II. General Description of Current Fire Situation

The primary goal of wildland fire protection in MMU is to protect the wide range of assets found within the unit from the effects of wildfire. The wildland protection system was created and funded to protect both public and private assets at risk. The following have been identified as assets at risk from wildfires: timber, watershed, wildlife, unique scenic and recreation areas, range, wildlife, air quality, structures and people.

Assets at Risk

Asset at Risk	Public Issue Category	Location and ranking methodology
Hydroelectric power	Public welfare	1) Watersheds that feed run of the river power plants, ranked based on plant capacity; 2) cells adjacent to reservoir based plants (Low rank); and 3) cells containing canals and flumes (High rank)
Fire-flood watersheds	Public safety Public welfare	Watersheds with a history of problems or proper conditions for future problems rank based on affected downstream population
Soil erosion	Environment	Watershed ranks based on erosion potential
Water storage	Public welfare	Watershed area up to 20 miles upstream from water storage facility, ranked based on water value and dead storage capacity of facility
Water supply	Public health	1) Watershed area up to 20 miles upstream from water supply facility (High rank); 2) grid cells containing domestic water diversions, ranked based on number of connections; and 3) cells containing ditches that contribute to the water supply system (High rank)
Scenic	Public welfare	Four mile view shed around Scenic Highways and 1/4 mile view shed around Wild and Scenic Rivers, ranked based on potential impacts to vegetation types (Grass. brush, tree, etc.)
Timber	Public welfare Environmental	Timberland ranked based on value and susceptibility to damage
Range	Public welfare	Rangeland ranked based on potential replacement feed cost by region, owner, and vegetation type
Air quality	Public health Environmental Public welfare	Potential damages to health, materials, vegetation, and visibility; rank based on vegetation type and air basin
Historic buildings	Public welfare	Historic building rank based on fire susceptibility
Recreation	Public welfare	Unique recreation areas, areas with potential damage to facilities, rank based on fire susceptibility
Structures	Public safety Public welfare	Rank based on housing density and fire susceptibility
Non-game wildlife	Environment Public welfare	Threatened and endangered species locations and habitats based on input from California Department of Fish and Game and other experts.
Game wildlife	Public welfare Environment	Threatened and endangered species locations and habitats based on input from California Department of Fish and Game and other experts.

Asset at Risk	Public Issue Category	Location and ranking methodology
Infrastructure	Public safety Public welfare	Infrastructure for delivery of emergency and other critical services (e.g. repeater sites, transmission lines)
Ecosystem Health	Environment	Rank based on vegetation type and fuel characteristics

Table 1 Assets at Risk

The assets at risk have been divided into 450 acre parcels for manageability and evaluation purposes within the unit. These 450 acre cells are designated as Quad 81st. This designation is based on the sectioning of a USGS 7.5 minute quadrangle map divided into a 9x9 grid pattern; the result is squares of 450 acres. Fire Management Plan assessments are made at the Q81st level therefore; each Q81st in MMU has a ranking applied to it for LOS, AAR, fuel hazards, etc.

Fire protection resources are limited primarily by budget constraints. Therefore, resources are allocated, in part, based on the rank of the asset. The assets are ranked, high, medium and low, as to their susceptibility to wildfire. (For more information regarding the evaluation of asset wildfire susceptibility, refer to the California Fire Management Plan.) The ranking is scaled to the Q81st and transferred to GIS maps. The map overlays have been evaluated by unit staff. The areas with the highest combined asset values and fire risk have been targeted for pre-fire management activities (See Target Area Map). Many factors are involved in target area identification, including political climate of the region and fire suppression cost reductions.

The process of enumerating assets at risk also aids in identifying who benefits from those assets. The MMU Fire Management Plan is structured on the California Fire Management Plan which allocates those who benefit from the protection of an asset should pay for that protection. Throughout MMU many cooperative pre-fire management projects have been established and accomplished. New projects are continuously being evaluated and prioritized. MMU has been relatively successful in apportioning its resources based on public versus private benefits. The primary reason for MMU’s effective cost apportionment efforts is evident through the Department’s Vegetation Management Program (VMP), where a cost apportionment formula is built into the contract. VMP is the Unit's primary tool for pre-fire management projects however; budget reductions have nearly eliminated VMP as a tool for fuel reduction projects in MMU.

