the same chemical applied during the rosette stage or the flowering stage. Some herbicides are specific to particular groups of plants (e.g., Fusillade affects only grasses), while others can kill nearly all kinds of plants. Still others are permitted for use in California, while others are not. Systemic herbicides (as opposed to contact herbicides) are likely the most effective for control of invasive species due to their ability to spread via translocation into root tissue.

Herbicide application should be used following removal of all tree and other perennial species that have the ability to regenerate from root fragments when removal of all plant material is not feasible. Herbicide use should be limited to localized applications rather than foliar applications to eliminate the possibility of drift and impacts to neighboring desirable vegetation. A wide range of herbicides are available for such types of treatment. Herbicide labels and material safety data sheets list susceptible target plant species and provide proper direction in the use and handling of the products. Herbicides should be applied in accordance with state and federal law.

8.4.2 Cut and Daub

Cut and daub treatment is recommended for larger invasive plants, such as large trees and shrubs, to control regrowth and kill the portion of the plant remaining belowground. Cut and daub involves the cutting of invasive plant stalks or trunks and then the direct application of an appropriate systemic herbicide directly to the cambium layer of the freshly cut stump or stem. Other related methods include drill and fill, where holes are drilled into the trunk of a tree and herbicide is injected, or the glove method, where an herbicide-soaked glove is used to apply directly to plant foliage or freshly cut stumps. It is critical that the herbicide treatment occur immediately after the plants are severed so that the herbicide is carried into the plant tissue. If enough time elapses to allow the cut surface of the severed plant to dry out, a fresh cut should be made prior to herbicide application.

8.4.3 History of Chemical Treatment Use in the Plan Area

On April 5, 2005, the City adopted Resolution 79133 which directed the preparation of the appropriate environmental review documents consistent with CEQA for evaluating a limited exemption to the City's Integrated Pest Management policy for the selective use of glyphosate

(in formulations such as Round-up or Rodeo) and triclopyr (in formulations such as Garlon and Pathfinder) for managing vegetation for wildfire hazard reduction purposes in the City's VHFHSZ. No environmental review was completed; therefore, OFD has not used herbicides for vegetation management on City-owned property or along roadsides in the Plan Area.

8.4.4 Best Management Practices for Chemical Techniques

The following BMPs should be implemented, where feasible, when utilizing chemical vegetation management techniques. In all circumstances, equipment should be utilized only for its intended use. Additional BMPs are provided in Section 10.

- OFD should consult with a state-licensed pest control advisor and/or the Alameda County agricultural commissioner to identify the appropriate site-specific herbicide application approach to meet vegetation management standards;
- The timing of herbicide applications should be considered to minimize impacts to adjacent retained vegetation and nearby resources (typically between June 15 and November 15, with a potential extension through December 31 or until local rainfall greater than 0.5 inches is forecasted within a 24-hour period from planned application);
- Only herbicides and surfactants that have been approved for aquatic use by the U.S. Environmental Protection Agency and are registered for use by the California Department of Pesticide Regulation should be used for aquatic vegetation control work;
- Herbicide application should be consistent with Federal Insecticide, Fungicide, and Rodenticide Act label instructions and use conditions issued by the U.S. Environmental Protection Agency, California Department of Pesticide Regulation, and the Alameda County agricultural commissioner;
- The lowest recommended rate to achieve vegetation management objectives of both herbicides and surfactants should be utilized to achieve desired control;
- An indicator dye should be added to the tank mix to help the applicator identify areas that have been treated and better monitor the overall application;
- No application to plants whose base is submerged in stream channels should occur;
- Safe procedures for transporting, mixing, and loading herbicides should be followed; and
- The use of foliar (spray) applications should be minimized, prioritizing localized or direct applications.

9 VEGETATION MANAGEMENT AND MAINTENANCE STANDARDS AND AREAS

This section outlines vegetation management and maintenance standards by dominant vegetation type, specific recommendations for key areas, and the procedures for identifying and planning annual vegetation treatment operations. The vegetation treatment techniques presented in Section 8 are the practices and actions used to modify or remove vegetation, while the vegetation management and maintenance standards presented below are the measurable guidelines to achieve the desired vegetation condition to reduce the fire hazard.

9.1 Vegetation Management and Maintenance Standards

Vegetation management for fire hazard reduction is an ongoing, cyclical process. Given the dynamic nature of vegetation, a single management prescription cannot be assigned to any location and be effective in perpetuity. Therefore, the management and maintenance standards presented in this section are derived from the principles of vegetation management for fire hazard reduction and have been broken down by dominant vegetation community/land cover type (grassland/herbaceous, brush/scrub, tree/woodland/forest, invasive species, and other combustible material). Certain vegetation community/land cover types found in the Plan Area (freshwater emergent wetland and urban) do not present a wildfire hazard due to high moisture levels or noncombustible condition. Therefore, management standards have not been developed for these types of vegetation communities.

This "dynamic approach" allows the vegetation management techniques outlined in the previous section to be selected based on the needs of each management area as conditions change over time. The management and maintenance standards outlined in this section are intended to modify fuel arrangements to reduce the potential for ignitions, rapid fire spread, crown fires, and extreme fire behavior. These standards have been developed to reduce fuel loads, eliminate fire ladders, disrupt the horizontal continuity of vegetation, minimize ignition potential, and prioritize retention of fire-resistant plants.

During annual work plan development, OFD will identify the appropriate vegetation management technique for a given area such that the treatment standards identified below can be achieved. As noted, the application of vegetation management techniques will be influenced by site features (e.g., slope, access, treatment area size) and the condition of vegetation at the time of inspection.

9.1.1 Principles of Vegetation Management to Reduce Fire Hazard

The vegetation management and maintenance standards presented in this section are intended to reduce fire hazard by rearranging and maintaining the spatial distribution of fuels. As noted by Reinhardt et al. (2008), all vegetation will burn, given the right conditions. Therefore, the goal of fuel treatment is not to remove all vegetation, but to minimize the potential for ignitions, crown fires, and extreme fire behavior by reducing fuel loads and altering the structure, composition, and spacing (horizontal and vertical) of retained vegetation. To achieve this, a combination of methods is necessary and dependent on vegetation type, structure, and condition.

In grass-dominated vegetation types, management is intended reduce vegetation height (e.g., mowing, grazing) resulting in a shorter and more compact surface fuel layer that is less ignitable and less likely to sustain fire spread. Implemented beneath shrub or tree canopies, such treatments also minimize the potential for surface to crown fire transition. Management is also intended to maintain low fuel volumes in the land areas between shrub- and tree-dominated vegetation types.

In shrub-dominated vegetation types, management is intended to reduce surface fuel loading and flame lengths and slow fire spread by increasing the horizontal spacing between retained shrubs. In areas beneath trees, management is also intended to increase the vertical spacing between shrub and tree canopies to reduce the potential for surface to crown fire transition. Removal or treatment (e.g., chipping) of dead material from shrub-dominated types also reduces dead fuels loads, can assist in reaching spacing standards, and helps minimize the growth of highly-ignitable grass/herbaceous vegetation.

In tree-dominated vegetation types, management is intended to increase the horizontal spacing between retained trees to reduce the potential for crown fire spread. It is also intended to remove fuel ladders by increasing the vertical spacing between surface fuels (shrubs, grasses) and tree canopies to reduce the potential for surface to crown fire transition. Creating more fire resilient tree stands involves a three-part process of reducing surface fuels, reducing ladder fuels (i.e., fuel that can facilitate fire spread from ground fuels into tree crowns), and reducing tree crown density through crown thinning (USFS 2013). As noted by Nunamaker et al. (2007), surface and ladder fuels should have the highest priority for management to reduce fire intensity, rate of spread, and crown fire potential. Active crown fires are initiated with torching, but are ultimately sustained by the density of the overstory crowns. Reduction in potential surface fire behavior plus an increase in canopy base height minimizes torching potential (Agee and Skinner 2005).

Crown thinning via selective removal of trees within a stand can achieve desired horizontal spacing between retained tree canopies to minimize potential crown fire spread. Thinning from

below, a technique in which trees are removed from the lower forest/stand canopy, can reduce the severity and intensity of wildfires by reducing crown bulk density and increasing crown base height (Graham et al. 1999). Thinning or removal of overstory trees can result in higher mid-flame wind speeds and decreased fine fuel moisture, which can increase surface flame lengths, resulting in crown fires and increased fire intensities. However, sufficient treatment of surface fuels (understory, slash, and ladder fuels) results in a reduction in fire behavior sufficient to outweigh these effects (Graham et al. 1999; Agee and Skinner 2005). Table 8 summarizes the effects and advantages associated with fuel management in tree-dominated vegetation types.

Table 8
Principles of Fire Resistance to Tree-Dominated Vegetation Types

Principle	Effect	Advantage	Concerns
Reduce surface fuels	Reduces potential flame length	Control easier; less torching	Surface disturbance less with fire than other techniques
Increase height to live crown	Requires longer flame length to begin torching	Less torching	Opens understory; may allow surface wind to increase
Decrease crown density	Makes tree-to-tree crown fire less probable	Reduces crown fire potential	Surface wind may increase and surface fuels may be drier
Keep big trees of resistant species	Less mortality for same fire intensity	Generally restores historic structure	Less economical; may keep trees at risk of insect attack

Source: Agee and Skinner 2005

Another important factor in any vegetation management plan is the lifespan of fuel treatments (Reinhardt et al. 2008). Given the dynamic nature of vegetation, especially in the Plan Area, maintenance and routine annual treatment of vegetation is a critical component for managing wildfire hazard. The vegetation management and maintenance standards outlined in this section are intended to be implemented over the life of this VMP, as outlined in Section 9.3, Property Assessment, Identification of Treatment Needs, and Work Plan Development.

9.1.2 Grassland/Herbaceous

This section outlines management and maintenance standards for grasses; other light, flashy fuels; and surface fuels capable of igniting and carrying fire. Grassland/herbaceous fuels in the Plan Area are composed of the annual grassland and perennial grassland vegetation community/land cover types. However, grass, other light, flashy, or surface fuels may be found within other mapped vegetation communities/land cover types and should be treated to the standards outlined in this section. The following management standards shall apply to grass/herbaceous fuels:

- Within 30 feet of a habitable structure, grasses (annual and perennial), weeds, and thistles shall be treated such that heights do not exceed 3 inches;

- Beyond 30 feet from a habitable structure, grasses (annual and perennial), weeds, and thistles shall be treated such that heights do not exceed 18 inches, but it is recommended to cut grasses below 6 inches in height;
- Cut grass may be left on the ground surface to protect soil as long as it does not exceed 6 inches in height;
- All dead or dying ground cover, vines, or other surface vegetation shall be removed or chipped and spread on site;
- All dead twigs, branches, or limbs from overstory shrubs and/or trees shall be removed or treated (e.g., chipped) and spread as a ground cover (mulch) on site;
- All mulch or chipped material shall be spread to a depth not to exceed 6 inches; and
- All material removed from the site shall be properly disposed of per City standards.

9.1.3 Brush/Scrub

This section outlines management and maintenance standards for brush/scrub vegetation. Brush/scrub fuels in the Plan Area are composed of the chamise-redshank chaparral and coastal scrub vegetation community/land cover types. Brush/scrub vegetation is typically characterized by relatively open to dense woody shrub cover and may include some scattered trees or clusters of trees. Brush/scrub fuels may be found within other mapped vegetation communities/land cover types and should be treated to the standards outlined in this section. The following management standards shall apply to brush/scrub fuels:

- All dead brush/scrub shall be removed;
- All dead and dying growth shall be removed from brush/scrub;
- Individual shrub crowns shall be horizontally separated from adjacent shrubs, shrub groupings, or trees by at least two times the height of the shrub crown. Groupings of shrubs may be retained such that the grouping does not exceed 8 feet in diameter. Shrub groupings shall be horizontally separated from adjacent shrubs, shrub groupings, or trees by at least two times the height of the shrub crown;
- Where brush/scrub is located within the dripline of an individual, isolated tree or small tree grouping, the vertical separation between the top of the shrub and the lowest tree branch shall be at least three (3) times the height of the shrub crown or 8 feet, whichever is greater;
- Individual, isolated pyrophytic trees located within brush/scrub stands shall be prioritized for removal;

- To minimize soil erosion potential, removed shrubs shall be cut at or near the ground surface and root systems left intact;
- All vegetative material from brush/scrub removal or trimming shall be removed or treated (e.g., chipped) and spread on site;
- All chipped material shall be spread to a depth no greater than 6 inches;
- All material removed from the site shall be properly disposed of per City standards; and
- When brush/scrub removal is necessary to achieve the spacing standards outlined above, removal of pyrophytic plants shall be prioritized over fire resistant plants.

9.1.4 Tree/Woodland/Forest

This section outlines management and maintenance standards for tree-dominated vegetation types. Tree/woodland/forest fuels in the Plan Area are composed of the coast oak woodland, closed-cone pine-cypress, eucalyptus, redwood, valley/foothill riparian, urban (acacia), and urban (mixed tree stand) vegetation community/land cover types. Tree-dominated vegetation in the Plan Area varies from relatively open tree stands to dense stands with relatively closed canopy cover. Trees or small clusters of trees may be found within other mapped vegetation communities/land cover types and should be treated to the standards outlined in this section. The general management standards outlined below shall apply to all tree-dominated fuel types. Type-specific standards providing additional clarification are included in subsequent sections.

9.1.4.1 General Standards

The following management standards shall apply to all tree-dominated fuel types:

- All dead trees shall be removed;
- All dead/dying growth and litter shall be removed from trees per Oakland Fire Code Section 4907.3.1.4;
- Portions of tree crowns extending to within 10 feet of any structure shall be pruned to maintain a minimum horizontal clearance of 10 feet;
- Portions of tree crowns that extend within 10 feet of the outlet of a chimney shall be pruned to maintain a minimum horizontal clearance of 10 feet;
- Portions of tree crowns above roads shall be pruned to maintain 13.5 feet of vertical clearance above the road surface (Oakland Fire Code Section 4907.5);
- Trees within 100 feet of habitable structures shall be pruned to remove limbs located less than 6 feet above the ground surface (Oakland Fire Code Section 4907.3.1.3);

- Where brush/scrub is located within the dripline of a tree, the vertical separation between the top of the retained shrubs and the lowest tree branch shall be at least three (3) times the height of the retained shrub crown or 8 feet, whichever is greater;
- To minimize soil erosion potential, stumps from removed trees shall be left intact, with stump heights not exceeding 6 inches (as measured from the uphill side);
- All vegetative material from tree removal or trimming shall be removed or treated (e.g., chipped) and spread on site (where necessary for erosion control, logs no smaller than 8 inches in diameter [small end] may be retained on the soil surface);
- All chipped material shall be spread to a depth no greater than 6 inches;
- Where they exist, trail networks shall be maintained to facilitate access and to create breaks in surface fuels;
- All material removed from the site shall be properly disposed of per City standards; and
- When tree removal is necessary to achieve identified spacing standards, removal of pyrophytic plants shall be prioritized over fire-resistant plants.

9.1.4.2 Specific Standards

The overall intent of the management and maintenance standards for tree/woodland/forest included in this section is to reduce densities by thinning stands, promote retained tree trunk diameter growth, promote retained tree health by reducing competition, retain ground surface shading through canopy retention, retain fire-resistive species, and provide horizontal separation to minimize the potential for crown-to-crown fire spread. In addition to the general standards for tree/woodland/forest vegetation community/land cover types identified above, the following management standards shall apply to specific tree-dominated vegetation types. The specific standards presented below shall override general standards should conflicts exist.

