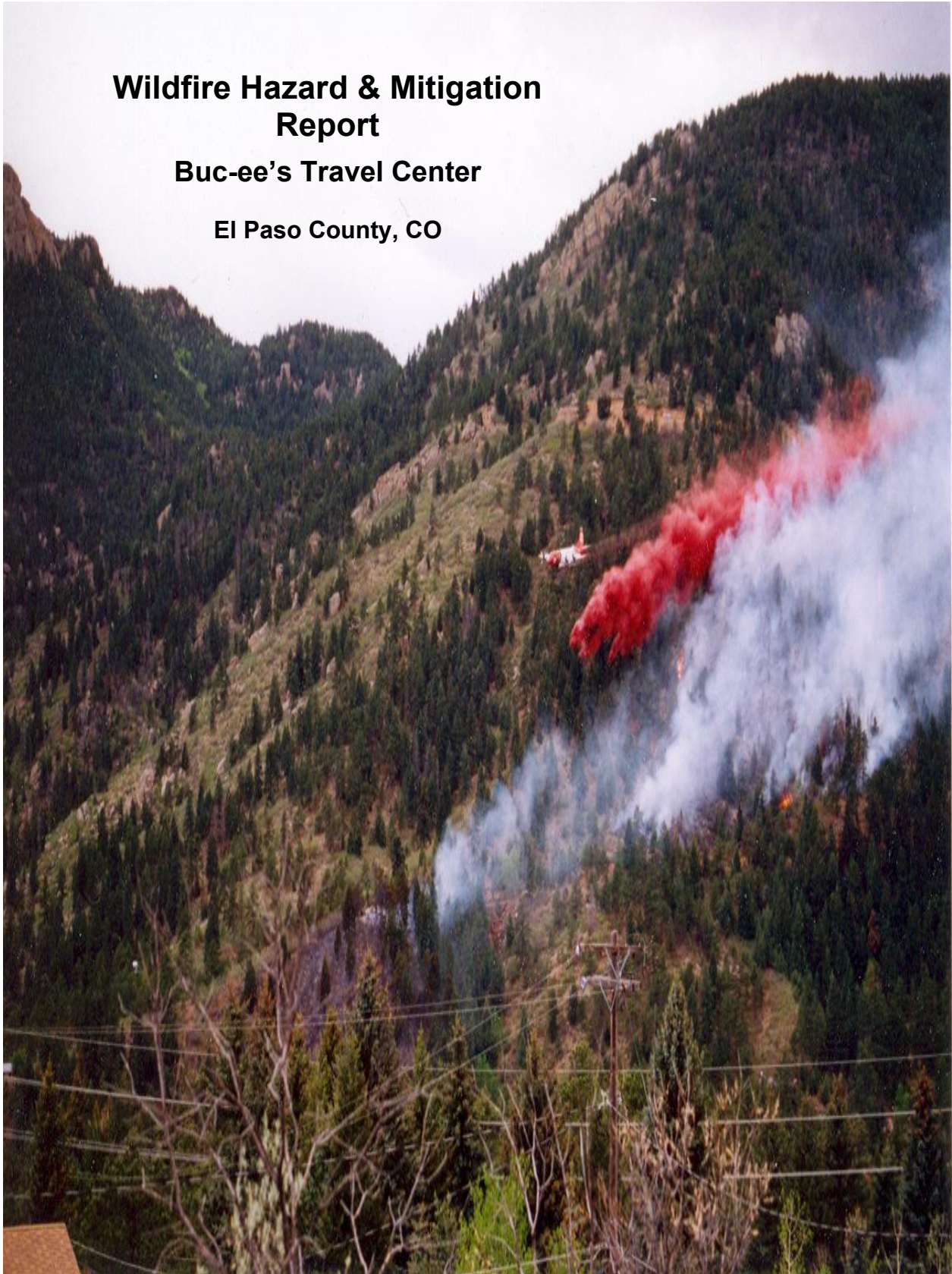


Wildfire Hazard & Mitigation Report

Buc-ee's Travel Center

El Paso County, CO



Wildfire Hazard Evaluation Report

For the

Buc-ee's Travel Center

El Paso County, CO

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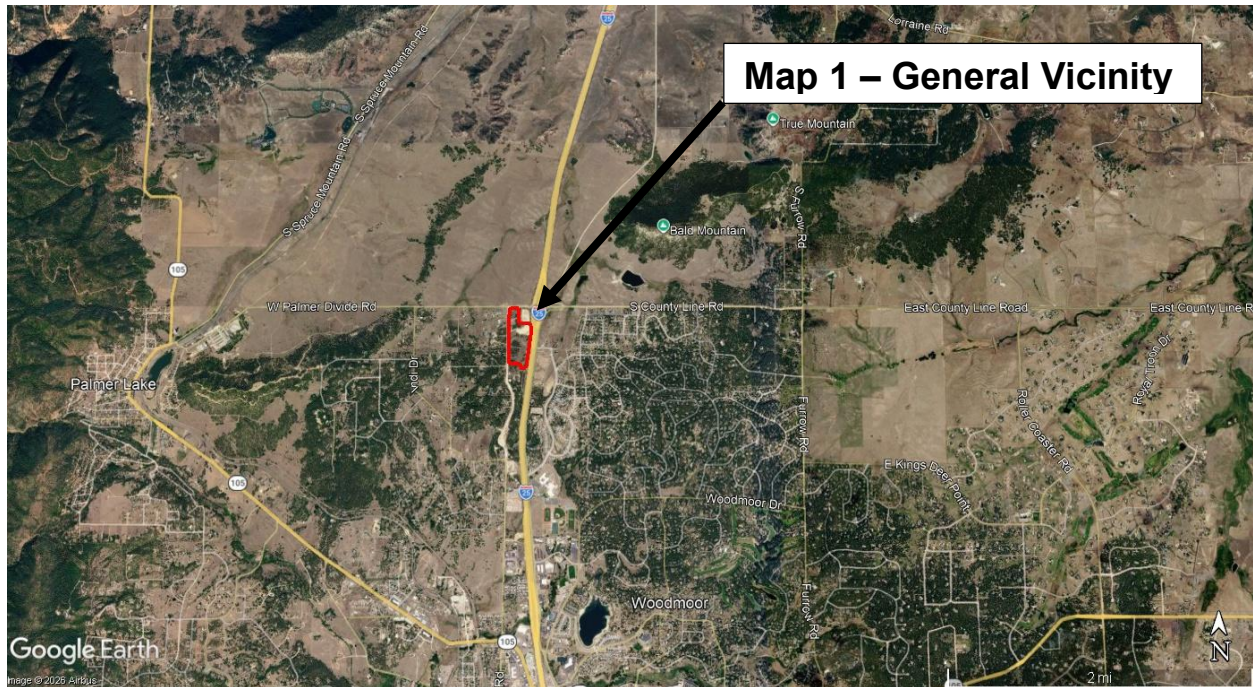
Warning and Disclaimer: The degree of protection from wildfire hazards intended to be provided by this plan is considered reasonable for planning purposes. It is based on accepted forestry and fire science methodology. This plan is intended to aid Buc-ee's Ltd in minimizing the dangers and impacts from 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.

September 2026

General Description

BUC-ee's LTD proposes the development of 30.8 acres in the northwest quarter of Section 2, Township 11 South, Range 67 West in northern El Paso County. The property is located west of Interstate 25 and south of County Line Road along Beacon Lite Road (see Map 1). The parcel listed under this report has been reconfigured and does not have a schedule number at present.

This wildfire hazard assessment is intended to address the current condition on the property in the short term. Once development starts, the site plan indicates most of the stands of ponderosa pine will be removed. The open meadows or grass locations will be converted to non-combustible surfaces such as asphalt parking for example. This is described further in "Other Considerations" section.



The subject property is bordered to the north by Douglas County Open Space and agricultural lands. On the east side, it is bordered along its entire length by Interstate-25. The south and west sides are bordered by private properties, most notably the Tri-Lakes church of Christ and the Beacon Heights subdivision.

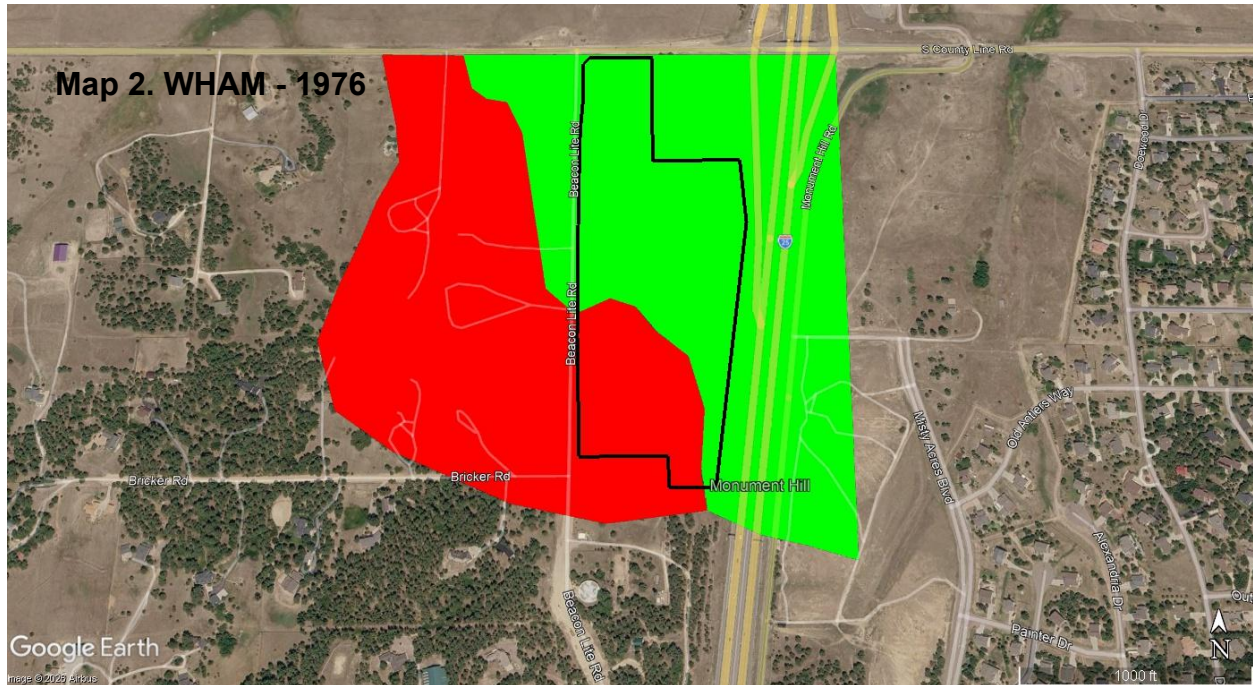
The northern portion of El Paso County area does have a wildfire history. Most notably, the Black Forest Fire burned in June of 2013. It was the most destructive fire in Colorado history until the Marshall Fire in Boulder County in 2021. Over 14,000 acres burned, and 509 structures were destroyed.

Prior to the Black Forest Fire, in 1989, wildfire ignited below Mount Herman which reached approximately 100 acres and was referred to as the Berry Fire. On April 14,

2022, a small fire was suppressed in the same vicinity. Ignitions have repeatedly occurred in the area.

Wildfire Hazard

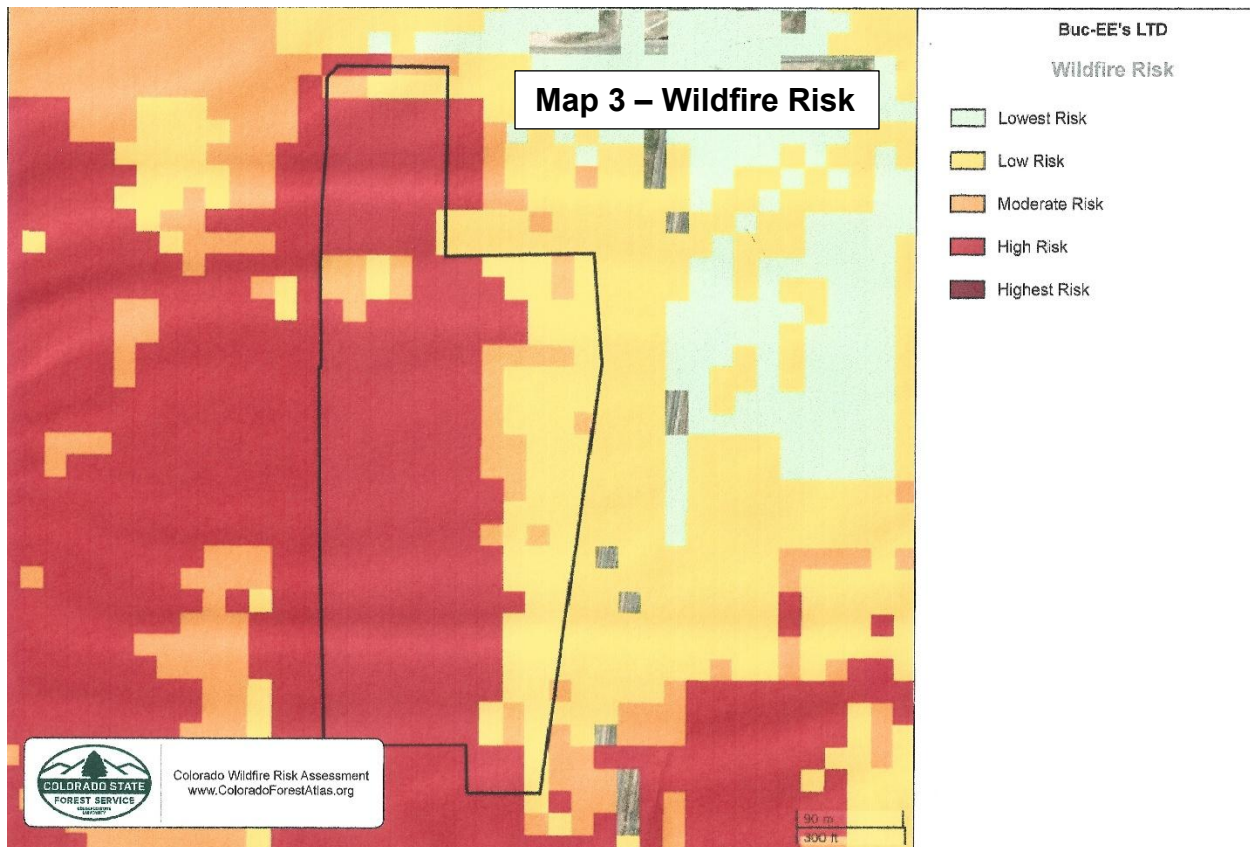
Based upon the Wildfire Hazard Area Map (WHAM) developed by the Colorado State Forest Service (CSFS) in 1976, the proposed development for Buc-ee's Ltd contains a low hazard for grass and a severe hazard for trees (see Map 2).



Legend: Green = Low Hazard (Grass) Red = Severe Hazard (Trees)

The Colorado State Forest Service 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 wildfire events and acres mitigated up to 2017. A copy is attached to this report.

Within the assessment report of the property, the Wildfire Risk to Assets within the property ranges from High to Low (see Map 3). 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.



The High-Risk Rating is located along the clusters or dense pockets of ponderosa pine that run parallel to Beacon Lite Road. In the fifty years since WHAM was developed the original pine has grown and dispersed seed for reproduction. This borders developed properties on the west side of the road which could be at risk of loss or damage from a fire. The moderate to low risk reflects a fuel which is composed of grass and isolated pockets of pine reproduction or individual pines.

The CO-WRAP assessment uses a detailed and distinct series of fuel models. This is a more dynamic approach as 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 might be described incorporating these variations.

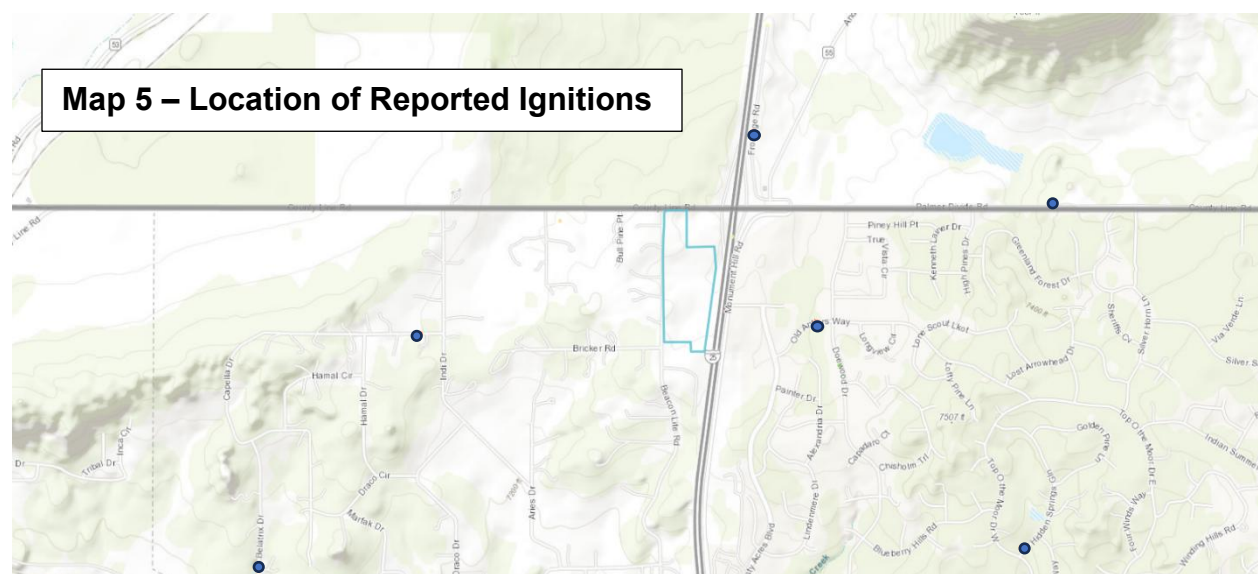
The Burn Probability is the annual probability of any location becoming subjected to a wildfire event. The assessment assigns a rating of high. Beacon Lite Road appears to be heavily traveled by residents and visitors alike. Besides upon observations made during the site visit, there appears to be an inordinate amount of trash along the road right-of-way. The carelessness of trash disposal includes opportunities for a fire ignition from spent cigarettes.

A field inspection was performed on September 6 & 7, 2026 to determine if any change should be made to the CO-WRAP assessment.

The Wildland Urban Interface Risk is low on the northern portion and along the east. This area has residential development to the west, so wildfire could threaten homes or pose a risk to lives.

The Burn Probability rating of high appears somewhat misleading. The assessment provides a listing of actual ignitions by year, from 1992 through 2020. Focusing on and around the site, there are very few reported ignitions that have occurred (see Map 5). This low number of ignitions could be attributed to a lack of reporting or a public response to wildfire awareness.

The Heat Map (see Map 6) or fire ignitions in and around the property reflect the highest rating. Fire Ignitions is an ignition density that reflects historical ignition patterns. Occurrence is derived by modeling historic wildfire ignition locations to create an ignition density map. Historic fire report data were used to create ignition points for all Colorado fires. This included both federal and non-federal fire ignition locations.



Despite the low actual number of known ignitions, the high utilization of the I-25, County Line and Beacon Lite Roads, there remains a high probability of a fire ignition somewhere in the area.



Based upon the field inspection, **the wildfire risk was confirmed as ranging from high to low.**

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 Buc-ee's Ltd development.

Fuels

The area was field checked, and the results of the COWRAP Assessment were adjusted. 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 wildfire will burn in that fuel type which best supports that fire to spread. 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.

In the CO-WRAP assessment, the eastern half of the property is classified as either Short, Sparse Dry Climate Grass (GR1) or Moderate Load, Dry Climate Grass-Shrub (GS2). However, the GS2 designation appears incorrect because the shrub component is absent. It may be more appropriate to consider this fuel model as Moderate Load, Dry Climate Grass (GR4). The fuel bed depth is about two (2) feet (see Photo 1). These two fuel models combined represent just under one-half of the area.



Photo 1. An example of Fuel Model GR4. These grasses reach upwards two feet in height.

The remaining half of the area is the clusters of ponderosa pine. The assessment describes these locations as Very High Load, Dry Climate Shrub (SH7). Again, this appears to be a misrepresentation. These ponderosa pine stands are best described by the TU5 fuel model, Very High Load, Dry Climate Timber-Shrub. This fuel model contains heavy conifer litter with a shrub or small-tree understory, which in this instance is dog-hair ponderosa pine. (see Photo 2).



Photo 2. An example of the ponderosa pine stands within the property. Note the grass understory which would carry a fire to other locations. Burning grass may lead to the torching of the pine canopy.



Photo 3. Another example of a ponderosa pine stand. Note the density of the “dog-hair” pine reproduction.

For the most part, the conifer needles and other litter appear to be compressed on the forest floor. While the litter layer will still burn, flame lengths will be low, and a fire may just smolder through the needle layer. This does not mean that enough heat could be generated to ignite some clumps of small trees, particularly the ponderosa pine ‘dog-hair’ in combination with the grass understory (see Photo 3). This could generate enough heat to ignite some of the larger overstory, commonly referred to as ‘torching’.

This condition is reflected in the assessment. The type of wildfire predicted is a passive canopy fire. This is a crown fire where the crowns of individual trees or small groups of trees burn, but solid flaming in the canopy should not be maintained except for short periods.

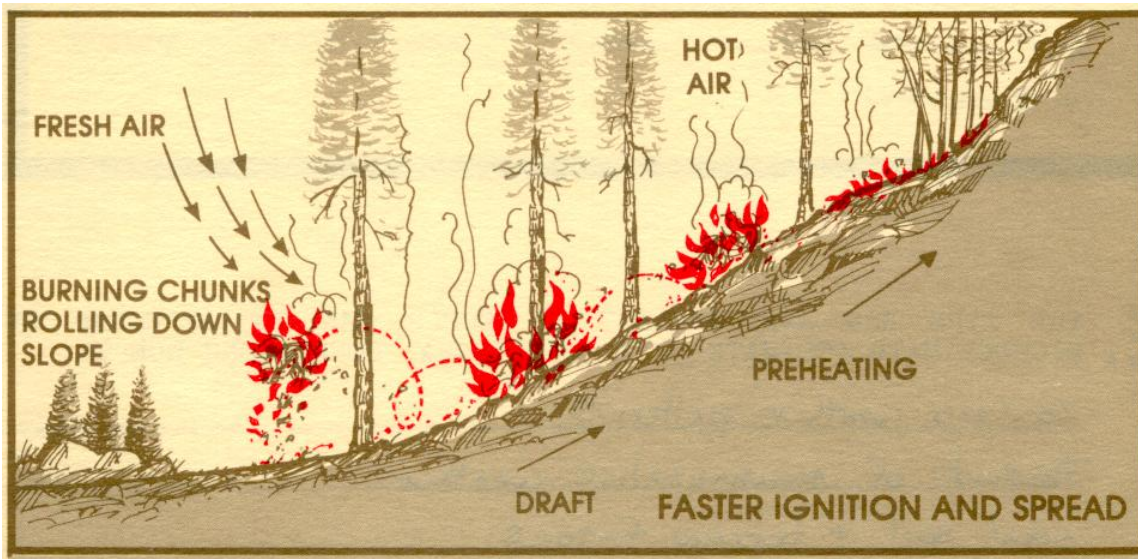
Once construction is completed, the fuel model for the property would be changed to Urban/Developed (NB1). To be considered for this designation, the location cannot support wildfire spread on its own. However, the site could experience structure loss or damage due to firebrands.

Topography

The topography of the site is one of the main factors that will influence the spread of fire. 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 down slope during the evening and early morning hours.

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

Figure 1. Slope Affects Fire Spread



The slopes on the property range from 0% up to 5%.

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.

Grass, for example, are described as being one-hour time lag fuels. Time lag is a measure of the rate at which a given dead fuel gains or loses 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 dry or wet weather to affect its combustibility.