Ignition Workload Assessment (Level of Service)

The Level of Service (LOS) rating is a ratio of successful fire suppression efforts to the total fire starts. It divides the annual number of small fires extinguished by initial attack by the total number of fires. This number is then multiplied by 100 to get a percentage. This method measures initial attack success and failure rates of small fires throughout the Unit. The LOS uses a Geographic Information System (GIS) that overlays a 10 year history of wildfires onto a map and derives the average annual number of fires by size, severity of burning and assets lost. This data provides a LOS rating, in terms of a success and failure calculation.

$$\text{Success Rate} = \frac{\text{Annual number of fires that were small and extinguished by initial attack}}{\text{Total number of fires}}$$

*100 = Success rate in percent

The result is an initial attack success rate in percentage based on vegetation type and area. Success is defined by fires that are controlled before unacceptable damage and cost are incurred and where initial attack resources are sufficient to control wildfires.

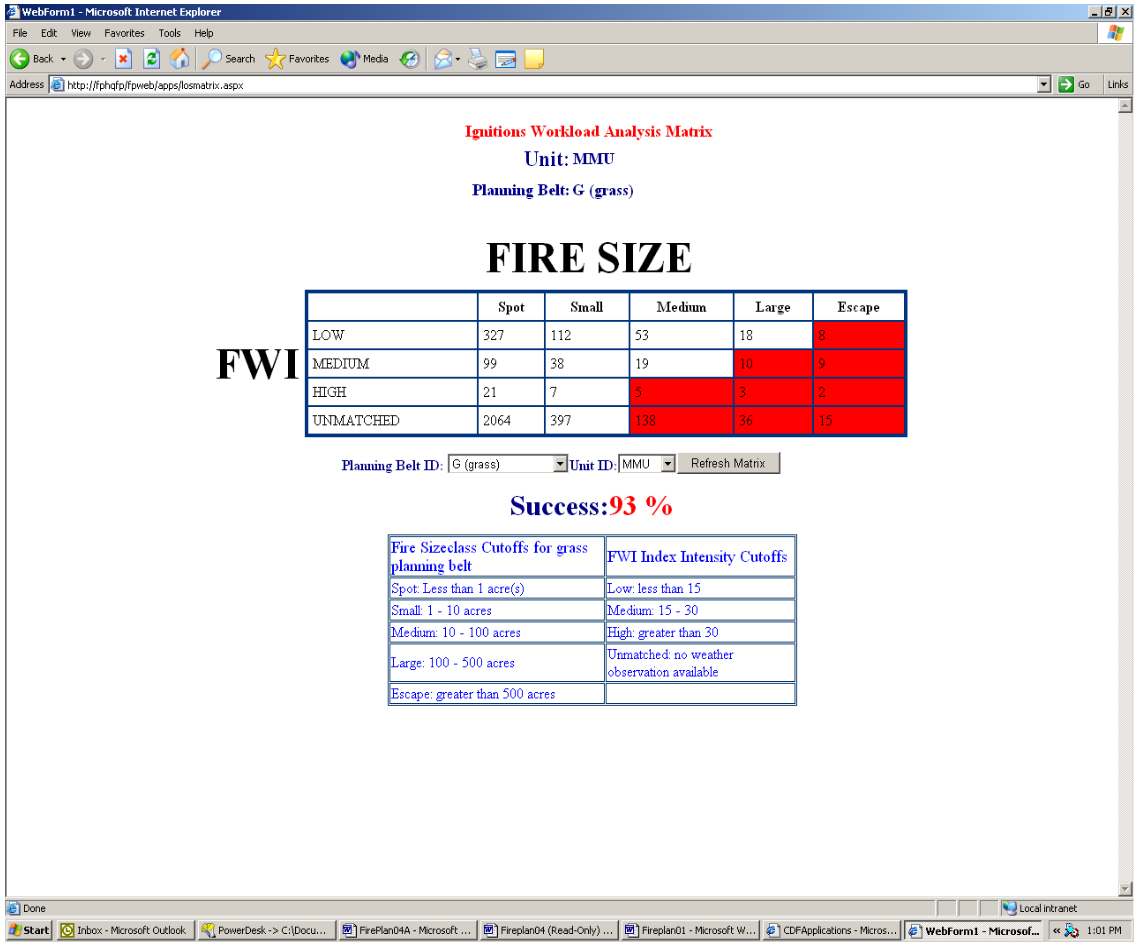
A matrix is used to define and display successful initial attacks in this framework. The matrix axis defines fire sizes and intensities. The body of the matrix contains the fire activity workload for the fire management analysis zone.

