WILDLAND VEGETATIVE FUEL MANAGEMENT PLAN

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1. EXECUTIVE SUMMARY

The Wildland Vegetative Fuel Management Plan (WVFMP or Plan) proposes treatments of vegetation and associated fuels within the 800-acre UC Berkeley Hill Campus (Plan Area or Hill Campus) to improve public safety and reduce losses/damage from wildland fire.

This Plan describes the wildland fire management objectives, provides context to regional planning by highlighting partnerships, and highlights both past and current vegetation treatments and the regional planning context in terms of partnerships and both past and current vegetation treatments.

The WVFMP then characterizes existing conditions, focusing on wildland fire aspects that influence both wildfire threats, response, and potential management, such as fire history, hazard ratings, access, topography, water resources, plant and wildlife resources, and vegetative fuel models. A detailed fire behavior analysis is presented that predicts flame lengths, fire spread rates, potential for crown fire, and spot fire distribution.

Vegetation treatments are proposed that address the existing conditions and are categorized as Evacuation Support Treatments, Fire Reduction Treatments, Fuel Break Treatments, and Creation of Roadside Temporary Refuge Areas. Each vegetation treatment type achieves different goals and objectives.

Treatments are conducted through a variety of activities, which are described in the Plan. These activities include manual vegetation treatment, mechanical vegetation treatment, prescribed burning, managed herbivory (livestock grazing), herbicide application, and biomass utilization and disposal. Any of the activities could be used singularly or in combination to implement any of the goals of the treatment types. Proposed projects have been designed and are described herein, including the location, goal, and vegetation treatment activity(ies) of each project.

A set of best practices and environmental protection measures are included in this Plan, along with a list of permits and approvals that could be required. A program that ensures ongoing maintenance, monitoring, and adaptation is also included.

The Plan will be reviewed by the UC Berkeley Fire Mitigation Committee. The Chancellor is the UC Berkeley decision-making body with discretionary authority to approve the Plan.

2. OVERVIEW OF THE PLAN

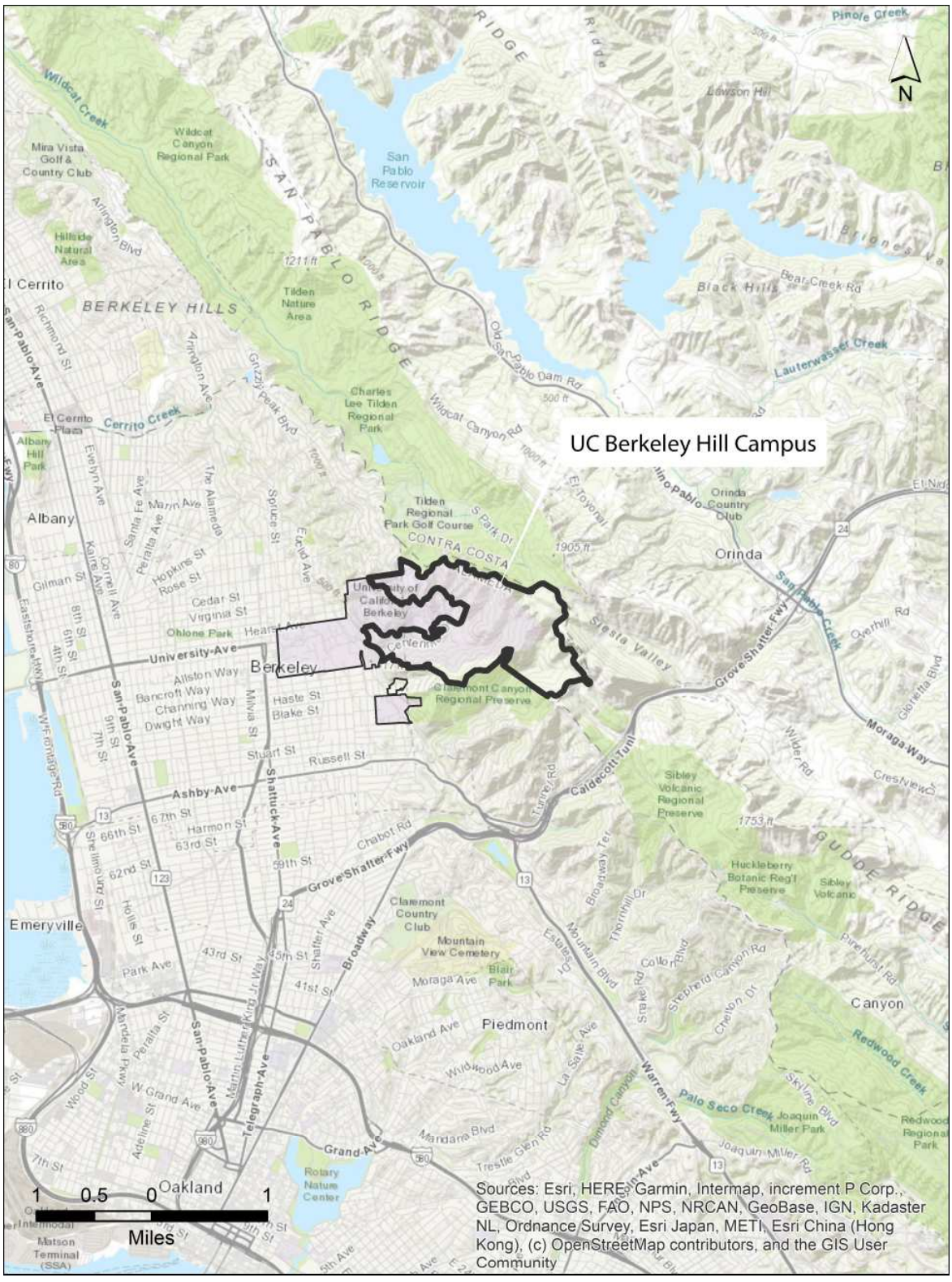
The Wildland Vegetative Fuel Management Plan (WVFMP or Plan) for the UC Berkeley Hill Campus (Plan Area or Hill Campus) is proposed by the University of California, Berkeley (UC Berkeley) to treat vegetative fuels within the Plan Area. The WVFMP covers vegetation management to improve public safety and reduce potential impacts of a wildland fire. The Plan serves as one component of UC Berkeley's range of actions to reduce wildfire risk and minimize the potential for harmful effects of wildfire on people, property, and natural resources within the 800-acre Plan Area, as shown in Figure 1. As part of the Plan, UC Berkeley would implement vegetation treatment activities on approximately 300 acres annually within the Plan Area.

The Plan will be reviewed by the UC Berkeley Fire Mitigation Committee, an interdepartmental body comprising UC Berkeley staff and faculty. The Chancellor is the UC Berkeley decision-making body with discretionary authority to approve the Plan.

The WVFMP presents a multifaceted approach to vegetation treatment. The Plan includes different vegetation treatment types, each achieving different goals and objectives. The vegetation treatment types are fire hazard reduction, evacuation support, temporary refuge areas, and fuel breaks. The Plan also describes vegetation treatment activities that would be implemented to achieve the goals of each treatment type. The vegetation treatment activities are manual treatment, mechanical treatment, prescribed burning, prescribed herbivory (livestock grazing), and targeted ground application of herbicides. Any of the activities could be used singularly or in combination to implement any of the goals of the treatment types. Proposed projects have been designed and are described herein, including the location, goal, and vegetation treatment activity(ies) of each project.

The WVFMP does not include other aspects of fire management, such as ignition detection (including installation of cameras or increased roving patrol), a program to enhance fire suppression capabilities (emergency response), nor the placement of water tanks in remote areas of the Hill Campus. This Plan focuses on fuel management through vegetation treatment only.

A fuel management plan focuses on vegetation management to alter fire behavior – potentially to decrease ignitability, reduce fire intensity and heat output so that fires can be contained and suppressed more easily, resulting in smaller, and less damaging wildfires. In contrast, a wildfire management plan typically includes all aspects of wildland fire management, including ignition detection, reporting (i.e., communications), response (encompassing water supply, designated authorities, communications), and post-fire recovery. A wildfire management plan is typically a large document that includes a detailed fire prevention plan that encompasses patrols, education and public outreach, property closure triggers, and operations plan. A wildfire management plan also includes details on wildfire response, such as hydrant locations, engine response times, landowner responsibilities during a wildfire (including evacuation support), and post-wildfire actions including maintenance.



Vicinity Map UC Berkeley Hill Campus Wildland Fuel Management Plan

Figure 1. Map of the Hill Campus vicinity

2.1 PLAN OBJECTIVES

The objectives of the Plan guide its implementation and will help UC Berkeley to plan, budget for, execute, and monitor the results of its actions. The objectives of the Plan are to:

- Increase the Plan Area's resistance to catastrophic wildfire to reduce the potential for loss of human life and property damage from wildfire.
- Provide a range of vegetation treatment and maintenance activities in a manner that mitigates adverse environmental effects.
- Thin vegetation to reduce the likelihood in a wildfire event of ember production starting new fires (known as ember cast).
- Increase the pace and scale of vegetation treatment and maintenance activities to reduce the overall fuel volume available to burn, thereby increasing the probability of containment of a future fire.
- Manage highly flammable invasive plant species and promote fire-resistant native plant species to reduce wildfire risks and enhance biodiversity.
- Maintain the visual character of the Plan Area for recreational users and neighboring communities.
- Enable UC Berkeley staff to make informed and adaptive management decisions that are cost-effective and environmentally sustainable.
- Maintain an active role in regional efforts to reduce wildfire hazard in the East Bay hills.

2.2 REGIONAL WILDFIRE RISK REDUCTION PLANNING

The Plan is consistent with local and state codes and ordinances that pertain to wildfire risk reduction. More than twenty reports and plans address wildfire hazard in the Oakland/Berkeley Hills, and the Plan is consistent with or considers information in the following campus, regional, and statewide vegetative fuel management documents:

- **UC Berkeley, *2020 Long Range Development Plan* (2005)** – includes policies to manage vegetation in the Plan Area to reduce fuel load focusing on high-hazard introduced species.

- **CAL FIRE Santa Clara Unit Plan, *Strategic Fire Plan* (2018)** – identifies the 16,200 acre Oakland-Berkeley Hills as a Priority Area, and specifically mentions the 1991 Oakland Tunnel Fire, which destroyed 3,000 homes for a loss of 1.8 billion dollars, and identifies the "Berkeley upper Strawberry Canyon fuel reduction project" as a priority vegetation reduction project in Claremont Canyon; the Plan Area encompasses both canyons.

- **CAL FIRE, *California Strategic Fire Plan* (2018)** – provides a roadmap for reducing the risk of wildfire in the state by focusing on fire prevention and suppression activities and natural resource management to maintain the state's forests as resilient.

- ***2018 State of California State Hazard Mitigation Plan*** – represents the state's primary hazard mitigation guidance document that includes discussions on wildfire and structural fire hazards and provides a mitigation plan for an effective wildfire suppression plan.

- ***Alameda County Community Wildfire Protection Plan* (2015)** – provides a comprehensive analysis of wildfire hazards and risks, and identifies proposed projects to reduce the risk of wildfire in the wildland-urban interface areas of Alameda County. The Plan prioritizes vegetation treatment projects in the Plan Area.

- **East Bay Regional Park District, *Wildfire Hazard Reduction and Resource Management Plan* (2009)** – identifies a framework for undertaking ongoing vegetation management activities on park lands in the East Bay hills in Alameda and Contra Costa counties adjacent to the Plan Area.

- **East Bay Municipal Utility District, *East Bay Watershed Fire Management Plan* (2000)** – guides the implementation of fire protection and preparedness activities that meet key watershed management objectives adjacent to the Plan Area.

- **Lawrence Berkeley National Laboratory, *Federal Wildland Fire Management Plan* (2015) –** provides a comprehensive wildland fire management plan to be implemented by LBNL on LBNL-managed property in the Hill Campus.

- **City of Oakland**, ***Draft Vegetation Management Plan* (2019) –** includes a framework for managing fuel loads and high hazard vegetation management activities to reduce fired hazard on approximately 1,300 acres within the City of Oakland, including Claremont Avenue and Garber Park, located immediately south of the Plan Area.

- **City of Berkeley Wildfire Evacuation Plan (Draft) (2019)** – The City of Berkeley's Fire and Rescue Department recognizes the threat wildfire poses to its approximately two thousand residents in neighborhoods north and south of the Plan Area and establishes a High Fire Hazard District. Centennial Drive has been identified as one of only three evacuation routes in its newly revised evacuation plan.

2.3 PARTNERSHIPS

The proposed treatments included in this Plan are part of a regional effort to remove high hazard fuels and reduce risks from wildfires in high hazard areas by installing and maintaining major ridgetop fuel breaks and improve public safety within evacuation corridors for the communities of Oakland, Berkeley, and other East Bay municipalities. UC Berkeley works closely with internal and external fire management partnerships which have assisted in the development of the Plan, including Hills Emergency Forum (HEF), Diablo Firesafe Council, and various neighborhood groups, along with internal interdisciplinary planning teams. HEF has partnered with UC Berkeley as a technical advisor of the Plan; Diablo Firesafe Council has partnered with UC Berkeley for community outreach and liaison; and the Alameda County Resource Conservation Service for oak planting coordination. UC Berkeley maintains the following partnerships:

- **Hills Emergency Forum (HEF):** UC Berkeley participates regularly in HEF, an inter-agency organization of nine partner agencies in the East Bay hills aimed at regional wildfire prevention and protection. The nine members coordinate collection, assessment and sharing of information on East Bay hills fire hazards, and HEF provides a forum for building interagency consensus on developing fire safety standards and codes, incident response and management protocols, public education programs, multi-jurisdictional training, and vegetation reduction strategies.

- **Diablo Firesafe Council**: UC Berkeley supports and collaborates with the Diablo Firesafe Council, a non-profit organization that provides resources to coordinate public and private landowners in Alameda and Contra Costa counties to reduce the threat of wildfire. UC Berkeley staff has attended and participated in its Partners in Prevention event and will continue to do so. UC Berkeley also supports the local Diablo Firesafe Council in the development and implementation of the Alameda County Community Wildfire Protection Plan (2015).

- **Special Districts**: Open Space lands owned and managed by the **East Bay Municipal Utility District (EBMUD)** and **East Bay Regional Park District (EBRPD)** lie immediately to the east and south of the Plan Area. EBMUD owns and manages land and waterbodies and is responsible for management surrounding nearby reservoirs. EBRPD owns and manages Tilden Regional Park to the east and Claremont Canyon Regional Preserve to the south of the Plan Area. Both agencies continue to implement vegetation management activities on its open space lands. UC Berkeley and these special district partners actively manage open spaces by installing and maintaining regional ridgeline fuel breaks that increase fire safety for landowners.

- **Pacific Gas & Electric (PG&E):** PG&E provides electricity to UC Berkeley (and LBNL) from a substation in the Plan Area, and the Plan Area encompasses right-of-way for overhead transmission lines. UC Berkeley collaborates with PG&E to treat vegetation in the Hill Campus along PG&E's electric transmission line right-of-way to increase power reliability and reduce ignition potential, and resulting wildland fire hazard.

- **Lawrence Berkeley National Lab (LBNL):** UC Berkeley partners with LBNL to actively install and maintain regional ridgeline fuel breaks. LBNL manages its property to ensure safety for its facilities and employees. In addition, since 1996, LBNL has maintained about 75 acres of UC Berkeley property in the Hill Campus for fire safety, consistent with its LRDP, under a Letter of Cooperation.

- **Cities**: The **cities of Oakland and Berkeley** inspect homes for defensible space compliance where they are adjacent to the Plan Area and cooperatively maintain road rights-of-way on routes abutting the Plan Area. UC Berkeley and the cities of Oakland and Berkeley participate in inspection and maintenance of defensible space on UC Berkeley land (including within the Plan area) and adjacent private and public properties.

2.4 PAST AND ONGOING VEGETATION TREATMENTS

2.4.1 HISTORY OF FIRE AND FUEL MANAGEMENT PLANNING IN THE HILL CAMPUS

The first known recommendations for fire management planning in the UC Hill Campus were recorded seven days after the Berkeley Fire in 1923. Nelson et al (1923) reported that this fire not only devastated a portion of the residential section, but also spread along the Berkeley Hills south to Tunnel Road in less than four hours. The group recommended the eucalyptus and pine trees killed by fire be piled and burned, or utilized for firewood. They recommended the forested areas which were burned be planted with fire resistant species, such as Redwood, to provide greater shade. The group also recommended increased education, prevention, detection and suppression activities.

A Study of the Long Term Use Potential of Strawberry Canyon and the Undeveloped Hill Lands (chaired by Robert L. Cockrell) recommended in 1958 that access be improved on the north facing slope and that water supplies (mains and hydrants) be established along major roads traversing the south and head of the canyon (Cockrell, 1958).

Dr. Harold Biswell prepared a thorough report in 1974 of "The Wildfire Problem and Management Plan for the Reduction of Fire Hazards in the Hill Area of the University Campus." He advocated controlled broadcast burning under the coniferous stands, in the briars, as well as in the grassland and chaparral. Additionally, Dr. Biswell recommended the eradication of eucalyptus sprouts and French broom. Lastly, he suggested more coast live oak be planted in lieu of the north coastal scrub on the north facing slopes of Strawberry Canyon, and in other locations (Biswell, 1974).

Garret Eckbo and Associates included fuel management recommendations as part of a campus-specific Vegetation Plan in "A Land Use and Vegetation Management Study" (1976). This study classified existing vegetation units. Desired vegetation was stated for each unit, and fuel management prescriptions were specified. This study called for conversion of a major portion of eucalyptus sprouts to grass, greatly increased conifer plantations, and oak/bay woodland. The fuel management techniques that were often suggested were to pile and burn large diameter fuels every 25 years, broadcast burning at 10 or 25 year intervals, hand clearing, piling and burning soft chaparral, and cutting sprouts (then two years old) then treating with the chemical 2,4,D, which is also known as 2,4-Dichlorophenoxyacetic acid. The study also recommended the use of goats and cattle to clear brush and maintain grassland.

As a start of implementing the Garrett Eckbo report, Mark Hamlin, a contractor who prepared a report for UC Berkeley's Office of Environment, Health & Safety, recommended the creation of a fuel break in the conifers and brush north of Panoramic Hill. Reduction of fuels was to be accomplished using controlled broadcast burns.

The UC Berkeley Committee on Conservation and Environmental Quality submitted in 1978 a "Proposed Management Plan for Strawberry and Claremont Canyons" (McBride, 1978). This committee recommended that a fuel management zone 100 feet wide be established on UC boundaries where they are adjacent to residential property. The density of shrubs and trees were to be reduced in this strip, trees limbed, and mulch burned on a periodic basis. An experimental forest was proposed for the Claremont Canyon area.

A UC Berkeley/EBRPD Joint Agency Fuel Management Plan for the Dwight Derby Site/Berkeley Open Space Regional Park was issued in 1983 where the area behind the Clark Kerr Campus and at the base of Panoramic Hill was to be managed with hand crews, goats and broadcast burning to reduce the fire hazard in the area. In 1984, the Hill Area Task Force recommended vegetation management activities in limited areas of the Hill Campus. The group recommended that eucalyptus sprouts be removed. The establishment of a 100-foot wide buffer zone along UC/private property boundaries was proposed to reduce fire hazard. The Task Force endorsed clearing, pruning and prescribed burning to maintain discontinuous fuel distribution in the buffer zone. Roadsides were to be mowed each spring.

A 1986 Plan by C.L. Rice and R. Aronson proposed a suite of treatments in all vegetation types throughout the Hill Campus (Rice and Aronson, 1986). Eucalyptus sprouts (then 13 years old) were removed on approximately 50 acres, goats grazed 40 acres and five prescribed burns were conducted.[1] The understory of coniferous forests on the north-facing spurs below the Jordan Fire Trail were thinned. Oak trees were planted in the area south of the satellite dish, now encompassed by LBNL, and native grass seed was distributed on Chaparral Hill. The plan was implemented until 1991, just months before the Oakland Tunnel Fire.

The 2020 Hill Area Fire Fuel Management Program (2003) is currently being implemented by UC Berkeley in the Hill Campus to reduce fire risk to the campus, LBNL, neighboring residents, and recreational visitors to adjacent park and watershed lands. The program, which was prepared by Safe Solutions Group (2003), approaches fuel management by offering a broad set of priorities and decision criteria for treatments. The program prioritizes defensible space treatments both around structures and along property boundaries. The program does provide a process for larger-scale treatments, which allow for eucalyptus removal in Claremont Canyon and goat-grazing near MSRI. The program also recommends roadside and evacuation treatments that could extend to 100-feet from pavement edge, as funding allows. Ongoing vegetation management activities under this plan are largely funded and implemented by Facilities Services Department. While a baseline level of funding is provided to conduct treatments required by law, maintenance and larger treatments are undertaken as funding becomes available. This program would be replaced and superseded by this WVFMP.

2.4.2 PAST VEGETATION TREATMENTS

UC Berkeley has managed the Plan Area for fire hazard reduction for decades. The 1980s saw a combination of treatments in Strawberry Canyon that spanned prescribed burns, goat grazing, eucalyptus removal, and forest thinning with hand crews.[2] In the 2000s, efforts focused on eucalyptus removal in Claremont Canyon.[3]

More recently, UC Berkeley Facilities Services Department has planned for and undertaken regular vegetation treatment activities in the Plan Area. The vegetation treatments are reviewed and approved by the Fire Mitigation Committee, an inter-department committee headed by the Scott Stephens, Wildland Fire Science professor from the College of Natural Resources, with representation from the university's Facilities Services, Environmental Health and Safety, Lawrence Berkeley National

[1] Prescribed burns were conducted at the following locations: Lawrence Hall of Science (3 times), Botanical Garden 1988), Panoramic Hill, Tightwad Hill, Big C eucalyptus grove.
[2] Fire Prevention Committee meeting minutes, 1986-91.
[3] Fire Mitigation Committee meeting minutes 2000-2011.

Laboratory Protective Services, and UC Berkeley Police and Capital Projects departments. The treatments covered by the 2020 LRDP EIR that Facilities Services has implemented over the years in the Plan Area include:

- Remove dead trees and hazardous trees or limbs that pose an imminent public safety risk;
- Remove vegetation along 100 feet of either side of roadways and trails to maintain emergency evacuation access;
- Provide defensible space, by removing vegetation within 100 feet of all structures consistent with the California State Public Resources Code (PRC) 4291; and
- Remove vegetation along a 15-foot strip of land adjacent to roads and near property boundaries, and a 50-foot radius of designated turnouts along Grizzly Peak Boulevard and Claremont Avenue.

Typically, vegetation treatment activities carried out by Facilities Services is implemented by hand crews and hand-held tools, with occasional use of machinery to cut grass and shrubs and to chip woody material. Herbicide is applied by hand-held tools to roadside vegetation, however it is currently limited in its use. Removal of exotic plants occurs in areas previously treated. In recent years, Facilities Services has replaced hazardous Monterey pine trees with fire-resistant trees, shrubs, and grasses on an area known as Tightwad Hill. In addition, the Claremont Canyon Conservancy, UC Berkeley Forestry Club and a local non-profit, Take to The Hills, have participated in maintaining prior treatments in the Plan Area through removal of flammable exotic invasive species and planting less flammable species. The combined efforts typically exceed 500 volunteer-days annually. Additionally, UC Berkeley has participated in and will continue to participate in Wildfire Awareness events organized by the Berkeley City Council.

2.4.3 HISTORY OF EUCALYPTUS MANAGEMENT IN THE HILL CAMPUS

While certain eucalyptus stands in the Hill Campus have been actively managed, others have been neglected. Some eucalyptus stands have been treated three times through thinning, pruning, understory removal, overstory removal – often with herbicide application to the cut stumps. In some stands, trees have been cut and herbicide applied to the stumps. Most eucalyptus trees in the Hill Campus have been cut and treated with herbicide twice, whereas some small stands of eucalyptus have never been removed. In all areas of treatment tree trunks were removed.

In 1974 FEMA provided millions of dollars via a grant to create a multi-jurisdictional fuel break that covered the East Bay Hills. The fuel break project was aimed at removing eucalyptus trees that were top-killed from a freeze in 1973 and played an important role in determining current conditions of the fuels in the Hill Campus because the structure of the eucalyptus stands changed. Almost all of the eucalyptus trees that were cut resprouted, despite being treated with herbicide after cutting.

Approximately 50 acres of the then 12-15 year-old eucalyptus sprouts were cut between 1988 and 1991 in Strawberry Canyon and on top of Chaparral Hill. Again, most of the eucalyptus trees in Strawberry Canyon resprouted, despite being treated with herbicide after cutting.

UC Berkeley cut approximately 90 acres of 20-year old eucalyptus sprouts in Claremont Canyon between 2005-2006, and because of effective herbicide application did not experience any resprouting. Approximately 2 acres of 24-year old eucalyptus resprouts near signpost 18 were cut and left to sprout again.

Hazard trees throughout the Hill Campus were felled as necessary between 1974 and 2019. Most recently, hazardous trees around one building in the Field Station for the Study of Behavior, Ecology and Reproduction (FSSBER) were felled in 2019, and trees that might block evacuation and access along a swath 100-feet on both sides of Centennial Avenue, were removed in 2019-2020, as shown on Figure 5. This treatment did not target eucalyptus, however most of the trees removed were eucalyptus because they were adjacent to the road and were more likely to block access or egress.

2.4.4 ONGOING VEGETATION TREATMENTS

Using funding received by CAL FIRE California Climate Investments Forest Health Grant, Facilities Services expanded its ongoing vegetation treatment and maintenance activities in the Plan Area that are covered by the 2020 LRDP EIR to implement treatments to improve emergency access and evacuation support within 100 feet of either side of large portions of Centennial Drive, as shown on Figure 5. Total area of vegetation removed in the winter of 2019-2020 was 33.3 acres within the Plan Area, which comprises an area 100-feet from pavement edge along the UC Berkeley-managed length of Centennial Drive (see Figure 5). UC Berkeley proposes to conduct a similar evacuation treatments support project along upper portions of Claremont Avenue covering roughly 18 acres within the Plan Area (see Figure 5), and 89 acres along the Jordan Fire Trail. The Centennial Drive, Claremont Avenue and Jordan Fire Trail treatments are consistent with CAL FIRE guidelines as they appear in Protective Practices for CAL FIRE's 35 Emergency Fuels Reduction Projects dated April 5, 2019.[4]

Current vegetation treatments take the form of Defensible Space Creation and Maintenance, Roadside Treatments, Turnout and Signpost Treatments, Exotic Plant Removal and Maintenance, as well as Evacuation Support, Hazard Tree Removal, and Replanting with Fire-resistant Vegetation. The total acreage of these types of treatments is 308 acres, as shown on Figure 2. Generally, treatments occur annually, however the Evacuation Support Treatments have been limited by funding, and will take place in 2019-2021, and periodically thereafter.

