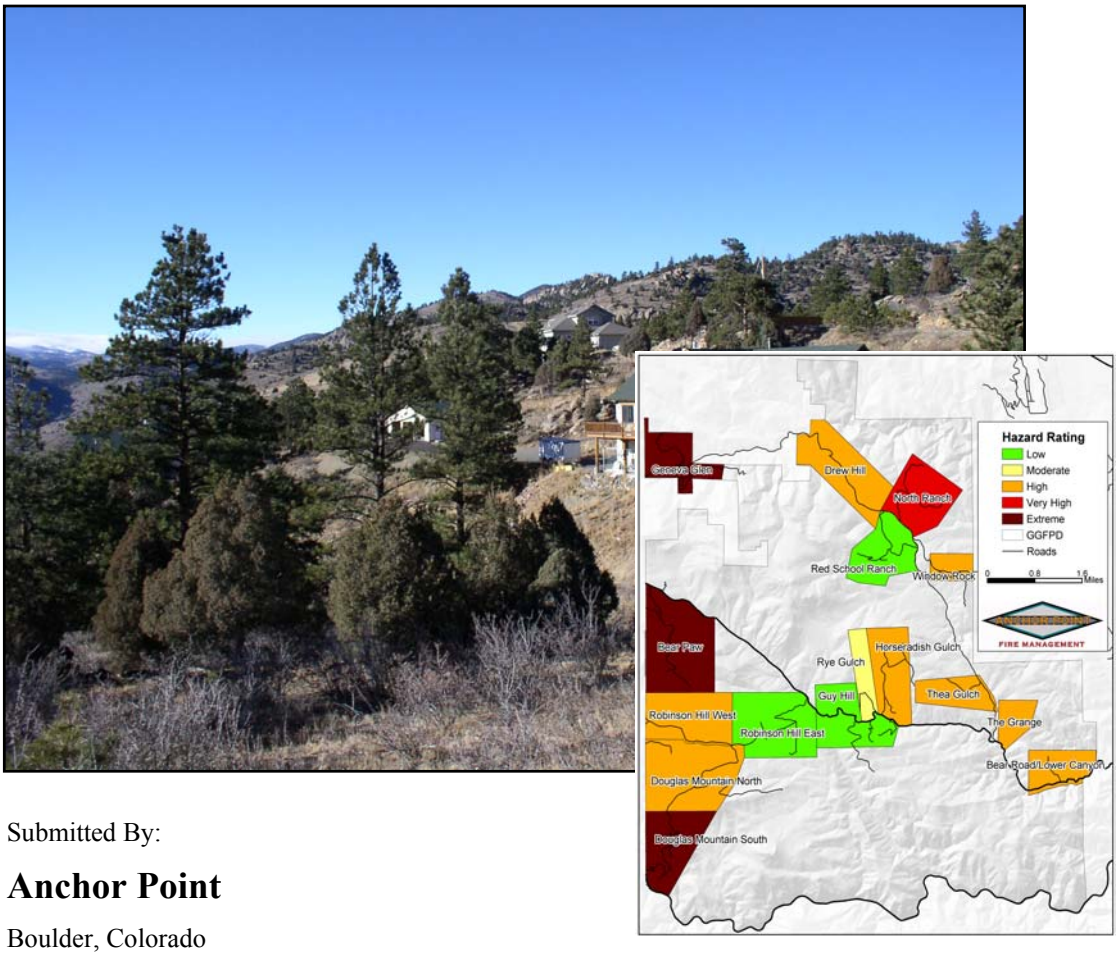
Wildland Urban Interface

Community Wildfire Protection Plan

Prepared for:

Golden Gate Fire Protection District

Golden, Colorado



Submitted By:

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Boulder, Colorado

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Table of Contents

List of Figures

List of Tables

Purpose

The purpose of this analysis is to provide a comprehensive, scientifically based assessment of the wildfire hazards and risks within the Golden Gate Fire Protection District. The assessment will aid stakeholders in developing short-term and long-term fuel and fire management plans. This initial level of pre-planning will assist land managers in making valid, timely decisions for planned and unplanned ignitions. The assessment estimates the hazards associated with wildland fire in proximity to communities. The hazard information, in conjunction with values-at-risk information, defines "areas of concern" for the community and allows for prioritization of mitigation efforts.

Goals and Objectives

Goals for this project include the following:

1. **Enhance Life Safety for Residents and Responders.**
2. **Mitigate Undesirable Fire Outcomes to Property and Infrastructure.**
3. **Mitigate Undesirable Fire Outcomes to the Environment and Quality of Life.**

In order to accomplish these goals the following objectives have been identified:

1. Establish an approximate level of risk (the probability of an ignition occurrence) for the study area.
2. Provide a scientific analysis of the fire behavior potential of the study area.
3. Group values-at-risk into "communities" that represent relatively homogenous hazard factors.
4. Identify and quantify factors that limit (mitigate) undesirable fire effects to the values-at-risk (hazard levels).
5. Recommend specific actions that will reduce hazards to the values-at-risk.

Other Desired Outcomes

1. **Promote community awareness:**
Quantification of the community's risk from wildfire will facilitate public awareness and assist in creating public action to mitigate defined hazards.

2. **Improve wildfire prevention through education**:
Awareness, combined with education, will help to reduce the risk of unplanned human ignitions.

3. **Facilitate appropriate hazardous fuel reduction:**
The prioritization of hazardous Fire Management Units (FMU) can assist land managers in focusing future efforts towards the areas of highest concern from both an ecological and fire management perspective.

4. **Promote improved levels of response:**
The identification of areas of concern will improve the accuracy of pre-planning, and facilitate the implementation of cross-boundary, multi-jurisdictional projects.

Study Area Profile

Figure 1: Typical Area

The Golden Gate Fire Protection District (GGFPD) is located in Jefferson County, five miles west of Golden, Colorado. The district is bordered on the east by the City of Golden and the Fairmont Fire Protection District, on the south by Clear Creek Canyon, on the west by High Country Fire Protection District and on the north by Coal Creek Fire Protection District. GGFPD covers an area of 49 square miles and has approximately 400 homes. The primary access to the district is via Golden Gate Canyon Road.

For the purposes of this report, communities have been assessed for the hazards and risks that occur inside the district

boundaries. Rankings and descriptions of communities, as well as hazard and risk recommendations, only pertain to the portions of those areas that lie within the boundaries of GGFPD unless otherwise noted.

The area is considered to be in the Foothills and Montane zones (5,500'- 9,500') of the eastern slope of the Northern Colorado Front Range.[1] A portion of GGFPD can be considered to be in the Sub-Alpine zone, areas above 9,500', however this represents such a sparsely inhabited portion of the district that it has no noticeable impact on fire in the Wildland/Urban Interface (see Figure 4). The dominant vegetation is composed of various species of mountain grasses and ponderosa pine (*Pinus ponderosa)*. Coverage ranges from savanna to dense forest. Dense stands of mixed conifers are common primarily on north facing slopes. These stands are primarily composed of lodgepole pine *(Pinus contorta),* Douglas-fir *(Pseudotsuga menziesii)* and ponderosa pine *(Pinus ponderosa).* At lower elevations scattered pinyon pine *(Pinus edulis)* and Rocky Mountain juniper *(Juniperus scopulorum)* are mixed with intermittent short grasses especially on south-facing slopes. Various species of Sage (genius *Artemesia*) and alpine shrubs occur in stringers and patches at the lower elevations, particularly on south-facing slopes and in ravines.

Current Risk Situation

For the purposes of this report, risk will be considered to be the likelihood of an ignition occurrence. This is primarily determined by the fire history of the area. Hazard is the combination of the wildfire hazard ratings of the WUI communities and fire behavior potential, as modeled from the fuels, weather and topography of the study area.

The majority of the district is at a high risk for Wildland Urban Interface (WUI) fires. The city of Golden as well as Golden Gate Canyon Estates and Golden Gate Park Estates, just west of GGFPD, are listed in the Federal Register as communities at high risk from wildfire (http://www.fireplan.gov/reports/351-358-en.pdf). The area is shown in the Colorado State Forest Service WUI Hazard Assessment map to be an area of high Hazard Value (an aggregate of Hazard, Risk and Values Layers). This area also has a significant fire history. The Golden Fire Department has responded to 105 wildland ignitions in the last five years.

Development is increasing in the study area at an impressive rate. As the density of structures and the number of residents in the interface increases, potential ignition sources will multiply. Development is moving away from main roads into increasingly remote areas, often those with heavier fuel loads. Unless efforts are made to mitigate the potential for human ignition sources spreading to the surrounding forest, the potential for a large wildfire occurrence will increase.

The study area is home to two state parks, Golden Gate State Park and White Ranch State Park. Due to their close proximity to Golden and the Denver metro area, these parks experience heavy visitor use. This additional traffic and recreational presence increases the risk of human caused ignitions.

For reference to the rest of this document, Figure 2 and Table 1 show the communities that comprise the Wildland/Urban Interface study area, and Figures 3 and 4 show the general topography of the area.

[1] Elevation limits for life zones were based on life zone ranges from: Jack Carter, "Trees and Shrubs of Colorado" (Boulder, CO: Johnson Books, 1988).