The general matrix has five columns for fires of different sizes and three rows for different intensity levels. The actual size classes and intensity levels are defined for regions of similar vegetation types. The dark shaded portion of the matrix indicates fires that would be expected to exceed budget protection. The lightly shaded portion indicates successful initial attack suppression, or fires that are normally contained within allowable suppression costs.

In this matrix, the lightly shaded area represents fires that are successfully attacked and the dark shaded area represents fires that weren't successfully attacked. This designation of successful matrix cells is the same for planning belts.

Planning Belts are areas consisting of similar vegetation types. These areas have similar fire behavior characteristics and are based on the Fire Behavior Prediction System fuel modeling correlation.

MMU has four planning belt types; Grass, Brush, Conifer and Woodland.



Ignitions Workload Analysis Matrix

Unit: MMU

Planning Belt: G (grass)

FIRE SIZE

FWI

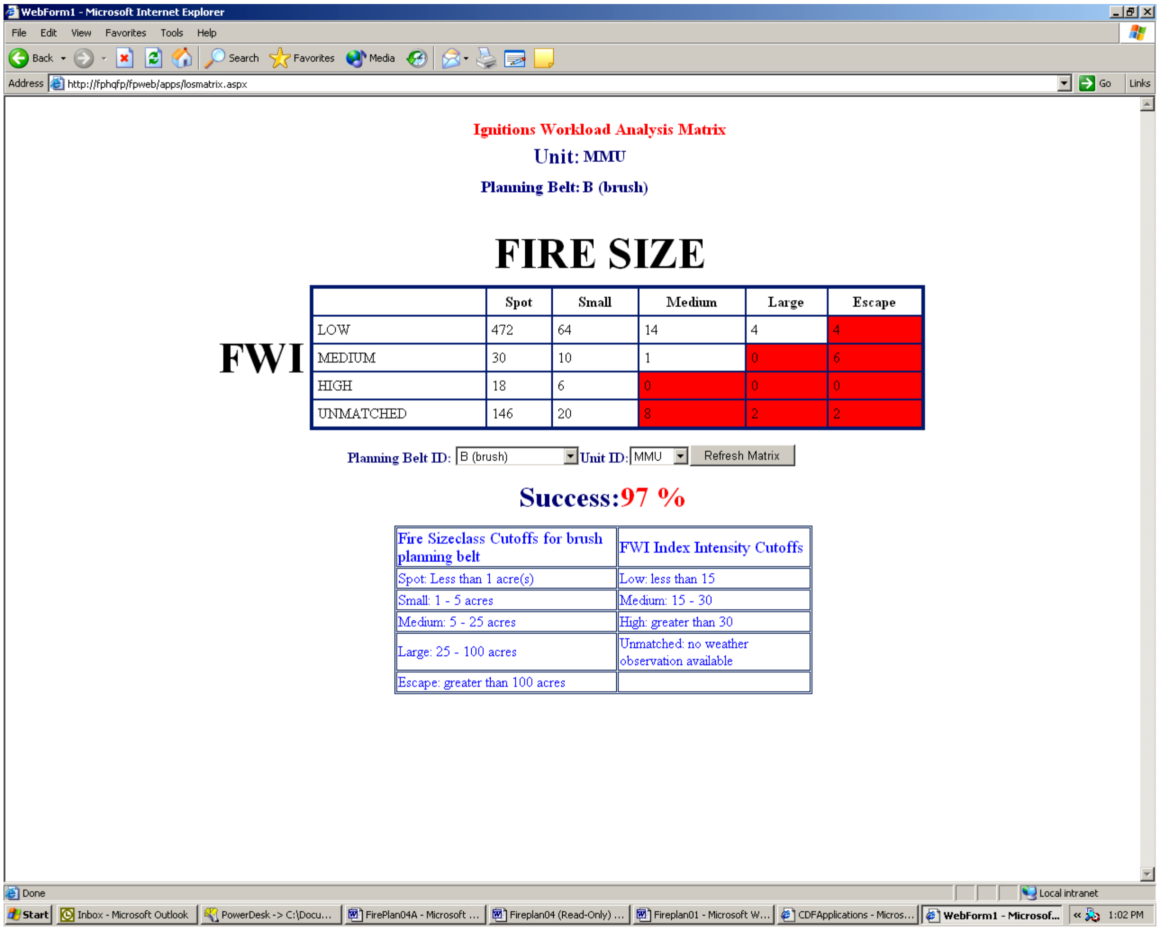
	Spot	Small	Medium	Large	Escape
LOW	327	112	53	18	8
MEDIUM	99	38	19	10	9
HIGH	21	7	5	3	2
UNMATCHED	2064	397	138	36	15

