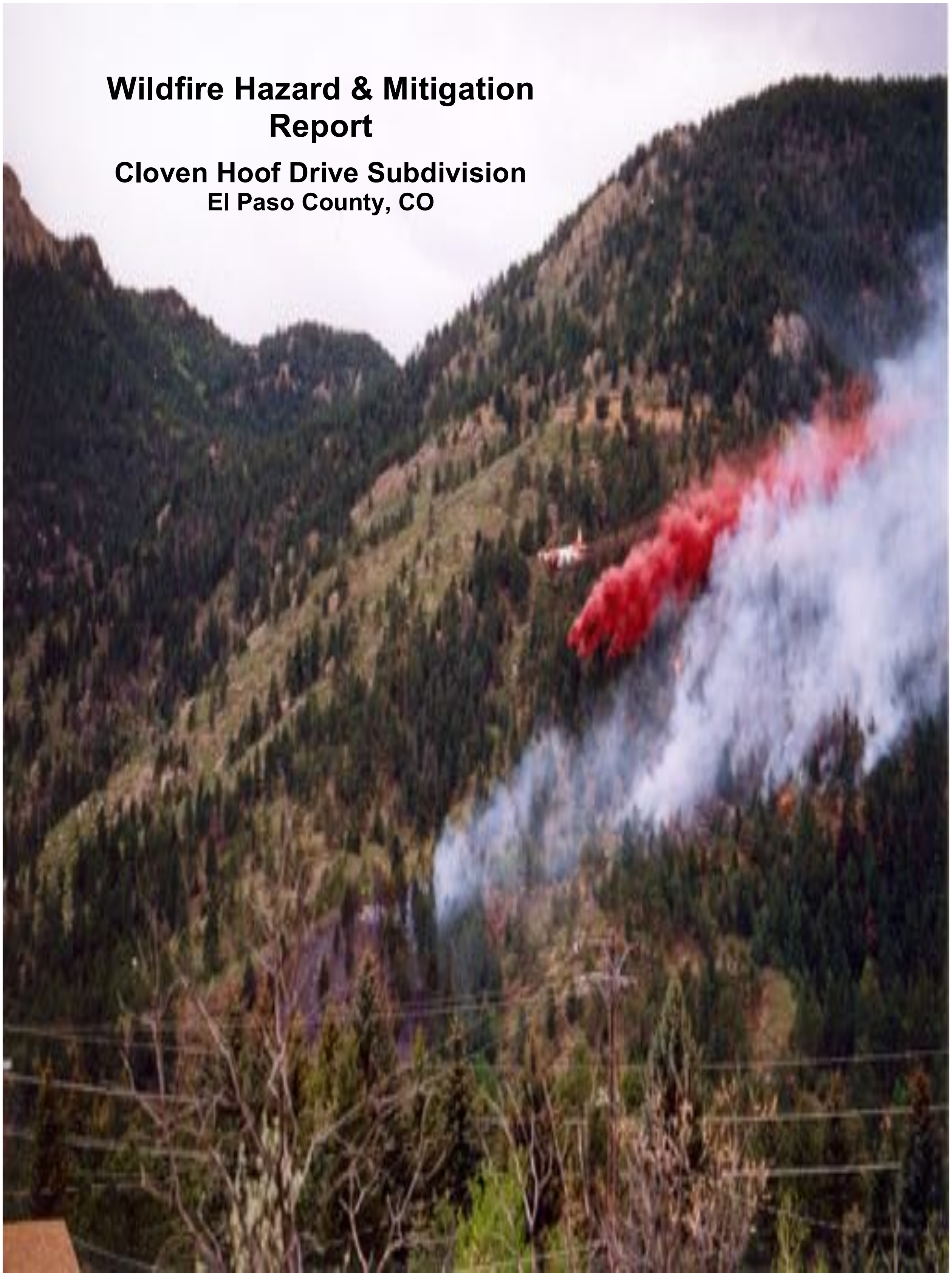
Wildfire Hazard & Mitigation Report

Cloven Hoof Drive Subdivision

El Paso County, CO



Wildfire Hazard Evaluation Report

For

Cloven Hoof Drive Subdivision

El Paso County, CO

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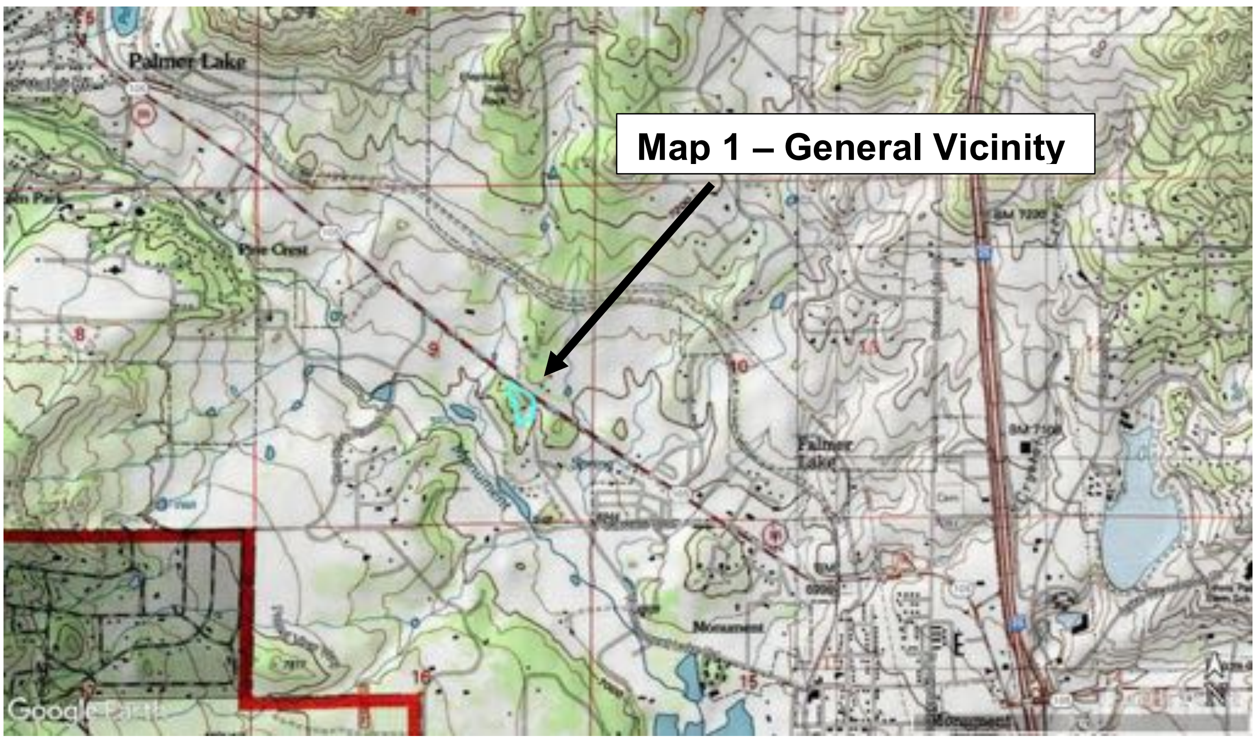
Warning and Disclaimer: The degree of protection from wildfire hazards intended to be provided by this plan is considered reasonable for planning purposes. It is based on accepted forestry and fire science methodology. This plan is intended to aid the Cloven Hoof Drive subdivision in minimizing the dangers and impacts from wildfire hazards. Fire is a natural force and a historical part of the ponderosa pine and native grassland ecosystems. Therefore, unforeseen or unknown wildfire conditions, natural or man-made changes in conditions such as climate, vegetation, fire breaks, fuel materials, fire suppression or protection devices, and ignition sources may contribute to future damages to structures and land uses even though properly permitted within designated wildfire hazard areas.