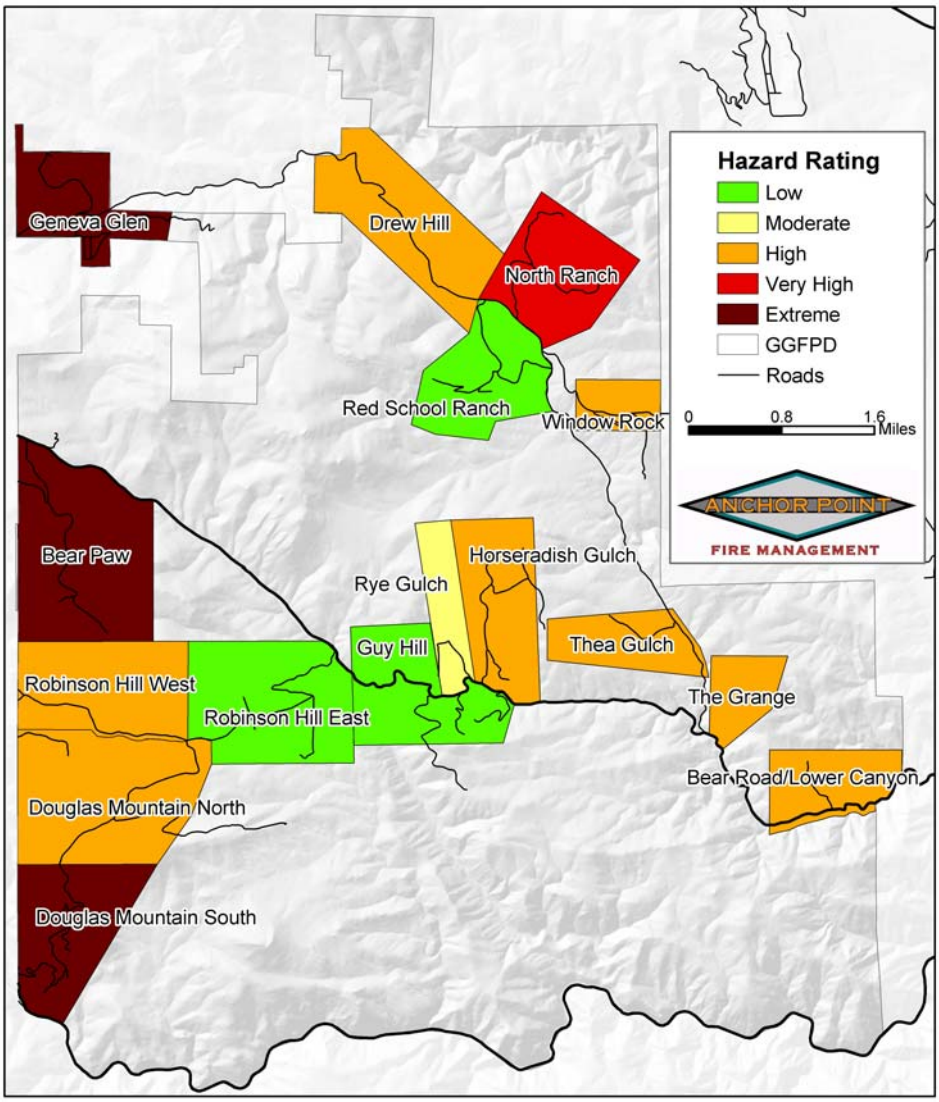

Figure 2: Study Area Communities

Table 1: Hazard Ranking of Communities in the Study Area

1. Bear Paw	9. Drew Hill
2. Geneva Glen	10. The Grange Area
3. Douglas Mountain-South	11. Robinson Hill-West
4. North Ranch	12. Bear Road/Lower Canyon
5. Douglas Mountain-North	13. Rye Gulch
6. Horseradish Gulch	14. Robinson Hill-East
7. Thea Gulch	15. Guy Hill
8. Window Rock	16. Red School Ranch

Extreme Very High High Moderate Low

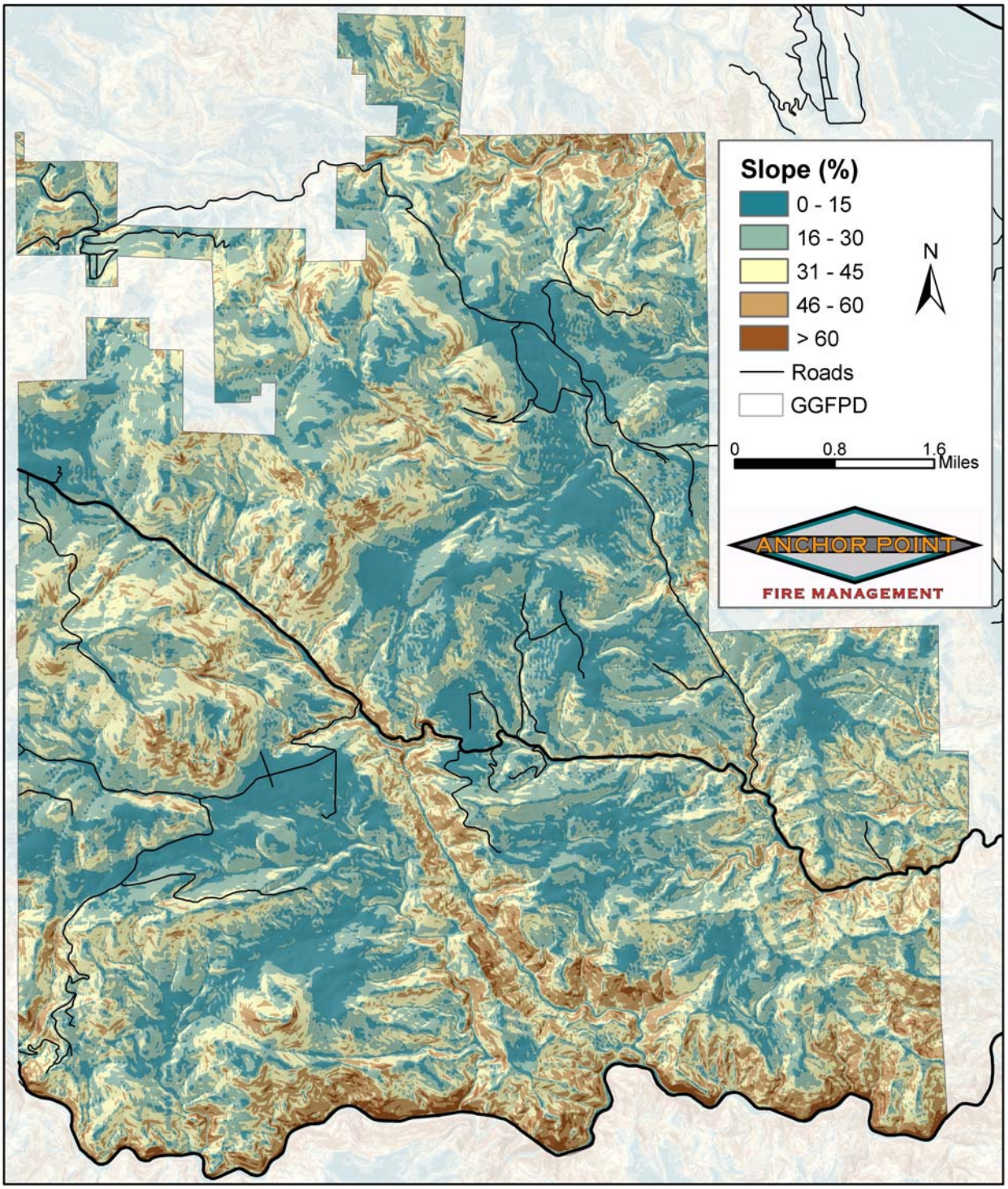

Figure 3: Percent Slope

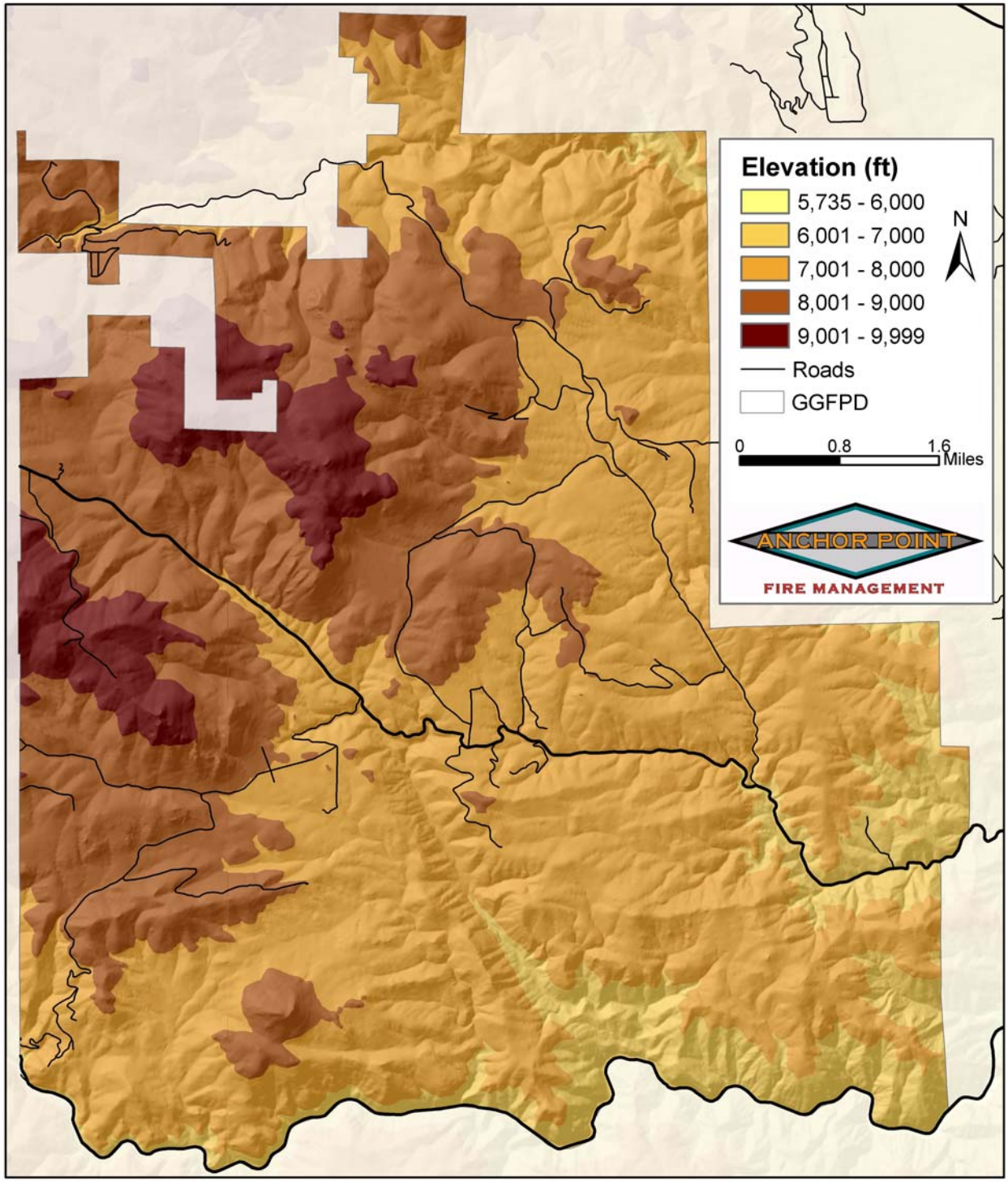

Figure 4: Elevation

Fire Behavior Potential

From the Wildfire Hazard Analysis carried out as a part of this study (see Appendix A), the fire behavior potential of GGFPD was modeled. This model can be combined with structure density and values-at-risk information to generate current and future “areas of concern”. This is also sometimes referred to as a "values layer".

Fire behavior potential maps, Figures 5-7, are shown for the outputs of the FLAMMAP model (crown fire activity, flame length, and rate of spread) for the analysis area given the average weather conditions existing between May and October. Weather observations from the Boulder Remote Automated Weather Station (RAWS) were averaged for a ten-year period (1992-2002) to calculate these conditions. The mean for each variable (1 hr, 10 hr, and 100 hr fuel moisture, woody fuel moisture, herbaceous fuel moisture, and wind speed) was calculated. The average of each mean/month was then calculated to represent an average fire season day.