Table 1. Approximate Acreage of Ongoing Vegetation Treatment Types

Total Defensible Space	68
Total Roadside Treatments	3
Total Turnout Treatments	2
Total Exotic Plant Removal	76
Total Evacuation Support Treatments	151
Hazard Tree Removal	5
Replanting	3
Total	*308*

[4] http://leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml?lawCode=PRC&sectionNum=4291; http://resources.ca.gov/wp-content/uploads/2019/04/Signed-North-Orinda-Waiver.pdf

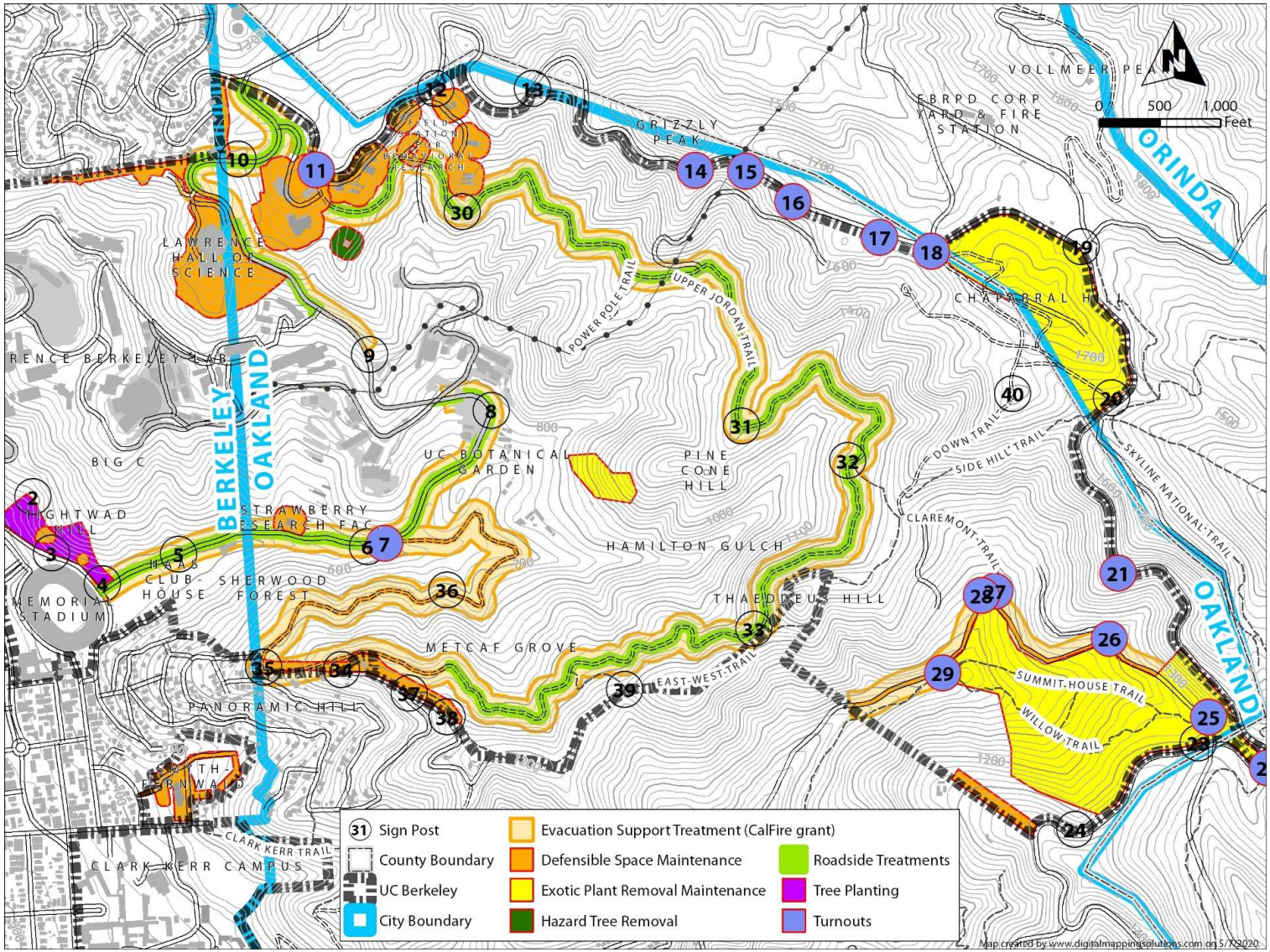


Figure 2. Ongoing vegetation treatments in the UC Hill Campus.

2.4.4.1 Defensible Space and Roadside Treatments

Since 2014, UC Berkeley has applied the set of standards below to direct initial treatments and maintenance activities in the Roadside Treatment and Defensible Space Maintenance areas in the Plan Area. The standards for the Roadside Treatments apply to the strip of land within 15 feet of the pavement edge from both sides of designated roadways. The Defensible Space Maintenance area applies to areas within 100 feet of any structure, unless specified otherwise. These distances are consistent with California State PRC 4291.

2.4.4.2 Standards for Defensible Space

- A minimum of five-foot wide zone (the Non-Combustible Zone) nearest the structure should be kept free of all woody plants and combustible materials.
- Keep the ground free of dead leaves, mulch, needles or other plant debris. The ground surface should be composed of inorganic, non-combustible, material such as decomposed granite, pebbles, or rock/flagstone.
- Vegetation in the non-combustible zone could include irrigated lawns and succulents, but would exclude woody plants.
- Dead material that drapes over ground cover will be removed. This includes leaves, bark, and branches.
- Cut and chip trees with a high fuel volume that are at risk of falling on buildings, structurally unsound, or are unhealthy. Large, "legacy trees" that are structurally sound, and with branches that are 30-40 feet above ground will be retained.
- Remove all dead plants and dry vegetation.
    - Cut grass and weeds within 15-feet of the pavement edge and within 30-feet of a structure to less than four inches in height.
    - Remove leaves, bark, and humus under trees and shrubs (including vines and semi-woody species) so that the buildup of leaves and humus will not exceed two inches in depth anywhere in a defensible space within a year. However, do not expose bare earth in over 50 percent of the site.
    - Remove dead material that drapes over ground cover (including leaves, bark, and branches).
    - From mature trees, remove all vines, loose papery bark, dead branches, and live branches smaller than three inches in diameter to a height of 8 feet above the ground.
    - Remove all dead branches from within live ground covers, vines, shrubs (including semi-woody species), and immature trees.
- Prune trees and large tree-form shrubs (e.g., elderberry or toyon) that are being retained.
    - All lower tree branches, under three inches in diameter, will be removed up to eight feet above the ground, or on the lower third of trees, whichever is less (see Figure 3, below). OR,
    - All lower tree branches, under three inches in diameter, will be removed to provide vertical clearance of three times the height of the understory plants, or eight feet above understory plants, whichever is greater. Retention of short understory shrubs provides aesthetic benefits and wildlife habitat without sacrificing fire safety; alternatively, trees will be pruned to a higher height in order to allow for screening from the understory shrubs.

- In young trees, remove the branches on the lower one-third of the height of the tree. Example: if a tree is 10 feet tall, prune the lower three–four feet and keep the understory plant material to less than one feet in height. As the tree grows to 24 feet in height, it can achieve the eight-foot distance from the ground, and the understory plant material can reach 2.5 feet in height.

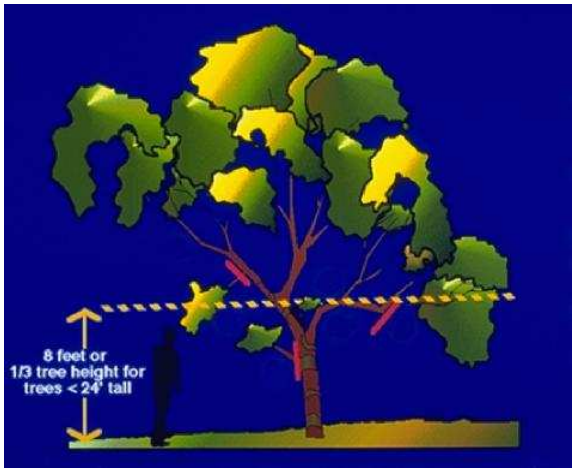


***Figure 3**. Prune branches to a height of 8 feet above the ground. In young trees, prune branches on the lower one-third of the height of the tree. Do not disturb or thin the tree canopy. This promotes growth in the understory, which is more easily ignited.*

- All dead branches smaller than three inches in diameter will be removed. All dead limbs greater than three inches in diameter should be retained where they do not pose a public safety of fire risk.
  - Do not thin or prune the upper tree canopy, as this will promote more growth in the lower parts of the tree, and may result in increased risk that fire will spread to the tree canopy.
  - Sometimes small trees may need to be cut to the ground in order to achieve the separation of the ground level from another, larger, tree canopy, or because mowing equipment cannot avoid the small trees.
  - Maintain at least eight feet of vertical clearance between roof surfaces and overhanging portions of trees.
- Manage individual plants or shrub masses to maintain horizontal spacing, per Figure 4 below. Design distinct groupings of shrubs (including vines, semi-woody species, all types of brush, and all chaparral species). Make sure the plant groupings are small enough to provide adequate horizontal separation between groupings and to allow proper maintenance; groupings should measure no wider than two times the grouping height, or 120 square feet. The space between islands should be greater than three times the height of the shrubs (see Figure 4).
- Remove and safely dispose of all cut vegetation and hazardous refuse, using a gasifier or air-curtain type burner wherever possible.
- Chipped materials may remain on site, provided the mulch layer is no greater than three inches in depth.

Figure 4. *Shrub island spacing. Design groups of plants small enough to provide horizontal separation between groups. This allows proper maintenance and helps slow the spread of fire. Each shrub or group of plants should measure no wider than two times its height, or less than 120 square feet (or 6 feet x 20 feet). The space between groups should be greater than three times the height of the shrubs.*

2.4.4.3 Standards for Roadside Treatments

Within 10 feet of road pavement edge:

- Grassland vegetation and invasive weeds will be mowed to a 4-inch height or treated with herbicide annually. In unusual circumstances when rains occur after grass is mowed, grass may be allowed to regrow or need to be re-mowed.
- Understory shrubs will be removed under trees, or shortened to create a vertical distance between the top of the shrub and the bottom of the tree canopy of three times the shrub height.
- Trees will be pruned of lower branches (to eight feet in height, or the lower third of branches).
- All tree branches extending over roadway surfaces should be pruned to ensure at least 15 feet of vertical clearance.

2.4.4.4 Evacuation Support Treatments

Evacuation support treatment project areas are identified on Figure 5. In all areas, vegetation treatment for evacuation support focuses on removing highly flammable trees, understory shrubs and small trees that could enable torching, and trees that may block access/egress should they fall. The goal for evacuation support treatments is to improve public safety and reduce loss from wildfires by supporting the conversion of the existing fire-prone forest to vegetation with more favorable burning characteristics.

In areas located within 100 feet of Centennial Drive, Claremont Avenue, and Jordan Fire Trail (see Figure 5) vegetation treatments focus on achieving a two to four-foot predicted flame length immediately after treatment. Vegetation treatments aim to remove high-volume vegetation and create discontinuity in the fuel so that in the event of fire, the rate of spread is slowed, and flame lengths meet the treatment goal in treated areas. UC Berkeley treats and maintains the first 10 feet from the pavement edge for evacuation support treatments, as described above in Sections 1.4.4.3.

In the Plan Area, UC Berkeley removes all dead, unhealthy or trees leaning toward Centennial Drive, Rim Way, Claremont Avenue and Jordan Fire Trail. “Specimen” trees identified by the UC Berkeley landscape architect that are healthy and that do not pose a public hazard are retained, per the campus Specimen Tree Program (UC Berkeley, 1990) and all shrubs under them removed. Trees to be retained are protected during treatment periods. UC Berkeley applies practices consistent with those used by the International Society of Arboriculture and follows current California Forest Practice Rules.

In evacuation support treatment areas, UC Berkeley removes lower branches of all trees to a minimum height of 8 feet, and understory vegetation. Shrubs are removed or thinned to a minimum spacing of 6 feet. Surface vegetative fuels may include short shrubs with little dead material, leaf litter, annual and perennial grass. Taller shrubs may be present well away from a tree canopy. Grass is cut every fire season within 10 feet of the pavement edge of Centennial Drive, Rim Way, and Jordan Fire Trail. Branches hanging over roadbeds or fire trails are trimmed to a height of 15 feet above ground. Dead surface fuels smaller than six inches in diameter are removed. Leaf litter of less than six inches in depth is typically left and dead trees are removed. Chips will cover most surfaces within the area upon completion of the treatment; in this treatment area chip depth can be as deep as six inches.
See https://facilities.berkeley.edu/news/centennial-drive-evacuation-support-project for details of the prescription.

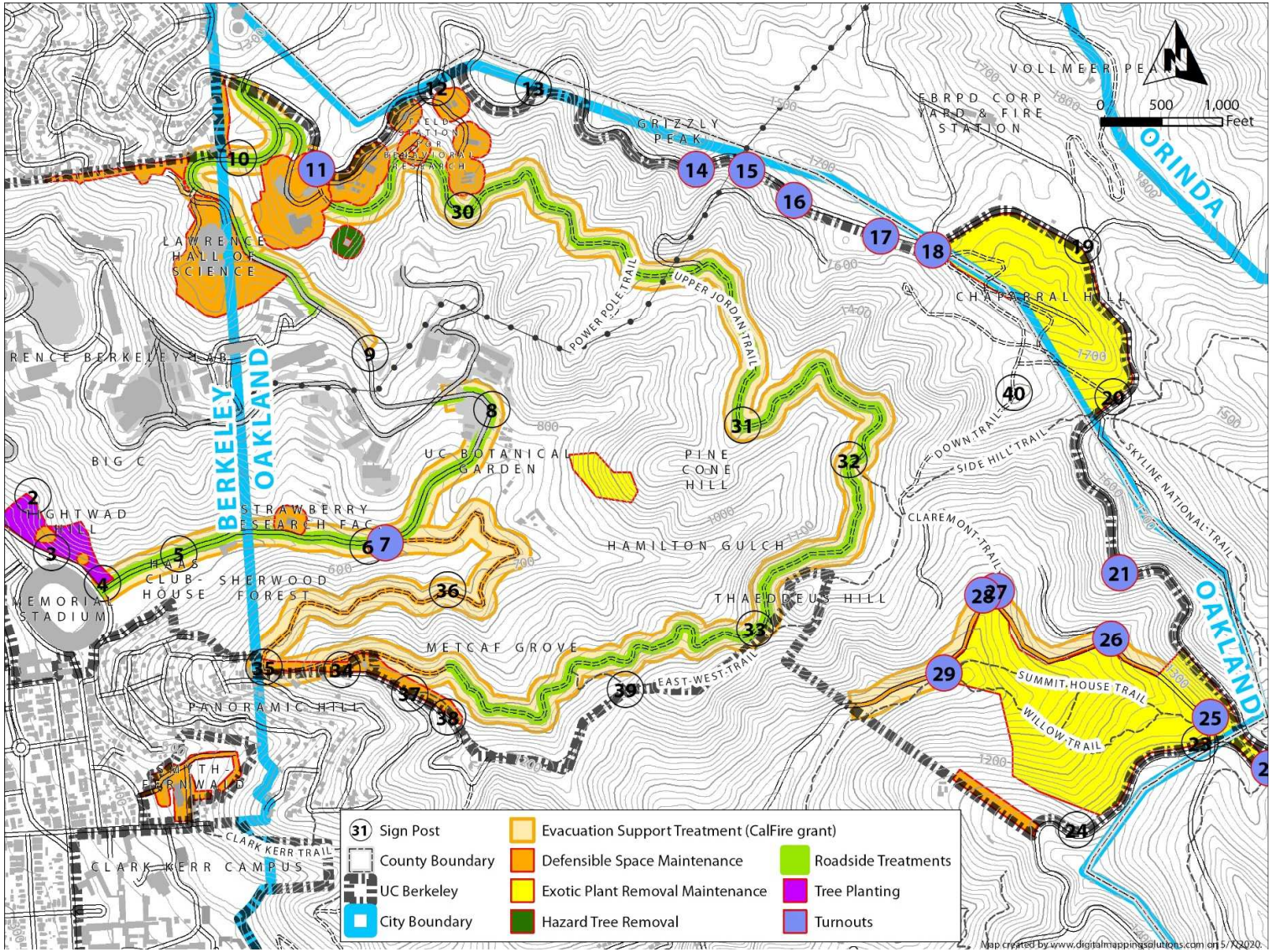


Figure 5. Map of ongoing vegetation treatment projects funded by CAL FIRE grant

2.4.4.5 Standards for Turnout Treatments

Vegetation at turnouts is treated annually and performed according to specified actions, depending on the location. Generally, treatments are to cut grass, and remove debris for a 50-foot radius from pavement edge. Refer to Figure 2 for the locations of treatments these turnouts. UC Berkeley performs the following activities annually at two expanded locations where an additional value at risk is present or where a staging area is possible. In addition, treatments are also applied to the Vista Parking Lot near the Lawrence Hall of Science:

Sign Post 24

- Cut flashy vegetative fuels (e.g. dry grass, which is easily ignited) from pavement edge to the incline of western slope, and approximately 300 feet east of the UC Berkeley property boundary; remove all Coyote Brush within 300 feet east of the UC Berkeley property boundary.
- Spread or haul away wood chips so that there is a three-inch maximum depth.
- Do not treat the first two feet near the fence (avoid succulents).
- Perform the following actions at the driveway entrance:
  - Clear vegetation along the east side of the driveway where cars may park
  - Clear vegetation 50 feet from west of roadside western slope

Sign Post 29

- Cut flashy fuels at the entrance where vehicles park between the gate and logs, and pavement edge from entrance for 50 feet east bound on Claremont Avenue.
- Cut flashy fuels for 10 feet on both sides of the road from the entrance along emergency access road to first marked trail, and beyond to eastern incline (areas also to be trimmed: redwoods and campus signs).
- Cut flashy fuels north of the emergency road to paved road.
- Spread wood chips (or haul away) so that there is a three-inch maximum depth.
- Cut flashy fuels along Willow Trail 30 south of emergency road.
- Cut flashy fuels from the emergency road north to the logs at pavement edge landing located north of the emergency access road, generally opposite the trail map.
- No trail maintenance.
- Stay away from creek bank and other water sources.

Vista Parking Lot

- At Vista Parking Lot: From the boundary of private yards 100 feet south on UC Berkeley land: continue weed whipping west to Campus Drive.
- Cut grass on 10 feet west of (below) Vista Parking Lot and parking to freight entry.
- Spread or haul away wood chips so that there is a three-inch maximum depth.

See also Appendix B “2018 SCU Ops Guide (1)” which is included in bid packages for Annual Work.

2.4.4.6 Exotic Plant Removal

The following work will take place in the area described as Exotic Plant Removal in the map entitled Annual Maintenance Activities (Figure 2).

Over the years, in specific areas, UC Berkeley has removed eucalyptus and acacia sprouts in the Plan Area. In these areas, occasional eucalyptus and acacia seedlings that are found will be removed. Eucalyptus seedlings smaller than two inches in diameter are pulled and Monterey pine trees smaller than four inches are cut or pulled, as is French broom plants. Eucalyptus, acacia, and French broom sprouts and seedlings that are cut are treated with herbicide according to the Pest Control Advisor (PCA) recommendation. Cut material is not expected to be of large volume and is left on site when it cannot be safely or feasibly chipped, in lengths no longer than two feet. The small volume of cut material should be no higher than 18 inches off the ground in an area no more than 1/10th acre, and further than 300 feet from existing structures.

2.4.4.7 Tree Planting

Tree planting is conducted under the supervision of the Facilities Services Fire Mitigation Program Manager and campus Landscape Architect, based on field conditions. Native trees, including oaks, maples, and buckeyes, are selected by staff, with volunteer labor planting the trees in openings on the slope during the late winter or spring. This activity has occurred on Tightwad Hill, in openings created from the removal of hazard trees (see Figure 5). Table 2 includes the annual acres of ongoing vegetation treatments in the Plan Area since 2014.

Table 2. Annual Acres of Ongoing Vegetation Treatments by UC Berkeley

Fiscal Year	Defensible Space Maintenance (acres)	Exotic Plant Removal (acres)	Roadside Treatment (acres)	Evacuation Support Treatment (acres)	Turnout Treatment (acres)	Tree Planting (acres)	Total (acres)
2014	70	76	3	0	2	0	151
2015	70	76	3	0	2	0	151
2016	69	76	3	0	2	5.3	155
2017	66	76	8	0	2	5.3	157
2018	66	76	4	0	2	5.3	153
2019	69	76	3	131	2	5.3	286

Source: Facilities Services

Treatments are aimed at maintaining the vegetation per the standards described in the previous sections. Facilities Services inspects sites annually in order to develop a work plan that addresses the needs of the area. In most cases, the area needs to be treated in some manner to reach the standards; however, in other locations, such as at the end of Mosswood or Canyon drives, work needs only to occur periodically. A full monitoring and maintenance plan appears in Section 7 of this Plan.

3. DESCRIPTION OF EXISTING CONDITIONS

3.1 PLAN AREA

The Plan Area comprises the roughly 800-acre UC Berkeley Hill Campus in the hills adjoining but east of the UC Berkeley Campus Park and California Memorial Stadium. The Plan Area is located primarily in Alameda County with a small area in unincorporated Contra Costa County (see Figure 1). Roughly 85 percent of the Plan Area is located within the City of Oakland; the lower or westernmost portion of the Plan Area lies within the City of Berkeley. The Plan Area is bounded on the east by Grizzly Peak Boulevard; to the west by Stadium Rim Way and private residences; to the south by Grizzly Peak Boulevard and the East Bay Regional Park District's Claremont Canyon Regional Reserve; and to the north by LBNL and private residences. LBNL manages approximately 200 acres in the Hill Campus, which is not included in the Plan Area. LBNL is a federally funded research and development center, operated and managed by the Regents of the University of California on behalf of the United States Department of Energy. The Plan Area is located within the wildland-urban interface (WUI), which is the area where humans and their development meet or mix with wildland fuel.

3.2 FIRE HISTORY

California has long been recognized as one of the most fire-prone natural landscapes in the world. Wildfire, particularly WUI fire, represents the third greatest source of hazard to California, behind flood and earthquake hazards, both in terms of recent state history as well as the probability of future destruction of greater magnitudes than previously recorded (State of California Hazard Mitigation Plan, September 2018). Wildfires in the state in 2017 and 2018 were by far the most destructive and deadly in recent history. In California in 2017, 10,280 structures were damaged or destroyed and 47 people lost their lives (https://www.fire.ca.gov/incidents/2017/). In 2018 24,226 structures were damaged or destroyed and 100 fatalities occurred in the state[5].

The East Bay hills' combination of hot dry summers, conducive topography, flammable vegetation, dense urban development, limited fire-fighting access, and Diablo winds (winds generally blown east to west and usually occurring during late summer and early fall) present significant risks to the public and structures and property along the wildland-urban interface.

Historic wildfire ignitions in the East Bay hills have not been well documented, but are often directly related to human activity. Records are in the form of newspaper articles and old fire planning studies but support the conclusion that wildfires pose a substantial risk to the Plan Area. As shown in Figure 6 below, between 1923 and 1998, 11 Diablo wind fires burned 9,840 acres of the East Bay hills, destroying 3,542 homes and killing 26 people, with more than 2 billion dollars in financial loss in current dollars. During the same period, three large west-wind fires burned 1,230 acres of grass, brush, trees, and four homes in the East Bay hills.[6]

[5] https://www.fire.ca.gov/incidents/2018/

[6] EBRPD WHRRMP 2010.

The 1991 Oakland Tunnel Fire set a tragic record for loss of homes to California wildfire, which has now been surpassed by the 2003 Southern California fires, 2017 North Bay Fires, and the 2018 Camp Fire. Until 2017, the 1991 Tunnel Fire stood as the highest destruction of California homes per acre. For eight decades, the 1923 Berkeley Fire, which burned 130 acres north of the Plan Area, held the California record for the greatest number of structures destroyed by wildfire (584 structures). This fire also burned through the Plan Area and destroyed several structures on the north side of the UC Berkeley campus. Additional smaller fires have also ignited near the Plan Area including, most recently, the Grizzly Fire. In 2017, the Grizzly Fire burned 20 acres in the Plan Area and caused the evacuation of more than 1,000 youth campers, researchers, and other staff. The event prevented access by emergency responders along Centennial Drive and disrupted research, camps, and other UC Berkeley functions.

The 2017 Grizzly Fire brought to the foreground the need for increased fire safety in UC Berkeley's Hill Campus. This fire occurred Aug 2, 2017, during a hot, but generally windless day. Despite the moderate weather, the fire burned 20 acres and required involvement of 14 agencies in its suppression. The potential risk to public safety was illustrated by the required evacuation of four international laboratories (Mathematical Sciences Research Institute (MSRI), Space Sciences Laboratory (SSL), Lawrence Hall of Science (LHS), and LBNL), the public UC Botanical Garden, as well as seven children's summer camps. The potential for business disruptions and property damage was illustrated as it burned near PG&E transmission lines, which are critical infrastructure providing the sole source of power to LBNL and the UC Berkeley Campus Park.

