

January 20, 2009

Los Trancos County Water District
Attn: Charles Krenz, Board Member
162 Los Trancos Circle
Portola Valley, CA 94028

**LOS TRANCOS WOODS
ROADSIDE FIRE HAZARD ASSESSMENT AND MITIGATION PLAN
With Notes on Common Defensible Space Problems**

PURPOSE

Moritz Arboricultural Consulting of Urban Forestry Associates was hired by the Los Trancos County Water District to conduct a roadside fire hazard assessment of the Los Trancos Woods area then develop a fire-hazard mitigation implementation strategy. The roadside survey was conducted on August 5, 2008 where the condition of roadside vegetation was observed with consideration of a wildfire threat to the community. Special attention was given to prevention of roadside ignitions, safe evacuation of residents, and fire suppression activities. We have also included some notes on common defensible space problems and landscape mitigation strategies.

IMPORTANCE OF ROADWAYS TO FIRE PREVENTION AND SUPPRESSION

Well-managed roadside vegetation is critical for firesafe emergency response and for evacuation, but it is also important for ignition prevention and limit the potential spread of urban wildfires. Heavy roadside vegetation can generate flame lengths that fully span a two lane road, reaching temperatures in excess of 1,400 degrees Fahrenheit. Fires of these intensities can obstruct emergency response and evacuation. These roads need adequate roadside clearance to keep flames away from fleeing residents and emergency responders. Most of the fatalities in the 1991 Tunnel Fire in Oakland and the 2003 Cedar Fire in San Diego occurred while residents were trying to evacuate.

Management of roadside vegetation, particularly fine, easily ignited materials at the edge of pavement helps prevent automobile- or smoking-related fires from starting. Roadsides are common areas of wildfire ignition.

Clearing shrubbery and pruning trees near the edges of roads helps slow fires, reduce fire intensity and gives firefighters more time to reach these fires before they become conflagrations. Once a wildfire spreads through a community, roadways become evacuation routes for residents and working platforms for fire containment, fire suppression and structural defense. After firefighters arrive and begin their initial attack, roads become critical to firefighting operations. Roads permit physical access to large fire trucks, provide safe driving and working conditions where flames are not impinging on roads and hydrants, and create interruptions in the burning landscape that make fire control possible.

ROADWAY NETWORK AND EMERGENCY NEEDS

Roadside vegetation fuels are the most critical on the treatment agenda because getting residents out safely and emergency crews into the residential areas and wildland fire zone are the most important actions in an urban/wildland fire event. In the event of a major wildfire in Los Trancos Woods, emergency personnel would direct evacuees from collector streets to arterial avenues that lead out of the community to safety. Firefighters would also use roads as part of their strategy to contain and suppress the fire.

Los Trancos Woods is served by five collector streets: Ramona Road, Vista Verde Way, Old Spanish Trail, Joaquin Road, and Los Trancos Road (including both the Portola Valley section, the Los Trancos Woods section and Los Trancos Circle). These collectors connect with two principal arterial avenues leading north to Portola Valley: Los Trancos Road in the northeast and Alpine Road to the northwest. The community should consider the possibility of designating (and providing signage for) a southern evacuation route leading from Old Spanish Trail to Page Mill Road should the northern escape routes become blocked by fire. Another possible evacuation route to the north and then west is Rapley Trail off of Alpine Road that leads to Skyline Boulevard. Clearance along all of these roads in the community—local, collector, and arterial—including intersections is critically important. Of equal importance is the firesafe maintenance of the escape routes, particularly Los Trancos Road, to the north of the Los Trancos Woods study area. A well designed fire management plan along these roads can provide both riparian habitat and fire safety.

Roadside Vegetation Management Issues and Mitigation Strategies

The community-wide roadside assessment of vegetation revealed the following common roadside issues related to safe evacuation and effective fire suppression for the community:

Shoulder Grass and Weeds. Periodically disturbed (scarified by vehicles, graded, mowed or sprayed) roadside areas in the community support weedy plants including grasses and forbs. This is also where leaves, grass cuttings, and other organic matter including trash accumulate. In many areas shredded redwood bark has been used as landscaping mulch. All of these fine roadside fuels are particularly receptive to hot-car-exhaust fragments (“clinkers”), exposure to exhaust pipes and catalytic converters and discarded cigarettes or matches. Shoulder weeds should be mowed and raked clean annually beginning June 1st and so maintained throughout the fire season (as declared by the fire department) for a distance of at least 10 feet beyond the outward edge of paved roads. Substitute gravel or coarse wood chips for shredded redwood bark in landscaped areas along roadsides.

Roadside Shrubs. Privacy shrubbery and “volunteer” invasive shrubs commonly found along roadsides are easily ignited (especially where shoulder weeds are present) and burn with great intensity producing radiant heat and direct flame impingement hot enough to boil pavement. In addition, burning shrubs act as ‘ladder fuels’ that can move ground fires into the treetops where they become virtually unstoppable crown fires. Shrubs that have high surface to volume ratios (twiggy shrubs), shrubs that tend to accumulate dead materials (fine twigs and leaves) or have foliage rich in volatile oils (e.g., waxes, oils, and terpenes), or all three, are highly fire-prone and become troublesome along roadways.

Common roadside shrubs of concern in the area include four introduced shrubs French broom (*Genista monspessulana*), Spanish broom (*Spartium junceum*), juniper (*Juniperus* spp.), and Himalaya berry (*Rubus discolor*). Three native shrubs of concern include chamise (*Adenostoma fasciculatum*), manzanita (*Arctostaphylos glauca*, *A. tomentosa*), poison oak (*Toxicodendron diversiloba*), sagebrush (*Artemisia californica*) and coyote bush (*Baccharis pilularis*).

All shrubs should be removed from shoulder areas, extending 10 feet out from paved road surfaces. Shrubs and shrub islands (shrub islands should not be greater than 15-feet in diameter) in the 10- to 20-foot zone out from the road pavement should be separated by a distance of no less than two times the shrub or shrub-island height. This zone should be maintained throughout the fire season. Where steep natural drainages intersect roads, a 30-foot downslope treatment is advised. Annual treatments (e.g., mowing or spraying herbicide in a safe manner) may be necessary where there are heavy infestations of invasive shrubs such as broom.