November 2023

General Description

The Cloven Hoof Drive Subdivision is planned for the Monument area in unincorporated northern El Paso County, Colorado. The development plan proposes the subdivision of two existing lot configurations into four for the purpose of construction of two new residential structures. The subdivision is 3.07 acres in size.

The property is located at the northern terminus of Cloven Hoof Drive. State Highway 105 is located along the northern boundary of the property. The parcels referred to under this report are identified with the El Paso County Assessor's Schedule Numbers 7109002018 and 7109002019.



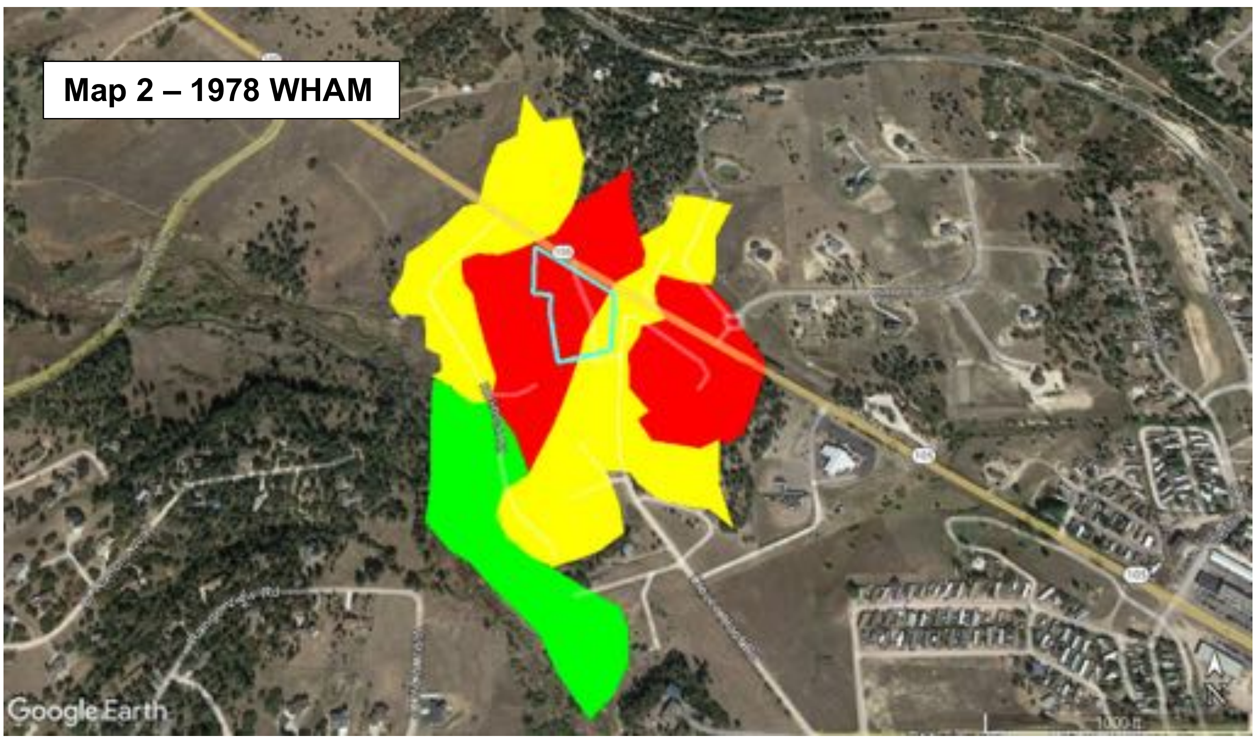
Individual tracts with residential structures lie to the west along Rockbrook Road. Sydni's Subdivision is found to the south along with Illumination Point Subdivision and Meadows subdivision to the southeast. The north is bordered by State Highway 105 and the Pioneer Preserve on the other side of the highway.