3.3 HAZARD RANKING

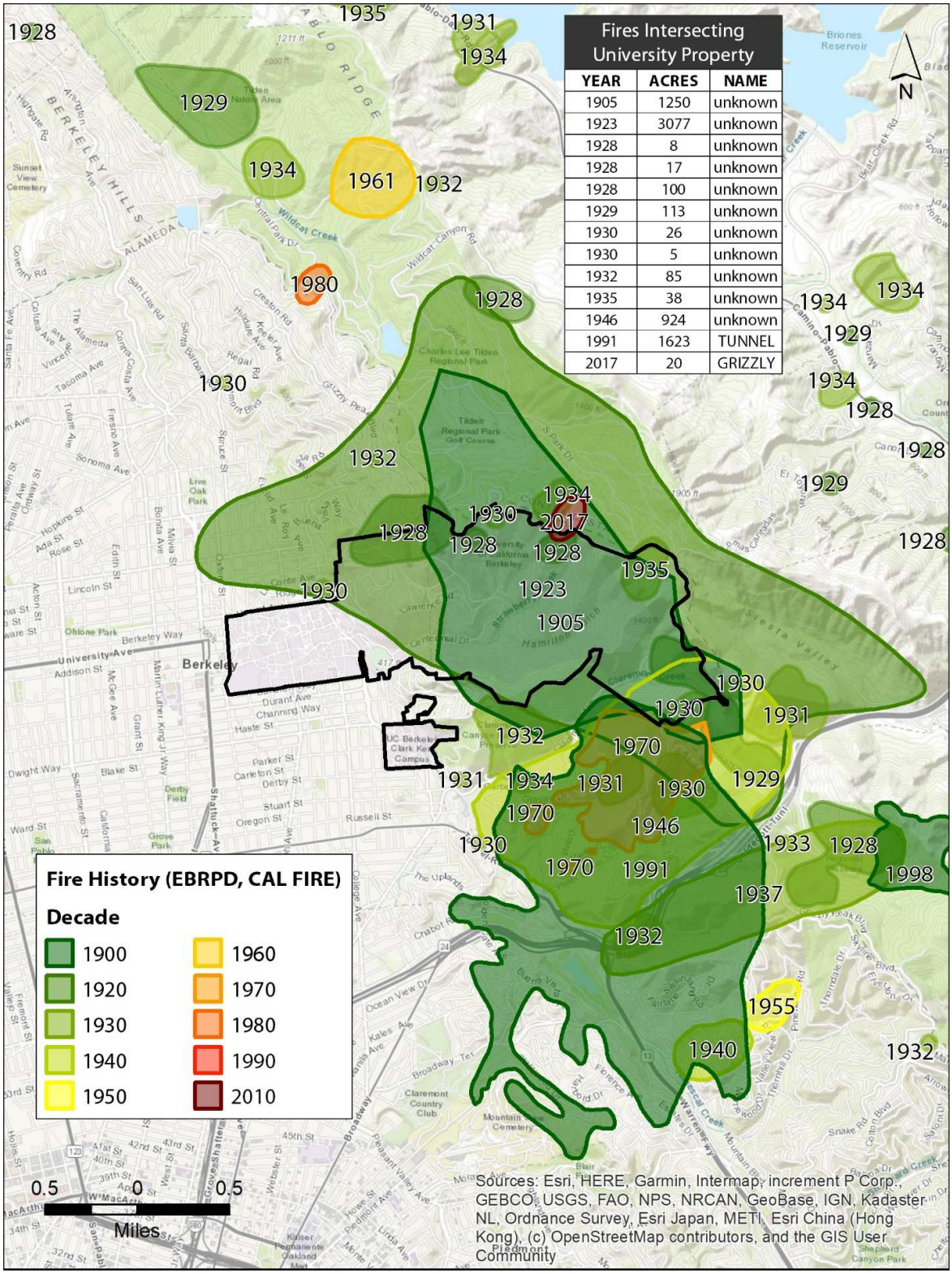
The Plan Area directly abuts the residential area in Panoramic Hill. As mentioned before and demonstrated in part by the 2017 Grizzly Fire, access between and within the Plan Area and potentially fire-affected residential areas is poor or non-existent. Once one home ignites, house-to-house ignition is almost certain due to the combustible building characteristics, density of structures, and volume of vegetation between structures in this neighborhood that was developed in the 1900s.

The Plan Area is located within a Local Responsibility Area Very High Fire Hazard Severity Zone as identified by the most recent Fire and Resource Assessment Program map for the cities of Berkeley and Oakland.[7] It is also located in a State Responsibility Mutual Threat Zone. The Plan Area lies adjacent to the 1991 Tunnel Fire location; the current vegetation on the Hill Campus is the same as the vegetation that fueled the Tunnel Fire.

3.4 VEGETATIVE FIRE HAZARD

The expected intensity of a wildfire in the Plan Area is likely to prevent emergency access or evacuation, as well as be devastating to the environment. Hot winds during fire events can carry burning embers, potentially for miles. As noted in the textbook by Scott et al. (2015), the spotting potential of Eucalyptus forests is "unparalleled in terms of both density and distance as a result of the

[7] https://osfm.fire.ca.gov/media/5604/berkeley.pdf;
https://osfm.fire.ca.gov/media/5606/oakland.pdf ;
https://osfm.fire.ca.gov/media/7271/fhszs_map1.pdf



Fire History Map UC Berkeley Hill Campus Wildland Fuel Management Plan

Figure 6. Fire history of the East Bay Hills

abundance and aerodynamic properties of the tree bark" (McArthur 1967). Eucalyptus spot fire distances of 30 - 41 kilometers were documented during one of the worst modern fire sieges on record, the Black fires in Victoria Australia on February 7, 2009, when 173 lives and over 2,000 structures were lost under hot and windy weather. Eucalyptus tree bark peels and remains draping, hanging and/or loosely attached and curled inward toward the tree bole, and it may act as a ladder fuel that enhances torching and ember production. McArthur (1967) shows a picture of *Eucalyptus obliqua* alight 60-70 feet above ground under "very mild" meteorological conditions. The bark eventually falls and creates a deep layer of combustible litter that decomposes very little, which may also contribute to crown fire under mild conditions. Crown fire is fire than has burned upward into the tree canopy. Spotting is the transfer of embers ahead of a fire front which can ignite smaller vegetation fires. Spotting has been identified as critical to the spread of some of the most destructive wildfires (Koo et al 2010).

The effects of spotting are sobering to those concerned with fire safety and damage. Secondary spot fires and roof ignitions from these firebrands substantially increase the extent of values at risk, potentially causing an urban conflagration involving far more than 2,200 structures currently considered at risk within and adjacent the Plan Area. A huge number of structures lie downwind of eucalyptus groves, many of which have not been retrofitted to meet modern building code requirements designed to withstand fire. With a high density of urban ignitions, a mass fire could occur, whereby the coalescence of the individual spot fires increases fire spread and intensity, such as occurred in 2017 in Coffey Park, Santa Rosa. These factors may help explain the devastating effects of the Diablo-wind-driven Tunnel Fire, and the 1923 Berkeley Fire. Prevention of crown fire in eucalyptus in the Berkeley/Oakland hills, and elsewhere in the East Bay is of paramount importance to the fire safety of a very large population, but is largely beyond the scope of the Plan.

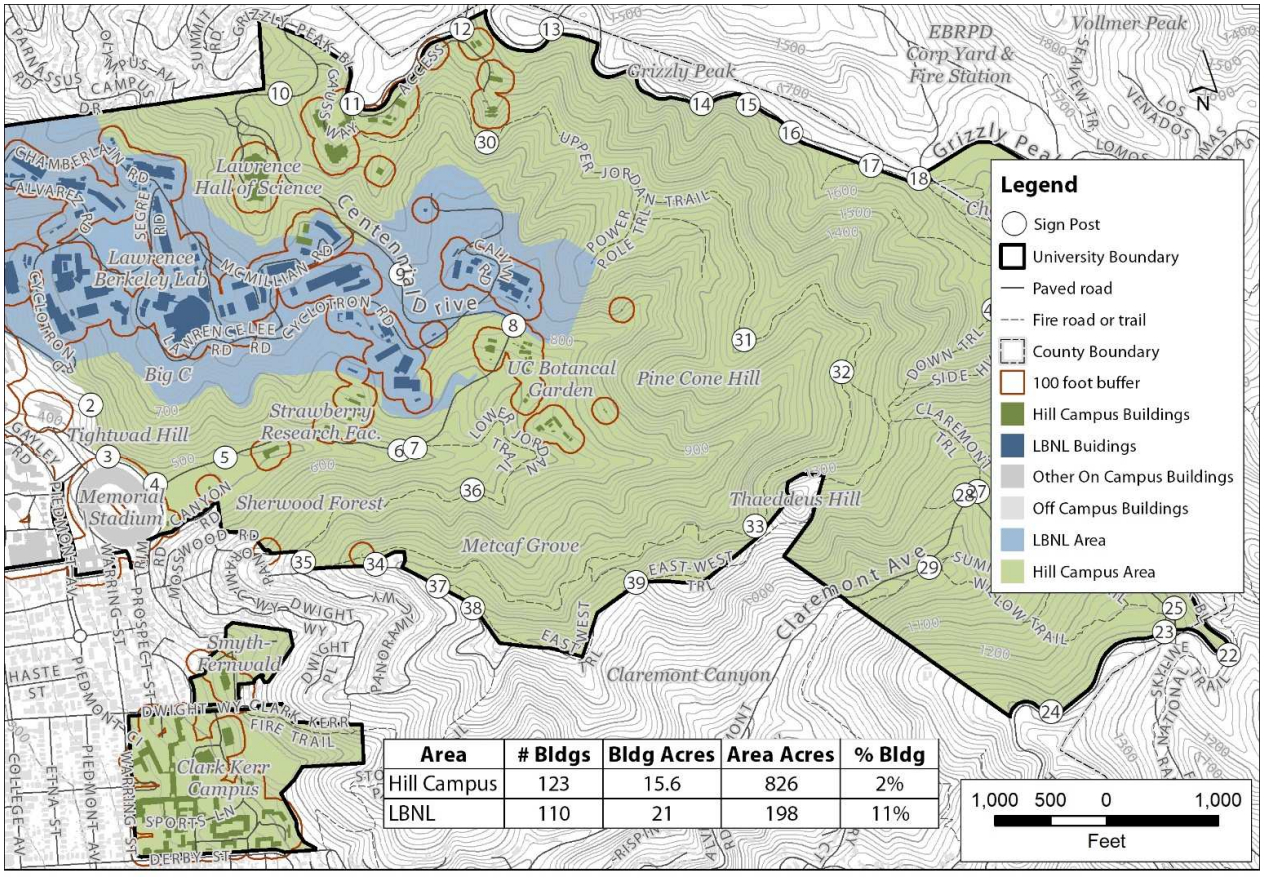
3.5 INFRASTRUCTURE

The Plan Area is heavily vegetated open space although it contains several UC Berkeley campus public and research facilities concentrated along Centennial Drive. Facilities include Lawrence Hall of Science, Mathematical Sciences Research Institute, Space Sciences Laboratory, Space Sciences Laboratory, Field Station for the Study of Behavior, Ecology and Reproduction, Botanical Garden, Facilities Services Strawberry Facility, and Strawberry Canyon Recreational Area (shown on Figure 7.) A Pacific Gas & Electric (PG&E) substation serving the Campus Park and LBNL is located in the Plan Area and included overhead transmission lines. The 2020 LRDP EIR reported that two Secondary Historical Resources are located in the Plan Area. These are Charter Hill and the Big C, and the Botanical Garden itself. In addition, a historic structure designed by Julia Morgan, built in 1911 and relocated to the Botanical Garden in 2014, is listed on both the California and national historic registries (LRDP EIR).

3.5.1 ACCESS AND ROADS

Paved public access roads within the Plan Area include Centennial Drive, Stadium Rim Way and Claremont Avenue. Grizzly Peak Boulevard defines the Plan Area's eastern boundary. Centennial Drive, aligned east-west, serves as the primary emergency access to and a major evacuation route from the Plan Area to the west, as well as private residences and research institutes. Unimproved dirt fire trails provide emergency vehicle and maintenance access (EVMA), as well as recreational access within the

Plan Area. These fire trails include the East-West Trail and Upper and Lower Jordan Fire trails, which are heavily used for recreation and dog walking. Upper Jordan Fire Trails serve as the primary alternative emergency evacuation route for the Panoramic Hill neighborhood to the south, with 404 structures and a population of almost 1,000 residents. Centennial Drive is the primary emergency evacuation route for the 1,048 structures (day-time population 2,081) in the residential area to the north and has been designated by the Berkeley Fire Department as one of only three major evacuation routes for approximately 1,900 Berkeley residents. LBNL (with more than 3,000 employees) has two evacuation routes, one of which is through the Strawberry Gate on Centennial Dr.



Structures at Risk UC Berkeley Hill Campus Wildland Fuel Management Plan

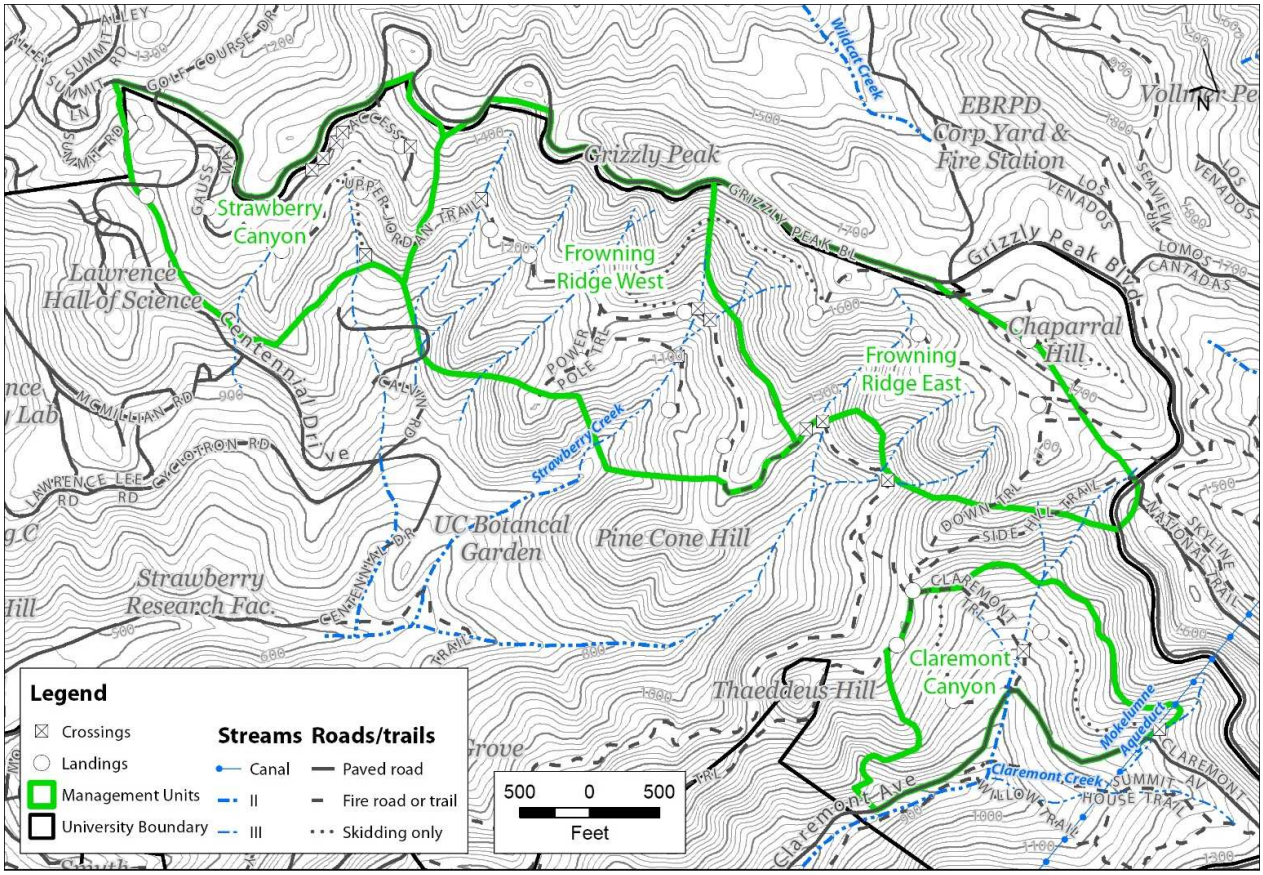
Figure 7. Structures and facilities at risk in the Hill Campus

The current road network has been inspected and appears stable and sufficient to access proposed treatment areas. Many of these roads were successfully used in earlier tree-removal projects in the 1970s and late 1990s. UC Berkeley will inspect internal "appurtenant" roads before, during and after operations.

3.5.2 ROAD USE CLASSES

The Plan Area contains internal seasonal roads that represent "mainline" roads with native dirt and gravel surfaces, and moderate to low grades (Figure 8). Upper Jordan Fire Trail and the East-West Trail are in this class. These roads are behind locked gates and managed by UC Berkeley. These roads are

not all-weather and vehicle use is restricted to dry summer months to avoid rutting and sediment movement into watercourses. Extended dry periods during the winter months between mid-November and mid-April occasionally occur, and ground conditions may be sufficiently dry for vehicle use, with prior approval by UC Berkeley Facilities Services.



Management Units Map — UC Berkeley Hill Campus Wildland Fuel Management Plan

Figure 8. Road classes indicating routes suitable for skidding, hauling and public permanent roads

The Plan Area also contains trails that are generally too steep or have turns too tight to accommodate full-sized trucks, but can support 4WD pickups and may be used during treatments. Examples include Power Pole Trail, Down Trail, Claremont Trail, East Connector, and the newly built trail from Upper Jordan Fire Trail to Grizzly Peak at MP17 (i.e., "Botanical Experience Trail").

UC Berkeley PDM Unit Operations Maps (Figure 8) show roads classified into appropriate uses as follows:

"**Permanent/public**" – these are public paved roads used to access treatment areas: Claremont Avenue, Grizzly Peak Boulevard, and Centennial Drive.

"**Suitable for hauling**" – these roads, shown in Figure 8 as *Fire road or trail*, were used for hauling and truck use in the past and are in good condition for use during treatment

"**Suitable for skidding only**" – these roads and trails, shown in Figure 8 as *Skidding only* are too steep or have inadequate turn radii to permit safe truck use – these skid roads lead to landings.

Appurtenant Road Class	Appropriate Use Class	Approximate Miles
Internal Seasonal	Suitable for Hauling	2.9
Internal Seasonal Jeep	Suitable for Skidding Only	1.6
Internal Permanent	Suitable for Hauling	0.3
Public Permanent	Suitable for Hauling	4.2

3.5.3 LANDINGS

The Plan Area contains 22 mapped (see Figure 9) landings that were either used previously or are located on flat areas suitable for construction and use with minimal ground disturbance. In some cases, landings may not be used for future projects, while in other cases existing landings may be required to facilitate operations. Due to limitations of the terrain, there a several locations where skid trails (routes used by tracked or wheeled skidders to move logs to a landing or road) meet landings on the haul roads near ephemeral watercourses. In these areas, UC Berkeley would take protective measures to prevent chip movement into watercourses or possibly block drainages.

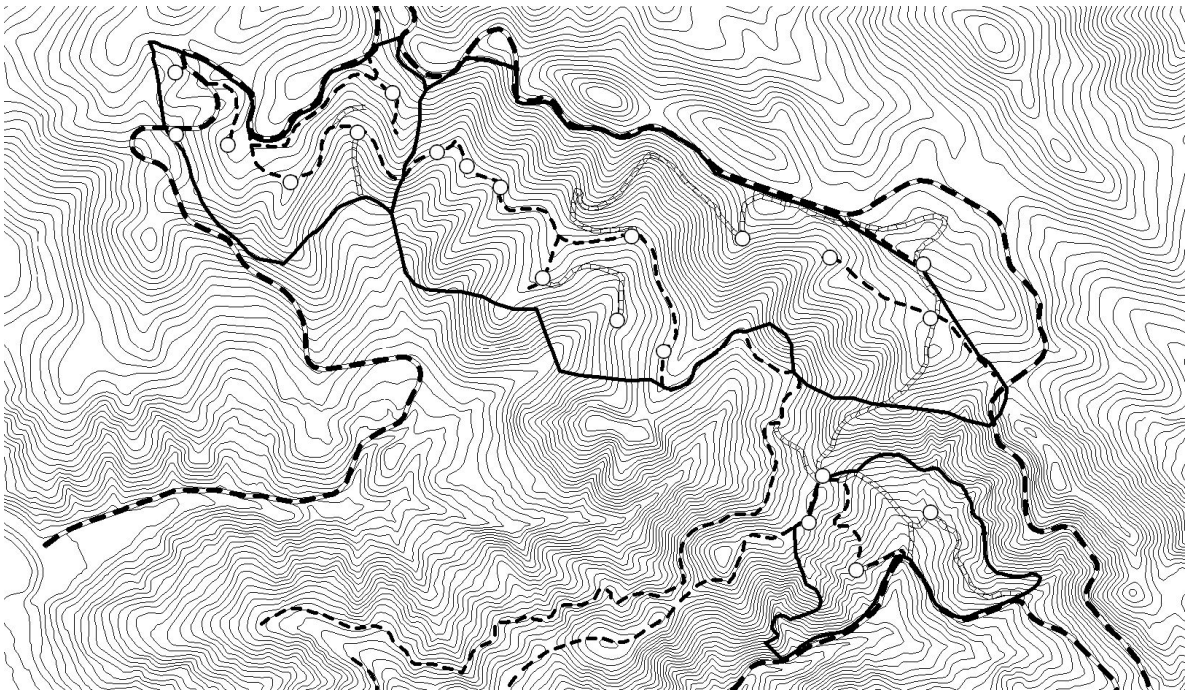


Figure 9. Map of existing landings in the Hill Campus

3.6 TOPOGRAPHY

Slopes in the Plan Area are steep, averaging more than 30 percent. Elevations in the Plan Area range from a low of about 400 feet above mean sea level at its western edge and rise to almost 1,800 feet above mean sea level at Chaparral Hill at its eastern edge.

3.7 WATER RESOURCES

The Plan Area lies within two watersheds: Strawberry Canyon and Claremont Canyon, which drop to the west, divided by a major east-west ridgeline. Grizzly Peak Boulevard forms a major ridgeline in the east. The Plan Area contains several drainages. Strawberry Creek, which flows year-round traverses the Plan Area. All other drainages are ephemeral except for an approximately 200-foot segment that drains the Claremont Unit where year-round water was found and is associated with a permanent wet area containing riparian vegetation. The remaining ephemeral watercourses drain surface water during winter months, but do not likely sustain habitat for riparian plants, fish or amphibians other than newts and tree frogs.

3.8 WILDLIFE

The Plan Area supports a diverse array of wildlife. Riparian corridors and adjacent oak-bay woodlands, scrub, and remnant grasslands are particularly valuable to some amphibians, birds, and small mammals. Mature trees, including blue gum and conifers, provide suitable nesting substrate for a number of bird species, particularly raptors such as red-tailed hawk and great horned owl.

The 2020 LRDP (UC Berkeley, 2004) states that the Hill Campus provides suitable habitat for the state and federally-threatened Alameda whipsnake, California red-legged frog, numerous bird species of concern, and several special-status plant species. Alameda whipsnake is found in chaparral, Diablan sage scrub, and northern coyote brush scrub, as well as adjacent riparian scrub, grasslands, and woodlands. Typical habitat characteristics for this species include open to partially open scrub/chaparral cover on east, southeast, and southwest-facing slopes with abundant rock outcrops, rodent burrows, and western fence lizard prey. The mosaic of native habitat also provides important foraging opportunities for a number of mammalian and avian predatory species, including mountain lion, bobcat, grey fox, coyote, striped and spotted skunk, great horned owl, red-tailed hawk, and other raptors.

3.9 PLANT RESOURCES

As shown in Figure 10, the LandFire 2016 (USGS 2020) dataset of vegetation indicates the majority of the Hill Campus is mapped as Central and Southern California Mixed Evergreen Woodland. Large patches of Southern California Coastal Scrub, and Dry/Mesic Chaparral are located on the higher elevations of the Hill Campus in Hamilton Gulch, and below Signposts 14-18. Vegetation mapped as Western Urban vegetation follows the roads. The western portion of the Hill Campus, near the Strawberry Canyon Recreation Area, are mapped as Warm Climate Ruderal Deciduous and Evergreen Forests.

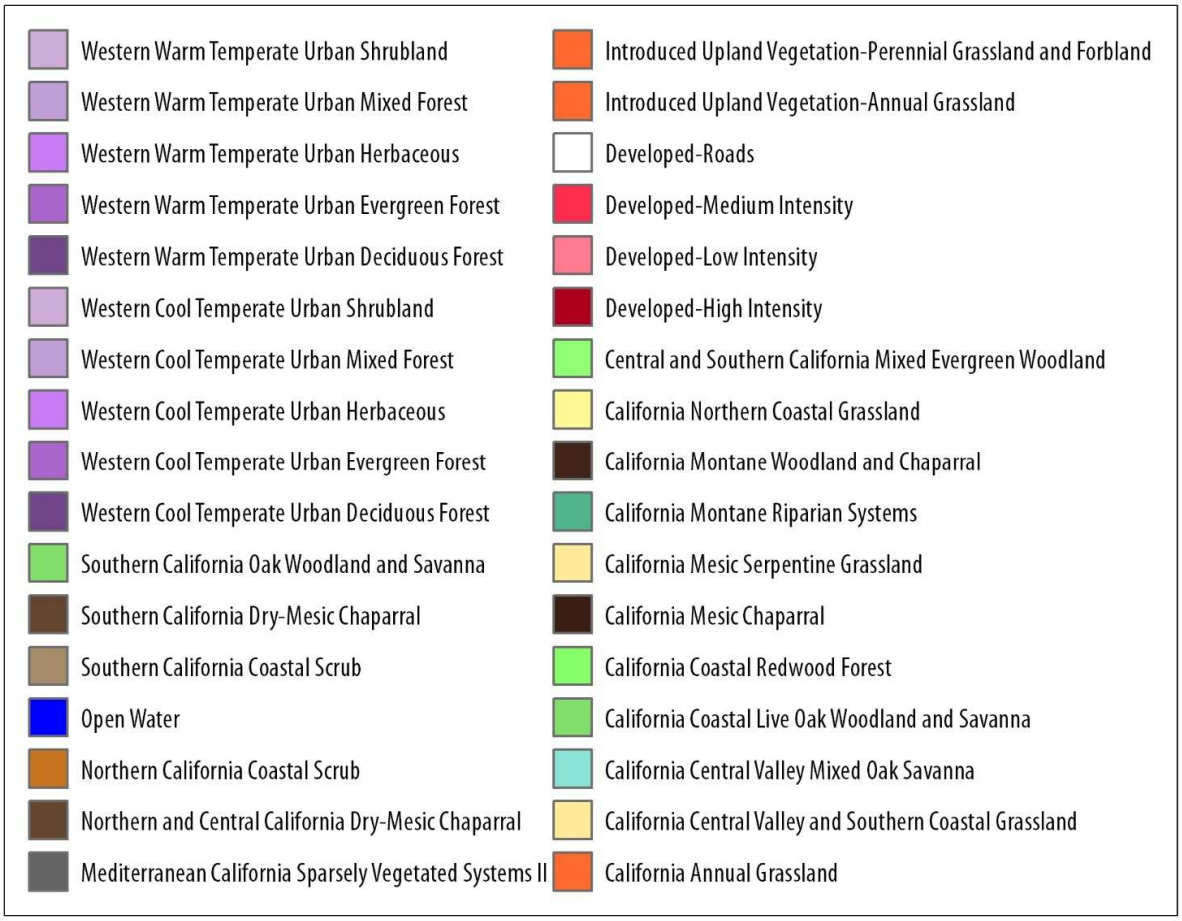


Table 3. Vegetation types mapped through the LandFire mapping program (2016 refresh)

EXISTING VEGETATION TYPE	ACRES
Central and Southern California Mixed Evergreen Woodland	2.22
California Coastal Redwood Forest	114.76
Mediterranean California Mixed Oak Woodland	5.34
Mediterranean California Lower Montane Conifer Forest and Woodland	3.78
Mediterranean California Mixed Evergreen Forest	65.61
California Maritime Chaparral	0.22
Northern and Central California Dry-Mesic Chaparral	72.50
California Central Valley Mixed Oak Savanna	0.67
California Coastal Live Oak Woodland and Savanna	266.65
California Lower Montane Foothill Pine Woodland and Savanna	8.90
Northern California Coastal Scrub	8.23
California Northern Coastal Grassland	0.67
California Coastal Closed-Cone Conifer Forest and Woodland	0.22
Mediterranean California Lower Montane Black Oak-Conifer Forest and Woodland	4.00
California Lower Montane Blue Oak-Foothill Pine Woodland and Savanna	9.79
Developed-Low Intensity	26.02