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

The effect of wind on a fire was on display most dramatically during the Marshall Fire in Boulder County (December - 2021) . This fire grew to over 6,200 acres and destroyed 1,084 homes. The wind gusts of up to 115 miles per hour were 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. 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 assumed 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. Slopes steepness is set at 5%.

Based on these inputs, wildfire would spread at a rate of 39.6 feet per hour (0.66 ft./min.) with a flame length of approximately three tenths (0.3) feet.

If the inputs are changes to reflect a growing season plagued by long term drought, the outcome is decidedly 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 with early dry growing season conditions. The live woody fuel moisture is composed of leaves and fine stems that have matured and are set at 100%, which would normally be a late growing season condition.

The wind speed of 20 mph and a slope of 5% remain the same as in the previous example. With the drier conditions, flame lengths could reach 27.2 feet. The rate of spread accelerates up to 4,984 feet per hour or 830 feet per minute.

The probability of fuels igniting in advance of the fire front is 86%. In the time that it may take for the fire to be noticed, reported to the fire department's dispatch office and for the arrival of the initial attack force, the fire could have traveled over 400 feet. Spotting fires from torching trees may carry 0.3 miles (1,584 ft.).

It can be predicted that local suppression forces may not be able to contain the initial fire outbreak with mobile engines and hand constructed control lines in the second scenario.

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 from the winter of 2022 through the present date 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 and the recent 24 Fire provide 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 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, near Monument, 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 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 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 ignition and combustion.

Mow grass to 4 inches tall or less where practical or if necessary, over the short term. Avoid large accumulations of surface fuels such as logs, branches, slash and mulch from subsequent ponderosa pine removal .

Besides incorporating the mitigation steps described above, Treat slash from any tree cutting activity by either removal from the site or chipping it in place.

• 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 grass fuel model is continuous. It extends out in all directions across the property (see Photo 4).



Photo 4. Note the wide spacing, roughly 100 feet, between neighboring pine stands. This reduces the risk of a “running” crown fire. The availability of the grass to burn will affect the rate of spread.

- **Availability**

The final consideration is the availability of the fuel to be physically burned. This factor is 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 overall availability of the fuels to burn. The trend of above average daytime 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.

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.

A concern to this location is fire brands that may be lifted into the air from a grass fire north of the property in Douglas County. Early winter cold fronts from the north have created high wind events creating conditions for rapid fire spread (see Photo 5). The grass fuel model crosses topography that leads directly onto the Buc-ee's development site. This scenario could result in a wildfire event comparable to the Marshall Fire in Boulder County.

Roads and Driveways

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

Due to the extent of the proposed development, access to the property does not appear to pose an issue for emergency equipment.



Photo 5. A view to the north of the property into Douglas County from County Line Road. This fuel type extends for at least four (4) miles.

Water Supply

The property lies within unincorporated land of El Paso County, and fire protection is provided by the Tri-Lakes Monument Fire Protection District.

The initial response to a wildfire event could be from Station 3 of the Monument Fire Protection District. The station is located at 1855 Woodmoor Drive and is approximately three (3.0) miles away from the property. It may take upwards of seven (7) minutes to reach the property.

The district has the availability of 3 engines, 1 tower ladder, 3 brush trucks and 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.

Station 1 may also respond to an incident. It is located at 18650 Highway 105 and is five (5.0) miles away from the property. It may take upwards of nine (9) minutes to reach the property.

There is a daily staffing of 23 full-time personnel.

The Palmer Lake Volunteer Fire Department may also serve as an initial attack resource as well as mutual aid. The fire department has a complement of four full-time staff along with seven part-time staff and fifteen volunteers. The fire department is three (3) miles away and might take upwards of seven (7) minutes to reach the property.

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

Forest Management

Based upon the proposed site plan, most of the ponderosa pine are to be removed from the property. Hence, there is no need for a comprehensive forest management plan.

Vegetation Management/Landscaping

The landscape plan specifies that all weeds in the limit of construction should be removed from the site. The root systems should be removed as well. This appears to be a generic planting note.

At present the following noxious weeds are observed:

Canada thistle (*Cirsium arvense*)
Knapweed (*Centaurea nigra*)
Common Mullien (*Verbascum thapsus*)

In the short term, the presence of noxious weeds is not a concern. Based on the site plan, most locations of these weeds will be buried during the earthwork process. In the long term, areas that are left open, edges outside the limits of construction and detention pond locations will be susceptible to infestation by these noxious weeds (see Photo 6).



Photo 6. An example of the detention pond surface from the Buc-ee's Johnstown location.

The use of upright or spreading ornamental junipers should be prohibited (see Photo 7). These plants are very susceptible to ignition from aerial brands. Note that there are no ornamental junipers listed in the Monument planting plan. They are provided as examples of risk associated with their use in case of a plant substitution from the submitted plan.



Photo 7. The proximity of upright and Pfitzner junipers pose a threat to the pressure tanks that serve the gas pumps. This is located at the Johnstown location.

Appendix A

Fuel Model Descriptions

Fuel Model 1 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.

Low Load, Dry Climate Grass (GR2) Summary Page

Moderate Load, Dry Climate Grass (GR4) Summary Page

Moderate Load, Dry Climate Grass-Shrub (GS2) Summary Page

Very High Load, Dry Climate Shrub (SH7) Summary Page

Very High Load, Dry Climate Timber-Shrub (TU5) Summary Page

Urban/Developed (NB1) Summary Page

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, 1/4-inch, tons/acre	.74
Live fuel load, foliage, tons/acre	0
Fuel bed depth, feet	1.0

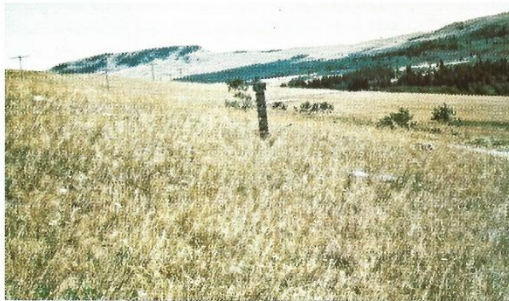


Photo 1. Western annual grasses such as cheatgrass, medusahead ryegrass, and fescues.

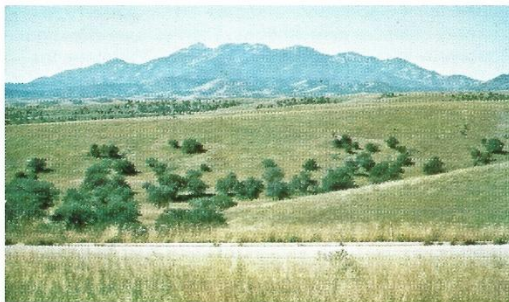


Photo 2. Live oak savanna of the Southwest on the Coronado National Forest.



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

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, 1/4-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.

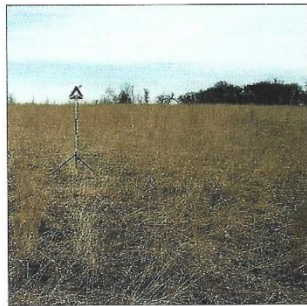


Photo 24. Closed stand of birch-aspen with leaf litter compacted.



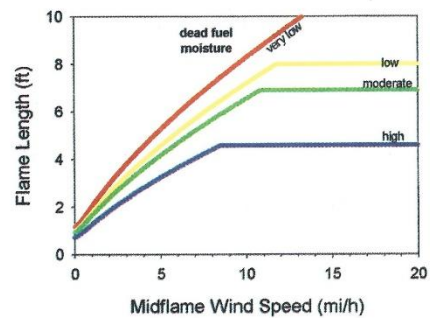
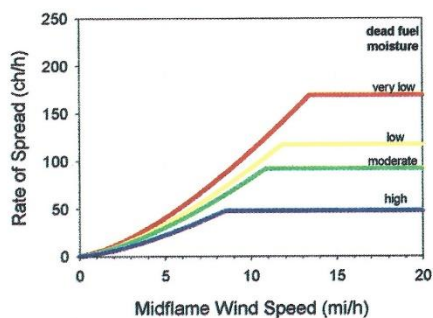
GR2 (102)

Low Load, Dry Climate Grass (Dynamic)



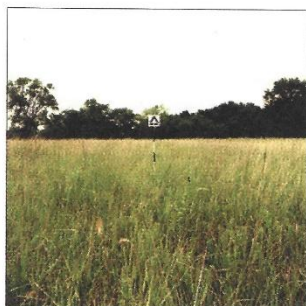
Description: The primary carrier of fire in GR2 is grass, though small amounts of fine dead fuel may be present. Load is greater than GR1, and fuelbed may be more continuous. Shrubs, if present, do not affect fire behavior.

Fine fuel load (t/ac)	1.10
Characteristic SAV (ft-1)	1820
Packing ratio (dimensionless)	0.00158
Extinction moisture content (percent)	15



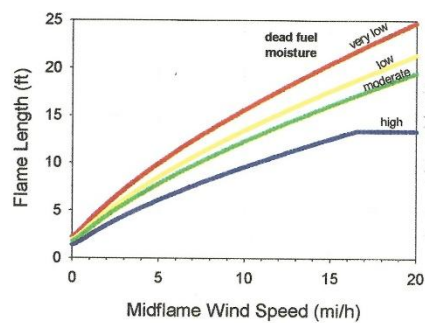
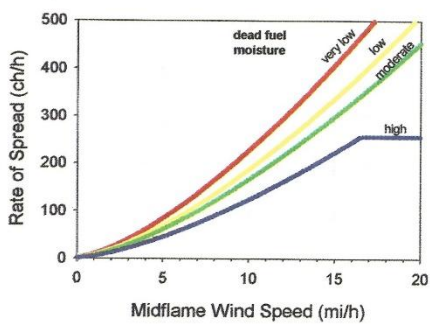
GR4 (104)

Moderate Load, Dry Climate Grass (Dynamic)



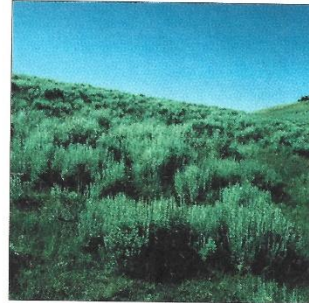
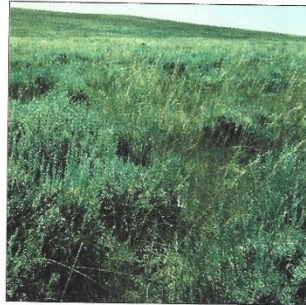
Description: The primary carrier of fire in GR4 is continuous, dry-climate grass. Load and depth are greater than GR2; fuelbed depth is about 2 feet.

Fine fuel load (t/ac)	2.15
Characteristic SAV (ft-1)	1826
Packing ratio (dimensionless)	0.00154
Extinction moisture content (percent)	15



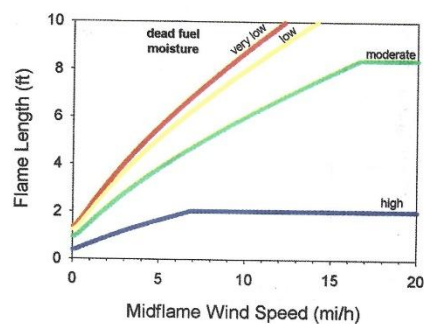
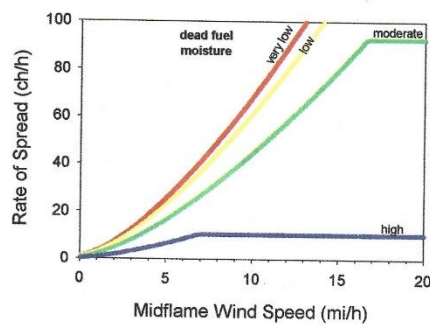
GS2 (122)

Moderate Load, Dry Climate Grass-Shrub (Dynamic)



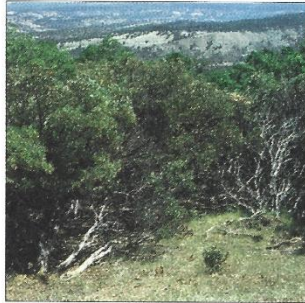
Description: The primary carrier of fire in GS2 is grass and shrubs combined. Shrubs are 1 to 3 feet high, grass load is moderate. Spread rate is high; flame length moderate. Moisture of extinction is low.

Fine fuel load (t/ac)	2.1
Characteristic SAV (ft-1)	1827
Packing ratio (dimensionless)	0.00249
Extinction moisture content (percent)	15



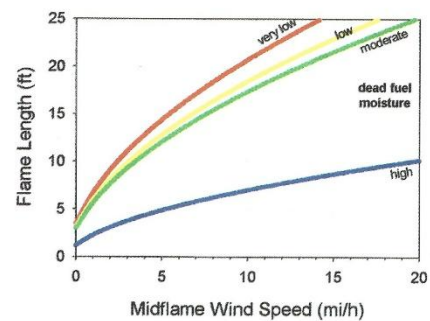
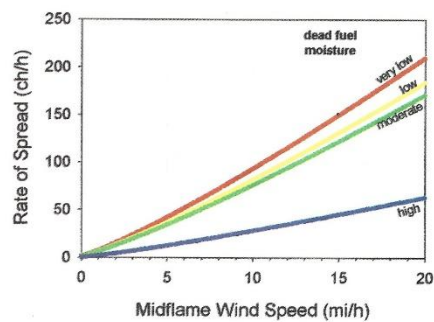
SH7 (147)

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



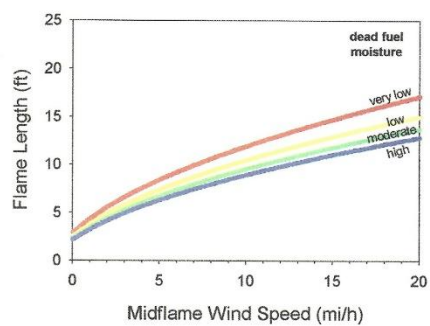
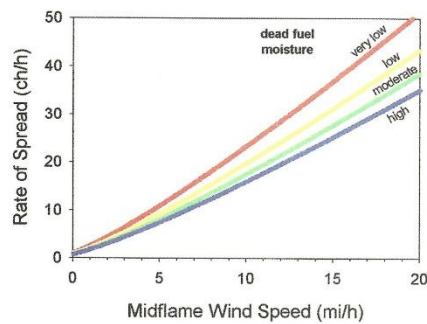
TU5 (165)

Very High Load, Dry Climate Timber-Shrub



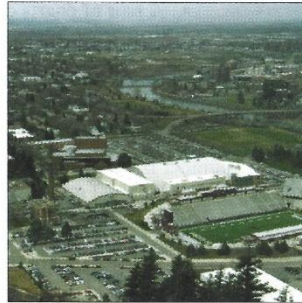
Description: The primary carrier of fire in TU5 is heavy forest litter with a shrub or small tree understory. Spread rate is moderate; flame length moderate.

Fine fuel load (t/ac)	7.0
Characteristic SAV (ft-1)	1224
Packing ratio (dimensionless)	0.02009
Extinction moisture content (percent)	25



NB1 (91)

Urban/Developed



Description: Fuel model NB1 consists of land covered by urban and suburban development. To be called NB1, the area under consideration must not support wildland fire spread. In some cases, areas mapped as NB1 may experience structural fire losses during a wildland fire incident; however, structure ignition in those cases is either house-to-house or by firebrands, neither of which is directly modeled using fire behavior fuel models. If sufficient fuel vegetation surrounds structures such that wildland fire spread is possible, then choose a fuel model appropriate for the wildland vegetation rather than NB1.

Expected fire behavior:

No fire spread

Appendix B

COWRAP Assessment

(Provided under Separate Cover)

2022 Colorado Wildfire Risk Assessment Summary Report



Buc-EE's LTD



**Report was generated using
www.ColoradoForestAtlas.org**

**Report version: 3.0.0
Report generated: 9-8-2026**

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Disclaimer

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User should also note that property boundaries included in any product do not represent an on-the-ground survey suitable for legal, engineering, or surveying purposes. They represent only the approximate relative locations.

Introduction

Colorado Wildfire Risk Assessment Report

Welcome to the Colorado Wildfire Risk Assessment Summary Reporting Tool.

This tool allows users of the Risk Reduction Planner application of the Colorado Forest Atlas web portal to define a specific project area and generate information for this area. A detailed risk summary report can be generated using a set of predefined map products developed by the Colorado Wildfire Risk Assessment project which have been summarized explicitly for the user defined project area. The report is generated in PDF format.

The report has been designed so that information from the report can be copied and pasted into other specific plans, reports, or documents depending on user needs. Examples include, but are not limited to, Community Wildfire Protection Plans, Local Fire Plans, Fuels Mitigation Plans, Hazard Mitigation Plans, Homeowner Risk Assessments, and Forest Management or Stewardship Plans. Example templates for some of these reports are available for download on the Colorado Forest Atlas web portal.

The Colorado WRA provides a consistent, comparable set of scientific results to be used as a foundation for wildfire mitigation and prevention planning in Colorado.

Results of the assessment can be used to help prioritize areas in the state where mitigation treatments, community interaction and education, or tactical analyses might be necessary to reduce risk from wildfires.

The Colorado WRA products included in this report are designed to provide the information needed to support the following key priorities:

- Identify areas that are most prone to wildfire
- Plan and prioritize hazardous fuel treatment programs
- Allow agencies to work together to better define priorities and improve emergency response, particularly across jurisdictional boundaries
- Increase communication with local residents and the public to address community priorities and needs



Products

Each product in this report is accompanied by a general description, table, chart and/or map. A list of available Colorado WRA products in this report is provided in the following table.

COWRA Product	Description
Wildland Urban Interface	Housing density depicting where humans and their structures meet or intermix with wildland fuel
Wildland Urban Interface Risk	A measure of the potential impact on people and their homes from wildfire
Wildfire Risk to Assets	The overall composite risk occurring from a wildfire derived by combining Burn Probability and Values at Risk Rating
Burn Probability	Annual probability of any location burning due to wildfire
Terrain Difficulty Index	Reflects the difficulty to suppress a fire given the terrain and vegetation conditions that may impact ground resource access and capabilities
Characteristic Flame Length	A measure of the expected flame length of a potential fire
Fire Intensity Scale	Quantifies the potential fire intensity by orders of magnitude
Fire Type	Potential for canopy fire type for extreme weather conditions (canopy fire potential)
Rate of Spread	The speed with which a fire moves in a horizontal direction across the landscape
Surface Fuels	Characterization of surface fuel models that contain the parameters for calculating fire behavior outputs
Vegetation	General vegetation and landcover types
Watershed Protection Risk	A measure of risk to watershed protection areas based on the potential negative impacts from wildfire.
Riparian Assets Risk	A measure of the risk to riparian areas based on the potential negative impacts from wildfire
Forest Assets Risk	A measure of the risk to forested areas based on the potential negative impacts from wildfire

COWRA Product	Description
Building Damage Potential	Estimates the potential for building loss
Defensible Space Index	The arithmetic mean of the three defensible space components: canopy, fuels, and slope. The colors shown represent the relative range and are the average for all of the buildings in the hexagon.

Wildland Urban Interface

Reflects housing density depicting where humans and their structures meet or intermix with wildland fuels

Colorado is one of the fastest growing states in the Nation, with much of this growth occurring outside urban boundaries. This increase in population across the state will impact counties and communities that are located within the Wildland Urban Interface (WUI). The WUI is described as the area where structures and other human improvements meet and intermingle with undeveloped wildland or vegetative fuels. Population growth within the WUI substantially increases the risk from wildfire.



The Wildland Urban Interface (WUI) layer reflects housing density depicting where humans and their structures meet or intermix with wildland fuels. In the past, conventional wildland-urban interface data sets, such as USFS SILVIS, have been used to reflect these concerns. However, USFS SILVIS and other existing data sources did not provide the level of detail needed by the Colorado State Forest Service and local fire protection agencies, particularly reflecting encroachment into urban core areas.

The new WUI data set is derived using advanced modeling techniques based on the Where People Live (housing density) data set and 2021 LandScan USA population count data available from the Department of Homeland Security, HSIP data. WUI is simply a subset of the Where People Live data set. The primary difference is populated areas surrounded by sufficient non-burnable areas (i.e. interior urban areas) are removed from the Where People Live data set, as these areas are not expected to be directly impacted by a wildfire. Fringe urban areas, i.e. those on the edge of urban areas directly adjacent to burnable fuels are included in the WUI. Advanced encroachment algorithms were used to define these fringe areas.

Data is modeled at a 20-meter grid cell resolution, which is consistent with other CO-WRA layers. The WUI classes are based on the number of houses per acre. Class breaks are based on densities well understood and commonly used for fire protection planning.



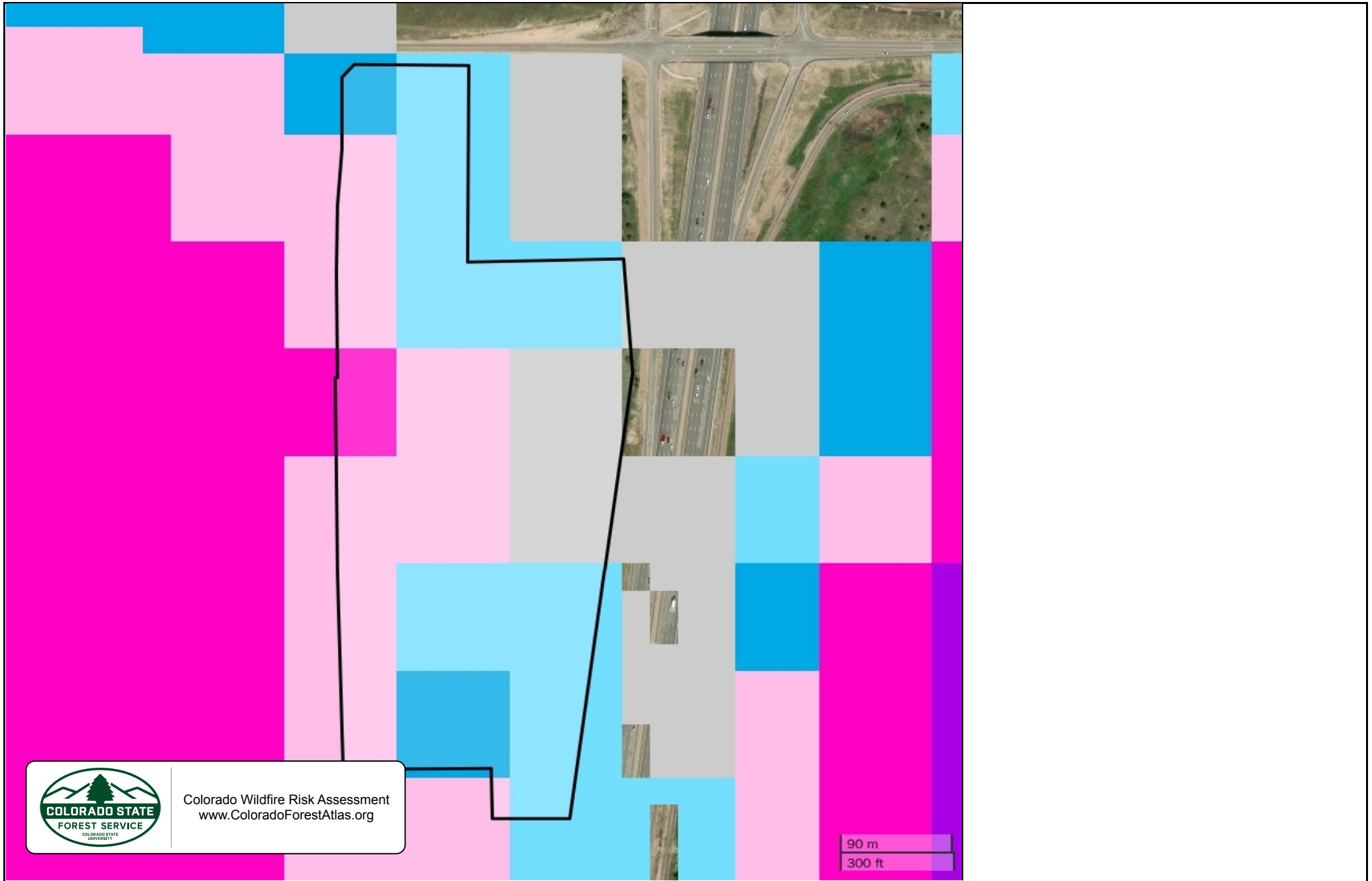
Housing Density		WUI Acres	Percent of WUI Acres
	1 - Less than 1 house/40 ac	4	14.4%

	2 - 1 house/40 ac to 1 house/20 ac	12	40.4%
	3 - 1 house/20 ac to 1 house/10 ac	3	10.6%
	4 - 1 house/10 ac to 1 house/5 ac	9	31.8%
	5 - 1 house/5 ac to 1 house/2 ac	1	2.7%
	6 - 1 house/2 ac to 3 houses/ac	0	0%
	7 - More than 3 houses/ac	0	0%
	None	29	100%

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Wildland Urban Interface

-  1 - Less than 1 house/40 ac
-  2 - 1 house/40 ac to 1 house/20 ac
-  3 - 1 house/20 ac to 1 house/10 ac
-  4 - 1 house/10 ac to 1 house/5 ac
-  5 - 1 house/5 ac to 1 house/2 ac
-  6 - 1 house/2 ac to 3 houses/ac
-  7 - More than 3 houses/ac



Wildland Urban Interface (WUI) Risk

The Wildland-Urban Interface (WUI) Risk Index layer is a rating of the potential impact of a wildfire on people and their homes.