The northern El Paso County area does have a wildfire history. Most notably, the Black Forest Fire burned in June of 2013. It was the most destructive fire in Colorado history until the Marshall Fire in Boulder County in 2021. Over 14,000 acres burned, and 509 structures were destroyed.

Prior to the Black Forest Fire, in 1989, a wildfire ignited below Mount Herman which was referred to as the Berry Fire. On April 14, 2022, a small fire was suppressed in the same vicinity. High winds brought down power lines in late October of 2022. This sparked a three-acre wildfire just to the northwest of the property along Highway 105. Ignitions have repeatedly occurred in the area, with 2022 experiencing several fires occurring along Interstate 25.

Wildfire Hazard

Based upon the Wildfire Hazard Area Map (WHAM) developed by the Colorado State Forest Service (CSFS) in 1978, the site of the proposed Cloven Hoof Road Subdivision contains a medium hazard for grass and a severe hazard for brush (see Map 2).

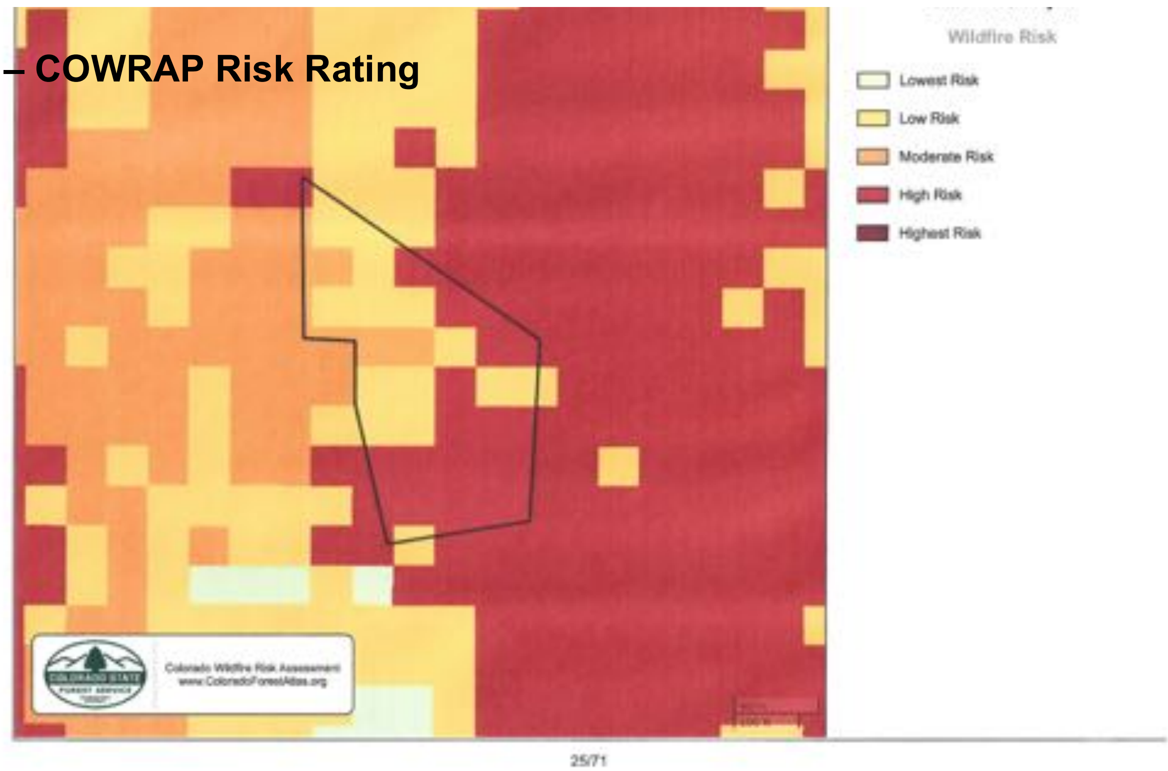


Legend: Green = No Hazard; Yellow = Low Hazard (grass); Red = Severe Hazard (brush/trees)

Since the publication of this hazard map series, the CSFS developed a wildfire risk assessment tool in 2012 referred to as the Colorado Wildfire Risk Assessment Web Portal (CO-WRAP). This assessment was recently updated to include events up to 2017.

Within the assessment report, the Wildfire Risk to the property is split between low to the lowest and moderate to high. Wildfire risk is a composite rating which identifies the probability of loss or harm from a wildfire. Risk identifies the greatest impacts from a wildfire to a range of assets, such as the level of Wildland Urban Interface. Wildfire Risk is determined uniformly across the entire state.

Map 2 – COWRAP Risk Rating



An interesting observation from the assessment is the high rating for Burn Probability. The Burn Probability is the annual probability of any location becoming subjected to a wildfire event. The assessment gives the Cloven Hoof Subdivision a high ranking in this regard. This is not unexpected due to the number of ignitions locally on private and Federal lands in the local area. The Waldo Canyon Fire of 2012 and the Marshall Fire in 2021 weigh heavily on recent memory. The proximity of Highway 105 should not be discounted as it may provide a source for wildfire ignitions.

Also, the type of wildfire that might occur should be limited to a slow moving groundfire. The fuels that will carry a wildfire across the property are limited to Gambel oak brush and tall grasses (see Photo 1). The grass becomes a flash fuel as it cures and dries. This dry fuel condition was a factor in the Marshall Fire in 2021.