Roadside Trees. Three common ornamental trees that have been planted along roadsides in Los Trancos Woods are Monterey pine (*Pinus radiata*), Monterey cypress (*Cupressus macrocarpa*), and bluegum eucalyptus (*Eucalyptus globulus*). Each of these trees can be extremely fire-prone, especially if they are not well maintained or grow near shrubbery that can ignite them from below. Other trees that are declining or diseased also create a fire hazard: Sudden Oak Death (*Phytophthora ramorum*) on coast live oak (*Quercus agrifolia*) is an example of a widespread disease in the community. These dry trees burn with great intensity, often causing crown fires and can cast embers downwind igniting new fires.

Trees growing near roadsides need to be pruned to a height of 16 feet above the road to give fire trucks clear access. Crown-to-crown continuity over the road surface (created by overhanging branches) needs to be disrupted by at least 10 feet. Large trees growing within 20 feet of roads need to be adequately spaced so their crowns are not touching with lower limbs pruned to a height of 8 to 10 feet above grade. On smaller trees, no more than 1/3 of the lower live crown should be removed. Tree litter including leaves, twigs, and bark need to be raked and removed. Dead trees should be cleared and trees infected with Sudden Oak Death should be treated or removed under the direction of a certified arborist.

Intersections. Vegetation clearance and maintenance near intersections is critical to facilitate good visibility for emergency traffic where vehicle speeds of panicking residents are high and smoke limits visibility. Fire engines also stage in these areas for safety reasons or to await an assignment from the fire incident command. There are five intersections in Los Trancos Woods (described below) that could be improved for fire safety. All intersections in the community should have an ongoing maintenance program to keep them safe.

1. Los Trancos Circle at El Nido: the large patch of Himalayan blackberry should be cleared.
2. Lake Road at Old Spanish Trail: shrubbery beneath a stand of eucalyptus should be cleared.
3. Joaquin Road at Old Spanish Trail: juniper beneath Monterey pines and Italian cypresses (*Cupressus sempervirens*) should be removed and trees thinned and pruned.
4. Las Piedras Court at Old Spanish Trail: continuity among shrubs and trees should be reduced or eliminated.
5. Bonita Road at El Rey Road: Some winter maintenance (mowing and raking) of periwinkle (*Vinca major*) should be performed. Periwinkle is resilient to periodic mowing and will quickly re-sprout.

Fire Hydrants. Firefighters need to be able to quickly find, couple their hoses to, and safely work near fire hydrants. The location of each hydrant should be clearly marked on the roadway with a standard, blue hydrant reflector. Vegetation for a distance of 20 feet surrounding each hydrant should be managed for fire control—ground fuels (grass, leaves, bark) removed, shrubs thinned and maintained, trees limbed up 8 to 10 feet. Areas immediately surrounding fire hydrants in Los Trancos Woods are generally well maintained, but could be improved. For example, at the intersection of Old Spanish Trail and Joaquin Road the hydrant is buried in oleander (*Nerium oleander*). The hydrant near 270 El Nido is located along a narrow stretch of road that would make it difficult for an engine to use without blocking the road. In this case, it might be prudent to create a turnout here.

General Roadside Conditions

Following is a description of roadside vegetation in Los Trancos Woods and adjacent communities and wildlands. Roads range from relatively wide, divided roads with gradual curves to extremely narrow winding roads. Roadside weeds on many of these roads appear to have been mowed for 4-6 feet from the roadside edge. On many undeveloped properties and undeveloped portions of residential properties, particularly those with steep slopes, the heavy fuels extend right up to the road edge. Beyond the weeds on scarified shoulders, weeds, shrubs and trees have been largely unmanaged in the community, which severely limits the road's value for safe evacuation, emergency response and fire perimeter control.

The emergency evacuation routes, particularly Los Trancos Road, are the highest priority for treatment.

Ramona Road. Ramona Road is a relatively wide, curb-edged, two-lane divided road leading from Los Trancos Road south to Vista Verde Way. Weeds and heavy brush including small bay laurel (*Umbellularia californica*), French broom, juniper, and toyon (*Heteromeles arbutifolia*) fuels along this road diminish its value for evacuation and firefighting needs. In addition to clearing and trimming roadside vegetation, it would be worthwhile to select less flammable brush species such as wax myrtle (*Myrica californica*), oleander, and red-flowering currant (*Ribes sanguineum*) for landscape planting.

Recommendations for Ramona Road:

- Thin out brush as much as possible, always favoring the more fire resistive species (See attached “Pyrophytic vs. Fire Resistant Plants”).
- Keep poison oak a minimum of twenty feet from the road edge horizontal distance.
- Remove trees that have the potential to fall during a fire, causing the fire safe access to become blocked. Sudden Oak Death is increasingly becoming an issue with dead falls. Trees with significant structural defects, such as basal decay cavities, or dead trunks.
- Perform severe crown reduction trimming on mature California bay laurels, pines.
- Remove all small trees of the following fire-prone species: California bay laurels, Douglas firs, pines, acacia, and broom.

Recommendations for the intersection of Ramona Road and Vista Verde Way:

- Replace lath fencing with wire.
- Replace potato vine with another more clean vine, as potato vines accumulate a high amount of dead material.

Carmel Way. Carmel Way is an extremely narrow, undivided road leading to the northeast from Ramona Road. The road ends at three driveways (that would provide a turn-around opportunity for fire trucks) and a fire hydrant. There has been some roadside mowing in the past that has provided some ignition protection. Fences along this road tend to crowd the road, confining anyone traveling along the road to the narrow paved surface itself. These fences should be moved back from the road at least 10 feet. There is also relatively flammable grape-stake fencing that could be replaced with heavier-timbered fencing or wire that would be less flammable. Vegetation northwest of the hydrant needs management for a distance of at least 30 feet. Ground fuels could be removed, shrubs reduced, and tree crowns separated and limbed up. There is an oak tree about half-way up Carmel Way that makes the road so narrow that a Type 1 engine could not pass by. This tree should be removed.

Deer Path Way. Deer Path Way is a narrow, one-lane road extending from Ramona Road to the east for about 600 feet where it ends in a cul-de-sac that serves two homes. Dense, heavy brush

vegetation north of the road encroaches nearly to the roadside; trees to the south could be thinned and lower branches pruned. Additional brush clearance is also needed north of the intersection to increase traffic visibility.