The key input, WUI, reflects housing density (houses per acre) consistent with Federal Register National standards. The location of people living in the wildland-urban interface and rural areas is essential for defining potential wildfire impacts to people and homes.

The WUI Risk Index is derived using a response function modeling approach. Response functions are a method of assigning a net change in the value to a resource or asset based on susceptibility to fire at different intensity levels, such as flame length.

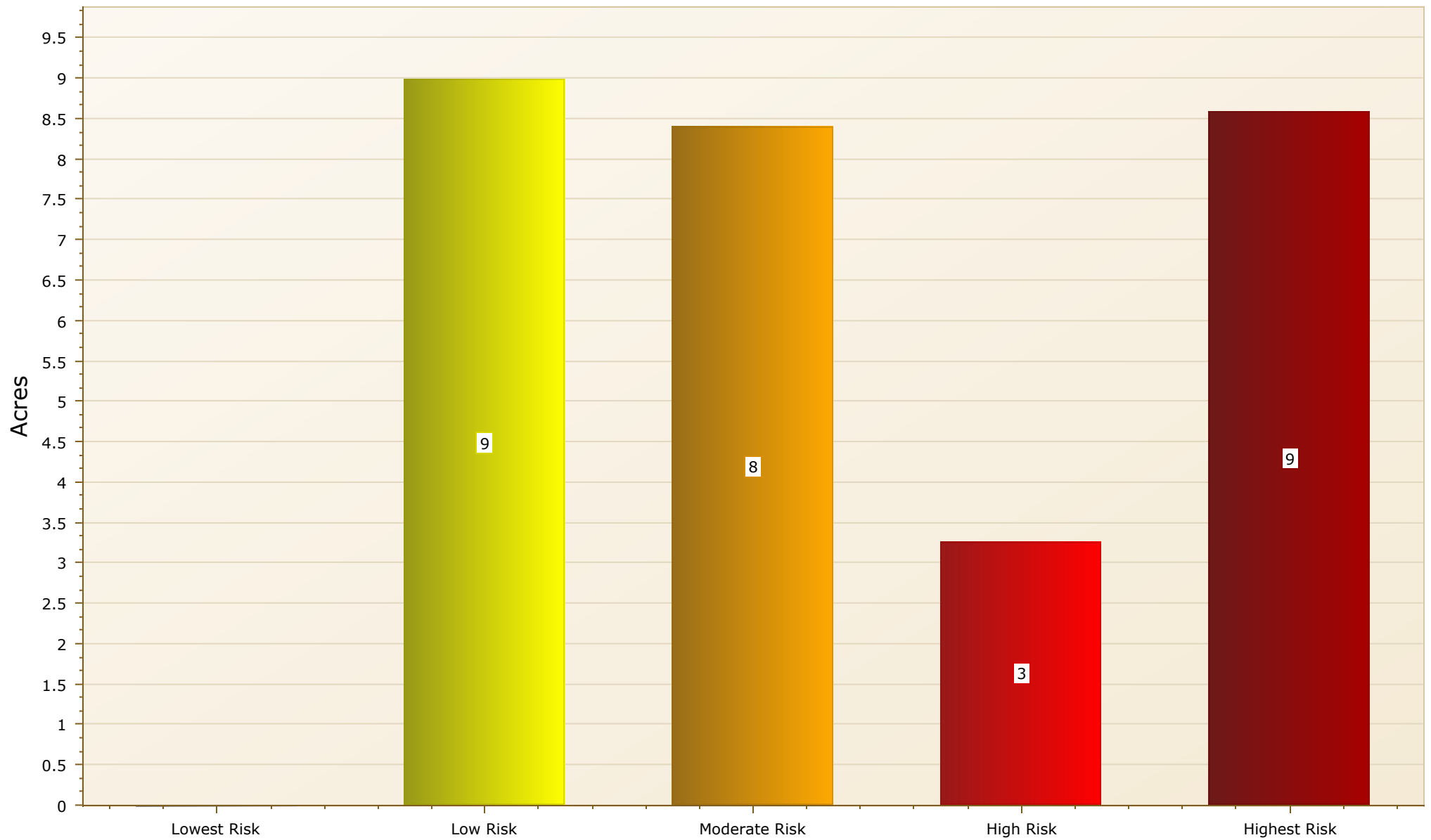
To calculate the WUI Risk Index, the WUI housing density data were combined with flame length data and response functions were defined to represent potential impacts. The response functions were defined by a team of experts led by Colorado State Forest Service mitigation planning staff. By combining flame length with the WUI housing density data, it is possible to determine where the greatest potential impact to homes and people is likely to occur. Customized urban encroachment algorithms were used to ensure those fringe urban areas were included in the WUI Risk outputs. Encroachment distances into urban areas were based on the underlying fuel models and their fuel types and propensity for spotting and spreading.

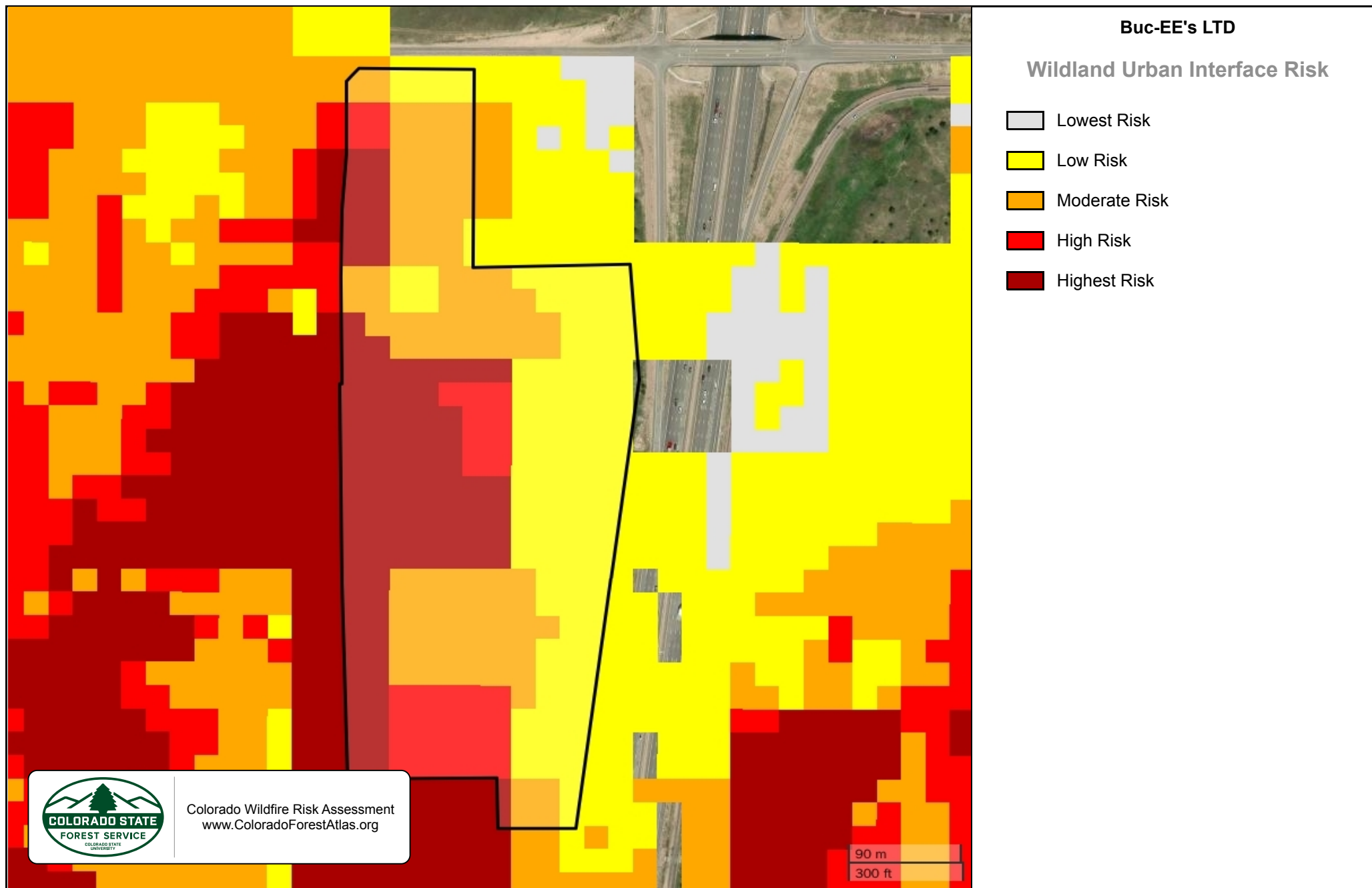
The WUI Risk Index has been calculated consistently for all areas in Colorado, which allows for comparison and ordination of areas across the entire state. Data is modeled at a 20-meter cell resolution, which is consistent with other CO-WRA layers.

WUI Risk Class		Acres	Percent
	Lowest Risk		0%
	Low Risk	9	30.7%
	Moderate Risk	8	28.7%
	High Risk	3	11.1%
	Highest Risk	9	29.4%
Total		29	100%

Wildland Urban Interface Risk

Buc-EE's LTD





Firewise USA Recognized Sites

Description

Firewise USA® is a national recognition program that provides resources to inform communities how to adapt to living with wildfire and encourages neighbors to take action together to reduce their wildfire risk. Colorado communities that take the following five steps can be recognized as Firewise:

1. Form a Firewise board or committee
2. Obtain a wildfire risk assessment from the CSFS or local fire department, and create an action plan
3. Hold a Firewise event once per year
4. Invest a minimum of \$24.14 per dwelling unit in local Firewise actions annually
5. Create a National Fire Prevention Association (NFPA) profile and follow the application directions located at <https://portal.firewise.org/user/login>

The Firewise USA® dataset defines the boundaries of the recognized communities. Mapping Firewise USA® boundaries will generally be completed by CSFS staff.

Note: These are estimated boundaries using a variety of methods with varying degrees of accuracy. These are not legal boundaries and should not be construed as such. The boundaries may overlap with CWPP areas and are subject to change over time as the communities develop, change, and continue to implement wildfire mitigation efforts. To learn more about the Firewise USA® recognition program or to fill out an application, visit <https://www.nfpa.org/Public-Education/By-topic/Wildfire/Firewise-USA> - OR <https://csfs.colostate.edu/wildfire-mitigation/colorado-firewise-communities/>



FIREWISE USA®
Residents reducing wildfire risks

The designated area does not contain data for this section.

Community Wildfire Protection Plans (CWPPs)

Description

A Community Wildfire Protection Plan (CWPP) is a document developed and agreed upon by a community to identify how the community will reduce its wildfire risk. CWPPs identify areas where fuels reduction is needed to reduce wildfire threats to communities and critical infrastructure, address protection of homes and other structures, and plan for wildfire response capability. The Colorado State Forest Service (CSFS) supports the development and implementation of CWPPs and provides resources, educational materials and information to those interested in developing CWPPs.

The CWPP dataset represents the boundaries of those areas that have developed a CWPP. Note that CWPPs can be developed by different groups at varying scales, such as county, Fire Protection District (FPD), community/subdivision, HOA, etc., and as such, can overlap. In addition, the CWPPs can be from different dates. Often a county CWPP is completed first with subsequently more detailed CWPPs done for local communities within that county or FPD. CO-WRAP provides a tool that allows the user to select the CWPP area and retrieve the CWPP document for review (PDF).

At a minimum, a CWPP should include:

- The wildland-urban interface (WUI) boundary, defined on a map, where people, structures and other community values are most likely to be negatively impacted by wildfire
- The CSFS, local fire authority and local government involvement and any additional stakeholders
- A narrative that identifies the community's values and fuel hazards
- The community's plan for when a wildfire occurs
- An implementation plan that identifies areas of high priority for fuels treatments

CWPPs are not shelf documents and should be reviewed, tracked and updated. A plan stays alive when it is periodically updated to address the accomplishments of the community. Community review of progress in meeting plan objectives and determining areas of new concern where actions must be taken to reduce wildfire risk helps the community stay current with changing environment and wildfire mitigation priorities.

If your community is in an area at risk from wildfire, now is a good time to start working with neighbors on a CWPP and preparing for future wildfires. Contact your local CSFS district to learn how to start this process and create a CWPP for your community: <http://csfs.colostate.edu/pages/your-local-forester.html>
For the **Buc-EE's LTD** test project area, there are 1 CWPPs areas that are totally or partially in the defined project area.

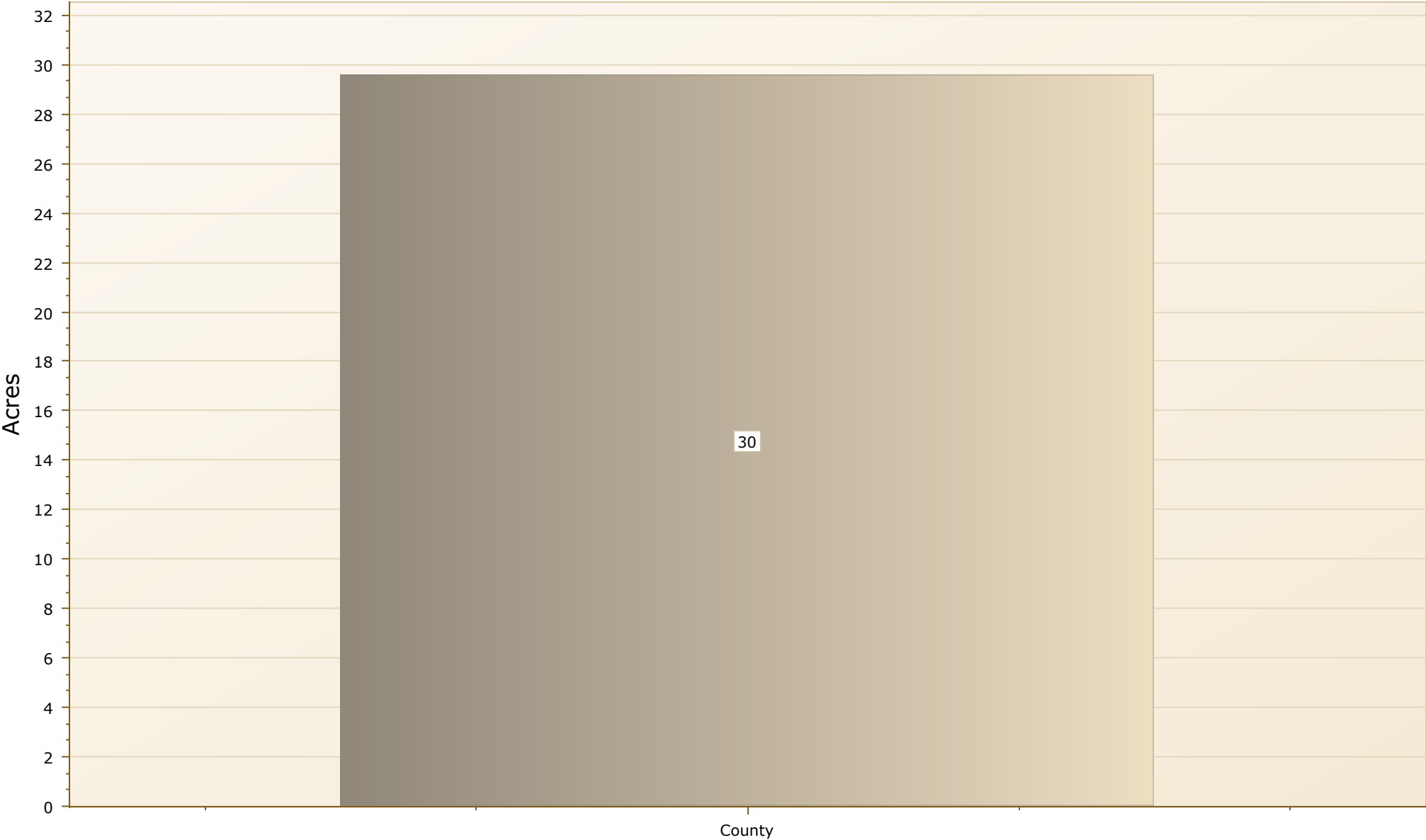


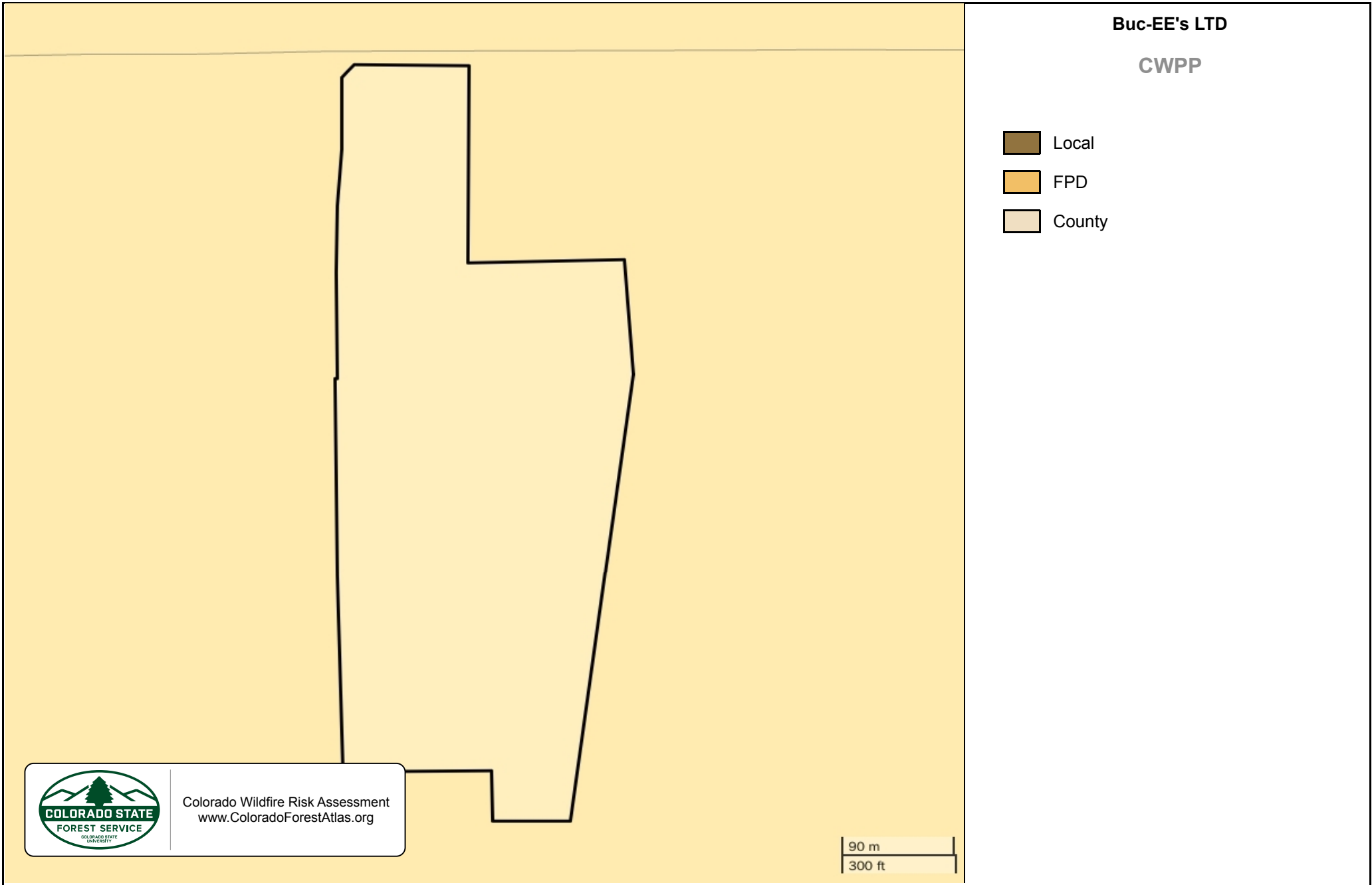
Community input is the foundation of a Community Wildfire Protection Plan that identifies community needs and garners community support.

CWPP Name	CWPP Type	CSFS District	Acres inside project area	Total Acres
El Paso County	County	Woodland Park	30	1,361,917
Total Acres				1,361,917

Community Wildfire Protection Plans

Buc-EE's LTD





Wildfire Risk to Assets

Description

Wildfire Risk is a composite risk map created by combining the Values at Risk Rating and the Burn Probability layers.
It identifies areas with the greatest potential impacts from a wildfire – i.e., those areas most at risk when considering the four values layers.

The Values at Risk Rating is a key component of Wildfire Risk. It is comprised of several individual risk layers including Wildland Urban Interface (housing density), Forest Assets, Riparian Assets and Watershed Protection risk outputs. The WUI component is a key element of the composite risk since it represents where people live in the wildland and urban fringe areas that are susceptible to wildfires and damages. The found individual risk layers are weighted to derive the Values at Risk Rating layer.