Note that the ponderosa pine forest is maturing with very little, if any, live green limbs reaching into the oak/grass surface fuels. So, there is little opportunity for a ground fire to reach into the canopy and become a crown fire. The ground fuels are not dense enough to generate sufficient heat to ignite the canopy (see Photo 2, pg. 7) . If a wildfire were to occur or pass through the property, there may be individual trees that could torch but this should not contribute to sustaining a crown fire.

Photo 1. A view of the property looking west across the northern portion from Cloven Hoof Drive. Note the absence of live green limbs reaching the forest floor.

One distinction that can be drawn from the assessment is the selection of the fuel models used in determining the wildfire hazard. The WHAM (Map 1) uses a simplistic approach and delineates between grass, shrub and tree fuel beds.

The CO-WRAP assessment uses a detailed and distinct series of fuel models. This is a more dynamic approach, but it does not delineate between smaller fuel beds but considers them uniform across large areas. So even though there may be clusters of shrubs or grasses present, a refined timber fuel model is described incorporating these variations.

A field inspection was performed on November 17, 2023, to determine if any change should be made to the original wildfire hazard area map conclusions or the CO-WRAP assessment. Based upon the field inspection, **the wildfire risk was confirmed as lowest to low in the ponderosa pine and moderate to high in the shrub/grass**.

There does not appear to be any extreme wildfire hazard as suggested in the WHAM of 1978.

Photo 2. A view near the western edge of the property. While there is Gambel oak present, it is very short in height. The fuel which will carry a wildfire is the dead oak leaves and a compressed pine needle bed.

Wildfire Behavior

This rating considers the role of the three major components that affect wildfire behavior: fuels, topography and weather. These three components will be examined in relation to the Center Ice View development plan.

Fuels

The area was field checked, and the results of the WHAM were modified and the COWRAP Assessment was confirmed based upon the observed fuel models on the property. The USDA – Forest Service Intermountain Forest and Range Experiment Station in Ogden, Utah, developed these fuel model descriptions. They are used as aids in estimating fire behavior (see Appendix A).

The criteria for choosing a fuel model reflects that a wildfire will burn in that fuel type which best supports that fire and carry its spread to other locations. There may be more than one fuel model represented on any given area of land. In addition, current and expected weather conditions will influence the condition of these fuels.

The Gambel oak stands can be described under Fuel Model 6, “Fires carry through the shrub layer where the foliage is more flammable…but this requires moderate winds greater than 8 mi/hr. Fire will drop to the ground at low speeds or at openings in the stand.”

These oak stands can be narrowed further under SH7, Very High Load, Dry Climate Shrub. This fuel load represents approximately 10.7% of the property. In this fuel model, when compared to SH6, is the possible presence 100-hour time lag fuels (1”-3” in diameter) such as dead oak stems or limbs.

The grass land type is broadly considered as Fuel Model 1 where wildfire spread is governed by fine, very porous and continuous herbaceous fuels that have cured or nearly cured. This grassland fuel is further refined in description as RNH 942, Minor roads with High Load Fuels, 39.3% of the area. This newly described fuel model considers the capacity for a wildfire to “jump” over a road. This model was selected to reflect the presence of the road that crosses the property with the grasses, shrubs and trees providing a high fuel load. As this road is to be abandoned, it will be the developed driveway that may be reflected by this model.

The final fuel model is TLML 191, Timber Litter, Moderate Load. This is like TL8 (188), Long-Needle Litter. The primary difference between the two is the increased load of 100-hour time lag fuels. Again, this is just larger diameter dead woody debris such as limbs or small diameter trees on the forest floor.

Topography

The topography of the site is one of the main factors that will influence a fire to spread. The aspect or compass direction that any slope faces influence the fuel type that exists and the amount of preheating these fuels receive by the sun. Aspect can also influence the effects of diurnal winds, as they move upslope during the daylight hours and downslope during the evening and early morning hours.

The slope on the property ranges from 1% upwards to 5% from the top of the hill heading east towards Highway 105. These are gentle slopes and should not significantly increase the rate of spread from fires originating from below.

The slope, originating on the neighboring property to the west, may be the biggest threat to spreading wildfire. This location has a slope of approximately 7%. This runs from Rockbrook Road uphill to the summit of the rise (see Photo 3).

As the percentage of slope increases, the rate of fire spread by convection increases. In other words, wildfires burn faster moving uphill (see Figure 1).

Figure 1. Slope Affects Fire Spread

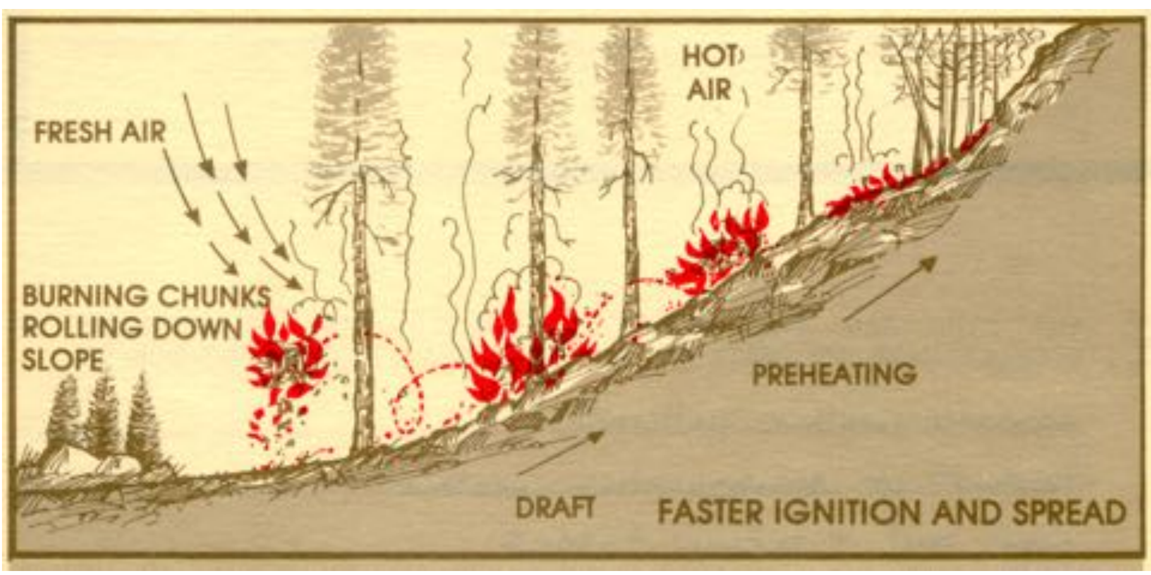


Photo 3. A view of the slope originating from the adjacent property. The thicket of ponderosa pine is not located on the subject property.