The “extreme conditions” maps, Figures 8-10, were calculated using ninety-seventh percentile weather data. That is to say, the weather conditions existing on the four most severe fire weather days (sorted by Energy Release Component ERC) in each season for the ten-year period were averaged together. It is reasonable to assume that similar conditions may exist for at least four days of the fire season during an average year. In fact, during extreme years such as 2000 and 2002, such conditions may exist for significantly longer periods. Even these calculations may be conservative compared to observed fire behavior. Drought conditions the last few years have significantly changed the fire behavior in dense forest types such as mixed conifer. The current values underestimate fire behavior especially in the higher elevation fuels, because the extremely low fuel moistures are not represented in the averages.

Weather conditions are extremely variable and not all combinations are accounted for. These outputs are best used for pre-planning and not as a stand-alone product for tactical planning. It is recommended that whenever possible, fire behavior calculations be done with actual weather observations during the fire. It is also recommended that the most current ERC values be calculated and distributed during the fire season to be used as a guideline for fire behavior potential. For a more complete discussion of the fire behavior potential methodology, please see Appendix A.

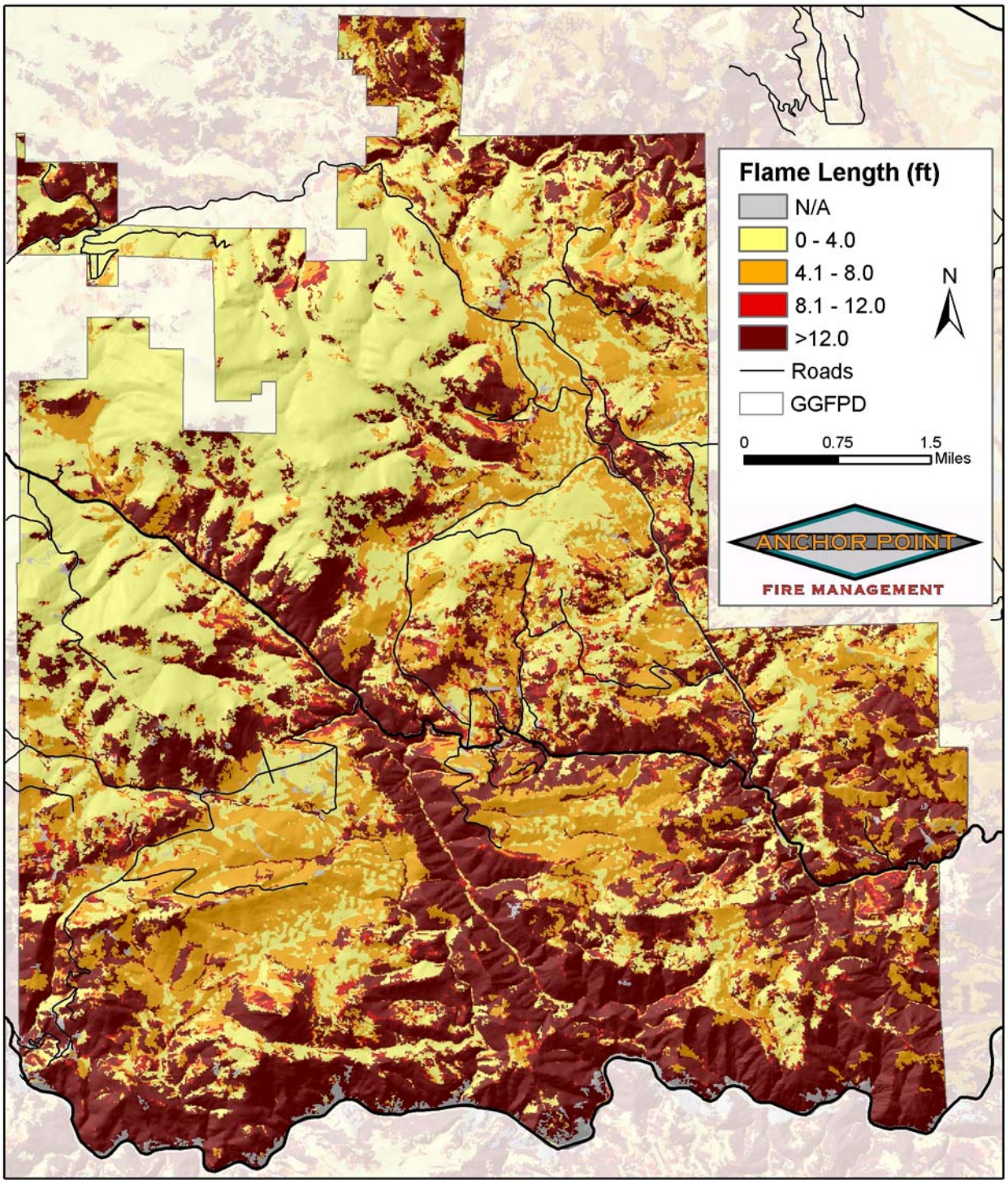

Figure 5: Flame Length Predictions (Average Weather Conditions)

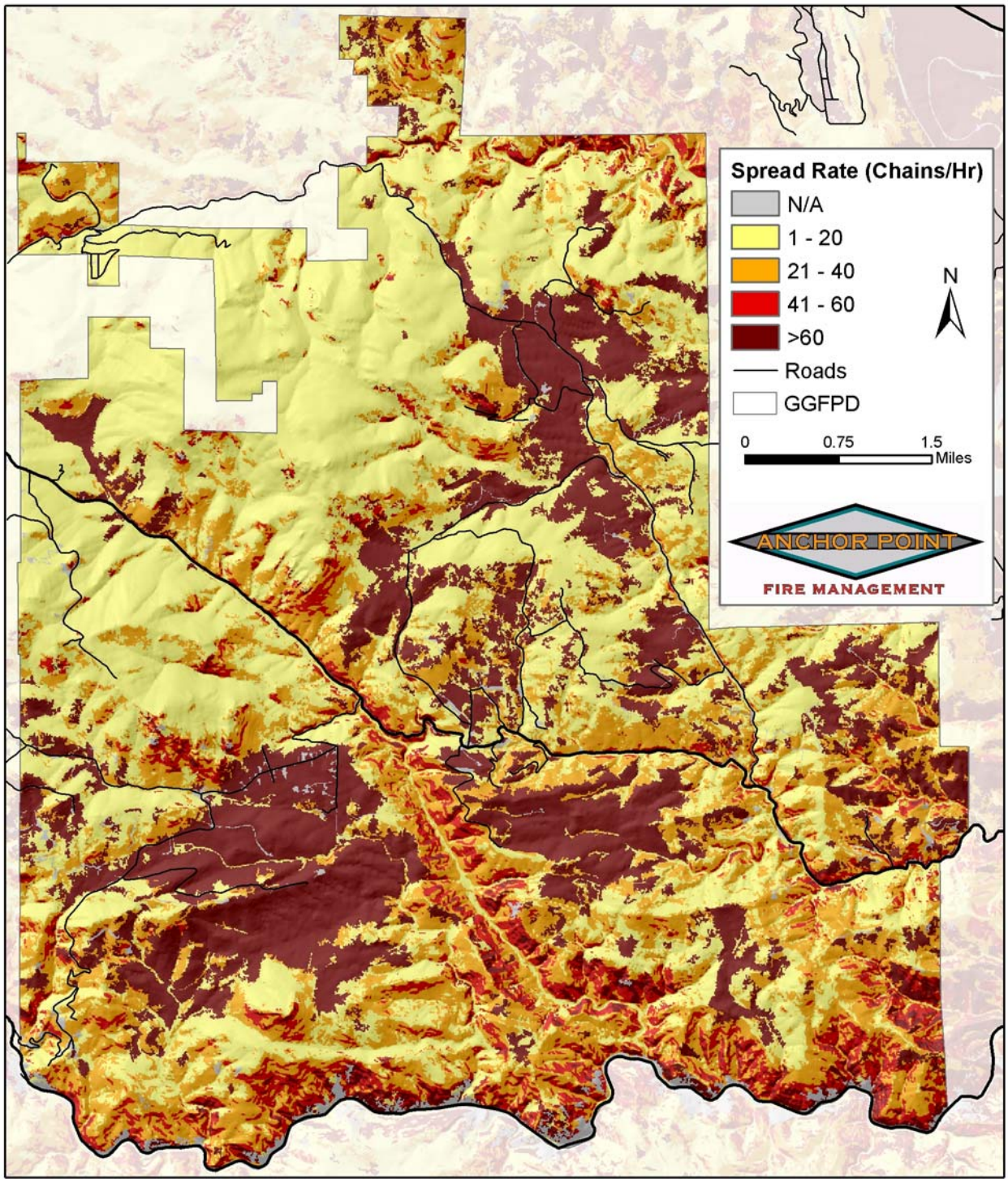

Figure 6: Spread Rate Predictions (Average Weather Conditions)