Developed-Medium Intensity	13.79
Developed-High Intensity	1.33
Developed-Roads	34.69
Temperate Pacific Freshwater Emergent Marsh	0.67
Western Warm Temperate Urban Deciduous Forest	37.14
Western Warm Temperate Urban Evergreen Forest	32.25
Western Warm Temperate Urban Mixed Forest	21.57
Western Warm Temperate Urban Herbaceous	15.35
Western Warm Temperate Urban Shrubland	44.48
Western Warm Temperate Developed Ruderal Deciduous Forest	12.01
Western Warm Temperate Developed Ruderal Evergreen Forest	5.12
Western Warm Temperate Developed Ruderal Mixed Forest	0.67
Western Warm Temperate Developed Ruderal Shrubland	0.44
Western Warm Temperate Developed Ruderal Grassland	3.56
Central California Coast Ranges Cliff and Canyon	0.22
Mediterranean California Foothill and Lower Montane Riparian Woodland	6.89
California Ruderal Grassland and Meadow	4.00
Californian Ruderal Forest	2.67

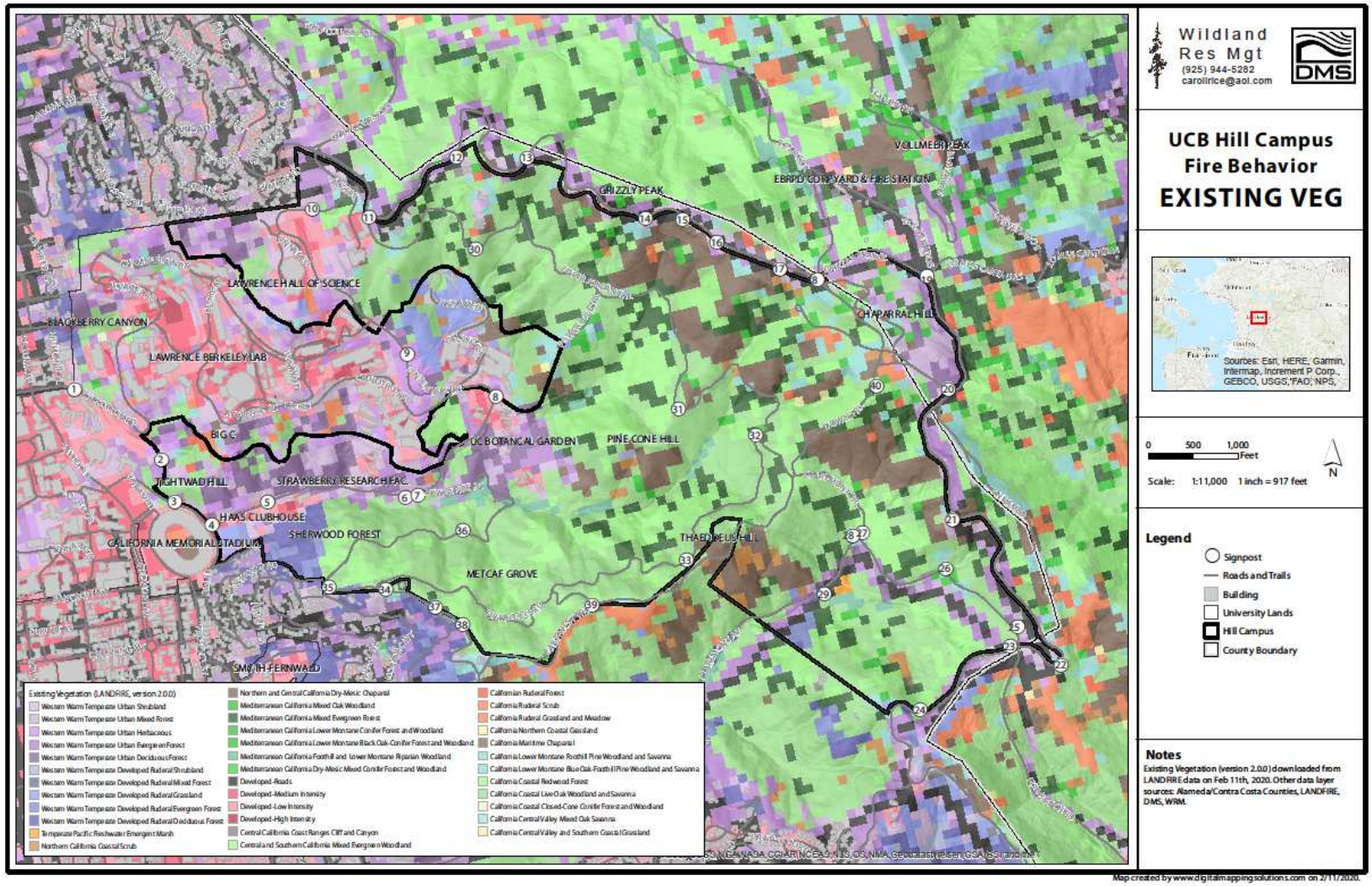


Figure 10. Current vegetation types, from 2016 LandFire data

3.10 VEGETATIVE FUEL MODELS

Fire managers in virtually all federal and state agencies, as well as in other countries where wildland fire hazards are significant, use fuel model systems for the various computerized fire behavior prediction systems (FBPS). Within the United States, information regarding fuel volumes and fire-behavior descriptions is based upon fuel models described in Rothermel (1983) and Scott and Burgan (2005). Each fuel model is given a number designation, which is interpreted consistently by fire managers across the continent.

Fuel models describe surface, grass, and shrub fuel characteristics with respect to potential fire behavior. A key significant factor is the amount and distribution of smaller-diameter fuels, because these materials generally spread wildland fires. Another important factor is the amount of dead biomass and the ratio of live-to-dead material in terrain with significant brush and numerous tree stands, since dead biomass contributes fine fuel litter as well as carries flames more readily. Fuel models include these considerations.

Fuel models may be categorized by several methods, including drawing polygons on maps from field surveys and samples, to defining spectral bands on satellite imagery. For the first approximation of fuels, UC Berkeley has used data from the Landscape Fire and Resource Management Planning Tools Project (LANDFIRE Version 1.40), a nationally-accepted and consistent mapping of fuel models and FBFM40 (the Scott and Burgan expanded 40 fuel models). Each of the fuel models present in the Plan Area are described below.

The most abundant surface fuel model (see Figure 11) in the Plan Area is Timber Understory (TU5), with 282.04 acres covered. This fuel model is abundant in the forest of the FSSBER, the Botanical Garden, and on the ridgeline dividing Strawberry and Claremont Canyons. The area mapped as TU5 also occurs in the area where treatments to remove eucalyptus occurred in 2005-6, south of Claremont Avenue and near the intersection of Grizzly Peak Boulevard and Claremont Avenue. Patches of TU5 tend to be large, and uniform.

The Timber Litter fuel model that has the greatest fuel volume is TL9, and is found in a stand north of Claremont Avenue above the Upper Jordan Fire Trail, and on the northern ridgeline defining Hamilton Gulch. Approximately 100 acres is split between other Timber Litter Fuel models TL 2,3,5,6, 7 and 8.

Shrub surface fuel models (97.33 acres) occur in the Plan Area bordering Claremont Canyon, the upper slopes of Claremont Canyon, and along Upper Jordan Fire Trail, and below Grizzly Peak Boulevard just east of the site of the 2017 Grizzly Fire. Shrubby surface fuel models appear as medium to large patches.

Grass covers only 21 acres of the Plan Area, located high along Grizzly Peak Boulevard, and in small patches throughout the upper canyon. The largest patch of grass is mapped near the Lawrence Hall of Science.

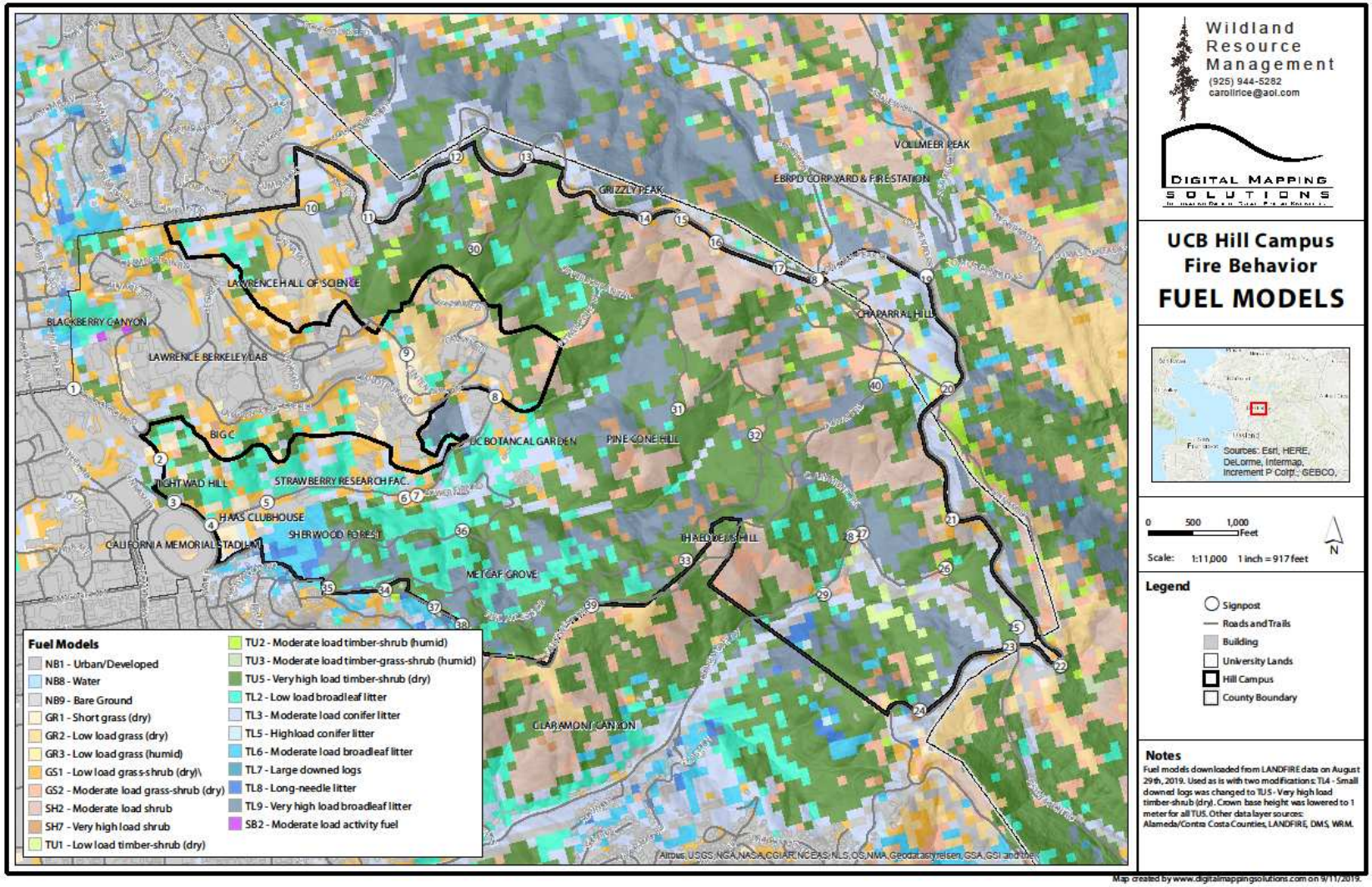


Figure 11. Fuel model distribution in the Hill Campus

Grass-shrub fuel models covers 54.88 acres in the Plan Area and is found near the Vista Parking Lot and the northern border of the Hill Campus.

Hill Campus	**768.72**
GR1	9.94
GR2	10.89
GS1	32.78
GS2	21.77
NB1	48.90
NB9	0.35
SB2	0.22
SH2	78.50
SH7	18.83
TU5	282.04
TL3	56.62
TL5	1.05
TL6	11.61
TL7	1.11
TL8	4.01
TL9	97.45
TU2	4.03
TU3	2.62

Table 4. Description of Fuel Models

Value	FBFM40	Description
91	NB1	Urban
98	NB8	Water
99	NB9	Barren
101	GR1	Short, sparse dry climate grass is short, naturally or heavy grazing, predicted rate of fire spread and flame length low
121	GS1	Low load, dry climate grass-shrub shrub about 1 foot high, grass load low, spread rate moderate and flame length low
122	GS2	Low load, dry climate grass-shrub shrub about 1 foot high, grass load low, spread rate moderate and flame length low
144	SH4	Moderate load, humid climate shrub, woody shrubs and shrub litter, possible pine overstory, fuelbed depth 2-3 feet, spread high and flame moderate
145	SH5	High load, humid climate grass-shrub combined, heavy load with depth greater than 2 feet, spread rate and flame very high
149	SH9	Very high load, humid climate shrub, woody shrubs and shrub litter, dense finely branched shrubs with fine dead fuel, 4-6 feet tall, herbaceous may be present, spread rate and flame high
161	TU1	Low load dry climate timber grass shrub, low load of grass and/or shrub with litter, spread rate and flame low

162	TU2	Moderate load, humid climate timber-shrub, moderate litter load with some shrub, spread rate moderate and flame low
163	TU3	Moderate load, humid climate timber grass shrub, moderate forest litter with some grass and shrub, spread rate high and flame moderate
165	TU5	Very high load, dry climate shrub, heavy forest litter with shrub or small tree understory, spread rate and flame moderate
181	TL1	Low load compact conifer litter, compact forest litter, light to moderate load, 1-2 inches deep, may represent a recent burn, spread rate and flame low
182	TL2	Low load broadleaf litter, broadleaf, hardwood litter, spread rate and flame low
183	TL3	Moderate load conifer litter, moderate load conifer litter, light load of coarse fuels, spread rate and flame low
186	TL6	Moderate load broadleaf litter, less compact than TL2. Spread rate is moderate, flame length low.
189	TL9	Very high load, fluffy broadleaf litter. Spread rate is moderate, flame length moderate

3.11 FIRE BEHAVIOR ANALYSIS

3.11.1 FIRE BEHAVIOR SUMMARY

One way of measuring potential damage and risk is to conduct a fire behavior analysis. Two analyses were performed, both using FlamMap 6.0, which predicts fire behavior across the landscape under the same conditions. Outputs from FlamMap are well-suited for landscape level comparisons of fuel treatment effectiveness because fuel is the only variable that changes. Outputs and comparisons can be used to identify combinations of hazardous fuel and topography, aiding in prioritizing fuel treatments (USFS, 2018).

One scenario focused on fire behavior resulting from winds blowing uphill, which is a fairly extreme set of weather conditions. The other scenario was based on an easterly (45 degrees) wind, which would facilitate fire spread toward the Campus Park. Other environmental inputs were the same.

For both scenarios, four types of burning characteristics were portrayed: flame length, crown fire potential, surface fire spread rate, and maximum spotting distance.

Flame Length

Flame length (measured in feet) is the length of the flame at the head of the fire measured from the middle of the combustion zone to the average position of the flame tip.[8] Flame length is often correlated to the ability to control a fire. A flame length of 8 feet is usually looked at as a cut-off point for strategic firefighting decisions on whether to attack the fire directly, or instead attempt control through indirect methods. Attacking the fire directly involves efforts to slow the flaming front at its

[8] Andrews and Rothermel, 1982. Charts for Interpreting Wildland Fire Behavior Characteristics. USDA Forest Service, General Technical Report INT-131. September 1982.

head – where it is advancing fastest. Indirect attack involves fire control methods on the fire's flank or well ahead of the fire (using backfires or retardants).

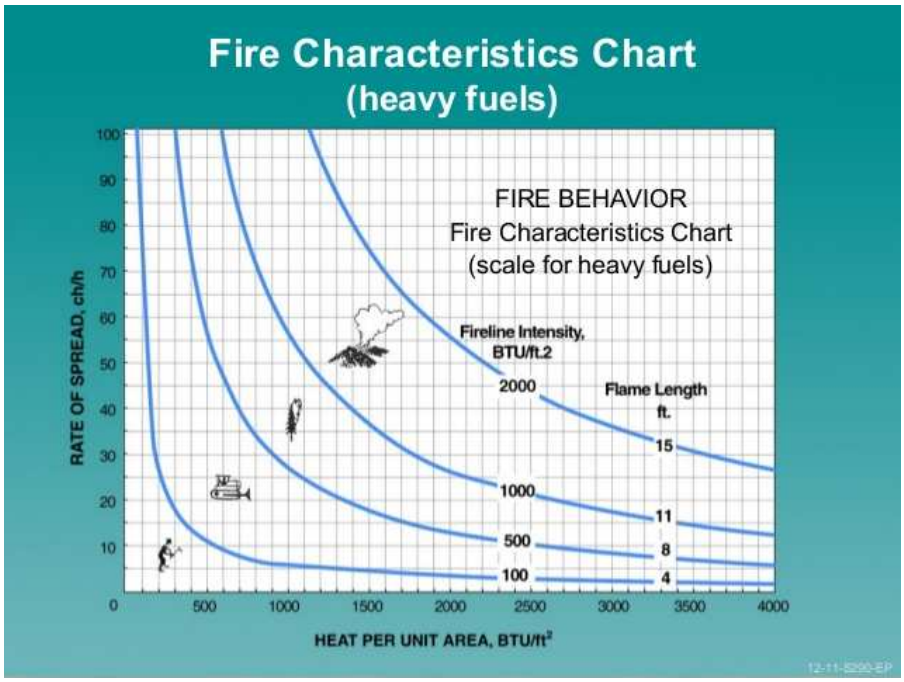


Figure 12. Limits to fire suppression based on flame length, rate of spread and heat per unit area

Rate of Spread

Rate of spread (measured in chains per hour, where one chain equals 66 feet, and 80 chains equals one mile) is the forward rate of spread at the head of a surface fire. While a fast rate of spread does not necessarily result in a problematic fire, a fast-moving fire coupled with high flame lengths cannot be suppressed with a hand-crew. High rates of fire spread is associated with both unmowed grasslands, and in stands of tall, dense shrubs.

A surface fire that makes the transition to some form of crown fire is modeled from canopy base height, stand height, canopy bulk density, and foliar moisture content. It is important to keep in mind that crown fire activity only pertains to treed fuel model types. Crown fires and torching can occur only where there are trees; shrub stands can burn intensely and still not torch.

Crown Fire Activity

Crowning activity indicates locations where fire is expected to travel into and possibly consume the crowns. When a fire burns through tree crowns, countless embers are produced and are distributed, sometimes at long distances. These embers can start new fires, which can each grow and confound the finest fire suppression forces.

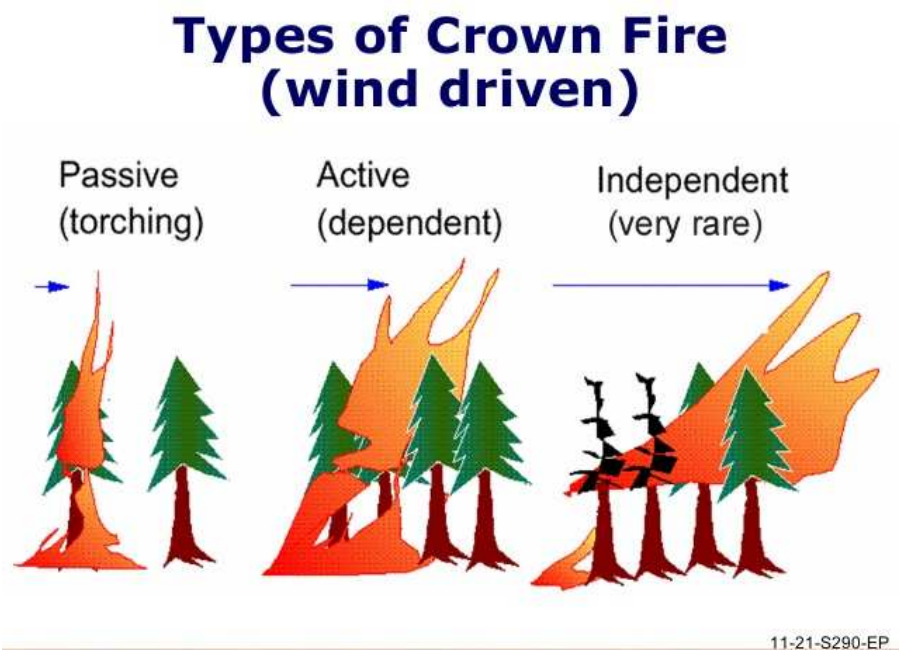


Figure 13. Types of crown fires

Maximum Spotting Distance

Wildfires can create embers that loft ahead of the flaming front that ignite new fires called "spot fires." "Spotting potential" describe the propensity of vegetation to create and disburse embers that have the potential to start countless new fires well in advance of the main fire. Thus, it is useful to know the maximum distance embers can be expected to be cast from its source. Typically, this is influenced most by the position on the slope of the area generating embers, as well as the wind speed and type of material burning.

Fire Prediction Summary

Under dry conditions with a wind blowing uphill at a 20 mile per hour speed throughout the Hill Campus, and current fuels are expected to produce fire behavior that is daunting for containment and control and likely to produce substantial levels of damage.

Almost half of the area is expected to burn with flames longer than 8 feet in length. Rates of fire spread are not excessively fast, and a large percentage of the area (nearer to the mouth of Strawberry Canyon) has slow fire spread rates. Torching is expected to be widespread in the upper reaches of the Hill Campus, however, crown fire is predicted to be rare. Under weather where winds blow uphill, new spot fires could be distributed as far as 2000 feet, which would extend well into neighboring residential areas and within the LBNL.

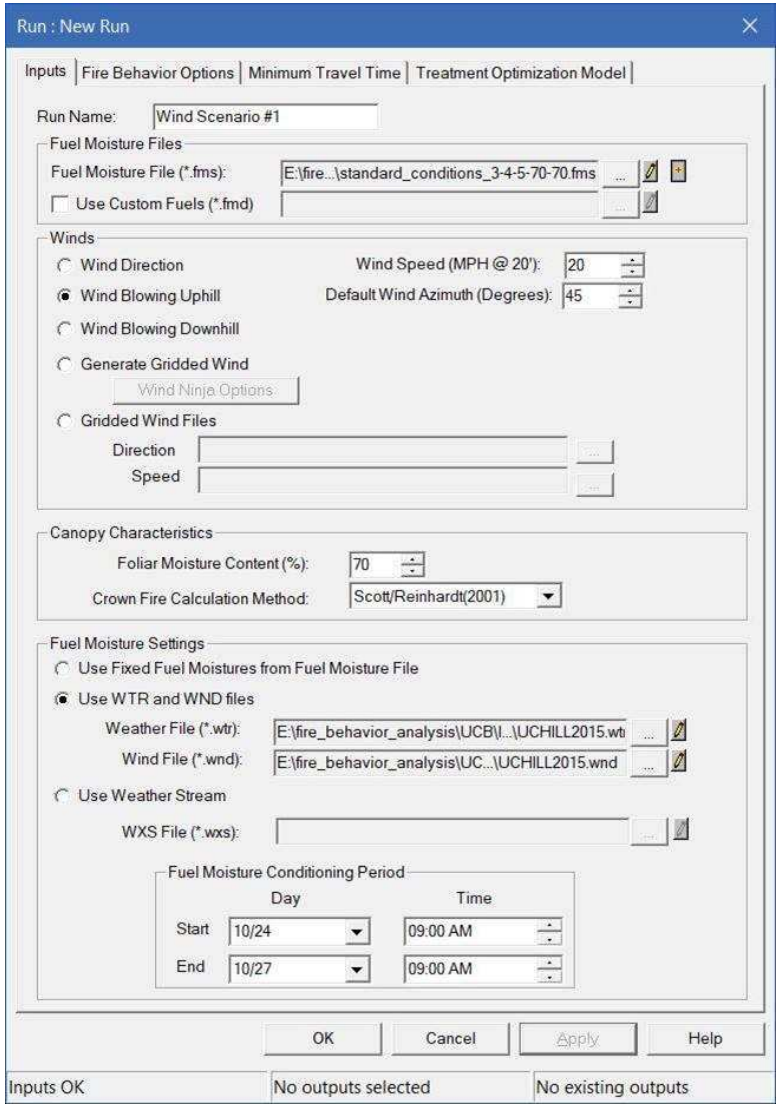
Using the same dry weather conditions and a strong wind (40 miles per hour) blowing from the northeast to the Campus Park and down Claremont Ave., the area is expected to burn with long flame lengths (greater than 8 feet in length) increases by a third, to more than half the Hill Campus.

In both wind scenarios, areas in the western portion of the Strawberry Canon, Botanical Garden and Chaparral Hill are expected to burn with short flame lengths and with slow fire spread rates.

With strong northeasterly winds, fire spread rates dramatically increase. Almost every area in the Hill Campus with trees is predicted to torch, with the exception of patches of the western portion of Strawberry Canyon. With strong winds blowing form the northeast a larger proportion of the Hill Campus is expected to spread new spot fires long distances (greater than 2000 ft).

3.11.2 WEATHER AND FUEL MOISTURE CONDITIONS

Two weather scenarios were selected for this analysis: one that portrays conditions with strong wind (20 miles per hour) that blows upslope in all locations. This is likely to portray conditions under which a wildfire burns with a westerly influence, and when fuels are a dominant influence. The second is under a Diablo Wind scenario, which is with a 40 mile per hour blowing from the northeast. The fuel moistures are the same CAL FIRE used to assess fire hazard severity statewide, and are almost the same as the 97th percentile of values for the nearest remote automatic weather stations.
The 97th percentile indicates that three percent of the days (roughly 10 days) are hotter, drier or windier than the weather selected for the simulation.