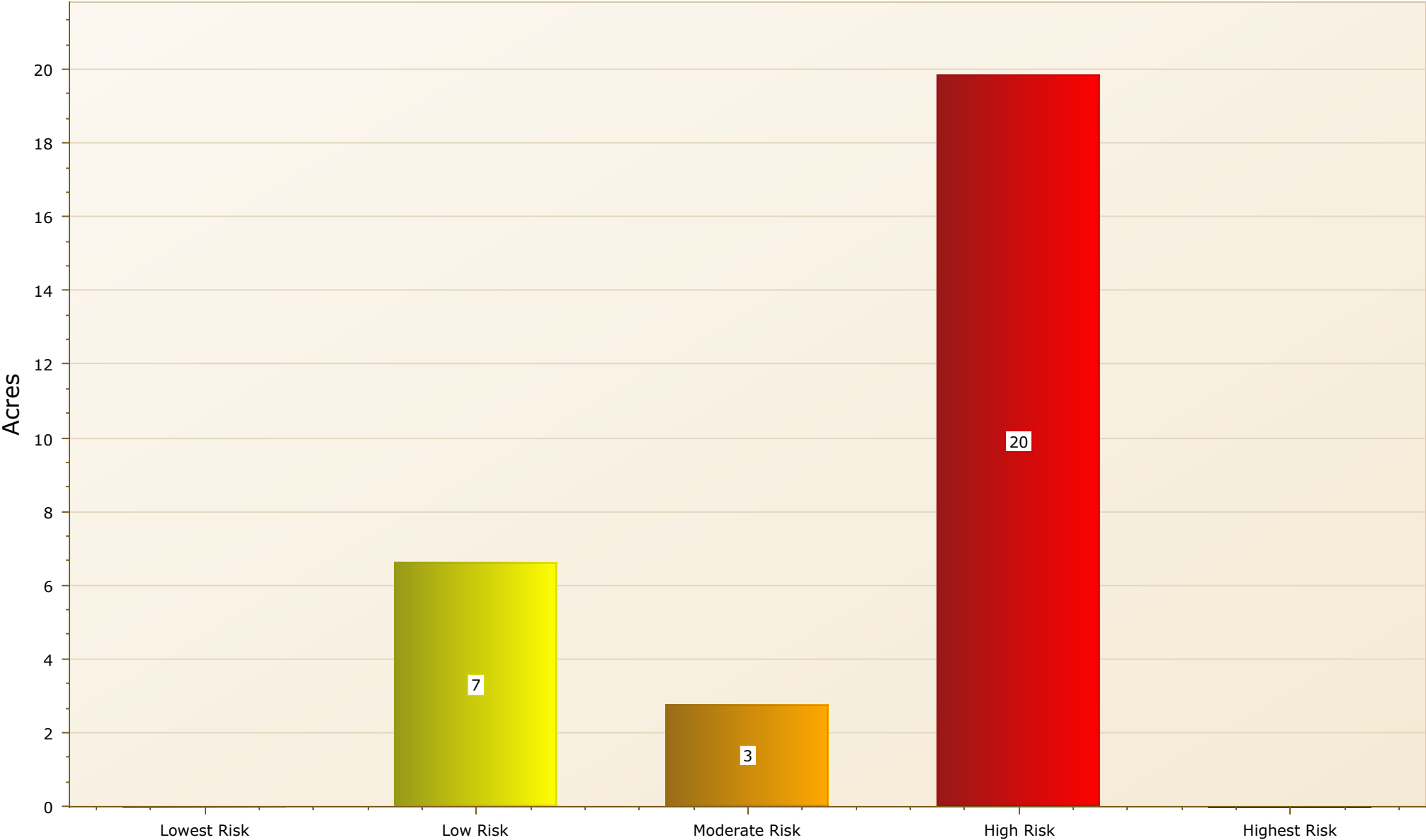
The risk map is derived at a 20-meter resolution. This scale of data was chosen to be consistent with the accuracy of the primary surface fuels dataset used in the assessment. While not appropriate for site specific analysis, it is appropriate for regional, county, or local planning efforts.

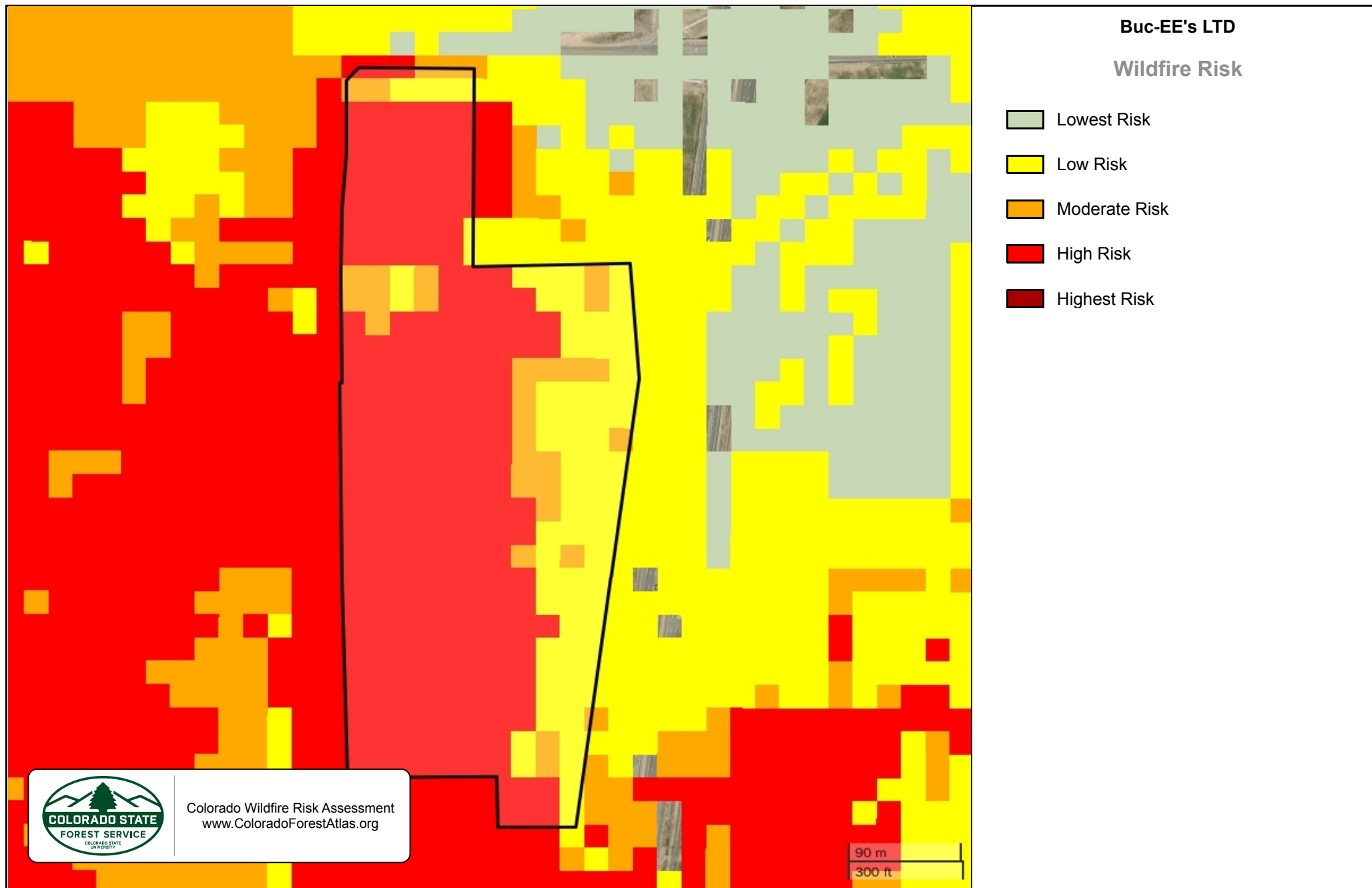
Wildfire Risk		Acres	Percent
	Lowest Risk		0%
	Low Risk	7	22.6%
	Moderate Risk	3	9.4%
	High Risk	20	67.9%
	Highest Risk		0%
Total		29	100%



Wildfire Risk to Assets

Buc-EE's LTD





Burn Probability

Description

Burn Probability (BP) is the annual probability of any location burning due to a wildfire.

The annual BP was calculated as the number of times that a cell was burned and the number of iterations used to run the models. The annual BP was estimated for Colorado by using a wildfire simulation approach with Technosylva's Wildfire Analyst software ([Wildfire Analyst](#)). A total number of 2,342,334 fires were simulated (3,200,000 if we consider those fires outside the Colorado border which were used in a buffer area around the study area to compute BP) with a mean ignition density of 8.68 fires/km2. The ignition points were spatially distributed evenly every 500 meters across the state. Only high and extreme weather conditions were used to run the single fires because they usually burn most of the annual burned area. All fires simulations had a duration of 8 h. After simulating all the fires, some cells were not burned by any simulated fire, resulting in a BP value of zero. Some cells were non-burnable due to the associated fuel type (i.e. water, roads, urban, agricultural areas, barren areas). However, the lowest BP value found in "burnable" cells was assigned to cells where the simulated fires did not reach.

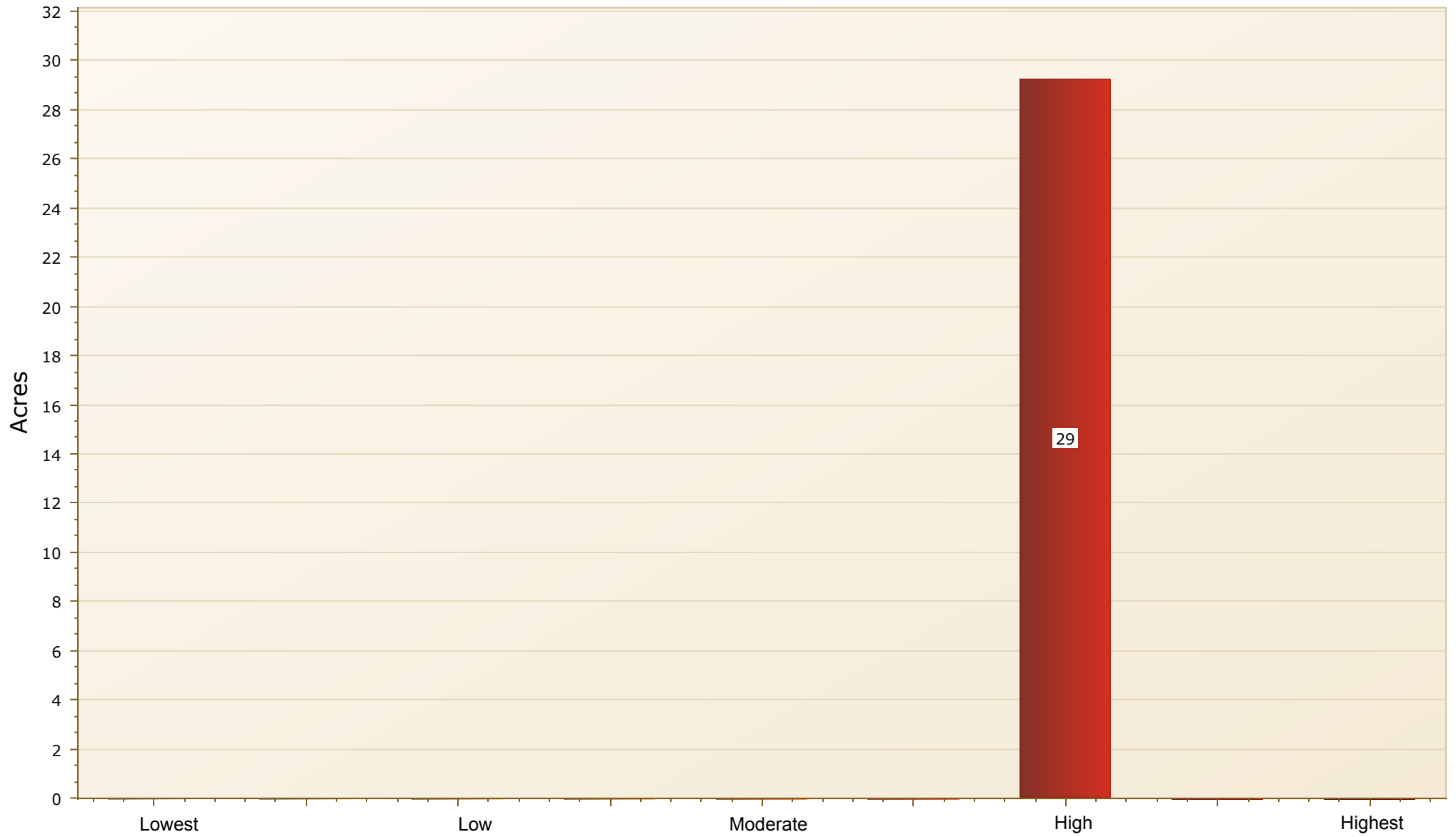
The Wildfire Analyst fire simulator considered the number of times that the simulated fires burned each cell. After that, results were weighted by considering the historical fire occurrence. The weighting was done by assessing the relation between the annual historical fire ignition density in Colorado and the total number of simulated fires with varying input data in high and moderate weather scenarios and the historical spatial distribution of the ignition points.

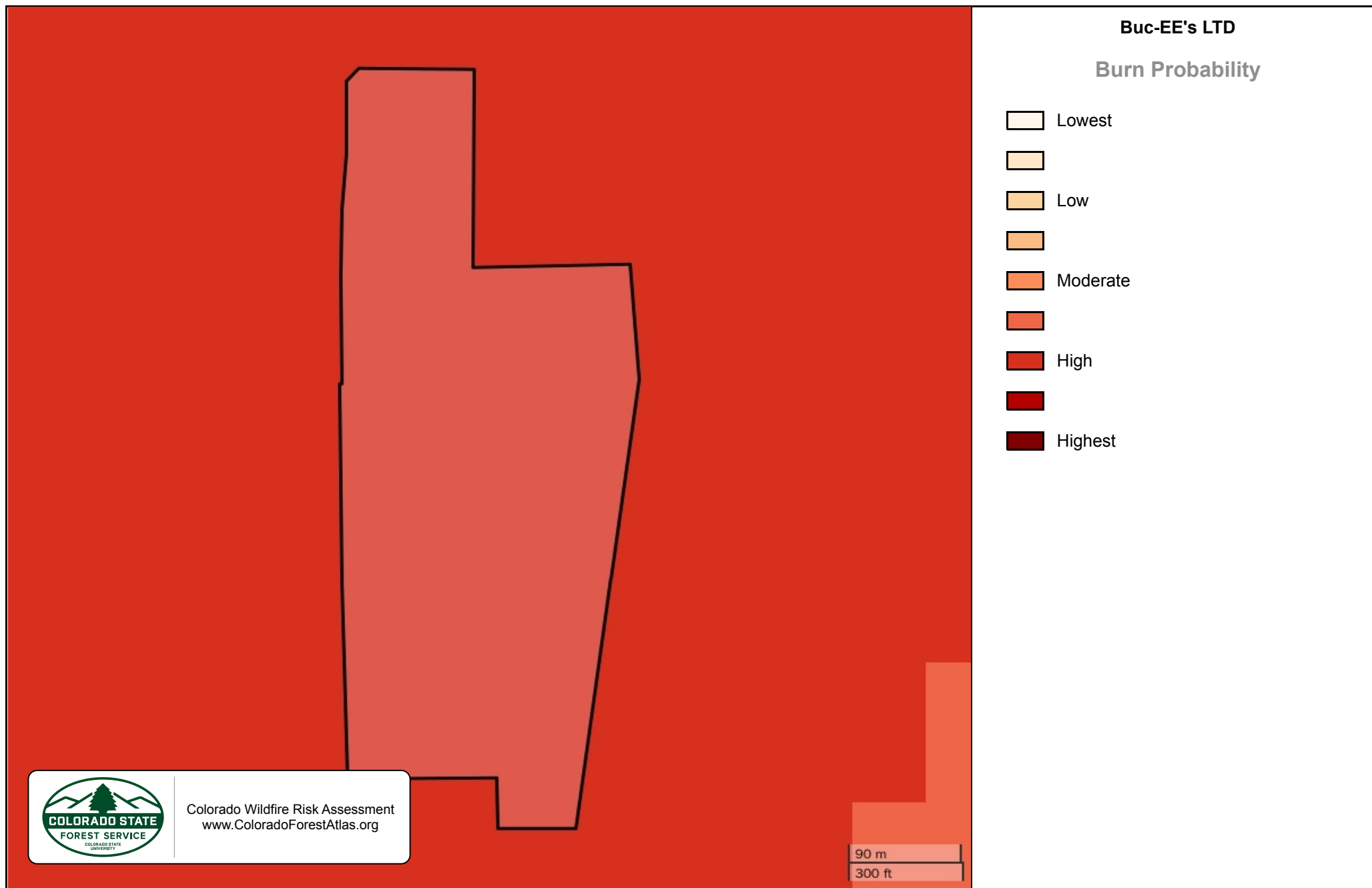
The probability map is derived at a 20-meter resolution. This scale of data was chosen to be consistent with the accuracy of the primary surface fuels dataset used in the assessment. While not appropriate for site specific analysis, it is appropriate for regional, county or local protection mitigation or prevention.

Burn Probability		Acres	Percent
Lowest			0%
			0%
			0%
			0%
Low			0%
			0%
			0%
Moderate			0%
			0%
			0%
High		29	100%
			0%
Highest			0%
Total		29	100%

Burn Probability

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Terrain Difficulty Index

Description

The 2012 and 2017 CO-WRA included a simple metric that described suppression difficulty based on fireline dozer rates. For 2022 CO-WRA, this standalone metric has been updated to reflect a more enhanced definition of areas where access to fires and suppression from ground resources is difficult. Although not a component of the standard risk assessment outputs, this metric is provided as it helps inform which areas may have limited suppression capabilities, especially for initial attack, across the State.

The Terrain Difficulty Index (TDI) is a metric that describes the characteristics of the landscape which evaluates the difficulty of extinction, especially in initial attack, although it can also be extrapolated to extended attacks. This static index quantifies the availability of access for the arrival of terrestrial means, the ability to penetrate the area where the fire originates, and the difficulty of extinguishing fuels.

Indicators such as the Accessibility Index, Penetrability Index and Fireline Opening Index (construction) have been used for the formulation of TDI. This index is based on other indices such as the Wildfire Suppression Difficulty Index (terrestrial) (SDIt) (Matthew P Thompson et al, 2018. Francisco Rodriguez and Silva et al, 2020.) which is a quantitative rating of the relative difficulty to perform fire control work. However, TDI is dynamic as it incorporates changes in surface fuels over time providing a less static perspective for a planning point of view.

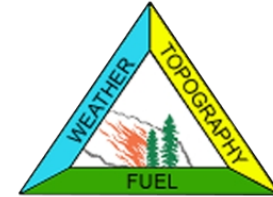
The designated area does not contain data for this section.

Wildfire Behavior Outputs

Description

Fire behavior is the way a fire reacts to the following environmental influences:

1. Fuels
2. Weather
3. Topography



Fire behavior characteristics are attributes of wildland fire that pertain to its spread, intensity, and growth. Fire behavior characteristics utilized in the Colorado WRA include fire type, rate of spread, flame length and fireline intensity (fire intensity scale). These metrics are used to determine the potential fire behavior under different weather scenarios. Areas that exhibit moderate to high fire behavior potential can be identified for mitigation treatments, especially if these areas are in close proximity to homes, business, or other assets.

Fuels

The Colorado WRA includes composition and characteristics for both surface fuels and canopy fuels. Assessing canopy fire potential and surface fire potential allows identification of areas where significant increases in fire behavior affects the potential of a fire to transition from a surface fire to a canopy fire.

Fuel datasets required to compute both surface and canopy fire potential include:

1. Surface Fuels are typically categorized into one of four primary fuel types based on the primary carrier of the surface fire: 1) grass, 2) shrub/brush, 3) timber litter, and 4) slash. They are generally referred to as fire behavior fuel models and provide the input parameters needed to compute surface fire behavior. The 2022 assessment uses the latest 2022 calibrated fuels for Colorado. The following custom fuels were included to improve the fire modeling in timber, WUI and agricultural areas:

- Timber: 2 new categories (171 and 191)
- Urban: 7 new categories (911,912,913,914,915,916 and 919)
- Roads: 5 new categories (941,942,943,944 and 949)
- Agriculture: 4 new categories (931,932,938 and 939)
- Water: 3 new categories (981,982 and 989)

2. Canopy Cover is the horizontal percentage of the ground surface that is covered by tree crowns. It is used to compute wind-reduction factors and shading.

3. Canopy Ceiling Height/Stand Height is the height above the ground of the highest canopy layer where the density of the crown mass within the layer is high enough to support vertical movement of a fire. A good estimate of canopy ceiling height is the average height of the dominant and co-dominant trees in a stand. It is used to compute wind reduction to mid-flame height, and spotting distances from torching trees.



4. Canopy Base Height is the lowest height above the ground above which sufficient canopy fuel exists to vertically propagate fire (Scott & Reinhardt, 2001). Canopy base height is a property of a plot, stand or group of trees, not an individual tree. For fire modeling, canopy base height is an effective value that incorporates ladder fuels, such as tall shrubs and small trees. Canopy base height is used to determine whether a surface fire will transition to a canopy fire.

5. Canopy Bulk Density is the mass of available canopy fuel per unit canopy volume (Scott & Reinhardt, 2001). Canopy bulk density is a bulk property of a stand, plot, or group of trees, not an individual tree. Canopy bulk density is used to predict whether an active crown fire is possible.

Weather

Weather data (1979-2022) from gridMET was used to analyze potential weather scenarios in which assessing fire behavior and spread. gridMET is a dataset of daily high-spatial resolution (~4-km, 1/24th degree) surface meteorological data covering the contiguous US. Air temperature data at 2m, relative humidity at 2m, and wind speed and direction at 10 m were all downloaded and used.

After computing the weather percentiles of the gridMET variables, data was interpolated using IDW algorithms (Inverse Distance Weighting) at 20-meter pixel resolution.

Dead fuel moisture content was estimated using the model of Rothermel and Rinehart (1983). Both temperature and air relative humidity at 2m from gridMET was used to define the fuel moisture model. The model also considered elevation and aspect to take into account the accumulated solar radiation at 14h (local time). 1% and 2% were added to the 1h-dead fuel moisture content to estimate 10h and 100h dead fuel moisture content, respectively.

For the first time in CO-WRA risk assessments, both herbaceous and woody live fuel moisture content was modelled using Technosylva's proprietary models based on optical imagery, drought indices and phenology. The models were trained with the WFAS National live fuel moisture content. Foliar moisture content in the canopies was considered as a constant value (80%) across the entire state.

Wind speed at 10 m was estimated at 20 ft applying a wind adjustment factor to use 20-ft wind speed in the fire spread and behavior equations. Afterward, wind speed percentiles were computed to use these data in the FB analysis at 20-meter pixel resolution. Wind direction for Colorado was analyzed for a 40-year period (1979-2022) considering the calculated wind speed percentiles from gridMET data. Predominant wind direction is from SW to NE, especially when wind speed is high or very high.

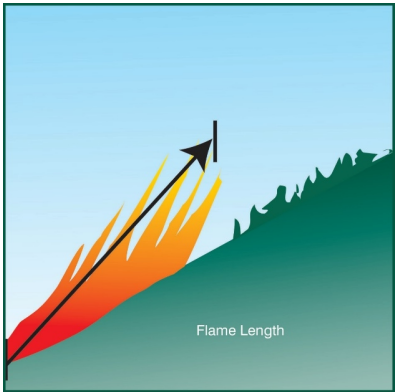
Characteristic Flame Length

The typical or representative flame length of a potential fire based on a weighted average of four percentile weather categories.

Flame Length is defined as the distance between the flame tip and the midpoint of the flame depth at the base of the flame, which is generally the ground surface. It is an indicator of fire intensity and is often used to estimate how much heat the fire is generating.

Flame length is typically measured in feet. Flame length is the measure of fire intensity used to generate the Fire Effects outputs for the CO-WRA and it is influenced by three environmental factors - fuels, weather, and topography. Weather is by far the most dynamic variable as it changes frequently. To account for this variability, four percentile weather categories were created from historical weather observations to represent low, moderate, high, and extreme weather days for each 20-meter grid cell in Colorado.