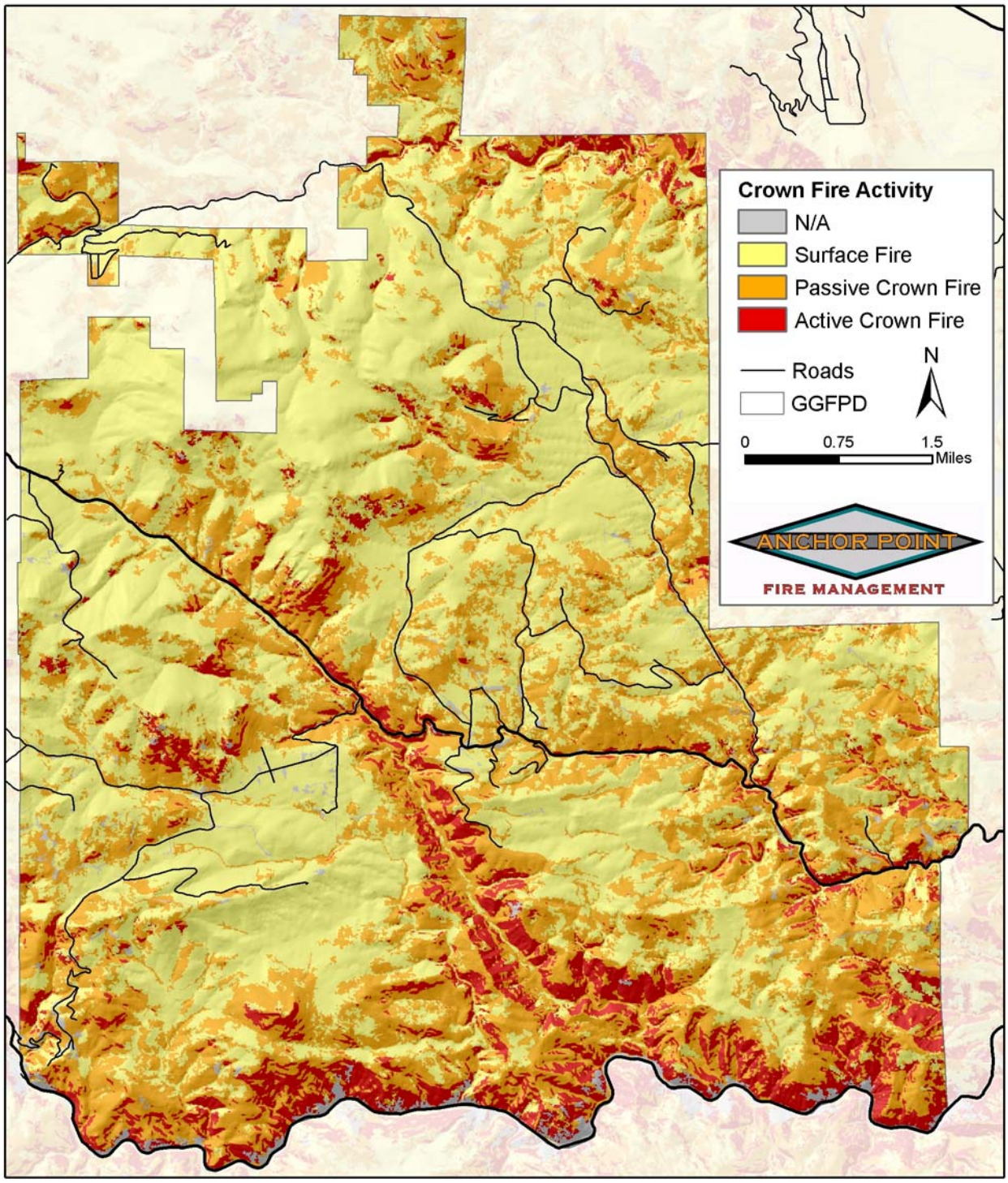

Figure 7: Crown Fire Potential (Average Weather Conditions)

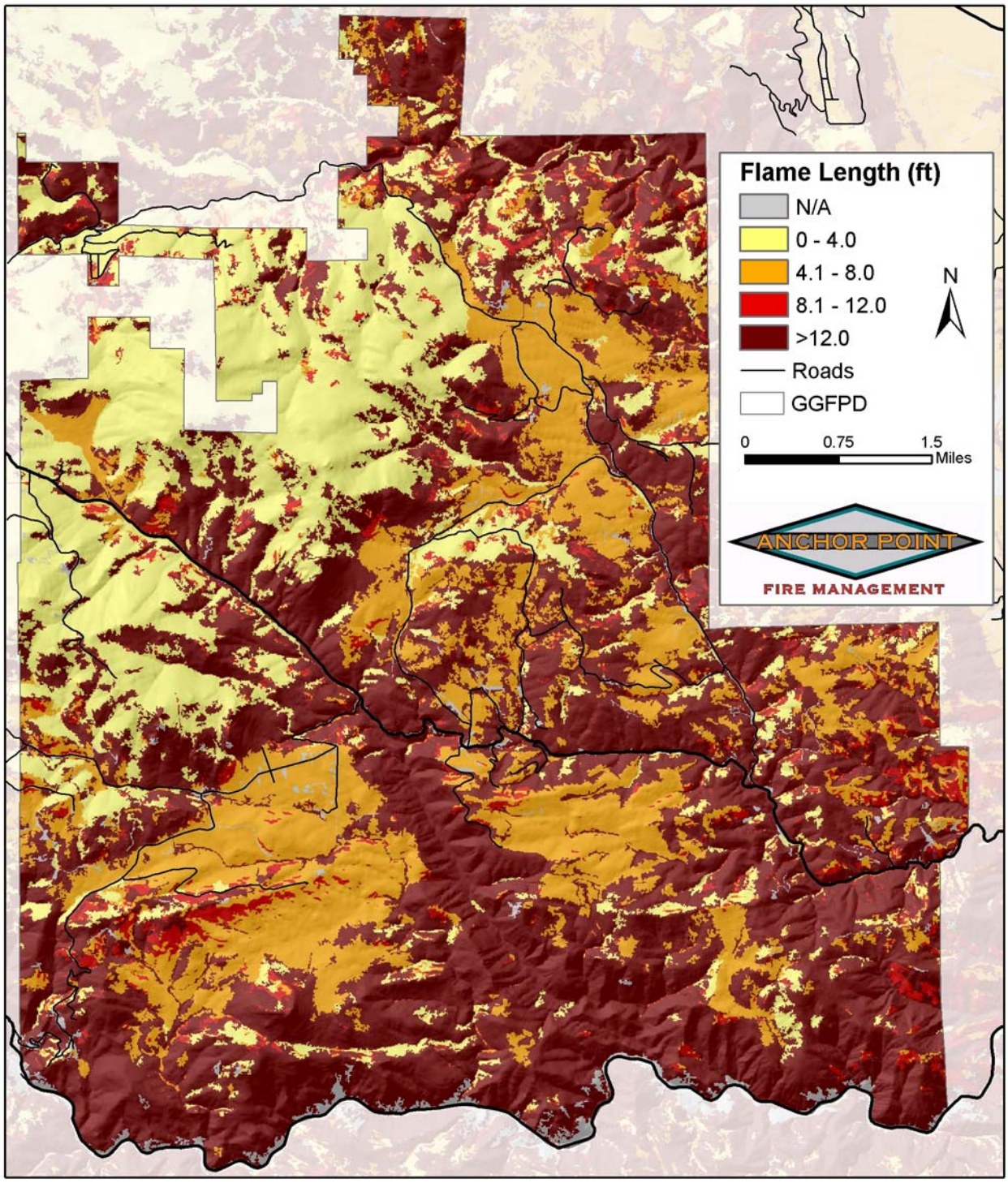

Figure 8: Flame Length Predictions (Extreme Weather Conditions)

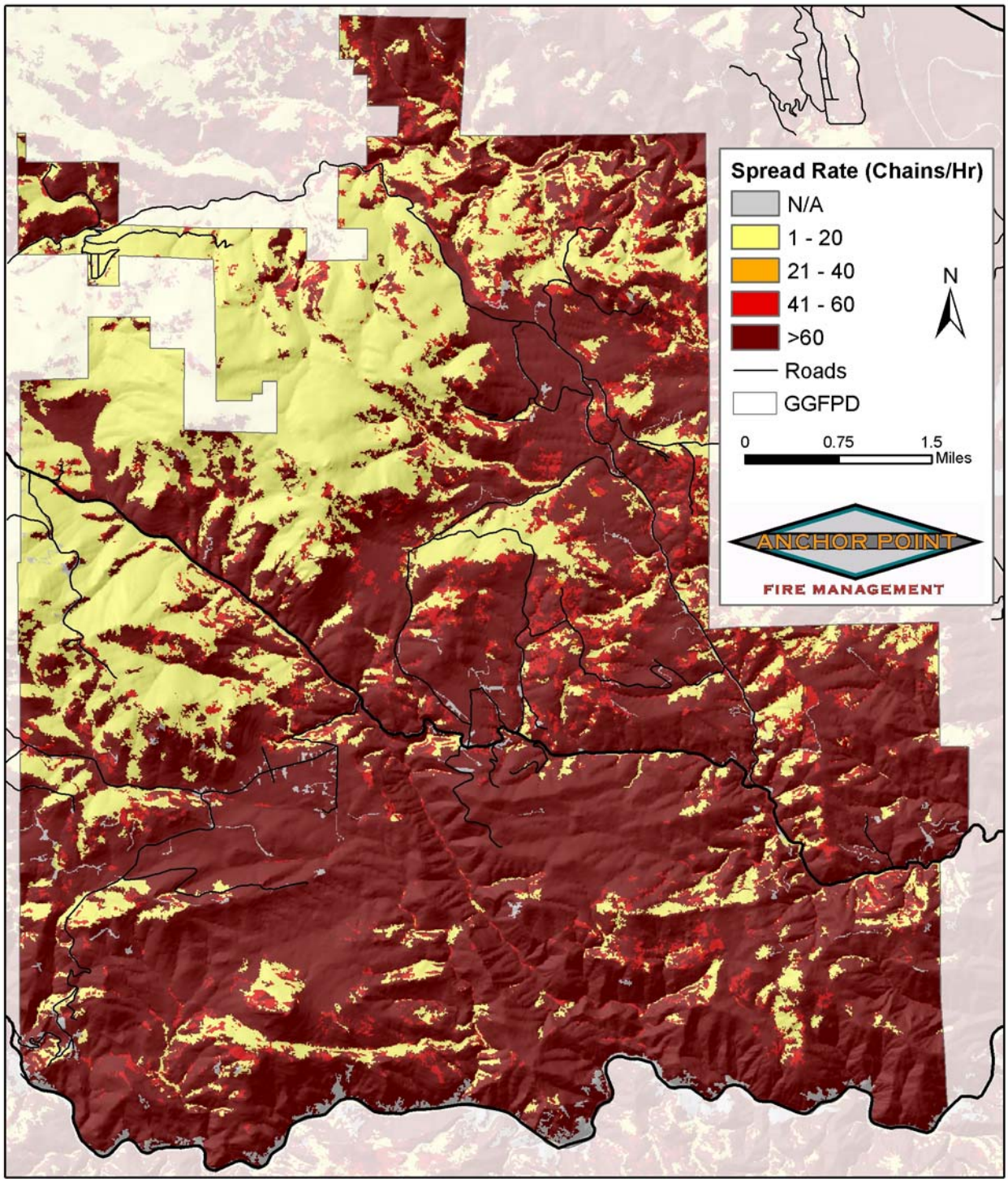

Figure 9: Spread Rate Predictions (Extreme Weather Conditions)