Planning Belt ID: G (grass) Unit ID: MMU Refresh Matrix

Success:93 %

Fire Sizeclass Cutoffs for grass planning belt	FWI Index Intensity Cutoffs
Spot: Less than 1 acre(s)	Low: less than 15
Small: 1 - 10 acres	Medium: 15 - 30
Medium: 10 - 100 acres	High: greater than 30
Large: 100 - 500 acres	Unmatched: no weather observation available
Escape: greater than 500 acres	

Chart 1 Level of Service (Grass)



Ignitions Workload Analysis Matrix

Unit: MMU

Planning Belt: B (brush)

FIRE SIZE

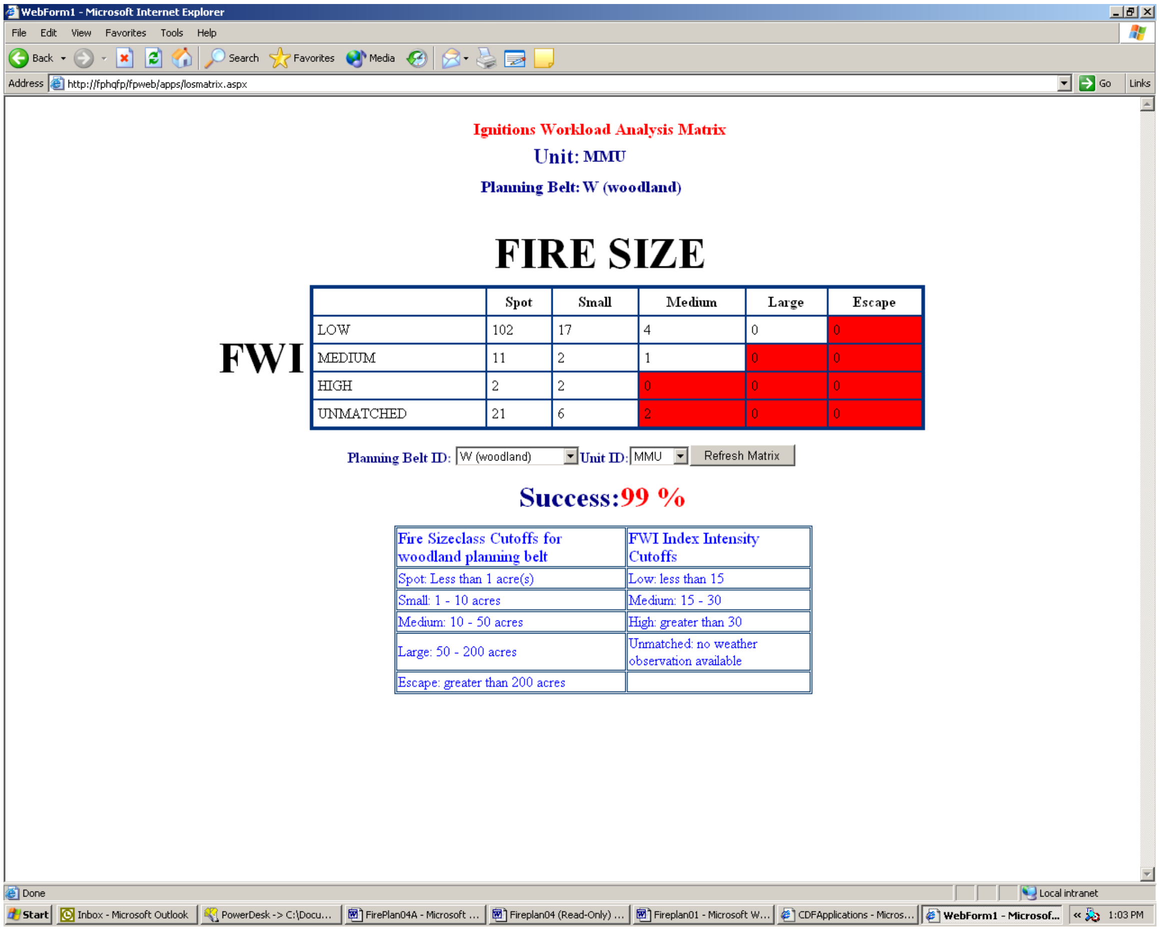
FWI	Spot	Small	Medium	Large	Escape
LOW	472	64	14	4	4
MEDIUM	30	10	1	0	6
HIGH	18	6	0	0	0
UNMATCHED	146	20	8	2	2