- **Eucalyptus:** Eucalyptus stands in the Plan Area include two primary types: mature and second-growth. Mature stands are those that have not been cut and typically have larger, single-stem trees with understories consisting of seedling/sapling eucalyptus trees, annual grasses, and eucalyptus tree litter (leaves, branches, limbs, and streamer bark). OFD currently manages many of the mature eucalyptus stands in the Plan Area to treat understory surface fuels. Second-growth stands are those that have been cut in the last 25 years and are characterized by their re-sprout growth form—multiple smaller stems (trunks) originating from the cut stump. This growth form contributes to increased fire risk by creating dense, lower-growing canopies with reduced vertical clearance from surface fuels (ladder fuels). The primary second-growth stand present in the Plan Area is

located at the North Oakland Regional Sports Field property. OFD does not currently manage the interior of this stand. A discussion of fuel loading and the fire hazard presented by eucalyptus stands is presented in Section 2.3.2. The following management standards apply to eucalyptus vegetation communities/land cover types:

- Thin mature eucalyptus stands to reach an average 35-foot horizontal spacing between trunks and 10-foot horizontal spacing between tree canopies. Prioritize retention of healthy trees and remove all single-stem eucalyptus with trunk diameters measuring less than 8 inches;
- Thin second-growth eucalyptus stands to reach an average 25-foot spacing between trunks and 10-foot horizontal spacing between tree canopies. Treat retained trees by removing all but one, single dominant stem (trunk). Prioritize retention of healthy trees and remove all single-stem eucalyptus with trunk diameters measuring less than 8 inches;
- Where small trees, shrubs, grasses, invasive species, and/or eucalyptus seedlings/saplings/sprouts exist beneath tree canopies (surface fuels), the vertical separation between the top of surface fuels and the lowest tree branch shall be at least three (3) times the height of the surface fuels or 8 feet, whichever is greater. Where duff, mulch, or bare soil exists beneath tree canopies, provide at least 8 feet of vertical clearance between the lowest tree branch and the duff/mulch/soil surface;
- Remove loose/stringy bark from retained individual eucalyptus trees up to a height of 8 feet to minimize crown fire transition (consistent with the Oakland Fire Code Section 4907.3.1.4);
- Implement treatment techniques to control sprout growth from cut stumps;
- Maintain duff layer at a depth no greater than 6 inches; and
- Prioritize retention of City protected and non-pyrophytic trees (e.g., oaks, bays) existing in eucalyptus stands and incorporate them into the tree spacing standards identified above.

- **Closed-Cone Pine-Cypress:** Pine stands (primarily Monterey pine) in the Plan Area primarily occur as mature, often dense stands and are often mixed with other tree species (eucalyptus or Monterey cypress). Open stands exist and tend to have a well-developed understory of oaks, bays, poison oak, and blackberry. Scattered individual pines are also found within other vegetation communities/land cover types. A discussion of fuel loading and the fire hazard presented by pine stands is presented in Section 2.3.2. The following management standards apply to closed-cone pine-cypress vegetation communities/land cover types:

- Thin mature pine stands to reach an average 30-foot horizontal spacing between trunks and 10-foot horizontal spacing between tree canopies. Prioritize retention of healthy trees and remove all single-stem pines with trunk diameters measuring less than 8 inches;
- Where small trees, shrubs, grasses, invasive species, and/or pine seedlings/saplings exist beneath tree canopies (surface fuels), the vertical separation between the top of surface fuels and the lowest tree branch shall be at least three (3) times the height of the surface fuels or 8 feet, whichever is greater. Where duff, mulch, or bare soil exists beneath tree canopies, provide at least 8 feet of vertical clearance between the lowest tree branch and the duff/mulch/soil surface;
- Maintain duff layer at a depth no greater than six (6) inches; and
- Prioritize retention of City protected and non-pyrophytic trees (e.g., oaks, bays) existing in pine stands and incorporate them into the tree spacing standards identified above.

- **Urban (Acacia) and Urban (Mixed Tree Stand):** Acacia trees (primarily blackwood acacia) in the Plan Area primarily occur as mature, often dense stands or shrub-like thickets and are also mixed with other tree species (oak, redwood, eucalyptus). Scattered individual acacia trees are also found within other vegetation communities/land cover types. A discussion of fuel loading and the fire hazard presented by acacia trees is presented in Section 2.3.2. The following management standards apply to the urban (acacia) and urban (mixed tree stand) vegetation communities/land cover types:
  - Thin acacia-dominated stands to reach an average 35-foot horizontal spacing between trunks and 10-foot horizontal spacing between tree canopies. Prioritize retention of healthy trees;
  - Where small trees, shrubs, grasses, other invasive species, and/or acacia seedlings/saplings/sprouts exist beneath other mature, tree canopies, the vertical separation between the top of surface fuels and the lowest tree branch shall be at least three (3) times the height of the surface fuels or 8 feet, whichever is greater. Where duff, mulch, or bare soil exists beneath tree canopies, provide at least 8 feet of vertical clearance between the lowest tree branch and the duff/mulch/soil surface;
  - Implement treatment techniques to control sprout growth from cut stumps;
  - Maintain duff layer at a depth no greater than 6 inches; and
  - Prioritize retention of City protected and non-pyrophytic trees (e.g., oaks, bays) existing in urban (acacia) and urban (mixed tree stand) vegetation types and incorporate them into the tree spacing standards identified above.

- **Oak Woodland:** Coast oak woodland in the Plan Area includes a mix of native tree species such as coast live oak, California bay, buckeye, black oak, and madrone. Less dense stands with relatively open canopies may include grass or brush/scrub understories, while dense stands with closed canopies typically include only duff or leaf litter in the understory. A discussion of fuel loading and the fire hazard presented by oak woodlands is presented in Section 2.3.2. The following management standards apply to oak woodland vegetation communities/land cover types:
    - In mature, closed-canopy oak woodlands with duff/leaf litter understories, the vertical separation between the top of surface fuels and the lowest tree branch shall be at least 3 feet. Where such stands abut brush/scrub vegetation communities/land cover types, provide horizontal spacing between the outward oak canopy edge and the nearest shrub equal to three (3) times the adjacent shrub height;
    - In more open oak woodlands with brush/scrub or grass understories, the vertical separation between the top of surface fuels and the lowest tree branch shall be at least three (3) times the height of the surface fuels. Encourage development of a dense tree canopy by prioritizing removal/treatment of understory shrubs/grass rather than pruning tree canopies;
    - Maintain duff layer at a depth no greater than 3 inches;
    - Remove individual eucalyptus, pine, or acacia trees from within oak woodlands; and
    - Remove invasive species (e.g., broom, pampas grass) from within oak woodlands.
- **Redwood:** Redwood vegetation communities/land cover types present relatively low fire hazard. Redwood forests in the Plan Area typically have dense canopy cover. A discussion of fuel loading and the fire hazard presented by redwood vegetation communities is presented in Section 2.3.2. The following management standards apply to redwood vegetation communities/land cover types:
    - In mature, closed-canopy redwood stands with duff/leaf litter understories, the vertical separation between the top of surface fuels and the lowest tree branch shall be at least 3 feet. Young redwood crown sprouts and sapling growth should be thinned to achieve this standard. Where such stands abut brush/scrub vegetation communities/land cover types, provide horizontal spacing between the outward oak canopy edge and the nearest shrub equal to three (3) times the adjacent shrub height;
    - In more open redwood stands where small trees, shrubs, grasses, invasive species, and/or redwood seedlings/saplings exist beneath tree canopies (surface fuels), the vertical separation between the top of surface fuels and the lowest tree branch shall be at least three (3) times the height of the surface fuels. Encourage development of a

dense tree canopy by prioritizing removal/treatment of understory shrubs, grass, or young redwood crown sprouts/seedlings rather than pruning tree canopies;

- Young redwood crown sprouts and sapling growth should be thinned. Retain three (3) sprouts (trunks) per stump;
- Maintain duff layer at a depth no greater than 3 inches; and
- Remove individual eucalyptus, pine, or acacia trees from within redwood vegetation communities;
- Remove invasive species (e.g., broom, pampas grass) from within redwood vegetation communities; and
- Maintain closed tree canopy to shade out understory ladder fuels.

- **Riparian:** Similar to redwood forest, riparian vegetation communities/land cover types present relatively low fire hazard due to year-round high moisture levels. Riparian forests in the Plan Area typically have dense canopy cover and are located along creeks and drainages. A discussion of fuel loading and the fire hazard presented by riparian vegetation communities is presented in Section 2.3.2. The following management standards apply to riparian vegetation communities/land cover types:
  - Minimize vegetation management activities in riparian areas and target the removal/treatment of down woody material and leaf litter;
  - Target ladder fuel treatment at the edge of riparian woodlands where they abut other vegetation communities/land cover types. In these areas, the vertical separation between the top of surface fuels and the lowest tree branch shall be at least 3 feet. Provide horizontal spacing between the outward canopy edge and the nearest shrub equal to three (3) times the adjacent shrub height;
  - Remove individual eucalyptus, pine, or acacia trees from within riparian vegetation communities;
  - Remove invasive species (e.g., broom, pampas grass) from within riparian vegetation communities; and
  - Maintain closed tree canopy to shade out understory ladder fuels.

9.1.5 Invasive Species

Invasive species observed in the Plan Area, or which are known to occur in the Oakland Hills, include French broom, pampas grass, blackberry, ivy, and numerous species of thistle. Invasive species can contribute to increased fuel loads and fire hazard, if not managed. The Weed

Workers' Handbook*:* A Guide to Techniques for Removing Bay Area Invasive Plants (Appendix F) provides management techniques and BMPs for treating invasive species and should be followed when managing invasive species in the Plan Area.

9.1.6 Other Combustible Material

Other combustible material, including, but not limited to, debris, trash, or yard waste that is placed, left, or deposited in the Plan Area should be removed or chipped and spread according to the standards outlined above. Any material removed from the Plan Area should be properly disposed of per City standards.

9.2 Current and Recommended Treatments for Specific Areas

Urban/residential parcel – eucalyptus stand with treated understory

The previous sections identified vegetation management standards by dominant vegetation type. Given the variability of site characteristics and parcel sizes across the Plan Area, site-specific recommendations are warranted for some specific areas, parcels, or portions thereof, as presented in the following sections. The City-owned parcels and roadsides in the Plan Area have been categorized based on size, location, and similar characteristics, as summarized in the following sections. The following sections also summarize existing vegetation management activities being implemented by the City along with vegetation management actions recommended under this VMP. This section also includes references to priority treatment areas (Priority 1, 2, and 3), which are defined in Section 9.3.3. Finally, a visual analysis of recommended treatments for select areas was conducted, with the results presented in Appendix G.

9.2.1 Urban and Residential Parcels

Urban and residential parcels are those which are generally smaller than 1 acre in size and are distributed throughout the Plan Area. In some cases, multiple adjacent parcels are owned by the

City. Urban and residential parcels are mapped as the following vegetation communities/land cover types: annual grassland (2.4 acres), closed-cone pine-cypress (8.9 acres), coastal oak woodland (18.7 acres), coastal scrub (2.4 acres), eucalyptus (13.8 acres), redwood (0.2 acres), urban (12.5 acres), and urban (acacia) (0.2 acres). Current management practices for these parcels includes manual treatment of vegetation, often under contract to private contractors. Current vegetation management on these parcels is focused on reducing ladder fuels, controlling invasive species (e.g., broom), reducing surface fuels (e.g., grasses, weeds, down material), maintaining fuel loads, and pruning tree canopies through the use of hand labor or mechanical techniques. Grazing has also been conducted on urban and residential parcels, primarily where multiple City-owned parcels abut each other, creating a larger area for treatment.

All urban and residential parcels fall entirely or largely within the 100-foot buffer from existing structures and are therefore considered Priority 1 treatment areas (as defined in Section 9.3.3). It is recommended that these parcels continue to be managed according to the standards outlined in Section 9.1. Table 9 summarizes the quantity, size, and acreage of the urban and residential parcels in the Plan Area. The locations of urban and residential parcels are presented in Figures 5.1 through 5.10.

Table 9
Urban and Residential Parcels within the Plan Area

Parcel Size	Quantity	Total Acreage
<0.1 acres	46	1.8
0.1 to 0.5 acres	114	23.1
0.5 to 1.0 acres	16	10.9
1.0 to 1.5 acres	9	11.0
1.5 to 2.0 acres	3	5.4
2.0 to 2.1 acres	3	7.0
Total:	**191**	**59.2**

Garber Park

Grizzly Peak Open Space

Tunnel Road Open Space

North Oakland Regional Sports Field

Parcel Category

- Urban and Residential
- Canyon Areas
- Ridgetop Areas
- City Park Lands and Open Space
- Other Areas
- Medians
- Plan Area Roads
- Priority Roadsides
- Oakland City Limits

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

DUDEK

0 487.5 975 Feet

FIGURE 5.1

City-owned Parcel and Roadside Categories

Draft Vegetation Management Plan - City of Oakland, California

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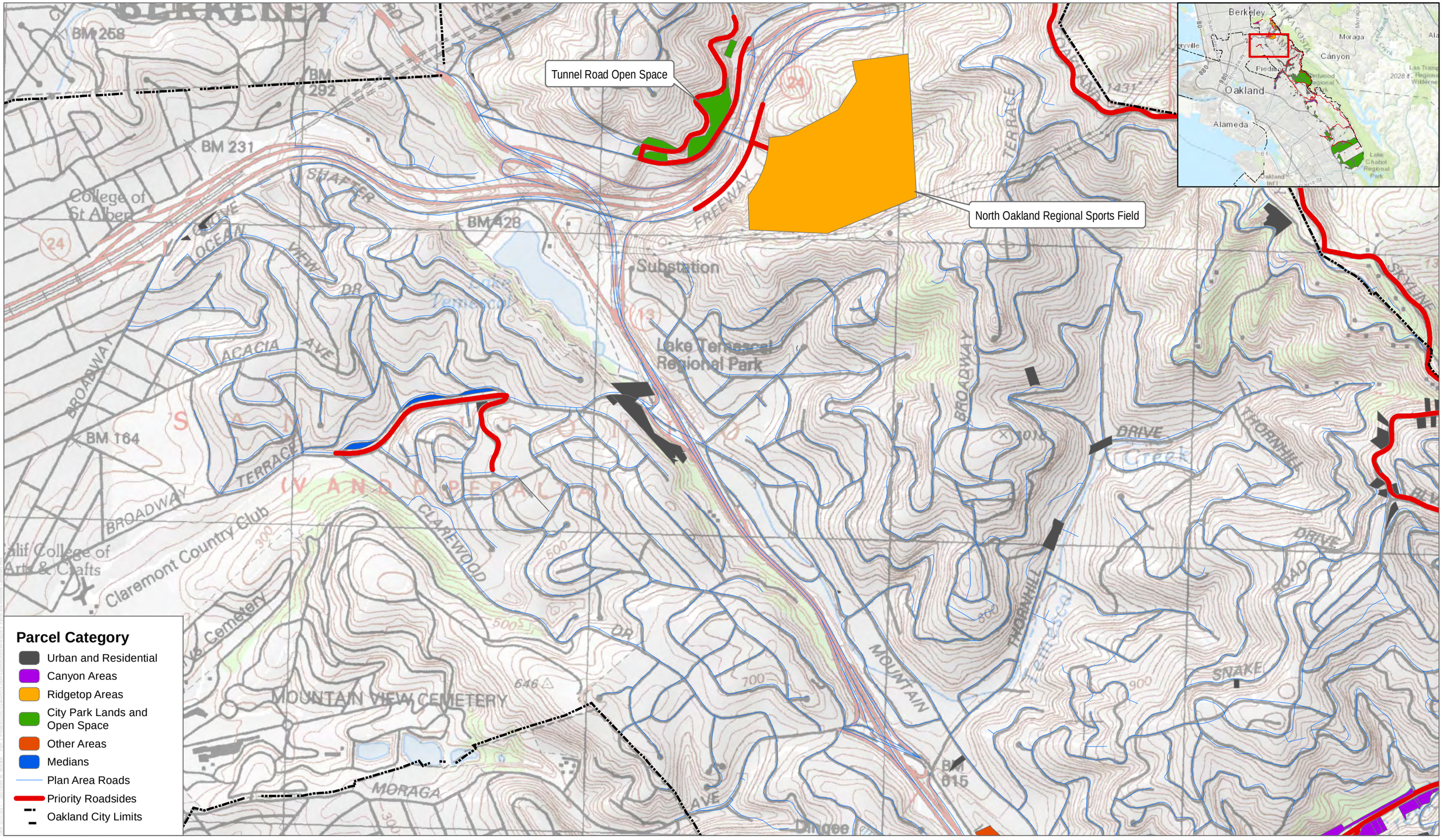