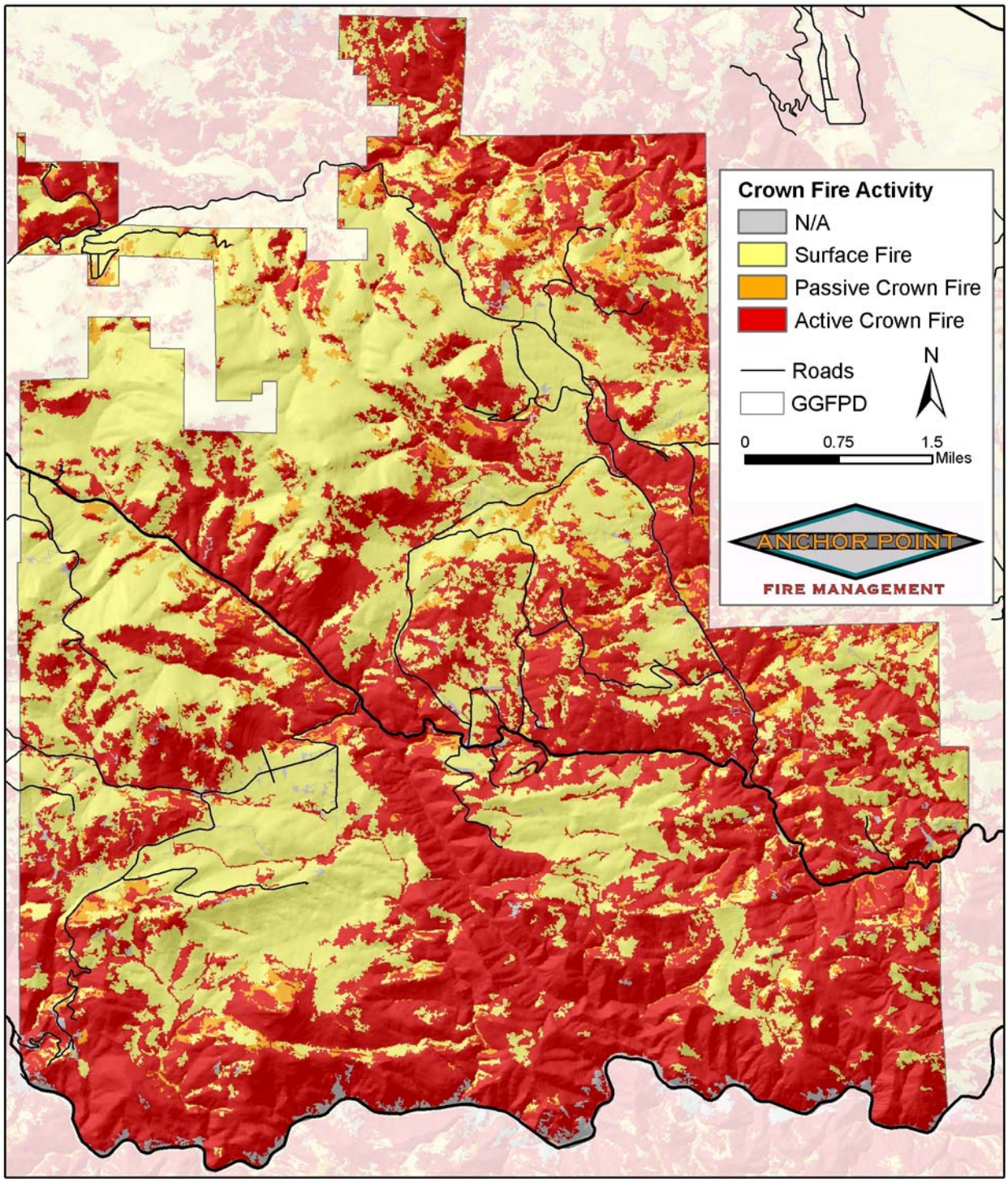

Figure 10: Crown Fire Potential (Extreme Weather Conditions)

Solutions and Mitigation

Establishing and Prioritizing Fire Management Units (FMUs)

An efficient method of prioritizing work efforts is to create Fire Management Units. FMU's should be created prior to planning or initiating fuels management projects and other mitigation. There are unique vegetation and/or mitigation management activities recommended for each unit. Units may be functional or geographic. The local land management and fire management agencies, ideally with the input of the citizen's advisory council, must determine priority actions. Recommendations are presented for the following items. Recommendations are not ordered in priority ranking.

- Access, Evacuation and Sheltering-in-Place
- Public Education
- Fire Department Involvement
- Home Mitigation
- Landscape Scale Fuels Modifications
- Water Supply

Access, Evacuation and Sheltering-In-Place FMU

Addressing

There are many areas within GGFPD that have missing or inadequate street signage and addressing. This problem is noted, where applicable, in the community description in Appendix B. While residents may consider weathered wooden address signage to be decorative, it is an impediment to quick and effective response. We consider proper reflective signage to be a critical operational need. The time saved, especially at night and in difficult conditions, is not to be underestimated. Knowing at a glance the difference between a road and a driveway (and which houses are on the driveway) cuts down on errors and time wasted interpreting maps. This is especially true for volunteer operators who do not have the opportunity to train on access issues as often as career firefighters. Recommendations for address markers can be found in Appendix D.

Evacuation Routes

Five road segments have been identified that could serve as alternative evacuation routes to the primary access roads. Most of these evacuation routes are old ranch roads and as such travel across private land. Agreements would need to be pre-planned with landowners to make use of these as emergency escape routes. These routes are highlighted in the overview of the district shown in Figure 11 (page 14).

1. **Horseradish Gulch to Thea Gulch**: There are about 20 homes in Horseradish Gulch that could be cut off from Golden Gate Canyon Road by an ignition in the southern end of the canyon that compromises access. With the topography and fuels that are present, this would not only be possible but likely during peak burning periods. It is possible to escape this area by driving across private ranch land into Thea Gulch. The access is gated, but the road is negotiable by most vehicles in dry conditions.
2. **Robinson Hill Road to Smith Hill Road**: It is possible to escape from the Robinson Hill - West community by continuing on Robinson Hill Road into Gilpin County. Robinson Hill Road eventually dead-ends into Smith Hill Road. This route is passable to passenger cars in dry conditions. Smith Hill Road can be taken south to Highway 119 or north back to Golden Gate Canyon Road. Portions of this evacuation route are narrow, winding and without turnarounds. Once you are on this route there are long stretches where you are committed. This factor should be considered before using this as an evacuation route.
3. **Horseradish Gulch to Guy Hill Road**: This route is an alternative to escaping Horseradish Gulch to the north by going through Thea Gulch. Continuing north where Evacuation Route 1 turns to the east eventually connects to Guy Hill Road via dirt ranch roads. This route was not driven during the fieldwork for this study and needs verification.

4. **Rye Gulch to Guy Hill Road**: At the present time only three homes exist in Rye Gulch, however these could easily be cut off by the same factors discussed for Horseradish Gulch. The communication towers may also be considered a value-at-risk in this area. A rough extension of Rye Gulch Road connects into Guy Hill Road and would provide an alternate escape route for residents. The access is not gated and should be passable by high clearance vehicles and 4WD. It would be desirable to improve the road, but considering how few homes are involved this may not be practical.

5. **Guy Hill Road North of Golden Gate Canyon Road**: Guy Hill Road connects to Crawford Gulch Road via a primarily good dirt road that is negotiable by passenger cars in dry conditions. About one mile north of Golden Gate Canyon Road, Guy Hill Road passes through an area of heavy fuel loading and steep topography. A shaded fuel break should be constructed through this area. Please see Table 2 (page 15) for mid-slope road fuel break recommendations.

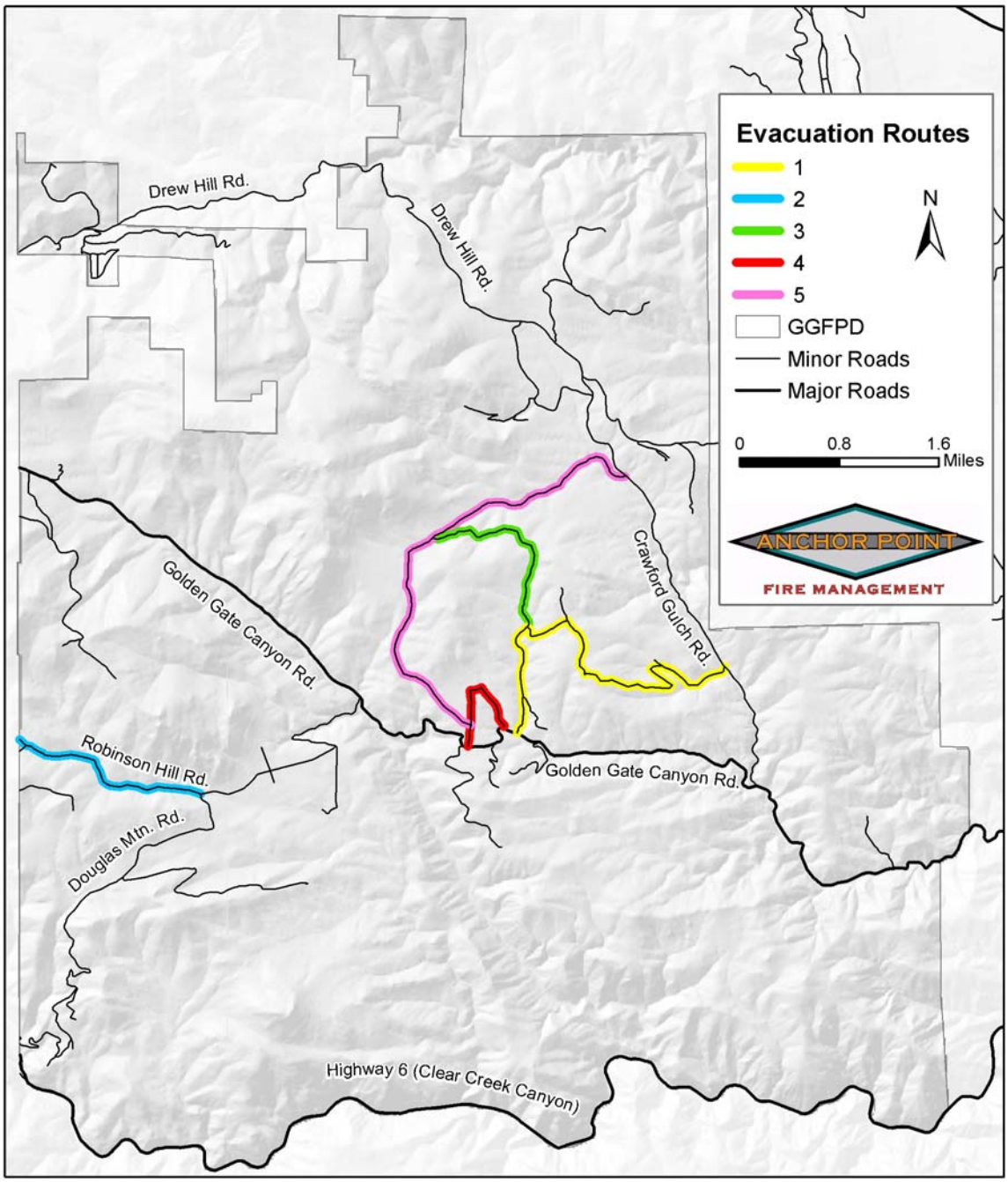

Figure 11: Evacuation Routes

ACCESS ROUTE FUELS MODIFICATION RECOMMENDATIONS

In addition to developing additional escape routes, a fuel modification project for primary access corridors should be implemented. Golden Gate Canyon Road, Crawford Gulch/Drew Hill Road, Robinson Hill Road, Douglas Mountain Road and US Hwy 6 constitute the primary transportation corridors through the district. In general, Golden Gate Canyon Road and Robinson Hill Road have adequate openings, however, many of the communities in the study area would benefit from fuels reduction along their principal access routes.