Planning Belt ID: B (brush) Unit ID: MMU Refresh Matrix

Success: 97 %

Fire Sizeclass Cutoffs for brush planning belt	FWI Index Intensity Cutoffs
Spot: Less than 1 acre(s)	Low: less than 15
Small: 1 - 5 acres	Medium: 15 - 30
Medium: 5 - 25 acres	High: greater than 30
Large: 25 - 100 acres	Unmatched: no weather observation available
Escape: greater than 100 acres	

Chart 2 Level of Service (Brush)



Ignitions Workload Analysis Matrix

Unit: MMU

Planning Belt: W (woodland)

FIRE SIZE

FWI

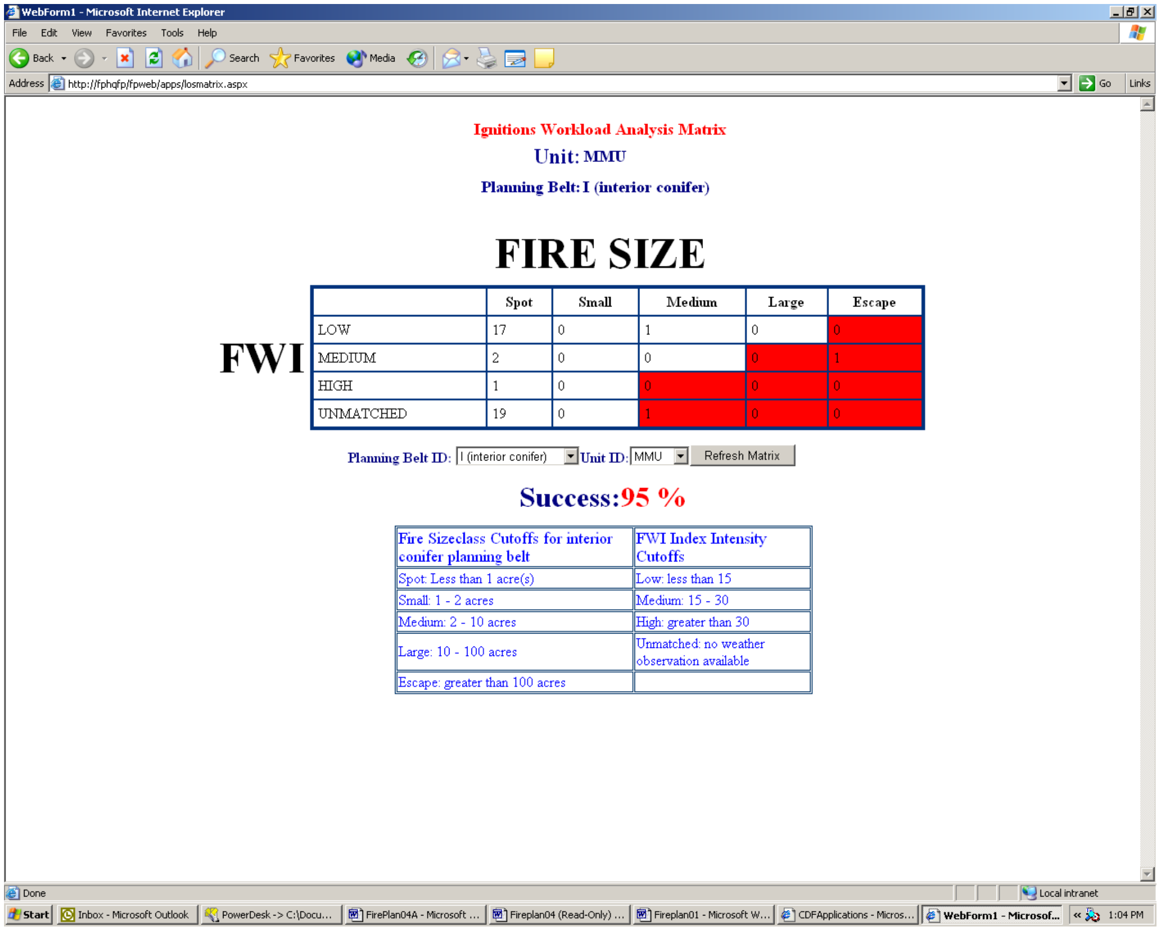
	Spot	Small	Medium	Large	Escape
LOW	102	17	4	0	0
MEDIUM	11	2	1	0	0
HIGH	2	2	0	0	0
UNMATCHED	21	6	2	0	0

