Appendix E Fuel Inventory

Appendix E

FUEL INVENTORY

This Appendix presents the results of the comprehensive fuel inventory conducted by District staff. Fuel hazard components are described for the thirteen vegetation classifications identified below:

- Native Perennial Bunchgrass or Grassland
- Non-Native Annual Grasslands
- Oak Savanna
- Grazed Grasslands
- Coastal Scrub
- Chaparral
- Chamise Chaparral
- Hardwood Forest
- Monterey Pine
- Eucalyptus Plantations
- Knobcone Pine Forest
- Redwood Forest
- Riparian

The description of each vegetation classification includes: watershed location, fuel characteristics, flammability, fire behavior, seasonal trends, daily or hourly susceptibility to weather variations, and management concerns. "Flammability" is defined as how easily vegetation can be ignited, based upon the amount of dead fine fuel, moisture content, and relative size of fuel.

Native Perennial Bunchgrass or Grassland

Watershed Location

Currently, the District does not map Native Perennial grasslands on the GIS database. These species are located among the watershed grasslands or intermixed in the understory of oak woodlands, oak savannas, or shrublands. Native grasslands comprise a small minority of the grasslands on District watershed lands.

Fuel Characteristics

Native grasses are light fuels adapted to shorter fire frequencies and tend to respond negatively to unnatural fire conditions; such as, extended periods of fire exclusion and higher levels of fuel loading. Provided that a seed bank is intact, burning frequencies of two to three years in native grasslands can often be beneficial.

Flammability

Highly flammable when cured, low flammability when live.

Fire Behavior

Native perennial grassland species produce much lower fuel load (1.0 tons per acre) on a yearly basis than annual grassland. Perennial grasslands exhibit fast rates of spread, with low burning intensities and resistance to fire control. However, these rates of fire spread, burning intensity, and resistance to control are lower than annual grasslands. Native perennial grasslands are a surface fuel with a continuous fuelbed. Fire intensities on flatter slopes (less than 25 percent) will be low and moderate on slopes exceeding 25 percent.

Seasonal Trends

Remain green well into the summer season. Flammability and fire behavior increase when cured.

Daily/Hourly Susceptibility

Highly susceptible; however, less susceptible than annual grasslands. Flammability and fire behavior increase as vegetation cures and/or is in alignment with hot, dry Foehn winds. Curing of this vegetation also significantly changes its daily and hourly susceptibility to weather variations. Fire intensity for cured perennial grasslands on east, northeast, and north facing slopes would range from moderate on flat slopes (less than 15 percent) to very high on slopes exceeding 25 percent.

Management Concerns

Water runoff is greater in grassland vegetation than any other vegetation types. Native grasslands stabilize soils from erosion, which can degrade water quality and reduce reservoir capacity. However fire will have only short term impacts on water quality. Conversion to Native Perennial Grasslands in some locations would reduce the need for fuel reduction activities, except along key access roads. This is an important consideration for areas where grazing is not likely to occur.

Appendix E

FUEL INVENTORY

Native grasslands represent the majority of the District's Plants of Concern and provide important habitat for wildlife and plant species. The District has been selecting areas to reintroduce native perennial grasslands, thereby reducing the amount of fuel loads in grasslands, oak savannas, or woodland understory. Mapping of native grasslands on the GIS database would be required to assign a lower Seasonal Fuel Inventory Rating in the FMP.

NATIVE PERENNIAL GRASSLAND

FUEL MODEL - *1 (based on 0.75 to 1.0 tons per acre)*

Seasonal Condition	**S, SW, W**	**NW, SE**	**N. NE, E**	**Seasonal Key**
Early Season	**L**	**L**	**L**	
Normal Fire Weather	**L**	**L**	**L**	
Late Season	**L**	**L**	**M**	M-Curing, Foehn Winds

East Bay Watershed Plants of Concern : Stebbins, R. 1996.
Biological Survey Studies for EBMUD.

Special Status Species	Mt. Diablo fairy lantern, Diablo sunflower, Santa Cruz tarplant, Oakland star-tulip, bent-flowered fiddleneck, and Oregon meconella.
Indicator Species	Squirrel-tail grass, pine bluegrass, purple needlegrass, California melic, acaena, wild onion, white brodiaea, skullcap, California Indian pink, primrose monkeyflower, Pacific sedum, cobweb thistle, brownie thistle, western larkspur, baby blue-eyes, California fescue, and butter and eggs.
Other Common species	Wild rye, Idaho fescue, California oatgrass, Pacific hairgrass, and bracken fern.

Non-Native Annual Grasslands

Watershed Location

The annual grasslands currently represent a significant percentage of the grassland fuel types which are located on approximately 10,000 acres (35 percent) of the District watershed lands. Annual grasslands represent the primary carrier of wildland fire spread throughout the watershed.

The annual grasslands are the most dominant vegetation classification on the west facing slopes of the eastern portion of the District watershed lands. These areas include Pinole Valley, the eastern portions of San Pablo and Upper San Leandro watersheds, and north of Briones reservoir.

Fuel Characteristics

Typically, annual grassland fuel loads are rated low; however, their annual yields are especially productive for the grass fuel type. This is due to excellent growing conditions in the East Bay, producing between two to three tons per acre. Annual grasslands typically die by late spring, are susceptible to wildland fire during summer and fall, germinate after first fall rainfall, and begin growth, flowering, and seed production prior to the following spring.

Flammability

Annual grasslands are extremely flammable under drying weather conditions.

Fire Behavior

Annual grassland species produce a much higher fuel load on a yearly basis than native perennial grasslands. This results in higher fire intensities and resistance to control, in addition to faster rates of fire spread than perennial grasslands. These grasslands are modeled as moderate fuel hazards when cured due to their high yield production. When in alignment with others factors such as steep slopes or prevailing winds this fuel type can produce high fire intensities.

Seasonal Trends

Annual grasslands cure rapidly, especially on south, southwest, and west aspect. Flammability and fire behavior increase as annual grassland vegetation cures.

Daily/Hourly Susceptibility

Annual grasslands are extremely susceptible to daily and hourly variations of both solar radiation and weather conditions. This susceptibility is increased significantly when the vegetation is cured. The annual grasslands located on the hot, dry, and inland west-facing slopes are the most flammable. Grasslands exposed to the cool, humid onshore flows or coastal fog are the most susceptible to weather variations.

Management Concerns

The annual recovery characteristics of annual grasslands minimize the impact of wildland fire on soil erosion and water quality in this vegetation.

The District has utilized livestock grazing for fuel management in grassland vegetation. In addition to reducing the annual grassland fuel loads, grazing is an effective tool in minimizing the encroachment of shrubs more likely to produce high intensity wildland fire. Over time, grazing has perpetuated the transition from native perennial species to annual introduced species; however, it has also effectively minimized the encroachment of coyote brush. Because the production of annual grassland reoccurs each year, repeated use of prescribed burning in grasslands is not considered an effective fuel reduction tool.

Prescribed burning in annual grasslands can be effective for regeneration of desired native species and limit the growth of undesirable noxious weeds that may out compete the native species. Use of prescribed fire must be carefully monitored as each grass species will respond differently to fire intensity, frequency, and time of year. The District has effectively utilized this tool on the watershed lands in the East Bay and on its Mokelumne watershed lands. Strategic treatment of vegetation along key access roads with prescribed fire (strip-burning) may be an occasional fuel management alternative.