Thinning along primary access roads into communities should include an area of at least 100' on either side of the centerline of the access routes where practical. This distance should be modified to account for increased slope and other topographic features that increase fire intensity (see Table 2). This is especially important in communities with steep narrow roads and few turnouts. In these areas, safer access for firefighters would make an impact in the number of structures that could be defended in a wildfire. Existing and natural barriers to fire should be incorporated into the project dimensions.

% Slope	Distance Above Road	Distance Below Road
30	70 feet	145 feet
35	65 feet	153 feet
40	60 feet	160 feet
45	55 feet	168 feet
50	50 feet	175 feet

Table 2: Recommended Treatment Distances For Mid-Slope Roads

The communities that should be considered highest priority for fuels reduction along access corridors include:

- Bear Paw
- Geneva Glen
- Douglas Mountain-South
- North Ranch
- Horseradish Gulch
- Drew Hill
- The Grange Area
- Robinson Hill West
- Rye Gulch
- Guy Hill

In addition to the escape routes suggested on page 13-14, other possibilities should be defined and similar fuels reduction projects employed. In areas where multiple routes exist, consider separating access routes for responders and escape routes for citizens in your preplanning.

The cooperation of adjacent, contiguous landowners should be secured. If this is not possible, more intensive thinning may need to occur within the road easement. Landowner participation allows the project to be more flexible in selecting trees and shrubs for removal. It allows greater consideration for the elements of visual screening and aesthetics. Enlarging the project dimensions, allows more options for vegetative selection while still protecting the access/egress corridor.

- Elements of the fuels modification space for access and egress routes should include:
    - Tree crown separation of at least 10' with groups of trees and shrubs interspersed as desired.
    - Crown separation greater than 10' may be required to isolate adjacent groups or clumps of trees.
    - Limb all remaining trees to a height of 8' or 1/3 of the tree height (whichever is greater).
    - Clean up ground fuel within the project area.

- Post placards clearly marking "fire escape route". This will provide functional assistance during an evacuation and communicate a constant reminder of wildfire to the community. Be sure to mount signage on non-combustible poles.

OTHER ACCESS ROUTE RECOMMENDATIONS

- In order to reduce conflicts between evacuating citizens and incoming responders, it is desirable to have nearby evacuation centers for citizens and staging areas for fire resources. Evacuation centers should include heated buildings with facilities large enough to handle the population. Schools and churches are usually ideal for this purpose. Fire staging areas should contain large safety zones, a good view in the direction of the fire, easy access and turnarounds for large apparatus, a significant fuel break between the fire and the escape route, topography conducive to radio communications and access to water. Golf courses and large irrigated greenbelts may make good safety zones for firefighting forces. Local responders are encouraged to preplan the use of potential staging areas with property owners.
- Identify and pre-plan alternate escape routes and staging areas.
- Perform response drills to determine the timing and effectiveness of fire resource staging areas.
- Educate citizens on the proper escape routes, and evacuation centers to use in the event of an evacuation.
- Utilize a reverse 911 system or call lists to warn residents when an evacuation may be necessary. Notification should also be carried out by local television and radio stations. Any existing disaster notification systems, such as tornado warnings, should be expanded to include wildfire notifications.
- Emergency management personnel should be included in the development of preplans for citizen evacuation.

Shelter-In-Place

The communities of North Ranch, Window Rock, Bear Paw, Geneva Glen, Bear Road, Douglas Mountain-South and The Grange Area could be easily cut off by ignitions in drainages below homes and critical access roads. In addition to improved access/egress, consideration should be given to developing “shelter-in-place” areas that are designed as alternatives to evacuation through hazardous areas.

There are several ways of protecting the public from an advancing wildfire. One of these methods is evacuation and involves relocation of the threatened population to a safer area. Another is to instruct people to remain inside their homes or public buildings until the danger passes. This concept is new to wildfire in the United States, but not to hazardous materials incident response where time, hazards, and sheer logistics often make evacuation impossible. This concept is the dominant modality for public protection from wildfires in Australia where fast moving, non-persistent fires in light fuels make evacuation impractical. The success of this tactic depends on a detailed preplan that takes into account the construction type and materials of the building used, topography, depth and type of the fuel profile, as well as current and expected weather and fire behavior.

Shelter–in-place should only be considered when the structure is determined to be “stand alone” in structural triage terms. In order to be "stand alone", homes need to have defensible space and be of ignition resistant construction. Depending on the fuel type and fuel bed depth, it may be necessary to continue treatment beyond the minimum recommended defensible space boundaries in order to make the home stand alone. For a list of defensible space recommendations please see the “General Recommendations” section of Appendix B.

Ignition resistant construction is also necessary for shelter-in-place tactics. Wooden roofs and old structures with untreated wooden sidings are particularly hazardous and should not be considered. It is preferable to have metal or asphalt roofs and ignition resistant materials such as stucco or concrete, especially close to the ground. Heavy timber constructions, such as log homes, are also resistant to surface fires. When combined with an ignition resistant type roof heavy timber may be acceptable. Eves should be enclosed. Any holes in the foundation, siding, or eves should be covered to prevent embers from entering.

Threats to residents remaining in structures include heat, smoke, and ignition of the structure itself. Several steps can be taken by residents to mitigate the effects of heat exposure. The following list highlights some of the important concepts:

- Close all doors and windows and shut down all ventilation systems such as air conditioning, heating, and attic fans.

- If there is adequate time and water, consider plugging downspouts and filling any gutters with water. The sand bags that mountain residents commonly have are good for this purpose.
- If a sprinkler that will reach the roof is available, it should be set up so that it covers as much of the roof as possible paying particular attention to the direction from which the fire is approaching.
- Fill all of the tubs and sinks, and any buckets that are easily handled, with water.
- Remove any lightweight or highly flammable window coverings. Heavy drapes or blinds should be closed in case the windows break.
- Move furniture away from windows. Remove flammables, such as gasoline and propane, to a safe distance away from the structure. Propane, and other volatile compressed gas tanks may rocket as far as ½ mile, so they are best removed to an area cleared of fuels, such as a concrete driveway or pad.
- Wear clothes of fire resistant natural fibers such as wool or cotton. Be sure to cover as much exposed skin as possible, and keep water with you for personal protection. Do not wear polyester or other synthetics that may melt to your skin when exposed to high temperatures.
- When the fire arrives retreat to the room in the house farthest away from the flaming front.
- Take drinking water with you and drink often to avoid dehydration.
- Even if it becomes uncomfortably hot and smoky do not run outside while the fire is passing.

Fires consume oxygen and produce toxic gasses and smoke. Much work has been done in the hazardous materials field on the infiltration of toxic gasses into structures. Average homes under average weather conditions may experience indoor concentrations of smoke and contaminants of 45 to 65 percent of the outdoor concentrations in 30 minutes. In two hours the concentrations may reach 60 to 65 percent of the outdoor levels.[2] These numbers are for homes with all doors and windows closed and ventilation systems turned off. Buildings with open windows, doors, or operating ventilation systems will experience contamination levels close to the outdoor levels in minutes. Residents can further slow contamination by blocking gaps around doors and windows with wet towels.

After the fire has passed, the main danger to residents is the home igniting from embers and sparks that entered during the flame front passage. Systematically patrol inside and outside looking for embers and spot fires. Be sure to include attics and other roof spaces. Houses may catch fire several hours after the fire has passed if embers are not found and extinguished. For more information on structural triage and preparation please see Appendix C.

Public Education Efforts FMU

The area around Golden is experiencing continuing development. Increasing property values have resulted in recently constructed high value residences mixed in with older residences and seasonal cabins, ranch properties and historic buildings in various states of decay. There is likely to be a varied understanding among property owners of the intrinsic hazards associated with building in these areas. An approach to wildfire education that emphasizes safety and hazard mitigation on an individual property level should be undertaken, in addition to community and emergency services efforts at risk reduction. Combining community values such as quality of life, property values, ecosystem protection and wildlife habitat preservation with the hazard reduction message will increase the receptiveness of the public.

Surveys indicate that some owners of large tracts of land in the district that are not interested in wildfire mitigation efforts. Continued attempts at providing educational materials to such individuals through personal contact should be conducted. Property owner education will continue to be a challenge in this area and personal contact will most likely be the best tool for the job.

RECOMMENDATIONS

- Utilize these web sites for a list of public education materials, and for general homeowner education:
  - http://www.nwcg.gov/pms/pubs/pubs.htm
  - http://www.firewise.org
  - http://www.colostate.edu/Depts/CSFS/fire/interface.html
- Provide citizens with the findings of this study including:

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[2]"Handbook of Chemical Hazard Analysis Procedures" (Washington, D.C.: FEMA, 1990).

    - Levels of risk and hazard.
    - Values of fuels reduction programs.
    - Consequences and results of inaction for planned and unplanned ignitions within the community.
- Create a Wildland Urban Interface (WUI) citizen advisory council to provide peer level communications for the community. Too often, government agency advice can be construed as self-serving. Consequently, there is poor internalization of information by the citizens. The council should be used to:
    - Bring the concerns of the residents to the prioritization of mitigation actions.
    - Select demonstration sites.
    - Assist with grant applications and awards.

Fire Department Involvement

Golden Gate Fire Department (hereafter referred to as GGFD) provides suppression services for the study area. The department has one fire station located on Robinson Hill Road near its intersection with Douglas Mountain Road. A second station is currently under construction south of the North Ranch community. When this station is completed, the district can be divided into north and south service areas. **Construction of this station will do more to improve response times in the district than any other single recommendation.** This facility eliminates the need to drive apparatus down Robinson Hill Road to get to calls in communities along Crawford Gulch Road and Drew Hill Road. It will also provide storage for apparatus that is now stored outdoors. The existing fire station (station 1), houses one Type III interface engine and other apparatus consisting mostly of older Type 1 engines (class A pumpers). With the exception of the Type III engine, all of GGFD's apparatus are quite old and in need of updating.