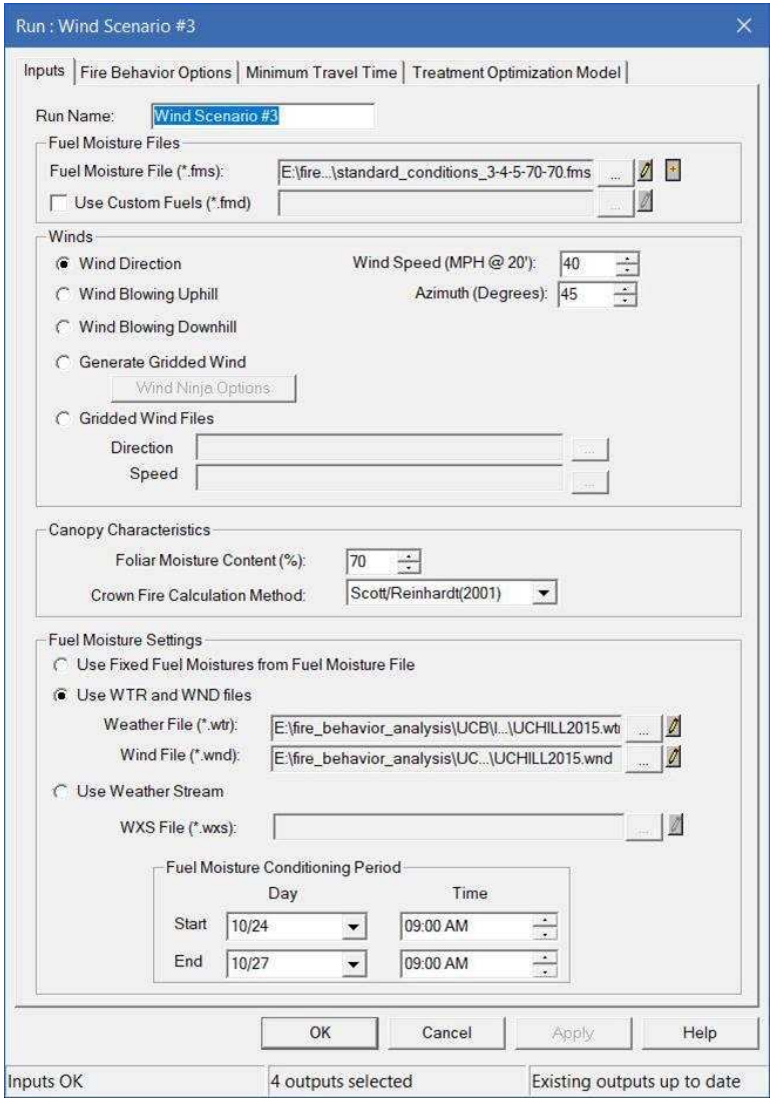


Figure 14. Inputs to fire behavior prediction software FlamMap

3.11.3 FIRE BEHAVIOR WITH UPSLOPE 20 MPH WINDS

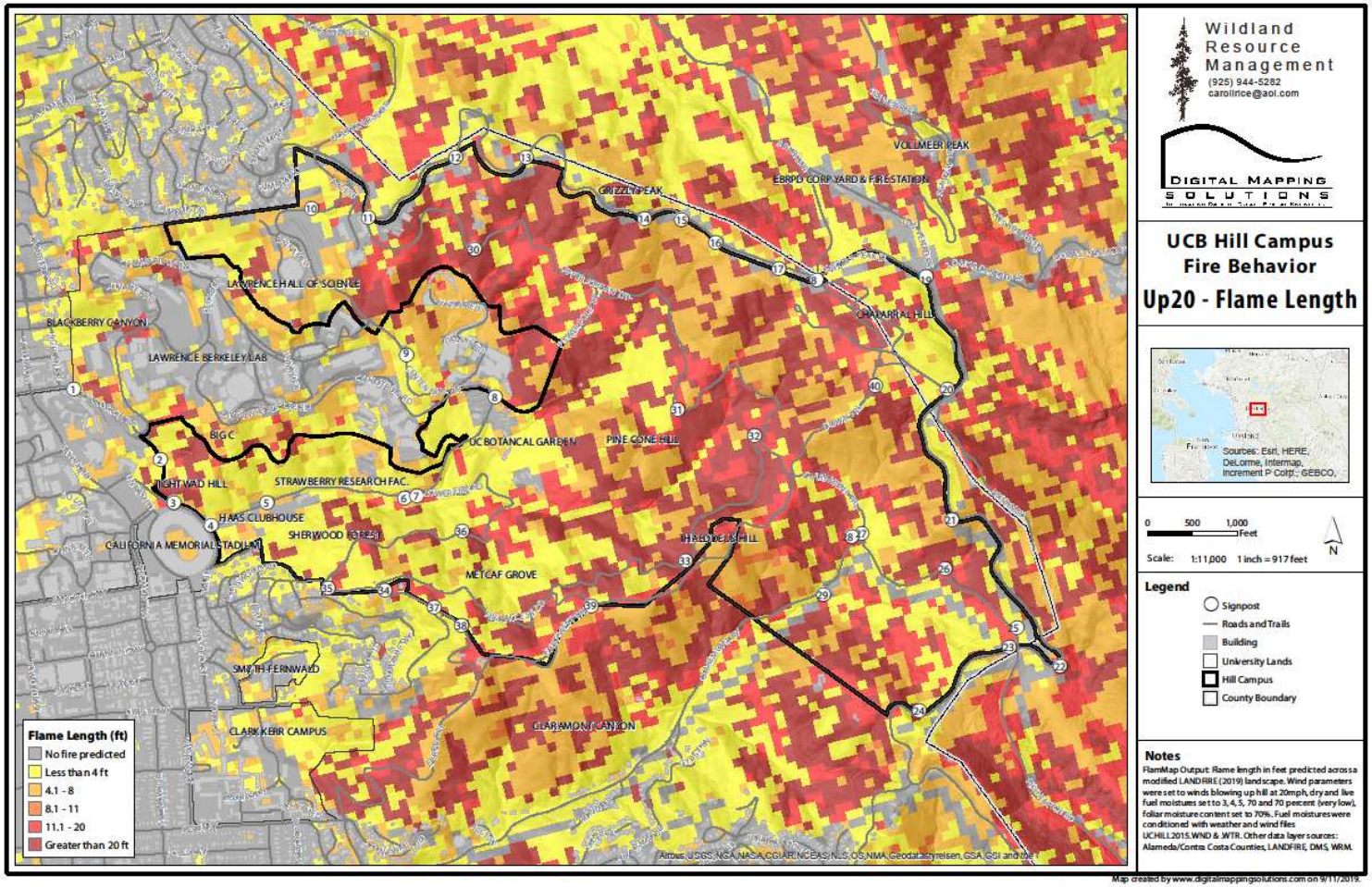


Figure 15. Predicted flame lengths with a 20 mile per hour wind blowing uphill in all directions

Flame Length (Figure 12)

As shown on Figure 12, almost half of the 800-acre Plan Area is expected to burn with flames longer than 8 feet (330.55 acres), indicating direct attack methods would not be appropriate, and that indirect suppression would be necessary. Land that is expected to burn with flames between 4-8 feet in length totals 219.72 acres, and the area that is expected to burn with low flames lengths, shorter than 4 feet, totals 36.97. In the Plan Area, 181.47 acres is not expected to carry fire, due to the lack of vegetative fuel.

Long flame lengths are associated with forested areas with a dense understory of shrubs and short trees, as well as in stands of thick, dense shrubs. The areas of longest flame length are located in the higher portion of the Hill Campus: northeast of LBNL, surrounding the Botanical Garden, throughout Hamilton Gulch, as well in in Claremont Canyon. Areas of shorter flame lengths are located in areas where a dense forest canopy overstory is present over a thin leaf litter of surface fuel. These areas are found in the western portion of the Plan Area, in lower Strawberry Canyon, in the Botanical Garden, on the southern side of Claremont Canyon, and atop Chaparral Hill.

Rate of Fire Spread (Figure 13)

Fast-moving fires are those where the rate of spread is greater than 20 chains[9] per hour (or a 1.4 mile per hour); a total of 282.29 acres in the Plan Area is expected to burn in this category of spread rates. The rate of fire spread in almost 300 acres is expected to be slow to moderate, or 1 to 20 chains/hr. Fire spread is not expected or barely moving in 189.21 acres. The slower spread rates in the Plan Area are found in lower Strawberry Canyon and south of Claremont Avenue, and on Chaparral Hill. Fast-moving fires are expected north of the Botanical Garden, north of Claremont Avenue, and on the west-facing slope of Frowning Ridge.

[9] A chain is a unit of length equal to 66 feet, commonly used in surveying and forest operations. Conveniently, 80 chains is equivalent to a mile. Chain is abbreviated ch.

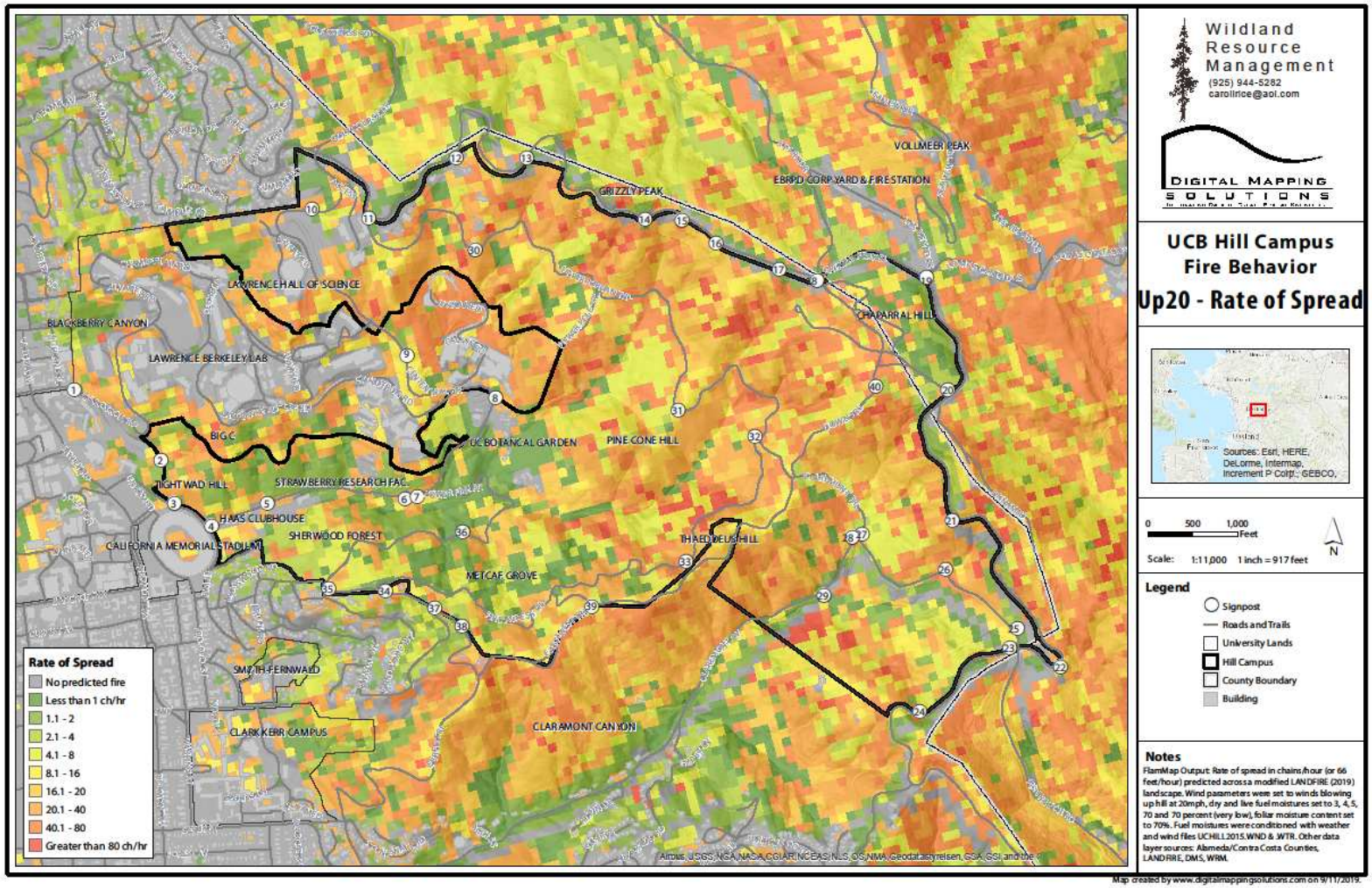


Figure 16. Predicted fire spread rates with a 20 mile per hour wind blowing uphill in all directions

Crown Fire Activity (Figure 14)

While only 21.61 acres in the Plan Area are expected to experience canopy-to canopy fire spread, more than 300 acres can be expected to torch, consuming the tree canopy and producing and distributing embers. Fires are expected to burn as a surface fire in 389.59 acres.

Surface fires are predicted in lower Strawberry Canyon, around Lawrence Hall of Science, the Botanical Garden and lands east, the shrubby slopes of Frowning Ridge, the northwestern portion of the Plan Area in Claremont Canyon, Chaparral, Hill, and on the north-facing slopes between the Lower and Upper Jordan Fire Trails. Areas without trees cannot torch or produce canopy fires. Torching can be expected northeast of LBNL to Grizzly Peak Boulevard, the upper slopes of Hamilton Gulch, and portions of Claremont Canyon. Minor ridgelines between Lower Jordan Fire Trail and the southern boundary of the Plan Area are also expected to experience torching. Canopy fire is rare and occurs in small patches sprinkled throughout the Hill Campus.

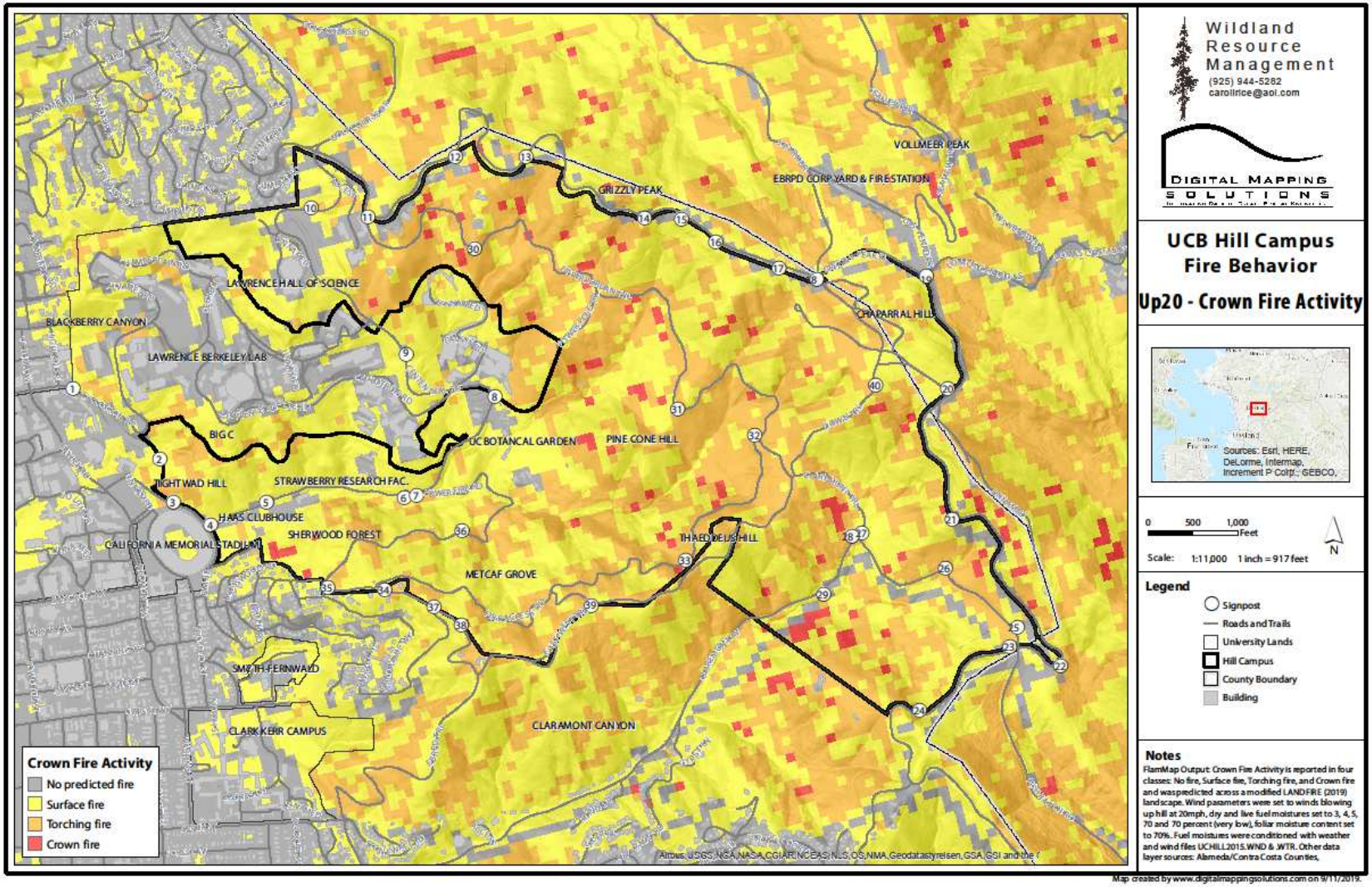


Figure 17. Predicted crown fire activity with a 20 mile per hour wind blowing uphill in all directions

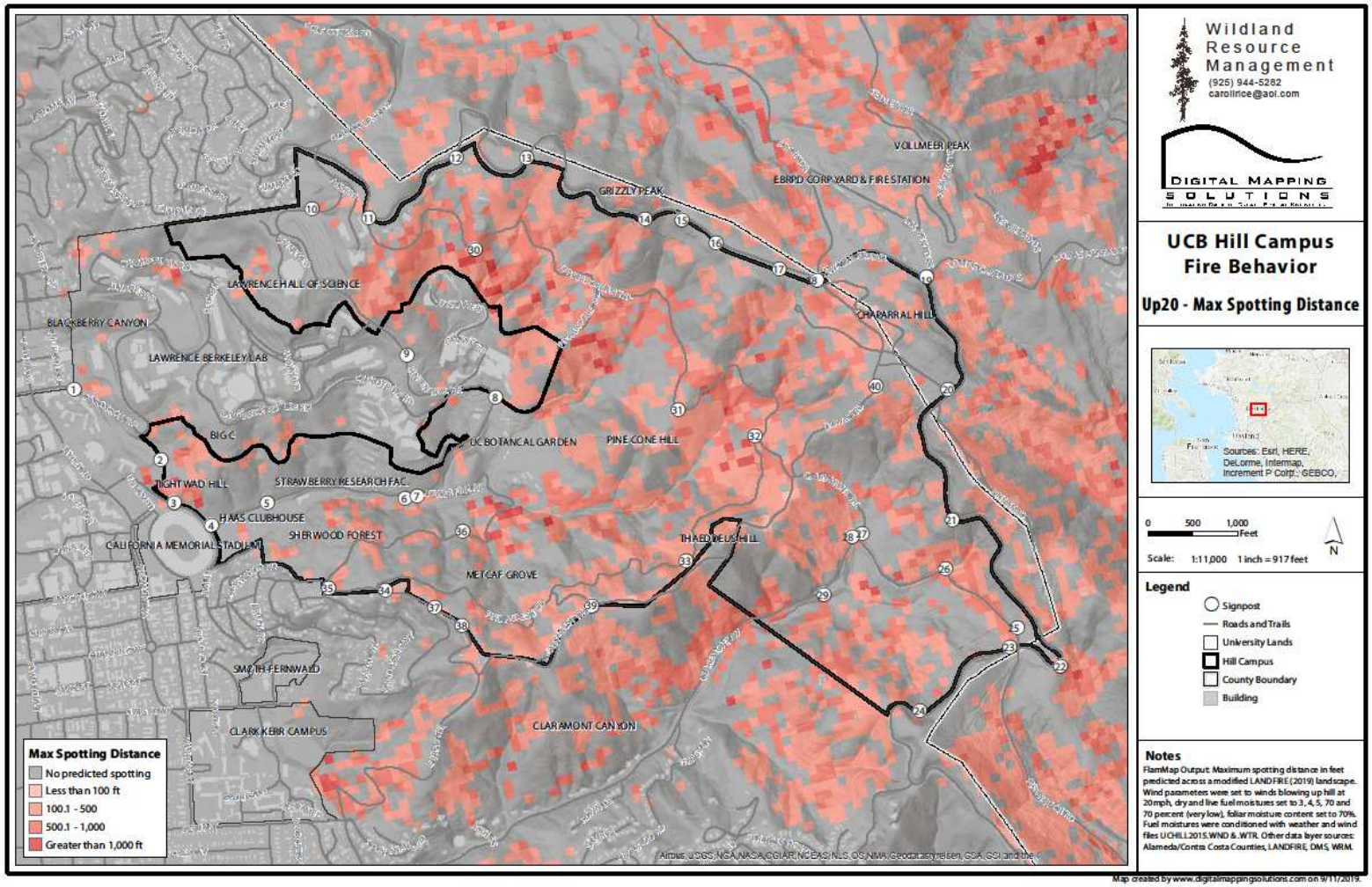


Figure 18. Predicted maximum spotting distance with a 20 mile per hour wind blowing uphill in all direction

Maximum Spotting Distance (Figure 15)

Under a scenario where fire runs uphill throughout the Plan Area, modeling shows that the longest maximum spotting distance would be between 1,000-2,000 feet, and is located above the eastern portion of LBNL. Long-distance spotting is also predicted to occur in Hamilton Gulch, south of the Botanical Garden, and along the southern boundary of the Plan Area in Claremont Canyon. A small patch of potential long-distance spotting is located on Rim Way, close to the Campus Park.

3.11.4 FIRE BEHAVIOR WITH NORTHEAST 40 MPH WINDS

Flame Length (Figure 16)

With a very strong wind (40 miles per hour) blowing from the northeast, more than half of the Hill Campus is expected to burn with flames longer than 8 feet (411.3 acres). This is almost a third more acreage than with a 20 mile per hour wind that blows uphill. Acreage that is expected to burn with shorter flame lengths, i.e. between 4-8 feet in length, totals 137.11 acres, and the area that is expected to burn with low flames lengths, shorter than 4 feet, totals 23.45 acres. Land in the Plan Area, not expected to carry fire, due to the lack of vegetative fuel totals 174.39 acres.

Projected flame lengths longer than 8 feet would be widespread in the upper reaches of the Plan Area, whereas flames less than 4 feet in length would be common in western portions of Strawberry Canyon, the Botanical Garden, Chaparral Hill, and in portions of Claremont Canyon. As with the other wind scenario, long flame lengths are associated with areas of trees with thick understory vegetation and in areas of shrubby vegetation. Areas of more benign fire behavior (in terms of flame lengths) in this wind scenario continue to be located in areas where a dense forest canopy is combined with a thin leaf litter.

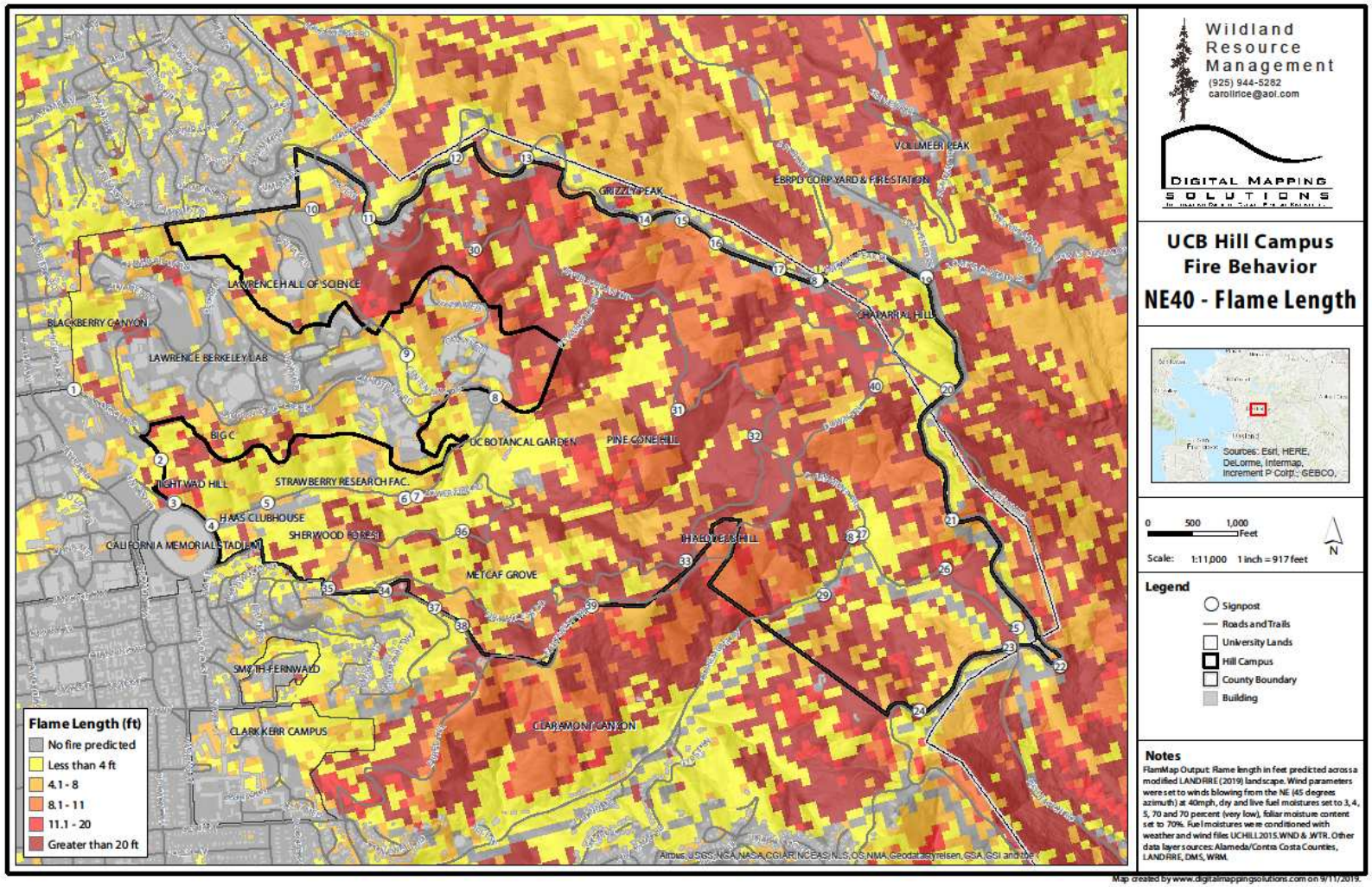


Figure 19. Predicted flame lengths with a 40 mile per hour wind blowing from the northeast

Rate of Fire Spread (Figure 17)

High rates of fire spread are associated with both unmowed grasslands, and in stands of tall, dense shrubs. Acreage where a fire is expected to burn with a rate of spread greater than 20 miles per hour (or a 1/4 mile per hour) totals of 428.48 acres, or almost double that under a 20 miles per hour uphill wind scenario. Moderate spread rates, from 1 to 20 ch/hr, is predicted on 157.1 acres. Fire spread is not expected or barely moving in 182.72 acres, which is almost the same as under a 20 miles per hour uphill wind scenario.

The patterns of spread rates are similar to the 20 miles per hour uphill wind scenario, with slower spread rates found in lower Strawberry Canyon, at the Botanical Garden, and Chaparral Hill. Fast-moving fires are to be expected north of the Botanical Garden and Claremont Avenue, and on the west-facing slope of Frowning Ridge. Areas above Upper Jordan Fire Trail and in Claremont Canyon are anticipated to spread faster with a northeast wind.