Weather

Weather is the most variable of all the factors. The accumulative effects of weather over time can influence vegetation curing and fuel moisture content.

Grasses, for example, are described as being one-hour time lag fuels. Time lag is a measure of the time needed for a fuel particle to lose about 63 percent of the difference between the initial moisture content and the equilibrium moisture content. Simply stated, it is the amount of time needed for a given dead fuel to gain or lose moisture. Hence grasses tend to be influenced by the weather conditions on an hourly basis. Wood fuels that are three inches in diameter or larger are considered 1,000-hour time lag fuels. This type of fuel requires a long period of time of dry or wet weather to affect its combustibility.

Winds can influence the direction and rate of spread of a wildfire. Of greater concern is the short spotting of the fire by embers transported by winds ahead of the main fire.

The effects of wind on a fire were on display most dramatically two winters ago (December - 2021) during the Marshall Fire in Boulder County. This fire grew to over 6,200 acres and destroyed 1,084 homes. The wind gusts up to 115 miles per hour where reported. The wildfire reached the town of Superior, three miles away, in just one hour.

It should be noted that this level of high wind activity is not uncommon along the foothills where the proposed residential development is located. Finally, it should not be assumed that the main periods of fire danger would be in the summer months. As history has shown, out of season fire events are much more common than might be expected by the public.

While the weather may contribute greatly to a wildfire event, it is immune to outside influences.

Predicted Fire Behavior

Using the USDA – Forest Service BehavePlus fuel modeling system 5.05 , the following predictions can be made based upon an 80-degree temperature day with a relative humidity of 18% with little cloud cover at 1:00 p.m. in the month of July.

Using the inputs of the 1-hour dead moisture being 7%, the 10-hour and 100-hour dead fuels are both set at 10%; live herbaceous (grasses) and live woody stems are set at 200%. This would be an expectation of mid-summer growth. It could be a windy day, or the site is experiencing strong downdrafts from thunderstorms, so the windspeed is set at 20 mph. The slope steepness is set at 7%.

Based on these inputs, a wildfire would spread at a rate of 46 feet per hour with a flame length of one-half of a foot or about six (6) inches.

If the inputs are changes to reflect a growing season plagued by long term drought, the outcome is not negatively different. The 1-hour dead fuel moisture is lowered to 3%. The 10-hour and 100-hour dead fuels have dried to 5%. The live fuel moisture is 50%, reflecting early dry growing season conditions. The live woody fuel moisture is composed of leaves and fine stems that have matured and is set at 100%, which would normally be a late growing season condition.

The wind speed of 20 mph and a slope of 7% remain the same as in the previous example. With the drier conditions, flame lengths remain low at about eight (8) feet. The rate of spread increases to over ninety (90) feet per hour or 1.5 feet per minute.

It is predicted that local suppression forces should be able to contain the initial fire outbreak with mobile engines and hand constructed control lines.

It should be noted that these predictions are based upon normal weather conditions prevailing over the course of a year. Weather conditions that were exhibited during the winter of 2022 have been outside of normal conditions resulting in the catastrophic losses experienced throughout the western United States this past fire season. Again, the Marshall Fire provides an insight into what fire behavior might occur even in the winter season.

If such conditions are present on or in the vicinity of the proposed development site, any wildfire event can be predicted to be more severe and resistant to initial control efforts.

Wildfire Mitigation

It should be noted here that the occurrence of a wildland fire on this property and any subsequent spread of a wildfire to adjacent land could never be eliminated. In the Spaatz Fire, suppression forces were able to arrive on scene in approximately four minutes after the fire was reported. Even with this rapid response, the wildfire reached a size of 67 acres before it was controlled.

The potential for loss can be reduced and the odds can be improved that initial response forces can be successful in keeping a wildfire to the smallest size possible and structure loss to a minimum. But even with the best efforts of suppression forces, there will always exist a level of risk of loss to wildfire.

The only way to reduce the risk of loss from a wildfire is to modify the factors that influence fire behavior. Of the three factors discussed previously, the only factor that could be modified prior to a wildland fire is the fuels. The efforts in modifying fuels can be targeted to their arrangement, continuity and availability.

- **Arrangement**

The arrangement of fuel considers the size, shape and compactness of the fuel itself. Smaller fuel sizes have a greater surface area exposure for preheating. If these smaller sized fuels are only lightly compacted in spacing this results in easier ignition and increased combustion.

Fuels that are tightly compacted and larger in size have lower surface areas. This reduces the ease of ignition and combustion.

One technique in reducing the readily ignitable fuel level would be to remove fuels, such as dead leaves, fallen limbs and other small organic debris, from the proposed subdivision. However, it is not practical to remove these types of fuels from the entire property.

During the construction phase of any residential structure, the most likely source of ignition will come from workers and their activities. These sources of ignition may come from flammable chemicals, improperly discarded cigarettes, shorts in electrical equipment, and other means.