ANNUAL GRASSLAND

FUEL MODEL - ***3 (based on 2.0 to 3.0 tons per acre)***

Seasonal Condition	**S, SW, W**	**NW, SE**	**N, NE, E**	**Seasonal Key**
Early Season	**M**	**L**	**L**	M-Early Curing
Normal Fire Weather	**M**	**M**	**M**	M-Curing by aspect
Late Season	**M**	**M**	**M**	

Oak Savanna

Watershed Location

Oak savanna is sparsely distributed throughout the watershed, covering approximately 418 acres (1.49 percent) of the watershed land. It is most common on south or west facing aspects in the eastern portion of the northern watershed. Over half of the District's oak savanna habitat is located in the Pinole and Briones watersheds.

Fuel Characteristics

The oak savanna fuel type consists of patches of sparsely-spaced oak trees growing on grassy hillsides. As grass is the primary carrier of wildfire spread in this fuel type, oak savanna assumes the grassland Fuel Inventory Hazard Rating for its location.

Flammability/Fire Behavior/Seasonal Trends/Daily or Hourly Susceptibility: See Annual Grasslands (or Native Perennial Grassland when added to GIS database).

Management Concerns: Oak savanna habitat is considered locally rare and is valued for its regeneration potential into oak woodlands. Prescribed burning considerations would be the same as those mentioned in annual grasslands. Oak savannas are adapted to frequent fire occurrence.

Common oak species found in oak savanna habitat include: coast live oak, valley oak, and occasionally Blue oak. Oak savannas provide valuable roosting and nesting locations for raptors, while providing an acorn crop for many vertebrates.

Grazed Grasslands (Annual Grasslands, Perennial Grasslands, Oak Savanna)

Watershed Location

Currently grazed units are attributed with a two (2), proposed units with a one (1), and ungrazed with a zero (0).

Flammability

Grazed grasslands will exhibit similar flammability as their appropriate grassland fuel type (Annual nonnative grassland or native perennial grassland). Grazing does not reduce the flammability.

Fire Behavior

Grazing of annual grasslands significantly reduces the fuel loading, resulting in lower burning intensities, rates of fire spread, and resistance to control. These grasslands are modeled as a low fire hazard even when cured or when in alignment with others factors such as steep slopes or prevailing winds. Grazed grasslands will generate low fire intensities on flatter slopes less than 25 percent and moderate intensity on steeper slopes.

The fire management criteria for grazed grasslands would be four (4) to six (6) inch stubble leaving approximately .50 to .75 tons per acre. As grazing is not as effective on slopes exceeding 30 percent slope, these slopes should be rated as ungrazed even if within a grazed unit.

Seasonal Trends

See seasonal trends in applicable grassland classification.

Daily/Hourly Susceptibility

Grazed grasslands are as susceptible as the applicable grassland fuel classification in terms of flammability. However, as fuel loading is reduced, the susceptibility in terms of fire behavior is significantly reduced.

Management Concerns

The grazing of grasslands or oak savanna habitat significantly lowers the potential fire intensity for all seasonal conditions. Grazing is an effective stubble management tool to implement "firesafe" road treatments, strategic fuel modification networks, and other types of fuel reduction.

GRAZED GRASSLAND
(Annual Grassland, Perennial Grassland, Oak Savannah)

FUEL MODEL - 1 (Based on less than 1 ton per acre)

Seasonal Condition	**S, SW, W**	**NW, SE**	**N, NE, E**	**Seasonal Key**
Early Season	**L**	**L**	**L**	L - Less than 35% slope
Normal Fire Weather	**L**	**L**	**L**	L-Less than 35% slope
Late Season	**L**	**L**	**L**	L-Less than 35% slope

Coastal Scrub

Watershed Location

The Coastal scrub plant communities are most typically located on hot, steep, south or west aspects throughout the District watershed lands, but are least prevalent in FMU 1, 3, and 4.

Fuel Characteristics

Coastal scrub tolerates a wide range of fire intervals, from a few to up to 40 years, based on the mix of resprouting and seeding capabilities of the component species. Structures of the plant associations that comprise Coastal scrub communities are typified by low to moderate-size shrubs with mesophytic leaves, flexible branches, and semi-woody stems growing from a woody base.

A common strategy of Coastal scrub to survive the annual dry period is to slow its growth and metabolism during water stress, causing die-back in the stems and leaves corresponding to the severity of the annual drought period. This increases the amount of dead material in the plant.

Flammability

Flammability in Coastal scrub is considered moderate due to the amount of dead fine fuels. Flammability increases on drier sites.

Fire Behavior

Fuel loading tends to be less than in chaparral plant communities; however, the oils in the foliage produce high fire intensities. Important variables in the fuel characteristics of each stand are live fuel moisture and the amount of dead fine fuel compared with live foliage.

Seasonal Trends

Early in the season the prolonged solar exposure and warmer temperatures increase the potential fire intensity in Coastal scrub plant communities. The exposure to these conditions is greatest on south, southwest, or west facing slopes, and significantly reduced on north and east facing slopes.

Under Normal Fire Season weather conditions, fuel temperatures are high and fuel moistures (live and dead) are low during dry periods. Flammability is high, while fire intensity can range from moderate on flat slopes to very high on slopes exceeding 25 percent.

Typically live fuel moistures reach their annual lows late in the season when Foehn winds are most likely to occur.

The hot, dry high intensity winds associated with Foehn conditions accelerate the daily drying out of fine fuels (1-hour and 10-hour time lag fuels) to create very explosive or fire behavior conditions with fast rates of spread and high to extreme wildfire intensity. The extreme conditions are most likely to occur on north, northwest, or east facing slopes under Foehn wind conditions.

Daily/ Hourly Susceptibility

The flammability of this plant community is very responsive to variation in fire weather (prolonged solar exposure, high temperatures and exposure to Foehn wind conditions).

Flammability is greatest on hot, dry, inland sites. The most likely aspects (south, southwest, and west) in which Coastal scrub is found on District watershed lands meet this criterion.

Coastal scrub is very susceptible to significant daily or hourly weather variations. Due to the amount of fine fuels and dead material in Coastal scrub, short periods of exposure to prevailing summer onshore winds and coastal fog can reduce flammability and fire intensities from the typical Normal Fire Weather conditions, especially along the western perimeter of

the watershed. The ratings for this plant community are based on the 90th percentile weather conditions. Monitoring of the daily Fire Danger Rating trends will indicate changes from hot, dry seasonal conditions to these short periods of onshore winds and coastal fog.

Coastal scrub is most susceptible under Foehn winds conditions, especially on the north, northeast, and east aspects, resulting in the potential for extreme fire intensity on steeper slopes.

Management Concerns

Prescribed burning of Coastal scrub is recommended when the ratio of dead to live fuels exceeds 40 percent. The dead to live fuel ratio will vary significantly depending on growing site, exposure to solar radiation and weather variations, droughts, and other factors. Without the use of prescribed fire, the amount of dead woody material in Coastal scrub plant communities excluded from fire will have the potential for high to extreme intensity wildland fires.