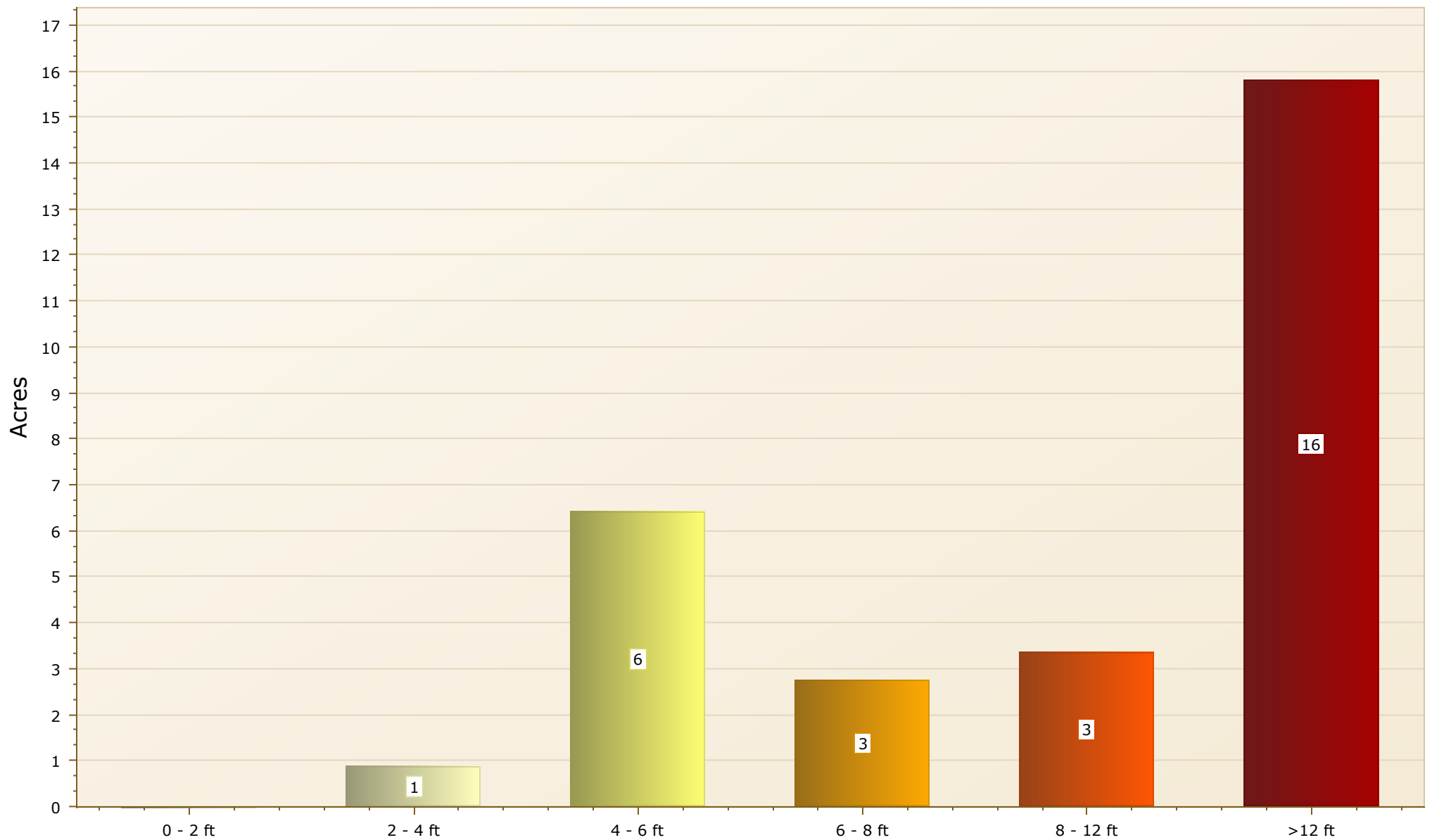
The Characteristic Flame Length represents the weighted average for all four weather percentiles. While not discussed in this report, the individual percentile weather Flame Length outputs are available in the CO-WRA data.

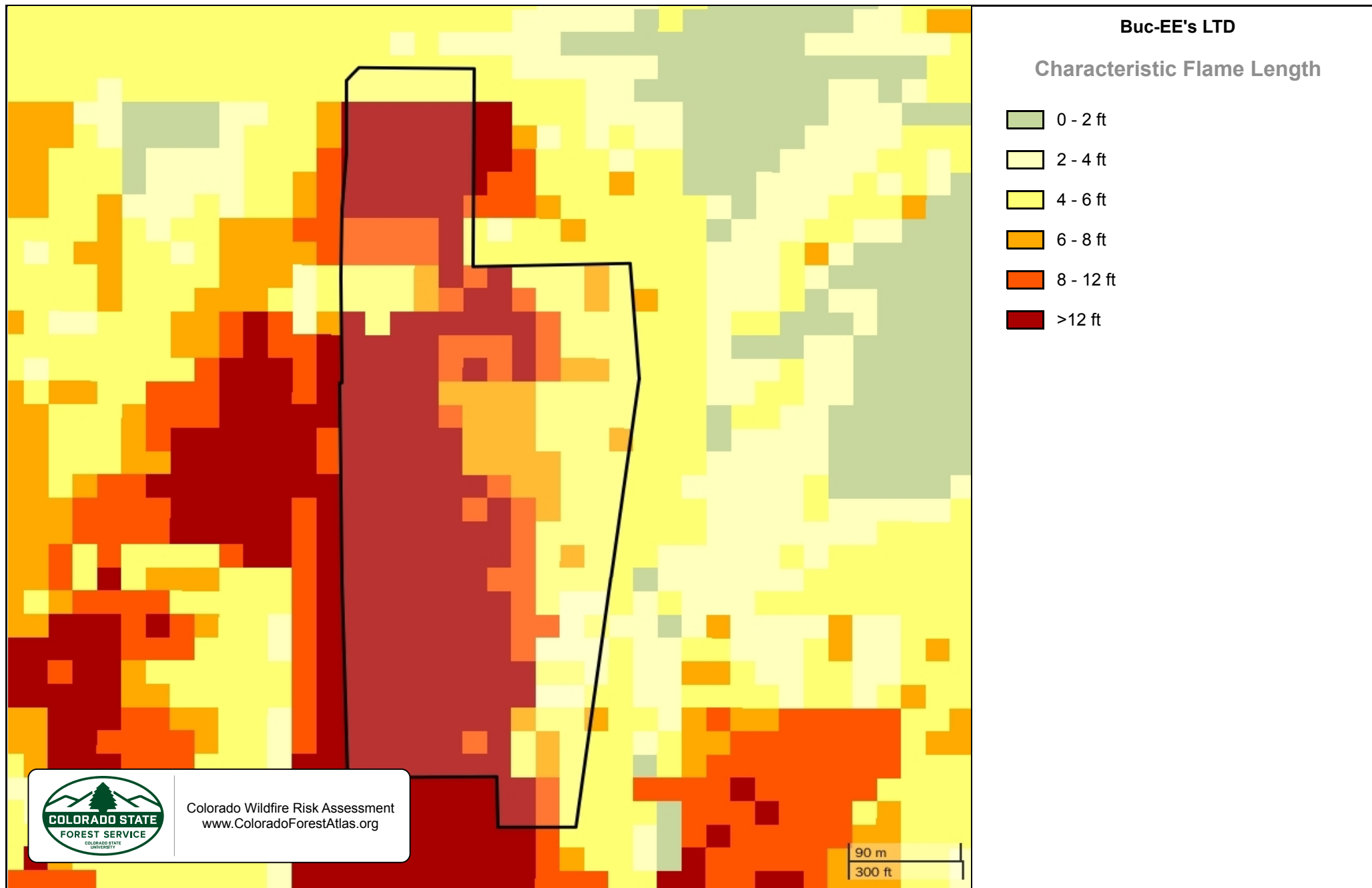


Characteristic Flame Length		Acres	Percent
	0 - 2 ft		0%
	2 - 4 ft	1	2.6%
	4 - 6 ft	6	18.6%
	6 - 8 ft	3	8%
	8 - 12 ft	3	9.7%
	>12 ft	16	45.7%
Total		29	85%

Characteristic Flame Length

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Fire Intensity Scale

Description

Quantifies the potential fire intensity by orders of magnitude.

Fire Intensity Scale (FIS) specifically identifies areas where significant fuel hazards and associated dangerous fire behavior potential exist. Similar to the Richter scale for earthquakes, FIS provides a standard scale to measure potential wildfire intensity. FIS consist of five (5) classes where the order of magnitude between classes is ten-fold. The minimum class, Class 1, represents very low wildfire intensities and the maximum class, Class 5, represents very high wildfire intensities.

1. Class 1, Lowest Intensity:

Very small, discontinuous flames, usually less than 1 foot in length; very low rate of spread; no spotting. Fires are typically easy to suppress by firefighters with basic training and non-specialized equipment.

2. Class 2, Low:

Small flames, usually less than two feet long; small amount of very short-range spotting possible. Fires are easy to suppress by trained firefighters with protective equipment and specialized tools.

3. Class 3, Moderate:

Flames up to 8 feet in length; short-range spotting is possible. Trained firefighters will find these fires difficult to suppress without support from aircraft or engines, but dozer and plows are generally effective. Increasing potential for harm or damage to life and property.

4. Class 4, High:

Large Flames, up to 30 feet in length; short-range spotting common; medium range spotting possible. Direct attack by trained firefighters, engines, and dozers is generally ineffective, indirect attack may be effective. Significant potential for harm or damage to life and property.

5. Class 5, Highest Intensity:

Very large flames up to 150 feet in length; profuse short-range spotting, frequent long-range spotting; strong fire-induced winds. Indirect attack marginally effective at the head of the fire. Great potential for harm or damage to life and property.

Burn Probability and Fire Intensity Scale are designed to complement each other. Unlike Wildfire Threat, the Fire Intensity Scale does not incorporate historical occurrence information. It only evaluates the potential fire behavior for an area, regardless if any fires have occurred there in the past. This additional information allows mitigation planners to quickly identify areas where dangerous fire behavior potential exists in relationship to nearby homes or other valued assets.

Since all areas in Colorado have fire intensity scale calculated consistently, it allows for comparison and ordination of areas across the entire state. For example, a high fire intensity area in Eastern Colorado is equivalent to a high fire intensity area in Western Colorado.

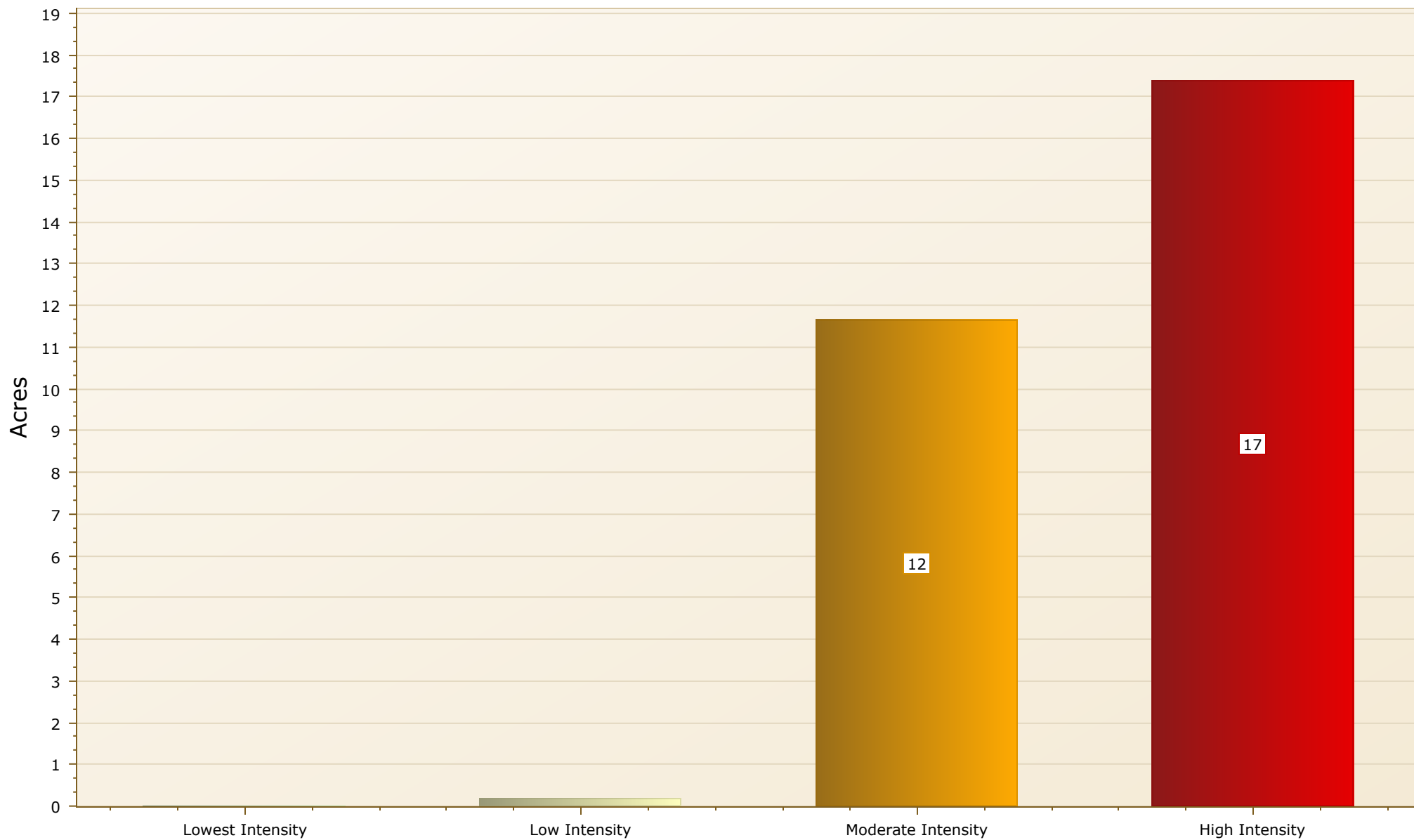
Fire intensity scale is a fire behavior output, which is influenced by three environmental factors - fuels, weather, and topography – and the spread itself (back, flank or head fire influences fire behavior for a given pixel for a specific fire simulation). Weather is by far the most dynamic variable as it changes frequently. Thus, each pixel may burn many times with different fire spread patterns based on the aforementioned factors. The fire intensity scale maps represent an average fire intensity map.

The fire intensity scale map is derived at a 20-meter resolution. This scale of data was chosen to be consistent with the accuracy of the primary surface fuels dataset used in the assessment. While not appropriate for site specific analysis, it is appropriate for regional, county, or local planning efforts.

FIS Class		Acres	Percent
	Lowest Intensity		0%
	Low Intensity		0.7%
	Moderate Intensity	12	39.9%
	High Intensity	17	59.4%
Total		29	100%

Fire Intensity Scale

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Fire Intensity Scale

-  Lowest Intensity
-  Low Intensity
-  Moderate Intensity
-  High Intensity



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Fire Type

Represents the potential fire type under the extreme percentile weather category.

Canopy fires are very dangerous, destructive and difficult to control due to their increased fire intensity. From a planning perspective, it is important to identify where these conditions are likely to occur on the landscape so that special preparedness measure can be taken if necessary. The Fire Type layer shows the footprint of where these areas are most likely to occur. However, it is important to note that canopy fires are not restricted to these areas. Under the right conditions, it can occur in other canopied areas.

There are two primary fire types – surface fire and canopy fire. Canopy fire can be further subdivided into passive canopy fire and active canopy fire. A short description of each of these is provided below.

- **Surface Fire** - A fire that spreads through surface fuel without consuming any overlying canopy fuel. Surface fuels include grass, timber litter, shrub/brush, slash and other dead or live vegetation within about 6 feet of the ground.
- **Passive Canopy Fire** – A type of crown fire in which the crowns of individual trees or small groups of trees burn, but solid flaming in the canopy cannot be maintained except for short periods (Scott & Reinhardt, 2001).
- **Conditional Crown Fire** – A type of crown fire in which an active crown fire is possible but one would not be predicted to initiate. Two outcomes are possible in that situation: surface fire if the fire starts in the stand as a surface fire, or active crown fire if fire enters the stand as an active crown fire.
- **Active Canopy Fire** - A crown fire in which the entire fuel complex (canopy) is involved in flame, but the crowning phase remains dependent on heat released from surface fuel for continued spread (Scott & Reinhardt, 2001).

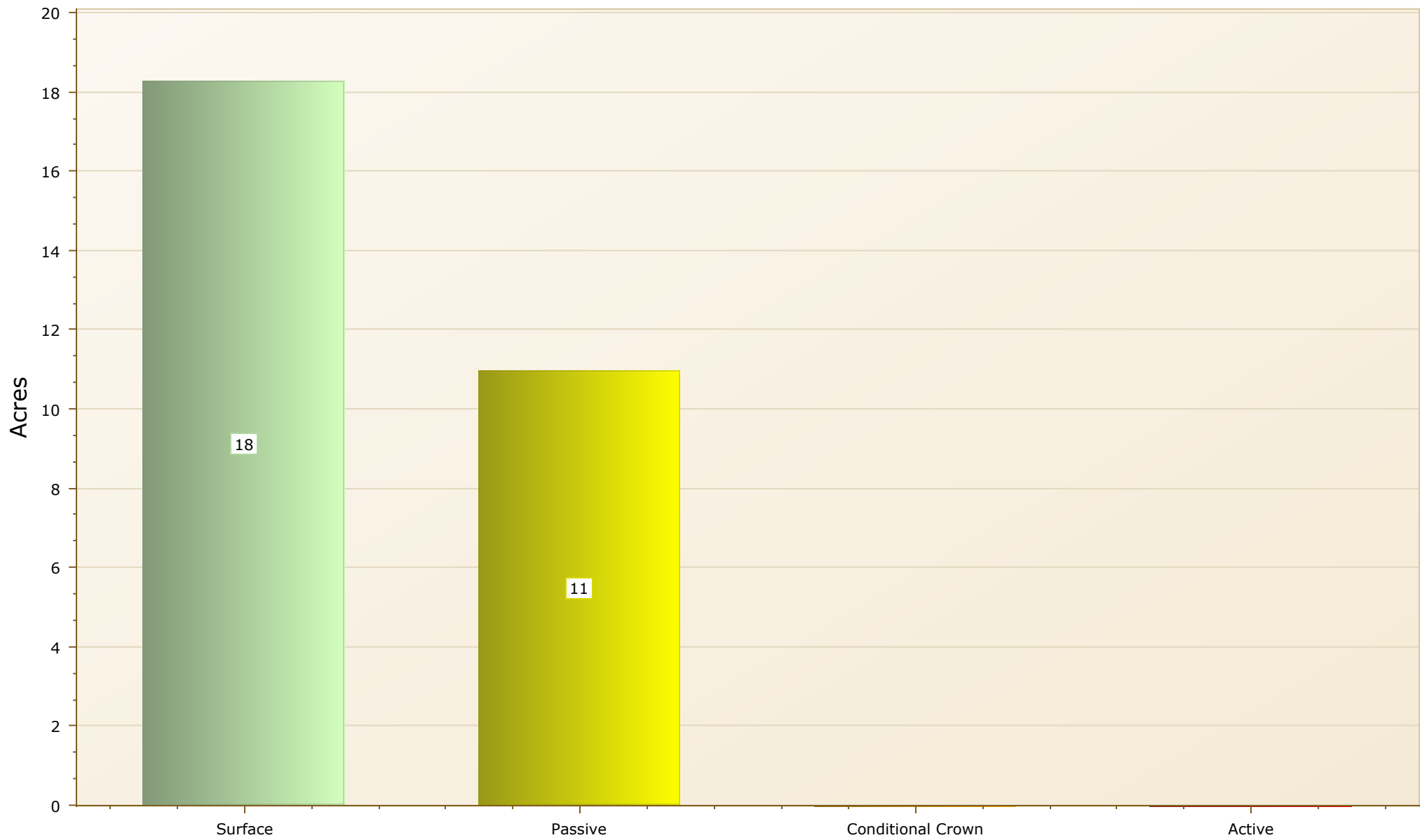
The fire type map is derived at a 20-meter resolution and was estimated based on the extreme weather scenario (percentile 97th). This scale of data was chosen to be consistent with the accuracy of the primary surface fuels dataset used in the assessment. While not appropriate for site specific analysis, it is appropriate for regional, county or local planning efforts.

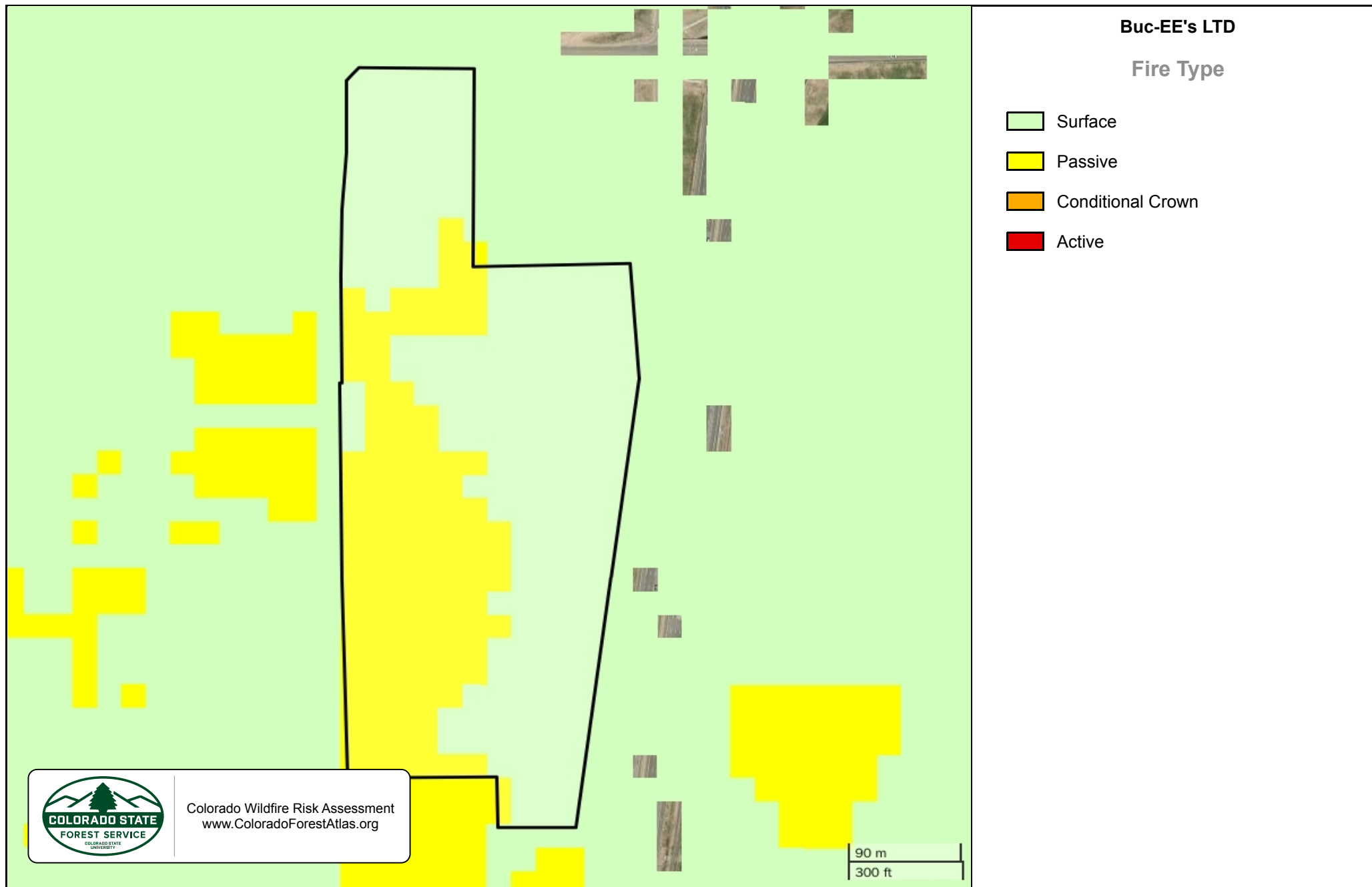


Fire Type		Acres	Percent
	Surface	18	62.5%
	Passive	11	37.5%
	Conditional Crown		0%
	Active		0%
Total		29	100%

Fire Type

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Rate of Spread

The typical or representative rate of spread of a potential fire based on a weighted average of four percentile weather categories.