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

DUDEK

FIGURE 5.**2**

City-owned Parcel and Roadside Categories

Draft Vegetation Management Plan - City of Oakland, California

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North Oakland Regional Sports Field

Parcel Category

- Urban and Residential
- Canyon Areas
- Ridgetop Areas
- City Park Lands and Open Space
- Other Areas
- Medians
- Plan Area Roads
- Priority Roadsides
- Oakland City Limits

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 5.3

City-owned Parcel and Roadside Categories

Draft Vegetation Management Plan - City of Oakland, California

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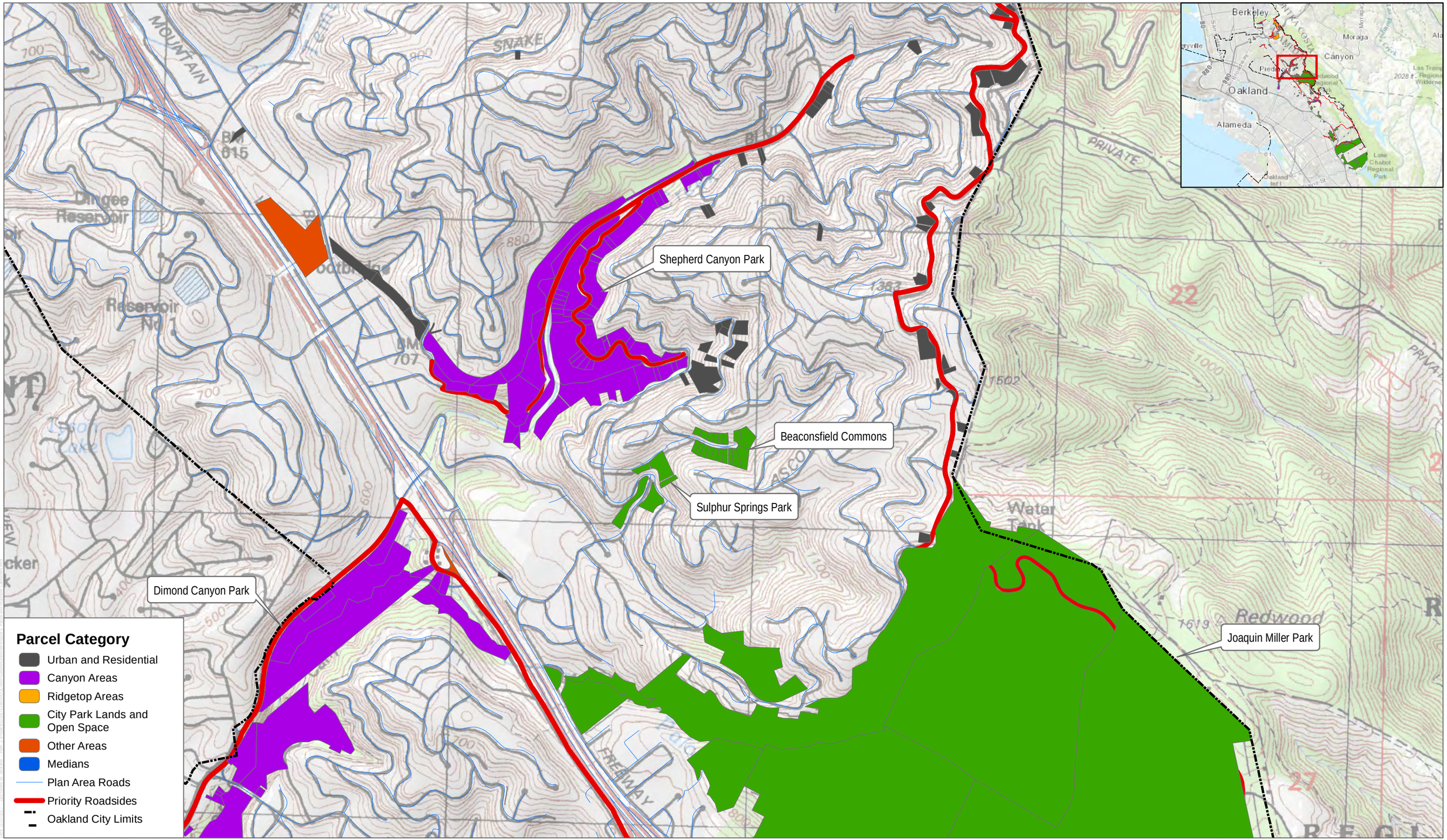

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

FIGURE 5.**4**

City-owned Parcel and Roadside Categories

Draft Vegetation Management Plan - City of Oakland, California

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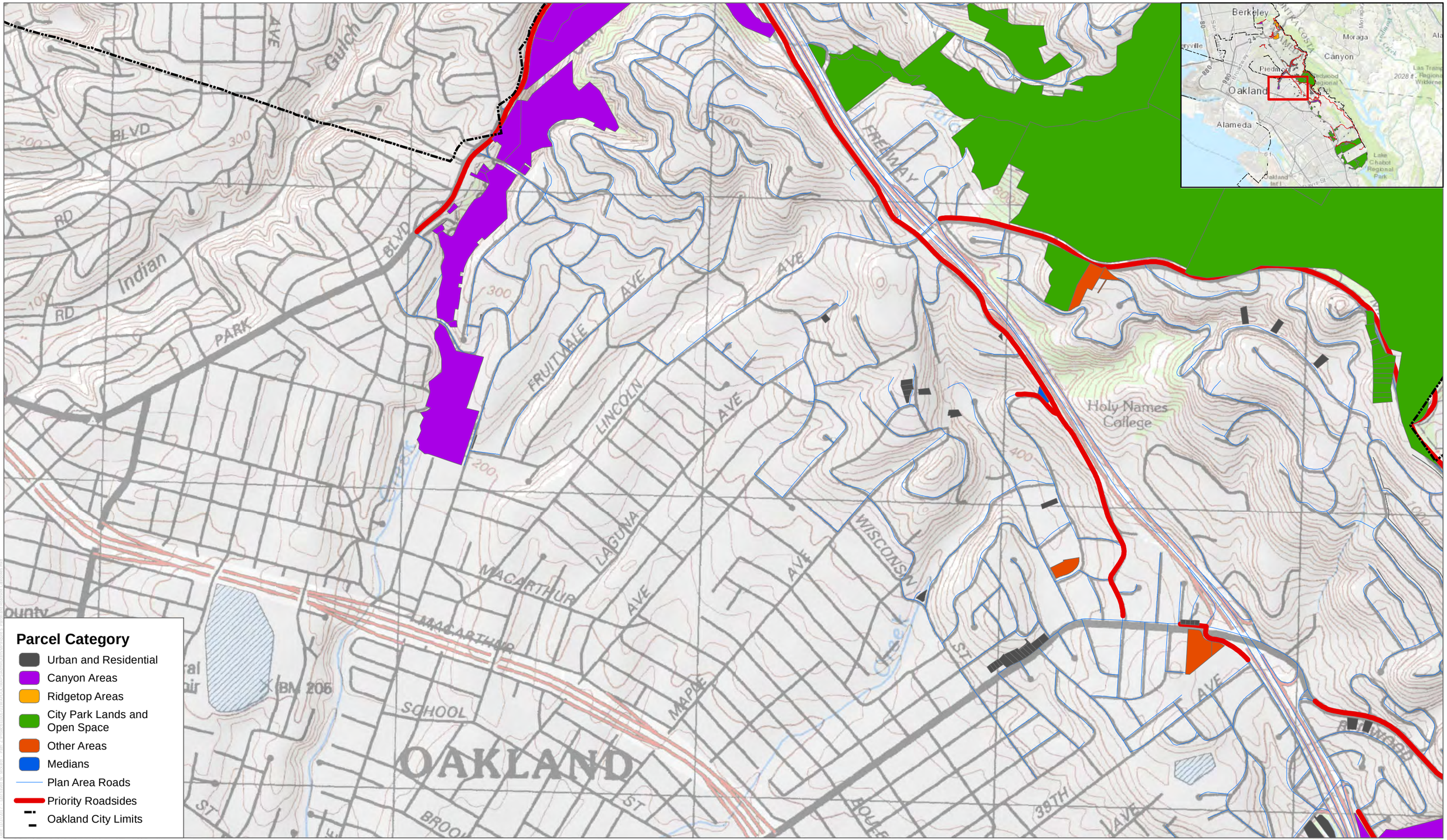

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 5.**5**

City-owned Parcel and Roadside Categories

Draft Vegetation Management Plan - City of Oakland, California

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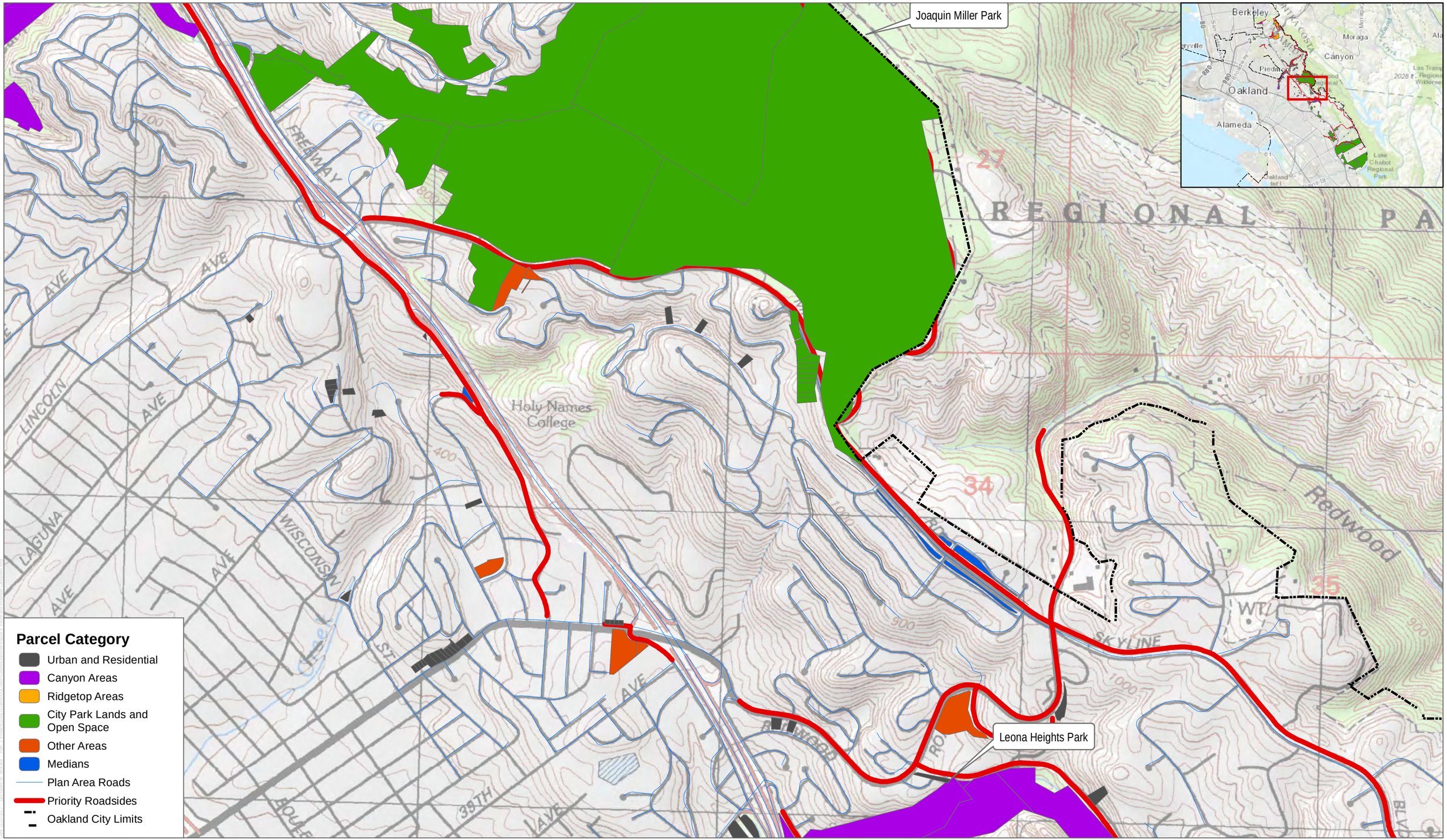

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 5.**6**

City-owned Parcel and Roadside Categories

Draft Vegetation Management Plan - City of Oakland, California

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Leona Heights Park

McDonell Avenue

Police/Safety Department

Leona Street

Blue Rock Court

City Stables

Parcel Category

- Urban and Residential
- Canyon Areas
- Ridgetop Areas
- City Park Lands and Open Space
- Other Areas
- Medians
- Plan Area Roads
- Priority Roadsides
- Oakland City Limits

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 5.7

City-owned Parcel and Roadside Categories

Draft Vegetation Management Plan - City of Oakland, California

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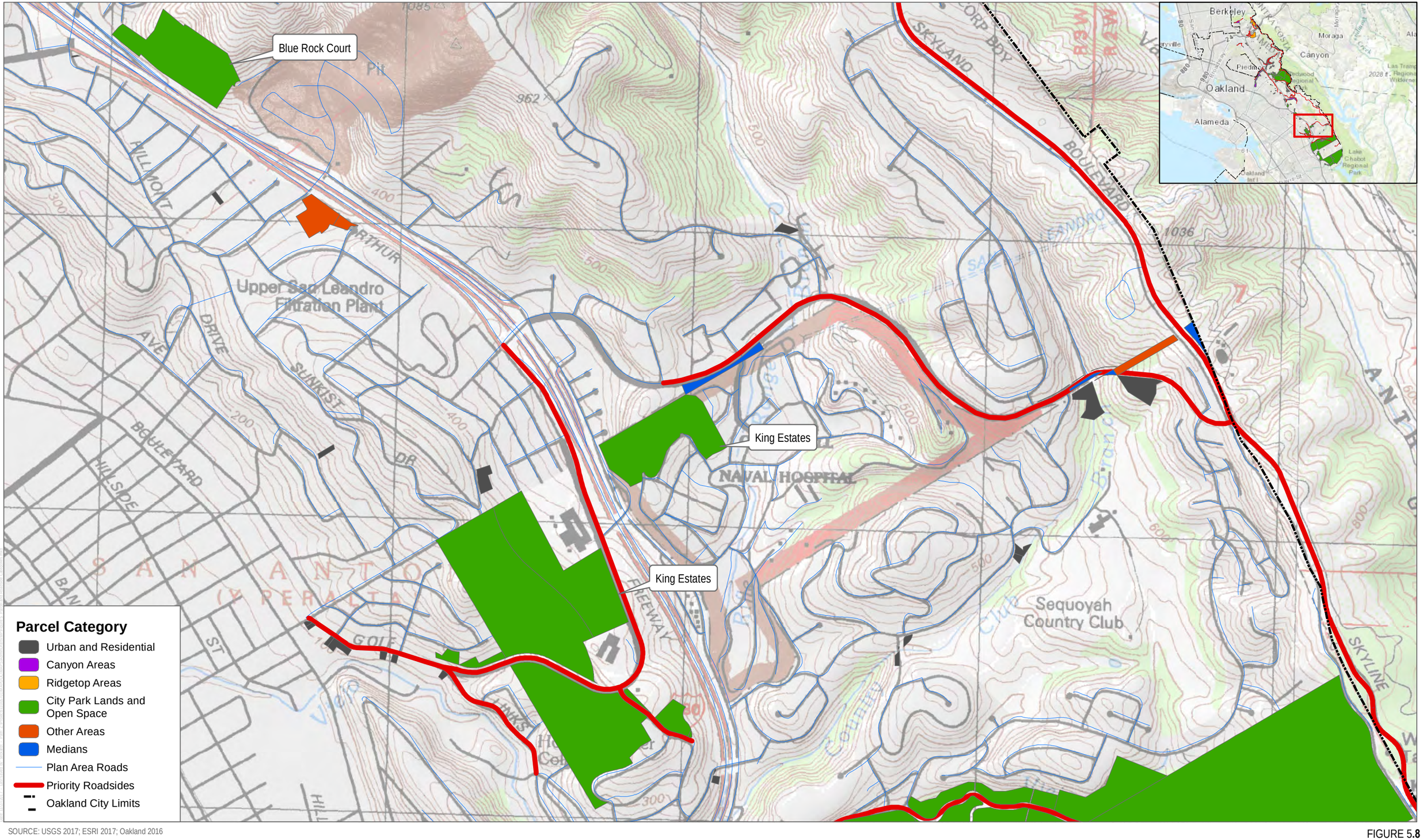