Following should be the criteria for determining when to introduce fire as a habitat enhancement (stand protection) management tool within the selected areas of coastal scrub vegetation:

- When Coastal Scrub fuel loading (both live and dead) exceeds 4.0 tons per acre, or
- when the dead fuel loading exceeds 1.5 tons per acre, or
- when the dead fuel to live fuel loading ratio exceeds 40% dead fuels, or
- when any combination of the above criteria would create flame lengths (calculated by BEHAVE) that exceed 11 feet in length or a fireline intensity of greater than 1,000 BTU's per feet per second.

FUEL MODEL - *6 (Brush less than 6 feet tall)*

Seasonal Condition	**S, SW, W**	**NW, SE**	**N, NE, E**	**Seasonal Key**
Early Season	**M**	**M**	**L**	M-Less than 100% live FM
Normal Fire Weather	**M**	**M**	**M**	M-Less than 100% live FM
Late Season	**M**	**H**	**H**	H- Foehn Winds

East Bay Watershed Plants of Concern : Stebbins, R. 1996.
Biological Survey Studies for EBMUD.
Special Status Species Oakland star-tulip, Mount Diablo fairy lantern
Locally Rare Species buckthorn, mahonia

Chaparral

Watershed Location

Chaparral covers approximately 21 acres of the watershed and can be found in three locations of the watershed: 1) on a northwest facing slope along Briones Reservoir in FMU 11 just northeast of the dam, 2) on a northeast facing slope of FMU 2, and 3) on a west facing slope of FMU 26 near Upper San Leandro Reservoir.

The chaparral classified under this fuel type was identified as Manzanita chaparral. A significant stand of Manzanita chaparral exists near Canyon , but does appear on the District GIS database.

Fuel Characteristics

Chaparral is a structurally homogeneous brushland type dominated by shrubs with thick, stiff, heavily cutinized evergreen leaves. As a stand ages, it forms a dense, almost impenetrable canopy of sclerophyllous shrubs, limiting the growth of shade intolerant herbaceous vegetation. The lack of a significant understory vegetation results in a stand that tends to be more even-aged. Stands are commonly adapted to frequent wildland fire or fire intervals of about 20-40 years.

Flammability

Chaparral has a low flammability (ignition). When ignited, it will burn at a high intensity. The higher the dead to live ratio in chaparral, the more flammable the venation of the plant community. The amount of dead material depends on the age of the stand, the type of brush species, site conditions, and periodic weather related events.

In a young stand (zero to 15 years), the amount of dead aerial fuel is minimal. As the canopy develops, the amount of dead woody stem material (standing branchlets and liter accumulation) increases in the understory. Older stands are typically more flammable than younger stands.

The type of species will vary by adaptability to the site and other species. Some species will result in higher liter accumulations (chamise) than others. Dead fuels are typically produced more rapidly on dry sites. The greater the solar exposure and water stress of a site, the higher the flammability .

Fire Behavior

Fire spread occurs mostly in the flammable, nearly continuous crowns and dead woody understory of chaparral stands. Higher fire intensities are expected to occur in older stands due to the large amount of dead woody material and high surface-to-volume ratio in its "flashy" fuels. At 20 years, the stand would produce moderate fire intensities, while those exceeding 35 years of age are considered as very high fire intensity and fast-spreading.

The resinous characteristic of the chaparral crown cover, fuel load, and location on steep slopes or dry aspects increase the projected intensity of wildland fire in this vegetation. When live fuel moistures drop below 60 percent, then a daily burning index of high or extreme is sufficient to produce rapid rates of spread, extreme burning intensities with a higher resistance to control.

Seasonal Trends

The annual live fuel moisture cycle is the best indicator of variations in flammability and fire behavior in chaparral. Live fuel moistures will drop earlier in the season on south, southwest, and west facing slopes due to increased solar exposure. Chaparral plant communities on these aspects (FMU 26) were modeled as moderate fuel hazards in the early season as the live fuel moistures will typically be nearing or dropping below 100 percent earlier than other aspects. These aspects will be more flammable and produce higher fire intensities than other aspects in the early season.

The longer periods of solar exposure, lack of rainfall, and increased temperatures near 90 degrees common in the early summer months continue to decrease live and dead fuel moistures of chaparral on all aspects.

When fuel moisture drops below 100 percent, new growth is complete and resembles the older perennial foliage. This stage is used as the key in the FMP to determining when chaparral is entering the Normal Fire Weather condition. Live and dead fuel moistures will continue to decline during the summer months, increasing flammability and fire intensity as the chaparral approaches the dormancy stage near 50 percent live fuel moisture. At dormancy, coloration of leaves will occur, with some dropping off from the stem. This increases the dead to live fuel ratios. Therefore, chaparral is modeled as a high fuel hazard for all aspects during Normal Fire Weather conditions and will produce extreme fire intensities on slopes exceeding 25 percent.

Chaparral is most flammable and produces the highest fire intensities when it reaches its annual low in live fuel moisture towards the end of the fire season and is exposed to Foehn wind conditions. Droughts, freezes, fungus, and other weather related events increase the stress on chaparral stands often speeding up the accumulation of dead material and decrease in live fuel moisture.

Daily/Hourly Susceptibility

Chaparral is less susceptible to changes in hourly, daily, and seasonal weather or solar exposures than lighter brush species or grass fuels. However, this characteristic also results in slower recovery to prolonged seasonal weather conditions. The prolonged seasonal effect is a steady decline of fuel moisture over the dry season.

Management Concerns

Prescribed burn frequencies are recommended every 20 to 25 years in the mature chaparral plant community. Periodic fire or prescribed burning can also be utilized to produce a diversity of age class in a stand which will minimize its susceptibility under extreme fire weather conditions and promote biodiversity. The 17-year historical fire records do not indicate any fire history in the known chaparral locations. Therefore, fire exclusion in these communities is likely to result in unnatural fuel accumulations.

Fire intensities likely under Normal Fire Weather and Late Season fire weather conditions could result in significant impacts to water quality and biodiversity. Water runoff will be significantly increased from these locations after a high intensity fire due to the reduction in vegetation cover and potential for hydrophobic soils. The identified chaparral plant communities are located adjacent to Briones Reservoir and near Upper San Leandro Reservoir.

Prescribed fire may be beneficial for regeneration of pallid manzanita species. All three chaparral locations are within identified potential pallid manzanita habitat areas and are designated as management areas where prescribed fire or low and moderate intensity wildland fire are recommended as management tool for the unit.

FUEL MODEL - *4 (Tall Brush greater than 6 feet tall)*

Seasonal Condition	S, SW, W	NW, SE	N, NE, E	Seasonal Key
Early Season	**M**	**L**	**L**	
Normal Fire Weather	**H**	**H**	**H**	H - Live FM < 100%
Late Season	**H**	**H**	**H**	

East Bay Watershed Plants of Concern : Stebbins, R. 1996.
Biological Survey Studies for EBMUD.
Special Status Species pallid manzanita, San Antonio Hills monardella

Chamise Chaparral

Watershed Location

Chamise is a fire-sensitive and widely distributed shade-intolerant shrub component of chaparral, woodland, and forest communities and is commonly found on the foothills and Coastal mountains of California as far north as Mendocino County.