Los Trancos Road. *This road is the highest priority for treatment as this is the major emergency response and evacuation route for Los Trancos Woods.* Los Trancos Road enters the community from the north as a wide, curb-edged, two-lane divided road. Roadside vegetation is relatively well managed, even a model for fire management in some areas. However, the east/creek side has extremely severe fuel loading and a dangerous fuel architecture.

Accumulated organic matter inside the curbs creates areas where roadside fires could start. These fuels should be removed. Trees in this area could be thinned or pruned to reduce crown-to-crown contact. At its intersection with Ramona Road, Los Trancos Road narrows to a single-lane, two-way road that winds to the south and west. At its intersection with Los Trancos Circle, Los Trancos Road becomes an extremely narrow, one-lane, one-way road leading to Vista Verde Way. These roads are generally lined with periwinkle and other introduced plants; trees and shrubs heavily encroach on the roadsides, creating in places a virtual alleyway of vegetation.

Foxwood Road. Foxwood Road is an extremely narrow, single lane road that extends to the southeast from a meander of Los Trancos Road. The narrow road width, roadside shrubbery, trees, and fences limit the use and safety of this road during a wildfire. In addition to management of roadside fuels, additional pull-offs for off-street parking should be created.

Los Trancos Circle. Los Trancos Circle is a narrow, one-lane road leading from Vista Verde Way north to Los Trancos Road. Los Trancos Circle is the continuation of a one-way loop road leading from and back to Los Trancos Road. These one-way roads create the potential for confusion and accidents during a wildfire. This is an area where clear evacuation signs would be warranted. Roadside weeds are generally well managed along this road. There are places however where roadside weed abatement and management of blackberry and bay laurel is needed.

Recommendations for Los Trancos Circle:

- The east wildland side of Los Trancos Road requires a minimum 30 feet of treatment for optimum access/egress safety and efficiency.
- Favor the large, broadleaf trees such as buckeye and valley oak.
- Discriminate against California bay laurel and cypress. The coast live oak is moderately fire resistive.
- Weed abatement, including perry winkle, should be conducted on all properties. The perry winkle can be cut, mowed essentially in the spring so that all the new, more fire resistive shoots are cut.

- Reduce abundant California bay reproduction. Replace them with a fire resistive shrubs, such as English laurel (*Prunus laurocerasus*), which is doing well in this area.
- Conduct weed abatement. Springtime mowing in the periwinkle will result in new sprouts. Mulch in so that the leaves and accumulated dead material are broken up into a mulch.
- Encourage replacement of grape stake fence with more fire resistive heavy fences such as wire fencing or stucco fencing.
- Check grape vines for internal dead wood.
- If possible, increase the road width in the future.

Bonita Road. Bonita Road is a narrow, one-lane road leading from Los Trancos Circle to the southwest. Vertical and horizontal clearance along this road is limited and could restrict fire engine movement. In particular, there is a California bay tree adjacent to a utility pole that should be removed. Branches above the road should be pruned to create at least 16 feet of vertical clearance.

El Rey Road. El Rey Road is an extremely narrow, one-lane road leading from Bonita Road to the northwest.

Recommendations for Bonita Road and El Rey Road:

- Perform weeding, concentrating on the Vinca, up Bonita at the intersection of the two roads.
- Perform excessive weed abatement on the left side of the road at this intersection, continuing on up to the water tank.
- Construct grading to make this area accessible to a fire engine, as there is a dry hydrant in this location.

Lake Road. Lake Road is an extremely narrow, one lane road leading from Los Trancos Circle to the northwest. A eucalyptus stand near the intersection has been generally well managed in terms of fuel reduction. Brush lining the road creates heavy fuel loading that would make the area highly unattractive to firefighters. Clearing brush along this narrow road is critical. A turn-around (either a hammerhead or cul-de-sac) is needed for this road. At the intersection of Lake Road and Old Spanish Trail there is an opportunity to create place where fire engines could safely park and either draft water from the lake using a pump or connect to a pipe that would drain the lake. At least 30 feet of clearance near the lake would be needed for this use.

Recommendations for Lake Road:

- Move the hydrant back away from the road.
- Relocate the dry hydrant from the lake so that it is adjacent to the charged hydrant.
- Discontinue using bay laurel as a screen species.

El Nido Road. El Nido Road is an extremely narrow, on-lane road leading from Los Trancos Circle to the northwest. Beginning at the intersection with Los Trancos Circle there is a 6-foot high redwood fence that has been built dangerously close to the road. Where possible wood fences should be set back at least 10 feet with clearance of 10-feet on either side.

Recommendations for El Nido Road:

- Clear second driveway on the left to reduce the height of ladder fuels on the trees.

Recommendations for El Nido and Los Trancos Circle Intersection:

- Use wire or heavy solid material for fencing.
- Reduce amount of grape stake used for fencing.
- Increase weed abatement along the road.
- Remove debris off rooftops during late summer.
- Perform severe weed abatement from 1087 Los Trancos Road down to 1036 Los Trancos Road.

Vista Verde Way. Vista Verde Way is a relatively wide, curb-edged, two-way road leading from Los Trancos Road in the north and dead-ends in the south of the community. Roadside weeds have been fairly well managed along this roadway and provide about 6 feet of clearance on both sides. Roadside trees and heavy brush including Spanish broom along this road need management. Just south of the intersection of Los Trancos Circle there is a redwood fence that crowds the road excessively. This fence disallows evacuees from adequately using the road for evacuation and emergency response.

Recommendations for Vista Verde Way:

- Remove young Monterey pine trees as soon as possible to save on the expense of removing larger trees.
- Move back exotic and invasive species at 3 Vista Verde.
- Heavily reduce ladder fuels at the intersection of Vista Verde Road and Ramona Road.

Old Spanish Trail. Old Spanish Trail is a relatively wide, curb-edged, two-way road leading from Lake Road southeast to its dead-end in the south. This road is an important connector between the north and south portions of Los Trancos Woods. Like Vista Verde Way, roadside weeds have been well managed to a roadside width of 4-6 feet. This should be extended to at least 10 feet. Trees and shrubs encroach dangerously along roadsides and should be cut back and separated.