Mutual aid is available from Fairmont and Golden Fire Departments. At the present time the chief of Fairmont Fire Department is also acting chief of GGFD. The department is obviously in a transitional period, the result of which will have ramifications for the type and quality of fire service in the district that are difficult to predict at this time.

GGFD employs 17 volunteer firefighters. Seven of GGFD's firefighters have NWCG (National Wildfire Coordinating Group) S-130/190 training (basic wildland fire fighter training and fire behavior). Two firefighters are qualified as Squad Bosses. Average response time from dispatch to first engine rolling is five minutes.

The need for more firefighters is clear. The ability to add and adequately train additional firefighters will be critical to the successful defense of this rapidly growing and increasingly complex Wildland Urban Interface.

RECOMMENDATIONS

- Training: Provide continuing education for all firefighters including:
    - NWCG S-130/190 for all department members.
    - Annual wildland fire refresher and "pack testing" (physical standards test).
    - S-215 Fire Operations in the Urban Interface.
    - S-212 Wildfire Power Saws.
    - S-290 Intermediate Fire Behavior.
    - I-200 and I-300 – Basic and Intermediate ICS.

- Equipment:
    - Consider the purchase of an additional type VI (4WD) engine.
    - Provide minimum wildland Personal Protective Equipment (PPE) for all firefighters.
        - (See NFPA Standard 1977 for requirements).
    - Provide gear bags for both wildland and bunker gear to be placed on engines responding to fire calls. This will help ensure that firefighters have both bunker gear and wildland PPE available when the fire situation changes.
    - Provide and maintain a ten-person wildland fire cache in addition to the tools on the apparatus. The contents of the cache should be sufficient to outfit two squads for handline construction and direct fire attack. Recommended equipment would include:
        - Four cutting tools such as pulaskis or super pulaskis.
        - Six scraping tools such as shovels or combis.
        - Four smothering tools such as flappers.
        - Four backpack pumps with spare parts.
        - Two complete sawyer's kits including chainsaw, gas, oil, sigs, chaps, sawyer's hard hat, ear protection, files, file guides, spare chains and a spare parts kit.

        - MREs and water cubies sufficient for 48 hours.

- Communications:
    - Surveys of GGFD officers revealed radio communications are poor or nonexistent in the following areas:
        - Most of Golden Gate Canyon State Park.
        - Ralston Creek Road.
        - Geneva Glen Road.
        - Drew Hill Road.
        - Golden Gate Canyon Road between mile markers 2 and 4.

      Other sources have reported that 800 MHz radio systems work "reasonably well" in the study area, however, we do not recommend the exclusive use of 800 MHz radios for WUI operations. Many local responders will be limited to VHF radios and VHF radios are still the dominant mode of communications for large (federal) fire incidents. The pursuit of a grant to equip apparatus with 800 MHz radios in addition to existing VHF radios may be desirable.

      Due to the restrictions of terrain, it is unlikely that more powerful base stations or portable radios would make any impact on communication problems. Some areas may see slight improvements in base station reception by increasing the height above average terrain of the base station antenna; however, the best solution is to increase the number of repeaters in the district. If landowners are a barrier to fixed repeater sites, another solution is to construct one or more mobile repeaters in engines or command vehicles. Mobile repeaters allow the vehicle to be positioned for optimum communication for each incident. Repeaters are expensive, but considering the fact that cell phone communications are only reliable east of Galbraith Park and on some isolated high points, grants and other sources of funding should be pursued in order to solve this important operational problem. If it is not possible to obtain a repeater frequency, which is likely, satellite phones may be a reasonable solution for emergency communications.

Home Mitigation FMU

Community responsibility for self-protection from wildfire is essential. Educating homeowners is the first step in promoting a shared responsibility. Part of the educational process is defining the hazard and risks both at the mid-level and parcel level.

The mid-level assessment has identified 4 of the 16 communities in the study area to be at extreme or very high risk. Construction type, condition, age, the fuel loading of the structure/contents and position are contributing factors in making homes more susceptible to ignition under even moderate burning conditions. Under extreme burning conditions, there is a likelihood of rapid fire growth and spread in these areas due to steep topography, fast burning or flashy fuel components and other topographic features that contribute to channeling winds and promotion of extreme fire behavior. These areas may also represent a high threat to life safety due to poor egress, the likelihood of heavy smoke and heat and/or inadequate response levels.

Table 3, on page 20, illustrates the relative hazard rankings for communities in the study area.

- A rating of 5 or less indicates an area of extreme hazard.
- A rating of 6 to 15 indicates a very high hazard.
- A rating of 16 to 25 indicates high hazard.
- A rating of 26 to 30 indicates moderate hazard.
- A rating of 31 or greater indicates a low hazard.

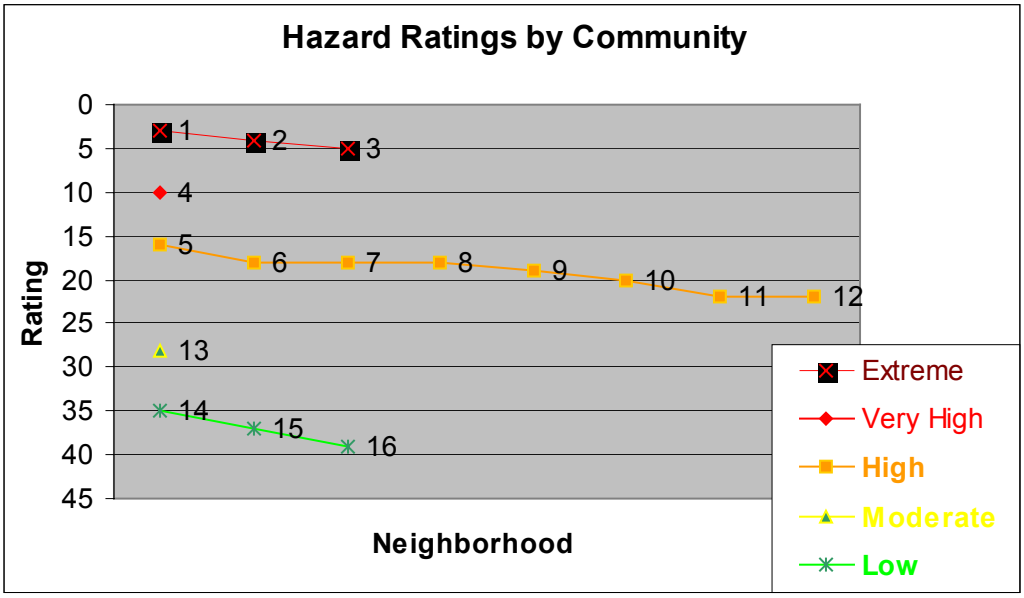
The communities with extreme to high hazard ratings should be considered an FMU where a parcel level analysis should be implemented as soon as possible. Please see Appendix B for more detailed information.

RECOMMENDATIONS

- **The most important goal for the improvement of life safety and property preservation is for every home in the study area to have conforming defensible space.** This is especially important for residences in high hazard communities that have wood or other flammable roofing types. **An aggressive program of evaluating**

and implementing defensible space for homes will do more to limit fire related property damage than any other single recommendation in this report.

- Conduct a parcel level wildfire hazard analysis for the homes in the study area. Completing this process will facilitate the following important fire management practices.
    - Establish a baseline hazard assessment for homes in these communities.
    - Education of the community through the presentation of the parcel level Hazard-Risk Analysis at neighborhood public meetings.
    - Identification of defensible space needs and other effective mitigation techniques.
    - Identification and facilitation of "cross-boundary" projects.
    - Community achievement of national FIREWISE status.
    - Development of a Pre-Attack/Operational Plan for the FMU and eventually the entire study area. A pre-attack plan assists fire agencies in developing strategies and tactics that will mitigate incidents that occur.
- Improve access roads and turnarounds to create safe access for firefighting resources. See Golden Gate Hazard Assessment Emergency Access and Water Supply (Appendix D).
- Discourage the use of cedar shakes or other flammable materials for roofs and sidings.
- Add reflective address signs at each driveway entrance to all homes (See Appendix D for recommendations).
- Utilize the structure triage methodology provided in Appendix C to identify homes not likely to be defendable.



1. Bear Paw	9. Drew Hill
2. Geneva Glen	10. The Grange Area
3. Douglas Mountain-South	11. Robinson Hill-West
4. North Ranch	12. Bear Road/Lower Canyon
5. Douglas Mountain-North	13. Rye Gulch
6. Horseradish Gulch	14. Robinson Hill-East
7. Thea Gulch	15. Guy Hill
8. Window Rock	16. Red School Ranch

Table 3: Hazard Ratings by Community

Landscape Scale Fuels Modifications FMU

One of the most effective forms of landscape scale fuels modification is the fuelbreak (sometimes referred to as "shaded fuelbreak"). A fuelbreak is an easily accessible strip of land of varying width, depending on fuel and terrain, in which fuel density is reduced, thus improving fire control opportunities. Vegetation is thinned removing diseased, fire-weakened and most standing dead trees. Thinning should select for the more fire resistant species. Ladder fuels, such as low limbs and heavy regeneration are removed from the remaining stand. Brush, dead and down materials, logging slash and other heavy ground fuels, are removed and disposed of to create an open park-like appearance. The use of fuelbreaks under normal burning conditions can limit uncontrolled spread of fires and aid firefighters in slowing the spread rate. Under extreme burning conditions where spotting occurs for miles ahead of the main fire and probability of ignition is high, even the best fuelbreaks are not effective. That being said, however, fuelbreaks have proven to be effective in limiting the spread of crown fires in Colorado. Factors to be considered when determining the need for fuelbreaks in mountain subdivisions include:

- The presence and density of hazardous fuels.
- Slope.
- Other hazardous topographic features.
- Crowning potential.
- Ignition sources.

With the exception of aspen, all of Colorado's major timber types represent a significant risk of wildfire. Increasing slope causes fires to move from the surface fuels to crowns more easily due to preheating. A slope of 30% causes the fire spread rate to double compared with the same fuels and conditions on flat ground. Chimneys, saddles and deep ravines are all known to accelerate fire spread and influence intensity. Communities with homes located on or above such features as well as homes located on summits and ridge tops would be good candidates for fuel breaks. Crown fire activity values for GGFPD were generated by the FlamMap model and classified into four standard ranges. In areas where independent and dependent crown fire activity is likely to exist, fuelbreaks should be considered. If there are known likely ignition sources (such as railroads and recreation areas that allow campfires) that are present in areas where there is a threat of fire being channeled into communities, fuelbreaks should be considered.