Chamise chaparral occurs on approximately 145 acres of District watershed lands and is typically located on hot and dry west, southwest, or south facing slopes. The greatest concentration is found in the upper San Leandro Reservoir watershed on Rocky Ridge, with smaller Chamise plant communities found on the eastern perimeter of FMU 1 and in FMU 26. Chamise may also occur as an understory shrub in the District's Hardwood Forest or knobcone pine fuel classifications.

Fuel Characteristics

Chamise is an extremely fire dependent native species, and the exclusion of fire will result in a senescent condition. Chamise is a resinous, diffusely branched shrub that varies from a few feet to 12 feet tall. Plants are deep-rooting and branch very close to the ground, with sharp-pointed, sclerified evergreen leaves approximately ¼ of an inch in length. Approximately 60 percent of the dry weight in chamise plants is located in the leaves and stems less than an inch in diameter, compared to other common shrubs like manzanita or scrub oak that have 25 to 30 percent of their dry weight in the same components. Bark typically becomes gray with age.

After a fire disturbance, the post-fire regeneration strategies of chamise are: adventitious-bud root crown and ground residual colonizer. Vigorous sprouting and germination of a large number of seedlings occur in the first years after fire. Growth of herbaceous vegetation is high in initial years after fire or cutting, but rapidly declines in later years. Dense stands are likely to develop by the end of the first decade and do not exhibit full canopy closure until after the second decade. Annual growth is minimal in stands around 60 years of age when the accumulation of biochemicals in the soils lead to stand stagnation.

Fire is beneficial for chamise seed germination. Seed production occurs as early as three years in chamise and continues at all age classes. Dispersal of seed is abundant and typically within or near the plant community. This occurs in the dry summer months. Seed production is greater after above-average rainfall. Dormant seeds accumulate in the soils until the heat of fire scarifies the impermeable seed coat to stimulate germination. Seedbanks increase with the age of the stand. A small proportion of the seedbank germinates without fire scarification; however, survival rates of seedlings are low.

During summer drought, the metabolic activity of the plant results in an accumulation of water-soluble phenolics in the leaves. These toxins are transported to the soil through rain or fog drip. The annual rainfall on District watershed lands fall within the 10 to 40 inches annual precipitation range common for Chamise plant communities.

Flammability

Chamise is the most flammable species of the District's brush fuel classifications due to the amount of dead fine fuels less than one inch in diameter. The fine fuels are easier to ignite and preheat live fuels when burning, further increasing stand flammability.

Fire Behavior

Typical fuel loads in Chamise are less than other chaparral species; however, their physical, chemical, and physiological features will produce higher fire intensities. The fuel load in younger stands from 10 to 15 years will produce only moderate intensity wildland fires. In older stands, the amount of fine fuels accumulates, increasing fire intensity.

Approximately 60 percent of chamise is less than 0.5 inches in diameter and would be classified as 1-hour timelag fuel (0 to ¼ inch in diameter) or 10-hour time lag fuels (1/4 to 1 inch in diameter).

The large amounts of fine fuels distributed continuously from the ground throughout the multi-stemmed canopy provide a vertical fuel ladder that carries wildland fire into the canopy of the plant community. As dieback occurs in the summer months, the accumulation of these dead fine fuels increases overall fire behavior.

The ether extractives (waxes, resins, oils, terpenes, and fats) and inorganic minerals found in the foliage further increase the rate of fire spread because of their high heat content. Older plants have greater concentrations of ether extractives.

Seasonal Trends

The fuel characteristics of Chamise will cause their live and dead fuel moistures to drop more rapidly than other brush species. High annual rainfall totals in the previous wet season increase the seed production and plant growth.

The prolonged solar exposure on south, southwest, and west facing slopes creates hot, dry locations where both flammability and fire intensity increase earlier than other aspects. The large concentration of Chamise along Rocky Ridge meets this criteria, while the Chamise located on the eastern perimeter of FMU 1 and in FMU 26 occur on east facing slopes progress at a slower rate.

Flowering occurs in the summer despite the onset of the dry period as Chamise store water in their lignotubers. The long dry period of summer and associated water stress suppress the photosynthesis and new sprouting and growth ceases. In late summer, after seed dispersal is complete, inflorescences will die back, and new growth becomes woody.

Important fuel hazard variables to monitor are age class, live fuel moisture, and the amount of live to dead fuel moisture. If monitored, this vegetation type will assume its normal fire season rating of high when live fuel moistures drop below 100 percent.

Chamise is most flammable late in the season when live fuel moistures reach their annual lowest, dead fine fuel moistures drop significantly, and concentrations of extractive chemicals increase. This flammability is further increased when exposed to hot, dry Foehn winds. The potential mortality

of the plant community from high intensity fire substantially increases. Perennating buds located just beneath the soil surface are quite susceptible to high fire intensities.

Daily/Hourly Susceptibility

The flammability of Chamise is more susceptible to seasonal, daily, and hourly variations in solar exposure or weather conditions than other brush due to its chemical composition and amount of dead fine fuels.

Management Concerns

The widespread distribution of Chamise provides large quantities of browse for wildlife and a staple for deer populations. The value for cattle and horse grazing is very low, but good for goats. The quality of this species for browse is limited by its palatability and stand density (difficult to penetrate). The dense stands provide cover, nesting sites, thermal cover, and resting and escape locations for smaller birds and mammals.

The fire cycle for Chamise can range from 10 to 100 years. High intensity wildland fire can cause significant damage to the regeneration strategy of Chamise plant communities. High intensity fire may substantially delay the recovery of this plant community by destroying the seed bank and sprouting capability.

The Chamise located on Rocky Ridge consists of prolonged solar exposures and steep slopes and is therefore susceptible to high intensity wildland fire under 90th percentile weather conditions and above. The introduction of prescribed fire would be beneficial to replicate natural fire regimes, create a diversity of age classes, enhance palatability, and open up stands for wildlife browse. The resulting fuel reduction would minimize the potential for high intensity wildland fire. Fire significantly enhances access to new growth for browsing wildlife. This browse prolongs palatability and stimulates new growth and delays the accumulation of woody fuels.

Prescribed fire would also decrease the potential mortality patterns related to high fire intensity and time of year. Spring or summer fires may cause high mortality rates, while fall fires result in relatively little mortality. Sensitivity to wildland fire is increased if seeds have imbibed water. Dry soil conditions help to protect seeds from mortality. Mortality also increases with increasing fire intensity. High fire occurrence may cause damage to seedlings, sprouts, and seedbank.

FUEL MODEL - *4 (Tall Brush greater than 6 feet tall)*

Seasonal Condition	S, SW, W	NW, SE	N, NE, E	Seasonal Key
Early Season	**M**	**L**	**L**	M - FM < 100%
Normal Fire Weather	**H**	**H**	**H**	H -FM < 100%
Late Season	**H**	**H**	**H**	

Hardwood Forest

Watershed Location

Hardwood forest is the District's predominant forest type, covering approximately 9,533 acres (34 percent) or about one-third of the watershed. Significant stands can be found in the northern portion of FMU 8 (Sather Canyon), in FMU 9, and around the Orinda interface.