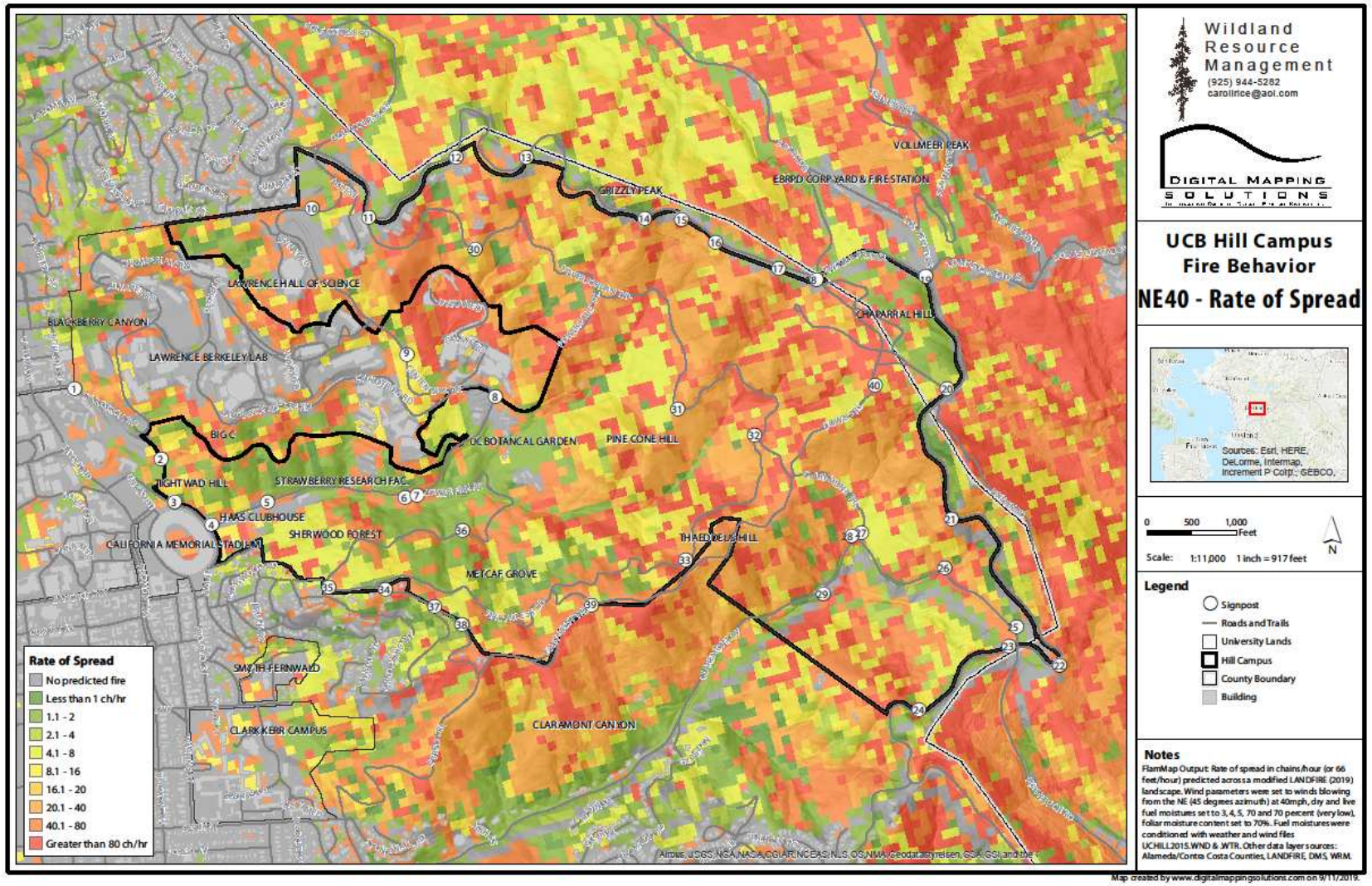


Figure 20. Predicted rate of fire spread with a 40 mile per hour wind blowing from the northeast

Crown Fire Activity (Figure 18)

The acreage predicted to burn with canopy-to canopy fire spread under a stronger wind from the northeast quadrupled, compared to a 20 miles per hour uphill wind scenario, is 81.76 acres. Surprisingly, less area (251.21 acres) is expected to torch. The area where surface fires are expected is almost the same, at 386.5 acres). Thus, the greatest shift is from fires torching to spreading from canopy to canopy during a wildfire.

Surface fires continue to be predicted in the same locations as in the 20 miles per hour uphill wind scenario, likely because of a lack of trees. Torching can be expected northeast of LBNL's Strawberry gate to Grizzly Peak Boulevard, upper slopes of Hamilton Gulch, and portions throughout Claremont Canyon. Minor ridgelines between Lower Jordan Fire Trail and the southern boundary of the Plan Area are also expected to experience torching. Canopy fire still occurs in small patches, however the patches are larger, and located in FSSBER, northeast of the Botanical Garden, west of Thaddeus Hill, and in and in Claremont Canyon both north and south of Claremont Avenue.

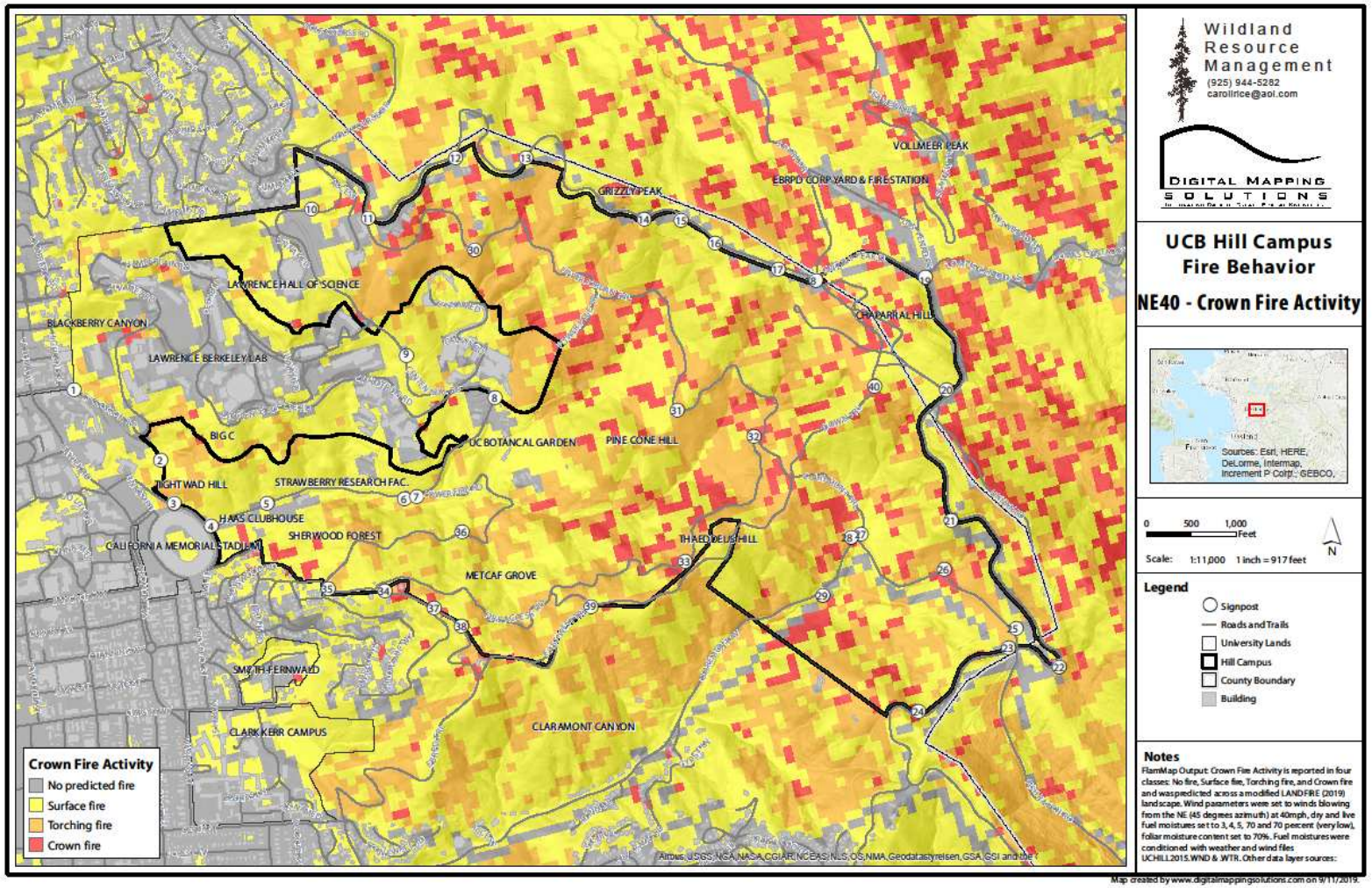


Figure 21. Predicted crown fire activity with a 40 mile per hour wind blowing from the northeast

Maximum Spotting Distance (Figure 19)

Not surprisingly, the scenario with faster windspeeds produced greater maximum spotting distances. The number of acres with 2,000 feet or more maximum spotting distance rose to 105 acres, or roughly an eighth of the Plan Area. However, areas of long-distance spotting potential change with a different wind direction. For example, there is no spotting predicted on Tightwad Hill. However, long-range spotting potential occurs above the Upper Jordan Fire Trail, northeast of the LBNL Strawberry Gate, and in Claremont Canyon northwest of signposts 27 and 28.

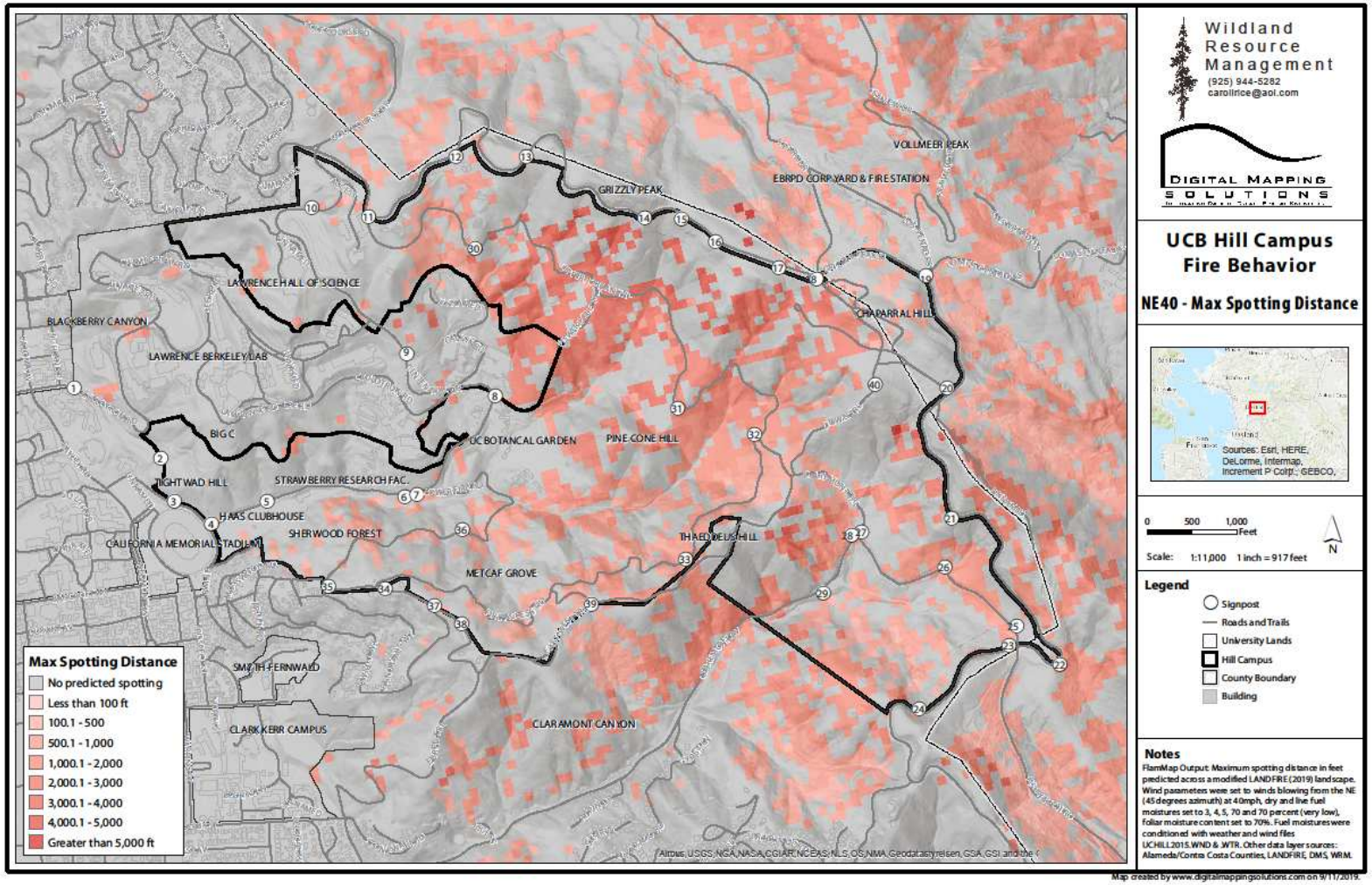


Figure 22. Predicted maximum spotting distance with a 40 mile per hour wind blowing from the northeast

4. DESCRIPTION OF PROPOSED TREATMENTS

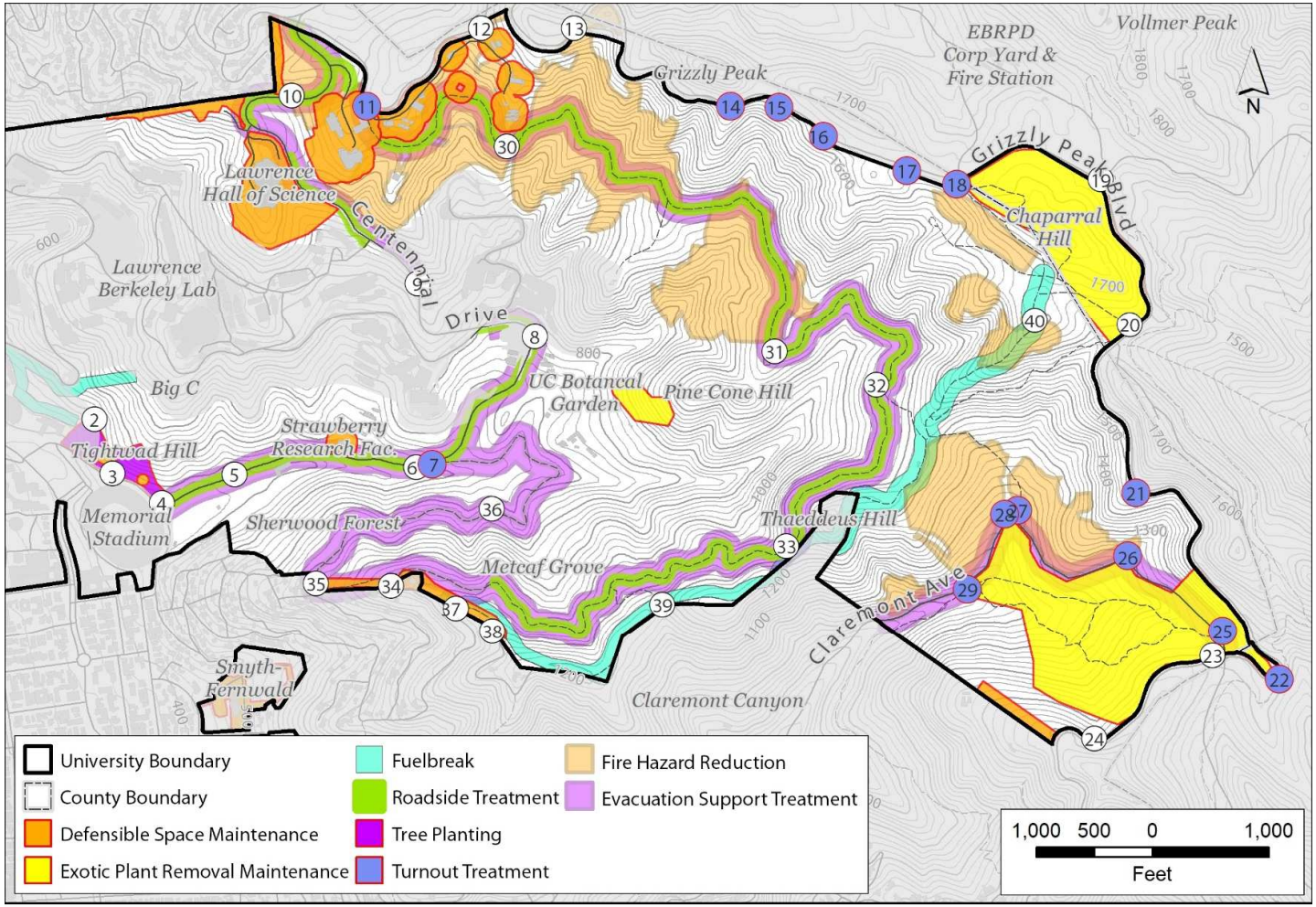
4.1 DESCRIPTION OF PROPOSED TREATMENTS

The Plan includes continuing with previously described (see section 2.4.4) current and ongoing vegetation treatments, and adding new vegetation treatments proposed for implementation throughout the Hill Campus. The treatment types include emergency evacuation support, fire hazard reduction, creation of fuel breaks, and creation of temporary refuge areas. As shown in Table 5, the combined acreage of the new treatment projects is 123.1 acres.

This section describes the four treatment types and the specific treatments that are proposed to be implemented in the Plan Area, which are shown in Figure 20 below.

Table 5. Acreages of Proposed Projects

Treatment Type	Acreage
Total Fire Hazard Reduction Fuel Treatment	98.4
Total Fuel breaks	23.2
Total Temporary Refuge Areas	1.54
Total	123.1



All Projects Considered

UC Berkeley Hill Campus Wildland Fuel Management Plan

Figure 23. Proposed areas of treatment

4.1.1 EVACUATION SUPPORT TREATMENTS

The treatment type of evacuation support is described in Section 1.4.4.4 Evacuation Support Treatments, as part of ongoing treatments undertaken by the university.

In addition to the treatments along Centennial Drive and Claremont Avenue, evacuation support treatments may be implemented along the Jordan Fire Trail (both Upper and Lower), the route along Grizzly Peak Boulevard and the route to LBNL from Hearst Avenue. The East Bay Regional Park District and East Bay Municipal Utility District both manage vegetation on the eastern side of Grizzly Peak Boulevard. UC Berkeley would conduct treatments along the western side of Grizzly Peak Boulevard similar to those proposed along Centennial Drive and Claremont Avenue.

Work associated with evacuation support treatments may involve complete closure of portions of Claremont Avenue, for a few hours at a time to allow cutting and skidding of trees growing close to the road. The Upper Jordan Fire Trail, an unimproved road on UC Berkeley land, would be closed to the public as necessary during tree removal activities. UC Berkeley will coordinate with local fire departments to permit emergency access or alternative access to the land served by the fire trail.

It is expected that the vast majority, if not all, of the work will be road-based with the use of a grapple saw and loader. The equipment will be positioned on the road and will reach into the vegetation. Hand crews will be used to apply herbicide as needed.

Figure 24. Example of a grapple saw

Completion of the proposed vegetation removal to support evacuation support treatments is expected to require 10 weeks spread over two years. In general, work could be conducted year-around but may be timed to minimize environmental effects (e.g., erosion, disturbance of special-status species). Skidding would not be performed after a heavy rain, per California Forest Practice Rules.

4.1.2 FIRE HAZARD REDUCTION TREATMENTS

Fire Hazard Reduction treatments, as shown on Figure 20, would be implemented in areas where treatments to remove eucalyptus were performed in the 1990s, but regrowth occurred because of ineffective herbicide application. In these locations a robust understory of California Bay and, to a lesser degree, Coast Live Oak, grew at the same time as the eucalyptus trees regrew. Currently these areas pose significant fire hazards in terms of flame lengths and ember production, and spotting distribution.

Treatments will consist of removing or pruning those trees most likely to torch and produce embers afar, potentially near the Campus Park or along the Jordan Fire Trail or near research and education facilities on campus.

The Fire Hazard Reduction Treatment involves the following activities:

- Evaluate trees and shrubs for both vertical and horizontal spacing and their corresponding potential to torch and produce embers; and
- Remove tall, unhealthy or structurally unsound trees, predominantly eucalyptus that are likely to torch and distribute embers; and remove short trees under tall trees.

Criteria for tree removal includes flammability/fire hazard, consideration of tree health, structure, height, potential for failure/falling, and competition with other trees (including for water, space, and light), and high fuel volume production of small diameter fuels. Criteria for retention of trees includes fuel characteristics (flammability, fuel volume amount of dead material), consideration of ability to slow spreading of invasive species and surface fuels, protection of understory, encouragement of nesting and improvement of flight patterns of raptors, prevention of erosion, and cost of removal.

Grouping of multiple trees that have torching potential because of their vertical connectedness will be thinned so that the canopies are separated vertically, with preference for retention being healthier trees that will allow for sustained growth. Tree health is measured in part by crown ratio (proportion of crown with foliage). Trees will be removed following a variable density thinning strategy to prevent crown fire spread by using gaps in tree canopy. Diagrams and pictures of variable density thinning appear as Appendix B. Canopy cover and tree density will be variable to help reduce canopy fire spread.

In a few locations of the Plan Area, in the denser stands where terrain is too steep to tractor yard, and cable yarding is infeasible, trees may be felled across slope and positioned against cut stumps so they remain stable over time. All tops and limbs must to be lopped and scattered or chipped as required. In these cases, stump heights may exceed six inches in order to safely hold log segments to be left on-site. All trees proposed for these alternative treatments must receive prior approval from project managers.

Otherwise, vegetation in specific areas identified as projects will be treated through the combination of the use of machinery and hand labor. Trees would be felled using hand tools or a mechanized feller-buncher or grapple saw. Road-based operations will be used wherever possible so disturbance off

roads, skid trails and fire trails is minimized. To prevent resprouting, an herbicide will be applied by a licensed California Qualified Applicator to the cambium ring of eucalyptus and acacia stumps. See Section 4.5 for specific herbicides considered. Felled trees will be skidded by rubber-tired or tracked vehicles along skid trails to landings. Selected tree trunks will be left on the slope. At the landings, trees would be stored or chipped using a grapple-fed chipper or a tracked chipper. Whole trees will be fed into the chipper and pulled through the blades by a conveyor belt and feed wheel. Chips will be both spread on-site to depth of six inches or less, or transported to an air curtain or gasifier to supply electricity directly to the university. Along roads and buildings, lower limbs of trees will be pruned, understory vegetation shortened and grass mowed.

Wherever possible, trees will be removed with machinery that can be positioned on roads, skid trails, landings and fire trails. Use of equipment with articulated arms with attached saws or grapples will be preferred types of machinery. During tree removal operations tractors will be positioned on existing, stable roads adjacent to some of the steeper areas, and cut material is winched for chipping and or hauling. Trees on steeper slopes and within 50 feet of water courses will be felled using hand-held equipment only; no heavy equipment is used for cutting or chipping in steep areas. Trees on steeper slopes will be felled using hand-held equipment only; no heavy equipment is used for cutting or chipping. A crane (positioned on a road) may be used to reposition tree trunks after cutting.

In most cases felled trees are removed (skidded) by rubber-tired or tracked vehicles along paths to landings.

In some cases, landings may not be needed, while in other cases, because cut material is to be mostly chipped and broadcasted back into the treatment areas, the chippers may be stationed on roads and out into the cutting areas, which will reduce the need for many of these landings. The equipment available to the operator and the limits on chip depths will be determined by the need to avoid and minimize impacts to sensitive resources (e.g., special-status wildlife) if present.

4.1.2.1 Access for Treatment Areas

There is vehicle access into and out of the treatment areas, with alternatives to allow for phased operations and account for public safety. All internal roads will need to be kept passable during operations for fire and emergency vehicle access. Truck traffic will need to be limited to weekdays and non-holidays typically between 8AM and 6PM and internal roads will need to be posted and closed to public access during operations. Upper Jordan Fire Trail is heavily used by the public, and is the main internal road accessing treatment areas. These notifications will be made at least a week in advance and posted at all trailheads with an information contact.

Cut material will not be removed from UC Berkeley property so vehicle traffic will consist primarily of moving equipment into and around the project area, and road watering as needed to reduce any fugitive road dust. Equipment will include low-bed trucks hauling chippers, skidders and tractors, as well as water trucks and service and employee vehicles.

Project equipment and debris will be staged in areas adjacent to Upper Jordan Fire Trail and in previously disturbed areas. Where possible, the project will use staging areas, landings and skid trails

from previous logging activities rather than constructing new ones. Equipment would be staged, fueled, and maintained at these landings while contractors are mobilized. Environmentally sensitive areas would be avoided. At the landings, trees would be stored temporarily, or chipped, or burned.

Most of the treatment area has slopes from 10-45 percent and is not too steep for travel by tractors and rubber-tired skidders. Tractors can also be positioned on existing and stable roads adjacent to some of the steeper areas, and cut material winched for chipping and or hauling. Some of these areas (less than 20 acres) could be ground-cable yarded from existing roads if desired. Grapple saws are types of equipment that can minimize ground disturbance. Because of a long reach from an articulated arm, trees can be cut and placed without traveling off the roadbed.

All of the area containing dense eucalyptus was removed in the past with tractors, however the pine stands on some of the steeper areas have not been removed. These stands will require more extensive "line pulling", or "endlining" (i.e. an operator will pull their tractor winch cables up to 100 feet to cut trees and "whole tree yard" the trees to more gentle ground or a landing for chipping). In some isolated cases where the distances are too great, these trees will need to be bucked and left on site, and the tops lopped and scattered. This could occur in areas smaller than 1/10th of an acre, and no closer than 300 feet from a structure. Where flame lengths are predicted to already be greater than 12 feet, cut material can remain.

There are many places, depending on equipment capabilities, where a chipper could be walked out onto some of the gentler terrain to chip and broadcast material; other areas will require logs to be skidded to a roadside or landing for chipping.

Existing landings are located adjacent to fire trails and paved roads. Equipment would be staged, fueled, and maintained at existing landings while contractors are mobilized. At these landings, trees are stored, chipped using a grapple-fed chipper or a tracked chipper, or transported to an air-curtain burner for disposal.

4.1.2.2 Biomass Disposal for Fire Hazard Reduction Treatments

Vegetation removed during treatment activities is called biomass. The objective is to leave or use all downed material on UC Berkeley property. Projects would leave or use all downed material on UC Berkeley property. The potential to obtain funds from the sale of salvaged wood materials is not part of the current project. A small portion of chips will be staged at various locations for potential use by a gasifier or use on the Campus Park. A greater volume of the biomass generated will be burned with an air curtain type of burner on UC Berkeley property, either in the Plan Area or outside the area. Some logs will be used as barriers to vehicular traffic on the Hill Campus, and otherwise kept as logs onsite.