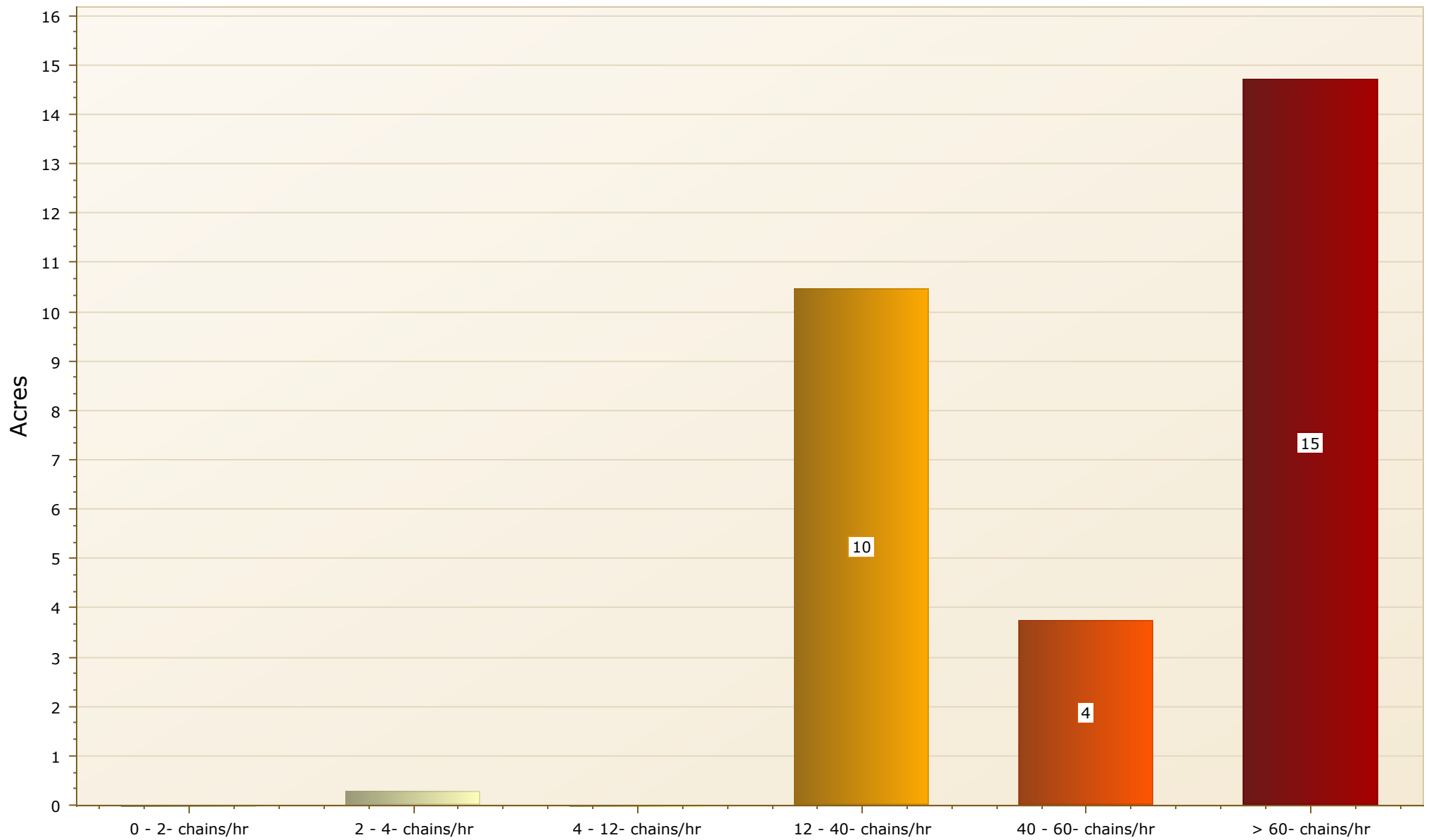
Rate of spread is the speed with which a fire moves in a horizontal direction across the landscape, usually expressed in chains per hour (ch/hr) or feet per minute (ft/min). For purposes of the CO-WRA, this measurement represents the maximum rate of spread of the fire front.

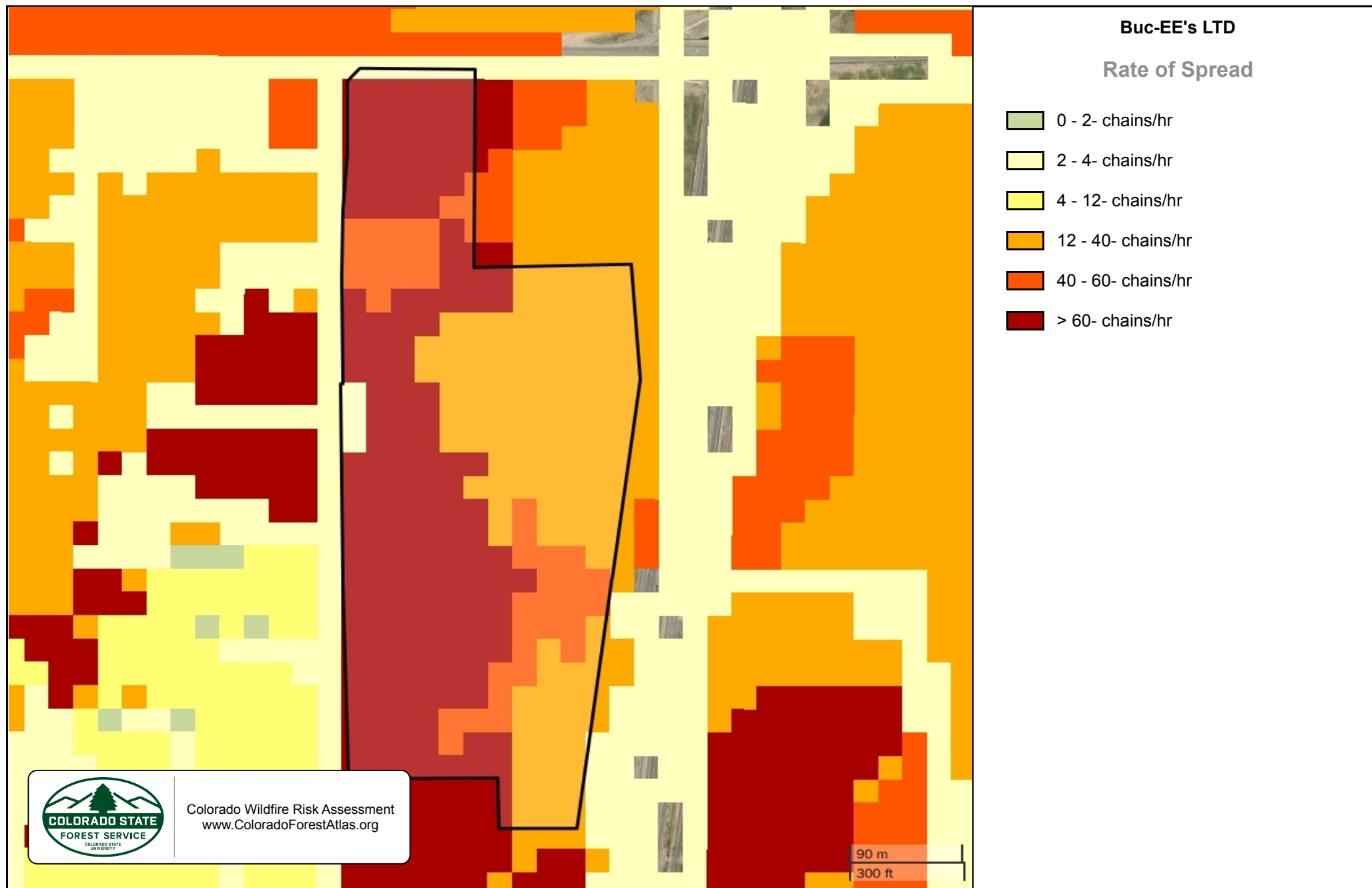
Rate of spread is a fire behavior output, which is influenced by three environmental factors - fuels, weather, and topography. Weather is by far the most dynamic variable as it changes frequently. To account for this variability, four percentile weather categories were created from historical weather observations to represent low, moderate, high, and extreme weather days for a 20-meter grid cell in Colorado.

Rate of Spread		Acres	Percent
	0 - 2- chains/hr		0%
	2 - 4- chains/hr		1%
	4 - 12- chains/hr		0%
	12 - 40- chains/hr	10	35.8%
	40 - 60- chains/hr	4	12.8%
	> 60- chains/hr	15	50.3%
Total		29	100%

Rate of Spread

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Surface Fuels

Fire behavior fuel models that contain the parameters required to calculate fire behavior outputs.

Surface fuels, or fire behavior fuel models as they are technically referred to, contain the parameters needed by the Rothermel (1972) surface fire spread model to compute surface fire behavior characteristics, e.g. rate of spread, flame length, fireline intensity, and other fire behavior metrics. As the name might suggest, surface fuels account only for surface fire potential. Canopy fire potential is computed through a separate but linked process. The CO-WRA accounts for both surface and canopy fire potential in the fire behavior outputs.

An up-to-date surface fuel dataset at 20-meter (m) resolution was developed for this project, based on Scott and Burgan (2005) fuel models, enhanced with custom fuels created by Technosylva. The custom fuels distinguish this assessment from previous ones performed in Colorado as they allow a better characterization of fire behavior across the landscape. Additionally, the urban and road custom fuel models included in the assessment are key for better characterizing the exposure, vulnerability and risk of both buildings and population in the Wildland Urban Interface (WUI). This also allows for better modeling of fire encroachment in urban areas considering the building density, community structure and fuels surrounding the buildings and urban areas.

The following custom fuels were included in order to improve the fire modeling in timber, WUI and agricultural areas:

- Timber: 2 new categories (171 and 191)
- Urban: 7 new categories (911,912,913,914,915,916 and 919)
- Roads: 5 new categories (941,942,943,944 and 949)
- Agriculture: 4 new categories (931,932,938a and 939)
- Water: 3 new categories (981,982 and 989)

Additionally, we also considered canopy fuel data to better simulate crown fire behavior. This includes:

- canopy bulk density (CBD),
- canopy base height (CBH),
- canopy cover (CC) and
- canopy height (CH).



Unmanaged forest with dead and downed trees and branches



Slash on the ground indicates that forest management treatments have occurred in this area

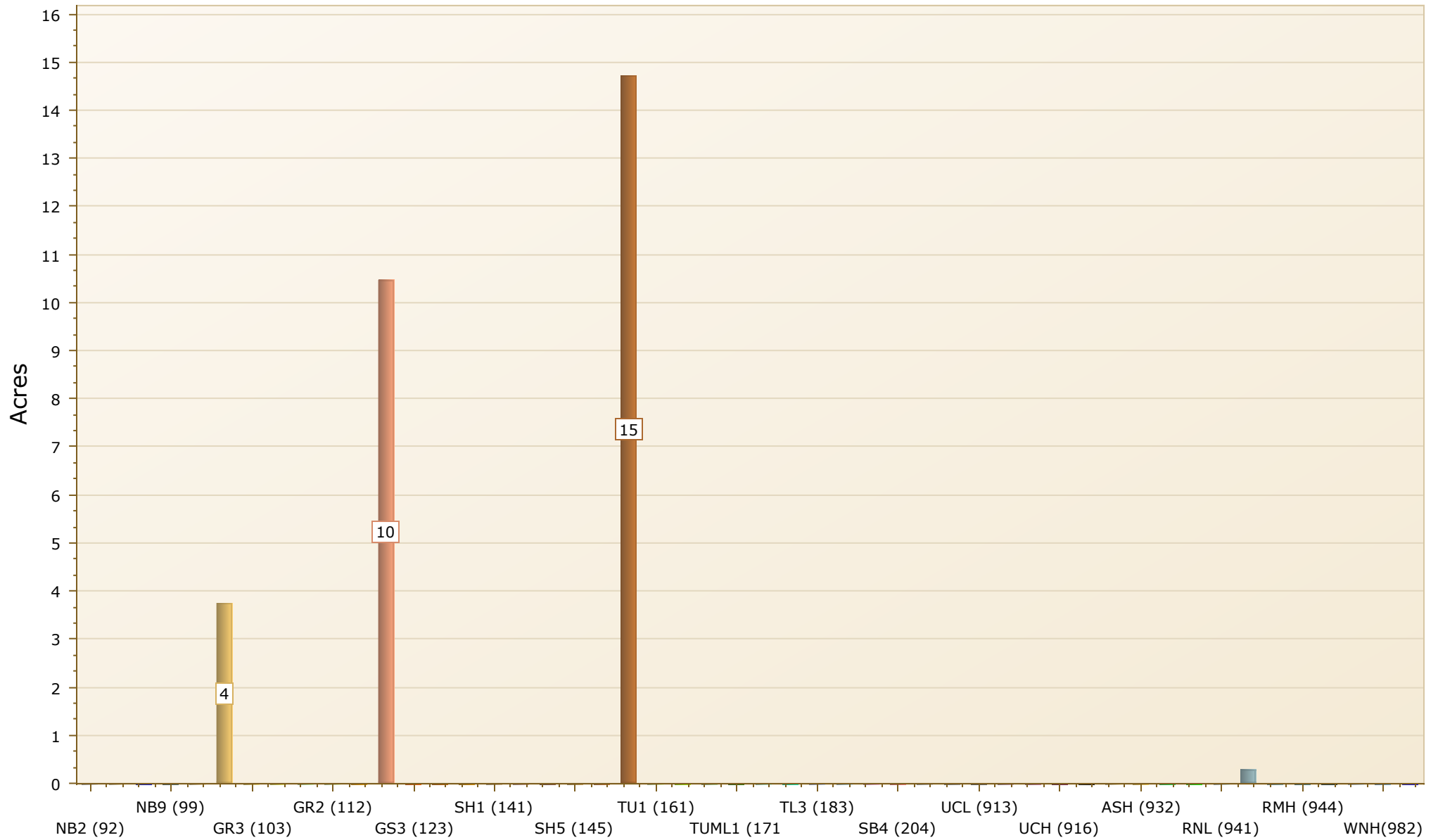
The updated fuel dataset also considered the effects of natural disturbances on vegetation (fires, insect and disease, and harvesting/fuel treatments) that occurred in Colorado from 2013 to 2022. More information about the methods used can be found in the Colorado 2022 Fuels Mapping Final Report.

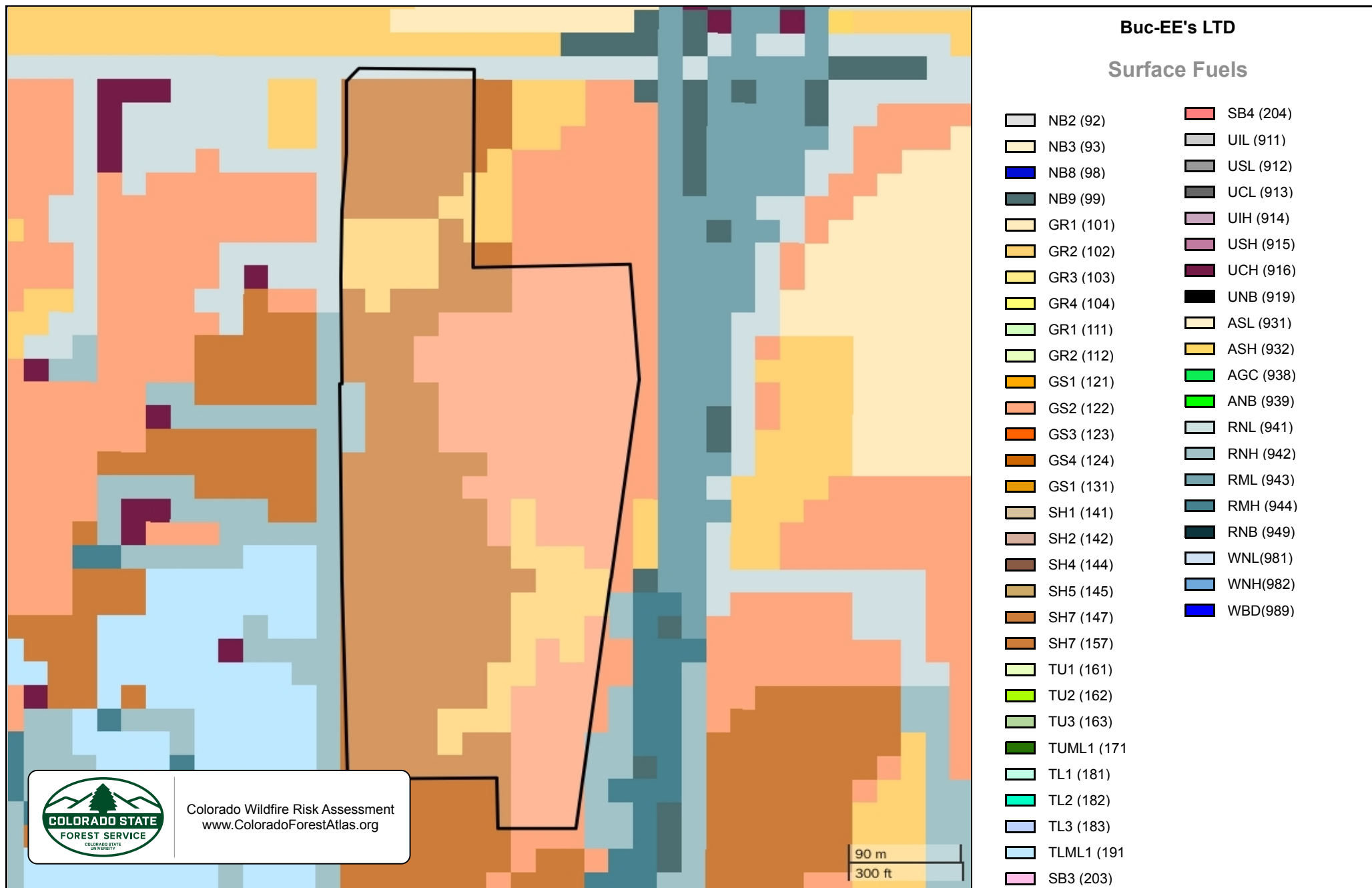
Surface Fuels	Description	Acres	Percent
NB2 (92)	Snow/Ice		0%
NB3 (93)	Agricultural		0%
NB8 (98)	Open Water		0%
NB9 (99)	Bare Ground		0%
GR1 (101)	Short, Sparse Dry Climate Grass		0%
GR2 (102)	Low Load, Dry Climate Grass	4	12.8%
GR3 (103)	Low Load, Very Coarse, Humid Climate Grass		0%
GR4 (104)	Moderate Load, Dry Climate Grass		0%
GR1 (111)	Short, Sparse Dry Climate Grass - ALPINE		0%
GR2 (112)	Low Load, Dry Climate Grass - ALPINE		0%
GS1 (121)	Low Load, Dry Climate Grass-Shrub		0%
GS2 (122)	Moderate Load, Dry Climate Grass-Shrub	10	35.8%
GS3 (123)	Moderate Load, Humid Climate Grass-Shrub		0%
GS4 (124)	High Load, Humid Climate Grass-Shrub		0%
GS1 (131)	Low Load, Dry Climate Grass-Shrub - ALPINE		0%
SH1 (141)	Low Load Dry Climate Shrub		0%
SH2 (142)	Moderate Load Dry Climate Shrub		0%
SH4 (144)	Low Load, Humid Climate Timber-Shrub		0%
SH5 (145)	High Load, Dry Climate Shrub		0%
SH7 (147)	Very High Load, Dry Climate Shrub		0%
SH7 (157)	Very High Load, Dry Climate Shrub	15	50.3%
TU1 (161)	Low Load Dry Climate Timber-Grass-Shrub		0%
TU2 (162)	Moderate Load, Humid Climate Timber-Shrub		0%
TU3 (163)	Moderate Load, Humid Climate Timber-Grass-Shrub		0%
TUML1 (171)	Timber Understory Dynamic ML (TSYL 2022)		0%
TL1 (181)	Low Load Compact Conifer Litter		0%
TL2 (182)	Low Load Broadleaf Litter		0%
TL3 (183)	Moderate Load Conifer Litter		0%
TLML1 (191)	Timber Litter ML (TSYL 2022)		0%

Surface Fuels	Description	Acres	Percent
SB3 (203)	High Load Activity Fuel or Moderate Load Blowdown		0%
SB4 (204)	High Load Blowdown		0%
UIL (911)	Isolated urban surrounded by Low FB fuel		0%
USL (912)	Scattered urban surrounded by Low FB fuel		0%
UCL (913)	Urban core surrounded by Low FB fuel		0%
UIH (914)	Isolated urban surrounded by High FB fuel		0%
USH (915)	Scattered urban surrounded by High FB fuel		0%
UCH (916)	Urban core surrounded by High FB fuel		0%
UNB (919)	Unburnable urban areas		0%
ASL (931)	Agricultural Low Load Fuels, with seasonal changes of its Burnable condition		0%
ASH (932)	Agricultural High Load Fuels, with seasonal changes of its Burnable condition		0%
AGC (938)	Golf courses - Non-Burnable (no encroachment)		0%
ANB (939)	Agricultural Fields, maintained in a Non-Burnable condition		0%
RNL (941)	Minor roads Low FB		0%
RNH (942)	Minor roads High FB		1%
RML (943)	Major roads Low FB		0%
RMH (944)	Major roads High FB		0%
RNB (949)	Roads surrounded by non-burnable fuels		0%
WNL(981)	Minor Water streams surrounded by Low Load Fuel (moderate encroachment)		0%
WNH(982)	Minor Water streams surrounded by High Load Fuel (high encroachment)		0%
WBD(989)	Water Bodies		0%
Total		29	100%

Surface Fuels

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Vegetation

The Vegetation map describes the general vegetation and landcover types across the state of Colorado.

In the CO-WRA, the Vegetation dataset is used to support the development of the Surface Fuels, Canopy Cover, Canopy Stand Height, Canopy Base Height, and Canopy Bulk Density datasets.

The 2020 LANDFIRE program data product (Existing Vegetation Type) was used to compile the Vegetation data for the CO-WRA. This reflects data current to 2020. The LANDFIRE EVT data were classified to reflect general vegetation cover types for representation with CFA.



Oak shrublands are commonly found along dry foothills and lower mountain slopes, and are often situated above Piñon-juniper.



Piñon-juniper woodlands are common in southern and southwestern Colorado



Douglas-fir understory in a ponderosa pine forest



Grasslands occur both on Colorado's Eastern Plains and on the Western Slope.