Recommendations for Old Spanish Trail:

- Replace the heads on the water tank so that they are the correct pipe diameter for hose attachment.
- Reduce vertical fuel continuity at 271 Old Spanish Trail.

- 495 Old Spanish Trail needs to have a hammer head turnout and gates set in 40 feet from the road to allow access for two fire engines up the driveway.

Recommendations for intersection of Old Spanish Trail and Joaquin Road:

- Create an enhanced fire apparatus clear zone at the intersection.

Las Piedras Court. Las Piedras Court is a relatively wide, curb-edged, two-way road leading from Old Spanish Trail northeast to a cul-de-sac that circles a coast redwood. With the exception of the first 100 feet on the southeast side of the street (where trees and shrubs crowd the street), roadside vegetation clearance is exceptional.

Joaquin Road. Joaquin Road is a relatively wide, curb-edged, two-way road connecting Old Spanish Trail with Alpine Road in the West. Roadside weeds are generally well managed. Beyond the mowed areas, shrubbery and tree boughs contact ground fuels creating a ladder pathway for fires. Fire-prone plants noted along this road include juniper, chamise, French broom, California bay, and eucalyptus. These plants should be removed or maintained and separated.

Recommendations for Joaquin Road:

- Create a cow line by raising the tree canopies at the transition zone.
- Create a minimum of 20 feet downslope clearing.

Alpine Road: Alpine Road is an extremely narrow, winding, two-way road on the western side of the community. Very little vegetation management has been practiced along this road. Roadside weeds, shrubbery, and trees would make this potentially important evacuation route problematic.

Recommendations for Alpine Evacuation Route:

- As oak trees slowly move out, focus on replacing with species such as big leaf maple, rather than the California bays which will naturally take over.

Ciervos Road: Ciervos Road is an extremely narrow, two-way road at the end of Alpine Road. Roadside weeds have been mowed to some extent, but like many roads in the community, shrubs and trees crowd the road and should be trimmed back and thinned.

ROLE OF DEFENSIBLE SPACE FOR EVACUATION

The condition of vegetation surrounding homes is critically important for roadside safety. Homes that are fully-involved with fire radiate intense heat that can close a roadway to emergency traffic. Encouraging residents to create defensible space around homes will benefit

the entire community. During the roadside survey we identified the following common issues relating to defensible space around homes:

Fencing:

Grape stake and lath fence is far more flammable than a more heavily timber fence. Replace with heavy timber or wire fencing. It was suggested that it be broken between solid wood and wire, replacing the wood where you need privacy say like opposite windows or patio or hot tubs etc and wire fence in other areas in the fence line.

Landscape Mulch: Shredded redwood bark (also called gorilla hair) is a common but highly flammable mulch used in the community. Using coarser organic materials such as wood chips or gravel create a more fire-resistive landscape.

Weeds: Dry grasses and forbs create fuelbeds that support fast-moving fires. Weed abatement helps slow fires and keep them out of trees and shrubs. Periwinkle is a common ornamental that now blankets roadsides in the community. This perennial flower can be mowed in the spring and will vigorously re-sprout new, more fire resistive shoots. All cuttings should be raked and removed.

Fire-prone Ornamentals:

Juniper, French and Spanish broom, bamboo, eucalyptus, Acacia, Monterey pine, Monterey cypress.

Arrangement of Vegetation:

Excessive ladder fuels consisting of mainly bay laurels and grasses for ignition fuels.

Privacy Screening:

The homeowners are using the broom and bay laurel as a screens or are maintaining them for screen purposes. These plants should be replaced with fire resistant species (See attached list "Fire resistant trees and shrubs for Screening").

Vines and Berry Bushes.

Dead vines with dead material internally that could carry a fire to other vegetation or homes should be removed.

Sudden Oak Death:

In the epidemic of SOD the susceptible oak species will be moving out. They will be replaced by bay laurel. The emphasis should be on replacing with species such as big leaf maple.

DESCRIPTION OF EXISTING CONDITIONS

This section forms the basis for actions to be taken. It describes the vegetation fuels, topography, weather and other information needed to predict wildland fire behavior and rank hazards.

Vegetation Fuels:

There are eleven plant communities/habitats within the borders of Los Trancos Woods. Moritz Arboricultural Consulting has identified eleven vegetation fuel types in both wildland and urban areas. The comparison of the UFA / MAC fuel types and hazard ratings are listed below:

TRA:	MAC:
Aquatic Feature	N/A
Chaparral	Chaparral - H+
Coastal Scrub	Coastal Scrub - H
Grassland	Short Grass (grazed/mowed) L
	Tall Grass - M
Mixed Evergreen Forest	Mixed Evergreen Forest – H+
Oak Savannah	Urban Savannah (grass carries fire) M
Redwood Forest	Redwood Forest - H
Urban Forest Garden	Fire-Prone Urban Forest (heavy undergrowth) - H+
	Fire-Prone Urban Forest - H
Vineyard	Vineyard - L

Eight of the MAC fuel types correspond to LTW plant community/habitat types. Several vegetation fuel model systems were employed to estimate fire danger and fire behavior: the USDA Forest Service created the National Fire Danger Rating System (NFDR) and the (a system of nine fuel models) and the Northern Forest Fire Laboratory system (USDA Forest Service NFFL) to model potential wildfire behavior in vegetation fuel types. Three of these NFFL models describe fire behavior in timber slash. The National Wildfire Coordinating Group at the Boise Interagency Fire Center identified 13 fuel models from short grass to southern rough and three logging slash models. These models are not particularly descriptive of Los Trancos vegetation fuel types because they cover the entire country and are reflective of timber lands, not urban and urban/wildland intermix fuel types. Of the fuel types identified for Los Trancos, six are not defined in the national models.

The vegetation is described in terms of dominant species and general percent cover in the overstory and understory. The prevalence and trends of invasion of exotic species is noted, as

are any shifts in species which can be expected over time without manipulation (i.e. shift from oak to bay or oak to Douglas fir, or shift from grass to coyote bush, etc.). A copy of the CALVEG map for the area, as mapped by the Forest Resource Assessment Program (FRAP) of the California Department of Forestry and Fire Protection is included but not recommended for. Similarly, a copy of the fuel types also mapped by the FRAP will be included with property boundaries outlined on it.