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 5.**8**

City-owned Parcel and Roadside Categories

Draft Vegetation Management Plan - City of Oakland, California

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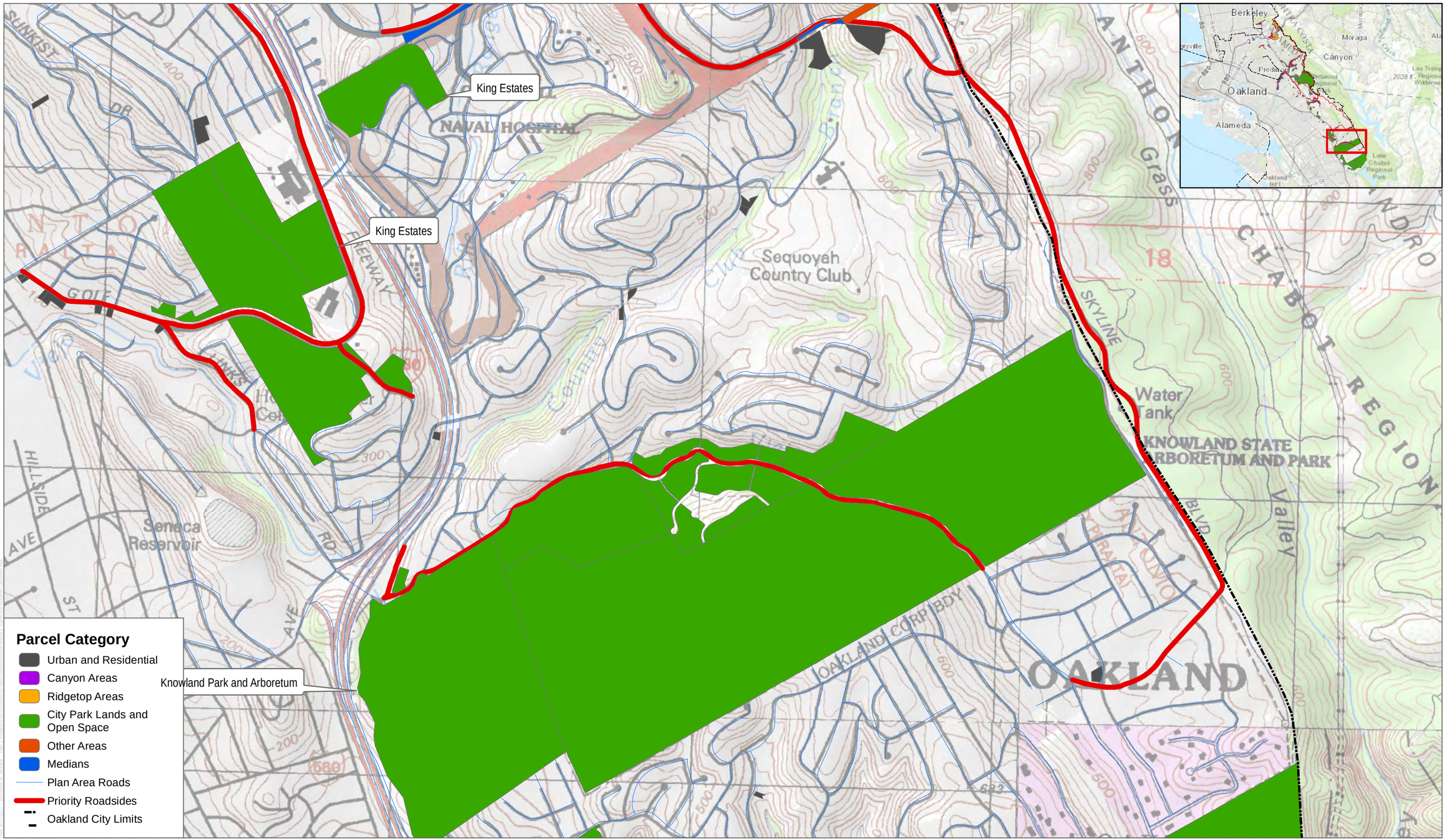

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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0 487.5 975 Feet

FIGURE 5.**9**

City-owned Parcel and Roadside Categories

Draft Vegetation Management Plan - City of Oakland, California

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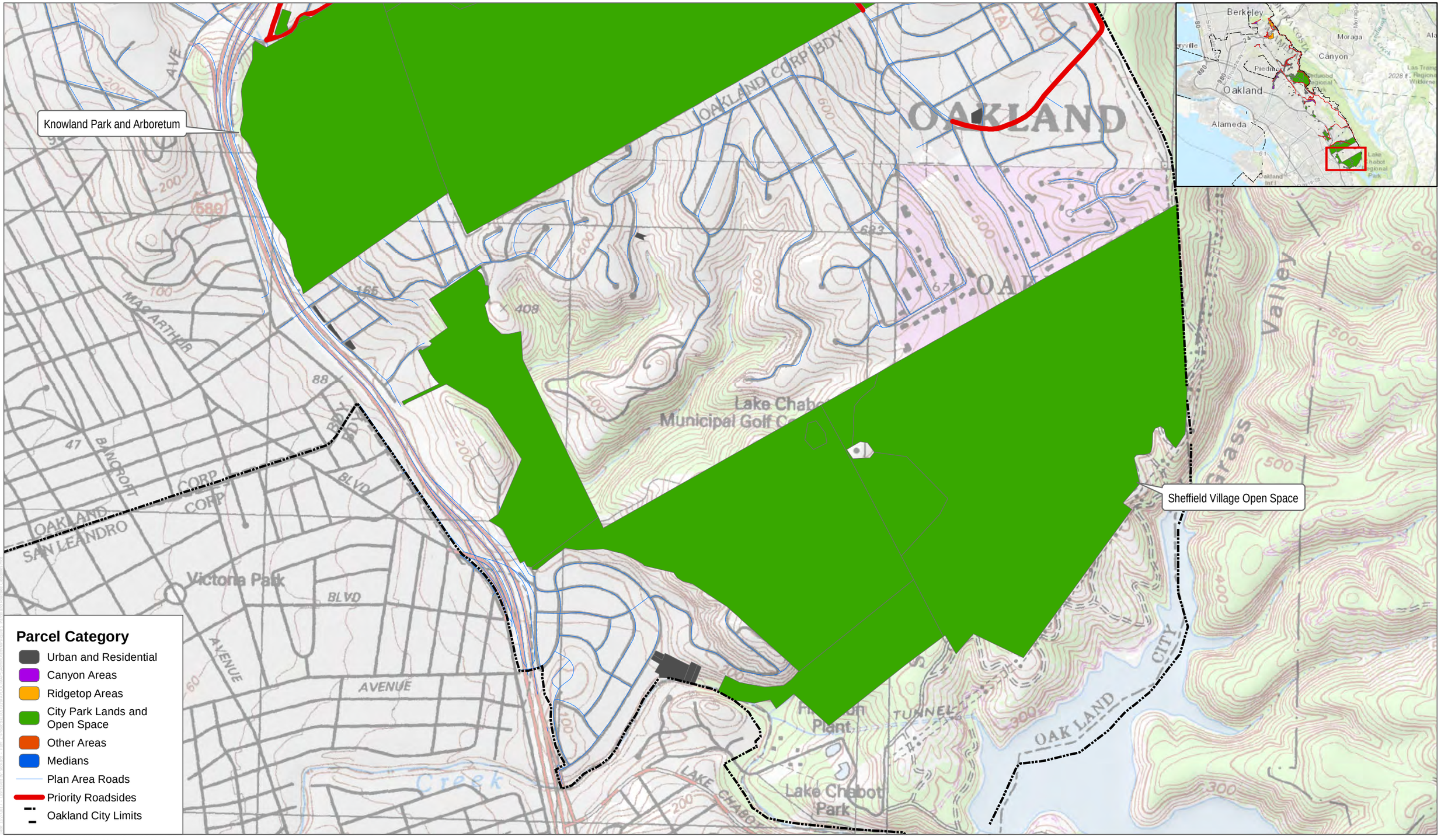

SOURCE: USGS 2017; ESRI 2017; Oakland 2016

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FIGURE 5.10

City-owned Parcel and Roadside Categories

Draft Vegetation Management Plan - City of Oakland, California

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9.2.2 Canyon Areas

Canyon areas are collections of multiple adjacent parcels that are situated within and along canyons and drainages in the Plan Area. Four canyon areas have been identified in the Plan Area, and current and recommended vegetation management practices are presented for each in the following sections. The locations of canyon area parcels are presented in Figure 5.

9.2.2.1 Garber Park

Garber Park – oak woodland understory

Garber Park is collectively 14.3 acres in size and is situated primarily along the south side of Claremont Avenue at the bottom of Claremont Canyon. The park primarily consists of a north-facing slope and is mapped entirely as coast oak woodland. Given its position within the lower part of the canyon and its north-facing slope, fuel moistures are typically high and fire hazard low. Fire behavior modeling resulted in no extreme fire behavior in Garber Park. Current management practices are limited to flashy fuel (e.g., grasses, weeds) treatment along Claremont Avenue to minimize ignition potential through the use of hand labor or mechanical techniques. A portion of the park falls within the 100-foot buffer from existing nearby residential structures, although treatment to 100 feet is not recommended due to the site's low fire hazard. The following management recommendations are provided for Garber Park:

- Maintain the existing trail networks to facilitate access and to create breaks in surface vegetation;
- Manage vegetation along adjacent roadside (Claremont Avenue) and near trailheads/entry points to minimize ignition potential. Treatment width should be based on field observations, but not to exceed 30 feet;
- Manage vegetation within 10 feet of the south and west property boundary line to facilitate firefighter access according to the standards outlined in Section 9.1.

9.2.2.2 Dimond Canyon Park

Dimond Canyon Park – riparian vegetation

Dimond Canyon Park is collectively 74.8 acres in size and is situated along Sausal Creek, south of State Route 13. The park includes the creek channel and some upland areas and is mapped as the following vegetation communities/land cover types: coast oak woodland (50.6 acres), coastal scrub (0.3 acres), eucalyptus (1.3 acres), redwood (5.5 acres), and urban (17.1 acres). It is primarily surrounded by residential development, with Park Boulevard forming its boundary in the northeast corner and Monterey Boulevard forming its boundary along the north. Leimert Boulevard and El Centro Avenue also bisect the park. Given its position along Sausal Creek, fuel moistures along the lower portions of the park are typically high and fire hazard low. Drier and more hazardous conditions exist in the park's upland areas. Fire behavior modeling resulted in primarily surface fire throughout the property, although small pockets of active crown fire were modeled in the coastal oak woodland area along Park Boulevard with grass/shrub understory and in a few small areas within the drainage with high slope gradients. Current management practices are limited to roadside treatment along Park Boulevard and Monterey Boulevard through the use of hand labor or mechanical techniques. Much of the park falls within the 100-foot buffer from existing structures, although treatment to 100 feet is not recommended due to lower fire hazard and the proximity to Sausal Creek. The following management recommendations are provided for Dimond Canyon Park:

- Maintain the existing trail networks to facilitate access and to create breaks in surface vegetation;
- Manage vegetation along adjacent roadsides (Park Boulevard, Monterey Boulevard, Leimert Boulevard, El Centro Avenue) and near trailheads/entry points to minimize ignition potential. Treatment width should be based on field observations, but not to exceed 30 feet; and

- Manage vegetation within 10 feet of the south and west property boundary line to facilitate firefighter access according to the standards outlined in Section 9.1.

9.2.2.3 Shepherd Canyon Park

Shepherd Canyon Park – grass with tree overstory

Shepherd Canyon Park is collectively 54.3 acres in size and is situated along Shepherd Creek in Shepherd Canyon, northeast of State Route 13. The park includes the creek channel and some upland areas and is mapped as the following vegetation communities/land cover types: annual grassland (2.0 acres), closed-cone pine-cypress (1.5 acres), coastal oak woodland (31.6 acres), eucalyptus (13.6 acres), and urban (5.7 acres). It is primarily surrounded by residential development and is bounded primarily on the west by Shepherd Canyon Road. Given its position along Shepherd Creek, fuel moistures along the lower portions of the park are typically high and fire hazard low; however, drier and more hazardous conditions exist in the park's upland areas. Fire behavior modeling resulted in active and passive crown fire concentrated along the western side of Shepherd Canyon Road where broom exists beneath eucalyptus tree canopies and surface fire throughout the remainder of the property. Current management practices include roadside treatment along Shepherd Canyon Road through the use of hand labor or mechanical techniques, and hand labor treatment, mechanical treatment, or grazing throughout the park to reduce ladder fuels, control invasive species, and reduce and maintain surface fuel loads. Approximately 9 acres of the park are currently grazed annually. Much of the park falls within the 100-foot buffer from existing structures or within 30 feet of existing roads. The following management recommendations are provided for Shepherd Canyon Park:

- Maintain the existing trail networks to facilitate access and to create breaks in surface vegetation;
- Manage vegetation along adjacent roadsides (Shepherd Canyon Road and Escher Drive) to minimize ignition potential. Treatment width should be based on field observations, but not to exceed 30 feet;

- Manage vegetation within 100 feet of structures according to the standards outlined in Section 9.1; and
- Continue to manage vegetation via grazing throughout the remainder of the park to maintain fuel loads.

9.2.2.4 Leona Heights Park

Leona Heights Park – upland area vegetation

Leona Heights Park is collectively 42.3 acres in size and is situated along a drainage south of Redwood Road and Campus Drive and east of State Route 13. The park includes the drainage channel and some upland areas and also extends south of the Merritt College parking lot located west of Campus Drive. Leona Heights Park is mapped as the following vegetation communities/land cover types: annual grassland (0.3 acres), coastal oak woodland (25.7 acres), eucalyptus (2.1 acres), redwood (13.8 acres), and urban (0.5 acres). The park is largely inaccessible given its steep terrain. Fire behavior modeling resulted in active and passive crown fire in coastal oak woodlands in upland areas in the eastern and northern portions of the park and primarily surface fire within redwood stands along the drainage bottom. Some isolated active crown fire was modeled in areas with steep slope gradients and only surface fire was modeled in the managed eucalyptus and oak stands at the park's western edge. Current management practices are limited to roadside treatment along Campus Drive through the use of hand labor or mechanical techniques, and hand labor treatment, mechanical treatment, or grazing in the lower portion of the park (approximately 9 acres) to reduce ladder fuels, control invasive species, and reduce and maintain surface fuel loads. A portion of the park falls within the 100-foot buffer from existing structures, along its northern and western boundaries. The following management recommendations are provided for Leona Heights Park:

- Manage vegetation along adjacent roadside (Campus Drive) to minimize ignition potential. Treatment width should be based on field observations, but not to exceed 30 feet; and
- Manage vegetation within 100 feet of structures and within the current 9-acre management area according to the standards outlined in Section 9.1.

9.2.3 Ridgetop Areas

Ridgetop areas are single parcels or collections of multiple adjacent parcels that are situated at or near the summit of the Oakland Hills in the Plan Area. Ridgetop areas present high fire hazard conditions due to typically lower fuel moistures and the potential for high or erratic winds during wildfire events. Three ridgetop areas have been identified in the Plan Area and current and recommended vegetation management practices are presented for each in the following sections. The locations of ridgetop area parcels are presented in Figure 5.