Planning Belt ID: W (woodland) Unit ID: MMU Refresh Matrix

Success: 99 %

Fire Sizeclass Cutoffs for woodland planning belt	FWI Index Intensity Cutoffs
Spot: Less than 1 acre(s)	Low: less than 15
Small: 1 - 10 acres	Medium: 15 - 30
Medium: 10 - 50 acres	High: greater than 30
Large: 50 - 200 acres	Unmatched: no weather observation available
Escape: greater than 200 acres	

Chart 3 Level of Service (Woodland)



Ignitions Workload Analysis Matrix

Unit: MMU

Planning Belt: I (interior conifer)

FIRE SIZE

FWI

	Spot	Small	Medium	Large	Escape
LOW	17	0	1	0	0
MEDIUM	2	0	0	0	1
HIGH	1	0	0	0	0
UNMATCHED	19	0	1	0	0

Planning Belt ID: I (interior conifer) Unit ID: MMU Refresh Matrix

Success:95 %

Fire Sizeclass Cutoffs for interior conifer planning belt	FWI Index Intensity Cutoffs
Spot: Less than 1 acre(s)	Low: less than 15
Small: 1 - 2 acres	Medium: 15 - 30
Medium: 2 - 10 acres	High: greater than 30
Large: 10 - 100 acres	Unmatched: no weather observation available
Escape: greater than 100 acres	

Chart 4 Level of Service (Interior Conifer)

Fuels

Fuel, in the context of wildland fire, refers to all combustible material available to burn on an area of land. Grass, brush and timber are the most common fuels found in our mountain ecosystem. Each fuel has its own burning characteristics based on several inherent factors. These factors include its moisture content, volume, arrangement and the plants genetic make up. All of these contribute to how a fire spreads, its intensity, and ultimately, its threat to assets.

Fuel loading is measured in tons per acre. Grass is considered a light fuel with Approximately ¾ tons per acre fuel loading. On the other end of the spectrum, thick brush, a heavy fuel, can have a volume of over 21 tons per acre. The intensity of the fire is directly related to fuel loading. Grass burns rapidly with a short period of intense, maximum heat output; brush on the other hand has a long sustained high heat output making it more difficult to control. Therefore, it is necessary to identify areas containing the more hazardous fuels in order to better manage the hazardous conditions by high fuel loads.

Hazardous Fuels Assessment

Fuel arrangement is critical in wildland fire behavior for it dictates how a fire spreads. Un-compacted fuels, such as grass, spread fire rapidly since more of its surface can be heated at one time. Compacted fuels such as pine litter burn slower because heat and air only reaches the top of the fuel. Vertical arrangement refers to a fuel’s ability to spread upward into treetops. These are called *ladder* fuels and are influential factors on fire spread. The ignition of ladder fuels allows the fire to spread from the ground into the treetops. *Crown* or *canopy* refers to the tops of trees and is very important in stands of burning timber. A fire once introduced by ladder fuels to the tops of dry conifers can spread as rapidly as a grass fire from treetop to treetop.