CH – CHAPARRAL (VERY HIGH HAZARD, NFFL Fuel Model #4) consists of dense evergreen and deciduous shrubs that can reach 10 feet tall and supports a sparse understory of herbaceous plants and litter. Dominant shrubs in this type include chemise (*Adenostoma fasciculatum*), manzanita (*Arctostaphylos glauca*, *A. tomentosa*), California lilac (*Ceanothus cuneatus*, *C. oliganthus* var. *sorediatus*), redberry (*Rhamnus crocea* ssp. *crocea*), scrub oak (*Quercus dumosa*), coffeeberry (*Rhamnus californica* ssp. *californica*), and holly-leaved cherry (*Prunus ilicifolia*). This type is notorious for exhibiting extreme fire behavior.

CS – COASTAL SCRUB (HIGH HAZARD) supports low shrubs, typically 3 to 6 feet tall, that are densely arranged with scattered openings supporting non-native annual grasses. Dominant plants in this type include coyote bush (*Baccharis pilularis*) poison-oak (*Toxicodendron diversiloba*), California lilac (*Ceanothus thyrsiflorus*), California bee plant (*Scrophularia californica*), blackberry (*Rubus ursinus*), toyon (*Heteromeles arbutifolia*), and sage (*Artemisia californica*). Fire behavior in coastal scrub is strongly affected by the live fuel moisture in the coyote bush.

CS variant – An atypical coastal scrub-like wildland fuel in an advanced development stage and containing some of the elements of chaparral was found on the east facing slope and some ridge top areas of the Blue Oaks development. This fuel was typified by the following species Coyote bush, yerba santa, buckeye, poison oak, toyon, catoneaster, holly-leaved cherry, California bay laurel, stunted coast live oak and scattered Manzanita.

FPO - FIRE-PRONE OAK WOODLAND (VERY HIGH HAZARD) consists of the native oak woodland dominated by a dense canopy of coast live oak (*Quercus agrifolia*), California bay (*Umbellularia californica*), California buckeye (*Aesculus californica*), and Pacific madrone (*Arbutus menziesii*). The dense understory of this woodland consists of poison-oak, toyon (*Heteromeles arbutifolia*), and other shrubs that create fairly contiguous ladder fuels from the forest floor to the tree canopy. The combination of dense understory vegetation, ladder fuels, and disease caused by Sudden Oak Death (*Phytophthora ramorum*) makes this type extremely flammable and prone to crown fires.

FPUF - FIRE-PRONE URBAN FOREST (HIGH HAZARD) includes residential areas that are moderate to densely landscaped with fire-prone ornamentals such as juniper (*Juniperus* spp.), pine (*Pinus* spp.), acacia (*Acacia* spp.), and eucalyptus (*Eucalyptus* spp.). Also present in these areas may be sparse to dense remnants of the native trees and shrubs such as coast live oak,

Pacific madrone, and poison-oak. This forest type is also strongly affected by Sudden Oak Death.

GR – GRASSLAND (MODERATE HAZARD) includes unmanaged, introduced annual grasses and native forbs including: bentgrass (*Agrostis tenuis*), oatgrass, annual agoseris (*Agoseris heterophylla*), ripgut brome (*Bromus diandrus*), soft chess (*Bromus mollis*), foxtail (*Hordeum leporinum*), ryegrass (*Lolium multiflorum*), needlegrass (*Nasella pulchra*), and California fescue (*Festuca californica*). When dry, this flashy fuel supports fires with high rates of spread under windy conditions.

MEF - MIXED EVERGREEN FOREST (VERY HIGH HAZARD) supports a mixture trees including coast live oak (*Quercus agrifolia*), tanoak (*Lithocarpus densiflora*), Pacific madrone, gold cup oak (*Quercus chrysolepis*), black oak (*Quercus kelloggii*), with minor components of big leaf maple (*Acer macrophyllum*), coast redwood (*Sequoia sempervirens*) and Douglas-fir (*Pseudotsuga menziesii*). The shrub layer is minimal but includes: tree reproduction, swordfern, California beaked hazel, poison oak and various brooms in limited areas. This mixture of trees and shrubs has a great potential for creating severe fire behavior.

MG - MOWED GRASS (LOW HAZARD, NFFL Fuel Model #1) includes grazed and mowed introduced annual grasses and both exotic and native forbs, including: bentgrass (*Agrostis tenuis*), oatgrass, annual agoseris (*Agoseris heterophylla*), ripgut brome (*Bromus diandrus*), soft chess (*Bromus mollis*), foxtail (*Hordeum leporinum*), ryegrass (*Lolium multiflorum*), needlegrass (*Nasella pulchra*), and California fescue (*Festuca californica*). Rates of fire spread are greatly reduced by grazing or the alteration of the fuel arrangement as a result of mowing; a fire in this type may self extinguish.

RF - REDWOOD FOREST (HIGH HAZARD) consists of a dense overstory of young growth coast redwood (*Sequoia sempervirens*), tanoak (*Lithocarpus densiflora*), , big-leaf maple (*Acer macrophyllum*), salal (*Gaultheria shallon*), tanoak, sword fern (*Polystichum munitum*), Douglas fir (*Pseudotsuga mensziesii*), and California bay (*Umbellularia californica*). Associated understory shrubs include California hazel (*Corylus cornuta* var. *californica*), wood rose (*Rosa californica*), and thimbleberry (*Rubus parviflorus*). Redwood forest is surprisingly flammable. The thick duff layer is especially receptive to fire brands and redwood bark ignites easily. Tanoak is highly susceptible to Sudden Oak Death; dead leaves retained on these mid-canopy trees exacerbate the fire hazard by creating ladder fuels.

US - URBAN SAVANNAH (MODERATE HAZARD) consists of residential areas where grass occupies greater than 50 percent of the overall landscape. Areas along roadways and near homes are typically densely landscaped with ornamental trees, shrubs, irrigated flowerbeds, and lawns. Other than the overstory canopy [typically valley oak (*Quercus lobata*) or coast live oak (*Quercus agrifolia*)] the grassland species dominate this plant community (See Grassland). While there may be some areas of down and dead overstory materials, grass usually is the fuel

that carries the fire. Crowning and torching of the overstory is highly unlikely. Thus, fire behavior in grassy areas is determined by whether the grass has been mowed or not.