It is suggested here that the reduction of the most ignitable fuel be done in areas that are within fifty feet of the pad of the proposed residence. This will reduce the amount of small, flashy fuel in proximity to the structure. It will also retard the spread of any fire towards adjacent property and provide suppression forces additional time to contain a fire quickly.

Once a residential structure is built, a wildfire safety zone should be established. Wildfire safety zones are intended to slow a fire down so that it may be controlled and extinguished. There are three zones that comprise a wildfire safety zone.

The first zone is the one that contains the most opportunity for modification. The minimum width recommended is thirty feet and is divided into three segments.

As these zones may be unique for each lot that is developed, it is difficult to make specific recommendations here. However, it is recommended that each lot be treated prior to completion of the structure and the issuance of the occupancy certificate.

Specific information on the development of wildfire safety zones is available through the Colorado State Forest Service in the Quick Guide Series Fire 2012-1, *Creating Wildfire-Defensible Zones* at the following link:
https://static.colostate.edu/client-files/csfs/pdfs/FIRE2012_1_DspaceQuickGuide.pdf

It is suggested here that the simplest modification would be periodically mow the grass around a structure out to a minimum distance of twenty-five (25) feet (see Photo 4). This will reduce the overall height of the grass and will mimic a compressed fuel bed which does not burn readily.

Photo 4. The grasses could be mowed to a reduced height which will retard a wildfire's rate of spread and intensity. The photo was taken from the R.O.W. along Cloven Hoof Drive.

- **Continuity**

The second factor affecting fuels that can be modified is their continuity. Is the fuel continuous or patchy in nature? Is the fuel layered in such a manner that it can leave the ground and spread into a vegetative canopy?

In this instance, the fuels in the Timber Litter fuel model are continuous. They extend primarily from the north to south. The grass is not continuous and are found mostly along Highway 105 and Cloven Hoof Drive.

- **Availability**

The final consideration is the availability of fuel to physically burn. The needle layer is typically a compressed fuel bed, so it does not burn readily but mostly creeps and smolders.

Availability is mostly influenced by the weather on a daily or yearly basis and cannot be readily influenced. The current weather patterns have contributed to a long-term drought situation that has influenced the availability of fuels to burn. This year has proven to be an exception with a very wet season with precipitation reaching over 70% of normal. The long-term trend of above average day time temperatures and below normal precipitation levels have allowed fuels to reach a higher state of availability than might normally be the case, particularly during winter months. This may result in wildfire acting in a manner that might be more characteristic of mid to late summer burning conditions.

Other Considerations

Firebrands & Secondary Ignitions

It is becoming more apparent that structure loss is not occurring during the passage of a burning wildfire front but from ignition of the structure by firebrands and secondary ignitions. Firebrands are burning materials or embers that are lifted into the air by convective wind currents. Firebrands can be cast hundreds of feet in advance of the fire front. This was very evident during the Marshall Fire and most recently in the devastation experienced in Lahaina, Hawaii.

Research and case studies in Australia have found that there is a 50% probability of loss of structures that are 100 – 200 feet from the fire front. This would seem to indicate that firebrands are a major contributing factor of structure loss.

In the U.S., studies indicate there is 90% probability that a structure with a non-flammable roof and that is at least 100 feet from the fuel bed will not be lost during a wildfire. However, this statistic may be misleading as the Cedar Fire (CA) in 2003 indicated that 60% -70% of the structures lost were ignited by firebrands. This would also infer that solely relying on 'defensible space' for structure protection may not be adequate.

In a professional paper by Scott (2005), the exposure of a structure to embers and firebrands is discussed. In an inference to fuel mitigation in the 'defensible space' zones, Scott states that "In no case is complete removal of the forest canopy required to mitigate crown fire potential near a structure." This infers that 'defensible space', while a good starting point, may not be the whole solution in preventing structure loss.

Currently, fire-safe construction is the recommended protocol for fire brand risk reduction by the professional wildfire community.

Roads and Driveways

Roads and driveways to the residence should be constructed in accordance with NFPA 1141, *Fire Protection for Planned Building Groups*. Specifically, road widths should not be less than twenty-four feet to allow for simultaneous access of emergency equipment and evacuation.

Driveways should provide a minimum width of twelve feet and a minimum vertical clearance of fifteen feet. The grade of any driveway should not exceed 12%. The entrance to the driveway from the road should not exceed a ninety-degree angle. A turnaround should be provided as access to the residence if it is over three hundred feet in length. These turnarounds should be within fifty feet of the structure.

The driveway that services Lot 1 exceeds this requirement by eight (8) feet. The authority having jurisdiction, Tri-Lakes Monument FPD in this instance, should make the final determination whether a turnaround is necessary.

From a detailed wildfire hazard assessment performed in a local subdivision, a common discrepancy found was inadequate or poor visibility of individual residential address numbers. Letters and numbers indicating the residential address should be a minimum of 4 inches in height with a ½" stroke. The numbers or letters should be strongly contrasting with the background color to readily visible from Cloven Hoof Drive to delineate the entrance for each residential property.

Landscaping

The vegetation that is used in the landscaping of the structure should be fire resistant. For example, ornamental junipers can be very flammable and easily ignited by aerial firebrands. Planting these shrubs near the exterior walls of any residential structure provides a readily available fuel source that could threaten the structure and divert suppression forces to protect the building instead of controlling a wildfire.

From the historical fire record of the region, the ignition of ornamental junipers around structures is a major contributor of damage and subsequent loss. **It is strongly recommended that the use of junipers and any other lowing growing ornamental conifer in the landscape be prohibited within thirty feet of a structure's foundation.**

If a native landscape is retained, the use of periodic irrigation helps keep landscapes lush and green, thereby lowering their ability to ignite. There are many irrigation techniques available that can keep plants less susceptible to burning while still adhering to water conservation principles.