The most common plant communities in this grouping are classified as mixed hardwood forest (comprising Coast Live Oak, California bay, and Madrone). Other plant communities include mixed oak woodland or Black Oak Woodland, occurring mostly near San Pablo and Briones Reservoirs. Hardwood forests on watershed lands can often be found on northeast facing slopes and along riparian zones of intermittent and perennial creeks.

Fuel Characteristics

The understory fuels are the primary carrier of wildland fire in the hardwood forest vegetation classification. The key to understanding wildland fire spread in this fuel type is vertical continuity ("fuel ladder"), which will carry fire from the surface fuels up into the canopy, and horizontal continuity, which carries the lateral spread of fire. Fire intensity is dependent on understory live fuel moisture and fuel load.

The understory in a hardwood forest can vary greatly with various combinations of vegetation types, vertical continuity, liter accumulation, and location. When the understory consists of light fuels, Fuel Model 1 is the most appropriate. Fuel Model 9, which represents hardwood litter, poison oak, brush, and other debris, is the most appropriate for scattered or dense stands.

Most of the District's hardwood forest vegetation classification is found on moist north or east facing aspects.

The District's fuel classification for Hardwood Forest was based primarily on overstory criteria. The conversion of this vegetation classification to an applicable fuel model requires understory fuel loading criteria. Due to the lack of site-specific understory assessments for the District watershed lands, this fuel classification was assumed to be Fuel Model 9, primarily due to the lack of fire history and potential for fuel accumulation in the understory.

The District is currently reevaluating the existing vegetation coverage. Providing a detailed site-specific understory assessment of this fuel classification would enhance the accuracy of the FMP and GIS database.

Seasonal Flammability

The flammability for this vegetation classification is based on the type and density of understory vegetation. When the understory is light or scattered, the potential for ignition is high. The higher the grass component in the understory, the higher the flammability. The flammability would be low for dense or moist understories.

Fire Behavior

Fire behavior is dependent on the composition of the understory. The critical component is the understory fuel load and the vertical fuel ladder. Dense understory fuels without a significant break in the vertical fuel ladder would represent high intensity areas. Fuel management treatments in the understory fuels significantly decrease fire intensity by reducing the understory fuel load and/or vertical ladder. Understories with light to scattered fuels would represent low fire intensity areas.

Seasonal Trends

The understory of the Hardwood Forests vegetation classification is assumed to be a low fuel hazard and produce lower fire intensities during the early season due to higher live fuel moistures resulting from shading. The benefits of this shading decrease as the dry season continues and fuel hazards are rated as moderate for all aspects.

Hardwood Forests tend to have increased fuel loads on east, northeast, and north aspects, which are prone to high intensity fire when exposed to Foehn wind conditions. These hot, dry, high intensity winds are in direct alignment with upslope wind patterns that dry out the understory vegetation, increasing flammability and fire behavior.

Daily/Hourly Susceptibility

Shading of the understory vegetation minimizes the effects of seasonal, daily, and hourly variations of solar exposure on the understory vegetation. The more open the understory, the greater the susceptibility to variations in weather conditions. Open canopies are more susceptible to solar exposure. Both will increase flammability and fire behavior.

Management Concerns

Understory fuel reduction or prescribed fire for underburning to establish mosaics of strategic fuel reduction to minimize the effects of Late Season fire weather conditions are critical on the dense north, northeast, and east facing slopes, which are in alignment with Foehn winds. In addition to reducing overall fire intensity, mosaics provide a diversity of age class in the plant community.

Strategic use of hazard abatement to establish shaded fuel breaks would reduce the Fire Hazard Intensity Rating to low where treatments are applied. Priorities should be based in order of structure protection, firesafe road access, watershed fire protection, and stand enhancement. Many of these areas occur near interface or intermix areas where fire risk and values are higher.

FUEL MODEL - 9 (scattered to dense)

Seasonal Condition	**S, SW, W**	**NW, SE**	**N, NE, E**	**Seasonal Key**
Early Season	**L**	**L**	**L**	
Normal Fire Weather	**M**	**M**	**M**	M-Live FM < 100%
Late Season	**M**	**H**	**H**	H - Foehn Winds

East Bay Watershed Plants of Concern : Stebbins, R. 1996.
Biological Survey Studies for EBMUD.

Special Status Species	San Antonio Hills monardella, western leather-wood, Mount Diablo fairy lantern,
Keystone Species	Coast live oak, black oak, valley oak
Locally Rare Species	Canyon live oak, Chase oak, bluish valley oak, buckthorn, mahonia, fairy lantern, celery-leaved lovage, western coltsfoot,

Monterey Pine

Watershed Location

Monterey Pine covers approximately 560 acres (2 percent) of the watershed and is considered a nonnative forest community. It is most common along the perimeter of San Pablo Reservoir and western portions of FMUs 11, 12, and 13. This fuel type can also be found in FMU 4 near Alhambra Valley Road and in FMU 20. Monterey Pines can also be found in many locations on adjacent EBRPD lands along the western perimeter of the watershed.

Fuel Characteristics

Monterey Pine is a closed-cone coniferous plant community and considered nonnative in the East Bay. The understory for Monterey Pine fuel type on EBMUD watershed lands is typically moderate and occasionally low, consisting of light grass and short brush species.

Monterey Pines typically occur in even-aged stands ranging in height from 50 to 115.5 feet tall, and live a maximum of 80 to 90 years. The resinous inner bark makes this tree very flammable when ignited. Monterey Pines are crown residual colonizers and rely strictly on seed for regeneration. They do not produce seeds until they are between five and ten years old, peaking at approximately twenty years. Seed production is greatest after a surface fire where the tree survives, in warm, dry years, and in open stands. Cones open for seed dispersal when exposed to the first warm, dry periods in early spring or when exposed to fire. They close when exposed to cooler temperatures and higher humidities. Seeds remain viable for decades.

Fire intensities exceeding 200 degrees Fahrenheit will significantly reduce seed germination. Monterey Pine will often invade areas with poor or shallow soils.

Monterey Pine is very susceptible to severe surface and crown fires. Trees are easily damaged by direct heat, but can survive moderate crown scorch. Younger Monterey Pine trees with thin bark are often killed by wildland fire, especially in dense stands or when fire spreads in the crowns.

Flammability

The flammability of this vegetation classification is strictly dependent on the understory. When the understory fuels are dense, a vertical fuel ladder is present, or the residual burning time is significant, the flammability of the Monterey Pine becomes a factor. Monterey Pines are noted for their extreme flammability. This is due, in part, to shedding bark, fine fuels, and/or volatile resins within the leaves and wood. The higher the grass component or light flashy fuels in the understory, the higher the flammability of the understory.

Fire Behavior

Fire intensity is based strictly on understory composition. Increased fire intensities are characteristics of dense understories or vertical fuels ladders, and lower fire intensities in light to scattered understories.

Seasonal Trends

Monterey Pine requires wet winters and is highly susceptible to frost. Tree crowns collect moisture from summer fog conditions.

Daily/Hourly Susceptibility

The more open the understory, the greater the susceptibility to variations in weather conditions; the more open the canopy, the greater the susceptibility to solar exposure. Both will increase flammability and fire behavior.