9.2.3.1 North Oakland Regional Sports Field

North Oakland Regional Sports Field – eucalyptus stand

The North Oakland Regional Sports Field property is collectively 53.6 acres in size and is situated to the south of State Route 24 immediately south of the Caldecott tunnels. The North Oakland Regional Sports Field property is mapped as the following vegetation communities/land cover types: coastal oak woodland (22.1 acres), coastal scrub (2.1 acres), eucalyptus (18.2 acres), urban (5.2 acres), and valley-foothill riparian (6.0 acres). The property is characterized by a second-growth eucalyptus stand in its northern half, which was burned in the 1991 Tunnel Fire, and a coastal oak woodland stand in its southern half. The lower, central portion of the property includes ball fields, and a dirt access road bisects the property as it runs upward from Broadway in the west, through the eucalyptus stand, toward the houses above on Skyline Boulevard. Public use in the lower portions of the property is a potential ignition source. Fire behavior modeling resulted in

active crown fire throughout most of the property's tree-dominated vegetation (eucalyptus and coastal oak woodland) and surface fire concentrated in managed areas along the property's dirt access road and in the area between the sports field and the eucalyptus stand.

Current management practices are limited to roadside treatment along the property's dirt access road through the use of hand labor or mechanical techniques to reduce ladder fuels, control invasive species, and reduce and maintain surface fuel loads. The property is beyond 300 feet from existing structures, although fire behavior modeling reveals a potential for extreme fire behavior, as noted. The following management recommendations are provided for the North Oakland Regional Sports Field property:

- Implement thinning recommendations in the property's eucalyptus stand within 30 feet of the site's dirt access road according to the standards outlined in Section 9.1 to compartmentalize fires and facilitate site access;
- Given the upper portion of the property's ridgetop location and the potential for ember generation resulting from crown fire, implementing thinning recommendations in the property's eucalyptus stand beyond 30 feet of the site's dirt access road according to the standards outlined in Section 9.1 is recommended when time and budgets allow;
- Remove eucalyptus trees and other invasive species from oak woodland and riparian vegetation communities, retaining native trees;
- Maintain the site's dirt access road in a serviceable condition, improving roadside drainage where erosion and gullying have deteriorated access road;
- Implement measures to prevent unauthorized vehicle access to the property's dirt access road; and
- Maintain vegetation along adjacent roadside (Broadway) and the edges of all parking areas to minimize ignition potential. Treatment width should be based on field observations, but not to exceed 30 feet.

9.2.3.2 Grizzly Peak Open Space

The Grizzly Peak Open Space property is collectively 69.1 acres in size and is situated along the southwest side of Grizzly Peak Boulevard, southeast of Marlborough Terrace. The property generally extends between Grizzly Peak Boulevard at the top of the slope down to Bay Forest Drive, Tunnel Road, Buckingham Boulevard, and Westmoreland Drive at the slope bottom. The Grizzly Peak Open Space property is mapped as the following vegetation communities/land cover types: closed-cone pine-cypress (27.6 acres), coastal oak woodland (3.2 acres), coastal scrub (32.3 acres), eucalyptus (4.3 acres), and urban (1.6 acres). The property extends across a steep,

southwest-facing slope and abuts residential structures, community assets (communications facility), and a priority access/egress route (Grizzly Peak Boulevard). Views from the property increase human presence along Grizzly Peak Boulevard, increasing potential ignition sources. Fire behavior modeling resulted in torching of tree canopies along the upper, northeastern portion of the property and active crown fire along the lower, southwestern portion of property in pine and eucalyptus stands.

Grizzly Peak Open Space – upper portion along Grizzly Peak Boulevard

Current management practices include roadside treatment along Grizzly Peak Boulevard through the use of hand labor or mechanical techniques, hand labor or mechanical treatment along Bay Forest Drive in the lower portions of the property, and grazing throughout the property to reduce ladder fuels, control invasive species, and reduce and maintain surface fuel loads. Fire behavior modeling reveals a potential for extreme fire behavior, as noted. The upper and lower portions of the property fall within the 100-foot buffer from existing structures and much of the property falls within 300 feet of structures. The following management recommendations are provided for the Grizzly Peak Open Space property:

- Manage vegetation within 100 feet of structures, within 30 feet of Grizzly Peak Boulevard and Tunnel Road, and within 30 feet of known human congregation areas along Grizzly Peak Boulevard according to the standards outlined in Section 9.1 (Priority 1);
- Implement thinning recommendations in the property's eucalyptus and pine stands in areas exhibiting extreme fire behavior and within 300 feet of structures according to the standards outlined in Section 9.1 (Priority 2);
- Given the upper portion of the property's ridgetop location and potential for ember generation resulting from crown fire, implement thinning recommendations in the property's eucalyptus stand beyond 30 feet of the site's dirt access road according to the standards outlined in Section 9.1 when time and budgets allow; and
- Remove eucalyptus trees and other invasive species from oak woodlands, retaining native trees.

9.2.3.3 City Stables

The City stables property is 7.4 acres, is located along Skyline Boulevard, is dominated by grassland fuels, and is largely within 10 feet from existing structures. One of the City's remote automated weather stations is situated in the property. Fire behavior modeling resulted in no extreme fire behavior on the City Stables property. Vegetation management on this parcel is focused on reducing surface fuels (e.g., grasses, weeds) and maintaining fuel loads through the use of hand labor, mechanical techniques, or grazing. The property is currently leased to a private contractor who retains responsibility for vegetation management. If the current lease expires within the timeframe of this VMP and the City regains management responsibility, it is recommended to resume management of vegetation on the entire property according to the standards outlined in Section 9.1.

9.2.4 City Park Lands and Open Space

City park lands and open space areas are collections of multiple adjacent parcels, are characterized by numerous vegetation types, and typically present high fire hazard conditions due to terrain, vegetation, and increased human presence resulting in increased ignition potential. Four primary park land and open space areas have been identified in the Plan Area; current and recommended vegetation management practices are presented for each in the following sections. In addition, smaller properties or collections of parcels that exhibit similar vegetation conditions have been included in this designation and are also summarized below. The locations of park land and open space parcels are presented in Figure 5.

9.2.4.1 Sheffield Village Open Space

Sheffield Village Open Space is collectively 455.4 acres in size and is situated at the southeastern-most portion of the Plan Area, at the southern end of Golf Links Road and at the northwestern end of Lake Chabot. The property includes the Lake Chabot Golf Course; however, given the low fire hazard condition of the golf course, no management recommendations are provided for that portion of the property. Sheffield Village Open Space is mapped as the following vegetation communities/land cover types: annual grassland (59.4 acres), closed-cone pine-cypress (5.9 acres), coastal oak woodland (143.9 acres), coastal scrub (59.3 acres), eucalyptus (27.9 acres), perennial grassland (0.8 acres), and urban (158.1 acres). Fire behavior modeling resulted in active crown fire in coastal scrub (where overstory trees are present), oak stands with a heavy shrub understory, and isolated areas within oak woodlands with grass understory where slope gradients are high and surface fire only throughout the remainder of the property.

Current management practices include grazing throughout the property (excluding the golf course) to reduce ladder fuels, control invasive species, and reduce and maintain surface fuel loads. Portions of the southern edge of the property fall within the 100-foot and 300-foot buffers from existing structures. On-site structures include those in the Dunsmuir Estates portion of the property (at the end of Peralta Oaks Court). The following management recommendations are provided for the Sheffield Village Open Space property:

Sheffield Village Open Space – grazed grassland and oak woodlands

- Manage vegetation within 100 feet of structures according to the standards outlined in Section 9.1 (Priority 1);
- Manage vegetation within 100 feet of on-site structures in the Dunsmuir Estates portion of the property as outlined in Section 9.1 (Priority 1);
- Maintain the existing trail/road networks to facilitate access and to create breaks in surface vegetation; and
- Continue to manage vegetation via grazing throughout the remainder of the park to maintain fuel loads.

9.2.4.2 Knowland Park and Arboretum

Knowland Park and Arboretum is collectively 473.5 acres in size and is situated in the southeastern portion of the Plan Area. The property extends between Interstate 580 in the southwest and Skyline Boulevard in the northeast and is bisected by Golf Links Road. The property includes the Oakland Zoo and Arboretum at the southwestern edge and a newly constructed gondola between the zoo and a hilltop near the center of the property. The Knowland Park and Arboretum property is mapped as the following vegetation communities/land cover types: annual grassland (104.6 acres), chamise-redshank chaparral (8.1 acres), closed-cone pine-cypress (9.1 acres), coastal oak woodland (162.0 acres), coastal scrub (61.8 acres), eucalyptus

(12.1 acres), freshwater emergent wetland (0.2 acres), perennial grassland (10.8 acres), redwood (0.2 acres), and urban (104.9 acres). Views from the water tank situated along Skyline Boulevard at the property's northeastern boundary increase human presence thereby increasing potential ignition sources. Fire behavior modeling resulted in active crown fire in the coastal scrub and chaparral stands in the central and eastern portions of the property (where overstory trees are present) and in the eucalyptus stands in the western portion of the property and surface fire only throughout the remainder of the property.

Knowland Park and Arboretum – grazed grassland and scattered trees

Current management practices include roadside treatment along Golf Links Road through the center of the property through the use of hand labor or mechanical techniques and grazing throughout the property to reduce ladder fuels, control invasive species, and reduce and maintain surface fuel loads. Approximately 350 acres of the property are currently grazed annually. Much of the perimeter of the property falls within the 100-foot and 300-foot buffers from existing structures. The following management recommendations are provided for the Knowland Park and Arboretum property:

- Manage vegetation within 100 feet of structures, within 30 feet of Golf Links Road, and within 30 feet of known human congregation/activity areas along Skyline Boulevard according to the standards outlined in Section 9.1 (Priority 1);
- Manage vegetation within 100 feet of on-site structures in the zoo portion of the property and within 100 feet of the zoo/open space interface to minimize ignition potential and modify potential fire behavior near this developed portion of the property;
- Maintain the existing trail/road networks to facilitate access and to create breaks in surface vegetation;
- Implement measures to prevent unauthorized vehicle access to the property's dirt access roads; and

- Continue to manage vegetation via grazing throughout the remainder of the park to maintain fuel loads.

9.2.4.3 Joaquin Miller Park

Joaquin Miller Park – trail through acacia tree stand

Joaquin Miller Park is 454.9 acres in size and is situated in the southeastern portion of the Plan Area. The property extends between Joaquin Miller Road in the south and Skyline Boulevard and the Oakland Hills ridgeline in the north. Skyline Boulevard runs along the park's western edge then through the northern portion of the park where it exits at the park's northern corner. The southern portion of the park is more developed and includes access roads, parking areas, an amphitheater, a dog park, and several structures (park headquarters, the historic Joaquin Miller house). The northern portion of the park is less developed, but provides for public access along numerous trails and dirt roads. The CSSC and the associated pallid manzanita restoration site is located partially on and off site but adjacent to the park's northern property boundary. Joaquin Miller Park is mapped as the following vegetation communities/land cover types: annual grassland (16.8 acres), closed-cone pine-cypress (115.4 acres), coastal oak woodland (106.0 acres), coastal scrub (5.8 acres), eucalyptus (38.6 acres), redwood (118.5 acres), urban (42.8 acres), urban (acacia) (6.6 acres), urban (mixed tree stand) (3.7 acres), and valley/foothill riparian (0.8 acres). Known areas for potential ignitions include a congregation area/car dump site along Skyline Boulevard approximately 800 feet up from its intersection with Joaquin Miller Drive and a congregation/bonfire area located at the top of Woodside Glen Court. Fire behavior modeling resulted in active and passive crown fire within the northern and central portions of the park within non-managed oak, pine, eucalyptus, and acacia stands. Active and passive crown fire also modeled within the acacia and mixed tree stands within the southern (lower) portions of the park and only surface fire modeled within redwood stands and throughout the lower, developed and managed portions of the park (except acacia and mixed tree stands).

Current management practices include roadside treatment along Joaquin Miller Road along the entire southern edge of the park and along Skyline Boulevard through the park through the use of

hand labor or mechanical techniques. Vegetation is also managed by hand labor or mechanical techniques in the areas adjacent to the dirt parking lot to the west of the CSSC, at the WUI along the park's northwestern boundary, and around structures, the dog park, and the amphitheater in the developed portion of the park. Fire trails within the center of the park are cleared, and vegetation within 20 feet of the trails managed via hand labor. Grazing is also conducted throughout the park in light, flashy fuel areas (grasslands, disturbed areas) to reduce and maintain surface fuel loads. Approximately 150 acres of the property are currently grazed annually. Fire behavior modeling reveals a potential for extreme fire behavior in the property's pine, eucalyptus, acacia, and mixed tree stands. Much of the southern and western portions of the park's perimeter fall within the 100-foot and 300-foot buffers from existing structures. The following management recommendations are provided for the Joaquin Miller Park:

- Manage vegetation within 100 feet of structures, within 30 feet of Joaquin Miller Road and Skyline Boulevard, and within 30 feet of known human congregation/activity areas along Skyline Boulevard and the top of Woodside Glen Court according to the standards outlined in Section 9.1 (Priority 1);
- Manage vegetation within 100 feet of on-site structures, including the historic Joaquin Miller House, as outlined in Section 9.1 (Priority 1);
- Implement thinning recommendations in the park's eucalyptus, pine, acacia, and mixed tree stands in areas exhibiting extreme fire behavior and within 300 feet of structures according to the standards outlined in Section 9.1 (Priority 2);
- Maintain the existing fire trail/dirt road network to facilitate access and to create breaks in surface vegetation;
- Avoid treatment within the pallid manzanita restoration area adjacent to the CSSC;
- Implement measures to prevent unauthorized vehicle access to the park's dirt access roads; and
- Continue to manage vegetation via grazing throughout the remainder of the park to maintain fuel loads.

9.2.4.4 King Estates

The King Estates property is collectively 97.1 acres in size and is situated southwest of Interstate 580, south of 82nd Avenue, and bisected by Fontaine Street. The King Estates property is mapped as the following vegetation communities/land cover types: annual grassland (64.0 acres), coastal oak woodland (12.4 acres), coastal scrub (4.3 acres), eucalyptus (1.3 acres), and urban (15.1 acres). Ignitions on the property are of concern given the proximity of homes, views from

the property, and the significant coverage of ignitable grasses on site. OFD has noted that the use of fireworks on and around the property is prevalent on and around July 4 annually. Fire behavior modeling resulted in isolated active crown fire only in coastal scrub where overstory trees are present and surface fire only throughout the remainder of the property.

Current management practices include roadside treatment along Fontaine Street and Crest Avenue through the use of hand labor or mechanical techniques, and grazing throughout the property to reduce ladder fuels, control invasive species, and reduce and maintain surface fuel loads. Approximately 88 acres of the property are currently grazed annually. The perimeter of the property falls within the 100-foot and 300-foot buffers from existing structures. The following management recommendations are provided for the King Estates property:

King Estates – grazed grassland, oak woodland, and grass/shrub fuels

- Manage vegetation within 100 feet of structures and within 30 feet of Fontaine Street and Crest Avenue according to the standards outlined in Section 9.1 (Priority 1);
- Maintain the existing trail/road networks to facilitate access and to create breaks in surface vegetation;
- Implement measures to prevent unauthorized vehicle access to the property's dirt access roads;
- Continue to manage vegetation via grazing throughout the remainder of the park to maintain fuel loads and minimize ignition potential, particularly prior to the 4th of July holiday.

9.2.4.5 Other Open Space Areas

Tunnel Road Open Space – grassland (lower) and oak woodland (upper)

Other small City-owned parcels or groups of parcels that are not otherwise classified above but exhibit similar vegetation conditions and are currently managed by the City are summarized below. Current management practices include roadside treatment through the use of hand labor or mechanical techniques, and hand labor treatment, mechanical treatment, or grazing throughout each area to reduce ladder fuels, control invasive species, and reduce and maintain surface fuel loads. Continued management of these areas is recommended according to the standards outlined in Section 9.1.

- Blue Rock Court – Collectively totaling 15.4 acres (annual grassland [2.2 acres], coastal oak woodland [5.1 acres], eucalyptus [8.0 acres], and urban [0.1 acres]), this area is located immediately north of Interstate 580, northwest of Blue Rock Court. Active and passive crown fire in the eucalyptus stand, surface fire only throughout the remainder of the property.
- Leona Street – Collectively totaling 1.9 acres (annual grassland [0.1 acres], coastal oak woodland [1.5 acres], and eucalyptus [0.2 acres]), this area is a road extension at the east end of Leona Street. Surface fire only in coastal oak woodland and annual grassland. Active crown fire in eucalyptus stand at the property's southern end.
- McDonell Avenue – Collectively totaling 1.1 acres (coastal oak woodland [0.6 acres] and urban [0.5 acres]), this area is a road extension at the east end of McDonell Avenue. Surface fire only.
- Police/Safety Department Property – Collectively totaling 11.3 acres (eucalyptus [7.9 acres] and urban [3.4 acres]), the eucalyptus stand is on the same parcel as the police/safety department site on Mountain Boulevard and is situated along the perimeter of the developed portion of the property. Surface fire only.