Wildland fire threat increases in lodgepole pine as the dense forest grows old

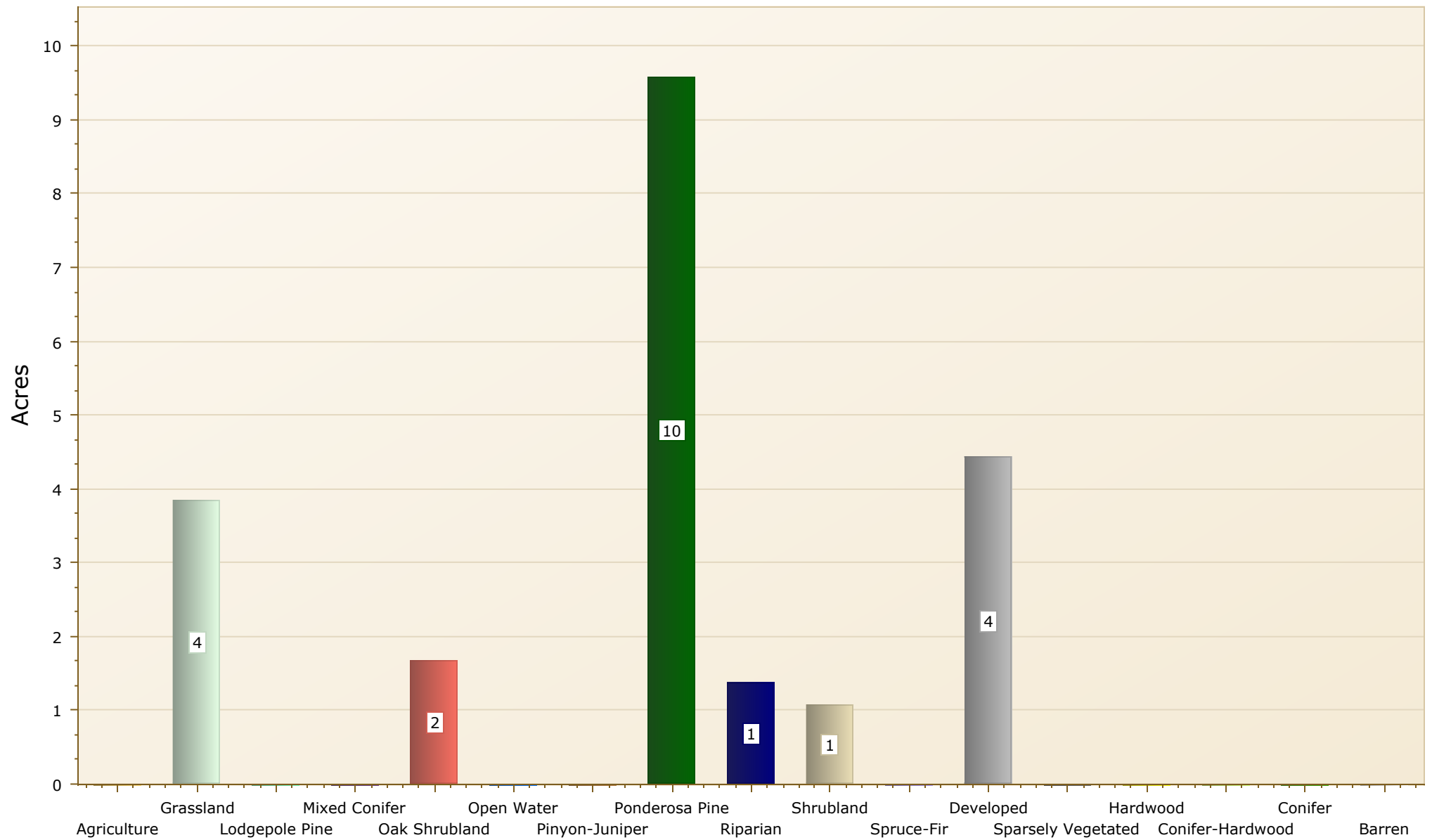


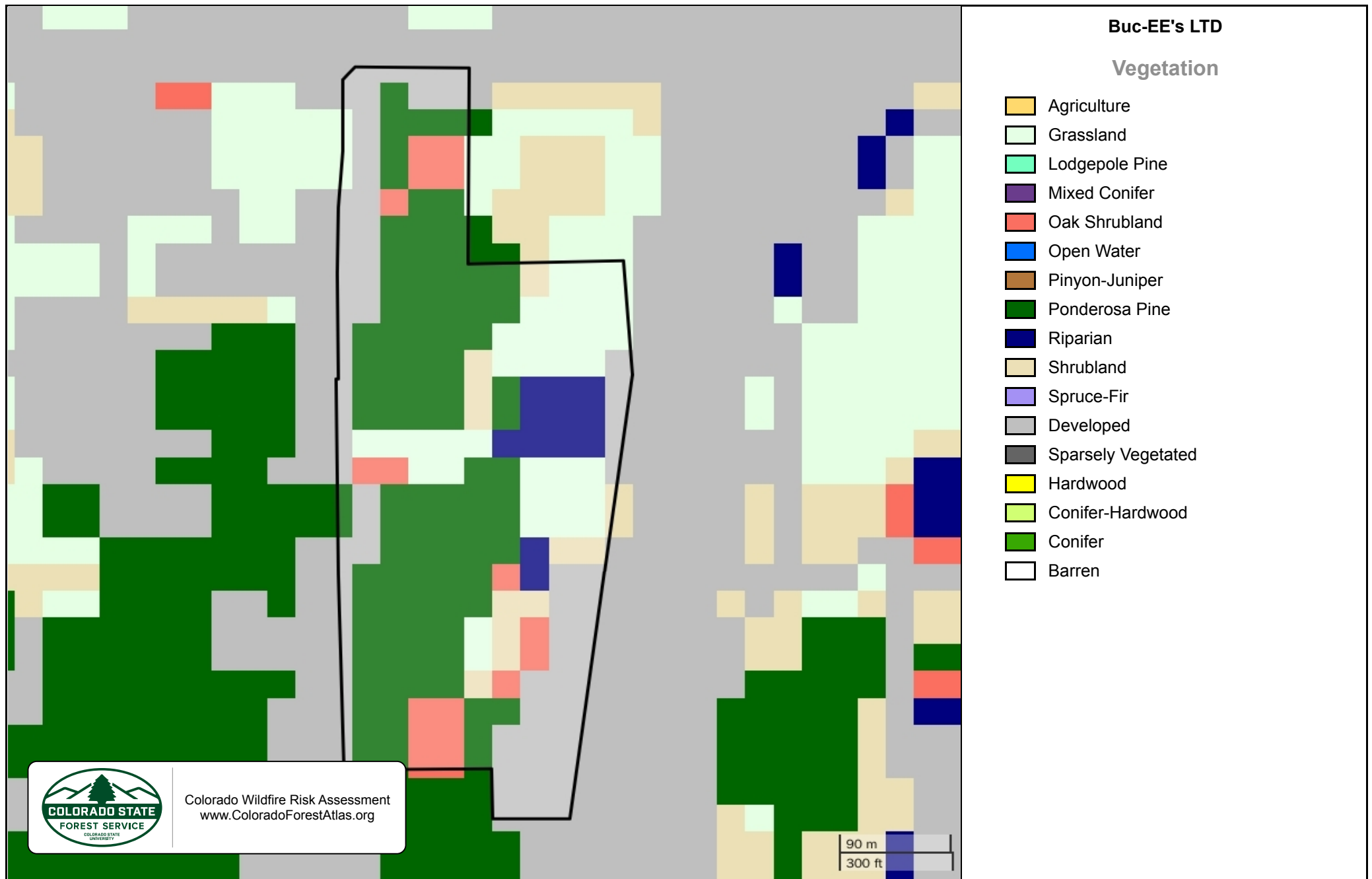
Overly dense ponderosa pine, a dominant species of the montane zone

Vegetation Class		Acres	Percent
	Agriculture		0%
	Grassland	4	17.5%
	Lodgepole Pine		0%
	Mixed Conifer		0%
	Oak Shrubland	2	7.6%
	Open Water		0%
	Pinyon-Juniper		0%
	Ponderosa Pine	10	43.5%
	Riparian	1	6.3%
	Shrubland	1	4.9%
	Spruce-Fir		0%
	Developed	4	20.2%
	Sparsely Vegetated		0%
	Hardwood		0%
	Conifer-Hardwood		0%
	Conifer		0%
	Barren		0%
Total		22	100%

Vegetation

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Watershed Protection Risk

A measure of the risk to Watershed Protection Areas based on the potential negative impacts from wildfire.

In areas that experience low-severity burns, fire events can serve to eliminate competition, rejuvenate growth and improve watershed conditions. But in landscapes subjected to high, or even moderate-burn severity, the post-fire threats to public safety and natural resources can be extreme.

High-severity wildfires remove virtually all forest vegetation – from trees, shrubs and grasses down to discarded needles, decomposed roots and other elements of ground cover or duff that protect forest soils. A severe wildfire also can cause certain types of soil to become hydrophobic by forming a waxy, water-repellent layer that keeps water from penetrating the soil, dramatically amplifying the rate of runoff.

The loss of critical surface vegetation leaves forested slopes extremely vulnerable to large-scale soil erosion and flooding during subsequent storm events. In turn, these threats can impact the health, safety and integrity of communities and natural resources downstream. The likelihood that such a post-fire event will occur in Colorado is increased by the prevalence of highly erodible soils in several parts of the state, and weather patterns that frequently bring heavy rains on the heels of fire season.

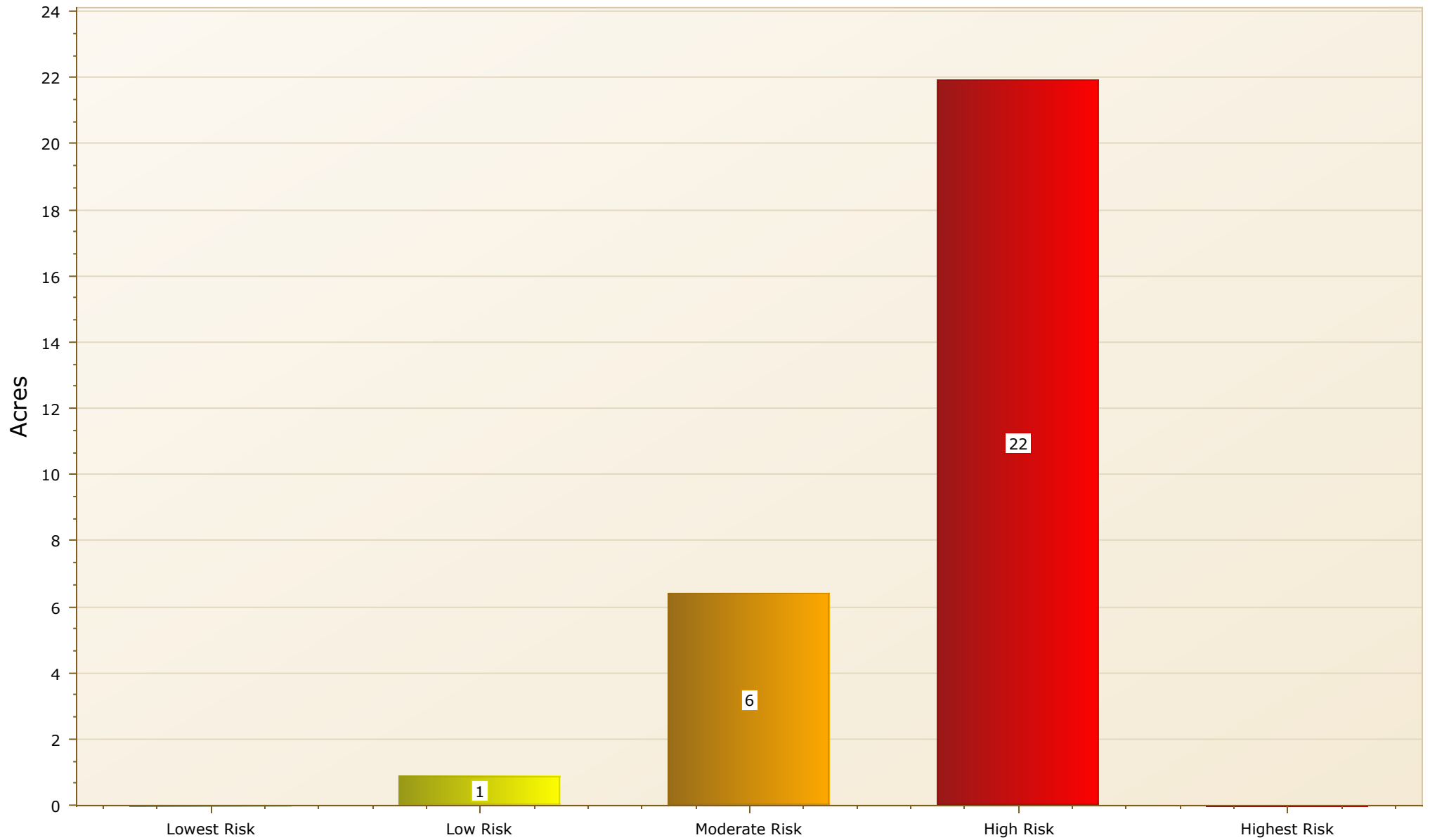
In the aftermath of the 2002 fire season, the Colorado Department of Health estimated that 26 municipal water storage facilities were shut down due to fire and post-fire impacts. The potential for severe soil erosion is a consequence of wildfire because as a fire burns, it destroys plant material and the litter layer. Shrubs, forbs, grasses, trees and the litter layer disperse water during severe rainstorms. Plant roots stabilize the soil, and stems and leaves slow the water to give it time to percolate into the soil profile. Fire can destroy this soil protection.

The risk index has been calculated by combining the Watershed Protection data with a measure of fire intensity using a Response Function approach. Those areas with the highest negative impact (-9) represent areas with high potential fire intensity and high importance for ecosystem services. Those areas with the lowest negative impact (-1) represent those areas with low potential fire intensity and a low importance for ecosystem services. The response function outputs were combined into 5 qualitative classes.

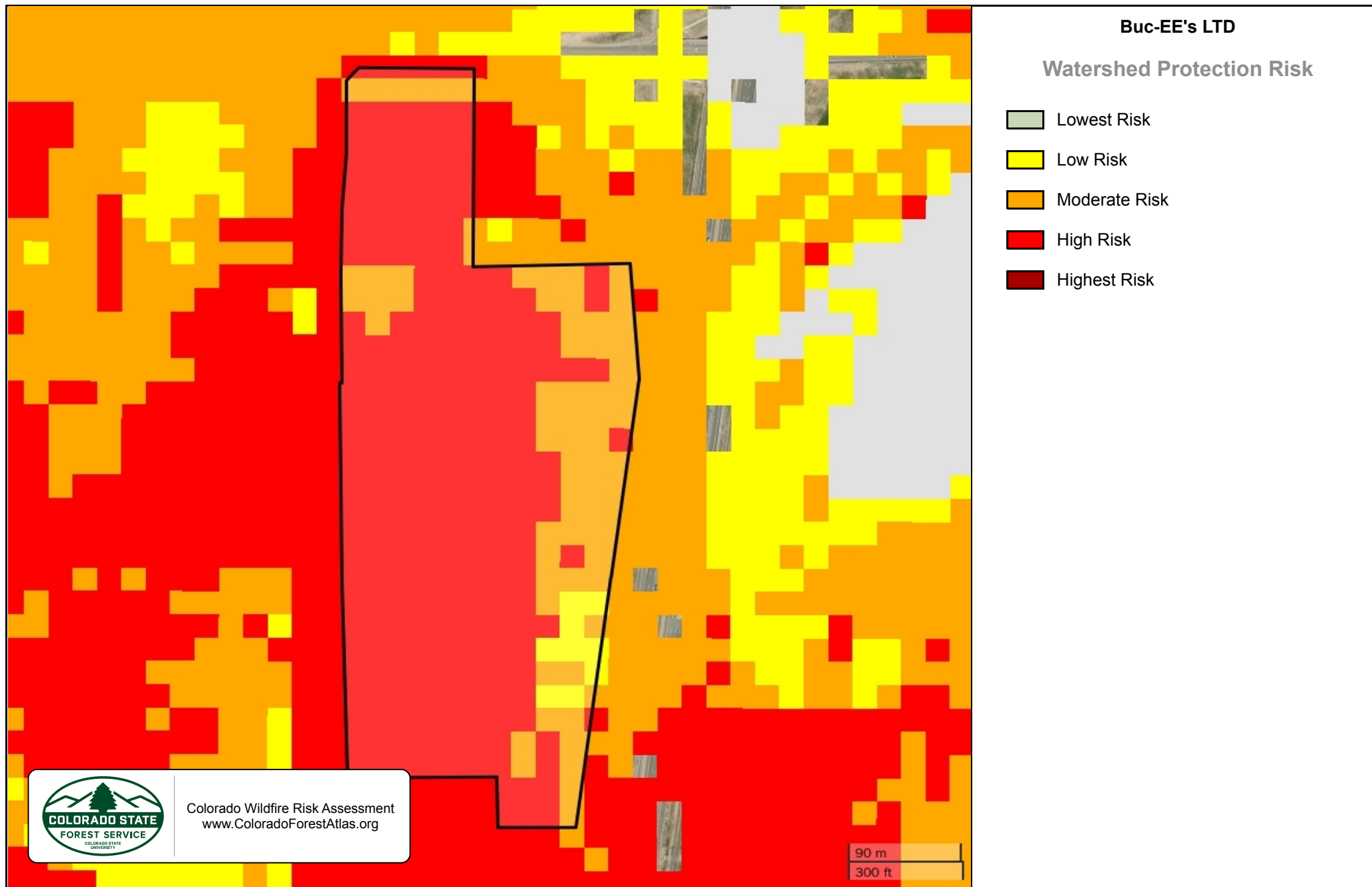
Watershed Protection Risk		Acres	Percent
	Lowest Risk		0%
	Low Risk	1	3%
	Moderate Risk	6	22%
	High Risk	22	75%
	Highest Risk		0%
Total		29	100%

Watershed Protection Risk

Buc-EE's LTD



52/66



Riparian Assets Risk

A measure of the risk to riparian areas based on the potential negative impacts from wildfire.



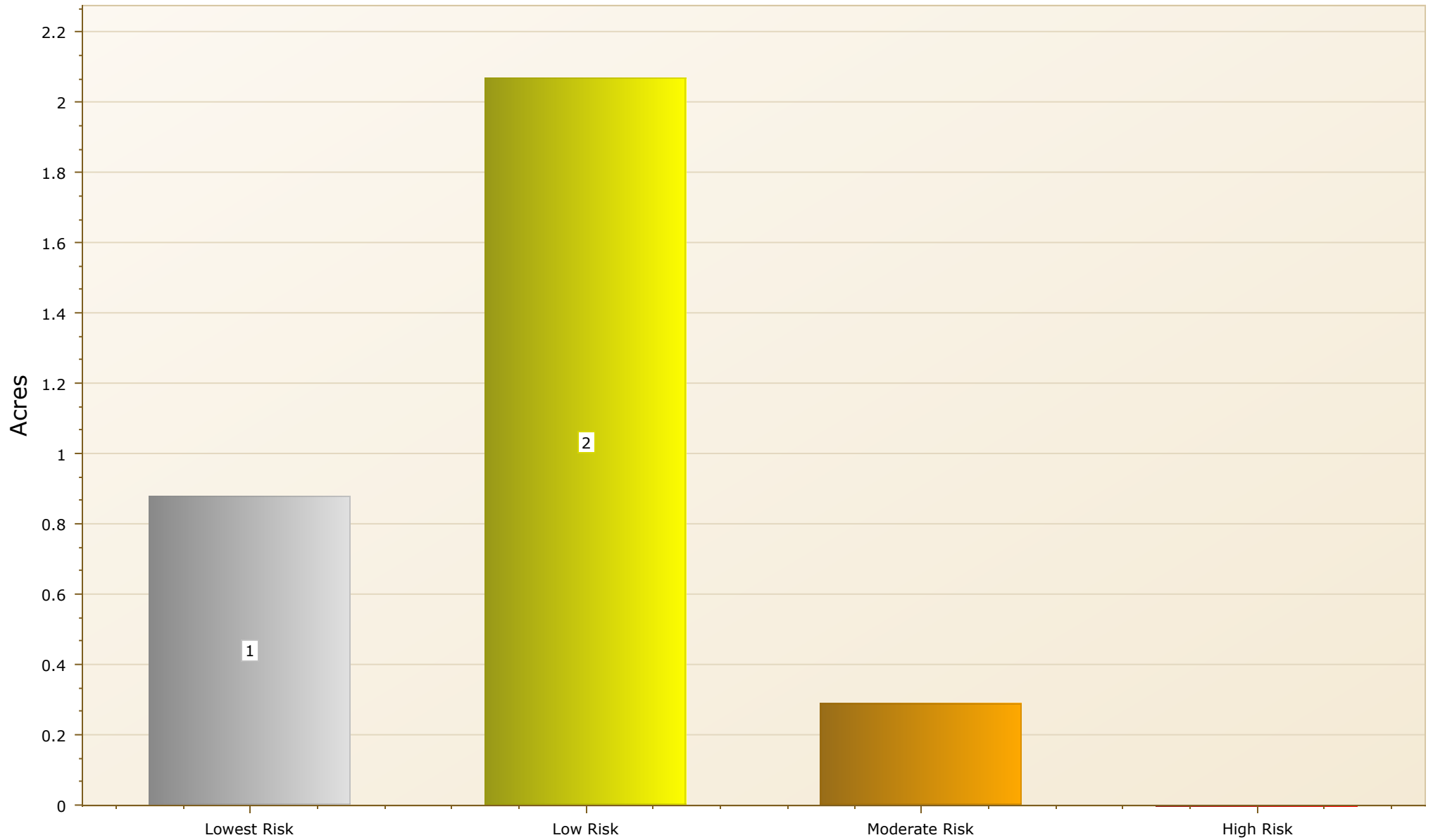
The risk index has been calculated by combining the Riparian Assets data with a measure of fire intensity using a Response Function approach. Those areas with the highest negative impact (-9) represent areas with high potential fire intensity and high importance for ecosystem services. Those areas with the lowest negative impact (-1) represent those areas with low potential fire intensity and a low importance for ecosystem services. The response function outputs were combined into 5 qualitative classes.

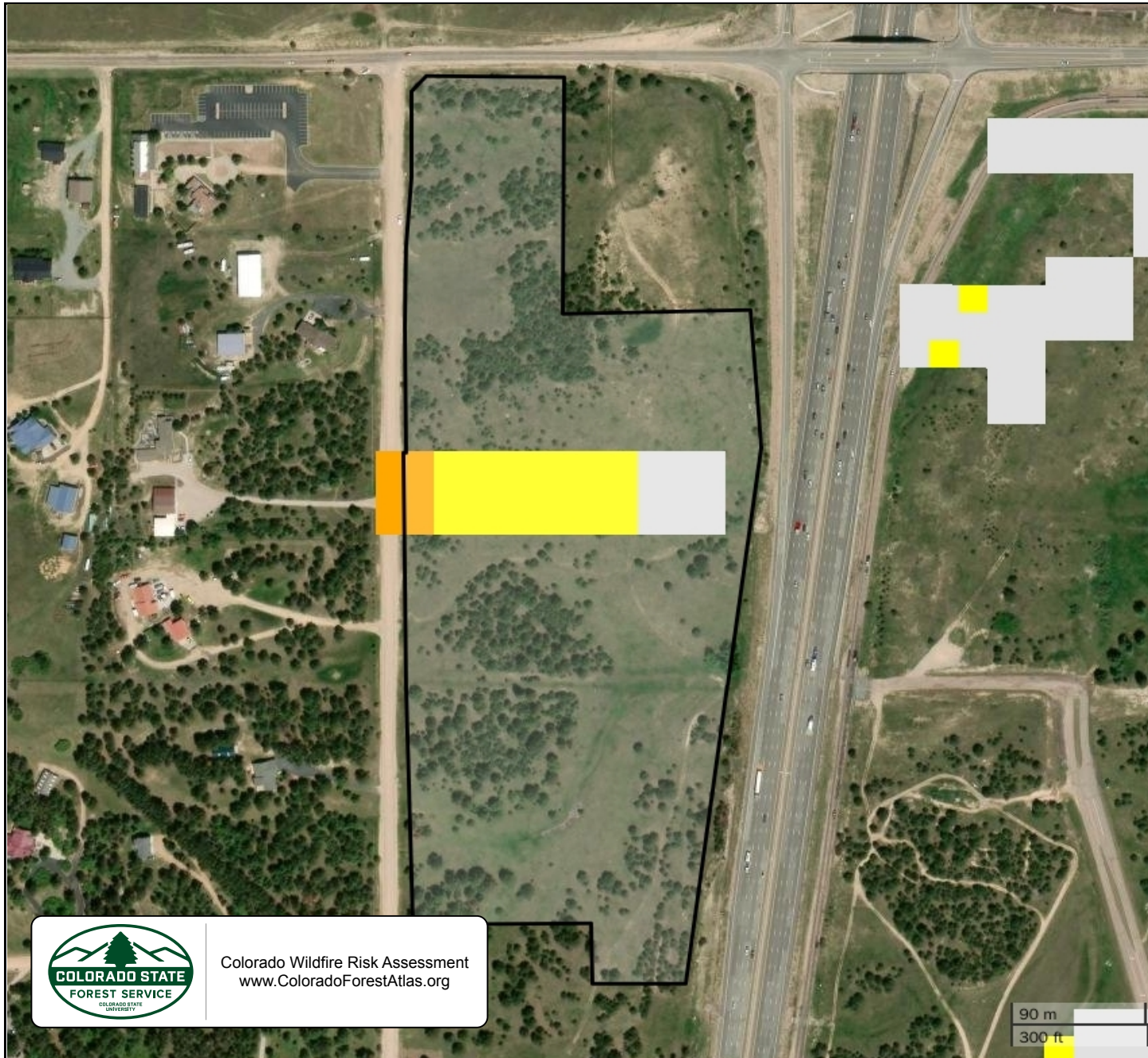
This risk output is intended to supplement the Watershed Protection Risk Index by identifying wildfire risk within the more detailed riparian areas.