Selected tree trunks are left on the slope. The trunks of these trees are cut into 20-to 30-foot lengths. In these cases, downed trees are cut by chain saws such that all portions of the tree are within six inches of the ground. Where possible, tree trunks will be placed and anchored to prevent movement, to help control sediment and erosion or support wildlife habitat. Other logs will be positioned on UC Berkeley property as barriers to illegal vehicular access.

Whole trees are fed into the chipper and pulled through the blades by a conveyor belt and feed wheel. Alternatively, the tracked chipper is driven to downed trees on slopes less than three percent. Remaining wood chips are expected to be between one and four inches long and would be spread on up to 20 percent of the site to a maximum depth of six inches, except for in Evacuation Support Treatment areas, and Defensible Space treatment areas, where the maximum depth is three inches. UC Berkeley will use some of the wood chips to create sediment traps. The maximum depth of chips is used for the sediment trap to increase both the length of time the traps function and the amount of sediment that can be retained. Chips may also be spread to the maximum depth over uneven terrain and around stumps. Chips will be spread on skid paths to reduce disturbance of soil. UC Berkeley expects the chips to decompose in approximately five years, restoring the original contours of the portion of the site in which they would be spread and reducing the evidence of skid road creation. Chip decomposition in previous projects on the UC Hill Campus has been observed to be five inches per year.[10]

4.1.2.3 Fire Hazard Reduction Projects

Fire Hazard Reduction (FHR) projects were identified in six discrete areas (see Figure 20 *Proposed Areas of Treatment*) in the Plan Area. The six treatment areas fall within three broad treatment areas: Strawberry Canyon, Frowning Ridge, and Claremont Canyon. The Strawberry FHR Project covers 23.7-acres, the Claremont FHR Project includes a 25.5-acre area and the Frowning FHR Project covers a 49.2-acre area. In all three areas, the treatments would focus on removing high hazard vegetation. The projects in the Strawberry Canyon treatment area are near the MSRI, SSL, LBNL and LHS with treatments aimed at protecting those facilities, as well as downhill near the Campus Park. The projects in the Frowning Ridge treatment area are uphill of the Botanical Garden and LBNL, and are similarly aimed at protecting those facilities, as well as downhill near the Campus Park. Actions in the uphill portion near Grizzly Peak Boulevard of the Frowning Ridge treatment area will also minimize the ability of embers to spread downhill to the Campus Park. Projects in Claremont Canyon area are aimed at protecting nearby residential neighborhoods, EBMUD watershed lands, and bolstering efforts to keep a fire from spreading to Strawberry Canyon through Hamilton Gulch.

The total area to be treated in these three projects is approximately 98.4 acres. Most of the treatment area comprises dense pine and eucalyptus tree cover that will have the trees cut, stumps treated, and protection given to interspersed native oak, bay and other tree species as well as native brush vegetation.

Proposed projects are also located in smaller areas in which brush is abundant but trees are sparse (fewer than 3 trees per acre) that will also be treated, but yarding will be less feasible or desirable given the potential impacts to existing vegetation and soils. Trees cut in these areas will be mostly felled, bucked and the tops lopped and scattered to a height less than 24 inches on-site to accelerate decomposition and reduce fuel loading. Cut material is not expected to be of large volume and is left on site when it cannot be safely or feasibly chipped, in lengths no longer than two feet. Large trunk segments will be fallen across slopes to ensure stability over time, and not positioned in a way that could undesirably alter surface water flow. Some of these log segments may exceed 24 inches in height

[10] Hazardous Fire Risk Reduction Environmental Impact Statement East Bay Hills, California, November 2014.

once on the ground, but will be limbed to minimize height. No cut material would be left within 20 feet of any watercourse or swale.

Strawberry Fire Hazard Reduction Project

Trees would be cut and moved, per Section 3.1.2. In addition, a cable system may also be used to move logs to landings without use of vehicles. UC Berkeley will use landings and skid trails from previous logging activities; six existing landings are adjacent to fire trails or paved roads in the Strawberry FHR treatment area. Equipment would be staged, fueled, and maintained at existing landings while contractors are mobilized. Any eucalyptus and acacia cut would be prevented from resprouting by application of herbicides to the stumps, as described in Section 3.2.

Completion of the Strawberry FHR treatment is expected to require 10 weeks spread over two years. In general, work could be conducted year-around but may be timed to minimize environmental effects (e.g., erosion and disturbance of special-status species). Skidding would not be performed after a heavy rain. Initial work contracts may be issued for several noncontiguous areas, for example, several five-acre areas adjacent to Grizzly Peak Boulevard. Subsequent work areas would be contiguous to those already completed, each with a clear path to the existing landing areas.

Claremont Fire Hazard Reduction Project

The Claremont FHR treatment involves similar activities as the Strawberry FHR treatment. Three roads to be used mainly follow existing dirt roads created during work done in 1974 and 1975 when trees were last cut on the site. Four existing landings are adjacent to existing fire trails or paved roads in the project area. Trees on steeper slopes and within 50 feet of water courses would be felled using hand-held equipment only; no heavy equipment would be used for cutting or chipping in these areas.

UC Berkeley anticipates that completion of the proposed work would extend over a period of two years, with 10 weeks of actual vegetation removal work. In general, work could be conducted year-around but may be timed to minimize environmental effects (e.g. erosion, disturbance of special-status species). Temporary closure of Claremont Avenue may be required during cutting and skidding of trees that are close to the roadway.

Frowning Fire Hazard Reduction Project

The same procedures described for the Strawberry FHR treatment area above would be used for tree removal, management of cut material, suppression of resprouting from stumps, and suppression of seedlings at Frowning Ridge.

In the Frowning FHR, temporary closure of Grizzly Peak Boulevard may be required during cutting and skidding of trees close to the roadway. The Upper Jordan Fire Trail, an unimproved road on UC Berkeley land, would be closed to the public as necessary during treatments. UC Berkeley would coordinate with local fire departments to permit emergency access or alternative access to the land served by the fire trail.

Eleven existing landings are located adjacent to fire trails or paved roads in the project area. Equipment would be staged, fueled, and maintained at these landings while contractors are mobilized. Environmentally sensitive areas would be avoided, through the use of exclusionary fencing or other types of protection and demarcation.

Completion of the proposed vegetation removal in the Frowning FHR is expected to require an estimated 10 weeks spread over two years. In general, work could be conducted year-around but may be timed to minimize environmental effects (e.g. erosion, disturbance of special-status species). Skidding would not be performed after a heavy rain. Initial work contracts may be issued for several noncontiguous areas, for example, eight acres of cutting adjacent to each of the two lower landings in the first year. Subsequent work areas would be contiguous to those already completed, each with a clear path to the existing landing areas.

A more specific type of fire hazard reduction treatments will occur along ridgelines in Frowning Ridge treatment areas FHR-FR-1, FHR-FR-3, FHR-FR-4, and FHR-FR-5, which are major spur ridgelines, and are crucial for fire containment. Treatments will be aimed at providing an anchor point for fire containment and reduce ember-casting potential. Fuel characteristics would produce a flame length less than 4 feet in areas with trees, and potentially offer backfire potential (i.e. with fuels that could ignite when managed) in areas of grass cover (based on post-treatment fuel conditions and weather condition noted in the fire behavior analysis (Appendix A). Post-treatment fuel characteristics will result in minimal torching or crown fire potential. The total width of treatment areas is approximately 200-feet along the ridges.

Treatment will remove small diameter trees and branches lower than 8 feet of the ground, per defensible space standards described in Section 5.3.1. All dead, unhealthy or leaning trees will be removed.

Grouping of multiple trees that have torching potential because of their vertical connectedness will be separated, with preference for retention being healthy trees that will allow for sustained growth. Health is measured in part by crown ratio (proportion of crown with foliage). Tree canopy cover and tree density will be of variable density to impede canopy fire spread.

4.1.3 FUEL BREAK TREATMENTS

Fuel breaks are strategically located linear strips where vegetation has been treated or removed to slow the spread of a fire or reduce the likelihood of crown fire transition, and as a defensive position for firefighting. Fuel breaks in the Plan Area are typically installed on ridgetops to limit spotting from trees between canyons and generally to help prevent fire spread from one canyon to another (see Figure 20).

There are two fuel break treatment projects, totaling approximately 23 acres in size. One is located along the ridgeline between Strawberry and Claremont Canyons, known as the East-West Fuel Break, and the other is located along Hearst Avenue as it approaches the LBNL entry gate, known as the Hearst Gate Fuel Break.

East-West Fuel Break Project

This fuel break project serves to help contain a wildfire spreading from Claremont Canyon to Strawberry Canyon and vice versa (see Figure 20). Because current vegetation in this treatment area is both forested and a mixture of brush and grass, the character of the fuel break will be a shaded fuel break in some segments and a non-shaded fuel break in other segments. In these locations, Monterey pines will be removed to prevent torching and ember production, and more importantly, ember distribution in the adjacent canyon. The material from the treatment within 50 feet of the fire trail will be chipped, and where the pines are located in scrub stands further than 100 from the fire trail, they will be lopped and scattered.

Part of the fuel break installation will require minor blading of the roadbed on the fire trail so that it is passible with 4WD vehicles, a Type III wildland engine, or small slip-on type engines after the project is complete. Machinery will also be used to cut brush and remove trees. Wherever possible, operations will be road-based to minimize disturbance. Hand labor will augment machinery to cut brush and move biomass. Herbicides will be applied via cut-stump method to eucalyptus and acacia trees. It is expected to take up to 8 weeks to implement using both manual and mechanical treatment methods.

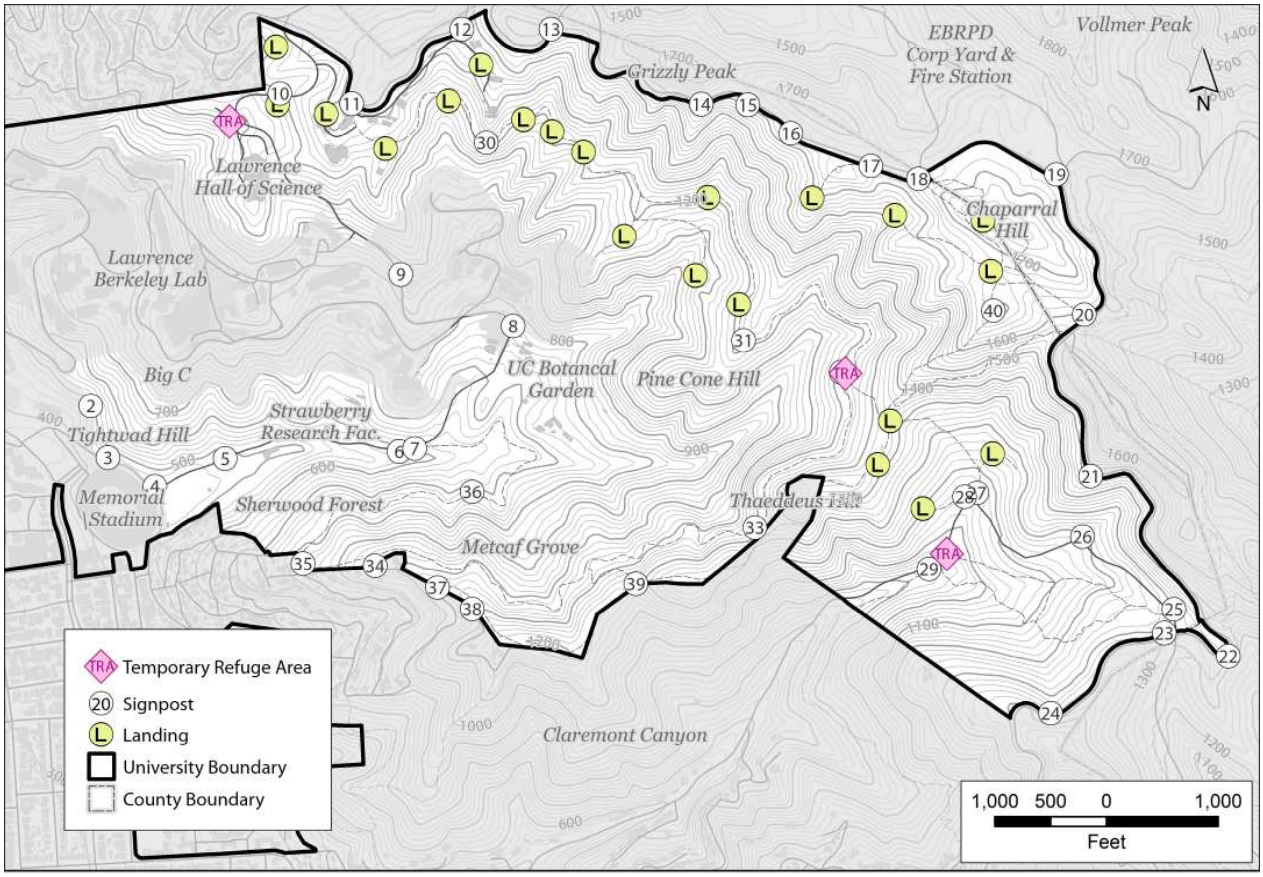
Hearst Gate Fuel Break Project

The Hearst Gate fuel break will aid containment of a fire between the LBNL's southern border and the Hill Campus. It is fairly short, covering approximately one acre. Because of its small size and lack of access, hand labor will be used to remove understory vegetation, thin and limb trees. The stumps of eucalyptus trees that were removed will have herbicide applied to prevent resprouting. Implementation of the Hearst Gate FB Project is expected to take up to 4 weeks to complete.

4.1.4 CREATION OF ROADSIDE TEMPORARY REFUGE AREAS

In selected locations, usually near intersections of roads and fire trails, all trees and shrubs will be removed in an approximately 200-foot diameter from the edge of pavement or fire trail to create an area of low-fuel volume for a firefighter and evacuee temporary refuge area. In order to provide an area where fire behavior would be survivable, the resulting fuel characteristics would consist of low volume, short fuels. This could be mowed grass, pavement, bare ground, or a thin layer of leaf litter. Temporary refuge areas can be constructed using a combination of machinery, hand labor and selective use of herbicides using cut-stump application methods. These places of refuge will be located in collaboration with local wildfire responding agencies, and sized to conform to previously published documents and guidelines.

Three temporary refuge areas are proposed. These locations include an area within the existing parking lot of the Lawrence Hall of Science, in an open area near Signpost 29 in Claremont Canyon, and adjacent to and within the Jordan Fire Trail.



Temporary Refuge Areas

UC Berkeley Hill Campus Wildland Fuel Management Plan

Figure 24. Map of temporary refuge areas

5. DESCRIPTION OF TREATMENT ACTIVITIES

Currently in the Plan Area, hand labor is used to create areas for defensible space. Occasionally, prescribed herbivory augments the hand labor; however, prescribed herbivory is a minor component of the total 154 acres currently treated with hand labor. Mechanical equipment is most often used for tree removal and cutting large areas of French broom. UC Berkeley anticipates using mechanical equipment to treat almost 284 acres of the Plan Area, primarily with a grapple saw and other types of equipment with articulated arms, which would result in most work being road-based. Prescribed burning is not currently conducted in the Hill Campus, but is included as a potential treatment activity. Herbicides are currently used sparingly, hand applied on stump cuts of trees and shrubs that sprout.

Table 6. Treatment Activities

Treatment Activities	Description	Method of Application
Manual Treatment	Use of hand tools and hand-operated power tools to cut, clear or prune herbaceous or woody species	Hand pull and grub, thin, prune, hand pile, lop and scatter, hand plant; often combined with pile burning
Mechanical Treatment	Use of motorized equipment to cut, uproot, crush/compact, or chop existing vegetation	Mastication, chipping, brush raking, grading, tilling, mowing, roller chopping, chaining, skidding and removal, piling; can be combined with pile burning
Prescribed Burning	Pile burning: Prescribed burning of piles of vegetative material to reduce fuel and/or remove biomass following treatment Broadcast burning: Prescribed burning to reduce fuels over a larger area or restore fire resiliency in target fire-adapted plant communities; would be conducted under specific conditions related to fuels, weather, and other variables	Pile burning: Place removed fuels in piles on site and burn fuel Broadcast burning: Burn understory within timber or oak forests, or broadcast treatment using fire with a control line along the perimeter
Prescribed Herbivory (managed livestock grazing)	Use of domestic livestock to reduce a target plant population thereby reducing fire fuels or competition of desired plant species	Grazing or browsing by cows, goats, or sheep
Herbicides	Chemical application designed to inhibit growth of target plant species	Ground-level application only, such as paint-on stems, backpack hand-applicator, hypo-hatchet tree injection, foliar spray with a hooded spray wand, or hand placement of pellets by a licensed applicator. No aerial spray is allowed.

5.1 MANUAL VEGETATION TREATMENT

Manual treatment involves the use of hand tools and hand-operated power tools to cut, clear, or prune herbaceous and woody species. Activities could include thinning trees; cutting undesired competing brush species; manually pulling, grubbing, or digging out root systems of undesired plants to prevent sprouting and regrowth; and placing mulch, such as wood chips from pruning operations, around desired vegetation to limit competitive growth and minimize erosion. This treatment allows for selective removal of targeted species.

Manual treatments are typically used in developed, sensitive or hard to access areas for small-scale projects. Consequently, ground disturbance associated with manual treatments is typically less than mechanical treatment within an equivalent area. Hand tools include, but are not limited to, shovels, Pulaski hoes, McLeod fire tools, weed whips and "weed wrenches" (tools that pull both shrub and root systems out), chain saws, hand saws, mechanized brush cutters, machetes, pruning shears, and loppers. Hand cutting can involve workers using chain saws and wedges to fell a tree in a direction that facilitates processing. Masticators, which is mechanical treatment method, and chippers are used occasionally to assist with manual treatments and process cut materials into mulch to remain on-site.

UC Berkeley has historically used hand labor for managing vegetation throughout the Plan Area, sometimes with the assistance of volunteer labor.

5.2 MECHANICAL VEGETATION TREATMENT

Mechanical treatment involves the use of heavy motorized equipment, such as tractors, masticators, or specially designed vehicles with attached implements designed to cut, tear uproot, crush/compact, or chop target vegetation. Mechanical treatment methods that may be used include mowing, masticating (mulching), grubbing, and chipping, among others. Grading by a tractor with an attached blade can maintain passable roadbeds. Mowing using a tractor reduces fuel height of vegetation and performed at the appropriate time can reduce the amount of manual work needed to maintain an area. Almost all of the eucalyptus stands in the Plan Area were removed using tracked mechanical equipment. Current best practices limit mechanical equipment to slopes less than 30 percent grade, which would constrain the area to be treated with tracked mechanical equipment.

Mechanical treatment is effective at removing dense stands of vegetation and is typically used in shrub and tree fuel types. Mechanical treatments are appropriate where a high level of control over vegetation removal is needed, such as near residential areas or in sensitive habitats. Unless followed with targeted application of herbicides, mechanical treatment has limited use for noxious weed control, as the machinery tends to spread seeds and may not kill root systems.

In certain instances, two or more pieces of heavy equipment are used in concert. For example, a feller-buncher or grapple saw 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. Feller-bunchers and grapple saws are used to quickly remove trees and may need to be supported by skidders to move trees and materials. Feller-bunchers are tracked vehicles with a self-leveling cab that mechanically grasps the standing tree, cuts it with a hydraulically powered chain saw,

and arranges cut trees in bunches to facilitate dragging the tree out of the forest (skidding). Use of feller-bunchers is limited to slopes of less than approximately 45 percent. As the name implies, grapple saws have a saw at the end of an articulated arm and are restricted to flatter terrain, usually on a roadbed.

Landings are typically needed to sort, store, and chip trees into mulch and spread or remove the material. A flat landing area is typically used for yarding operations, temporary stacking, loading, and trucking logs or brush off the treated site. All of the ground containing dense eucalyptus in the Plan Area was logged in the past with tractors. The Plan Area contains numerous landings from previous vegetation treatment activities that would also be used for future treatments (see Figure 9 in Section 2.5.3).

Typically, mechanical treatments will not result in the hauling of cut material from UC Berkeley property. Cut material is chipped and looped and spread directly back onto treated areas to help mitigate erosion potential. As needed, some logs could be anchored and utilized on-site for erosion mitigation, as well as for wildlife habitat. Vegetation removed during mechanical treatments (i.e. biomass) is handled in the same methods as described above under Manual Methods, or it is piled on-site and burned.

5.2.1 MOWING

Mowing tools, including rotary mowers or straight-edged cutter bar mowers, or flails, is 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. Timing of mowing has an impact on the type of vegetation promoted: mowing after annual grasses have dried enhances growing conditions for perennial native grasses, provided mowing does not occur during seed production. Mowing at the appropriate time to a height (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.

5.2.2 THINNING

The term thinning has broad use in forestry and wildland management. Thinning spans the complete removal of overstory to allow for the understory to thrive, or removal of smaller diameter trees (everything from trees smaller than four inches to 24 inches in diameter), or the removal of large diameter trees (as in commercial forestry operations). Sometimes thinning is specified in terms of post-treatment desired condition, i.e. tree spacing (distance between trees) or number of trees left per acre, or species and size class distribution of remaining trees.

During forestry operations tractors are positioned on existing, stable roads adjacent to some of the steeper areas, and cut material is winched for chipping and or hauling. Trees on steeper slopes and within 50 feet of water courses are felled using hand-held equipment only; no heavy equipment is used for cutting or chipping in steep areas. Trees on steeper slopes are felled using hand-held equipment

only; no heavy equipment is used for cutting or chipping. A crane (positioned on a road) may be used to reposition tree trunks after cutting.

Felled trees are dragged (skidded) by rubber-tired or tracked vehicles along paths to landings. Selected tree trunks are left on the slope. The trunks of these trees are cut into 20-to 30-foot lengths. In these cases, downed trees are cut by chain saws such that all portions of the tree are within six inches of the ground. Where possible, tree trunks are placed and anchored to prevent movement, to help control sediment and erosion or support wildlife habitat. Other logs are positioned on university property as barriers to illegal vehicular access.

A cable system may also be used to move logs to the landings without use of vehicles. As much as possible, UC Berkeley uses landings and skid trails from previous logging activities rather than constructing new ones.

5.2.3 YARDING

Yarding is the process of transporting entire or portions of cut trees from their cut location to a landing or staging area for subsequent treatment or transport. 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 relocated. 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. 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.

5.3 PRESCRIBED BURNING

Prescribed burning is the intentional use of fire under specified conditions of fuels, weather, location, and other variables defined in a burn plan. Prescribed fire produces lower intensity surface fires that are intended to control vegetation by enhancing the growth, reproduction, or vigor of certain species, in addition to managing fuel loads and/or maintaining a targeted vegetation community. Surface fire burns along the surface without significant movement into understory or overstory vegetation, with low flame lengths. Typically, prescribed burning requires the construction of fire breaks using manual or mechanical treatments if roads and trails are not already in place; use of existing roads and trails is preferred. In some cases, larger vegetation may be trimmed or removed manually by hand crews or by mechanical equipment in advance of burning, or vegetation may be pretreated with herbicides to kill the aboveground portions and cause them to dry before burning. Prescribed burning may be used where other activities are not feasible because of rocky soils, steep slopes, or irregular terrain. Factors that are considered when designing and implementing a prescribed burn include risk to structures and property, land use, environmental impacts, weather conditions, soil stability, slope and aspect, soil type, vegetation types and density, fuel moisture content, time of year, fire return interval, and the efficacy of alternative activity methods. Burning may occur throughout the year, but it is usually conducted during late spring when the ground is still wet, or during the fall or winter when

precipitation is imminent, and plants have completed their yearly growth cycle and their moisture content has declined.

UC Berkeley has carried out prescribed burns in the Plan Area in late winter when leaf litter is dry but annual grasses are moist and green, and in the summer when grasses are dry. No specific locations have been identified for prescribed burning, however, areas that have been treated under the CCI/CAL FIRE grant period are potential locations because fuels will have been reduced and a prescribed burn could be easier to control.

Prescribed burns typically last one day. Equipment used for a prescribed burn include fire engines, work crews, bulldozers, masticators, onsite water truck for fire suppression, and ignition devices such as drip torches. Prescribed burns in the Plan Area require a burn plan that includes a smoke management plan approved by the Bay Area Air Quality Management District.

5.4 PRESCRIBED HERBIVORY (MANAGED LIVESTOCK GRAZING)

Prescribed herbivory, also known as "managed livestock grazing," is the use of domestic livestock to accomplish specific and measurable vegetation management objectives. Objectives include removing biomass (fine fuel loads), reducing populations of specific plant species, slowing the reestablishment of shrubs on burned or mechanically thinned sites, preventing shrub encroachment into grasslands, and improving plant community structure for wildlife habitat values. Grazing is used both as an initial treatment to reduce the volume of hazardous fuels, and as a maintenance technique. See Section 7 of this Plan for more details about maintenance. Goats, sheets and cattle are most commonly used for this purpose because they are relatively common and easy to manage.[11] Grazing/browsing by these animals is best used for green herbaceous plants that produce fine fuels and smaller diameter woody species that produce highly flammable fire fuels.

Livestock are best selected according to site conditions and the types of vegetation that need to be managed. Goats are typically best suited to woody vegetation and in steep terrain; sheep eat both forbs and grasses and can be used in a variety of environments; and cattle are better suited to herbaceous plants, especially grasses. Successful herbivory treatments can enhance habitat for certain wildlife. For example, shrub species increase their vegetative output for winter browsing by deer and other wildlife. Managed grazing is most effective employing the proper combination of animals, stocking rates, timing, and rest.

Prescribed herbivory by domestic livestock should occur when the target plant species is (are) palatable and when feeding on the plants can damage them or reduce viable seeds. Additionally, prescribed herbivory should be restricted during critical growth stages of desirable plant species. When desirable species are present, the area needs a period without herbivory to allow the desirable species to recover. The frequency of moving the livestock is based on numerous site-specific factors, including slope, density and type of vegetation, stocking rate, type of livestock, and precipitation/moisture content of vegetation. Targeted grazing by livestock requires infrastructure that could include a herder,

[11] Natural Resource Conservation Service, Grazing Lands Technology Institute, 2003. National Range and Pasture Handbook. Revision 1.

fencing, mineral block, supplemental food and/or a watering site to keep the animals within the desired area. In addition, portable electric fencing is typically used for prescribed herbivory.

Prescribed herbivory is not new to the Hill Campus; both Strawberry and Claremont canyons were dairy farms in the 1940s. Since the 1980s, goats were used to manage grasslands and shrublands in the Plan Area including below the Lawrence Hall of Science, Math Science Research Institute and FSSBER. Currently, a herd of goats is reducing fuel hazards in the 29-acre FSSBER managed by the Office of Laboratory Animal Care (OLAC); OLAC and Facilities Services have an agreement to graze four locations in the Hill Campus to evaluate the potential of this treatment.