In an attempt to predict fire spread, the U.S. Forest Service has developed 13 fuel models that categorize fuels by their burn characteristics (Table 5). Four groups are used to classify fuels: grass, brush, timber and logging slash. The fuel model characteristics have been utilized to determine planning belts in the unit. The following is a brief description of the fuel models commonly found in CDF’s wildland protection area of Madera, Mariposa and Merced Counties:

Model 1: This model is used for dry grass with an average depth of 1 foot and a fuel loading of .75 tons per acre. Fires in fuel model 1 burn rapidly with flame length averages of 4 feet. This is probably the most common model in our area and it reflects nearly all of the grasslands found in the foothills below an elevation of approximately 1000 feet, including the west side of Merced County.

Model 2: Like fuel model 1, fires in fuel model 2 spread primarily by dry grass, however shrubs, pine or oak cover between one third and two thirds of the area. The material from these plants contributes to the fire intensity. Four tons of fuel exists per acre and the fuel bed depth is 1 foot. Fires in fuel model 2 burn slower but more intensely than fuel model 1. Indian

Lakes in Madera County, Highway 140 just north of Catheys Valley, and the top of Pacheco Pass are examples of this fuel type.

Model 4: This is a brush model and is characterized by stands of mature brush 6 feet or more in height with more then 16 tons of fuel per acre. Fires in this fuel model burn intensely (19 foot flame lengths) and spread relatively quickly. This fuel type is found in some areas of the Merced River Canyon and in the Coulterville-Greeley Hill area.

Model 5: Litter cast by shrubs in the under story carries fire in this brush model. The fires do not burn intensely (4 foot flame lengths) or rapidly since the young shrubs are green and their foliage does not burn. This fuel type is common at about the 2000 to 3000 feet elevation range of the Sierras, especially in the early months of summer while moisture is abundant.

Model 6: Unlike model 5, fires in this model will burn in the foliage of standing vegetation, but only when wind speeds are greater than 8 mph. Fires burn with an average flame length of 6 feet and spread at a rate of 2,112 feet/hour. Interior live oak, young chamise and manzanita are all associated with this fuel model. In many instances, a fuel model 5 will evolve into this model by the latter part of summer.

Model 8: This model reflects slow burning, low intensity fires burning in the leaf or needle litter under a conifer or hardwood canopy. These fires do not pose a threat unless low fuel moisture or high winds allow the fire to spread into the foliage. This model is found locally in areas treated for fuel reduction. It' low fuel buildups reflect the ideal fire behavior.

Model 9: Fires in this model also burn in needle or leaf litter under a conifer or hardwood canopy, but at a faster rate and a higher intensity than fuel model 8. Concentrations of heavier, dead material add to the likelihood of the fire spreading to the crowns of trees. This model is found in very limited areas under timber stands mostly where fuels have been reduced or low intensity fires have occurred over the last decade.

Model 10: Fires in this timber model burn with greater intensity (4.8 feet flame lengths) than the other timber models. This is to the amount of dead and down fuel accumulations, mostly in the form of large limbs and fallen trees (12 tons/acre). Fire burns at a moderate rate but "torching" of individual trees is common and can cause embers to spot ahead of the main fire. Crown fires are also a threat in this fuel type. In dry or high wind conditions fires in fuel model 10 can be very difficult to control. This fuel model is found in many areas of Madera and Mariposa Counties where stands of ponderosa pines or other conifers are present.

The local distribution of the fuel models is illustrated in Table 2. The table shows that the density of combustible material increases with elevation. Models 1 and 2 (grass) are found at the lowest elevations. Brush is found at the next higher elevation and timber above that, at the National Forest boundary. Local conditions also affect distribution.

North facing slopes tend to get slightly more rainfall and less sun, thus heavier vegetation grows on the north side of the mountain. Soil conditions can also preclude the growth of heavy fuels allowing only hardier species such as chamise to sprout. MMU has a wide variety of fuel types requiring a variety of fuel management prescriptions.