VIN – VINYARD (LOW HAZARD) consists of rows of irrigated grape vines with an exceptionally sparse to barren soil surface. Associated fences are often lined with showy shrubs such as lavender or rose. Fires typically do not burn this vegetation type.

FUEL SEVERITY RATING

Vegetation Type	NFFL Model	Developmental Stage (Appendix 4)	Flame Length (Appendix 4)	Fire Behavior Ranking (current study)
Chaparral	4	High	45	Highest – H+
Coastal Scrub	5	High	18	High – H
Fire-Prone Oak Woodland	7	Extreme	20+	Highest – H+
Fire-Prone Urban Forest	7	High	13	High – H
Grassland (tall grass)	3	Low	7	Moderate – M
Urban (Oak) Savannah	3	Low	7	Moderate – M
Mixed Evergreen Forest	10	Extreme	20+	Highest – H+
Mowed Grass	1	Moderate	5	Low – L
Redwood Forest	9	Extreme	14	High – H

FUEL TYPE FIRE BEHAVIOR SEVERITY MITIGATION

General Fire Hazard Mitigation Strategies:

Strategy: Select fire resistant plants

Actions:

- Select species with low surface to volume ratios (i.e. southern magnolia vs. pine, acacia vs. tulip tree, rhododendron vs. Australian tea, Myoporum or English laurel vs. cypress screen)
- Select broadleaf vs. needle-leaf species
- Select clean looking species with stout branches and twigs (non-twiggy)
- Select species listed as pest and disease resistant
- Select deciduous trees and shrubs with supple, moist foliage
- Select species with out volatile oils in their leaves (use the smell test). Sap is water-like and does not have a strong oil odor

Strategy: Reduce fuel volumes

Actions:

- remove deadwood from trees and shrubs
- thin forest stands that produce great amounts of litter and debris
- create shrub/grass mosaics from continuous shrub masses

- remove shrubs beneath and around existing and emerging trees
- select low-growing shrubs and ground covers as replacement plants
- remove/reduce plant lofty, loosely compacted litter accumulations, especially large debris such as branches and replace with compact, small particle mulch to prevent invasion of noxious weeds and elevate live fuel moisture

Strategy: Reduce fuel flammability

Actions:

- mow grass when it is 50% cured (by June 1st)
- replace annual grass with plants that do not cure (dry out)
- Remove deadwood in trees and shrubs
- establish a formal irrigated landscape in carefully selected areas close to the home (“foundation plantings”) and other structures
- remove sick, dying and dead shrubs and trees

Strategy: Establish/maintain fuel discontinuity

Actions:

- remove/reduce “ladder” fuels (grass to brush to trees)
- create shrub/grass mosaics from continuous masses by installing hardscape
- remove shrubs from beneath and around existing and emerging trees
- thin thickets of small trees and tree reproduction from large tree understories
- create low fuel zone near structural vulnerabilities such as windows, decks, large overhangs,

Strategy: Reduce the possibility of fire traveling through tree crown

Actions:

- Separate overlapping tree and large shrub canopies
- Thin fire-prone tree canopies (oak, bay, eucalyptus, pines, redwood and Douglas fir) to open canopy structure (no more than 30% foliar reduction)
- Prune out low hanging fire-available branches and twigs up to 3 inches in diameter to a minimum of 10 feet above ground under any portion of the canopy or to an elevation 10 feet above the highest ground elevation
- Perform fuel volume reduction actions mentioned above

Fuel Treatments:

Grassland and Urban (Oak) Savannah – L to M

This fuel type typically presents relatively low levels of fire intensity but can exhibit rapid rates of spread. Also grasses are important ignition fuels that should be treated where ignition is likely to occur (around homes, roads and other developed areas). Grass should receive particular attention where it serves as a transition fuel to heavier fuel types (grass to brush to trees). Grass should be mowed to no more than 4 inches in height in FACZ and

defensible space areas. It should also be mowed or grazed in fuel management zones where it might serve as a transition fuel.

Fire Prone Urban Forest (Hardwoods with minor components of conifers) - H

This fuel type is dominated by relatively healthy oaks, bays, madrones and tanoaks. It may have a minor big leaf maple, Douglas fir and/or exotic species component, but this more flammable component is isolated within a relatively open matrix of the more fire resistant park-like hardwood forest and is not frequent enough to have a significant effect on fire behavior. This type may also contain small areas (typically stump sprout second growth) of coast redwood and/or exotic species. This forest /fuel type does not support a continuous undergrowth of flammable brush, tree reproduction, and herbs. The undergrowth is relatively open and well-spaced. Scattered “jackpots” of down and dead fuel accumulations, declining trees or dead trees or small stands of heavy brush may cause torching of dominant canopy trees, but again these “jackpots” of flammable material are contained within a relatively fire resistant fuel type and architecture.

Fire-Prone Urban Forest hazard: The fire hazard of this fuel type is moderate to high, depending on topography and surrounding fuels. Fire is mainly confined to the litter layer with low rates of spread and intensity, but under severe fire weather situations may enter the canopy. Typical flame lengths are one to two feet. Fire suppression forces typically rely on this fuel type to “take a stand” and contain fire spread.

Maintenance: Low fire hazard maintenance in this forest/fuel type includes the following actions as needed:

- Raise tree crowns to a minimum of ten feet above grade. All parts of the canopy less than three inches in diameter should be no lower than eight feet vertical distance above grade. On slopes the canopy line will be parallel with the slope or an elevation of 10 feet above highest ground.
- Keep fire prone undergrowth sparse. Cured grass should be cut. Fire prone shrubs should be cut to no more than two feet in height and should be separated, crown to crown, by a distance of no less than two times their height. Always favor native wildlife and fire resistant species when thinning.
- Remove dead and diseased trees or branches and large areas of declining or dead foliage prior to the fire season or as they develop between June 1st and November 30th.
- Maintain trees in good health. See California Oak Foundation guide.

Fire-prone Urban Forest (Hardwoods with minor components of conifers) -H+

Mixed hardwoods with heavy undergrowth. This type consists of a canopy of tanoak, coast live oak, bay laurel and madrone, with minor components of Douglas fir, redwood and

exotics. It has excessive down and dead material and/or a dense undergrowth of douglas fir reproduction, oak reproduction, hardwood reproduction, bay and tanoak reproduction, ceanothus, manzanita, hazel, and exotics. This is the areas' second-most hazardous fuel type. It may have an unhealthy over-story/canopy.