Riparian Assets Risk		Acres	Percent
	Lowest Risk	1	27.3%
	Low Risk	2	63.6%
	Moderate Risk		9.1%
	High Risk		0%
Total		3	100%

Riparian Assets Risk

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Riparian Assets Risk

-  Lowest Risk
-  Low Risk
-  Moderate Risk
-  High Risk



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Forest Assets Risk

A measure of the risk to forested areas based on the potential negative impacts from wildfire.
This layer identifies those forested areas with the greatest potential for adverse effects from wildfire. This layer identifies those forested areas with the greatest potential for adverse effects from wildfire.

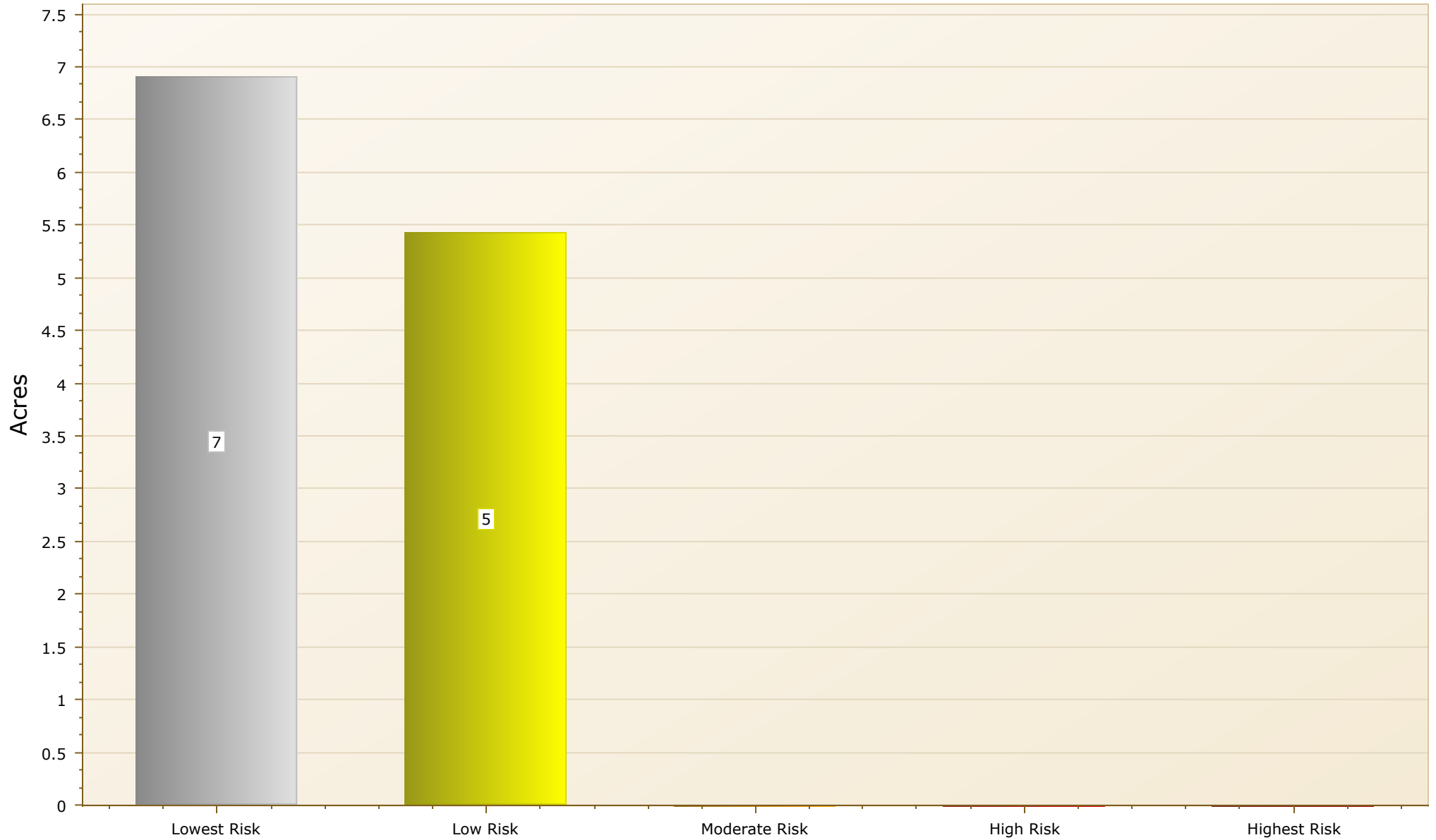
The risk index has been calculated by combining the Forest Assets data with a measure of fire intensity using a Response Function approach. Those areas with the highest negative impact (-9) represent areas with high potential fire intensity and low resilience or adaptability to fire. Those areas with the lowest negative impact (-1) represent those areas with low potential fire intensity and high resilience or adaptability to fire. The response function outputs were combined into 5 qualitative classes.

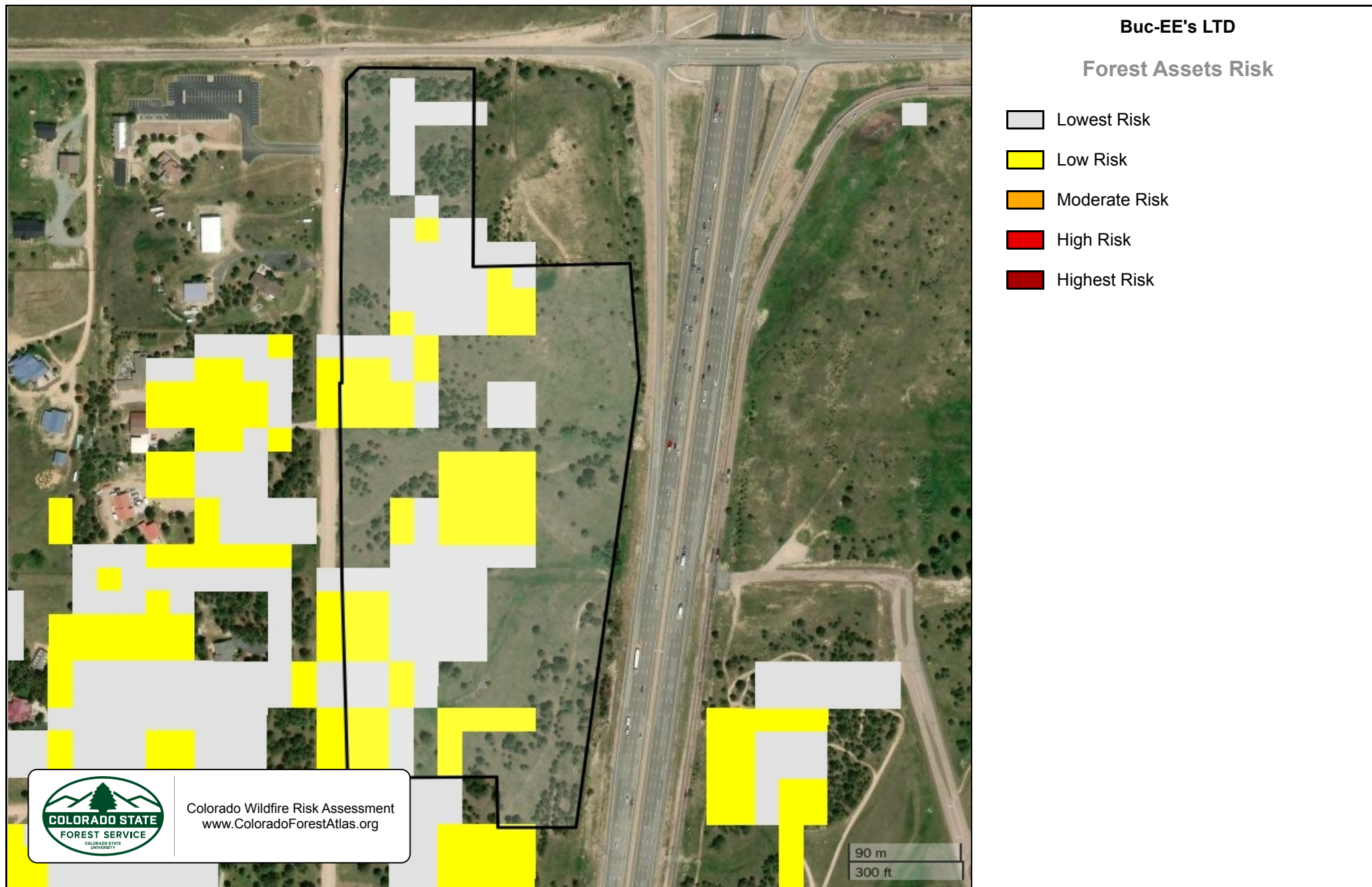
This risk output is intended to provide an overall forest index for potential impact from wildfire. This can be applied to consider aesthetic values, ecosystem services, or economic values of forested lands.

Forest Assets Risk		Acres	Percent
	Lowest Risk	7	56%
	Low Risk	5	44%
	Moderate Risk		0%
	High Risk		0%
	Highest Risk		0%
Total		12	100%

Forest Assets Risk

Buc-EE's LTD





Building Damage Potential

This metric estimates the potential for building loss and was derived using proprietary data from Technosylva Inc. on building damages that was created by analyzing 13 years of building damage data from state agency inspections after large fires.

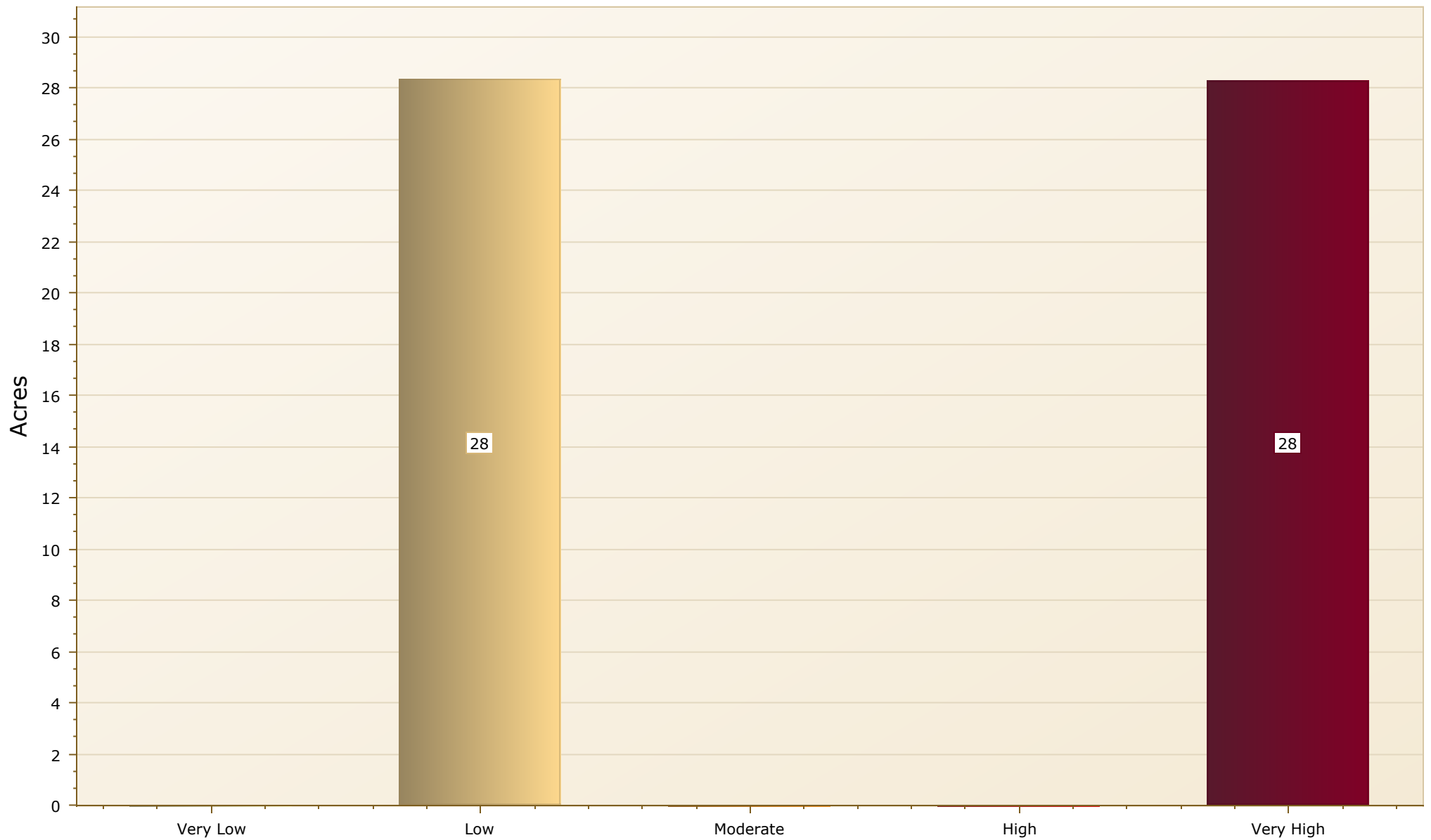
BDP is a spatially variable metric that is calculated on a building-by-building basis and aggregated to Uber H3 hexagons, providing a measure of the number of potential buildings lost based on the number of buildings threatened by fires in the specific area. BDP was calibrated using Machine Learning algorithms that identified the key factors that influenced building loss from historical damage inspection databases. The model has been calibrated using 13 years of damage inspection data and validated across multiple Western States with current wildfire data.

BDP is available as a static risk layer, although a key factor involved in the metric is conditional fire behavior. Conditional Flame Length derived in the fire behavior analysis conducted for the 2022 CO-WRA was used. However, the metric can also be used as a dynamic layer when modulated by the fire intensity of an active wildfire through conventional fire behavior analysis. Although applied as a static layer for the 2022 CO-WRA, the metric is used operationally in California by state agencies and private industry for risk forecasting

Building Damage Potential		Acres	Percent
	Very Low		0%
	Low	28	50.1%
	Moderate		0%
	High		0%
	Very High	28	49.9%
Total		57	100%

Building Damage Potential

Buc-EE's LTD





Defensible Space Index

The defensible space in a Wildfire Urban Interface (WUI) analysis context refers to the space that surrounds a specific building and can be used to define the hazard, or the exposure, to a wildfire occurrence. In this area, natural and manmade fuels are treated, cleared or reduced to slow the spread of wildfire near structures.

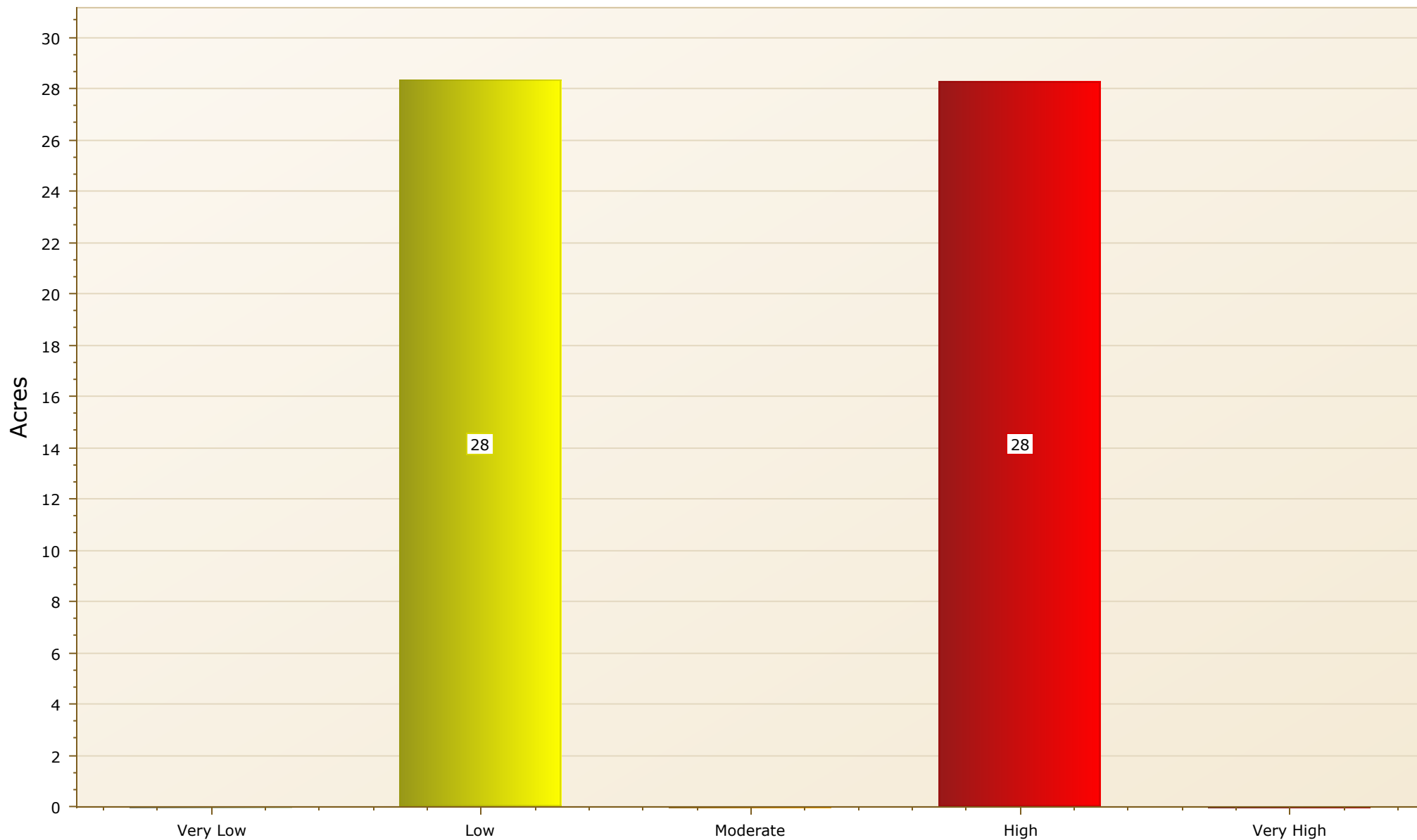
Individual building footprints were used to identify structure locations. Buildings were then grouped using Uber's hexagonal hierarchical spatial index. Within each hexagon, the building values were averaged and applied to the hexagon to remove building specific metrics. This provides a detailed measure of defensible space characteristics for small areas consistent with the accuracy of the structure locations and wildfire fuels and risk analysis data.

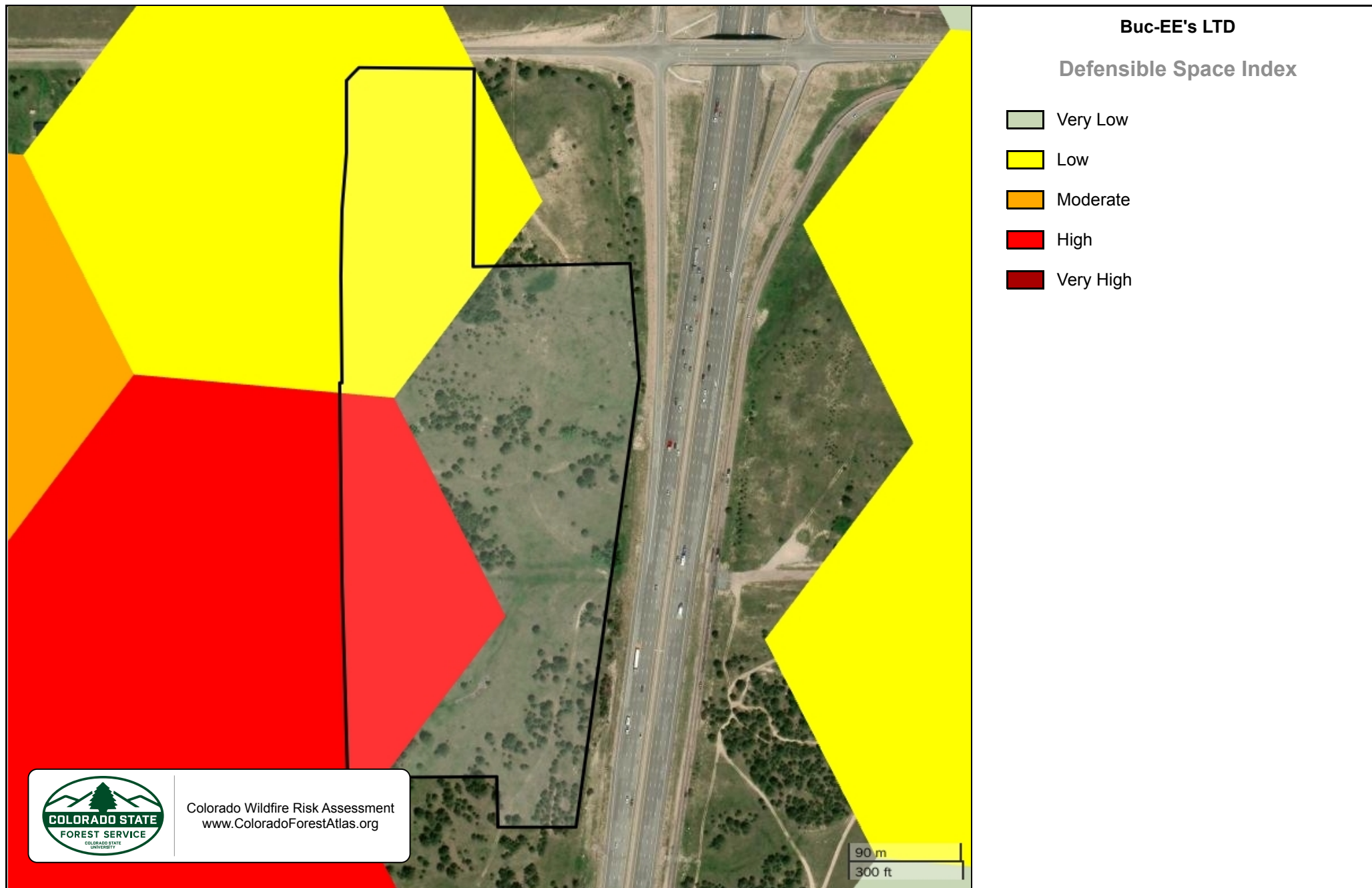
Each hexagon in the defensible space risk has a relative value from 0 to 1 that represents the average building hazard in that hexagon. This defensible space value is based on three spatial components/variables: 1) canopy cover, 2) slope, and 3) fuel models present within the buffer around the buildings analyzed.

Defensible Space Index		Acres	Percent
	Very Low		0%
	Low	28	50.1%
	Moderate		0%
	High	28	49.9%
	Very High		0%
Total		57	100%

Defensible Space Index

Buc-EE's LTD





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