Fuel Model #	Fuel bed depth (feet)	Tons per acre (live)	Tons per Acre (dead)	Flame Length (feet)	Spread Rate (feet/hour)	Comments
1	1	0	.74	4	5195	Dry grass. Common in areas under 1000' elevation.
2	1	.5	4	6	2331	Dry grass with 1/3 to 2/3 brush or tree canopy. Very common above 1000'.
3	2.5	2.5	3.01	12	6926	Grass model, not found locally.
4	6	5.01	16.03	19	4995	Thick brush with heavy dead component.
5	2	2	3.5	4	1199	Young or green brush with fire in the litter only.
6	2.5	2.5	6	6	2131	Mature or dry brush with foliage that will burn when exposed to wind.
7	2.5	2.5	4.87	5	1332	Brush model, not found locally.
8	.2	.2	5	1	107	Timber or hardwood with fire burning in light litter underneath.
9	.2	.2	3.48	2.6	499	Timber with fire in slightly heavier litter then model 8
10	1	1	12.02	4.8	526	Timber with heavy dead material underneath.
11	1	1	11.52	3.5	400	Light logging slash from a partial thinning operation
12	2.3	2.3	34.57	8	866	Moderate logging slash
13	3	3	58.1	10.5	899	Heavy logging slash

Table 2 National Wildfire Coordinating Group Fuel Models

The next phase of determining fuel hazard ratings for the MMU involves the combining of crown fuel characteristics and surface fuel characteristics. The method ascribes additional ladder and crown fuel indices to surface fuels on a specific area. If the vegetation data provide sufficient structural detail, the method imputes these additional indices from those data. If the vegetation data lack structural detail, the method imputes indices based on the fuel model. In MMU the majority of indices were based on the FPBS fuel models.

The potential fire behavior drives the hazard ranking. A rank is attributed to each Q81st in SRA within the unit. The ranking method portrays hazard ratings as moderate, high or very high. The final map displaying the fuel hazard ranks for CDF's Direct Protection Area (DPA) in MMU is used as another factor for determining pre-fire management target areas, fire size potentials and information for stakeholders with interests in ecosystem management, fuels management, and pre-fire management.

Knowledge of fire behavior in various fuel types is essential for designing a defensive plan against wildfire. Fires in grass burn rapidly but can be stopped by a roadway or plowed fire breaks. Fires in brush often burn with an intensity that prevents fire crews from safely applying water to the flame front. Fires in timber can ignite new fires (called spot fires) miles ahead of the main blaze, making control efforts very difficult and dangerous. Wide scale pre-fire management programs can help reduce the likelihood of a potential wildfire catastrophe.

Fire History

Wildfire history is a significant factor of the pre-fire management planning process. The Fire Management Plan assessment framework incorporates detailed information when determining the most beneficial locations for pre-fire management projects, an idea of the level of service on SRA for the unit, and various assets at risk information. Fire history is a piece of the puzzle that allows unit personnel to learn from the past and make an attempt to plan and prepare for future fire behavior. Having knowledge of fire history provides an account of historic fire travel in a particular area. Armed with knowledge of historic fire spreads fire suppression personnel are better equipped to predict current and future fire spread potentials. Identifying where the largest and most damaging fires have occurred is a necessary step in preparing for future wildfire. The most significant aspect of fire history in MMU is that personnel are able to compare the relationship between identified assets at risk and the historic burning patterns of wildfire. This allows for a more informed decision making process when preparing Fire Management Planning documents and procedures.

Figure 6 displays wildfire history on SRA in MMU between 1978 and 2004. The fires shown are 300 acres and greater through 1998. Fires recorded from 1999 through 2001 are 100 acres and greater, from 2002 until 2003 fires 50 acres or greater and currently 10 acres and greater. The map display signifies patterns that are used in pre-Fire Management Planning processes.

Fire Weather History

Wildfire behavior is influenced by three factors known as the fire environment. The fire environment involves fuel, weather and topography. Of these factors, weather is the most influential factor on fire behavior. Identifying patterns and locations of extreme wildfire behavior provides another tool for pre-fire management planners to use when attempting to reduce the costs and losses of wildfire.

In MMU, the severe fire weather assessments have been calculated through the collection of data from weather stations throughout the unit down to the Q81st level. The average number of days that each Q81st experiences severe fire weather has been calculated and displayed on a GIS map. This map is utilized in the planning process by overlaying the map on fire history maps, fire ignition maps and level of service maps. Furthermore, fire weather history has been incorporated into the level of service ratings for MMU which provides a more accurate depiction of the wildfire protection level of service within the unit during severe weather conditions (See appendix).