As there is larger native Gambel oak on the property, new construction should have any oak within thirty (30) feet of the structure removed. Where existing structures were built next to oak, limbs overhanging the roof should be removed (see Photo 5). Limbs that may reach combustible siding should be pruned away.

Another alternative to irrigated green space would be to line the footprint of the foundation of the structure with rock. If rock is used, it should be placed at a minimum width of five feet from the foundation. This will prevent flame lengths from reaching the building.

There are many different sizes and types of rock available. It should be noted here that it would be necessary to remove leaves and other litter from within this rock fuel break on an annual basis.

Photo 5. Oak limbs overhanging an existing structure and opportunity to prune away from the upper combustible wood siding.

Construction Considerations

As the fuel in this development are grasses, oak leaves and other small woody debris, predictable sources of fuel that will burn and allow entry of a wildfire into the structure will be debris that is trapped under or next to the building or accumulation in the roof gutters. Porch, foundation, roof and attic openings should be screened off or enclosed to keep debris from accumulating and burning underneath. This is particularly important where wooden decks are planned at ground level. This was a factor in the loss of structures in the Waldo Canyon Fire. These location concerns were also expressed in a joint publication by Green Builder Media and the NFPA. This recently released e-book, 'Design with Fire in Mind', can be downloaded using the link. Go to the Resources tab and click on e-books.

It is strongly recommended that all decks that are planned at ground level be required to be sealed off and enclosed to prevent the accumulation of flammable debris underneath them.

In a wildfire risk assessment in a local development, a significant entry point for fire into a house was through the eaves, overhangs or sofits. These locations can trap embers and combustible gas or heat, that can ignite the structure.

Based upon recommendations from FEMA, overhangs, if used, should be enclosed with a flat, horizontal sofit with a one-hour fire resistance rating. The fascia should be constructed of non-combustible material.

Note: There are two residential structures already existing on the property. These homes were built in 1943 and 1960. It is assumed that recommendations will apply to any new residential construction.

The combustibility of a roof is one of the most important factors in determining the risk of a structure to damage or loss from a wildfire. The use of combustible materials such as wood shingles does not necessarily increase their susceptibility to fire. However, as a wood shingle roof ages and is influenced by the weather, individual shingles may start to warp, curl, and lose the tightness that was exhibited upon initial installation.

Siding materials, while not as critical as compared to roof, can help to lower the overall risk of a structure to damage by a wildfire. Where a high wildfire risk exists, the wildfire intensity may ignite combustible siding material.

Due to the increased loss of structures to wildfire events nationwide, there is growing emphasis on 'hardening the structure'. A recent report published by Headwaters Economics discusses the costs of added protection during construction of a residential structure. A copy of the full report can be downloaded at: Construction Costs for a Wildfire Resistant Home, California Edition (headwaterseconomics.org)

The report lists several construction improvements that are relatively inexpensive to install.

Water Supply

The property lies within unincorporated land of El Paso County. There are multiple hydrants in proximity to the property. The hydrant at the terminus of Cloven Hoof Drive is situated on the opposite side of a barbed wire that is the border of the CDOT right-of-way.

A second hydrant is located at the southeast corner of the property. During a wildfire event, it may not be safely accessible for extended suppression efforts.

The safest and easiest hydrant to secure water refills is at the southeast corner of Peak View Blvd. and Cloven Hoof Drive. This is a wide intersection that will allow engines to turn around. The hydrant location is readily accessible with light fuel surrounding it.

It is assumed that the Tri-Lakes Monument FPD would be the primary resource for an initial attack on a wildfire. Station 1 is located approximately one (1) mile away, at 18650 State Highway 105.

The district has the availability of 3 engines, 1 tower ladder, 3 brush trucks, 2 water tenders at any given time. These resources are further boosted by the Donald Westcott FPD, which is in process of consolidating with the Tri-Lakes Monument FPD.

The Palmer Lake Fire Department has a complement of four full-time staff along with seven part-time staff and fifteen volunteers. This mutual aid is less than two miles away from the property's north boundary.

The Palmer Lake Fire Department has 4 apparatus available for initial attack. There are two brush trucks and 2 structure engines. Total water capacity would be 2,450 gallons.

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Appendix A

Fuel Model Descriptions

Fuel Model 1 Summary Page
Fuel Model 6 Summary Page
Fuel Model 8 Summary Page

Source: Anderson, Hal E. Aids to Determining Fuel Models for Estimating Fire Behavior, National Wildfire Coordinating Group, General Technical Report INT-122, April 1982.

"This report presents photographic examples, tabulations, and a similarity chart to assist fire behavior officers, fuel management specialists, and other field personnel in selecting a fuel model appropriate for a specific field situation. Proper selection of a fuel model is a critical step in mathematical modeling of fire behavior and fire danger rating."

GR2 – Low Load Dry Climate Grass
GR4 – Moderate Load Dry Climate Grass
SH5 – High Load Dry Climate Shrub

Source: Scott, Joe H. & Burgan, Robert E. 2005. Standard fire behavior fuel models: a comprehensive set for use with Rothermel's (1972) surface fire spread model. Gen. Tech. Rep. RMRS-GTR-153, Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 72 p.

"This report describes a new set of standard fire behavior fuel models for use with Rothermel's surface fire spread model and the relationship of the new set to the original 13 fire behavior fuel models."

FUEL MODEL DESCRIPTIONS
Grass Group

Fire Behavior Fuel Model 1

Fire spread is governed by the fine, very porous, and continuous herbaceous fuels that have cured or are nearly cured. Fires are surface fires that move rapidly through the cured grass and associated material. Very little shrub or timber is present, generally less than one-third of the area.