Management Concerns

As this species is considered a nonnative pyrophyte, regional pressure is present to reduce the number of Monterey Pine stands. They do not represent a significant fire hazard when the understory is maintained for low fire intensities. Thinning often opens up the stand, increasing the growth of understory fuels. Stands that are well spaced with light understory, proper horticultural practices, and maintenance of trees, e.g. spacing and above-ground clearance, can serve to minimize fire hazard. Unhealthy stands or those near interface areas represent the highest priority areas for replacement with native species.

Understory prescribed burning can be very beneficial to the long term maintenance of these stands. Moderate to high intensity fire in the understory can seriously damage this species. Strategic use of hazard abatement to establish shaded fuel breaks would reduce the Fire Hazard Intensity Rating to low where treatments are applied. Priorities should be based in order on structure protection, firesafe road access, watershed fire protection, and stand enhancement.

Monterey Pines provide erosion control with a widespreading root system. Monterey Pine is valued for its protection from solar exposure, wind , and noise. It is also used for Christmas trees. It is a coarse grained, light, soft wood and has little commercial value except as firewood. Some of the stands currently provide biodiversity value (bald eagle and other raptor species) on District watershed lands. Monterey Pine seeds provide food for small rodents, mammals and birds that are potential forage for the Bald Eagle and American Peregrine Falcon. Common pests that affect the Monterey Pine are : western dwarf mistletoe, western gall rust, various needle blights, and moths.

FUEL MODEL - *Combined Fuel Model 9 (60%) and Fuel Model 3 (40%)*

Seasonal Condition	S, SW, W	NW, SE	N, NE, E	Seasonal Key
Early Season	**L**	**L**	**L**	
Normal Fire Weather	**M**	**M**	**M**	Curing of grass, Low FM
Late Season	**M**	**M**	**M**	

Eucalyptus Plantation

Watershed location

Eucalyptus plantations cover approximately 287 acres (1 percent) of the District's watershed lands. A large stand (135 acres) is found on the northwestern perimeter of San Pablo Reservoir, adjacent to San Pablo Dam Road. The Chabot Reservoir watershed contains an additional 81 acres, with 19 acres in the Upper San Leandro watershed. This fuel type is also considered a nonnative forest.

Fuel Characteristics

Eucalyptus exhibits a high concentration of volatile oils (present in green foliage) and a large amount of available fuel content in understory . Keys to managing these stands in a safer fire condition are understory maintenance, spacing, and forest floor fuels. Untreated eucalyptus plantations have very dense, flammable vegetation, often exhibiting a vertical ladder into the canopy.

The stands on District watershed lands consist primarily of large, mature trees with moderate to dense canopy cover.

Flammability

Untreated eucalyptus plantations are known for their extreme flammability due to shedding bark, fine fuels, and/or volatile resins within the leaves and wood. Flammability can be reduced by treating the dead fine fuels and shedding bark in the understory.

Fire Behavior

Fire intensity in eucalyptus plantations is dependent on the composition of the understory and vertical fuel ladder. Fire intensities are greatest for dense understories and/or with vertical fuels ladders. Eucalyptus is a well know source of fire brands, especially under high intensity Foehn winds.

Seasonal Trends

Early season fuel moistures should remain high for eucalyptus plantations located on north, northeast, east, southeast, and northwest aspects. The stand along San Pablo Dam Road meets this criterion.

The seasonal trend of live fuel moisture in the eucalyptus understory fuels will continue to decrease throughout the dry summer period; however, the greatest threat is when stand is located on steep slopes in alignment with Foehn wind conditions. Foehn winds can dry out the understory fuels of these eucalyptus plantations, significantly increasing flammability and fire intensity.

Daily/Hourly Susceptibility

The more open the understory, the greater the susceptibility to variations in weather conditions; the more open the canopy, the greater the susceptibility to solar exposure. Both will increase flammability and fire behavior.

Management Concerns

As a nonnative pyrophyte, eucalyptus plantations are a target of regional public pressure for removal. Stands that have been thinned or logged with appropriate understory treatments do not represent significant fire hazards. Examples of these treatments can be found on the District near the water tower just east of the Grizzly Peak/Fish Ranch Road intersection, in Redwood Regional Park near Pinehurst Court, and Kennedy Grove Regional Recreation Area just north of San Pablo Dam.

Stands that have been thinned or treated by understory pruning and limbing up have a significantly reduced understory fuel hazard, provided that resprouting is controlled. These treated areas should be rated as low to moderate fuel hazards, based on existing conditions. These stands providing roosting locations for the Bald Eagle and other raptors and attract the bark-foraging birds.

FUEL MODEL - *Combined Fuel Model 9 (60%) and Fuel Model 3 (40%)*

Seasonal Condition	S, SW, W	NW, SE	N, NE, E	Seasonal Key
Early Season	**H**	**M**	**M**	Untreated
Normal Fire Weather	**H**	**H**	**H**	Untreated
Late Season	**H**	**H**	**H**	Foehn Winds

Knobcone Pine Forest

Watershed location

The knobcone pine forest fuel type is located exclusively along Flicker Ridge in FMU 19, adjacent to the Canyon intermix area. This fuel type covers approximately 56 acres (less than 1 percent) of the District's watershed lands. The Canyon intermix community located among high hazard fuels is at significant risk from high intensity fires spreading along this ridge.

The northwest portion of the knobcone forest is most critical to the protection of the Canyon intermix. The long-term management strategy for this area must include maintaining fuels in the knobcone pine plant community to minimize extreme fire intensities under wildland fire events.

Fuel Characteristics

Understory is extremely fire adapted and fire dependent. Exclusion of fire prevents regeneration, produces senescent, deteriorating knobcone pine forest with heavy accumulations of dead biomass material. Under natural fire intervals, fire consumes the dead material from the previous fire, while the event kills most of the current generation of knobcone pines. The plant community maintains the hazardous fuel killed by the fire until the next fire event. Reforestation is rapid after a fire event.

The knobcone pine community in the Canyon area is a dense, even-aged stand. Mosaics of other vegetation species are intermixed within this plant community.

Flammability

Knobcone pine is extremely flammable due to amount of dead fine fuels and residual biomass that accumulates in this plant community.

Fire Behavior

The Seasonal Fuel Inventory Rating for knobcone pine is high for all three of the seasonal ratings (early season, normal fire weather, late season) due to the buildup of dead resinous material and high flammability. Due to the chaparral species mixed with the knobcone pine, the fire behavior model for this fuel type is Model 4. This model best fits in chaparral, but is compatible with the resinous knobcone pine fuels. This will result in extreme fire behavior on steep slopes exceeding 25 percent. While the live fuel moistures will continue top decline throughout the dry season, the amount of dead fine fuels and buildup of resinous material in the knobcone pine vegetation will produce high intensity wildland fires early in the dry season.

Management Concerns

The EBWMP direction for the knobcone pine community is to develop a long-term strategy for managing the knobcone pine forest on Flicker Ridge, emphasizing the use of all available tools to promote ecosystem health while improving fire safety in the community of Canyon.