- Tunnel Road Open Space – Collectively totaling 4.4 acres (annual grassland [1.2 acres], coastal oak woodland [2.7 acres], and urban [0.5 acres]), this area is along Tunnel Road, west of State Route 24. Surface fire only.
- Sulphur Springs Park – Collectively totaling 3.6 acres (closed-cone pine-cypress [0.6 acres], coastal oak woodland [1.1 acres], and eucalyptus [1.8 acres]), this area is along Ascot Drive, southeast of Shepherd Park. Active and passive crown fire in the eucalyptus stands. Surface fire only throughout the remainder of the property.
- Beaconsfield Commons – Collectively totaling 4.2 acres (closed-cone pine-cypress [1.4 acres], coastal oak woodland [1.3 acres], and coastal scrub [1.5 acres]), this area is at the end of Chelton Drive, southeast of Shepherd Park. Active and passive crown fire in coastal scrub where overstory trees are present. Surface fire only throughout the remainder of the property.

9.2.5 Other Areas

Other City-owned properties in the Plan Area that are not otherwise classified above include fire stations (nos. 21 and 25), City facilities (parking lots, police stations), and developed parks and playgrounds (e.g., Montclair Park). This classification includes 13 properties encompassing 21.2 total acres. These properties are mapped as urban land cover types, fall entirely or largely within the 100-foot buffer from existing structures, and present a low fire risk as they are developed with irrigated and maintained landscaping. No current vegetation management activities are conducted on these parcels. No additional management recommendations are identified for these parcels; however, should conditions change (e.g., property abandoned and landscape vegetation dies) and hazardous conditions observed during annual field assessments, treatment should be conducted as identified for urban and residential parcels (Section 9.2.1). The locations of other areas are presented in Figure 5.

9.2.6 Roadside Treatment Areas and Medians

Grazed roadside treatment area along Golf Links Road

Roadside treatment areas include the area of land within 30 feet of the roadside edge (edge of pavement) for all roads in the Plan Area. The length of all roads in the Plan Area totals 308 miles. A portion of these are considered priority access/egress routes, which total 30 miles. Medians are similar to roadside treatment areas in that they are located adjacent to roads in the Plan Area. However, they differ in that they are distinct parcels owned by the City. In the Plan Area, there are 32 parcels classified as medians, which total 5.8 acres. Annually, vegetation management is conducted along all priority access/egress routes and within all medians. Current vegetation management along roadsides and within medians in the Plan Area is focused on reducing ladder fuels, controlling invasive species (e.g., broom), maintaining fuel loads, reducing ignitable surface fuels (e.g., grasses, weeds), and pruning tree canopies for vertical clearance through the use of hand labor or mechanical techniques and grazing.

Priority roadsides (30 miles) and all medians are considered Priority 1 treatment areas (as defined in Section 9.3.3). The remaining roadside areas (278 miles) are considered Priority 2 treatment areas (as defined in Section 9.3.3). It is recommended that these areas and parcels continue to be managed according to the standards outlined in Section 9.1. The locations of roadside areas and medians are presented in Figure 5.

9.3 Property Assessment, Identification of Treatment Needs, and Work Plan Development

This section outlines the components of evaluating, prioritizing, and planning vegetation management actions to be conducted in the Plan Area. While this section identifies preparation of an annual work plan to address vegetation management needs, regular and routine field inspections by OFD staff may necessitate modifications to the annual work plan.

9.3.1 Field Assessments

Field assessments of vegetation conditions in the Plan Area will be conducted by OFD staff in the spring months, although the exact dates of assessments will vary depending on weather conditions (e.g., annual rainfall, number of hot, dry days). The intent of field assessments is to inform the work plan development process by identifying the anticipated level of effort necessary to treat vegetation in the Plan Area and to identify which vegetation management techniques will be employed.

OFD also routinely patrols the Plan Area to inspect vegetation conditions and monitor the progress of treatment activities. This effort will continue and may result in recommendations to modify the annual work plan such that management standards are met. For example, vegetation that dies and cures on a property that has already been treated would require retreatment to meet identified management standards.

9.3.2 Treatment Timing

The timing of vegetation treatments is important to achieve the identified vegetation management standards. Given the variable nature of vegetation through changes in weather and season, the schedule of the treatment may often be just as important as the type of treatment selected. For example, treatments in grasslands typically take place when grass cures or dries out. Cutting grass too early will be ineffective as the grass typically grows back, effectively negating the treatment. Conversely, cutting grass too late will leave the grass in a hazardous condition during periods of high fire danger. Vegetation treatments also need to be conducted when the weather is not too dry or windy, as some treatment techniques (e.g., mechanical treatments) have the potential to ignite fires.

Treatment timing can also be used to avoid or minimize impacts to special-status plant and animal species. Given the species identified in the Plan Area, it is likely that there will be some periods at some locations when vegetation management activities need to be avoided (e.g., nesting season). Timing treatments to either control or avoid the spread of invasive plant species or insect pests is also critical. For example, treatments performed when plants have set or are setting seed will allow for greater seed dispersal. Treatment timing should therefore take advantage of differences in the timing of seeding of fire-resistant plant species and avoid periods when invasive or pyrophytic species are in seed. Table 10 summarizes treatment timing considerations for minimizing invasive species seed spread. Tree pruning should also be done when insect pests are not flying to minimize potential spread and resulting damage to other trees.

Table 10
Treatment Timing Considerations to Minimize Invasive Species Spread

Plant	Month											
	Jan.	*Feb.*	*Mar.*	*Apr.*	*May*	*Jun.*	*Jul.*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*
French broom	1	1	1	1	2	2	3	3				
Spanish broom				1	1	2	3	3				
Acacia		1	1	1	1	1	3	3	3			
Blackberry				3	3	3	1	1	1			
Eucalyptus	1	1	3	3	3	3	3	3	3	3		1
Yellow star-thistle					1	1	1	3	3	3		
Hemlock				1	1	3	3	3				
Spurge			1	1	1	1	2	2				
Fennel					1	1	1	1	3	3		
Milk thistle					1	1	3	3	3			

1	Conduct treatments during this time to avoid spreading seed
2	Use caution; treatments may spread seed if not contained
3	Use extreme caution or avoid treatments; seed spread likely if not contained

Source: LSA 2010.

The timing of vegetation management treatments shall be based on the results of the field assessments conducted by OFD staff. Typically, treatments will begin annually in the spring and early summer months, but timing may be adjusted according to weather (e.g., temperature, precipitation) or other site-specific factors. Vegetation treatments may also be conducted more than once annually, depending on site conditions and the results of subsequent assessments. The order in which properties are treated may also be adjusted according to field observations, with areas exhibiting more hazardous conditions being treated before those exhibiting less hazardous conditions. The availability of resources (e.g., goat herds) may also influence treatment timing; however, efforts shall be made to prioritize treatment of areas exhibiting more hazardous conditions.

9.3.3 Treatment Prioritization

Given the variability of parcel size and distribution, terrain characteristics, vegetative fuel cover, and potential fire behavior across the Plan Area, uniform application of vegetation management standards is not feasible. Treatment areas were therefore prioritized as presented below and based on the wildfire hazard assessment conducted in support of this VMP. During its annual field assessment effort and work plan development process, OFD will identify the areas requiring treatment, the type and extent of treatment necessary, and will prioritize treatment as outlined

below. Where possible, the geographic extent of priority areas was determined in a GIS such that treatment acreages could be calculated for parcels and parcel groups (e.g., large parks), as presented in Appendix C. Figures 6.1 through 6.10 presents the locations of the priority areas identified below.

Priority 1

Priority 1 areas include those where annual vegetation management activities should be focused first and include:

- The area within up to 100 feet of structures or critical infrastructure (e.g., water supplies, communications facilities) in the Plan Area. This treatment area provides defensible space for existing structures and reduces fire intensity at the wildland urban interface. This area may be reduced based on field observations during annual field assessments, or where otherwise recommended (e.g., riparian areas).
- The area within up to 30 feet from roadside edges (including City-owned medians) along major access/egress routes in the Plan Area. Roadsides are of concern because wildfires are generally started by human activity (e.g., sparks, catalytic converters, tossed cigarettes). Roadside vegetation management along these routes also enhances greater egress and ingress in the event of an emergency. This area may be reduced based on field observations during annual field assessments, or where otherwise recommended (e.g., riparian areas).
- Areas where vegetation management will contribute to multi-jurisdictional regional fuel breaks. In collaboration with other land owners and managers, vegetation management that enhances the fuel break network in the Oakland Hills allows for more effective containment and suppression activities should a wildfire occur.
- The area within up to 30-foot buffer around known/historic sources, areas, or sites of ignition. This treatment effort is intended to minimize wildfire ignitions originating from human activity. This area may be reduced based on field observations during annual field assessments.

Priority 2

Priority 2 areas include those where annual vegetation management activities should be focused once Priority 1 areas have been completed or if schedules and budgets allow for completion in addition to Priority 1 areas. Priority 2 areas include:

- The area within up to 30 feet from roadside edges along all other roads in the Plan Area not included in Priority 1. This area may be reduced based on field observations during annual field assessments.
- Areas between 100 feet and 300 feet from structures where modeled fire behavior exhibits crown fire or flame lengths in excess of 8 feet. Defensible space areas (0 to 100 feet from structures) are addressed under Priority 1. Treatment in this area is intended to minimize extreme fire behavior in areas near existing structures, also reducing spotting potential from crown fires that may ignite vegetation or structures at considerable distances from the fire.

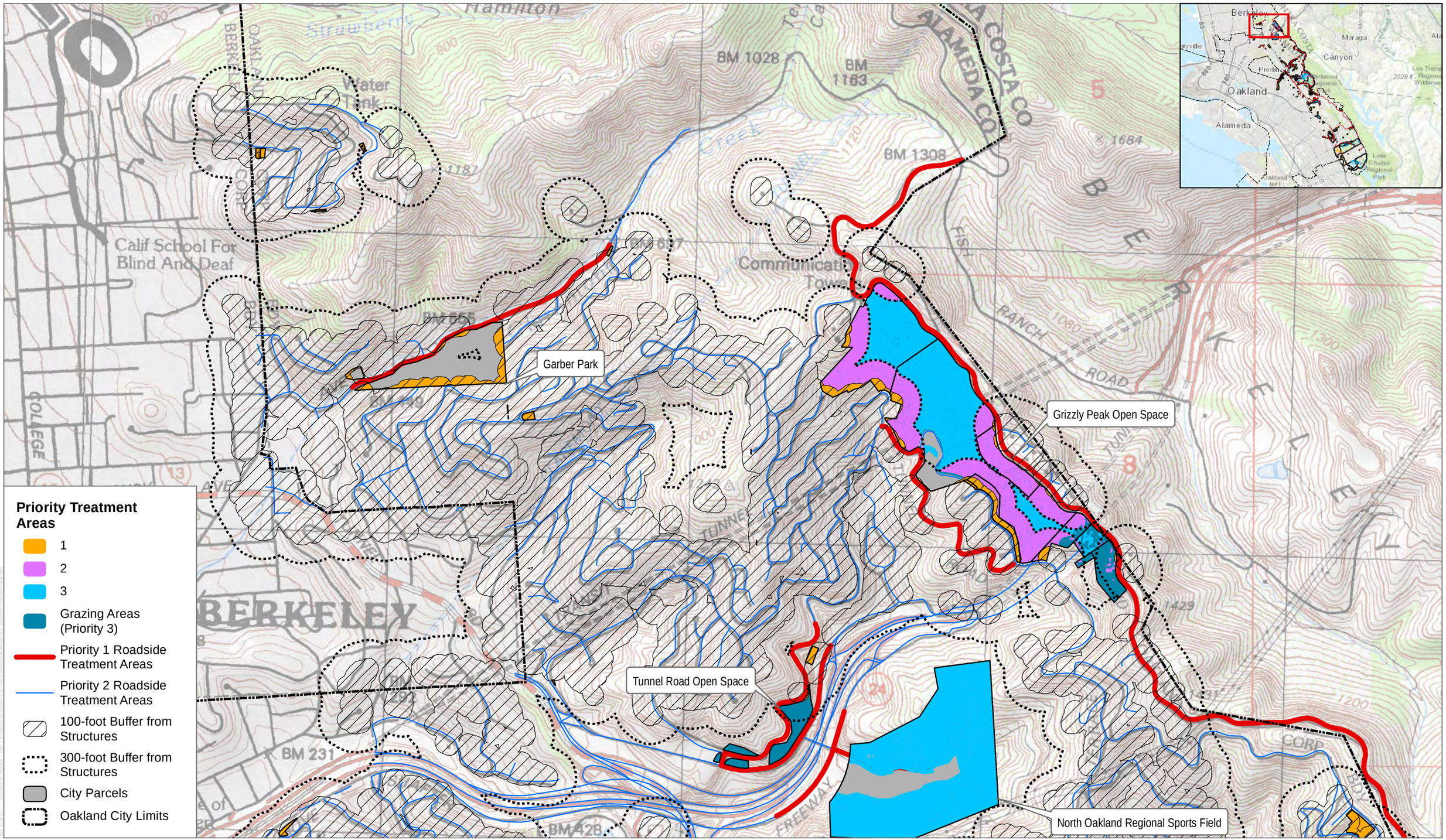
Priority 3

Priority 3 areas include those where annual vegetation management activities should be focused once Priority 1 and 2 areas have been completed or if schedules and budgets allow for completion in addition to Priority 1 and 2 areas. Priority 3 areas include:

- Areas that are currently being managed under the City's goat grazing program in areas beyond 300 feet from structures. The intent of this management activity is to maintain lower fuel loads within larger park lands or open space areas in the Plan Area.
- Areas beyond 300 feet from structures where modeled fire behavior exhibits crown fire or flame lengths in excess of 8 feet. Treatment in this area is intended to minimize extreme fire behavior and reduce spotting potential from crown fires that may ignite vegetation or structures at considerable distances from the fire.

9.3.4 Treatment Technique Selection

Treatment method selection is dependent on the dominant vegetation type being treated. Treatment may focus on grasses and surface fuels, brush or scrub, trees, or invasive species, each of which require different tools and techniques that can be employed to reach management standards, and multiple techniques may be employed on a property during treatment operations. Vegetation management technique selection shall be made from those identified in this VMP and will be based on the condition of vegetation observed during field assessments. Treatment techniques, or combinations thereof, will be identified in the annual work plans prepared by OFD.