5.5 HERBICIDE APPLICATION

Herbicides are chemicals that damage or kill plants and are categorized as selective or non-selective. Selective herbicides kill only a specific type of plant, such as broad-leaved plants, which allows the herbicide to be used to control weeds while maintaining grass species. Other herbicides, such as glyphosate (Roundup®), are non-selective and kill any type of plant. UC Berkeley could use Garlon 4[12] or Garlon 3A (triclopyr) and Stalker[13] (imazapyr) Transline, Glyphosate, Snapshot, and Surflan, using cut stump or basal bark application, which are described below. UC has a rigorous review procedure regarding the use of Tier 1 herbicides and prohibits all other herbicides.

To prevent resprouting of removed trees, an herbicide solution will be applied by a licensed California Qualified Applicator to the cambium ring of eucalyptus and acacia stumps within three minutes of felling. The herbicide mixture will likely consist of a combination of Garlon 14 or Garlon 3A (triclopyr) and Stalker[15] (imazapyr) in a solution of methylated seed oil, water, and marking dye. If application within 60 feet of running or standing water is necessary, Garlon 3A will be used, which is approved for use near aquatic areas. A typical tree requires 1 to 2 ounces of diluted solution. Foliar spray with a hooded spray wand is also considered.

Use of herbicides will be subject to the restrictions described on the product label, specified in the recommendation by the Pesticide Control Advisor, and by the 2014 Final Hazardous Fire Risk Reduction Environmental Impact Statement East Bay Hills, California.

5.5.1 CUT STUMP APPLICATION

To maximize the efficacy of treatment the tree must be cut leaving a stump not more than four inches in height above soil surface and the cut surface of the stump must be treated with an herbicide within minutes of the cut. The herbicides applied to the outer portion of the cut surface, including the cambium of the tree. The herbicide is translocated to the roots and disrupts the transportation of nutrients and water, causing the plant to die.

5.5.2 BASAL BARK APPLICATION

[12] Garlon is a registered trademark of Dow AgroSciences.
[13] Stalker is a registered trademark of BASF.
[14] Garlon is a registered trademark of Dow AgroSciences.
[15] Stalker is a registered trademark of BASF.

This treatment consists of spraying at very low pressure a solution of the herbicide mixed with esterified vegetable oil to the lower 12 to 15 inches of the resprout. This application method permits the operator to selectively treat resprouts without injury to adjacent vegetation, and is particularly effective on resprouts less than six inches in diameter. Since pines do not resprout, stump treatments are not needed.

Herbicide application must comply with the U.S. Environmental Protection Agency (EPA) label directions, as well as California Environmental Protection Agency and Department of Pesticide Regulation (DPR) label standards. Only ground-level application occurs. UC Berkeley does not use aerial application.

5.6 BIOMASS UTILIZATION & DISPOSAL

Implementation of the Plan would result in the removal of trees and other vegetation. Biomass disposal and utilization is a significant component of treatments.

Biomass may be disposed of or utilized in the following ways:

- Retained as logs to perform as barriers and erosion control
- Chipped and kept on site for erosion control
- Burned as logs in an air curtain burner
- Cut into smaller pieces and distributed in small areas in remote locations of the Hill Campus

Vegetation removed during mechanical treatments (i.e. biomass) is either left on-site or disposed of by skidding to landings to be chipped and then spread on-site. Alternatively, biomass can be transferred to other locations on the campus, disposed of in an air-curtain burner, or piled on-site and burned. Some of the fuels removed during treatment will also be converted to biochar, a charcoal-like substance that can be used to fertilize the soil.

The Plan includes possible purchase and utilization of a gasifier and a wood-burning hydronic boiler, and/or the rental of an air curtain burner. Both the air curtain burner and gasifier will reduce the production of greenhouse gases. For example, by burning the biomass the production of methane during chip and log decomposition will be eliminated. The fuels that are removed during treatment can be converted to electricity, which would substitute for the use of fossil fuels. The feedstock, or energy, would come from removing overstocked locations dead, unhealthy and structurally unsound trees instead of fossil fuels. The electricity would be used directly by the university. Both the air curtain burner and the gasifier can produce biochar for distribution to campus facilities such as the Botanical Garden or the Campus Park.

In some remote locations biomass will be lopped and spread directly back onto the treated areas to help mitigate erosion potential. Contract specifications will ensure the volume of cut material left onsite will be kept low enough to prevent excessive fuel buildup and not interfere with access for monitoring or establishment of desirable revegetation.

Opportunities for the use of large logs for barriers for vehicular traffic will be used when possible, as it both provides long-term carbon storage and blocks unauthorized use of the Hill Campus. In addition, logs will be anchored and used for on-site erosion control, and as wildlife habitat.

There will be no hauling of cut material from UC Berkeley property. Chips may be used on the Campus Park; the use of these chips would supplant the purchase of chips from elsewhere, thereby further reducing greenhouse gasses from the creation of chips and transportation needed.

Chipping is performed following other treatment techniques to reduce 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.

A significant amount of the material will be chipped. Chips are to be kept at average depths less than six inches as measured across any random 1/10 acre area. In general, chips are deposited back into the areas where trees are being removed. Additional areas, if needed, may be designated.

Chips could cover the majority of treated areas in the Plan Area. After approximately 3-5 years, chips are expected to decompose and native vegetation will cover treated areas. Past experience in Claremont Canyon demonstrated chips decomposed at a rate of five inches per year.[16] Eucalyptus chips were deposited in 2004 to a depth of 27 inches. As shown in the photo, in 2010 bare ground is exposed, indicating that decomposition occurred over 5 years, 5 months, at a rate of 5 inches per year (rate = 0.42 inches/month). Using this same rate a 24-inch depth of eucalyptus chips should be expected to decompose in 5 years, and the six-inch depth in a year.

The fire risk is anticipated to be low in areas mulched with chips because of the expected slow rate of spread, short flame lengths, and complete lack of spotting potential. Moreover, the size of the chipped materials is generally large and blocky, with a low surface area-to-volume ratio, and high packing ratio, which means they have much more fuel than air in the fuelbed which generally prevents ignition, and further limits spread since material adjacent to a burning particle is difficult to ignite. Dr. John Shelly, University of California Cooperative Extension Advisor, Forest Products and Biomass Utilization, visited the site in Claremont Canyon on August 25, 2006, specifically to assess the signs of decomposition. His opinion was that the chips would need to be 10 feet deep in order to produce anaerobic activity to the point of being an ignition concern. Chips maintain a higher moisture content than uncovered soil, which helps further prevent ignitions, even during dry conditions (Shelly, 2006). This provides a more favorable growing site for oak seedlings, but impedes the growth of eucalyptus seedlings or sprouts. In a fire event, areas where chips have been applied would facilitate containment.

[16] Communication dated March 4, between FEMA and UC Berkeley. Photo by Tom Klatt, UCPD, UC Berkeley.

Figure 25. Photographic documentation of chip decomposition

6. ENVIRONMENTAL PROTECTION MEASURES

6.1 BEST MANAGEMENT PRACTICES FOR FIRE MITIGATION

The following standards will be incorporated into the design on treatments in the Plan Area to minimize environmental impacts and comply with laws and regulations. Some of these standards have been applied to UC Berkeley wildland fuel treatments since 2014.

Projects funded by the CCI/CAL FIRE grant will comply with the Protective Practices for CAL FIRE's 35 Emergency Fuels Reduction Projects dated April 5, 2019.

- Treatment scheduling will be planned for times of the year which maximize effectiveness and minimize environmental impacts.
    - Large oak and pine trees should be pruned between November and April to avoid attracting pathogens.
    - Grasslands should be mowed to four inches in spring, but no later than June 15.
    - Desirable native annual wildflowers may remain unmowed until after they have set seed, provided they do not form a means of rapidly transmitting fire to any structure.
    - Treatments will not occur during extreme fire danger conditions. It is the contractor's responsibility to determine the fire danger prior to start of work every day.
    - Contractors will have spark arrestors on all machinery and comply with PRC 4442.
    - Ground-disturbing activities will not occur within one week following an inch of rain, or unless the ground is consistently firm and can support the weight of machinery without creating ruts.
- Diversity of native plant species should be retained to the greatest extent possible while still achieving fire safety goals. It is sometimes beneficial to selectively reduce the dominance of aggressive, flammable species such as French broom. Retain specimens of plants that are unusual or uncommon on the site. Invasive weeds in project areas should be removed as part of the vegetation management. Noxious weeds, such as French broom, yellow star thistle, stink-wort, and poison hemlock, should be targeted for removal. All eucalyptus and Monterey pine seedlings will be removed.
- Vegetation disposal should be conducted in a way that does not impact the natural vegetation or increase flammability. Generally, cut vegetation, such as grass and broadleafed herbs, can be left in place. Plant material can be left to decompose on site, removed to an offsite location, mowed, or chipped and spread to a depth of less than six inches. In no case may unprocessed plant material be left within 10 feet of the pavement edge or 100 feet of any structure.
- Bare soil will not be exposed in over 50 percent of the site, and no single bare patch will be larger than 15 square feet.
- Haul routes, if used for removal of vegetation debris, should be restored to natural conditions by the contractor upon completion of the project. Repair should ensure the ground is protected from erosion, rainfall runoff is dispersed, and native vegetation is restored before October 15.

- Herbicide application will be conducted per the label, and per the recommendation provided by the Licensed Pest Control Advisor. Notification signage will be posted at each pedestrian entry point, and the footpaths will be closed during herbicide application.

7. PERMITS AND APPROVALS

As UC Berkeley implements specific treatments activities in the Plan Area, regulatory permits and approvals may be required for individual project depending on circumstances. UC Berkeley may need permits and/or approvals from the following agencies:

7.1 FEDERAL

- **U.S Army Corps of Engineers**: Compliance with Section 404 of the Clean Water Act for discharge of fill Waters of the U.S.

- **U.S. Fish and Wildlife Service**: Compliance with Section 10 of the federal Endangered Species Act or potentially Section 7 of the act, if federal approval of the project is necessary.

7.2 STATE

- **California Department of Fish and Wildlife**: Compliance with the California Endangered Species Act, incidental take authorization permits under Section 2018 of the Fish and Game Code if take of listed species is likely to occur, and Section 1602 streambed alteration notification for activities that occur within the bed or bank of adjacent waterways.

- **San Francisco Regional Water Quality Control Board**: National Pollutant Discharge Elimination System construction stormwater permit for disturbance of more than 1 acre, discharge permit for stormwater, and Clean Water Act Section 401 water quality certification or waste discharge requirements.

7.3 LOCAL

- **Bay Area Air Quality Management District**: Open burn permit and review of smoke management plans for prescribed burns.

8. MAINTENANCE AND MONITORING

Treatment intervals and any ongoing maintenance activities that would occur after the initial treatments are based on results of a monitoring program described in this section. Maintenance is expected to be less burdensome after the treatments described herein are implemented. An example of the reduced maintenance needed has occurred in Claremont Canyon, where treatments similar to those proposed for fire hazard reduction projects were performed. After initial work to control French broom and Italian thistles, the area requires minimal follow-up treatments to be maintained in a relatively low fire hazard state. The importance of low maintenance needs cannot be under-estimated because university funding fluctuates, and funding for maintenance may not be consistently allocated

8.1 PURPOSE

Maintenance of treatments is needed in order to retain the benefits of initial treatments. While UC Berkeley has maintained defensible space around buildings and property boundaries, it has not maintained treatments completed in the 1970s, '80s, and '90s, which now need retreatment. UC Berkeley has maintained all areas treated since 2005. This has entailed retreating areas within 100 feet of property boundaries and buildings to maintain required defensible space, mowing roadside grass, and searching for and removing invasive flammable vegetation that was targeted for removal in initial treatment (i.e. Monterey pine, acacia and eucalyptus). Most maintenance actions have been conducted annually, however some treatments, such as the maintenance of a fuel break at the eastern end of Canyon and Moss roads on Panoramic Hill, have been conducted on a periodic basis (i.e., every 3-5 years).

Some treatments in the Plan Area conducted between 1988-1991 have not been retreated since and need treatment; these treatments are considered maintenance in forest management time-frames. These encompass areas in the Plan Area where eucalyptus resprouts from the 1974-1975 treatment were recut, but not killed. In other areas, such as in the FSSBER, maintenance of the tree stand has been sporadic. In the 1980s, trees smaller than eight inches in diameter were removed and killed. Goats were used to reduce surface fuels by grazing understory vegetation. In the 2000s most Monterey pines were cut and the large boles of the trees left to decompose. Maintenance of the areas within 100-feet of buildings continued through the defensible space treatments.

Monitoring is necessary to determine if the treatments are progressing towards and ultimately meeting the goals as defined in the 2020 LRDP, which are:

- Reducing fuel load by removing dead materials, reducing plant density and favoring species with lower fuel content;
- Reducing horizontal spread by reducing small-diameter fuel materials and by separating dense clusters of vegetation with areas of lower fuel load; and

- Reducing vertical fire spread by increasing separation of understory and crown fuels.

The monitoring program guides future maintenance requirements. It involves a set of protocols and methods, defining performance standards, establishing reporting standards, and scheduling and proposing remedial measures if performance standards are not met. Remedial measures to assist with obtaining specific performance standards will rely on maintenance actions. The maintenance actions may be used for routine site maintenance or prescribed as a remedial measure to meet a specific performance standard**.**

Permanent photographic points will be established within each treatment area in order to track changes in vegetation composition in the years following initial treatments.

8.2 FIELD INVESTIGATION (POST-TREATMENT)

Post-treatment monitoring will include data collection on the following environmental characteristics: erosion/soil stability, woody plant resprouting, resulting vegetation composition, and wood chip placement on a Post-treatment Assessment Form (Appendix E). This form and many elements of the monitoring program were informed by the EBRPD Wildfire hazard Reduction and Resource Management Plan (WHRRMP). Post-treatment monitoring will be conducted immediately following vegetation treatments. This data will also be evaluated on an annual basis, following treatment, to inform the ongoing management strategies. Year 0 post-treatment data will be compared to the results of subsequent post-treatment assessments during monitoring years 1-5, 7, 9, and 10 to track changes in vegetation following treatments.

Monitoring methods specific to post-treatment field assessments are presented below.

8.2.1 EXOTIC VEGETATION COMPOSITION

To measure exotic vegetation (and conversely native vegetation) composition within each treatment area, a biologist will walk through each separate vegetation community and determine the absolute vegetative cover of all woody plant species (native and exotic) based on a visual assessment in a way that is reproducible. This information will be used to establish baseline exotic woody plant cover percentages that will later be compared to post-treatment levels to determine if exotic woody plant performance standards are being met.

Additionally, stands of California Invasive Plant Council (Cal-IPC) rated exotic plant species known to be problematic in the Proposed Plan Area (Table 7) will be mapped in the field. These mapped areas will be targeted for treatment when vegetation management activities occur at the site.

Vegetation composition is linked to fuel characteristics and can therefore indicate whether the wildland fire related goals are being met.

Table 7. Exotic Plants Known to Occur in the Proposed Plan Area

Common Name	Scientific Name	Growth Form	Cal-IPC Rating[1]
Blackwood acacia	*Acacia melanoxylon*	Tree	Limited
Italian thistle	*Carduus pycnocephalus*	Annual herb	Moderate
Purple starthistle	*Centaurea calcitrapa*	Biennial herb	Moderate
Yellow starthistle	*Centaurea solstitialis*	Annual herb	High
Bull thistle	*Cirsium vulgare*	Biennial herb	Moderate
Poison hemlock	*Conium maculatum*	Biennial herb	Moderate
Pampas grass	*Cortaderia* spp.	Perennial herb	High
Artichoke thistle	*Cynara cardunculus*	Perennial herb	Moderate
Cape ivy	*Delairea odorata*	Perennial vine	High
Red gum	*Eucalyptus camaldulensis*	Tree	Limited
Blue gum	*Eucalyptus globulus*	Tree	Limited
Oblong spurge	*Euphorbia oblongata*	Perennial herb	Limited
French broom	*Genista monspessulana*	Shrub	High
Harding grass	*Phalaris aquatica*	Perennial herb	Moderate
Monterey pine	*Pinus radiata*	Tree	Not rated
Himalayan blackberry	*Rubus armeniacus*	Shrub/vine	High
Milk thistle	*Silybum marianum*	Annual/biennial herb	Limited

[1]Ratings from California Invasive Plant Inventory (Cal-IPC 2006), from http://www.cal-ipc.org/, accessed August, 2013.

8.2.2 HYDROLOGIC FEATURES

Hydrologic features, such as springs, creeks or dams, not previously identified in prior surveys should be mapped on an aerial photograph or with a handheld GPS unit, where accessible. The type of feature, type of underlying material (substrate), dominant vegetation growing within the feature, and general water quality (i.e. color, clarity [turbidity]) will be photographed and described.

8.2.3 PHOTOGRAPHIC POINTS

Photographs will be used in combination with other recorded data as a guide to track post-treatment conditions of an area. These photographs will also be used to inform the adaptive management strategy and develop or alter existing prescriptions for further action on the site.

The compass direction of each photograph will be noted and included in the annual report. Photographs will be taken during the both pre- and post-treatment site assessments, ideally during the spring or winter in order to show the full extent of each vegetation type. In years where individual sites do not require maintenance treatments, photographic documentation is not required.

Permanent photographic points will be established within each site determined to require initial and maintenance-type treatments prior to treatment during the first site assessment of each treatment area. The location of each photographic point will be established centrally within the treatment area or in a location that is representative of the site. Larger treatment areas may require multiple photographic points in order to track changes in vegetation. Once the location of the photographic point is determined, it will be recorded with a GPS unit or the coordinates will be recorded in latitude/longitude decimal degree format out to at least four decimal points, so that photographs can be taken from the same location during subsequent site visits.

Once a photographic point is established, at least one photograph facing north (recorded as 0°) will be taken from a height of 5 feet, with the horizontal angle of the photograph noted if not level. If additional photographs are required at the photographic point (to form a panorama), photographs will be taken in clockwise order with the azimuth/bearing rounded to the nearest 5 degrees.

8.2.4 EROSION/SOIL STABILITY

Within disturbed areas of bare soil (vehicle tracks, soil exposed during mechanical shrub removal, or other soil disturbances), signs of erosion, which include rills, large erosional features, and sloughed soil/seeding materials will be noted and mapped on aerial photographs or with a handheld GPS unit, where accessible. These areas will be addressed in the Stormwater Pollution Prevention Plan (SWPPP).

8.2.5 WOODY PLANT RESPROUTING

All trees found resprouting after being treated will be counted and their general location mapped on aerial photographs, or with a handheld GPS unit, where accessible, or sufficiently described so that additional maintenance treatments on the resprouts can be undertaken.

8.2.6 VEGETATION COMPOSITION

To measure exotic vegetation (and conversely native vegetation) composition within each treatment area, a technician with suitable expertise will walk through each separate vegetation community and determine the absolute vegetative cover of all woody plant species (native and exotic) based on a visual assessment in a way that is reproducible.

8.2.7 WOOD CHIP PLACEMENT AND DEPTH

All areas where wood chips were placed following tree/shrub removal will be mapped on aerial photographs or with a handheld GPS unit, where accessible. The depth of the wood chips will also be measured in ten random locations to the nearest inch to obtain an estimate of average depth.

8.3 ANNUAL REPORTING

A monitoring report detailing the status of each treatment area will be prepared annually. Annual reports for each treated area will be submitted to Facilities Services by March 31 each year following implementation of each treatment. The annual report will detail the monitoring activities and findings of the previous year. For each treatment area, the report will include the following:

- Table detailing the treated acreages of each vegetation community;
- A list of the maintenance treatments that took place over the previous year;
- Plant composition of each vegetation community based on aerial cover of woody species;
- Photographs obtained from each of the permanent photographic points;
- Wildlife observations;
- A description and photographs of any previously undocumented hydrologic features and archeological resources;
- A general description of the site, including general habitat quality;
- A description and photographs of any areas of surface erosion;
- Description of the location of applied wood chips and the average depth of the wood chips in these areas;
- A description of any sightings of special-status species and a completed California Natural Diversity Database (CNDDB) form for each observation;

Following initial treatment, annual reporting will be conducted every year for the first 5 years (Years 1 through 5), then every other year (Year 7 and Year 9), and will conclude with a final Year 10 monitoring report, assuming the WVFMP will be updated in that time. Table 8 includes a list of task items to be included in the annual report for each treatment area.

Table 8. Monitoring and Reporting Schedule

	Task Item	**Year 1-5, 7, 9, 10**
Post-treatment Field Investigations		
	Exotic Vegetation Composition	**X**
	Hydrologic Features	**X**
	Archeological Resources	**X**
	Photographic Points	**X**
	Erosion/Soil Stability	**X**
	Woody Plant Resprouting	**X**

	Task Item	Year 1-5, 7, 9, 10
	Vegetation Composition	**X**
	Wood Chip Placement	**X**
Annual Reporting		**X**

8.4 PERFORMANCE CRITERIA

This section defines specific performance criteria for each of the monitored site characteristics described in Section 3 necessary to trigger future treatments and/or remedial measures as part of the adaptive management framework. These provide interim and long-term success criteria for 10 years. Acreage criteria are established for both native and exotic vegetation within each vegetation community to be evaluated at the end.

8.4.1 EXOTIC SPECIES MANAGEMENT

Because significant levels of exotic woody plant recruitment are possible following the initial treatments, performance standards relating to reductions in exotic species plant cover focus on gradual reductions in exotic plant cover. It is anticipated that as exotic plants are removed, they will be replaced with native species through natural recruitment.

The overall vegetation recruitment and retention goal for native plants is 80 percent. Success will be achieved if the "native" metrics are attained or exceeded. Therefore, the overall goal is defined as achieving the projected "native/exotic" ratios. Non-native annual grasses are not considered in the performance standard of 20 percent cover.

To prevent the successful resprouting of treated exotic trees, all observed resprouts must be removed/treated within one year of the initial treatment (generally the cut-stump method) of exotic trees.

8.4.2 WOODY VEGETATION COMPOSITION

In each portion of the treatment area treated for woody species removal, using the methods described in the EBRPD WHRRMP, no more than 10 percent of the canopy coverage removed may return due to resprouts or seedlings. For example, if woody species comprised 80 percent of aerial cover prior to treatment within a portion of a treatment area where all woody plants were removed, the resprouts/seedlings of those plants could not comprise more than 8 percent of the aerial cover of that area.

8.4.3 WOOD CHIP PLACEMENT

These performance criteria focus on what proportion of a treatment area can be covered with wood chips, the depth of the applied wood chips, and the location of the distributed wood chips in relation to sensitive resources.

Within a treatment area, woodchip cover cannot exceed 20 percent of the treatment area if a tracked chipper is used or 10 percent of the treatment area if chipping is confined to roadways and landings. Additionally, the depth of applied wood chips cannot exceed six inches (USFWS 2013).

8.4.4 SOIL STABILITY AND EROSION

Unless noted during the initial site assessment, less than 5% of treatment area effected by vegetation treatment activities (e.g., vehicle tracks, upturned roots, and heavy equipment) or other disturbance shall have visual evidence of erosion (i.e. rills) that lead to a drainage feature or watercourse.

8.5 ADAPTIVE MANAGEMENT

In order to ensure that each treatment area is meeting or progressing towards meeting all applicable performance standards, remedial measures will be implemented as recommended in the annual report.

Should success criteria not be met, maintenance measures may be implemented more frequently or by use of different maintenance approaches, substituting new methods for those that do not demonstrate adequate efficacy. Coppiced (resprouted) eucalyptus stumps will be treated with differing methods until 100 percent mortality is achieved. The eucalyptus latent seed stock is expected to require between 5 and 10 years of continuous treatment to ensure that any naturally germinating exotic trees are removed. Seeds that are carried onto project areas from adjacent areas (typically upslope) would require treatment until all possible seed sources have been eliminated. In areas containing other exotic vegetation (e.g. broom) exceeding coverage of stated goals, the project manager would select from a suite of approaches to achieve annual metrics for each floral community. As unanticipated results are recorded (both positive and negative), these would further inform the project manager such that future maintenance either expands upon successful methods or discontinues those methods found to be unsuitable or ineffective. This process of adaptive management would be employed throughout the project life-cycle.

After UC Berkeley implements the maintenance treatments and remedial measures recommended in the annual report, through an adaptive management process, further monitoring on the resulting site conditions and subsequent treatments will ensure that the treated areas are meeting the goals of this WVFMP and the LRDP. New remedial measures not described may be employed as they are developed over the course of the current monitoring period of each treatment area.

8.5.1 EXOTIC SPECIES CONTROL

In areas more than 20 percent of the aerial cover consist of exotic species in Table 7, above8, additional maintenance actions will take place that year.

8.5.2 EROSION CONTROL

A native (locally sourced) erosion control seed mixture will be applied to all areas of accelerated erosion per the approved SWPPP.

If necessary, fencing, signs, maintenance, access control, jute fabric, sediment traps, mulch, straw wattles (without plastic monofilament netting), vegetation management, exotic species control, or any other commonly used erosion control technique may be used.

8.5.3 RELOCATE AND REDISTRIBUTE WOOD CHIPS

If the average depth of the wood chips exceeds six inches, wood chips in these areas will be redistributed to an average depth at or below six inches, as long as this does not result in an increase to the extent of the wood chips above 20 percent (when a track chipper is used) or 10 percent (if chipping was performed on a road or landing).

If wood chips cannot be distributed to the depth and extent permissible in the treatment area, the wood chips can be relocated and distributed to another treatment area where chipping has occurred, as long as the addition of wood chips will not prevent the receiving treatment area from meeting its performance criteria.

UCB Wildfire Hazard Reduction
Post Assesment Data Sheet

Grant Ar | Date (MM/DD/YYYY):

Recorder(s):

Acres Treated and Method:

Vegetation Management Goal(s):

Initial Treatment Date and Type(s):

Last Maintenance Treatment Date and Type

Special Status Animal Species Habitat initials:

% Increase — Species Status

% Decrease — Special Keystone Indicator

❑ No Change Total species:

Soil Erosion Potential ❑ Yes ❑ No initials:

Existing Sediment Sources:

Erosion Control Measures: Adequate Needed Explain below:

Vegetation Types Present initials:	**Special Status Plants Present** initial:
% cover within the treatment area	% cover within the treatment area

Existing Invasive Species initials:

% cover in Treatment Area	Management needed:	

New Hydrologic Features initials:

❑ Wetland ❑ none distance from treatment: ft.

length: ft. width: ft.

❑ Stream distance from treatment: ft.

❑ Riparian vegetation present length: ft. width: ft.

Cultural Resources Present: ❑ yes ❑ no initials:

Adequately Protected: ❑ yes ❑ no ❑ Site flagged

Description:

Site 1 GPS coordinates: E: N: State Plane Ca III NAD83

Site 2 GPS coordinates: E: N: State Plane Ca III NAD83

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