Pyrophytic Urban Forest Hazard: The fire hazard of this fuel type is among the highest in the area. Under high to extreme fire weather conditions the fire rate of spread is rapid and intensity is very high to extreme. Crowning, branding and spotting is common.

Maintenance: Mitigative actions may be most successful in this forest/fuel type. It can be converted from one of the most hazardous types to one of the least fire prone. Fire safe maintenance of this type includes the following actions:

Thin out overly dense stands to provide crown separation. Favor fire resistant species (such as oak or redwood rather than bay and fir).

Remove or substantially thin undergrowth. Separate shrubs by a distance of at least two times their height, crown to crown. Any fire prone shrubs should be cut to no more than two feet in height. Keep the undergrowth sparse. When thinning out undergrowth always favor fire resistant plants. Raise tree crowns to a minimum of 10 feet above grade. All parts of the canopy less than 3 inches in diameter should be no lower than eight feet vertical distance above grade. The canopy line will be horizontal to slope.

When thinning out undergrowth or planting, favor fire resistant plants.

Remove dead and diseased trees or branches and foliage prior to the fire season or as they develop.

Remove invasive shrubs, and bay laurel and Fir reproduction.

Clean up down and dead debris. Chip small materials and cut larger branches and trunks flat to maximize soil contact.

Maintain trees in good health. See California Oak Foundation guide.

Mixed Evergreen Forest – H+

This forest type is dominated by mature evergreen hardwoods such as oak, bay and tanoak. It may have a 25 to 35% fir and/or redwood component. It has sparse or no continuous undergrowth. The dominant trees are in good (healthy) condition. There is no significant accumulation of down and dead materials.

Mixed Evergreen Forest - fire hazard: The fire hazard of this fuel type is among the highest. Most fires will be in surface fuels with short flame lengths and slow rates of spread but there is a high potential for torching, crowning and branding where fuel concentrations are heavy. Crown fires may be infrequent but in severe fire weather when crowning does occur fires are hard to suppress. The crowning potential may be minimized through proper management of ground fuels and crown raising. The opportunity to provide ongoing maintenance and improvements in fire resistance is great.

Maintenance: Maintenance actions in this forest/fuel type are affordable and effective. If this type is not maintained and allowed to decline, it will become a very serious fire-

prone type, one of the most hazardous types. Fire safe maintenance of this type includes the following actions:

- Thin out overly dense stands to provide crown separation. Favor the more fire resistant species (such as oak and other broadleaf species rather than bay laurel and fir).
- Keep the fire prone undergrowth sparse and low. Separate fire prone shrubs by a distance of at least two times the height, crown to crown. Any fire prone shrubs should be cut to no more than two feet in height. When thinning out undergrowth always favor fire resistant species.
- Raise tree crowns to a minimum of 10 feet above grade. All parts of the canopy less than 3 inches in diameter should be no lower than 10 feet vertical distance above grade. On slopes the canopy line will be 10 feet above highest point. Raise the crowns of redwoods and firs as high as practical.
- When thinning out undergrowth or planting, favor fire resistant plants.
- Deadwood trees thoroughly, particularly firs.
- Remove dead and diseased trees or branches and foliage prior to the fire season or as they develop.
- Remove bay and Fir reproduction.
- Chip down and dead debris.
- Maintain trees in good health. See California oak Foundation for a guide.

Mixed Evergreen Forest with Heavy Undergrowth – H+

This extremely hazardous forest/fuel type is dominated by mature evergreen hardwoods (coast live oak, bay, tanoak, madrone, etc.) and 25 to 35% mature fir or redwood. It has a heavy undergrowth of tree reproduction, herbs and/or shrubs. Often it has excessive bay or fir reproduction. It typically has excessive down and dead debris due to SOD and/or competition.

Mixed Evergreen Forest with undergrowth - fire hazard: The fire behavior of this fuel type is high. The opportunity to provide improvements in fire resistance is great but at a greater cost than for hardwood forest or park-like mixed evergreen forest. However, once the initial work is done, maintenance will be significantly less over time.

Maintenance: Maintenance actions in this forest/fuel type are affordable and effective.

Fire safe maintenance of this type includes the following actions:

- Thin out overly dense stands to provide crown separation. Favor the more fire resistant species (such as oak and bay and fir).
- Clear undergrowth leaving only well spaced, fire resistant plants. Separate other shrubs by a distance of at least two times the height, crown to crown. Any fire prone shrubs retained should be cut to no more than two feet in height. When thinning out undergrowth favor fire resistant species.
- Raise hardwood tree crowns to a minimum of 10 feet above grade. All parts of the canopy less than 3 inches in diameter should be no lower than eight feet vertical distance above grade. On slopes the canopy line will be horizontal with slope. Raise the crowns of fir and redwood as high as practicable leaving no attached deadwood below the live crown.
- When thinning out undergrowth or planting, favor fire resistant plants.

- Deadwood trees thoroughly, particularly bays, redwoods and firs.
- Remove dead and diseased trees or branches and foliage prior to the fire season or as they develop.
- Remove fire-prone shrubs, and bay and Fir reproduction.
- Chip down and dead debris, up to six inches diameter and cut up larger branches and trunks down flat to maximize soil contact.
- Maintain trees in good health. See California Oak Foundation guide.

Douglas Fir Forest - absent Heavy Undergrowth – H+

Douglas Fir Forest - fire hazard: The fire behavior of this fuel type may be severe. Under moderate fire weather, fires will be in surface fuels with short flame lengths and slow rates of spread. Under high fire danger, torching, crowning and branding may occur. Crown fires are infrequent but when they do occur they are hard to suppress. Stand replacement fires do occur in this type. The crowning potential may be minimized through proper management of ground fuels, crown raising and selective stand thinning. The opportunity to provide ongoing maintenance and improvements in fire resistance is high.