Grasslands and savanna are represented along with stubble, grass-tundra, and grass-shrub combinations that met the above area constraint. Annual and perennial grasses are included in this fuel model. Refer to photographs 1, 2, and 3 for illustrations.

This fuel model correlates to 1978 NFDRS fuel models A, L, and S.

Fuel model values for estimating fire behavior

Total fuel load, < 3-inch dead and live, tons/acre	0.74
Dead fuel load, ¼-inch, tons/acre	.74
Live fuel load, foliage, tons/acre	0
Fuel bed depth, feet	1.0

Photo 1. Western annual grasses such as cheatgrass, medusahead ryegrass, and fescues.

Photo 2. Live oak savanna of the Southwest on the Coronado National Forest.

Photo 3: Open pine—grasslands on the Lewis and Clark National Forest

GR7 (107)

High Load, Dry Climate Grass (Dynamic)

Description: The primary carrier of fire in GR7 is continuous dry-climate grass. Load and depth are greater than GR4. Grass is about 3 feet tall.

Fine fuel load (t/ac)	6.4
Characteristic SAV (ft-1)	1834
Packing ratio (dimensionless)	0.00306
Extinction moisture content (percent)	15

Fire Behavior Fuel Model 6

Fires carry through the shrub layer where the foliage is more flammable than fuel model 5, but this requires moderate winds, greater than 8 mi/h (13 km/h) at mid-flame height. Fire will drop to the ground at low wind speeds or at openings in the stand. The shrubs are older, but not as tall as shrub types of model 4, nor do they contain as much fuel as model 4. A broad range of shrub conditions is covered by this model. Fuel situations to be considered include intermediate stands of chamise, chaparral, oak brush, low pocosin, Alaskan spruce taiga, and shrub tundra. Even hardwood slash that has cured can be considered. Pinyon-juniper shrublands may be represented but may overpredict rate of spread except at high winds, like 20 mi/h (32 km/h) at the 20-foot level.

The 1978 NFDRS fuel models F and Q are represented by this fuel model. It can be considered a second choice for models T and D and a third choice for model S. Photographs 15, 16, 17, and 18 show situations encompassed by this fuel model.

Fuel model values for estimating fire behavior

Total fuel load, < 3-inch dead and live, tons/acre	6.0
Dead fuel load, ¼-inch, tons/acre	1.5
Live fuel load, foliage, tons/acre	0
Fuel bed depth, feet	2.5

Photo 15. Pinyon-juniper with sagebrush near Ely, Nev.; understory mainly sage with some grass intermixed.

Photo 16. Southern hardwood shrub with pine slash residues.

Photo 17. Low pocosin shrub field in the south.

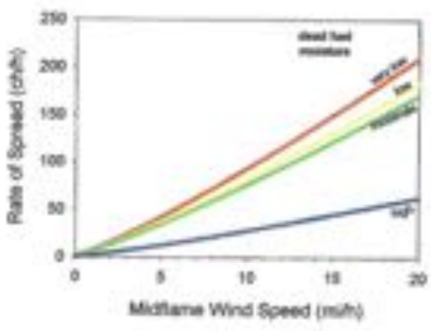
Photo 18. Frost-killed Gambel Oak foliage, less than 4 feet in height, in Colorado.

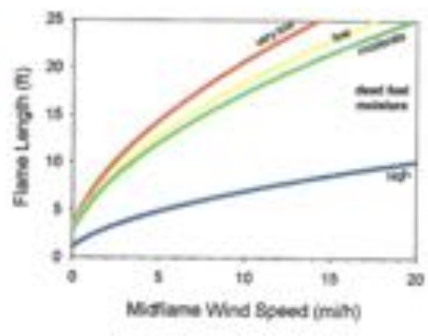
SH7 (147)

Very High Load, Dry Climate Shrub

Description: The primary carrier of fire in SH7 is woody shrubs and shrub litter. Very heavy shrub load, depth 4 to 6 feet. Spread rate lower than SH7, but flame length similar. Spread rate is high; flame length very high.

Fine fuel load (t/ac)	6.9
Characteristic SAV (ft-1)	1233
Packing ratio (dimensionless)	0.00344
Extinction moisture content (percent)	15





Timber Group

Fire Behavior Fuel Model 8

Slow-burning ground fires with low flame lengths are generally the case, although the fire may encounter an occasional "jackpot" or heavy fuel concentration that can flare up. Only under severe weather conditions involving high temperatures, low humidities, and high winds do the fuels pose fire hazards. Closed canopy stands of short-needle conifers or hardwoods that have leafed out support fire in the compact litter layer. This layer is mainly needles, leaves, and occasionally twigs because little undergrowth is present in the stand. Representative conifer types are white pine, and lodgepole pine, spruce, fir, and larch.

This model can be used for 1978 NFDRS fuel models H and R. Photographs 22, 23, and 24 illustrate the situations representative of this fuel.

Fuel model values for estimating fire behavior

Total fuel load, < 3-inch, dead and live, tons/acre	5.0
Dead fuel load, ¼-inch, tons/acre	1.5
Live fuel load, foliage, tons/acre	0
Fuel bed depth, feet	0.2

Photo 22. Surface litter fuels in western hemlock stands of Oregon and Washington.

Photo 23. Understory of inland Douglas-fir has little fuel here to add to dead-down litter load.

Photo 24. Closed stand of birch-aspen with leaf litter compacted.

TL8 (188)

Long-Needle Litter

Description: The primary carrier of fire in TL8 is moderate load long-needle pine litter, may include small amount of herbaceous load. Spread rate is moderate; flame length low.

Fine fuel load (t/ac)	5.8
Characteristic SAV (ft-1)	1770
Packing ratio (dimensionless)	0.03969
Extinction moisture content (percent)	35