SOURCE: USGS 2017; ESRI 2017; Oakland 2016; Dudek 2017

DUDEK

0 487.5 975 Feet

FIGURE 6.1

Treatment Prioritization Map

Draft Vegetation Management Plan - City of Oakland, California

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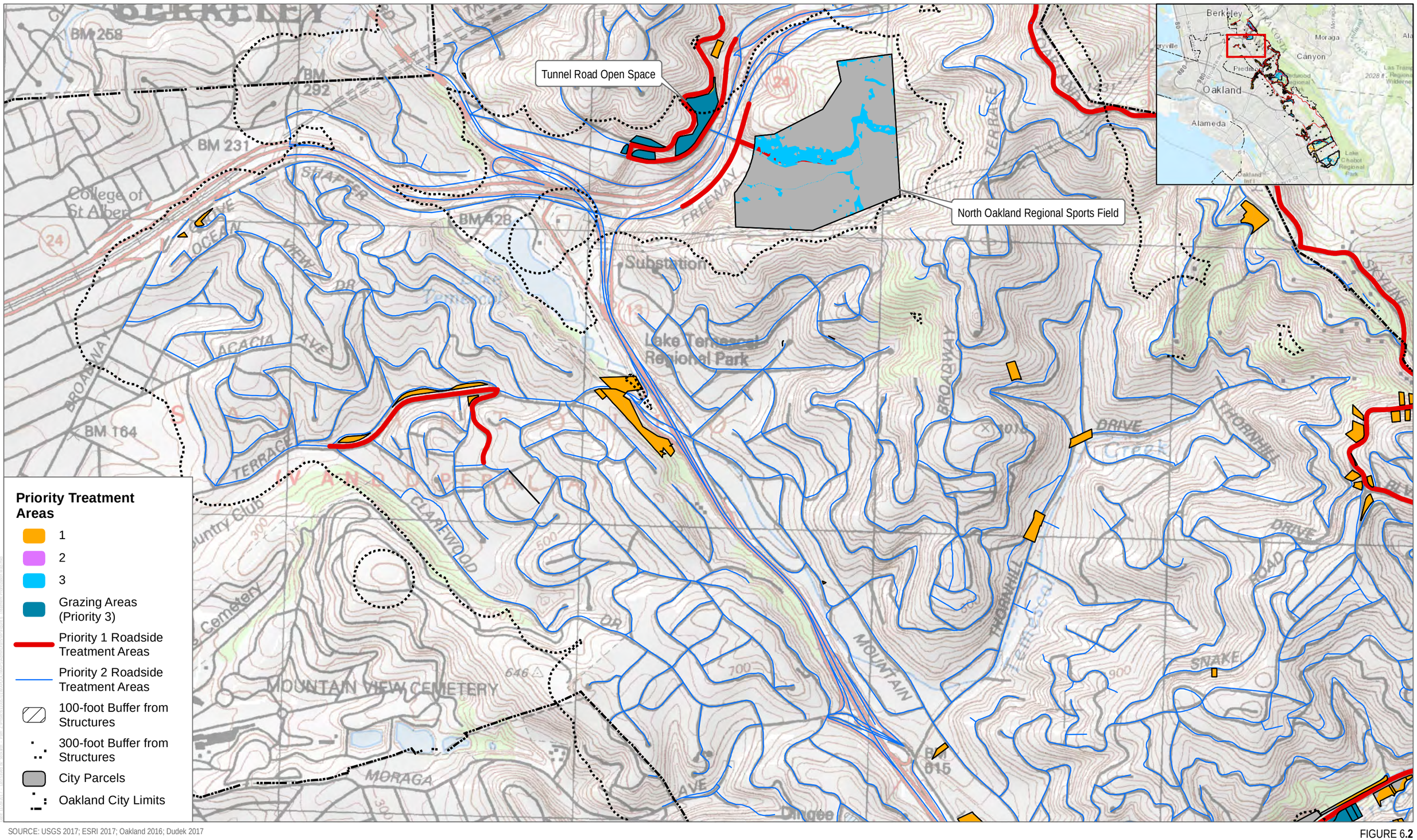

SOURCE: USGS 2017; ESRI 2017; Oakland 2016; Dudek 2017

FIGURE 6.2

Treatment Prioritization Map

Draft Vegetation Management Plan - City of Oakland, California

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North Oakland Regional Sports Field

Priority Treatment Areas

- 1
- 2
- 3
- Grazing Areas (Priority 3)
- Priority 1 Roadside Treatment Areas
- Priority 2 Roadside Treatment Areas
- 100-foot Buffer from Structures
- 300-foot Buffer from Structures
- City Parcels
- Oakland City Limits

SOURCE: USGS 2017; ESRI 2017; Oakland 2016; Dudek 2017

DUDEK

0 487.5 975 Feet

FIGURE 6.3

Treatment Prioritization Map

Draft Vegetation Management Plan - City of Oakland, California

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Shepherd Canyon Park

Beaconsfield Commons

Sulphur Springs Park

Dimond Canyon Park

Joaquin Miller Park

Priority Treatment Areas

- 1
- 2
- 3
- Grazing Areas (Priority 3)
- Priority 1 Roadside Treatment Areas
- Priority 2 Roadside Treatment Areas
- 100-foot Buffer from Structures
- 300-foot Buffer from Structures
- City Parcels
- Oakland City Limits

SOURCE: USGS 2017; ESRI 2017; Oakland 2016; Dudek 2017

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0 487.5 975 Feet

FIGURE 6.4

Treatment Prioritization Map

Draft Vegetation Management Plan - City of Oakland, California

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Priority Treatment Areas

- 1
- 2
- 3
- Grazing Areas (Priority 3)
- Priority 1 Roadside Treatment Areas
- Priority 2 Roadside Treatment Areas
- 100-foot Buffer from Structures
- 300-foot Buffer from Structures
- City Parcels
- Oakland City Limits

SOURCE: USGS 2017; ESRI 2017; Oakland 2016; Dudek 2017

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FIGURE 6.5

Treatment Prioritization Map

Draft Vegetation Management Plan - City of Oakland, California

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Joaquin Miller Park

Leona Heights Park

Holy Names College

Redwood

REGIONAL

Priority Treatment Areas

- 1
- 2
- 3
- Grazing Areas (Priority 3)
- Priority 1 Roadside Treatment Areas
- Priority 2 Roadside Treatment Areas
- 100-foot Buffer from Structures
- 300-foot Buffer from Structures
- City Parcels
- Oakland City Limits

SOURCE: USGS 2017; ESRI 2017; Oakland 2016; Dudek 2017

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FIGURE 6.6

Treatment Prioritization Map

Draft Vegetation Management Plan - City of Oakland, California

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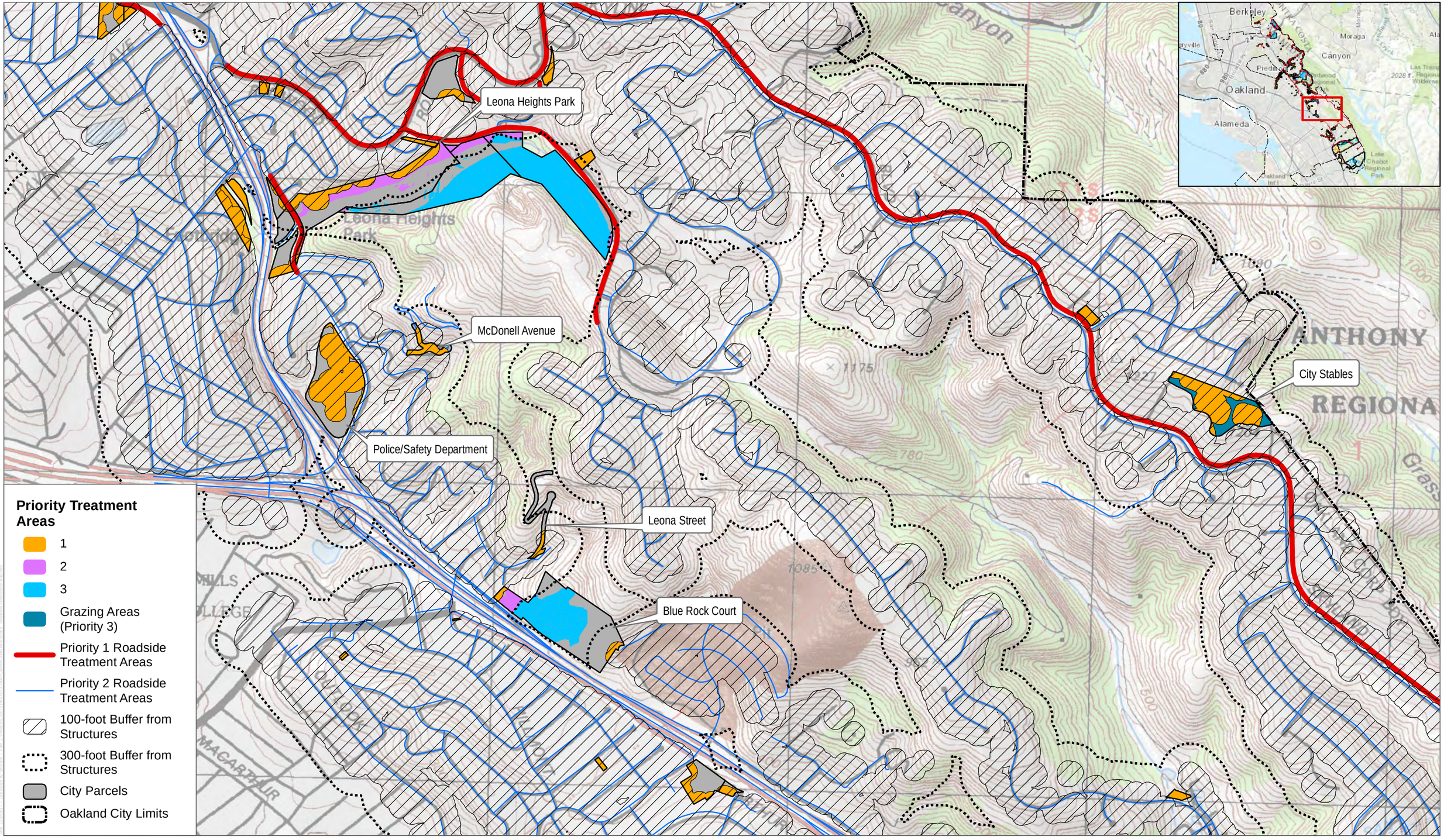

SOURCE: USGS 2017; ESRI 2017; Oakland 2016; Dudek 2017

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FIGURE 6.7

Treatment Prioritization Map

Draft Vegetation Management Plan - City of Oakland, California

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Blue Rock Court

King Estates

King Estates

Priority Treatment Areas

- 1
- 2
- 3
- Grazing Areas (Priority 3)
- Priority 1 Roadside Treatment Areas
- Priority 2 Roadside Treatment Areas
- 100-foot Buffer from Structures
- 300-foot Buffer from Structures
- City Parcels
- Oakland City Limits

SOURCE: USGS 2017; ESRI 2017; Oakland 2016; Dudek 2017

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0 487.5 975 Feet

FIGURE 6.8

Treatment Prioritization Map

Draft Vegetation Management Plan - City of Oakland, California

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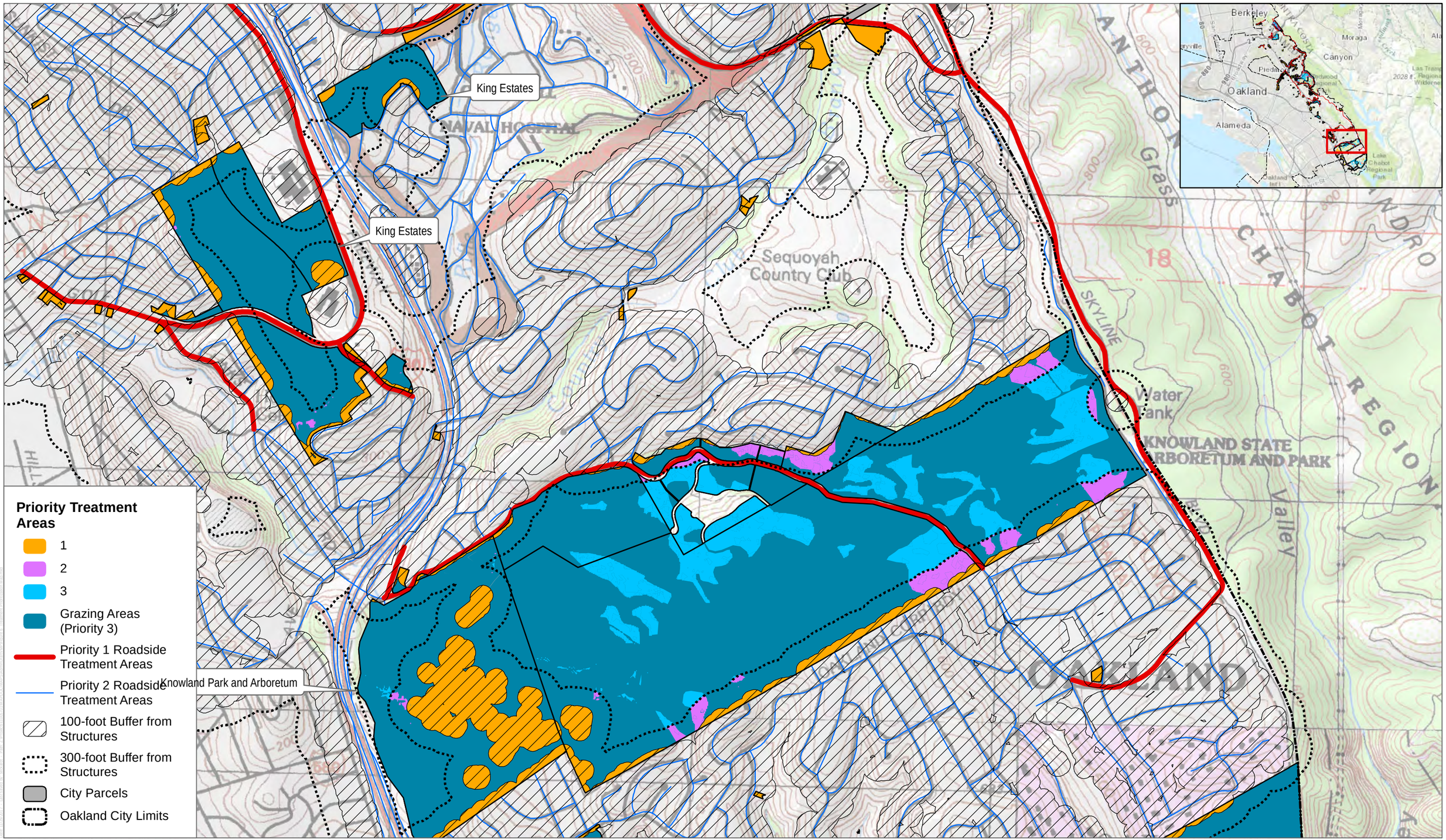

SOURCE: USGS 2017; ESRI 2017; Oakland 2016; Dudek 2017

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FIGURE 6.9

Treatment Prioritization Map

Draft Vegetation Management Plan - City of Oakland, California

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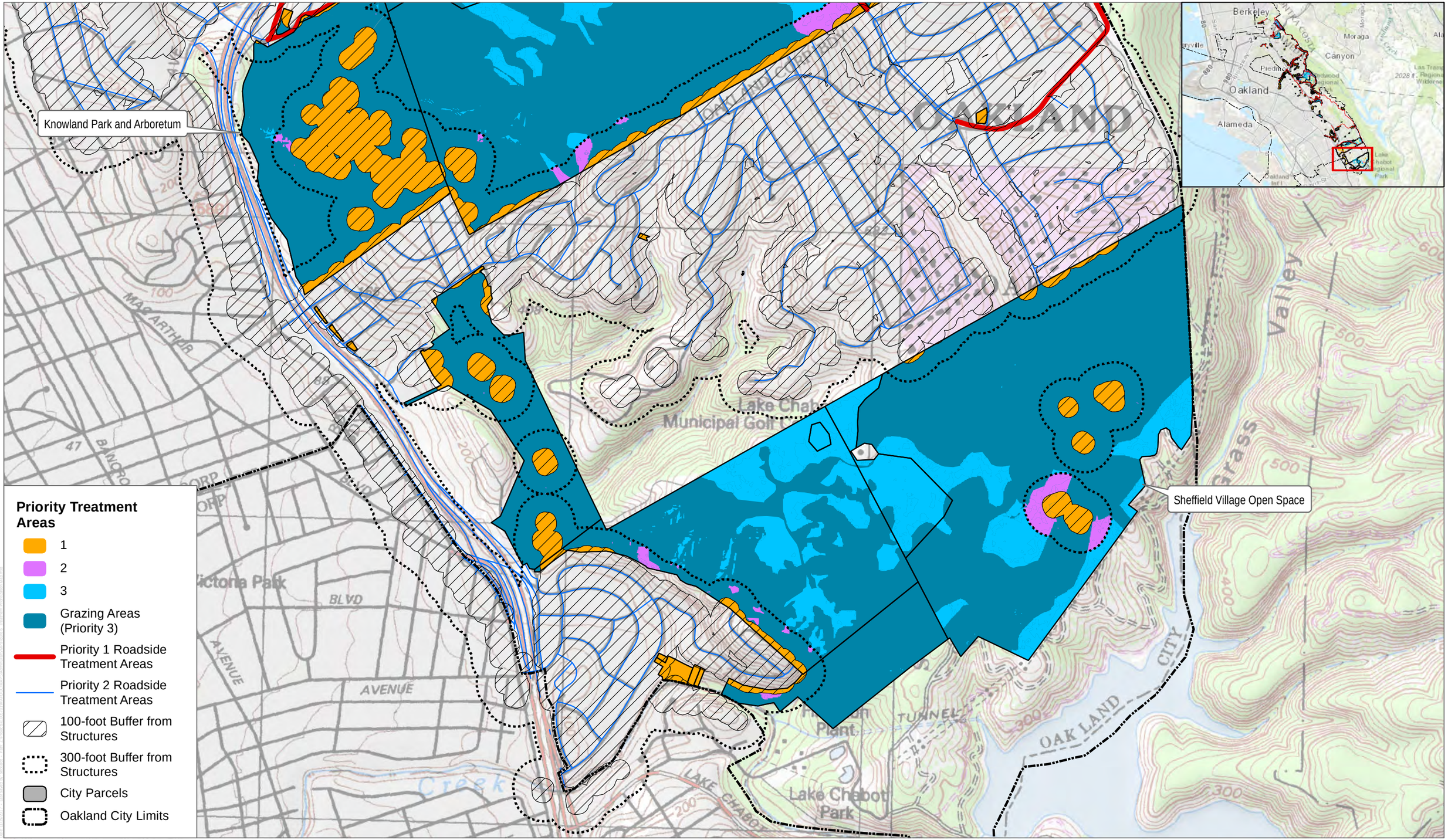

SOURCE: USGS 2017; ESRI 2017; Oakland 2016; Dudek 2017

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FIGURE 6.**10**

Treatment Prioritization Map

Draft Vegetation Management Plan - City of Oakland, California

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9.3.5 Annual Work Plan Development

OFD will prepare annual vegetation management work plans based on the site-specific conditions observed during field inspections. The work plans will identify vegetation treatment types, area or properties to be treated, implementation timing, resource needs and availability, funding sources, and monitoring and tracking needs. This process will also involve preparing bid specifications, advertising bids, and evaluating and selecting qualified contractors, as necessary. OFD will coordinate with other City department and other agencies or landowners, as appropriate, during annual work plan development.