Maintenance: Maintenance actions in this forest/fuel type are affordable and effective. Stand thinning, if needed, is more expensive. If this type is not properly maintained, it will be one of the most hazardous types. Fire safe maintenance of this type includes the following actions:

- Thin out overly dense stands to provide crown separation.
- Remove unstable, sick, declining and dead trees.
- Limb up trees as high as practical (More than 10 feet above grade).
- Remove diseased, dying, and dead branches or stubs attached to the trunk.
- Remove Fir reproduction (except where regeneration is necessary).
- Clear undergrowth leaving only well spaced, fire resistant plants. Separate other shrubs by a distance of at least two times the height, crown to crown. Any fire prone shrubs retained should be cut to no more than two feet in height. When thinning out undergrowth favor fire resistant species.
- Clean up dead and down debris.

Douglas Fir Forest - with Heavy Undergrowth – H+

The super canopy more than 50% over-mature fir. It has a sub-canopy of mature hardwood and/or fir juvenile trees. It has heavy undergrowth of flammable brush, and/or bay or fir reproduction. It has excessive down and dead debris. There is a highly significant sub-canopy of hardwoods, juvenile and pole-stage fir forming a highly flammable “ladder fuel” from reproduction size to mature trees. It has a continuous understory of fire-prone undergrowth, and excessive down and dead material.

Whole tree failure, as well as trunk and limb failure, are common resulting in heavy down and dead ground fuels mixed with heavy undergrowth encouraged by the open canopy. A second,

lower canopy of hardwoods has formed in many areas, and a dense third canopy of brush and hardwood reproduction has resulted in almost 100% coverage. Some exotic plant species have invaded this type, as well. The forest floor is littered with an abundance of dead needles and leaves. It can generate a blizzard of fire brands and this fuel bed is very receptive to spot fire ignitions. This is the most fire-hazardous forest plant community/ fuel type.

Douglas Fir Forest with undergrowth - fire hazard: The fire hazard of this fuel type is extreme. The opportunity to provide improvements in fire resistance is significant but at a greater cost than for hardwood forest or park-like mixed evergreen forest. However, once the initial work is done, maintenance will be significantly less.

Maintenance: Maintenance actions in this forest/fuel type are expensive but effective. Fire safe maintenance of this type is critical and includes the following actions:

Thin out overly dense stands to provide crown separation. Favor the more fire resistant species (such as oak and redwood rather than bay and fir).

Remove structurally unstable trees within falling distance of homes, drives and roads.

Thin out or remove sub-canopy.

Clear undergrowth leaving only well spaced, fire resistant plants. Separate other shrubs by a distance of at least two times the height, crown to crown. Any fire prone shrubs retained should be cut to no more than two feet in height. When thinning out undergrowth favor fire resistant species.

Raise the crowns of fir and redwoods as high as practicable leaving no attached deadwood below the live crown. All parts of the canopy less than 3 inches in diameter should be no lower than 10 feet vertical distance above grade. On slopes the canopy line will be essentially horizontal with slope.

Deadwood trees thoroughly, particularly bays, redwoods and firs.

Remove dead and diseased trees or branches and foliage prior to the fire season or as they develop.

Remove bay laurel and fir reproduction.

Clean up down and dead debris.

Maintain trees in good health.

Chaparral – H+:

Dominant shrubs in this type include chemise (*Adenostoma fasciculatum*), manzanita (*Arctostaphylos glauca*, *A. tomentosa*), California lilac (*Ceanothus cuneatus*, *C. oliganthus* var. *sorediatus*), redberry (*Rhamnus crocea* ssp. *crocea*), scrub oak (*Quercus dumosa*), coffeeberry (*Rhamnus californica* ssp. *californica*), and holly-leaved cherry (*Prunus ilicifolia*), but may have up to 35% fir or hardwood reproduction.

Chaparral - Fire Hazard: This type is notorious for exhibiting extreme fire behavior. This is one of the serious fire hazardous types due to the heavy horizontal fuel continuity and abundant fine material, almost 100% available to a potential fire. The high density and sclerophyll species may result in very low live fuel moisture. The expected fire behavior of this type under severe fire weather may be extreme. Fire in this fuel type displays high to extreme rates of spread with high intensities in strong winds. It can generate a blizzard of fire brands and this fuel bed is very receptive to spot fire ignitions.

Maintenance: Maintenance actions in this fuel type are affordable, effective and necessary for the health, vigor and survivability of the shrubs. Fire safe maintenance is critical to safety and includes the following actions:

- You may wish to favor a particular native species on site or convert to a new or more fire resistant type such as perennial grass. However, all of the chamise should be removed.
- Thin brush or brush islands up to 10.0 feet tall to a spacing of 2 X the height, on center. Always favor fire resistant species.
- Raise (trim up) the crowns by 1/3 the height in defensible space zones and along roads.
- Remove deadwood subcanopies.
- Clear all grass, cured herbs and flammable debris from under the shrub canopies.
- Remove dead shrubs near homes, drives, and roads.
- Remove structurally unstable trees within falling distance of homes, drives and roads.
- Clean up down and dead debris.

Coastal Scrub:

This vegetation fuel type is highly invasive in grassland and open hardwood forest in the absence of natural fire. As predicted at the time, the brush reproduced prolifically after the fire and is now over six feet tall. This type is dominated by a “doghair” stand of Ceanothus, coyote bush, coffeeberry, manzanita and possibly fir reproduction, but may have up to 35% fir or hardwood reproduction.

Coastal Scrub - Fire Hazard: This is one of the serious fire hazardous types due to the heavy horizontal fuel continuity and abundant fine material, almost 100% available to a potential fire. The high density of shrubs water stresses the stand. The expected fire behavior of this type is equivalent to heavy chaparral. Fire in this fuel type displays high to extreme rates of spread with high intensities in strong winds. It can generate a blizzard of fire brands and this fuel bed is very receptive to spot fire ignitions.

Maintenance: Maintenance actions in this fuel type are affordable, effective and necessary for the health, vigor and survivability of the shrubs. Fire safe maintenance is critical to safety and includes the following actions:

- First decide on the kind of mature landscape you envision. You may wish to favor a particular native species on site or convert to a new or more fire resistant type.
- Thin brush reproduction up to 10.0 feet tall to a spacing of 2 X the height, on center. Always favor fire resistant species.
- Raise (trim up) the crowns by 1/3 the height.
- Clear all grass, cured herbs and flammable debris from under the shrub canopies.
- Remove dead shrubs near homes, drives, and roads.
- Remove structurally unstable trees within falling distance of homes, drives and roads.
- Clean up down and dead debris.