This represents the District's highest priority area for prescribed fire treatment to minimize fire hazards and potential fire intensities. High intensity wildland fires represent a threat to the knobcone pine plant community, surrounding vegetation classifications (hardwood forest, Coastal Scrub), and the Canyon intermix. The Redwood forest located downslope and to the west of the knobcone pine forest serves as an effective fuelbreak for east to west fire spread and the grasslands to the east for west to east fire spread.

The existing stand on Flicker Ridge will undergo extreme senescence and mortality without fire and wildland fire under current fuel load and flammability conditions would be a significant threat to the Canyon community. Prescribed burning under a carefully selected parameters would address this issue.

Fuel management activities should be strategically designed to provide fire control and containment lines for intermix protection and in preparation of prescribed burning activities.

The knobcone pine is considered a locally rare species on the District's Watershed Plants of Concern list. The knobcone pine area in the Canyon has been identified as potential habitat pallid manzanita habitat, which is considered a Special Status Species. Prescribed fire treatments are the preferred fuel reduction treatment for potential pallid manzanita habitat. Prescribed fire would likely promote the regeneration of herbaceous species in the understory including fire-followers and endemics. There is no commercial value for knobcone pine wood.

The unpalatable characteristic of knobcone pine deter wildlife browse, while the cones are heavily spiked to provide protection from most predators. The knobcone pine does provide cover and nesting opportunities for birds and small animals.

FUEL MODEL - 9 (scattered to dense)

Seasonal Condition	**S, SW, W**	**NW, SE**	**N, NE, E**	**Seasonal Key**
Early Season	**H**	**H**	**H**	No differences
Normal Fire Weather	**H**	**H**	**H**	
Late Season	**H**	**H**	**H**	

East Bay Watershed Plants of Concern : Stebbins, R. 1996.
Biological Survey Studies for EBMUD.
Special Status Species pallid manzanita
Locally Rare Species knobcone pine

Redwood Forest

Watershed location

The redwood forest covers approximately 269 acres of the Upper San Leandro watershed, just northwest of the reservoir near the Town of Canyon. This deep valley location is located within FMU 18 and receives a significant coastal fog influence. This exposure to the onshore marine air helps to maintain damp, cool understory fuels, which are significantly sheltered from changes in fire weather conditions. Some smaller patches of redwood forest can be found integrated with the hardwood forest fuel classifications on the west side of Upper San Leandro Reservoir.

Fuel Characteristics

Redwood is a native evergreen species with extremely long life spans. The dense forest floor commonly consists of thick litter, shade tolerant fern species, and perennial herbs, with understory of California bay and hardwoods. Mature trees have a high resistance to fire, protecting themselves from low to moderate fire intensities with extremely thick basal bark (up to a foot deep) and high tree crowns. The root system consists of deep, widespreading lateral roots with no taproot. Redwoods do not require fire for reproduction. The dense canopy cover helps to maintain the damp, cool understory conditions.

Fire Behavior

Fire intensities range from low to high depending on the condition of the understory. Dense riparian stands minimize the impact of wind on fire spread, while the fire intensity is determined by the live fuel moistures in the understory.

Daily/Hourly Susceptibility

The redwood forest has extremely low susceptibility to daily and hourly changes; however susceptibility increases after long periods of drought or extended extreme fire weather conditions. This unique feature makes it an important habitat in biodiversity management.

The redwood forest location is in the shady bottom of a narrow canyon, which is commonly exposed to coastal fog. This site feature reduces the potential for drought stress, maintains higher fuel moistures, and minimizes evapotranspiration.

Management Concerns

The EBWMP describes the redwood forest as "a locally uncommon plant community because of its limited range in the East Bay." Redwood is a valuable timber species; however, this location has not been logged for over a century. The wood and burls are used for a wide variety of products.

Fire plays an important ecological role in the redwood forest fuel classification. Mature redwoods are resilient to fire, and their ability to sprout from the root crown or from dormant buds represents an adaptation to various fire intensities. While fire is not required for regeneration and fire frequency would most likely exceed 100 years without human causes, fire exclusion is not an effective long term management approach. Redwoods have utilized periodic fire to manage their understory fuels and young trees. A long-term management approach utilizing prescribed fire is needed to maintain natural fuel accumulations and forest health.

The redwood forest is a valuable District biodiversity resource providing habitat and thermal cover for variety of raptors, mammals, reptiles, and amphibians. The cavities of redwood trees provide nesting areas for woodpeckers and other birds.

FUEL MODEL - 9 (scattered to dense)

Seasonal Condition	**S, SW, W**	**NW, SE**	**N, NE, E**	**Seasonal Key**
Early Season	**L**	**L**	**L**	
Normal Fire Weather	**L**	**L**	**L**	
Late Season	**M**	**M**	**M**	Prolonged Foehn Winds

Riparian

The District watershed lands consist of four types of riparian plant communities; 1) herbaceous or bare riparian, 2) willow riparian scrub, 3) Oak/bay/willow riparian, and 4) mixed deciduous riparian woodland. The moist understory make this the least flammable of the fuel types. Riparian fuel classifications on District watershed lands is are distributed as follows:

377 acres of Oak/bay/willow riparian
221 acres of mixed deciduous riparian woodland
140 acres of herbaceous or bare riparian
59 acres of willow riparian scrub

Fuel Characteristics

Because this fuel type is commonly distributed in narrow bands with high variability in species composition and available moisture, it is impractical to assign a fuel model. Fire behavior would be predicted best by using characteristics of the neighboring fuel types. The light herbaceous or bare riparian assumes the grassland fuel hazard rating.

The oak/bay/willow riparian is located primarily on moderate to steep slopes along ephemeral and intermittent streams of the Upper San Leandro Reservoir and San Pablo Reservoir watersheds. As water runoff is a critical factor in the water quality of these two reservoirs, the biofiltration capacity of this vegetation plays a significant role. Deep thickets of willows in the arroyo are common in this riparian type, while the bays and oaks are located upslope of the stream. Therefore, the fuel moisture conditions of the willows are critical to the fire behavior in drainage, and the resulting damage to the biofiltration capacity. This fuel type can also be found in the Chabot Reservoir watershed, but is rare in Briones, Pinole, and Lafayette watersheds.

The mixed deciduous riparian woodland covers approximately 221 acres of watershed lands and is evenly distributed in the Upper San Leandro (68 acres), Pinole (62 acres), and San Pablo (51 acres), and Chabot (39 acres) watersheds. This fuel classification is typically found along perennial streams. The understory is commonly dense.

The herbaceous or bare riparian is defined as riparian areas not dominated by trees or shrubs. The Pinole (50 acres), San Pablo (44), and Upper San Leandro (31 acres) watersheds contain the majority of the District's 140 acres of herbaceous or bare riparian vegetation. This vegetation type is most commonly associated with grassland fuel models when exposed to water stress.

The smallest coverage (59 acres) of riparian vegetation is the willow riparian scrub, which is evenly distributed between the San Pablo (20 acres), Upper San Leandro (15 acres), and Pinole (14 acres) watersheds. Approximately 5 acres can be found in Chabot and Briones watersheds. This vegetation consists of a brushy thicket of willow and can be very susceptible to changes in fire weather during water stress.