This VMP includes an adaptive management component; therefore, the annual work plan is intended to be an internal, working document that may be modified throughout the year. Modifications to the annual work plan may be necessary due to various factors, including field conditions, weather, vegetation growth, contractor or crew completion rates, staff and resource availability, permit acquisition needs, and emergency conditions, among others.

9.4 Partners in Fire Prevention

The vegetation management actions identified in this VMP serve to address fire hazard in the Plan Area and contribute to regional efforts to mitigate wildfire hazard in the City's VHFHSZ and the Oakland Hills. OFD has a history of maintaining relationships and partnerships with other landowners and land managers that routinely treat vegetation for fire hazard reduction purposes and with community groups that seek to address fire hazard conditions in the Oakland Hills. In some cases, City property abuts land managed for fuel reduction purposes such that cohesive fuel breaks can be maintained. Advantages of such relationships and partnerships include:

- Information and data sharing;
- Resource sharing;
- Coordination of management activities;
- Facilitating property access;
- Grant funding and cost-sharing opportunities.

OFD routinely coordinates with the City's Parks, Recreation and Youth Development Department; Public Works Department; and with the following landowners or land managers: EBRPD, EBMUD, the California Department of Transportation, Pacific Gas and Electric, Contra Costa County Fire Protection District, and the University of California, Berkeley. OFD also

engages with local community groups focused on fire hazard reduction, including the Hills Emergency Forum and the Oakland Firesafe Council. This VMP recognizes that such coordination is an important component in addressing regional fire hazard conditions and recommends that coordination be continued over the course of the plan timeframe.

10 PRACTICES TO AVOID/MINIMIZE IMPACTS

In addition to the BMPs identified for the vegetation management techniques identified in this VMP, this section outlines additional practices intended to avoid or minimize potential impacts associated with vegetation treatment or removal. BMPs for general operations, vegetation management, and protection of biological resources are also provided in Appendix H.

10.1 Stormwater/Erosion Control

The vegetation treatment techniques identified in this VMP have the potential to affect soil stability. Soil stability may be indirectly affected by the removal of overstory vegetative cover, which reduces rainfall interception and thereby increases its surface erosion potential. This may result in the detachment and transportation of soil particles across the soil surface. Soil stability may also be directly affected by through the use of heavy equipment, tools, hand crews, or livestock, all of which can loosen, dislodge, or compact soils. This too can increase the potential for detachment and transportation of soil particles across the soil surface.

A procedure has been developed by the California State Board of Forestry (California State Board of Forestry 1990) to estimate a surface soil erosion hazard rating that considers soil characteristics (texture, depth to restrictive layer, percent of coarse surface fragments), slope, vegetative cover, and precipitation. The hazard rating is designed to evaluate the susceptibility of the soil within a given location to erosion. This rating should be determined and considered on a site-specific basis when determining the needs for erosion control BMPs in the Plan Area.

BMP Practices and Devices

There are various erosion control practices and devices available for slowing the rate of erosion. Recent research indicates that mechanical rehabilitation treatments, including straw mulch, hay bales, and jute rolls are more predictable for reducing soil erosion and post-fire hydrological problems than seeding or other treatments (Robichaud et al. 2010). Mulching may introduce exotic/invasive species seeds (Kruse et al. 2004) if brought in from off site (as opposed to chipped on-site material), so erosion potential should be high before the decision to use this material is finalized.

Numerous BMPs have been developed for use in erosion and sediment control, as identified by the Clean Water Program Alameda County (2009) which provides copies of the *California Stormwater BMP Handbook* (originally published by the California Stormwater Quality Association). This handbook presents detailed information regarding the implementation, maintenance, suitability, and limitations of different BMPs. The need for BMPs should be determined during annual work plan development or during subsequent monitoring efforts and

should consider erosion hazard rating and/or the history of on-site erosion. Table 11 identifies the different BMP types for erosion and sediment control, as provided by the Clean Water Program Alameda County (2009). Detailed information can be found at the following address:

https://www.cleanwaterprogram.org/business/construction2/item/construction-issues.html

Table 11
Erosion and Sediment Control BMPs

Erosion Control		Sediment Control	
Hydraulic Mulch	Velocity Dissipation Devices	Silt Fence	Sandbag Barrier
Hydroseeding	Slope Drains	Sediment Basin	Straw Bale Barrier
Soil Binders	Streambank Stabilization	Sediment Trap	Storm Drain Inlet Protection
Straw Mulch	Compost Blankets	Check Dam	Active Treatment Systems
Geotextiles and Mats	Soil Roughening	Fiber Rolls	Temp Silt Dike
Wood Mulching	Non-vegetation Stabilization	Gravel Bag Berm	Compost Socks and Berms
Earth Dikes and Drainage Swales		Street Sweeping and Vacuuming	Biofilter Bags

Source: 2017 California Forest Practice Rules (14 CCR, Chapters 4, 4.5, and 10).

In the event that a wildfire event occurs in the Plan Area, stabilization of soils in the burn area is a primary concern, especially in areas with steep slope gradients. Erosion control BMPs should be installed as soon as possible and prior to the onset of the winter period (November 15 to April 1).

Access Roads

In areas where existing dirt access roads will be retained, waterbreaks[7] and drainage structures should be constructed to minimize erosion potential. All waterbreaks and drainage structures should be installed no later than the beginning of the winter period (November 15 to April 1). Outside the winter period, waterbreaks and drainage structures should be installed prior to sunset if the National Weather Service forecast is a "chance" (30% or more) of rain within the next 24 hours. Waterbreaks should be constructed immediately upon conclusion of use of access roads which do not have permanent and adequate drainage structures. Distances between waterbreaks should adhere to the standards outlined in Table 12. Access roads should be closed to public vehicle travel following completion of vegetation treatment operations.

[7] A waterbreak (or waterbar) is a shallow trench with a parallel berm or ridge on the downslope side, angled downward across a road and installed to control surface runoff.

Table 12
Maximum Distance between Waterbreaks

Estimated Erosion Hazard Rating	Road Slope Gradient (percent)			
	≤10	*11–25*	*26–50*	*>50*
Extreme	100	75	50	50
High	150	100	75	50
Moderate	200	150	100	75
Low	300	200	150	100

Source: 2017 California Forest Practice Rules (14 CCR, Chapters 4, 4.5, and 10).

10.2 Watercourses

The purpose and intent of the City of Oakland's Creek Protection Ordinance (Oakland Municipal Code Chapter 13.16) is:

- Safeguarding and preserving creeks and riparian corridors in a natural state;
- Preserving and enhancing creekside vegetation and wildlife;
- Preventing activities that would contribute significantly to flooding, erosion or sedimentation, or that would destroy riparian areas or would inhibit their restoration;
- Enhancing recreational and beneficial uses of creeks;
- Controlling erosion and sedimentation;
- Protecting drainage facilities; and
- Protecting the public health and safety, and public and private property.

The ordinance includes permitting guidelines for development and construction projects taking place in or near creeks. This includes the clearing of vegetation for wildfire hazard reduction purposes. Vegetation management activities occurring within a creek protection zone (within 20 feet of the top of creek bank) would require a Creek Protection Permit. The intent is to assure that work done will avoid or limit, to the extent feasible, negative impacts to creeks. The primary measure to minimize impacts to creeks and other water courses in the Plan Area is avoidance, meaning all work should be conducted outside of the creek protection zone. Should it be necessary to conduct vegetation management activities within the creek protection zone, OFD shall obtain a Creek Protection Permit, as outlined in Oakland Municipal Code Chapter 13.16.

10.3 Revegetation

Revegetation of areas subject to vegetation treatment or removal can minimize the potential for erosion by stabilizing soils. Revegetation is recommended only in areas where disturbed and/or bare soil exists following vegetation management operations as a measure to stabilize soils. The need for revegetation should be determined during annual work plan development or during subsequent monitoring efforts and should consider slope, soil type, access, irrigation and maintenance needs, and other BMPs being implemented on site. OFD should consult with qualified professionals (e.g., landscape architects, revegetation specialists) to develop site-specific revegetation plans, as appropriate. Revegetation may include hydroseeding (as presented in Section 10.1), direct seeding, or container plant installation. Plant species selection should be consistent with revegetation goals and should consider erosion protection value (e.g., deep-rooted species). Pyrophytic species should not be used for revegetation purposes.

10.4 Special-status Plant Communities/Species

The OFD's Draft Protected and Endangered Species Policy and Procedures document (Appendix I) establishes a uniform procedure for the protection of endangered or threated species of flora while conducting vegetation management activities in the Plan Area. The Draft document (Appendix I) outlines policies to ensure that endangered plant species are protected during vegetation management activities, which shall, to the extent possible and/or if resources and emergencies allow, be followed during implementation of this VMP. These policies include requirements for contracting with qualified biological consultants to identify locations where such species exist, flagging avoidance areas, notifying contractors of avoidance areas during the contact bid phase, modifying vegetation treatment timing to promote seeding, obtaining agency permits, communicating with other City departments regarding vegetation management activities, and requiring that contractors do not impact or disturb areas designated for preservation.

10.5 Special-Status Wildlife Species

The vegetation management activities identified in this VMP have the potential to impact special-status wildlife via ground disturbance, vegetation removal or treatment, the use of vegetation management tools and equipment, or by increasing human presence within or adjacent to treatment areas. The special-status wildlife species with the potential to occur in the Plan Area are presented in Section 7.1.3. In order to minimize the potential for impacts to special-status wildlife species, the specific measures identified in Appendix H should be implemented, depending on wildlife species present in the identified treatment area. In general, these measures include conducting preconstruction biological surveys, identifying and marking avoidance or buffer areas, conducting

biological monitoring during vegetation management operations, and establishing work windows to avoid and minimize adverse effects on nesting birds and special-status plants and animals. In order to facilitate implementation of the special-status wildlife species avoidance measures, OFD should contract with qualified biological consultants.

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11 PLAN IMPLEMENTATION

The following sections outline the methods for implementing the vegetation management recommendations included in this plan over the 10-year plan timeframe.

11.1 Roles and Responsibilities

OFD, or its designee, will be responsible for implementing this VMP and will be responsible for the following:

- Assessing field conditions on a routine basis to determine the need for vegetation management action implementation;
- Developing annual work plans and budgets;
- Prioritizing vegetation treatment actions and areas based on field observations;
- Screening, selecting, and hiring contractors, or directing City personnel, to conduct identified vegetation management actions;
- Monitoring vegetation management actions during operations to ensure that avoidance measures and BMPs are being properly implemented; and
- Monitoring treated properties following vegetation management actions to ensure that treatment standards have been achieved.

11.2 Planning and Scheduling

Planning and scheduling of vegetation management activities is anticipated to be an ongoing process conducted throughout most of the calendar year and based on the results of field assessments conducted by OFD staff. Most planning and scheduling efforts will be conducted in the winter or spring months for work to be conducted in the upcoming spring and summer months, although such efforts may occur at different times during the year, depending on the need for additional, increased, or follow-up vegetation management activities. Concurrent planning and scheduling of different vegetation management activities on different properties is also anticipated, as some activities (e.g., prescribed fire) may necessitate a longer planning and scheduling period than others. Planning and scheduling activities will also consider site treatment timing priorities and constraints, available resources, and efficient progression of treatment activities across properties. Planning and scheduling activities will include preparation of bid specifications and bid packages, contractor screening, selection, and hiring, and developing direction for City personnel, where applicable.

11.3 Monitoring and Reporting

OFD routinely patrols and monitors the Plan Area to inspect vegetation conditions and monitor the progress of treatment activities. Monitoring in the spring months is intended to inform the annual work plan development process. Monitoring not directly associated with annual work plan development should be routinely conducted for the following purposes:

- Monitoring vegetation management activities during operations to ensure that avoidance measures and BMPs are being properly implemented;
- Monitoring treated properties following vegetation management activities to ensure that treatment standards have been achieved;
- Monitoring treated properties to determine the need for follow-up treatment actions;
- Monitoring treated properties to determine the need for post-operations BMPs; and
- Monitoring to document the success of vegetation treatment activities and identify needs for adjustments to vegetation treatment activities or standards.

OFD shall prepare an annual report summarizing the results of monitoring efforts, quantifying the number of parcels or acreage treated, documenting annual expenditures associated with VMP implementation, identifying any additional resource needs, and summarizing any pertinent issues identified and addressed during VMP implementation. Based on the results of monitoring efforts, the annual report shall identify any proposed future changes to vegetation treatment activities conducted in the Plan Area. The annual report shall be submitted to the Oakland City Council for review and comment.

11.4 Adaptive Management

Adaptive management is an iterative process of implementation, monitoring, and adjustment of management actions based on monitoring results (McEachern et al. 2007). The critical component of the adaptive management process for this VMP is the monitoring effort described in the previous section. The results of monitoring efforts conducted in support of this VMP will be used to determine which vegetation management activities or techniques are effective or ineffective; if there is a need to change or modify treatment techniques; if there is a need to adjust the timing, duration, or priority of vegetation treatments on a specific property or within the Plan Area; if additional avoidance/minimization measures or BMPs need to be employed; or if there needs to be changes to avoidance/minimization measures or BMPs to reduce potential adverse effects of vegetation management on sensitive biological resources, water resources, aesthetics, soils, and slope stability. Monitoring will also allow for consideration of other factors

occurring outside the parameters of this VMP (e.g., creation of a fuel break by a neighboring property owner) that may have an effect on vegetation management planning or implementation.

OFD will document the results of monitoring efforts, as described in the previous section, noting recommended changes to vegetation management activities or actions associated with avoidance/minimization measures or BMPs. This documentation will then be used by OFD during subsequent planning and scheduling efforts with recommended changes incorporated into the annual work plan.

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12 LIST OF PREPARERS

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This document was also reviewed by environmental scientists at Horizon Water and Environment and fire professionals and managers at the City of Oakland.

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