Fire Behavior

Normally, riparian areas are not considered as a serious fire hazard. However, during extreme fire danger periods and extended droughts, riparian areas can become trouble spots due to their high level of decadent and dense vegetative fuels. Fire intensity is dependent on the level of water stress, steepness of slope, narrowness of the canyon, and riparian fuel type. Fire intensity increases during longer periods of water stress, especially when it results in the accumulation of dead fine fuels or curing of vegetation. Fire intensity increases significantly for riparian vegetation located on slopes exceeding 25 percent. The type of riparian vegetation determines overall fuel load, accumulation of dead material, and live fuel moisture trends during water stress which all increase fire intensity.

Fire intensity will increase under late season Foehn wind conditions when located on north, northeast, or east facing aspects. Fire intensity further increases when riparian vegetation is located in narrow and/or steep canyons where upslope Foehn winds will be intensified.

Seasonal Trends

Due to the high fuel moistures associated with most of the District's riparian areas in spring and early summer, riparian fuel types are rated as a low fire hazard in early season. Willow riparian scrub maintains a low normal fire season fuel rating, while the other two riparian types (mixed deciduous riparian woodland, oak/bay/willow riparian woodland) are rated as moderate fuel hazards based on decreasing live fuel moistures and understory dead fuels as the fire season progresses. The latter two types of riparian fuel are often located in steep, narrow canyons or ravines adjacent to other higher hazard fuel types. These areas tend to dry out during the fire season, resulting in decreasing live fuel moistures. They are also very susceptible to high intensity fire under Foehn wind conditions. The mixed deciduous riparian woodland, oak/bay/willow riparian woodland are rated as high late season fuel hazards.

Daily/Hourly Susceptibility

The herbaceous or bare riparian and willow riparian scrub are most susceptible to the daily and hourly variations of solar exposure and weather variations due to the amount of dead fine fuels. Herbaceous or bare riparian often consists of wetland grasses and forbs; however, when located on dry locations, the curing of this vegetation will make this fuel classification nearly as susceptible as the grassland fuel types. The willow riparian scrub is commonly an impenetrable thicket of willows which consist of a high amount

of dead woody fine fuels. The susceptibility of both these fuel classifications increases significantly during periods of water stress.

The Oak/bay/willow riparian and mixed deciduous riparian woodland are dominated by trees species. The shading and location near water courses make these areas less susceptible to daily and hourly variations of solar exposure and weather variations.

As intermittent streams are more common (156.5 acres) than perennial streams (26 acres) on the District's watershed lands, water stress conditions are likely to occur during the long, dry summer drought conditions. The associated decrease in live and dead fuel moistures will make riparian vegetation very susceptible to variations in fire weather late in the summer.

Riparian vegetation is especially susceptible under late season conditions, which are even more explosive when aligned with Foehn winds. This is further increased when located in deep, narrow canyons on north, northeast, or east facing slopes. The cumulative effects of water stress, decreased live and dead fuel moistures, Foehn winds, and narrow drainages provide the necessary alignment of factor to produce high intensity wildland fire.

Riparian vegetation is often an effective barrier to wildland fire; however, under the late season Foehn wind conditions, this vegetation can be very explosive and result in significant watershed impacts on water quality and biodiversity if ignited.

Management Concern

Riparian vegetation plays a vital role in the protection of water quality and promotion of biodiversity. It provides a biofiltration role to protect reservoir water quality from the impacts of storm runoff, and minimize the impacts of soil erosion and sedimentation. Riparian vegetation stabilizes the creek bank and shades the water surface of creeks and pools, maintaining lower water temperatures. Riparian vegetation is known to host sensitive plant and animal species and is identified as critical habitat for maintaining biodiversity.

A long-term approach to managing of the riparian vegetation and its susceptibility to high intensity wildland fire is needed to minimize water quality impacts and protect key natural resources. Occasional monitoring of the accumulation of dead fine fuels of these areas will help identify key areas where high intensity wildfire will occur under extreme fire weather.

Appendix E

FUEL INVENTORY

Prescribed fire, under appropriate scheduling and prescription, can be an excellent tool for enhancement of riparian areas over the long term and establish a buffer of lower intensity fuel conditions to protect riparian vegetation for high intensity wildland fire spread. Fire impacts on riparian areas depend on the nature of the particular fire and riparian habitat. Cool or moderate intensity surface fires can be beneficial. Intense fires often impact the ladder or canopy fuels resulting in serious ecosystem damaging impacts. Resistance to fire suppression is quite high. Access to the fuels is limited while fuel continuity and arrangement is very dense. Long smoldering fires are very common and can become a nuisance to the wildlife and to the firefighters.

RIPARIAN FUEL INVENTORY RATINGS: ***No Applicable Fuel Model***

Herbaceous or Bare Riparian

Seasonal Condition	**S, SW, W**	**NW, SE**	**N, NE, E**	**Seasonal Key**
Early Season	**M**	**L**	**L**	Normal Fire
Weather	**M**	**M**	**M**	Curing of Grass
Late Season	**M**	**M**	**M**	

Mixed Deciduous Riparian

Seasonal Condition	**S, SW, W**	**NW, SE**	**N, NE, E**	**Seasonal Key**
Early Season	**M**	**L**	**L**	
Normal Fire Weather	**M**	**M**	**M**	
Late Season	**M**	**M**	**H**	Foehn Winds

Oak/Bay/Willow Riparian

Seasonal Condition	**S, SW, W**	**NW, SE**	**N,NE, E**	**Seasonal Key**
Early Season	**M**	**L**	**L**	
Normal Fire Weather	**M**	**M**	**M**	
Late Season	**M**	**M**	**H**	Foehn Winds

Willow Riparian Scrub

Seasonal Condition	**S, SW, W**	**NW, SE**	**N, NE, E**	**Seasonal Key**
Early Season	**L**	**L**	**L**	
Normal Fire Weather	**L**	**L**	**L**	
Late Season	**M**	**M**	**H**	Foehn Winds

East Bay Watershed Plants of Concern : Stebbins, R. 1996.
Biological Survey Studies for EBMUD.

Special Status Species	Northern California black walnut, Franciscan thistle, Lobb's aquatic buttercup
Keystone Species	western sycamore, coast live oak, black oak, valley oak
Indicator Species	giant chain fern, mule fat,
Locally Rare Species	wild onion, celery-leaved lovage, Oregon ash, Gooding's black willow, wax myrtle, marsh baccharis, California loosestrife, scarlet monkey flower, Philadelphia daisy, leopard lily, golden-eyed grass

Fuel Inventory/Understory Assessments

This classification enhances the existing vegetation coverage by providing site-specific information on the condition of the understory fuels, which is more appropriate for assessing the relative fuel hazard for specific vegetation classifications. This assessment is captured in the *Intensi.shp* theme.

MIXED WOODLAND FUEL INVENTORY CLASSIFICATIONS - 1997

Series	Stage (Age)	Understory Density
Mixed Woodland	1 (Zero to 10 years)	1 - None
Knobcone pine / Chaparral	2 (10 to 20 years)	2 - Scattered
Pallid Manzanita	3 (20 to 30 years)	3 - Dense
Shale Chaparral	4 (30+ years)	
Hard Chaparral		