Fuelbreaks should always be connected to a good anchor point like a rock outcropping, river, lake, or road. The classic location for fuelbreaks is along the tops of ridges to stop fires from backing down the other side or spotting into the next drainage. This is sometimes not practical from a WUI standpoint as the structures firefighters are trying to protect are usually located at the tops of ridges or mid-slope. Mid-slope positioning is considered the least desirable for fuelbreaks, however it may be easiest to achieve as an extension of defensible space work or an extension of existing roads and escape routes. One tactic would be to create fuelbreaks on slopes below homes located mid-slope and on ridge tops so that the area of continuous fuels between the defensible space of homes and the fuelbreak is less than ten acres. Another tactic that is commonly used is to position fuelbreaks along the bottom of slopes. In most of the study area this would require the cooperation of many individual landowners. In some areas the only way to separate residences from fuels is to locate the fuelbreak mid-slope above homes. This would provide some protection from backing fires and rolling materials. It would make sense to locate fuelbreaks mid-slope below homes, where this is possible, to break the continuity of fuels into the smaller units mentioned above. Even though this position is considered the least desirable from a fire suppression point of view, it would be the most effective approach in some portions of the study area.

Fuelbreaks are often easiest to locate along existing roadbeds (see the description of the fuels modification project for primary access corridors on page 11 of this report). The minimum recommended fuelbreak width is usually 200 feet. As spread rate and intensity increases with slope angle, the size of the fuel break should also be increased with an emphasis on the downhill side of the roadbed or centerline employed. The formulas for slope angles of 30% and greater are as follows: below road distance = 100' + (1.5 x slope %), above road distance = 100' – slope % (see Table 2 on page 15)[3]. Fuelbreaks that pass through hazardous topographic features should have these distances increased by 50%. Since fuelbreaks can have an undesirable effect on the esthetics of the area, crown separation should be emphasized over stand density levels. That is to say that isolating groupings rather than cutting for precise stem spacing will help to

[3] Frank C. Dennis, "Fuelbreak Guidelines for Forested Subdivisions" Colorado State Forest Service, Colorado State University [CSFS #102-1083], 1983.

mitigate the visual impact of the fuelbreak. Irregular cutting patterns that reduce canopy and leave behind islands with wide openings are effective in shrub models.

Another issue in mechanical thinning is the removal of cut materials. It is important to note that in Colorado's dry climate slash decomposes very slowly. One consequence of failing to remove slash is to add to the surface fuel loading, perhaps making the area more hazardous than before treatment. It is imperative that all materials be disposed of by piling and burning, chipping, physical removal from the area, or lopping and scattering. Of all of these methods lopping and scattering is the cheapest, but also the least effective since it adds to the surface fuel load.

It is also important to note that fuelbreaks must be maintained to be effective. Thinning usually accelerates the process of regenerative growth. The effectiveness of the fuelbreak may be lost in as little as three to four years if ladder fuels and regeneration are not controlled.

Current Projects

In the 2002 wildfire hazard assessment of the North Ranch and Red School Ranch communities, a need was identified for a shaded fuel break of approximately 117 acres along Homestead Road and Misty Road.[4] In 2004 the Hock fuelbreak and North Ranch HOA fuelbreak began implementation. These adjoining fuelbreaks address some of the access road issues and will reduce hazardous fuel loads in close proximity to existing and planned development in North Ranch. The North Ranch fuelbreak project will reduce hazardous stands of regenerating fir and provide for a plan to monitor beetle and other insect damage in the implementation area. When complete, the North Ranch fuelbreaks represent a major step to improving the safety of the North Ranch area and will reduce the "very high" hazard rating given to this community during the field survey in 2003.

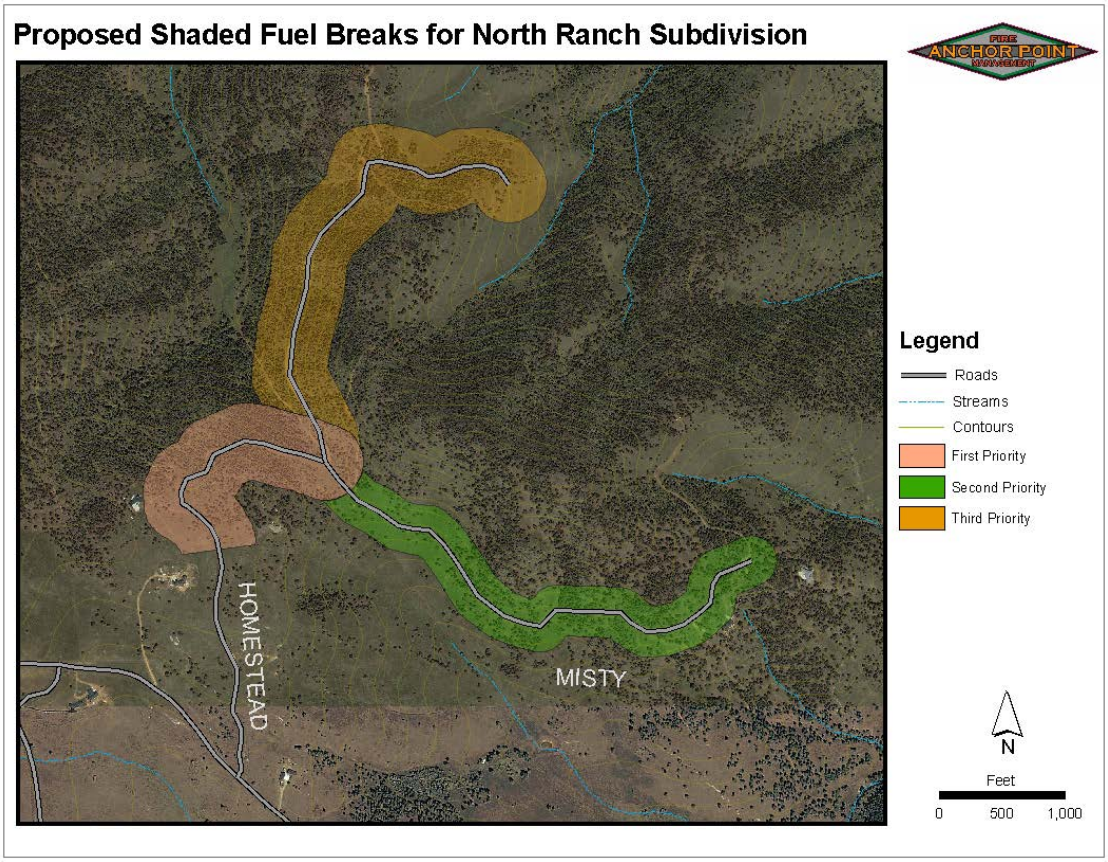


Figure 12: Anchor Point Recommended Fuelbreaks, 2002 North Ranch/Red School Assessment

[4] Chris White and Rod Moraga, "Wildfire Hazard and Risk Assessment for North Ranch and Red School Ranch" Anchor Point Group, Boulder, CO, 2002.

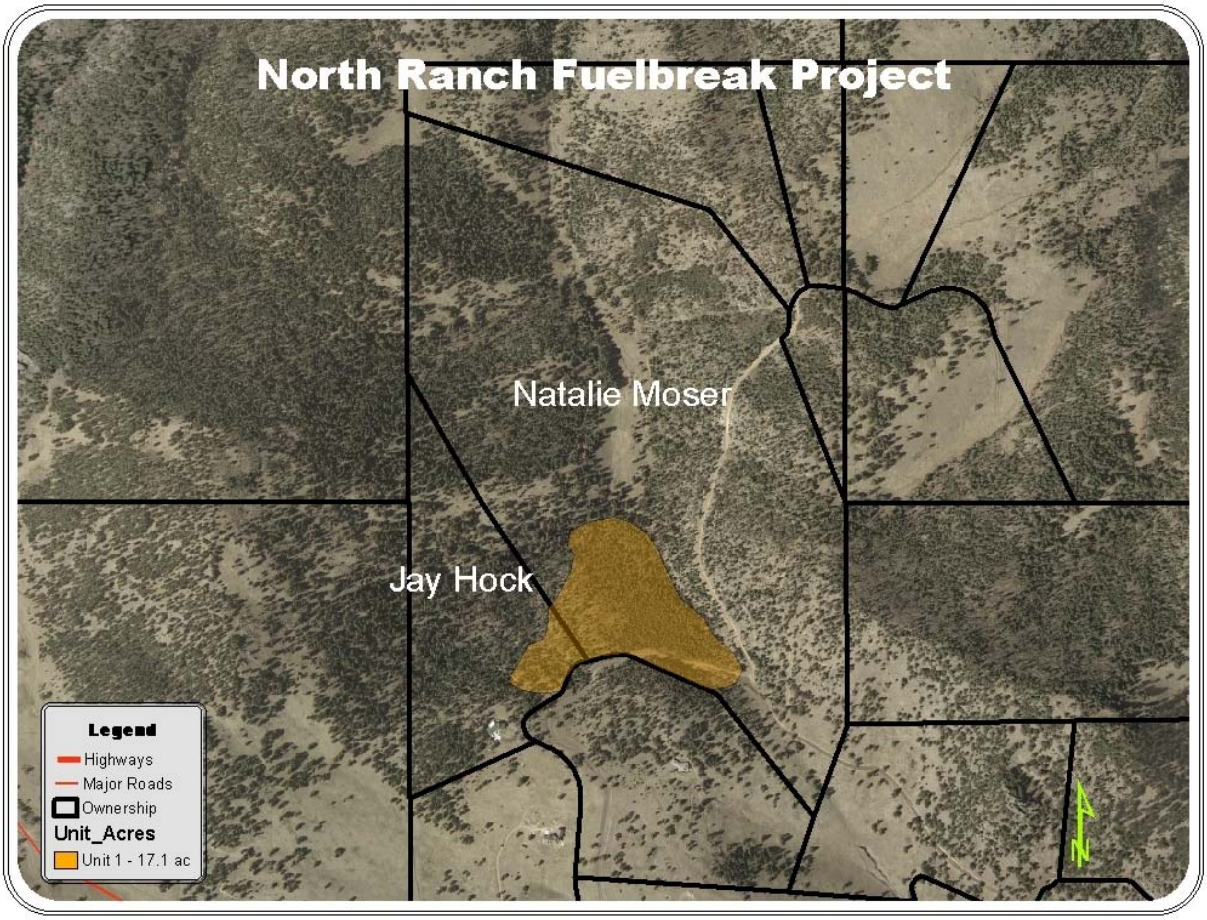


Figure 13: Hock and North Ranch HOA Fuelbreaks

RECOMMENDATIONS

The following recommendations are in addition to, not in place of, the fuels reductions mentioned in the "*Access Route Fuels Modification Recommendations"* section of this report.

Of the communities assessed in this study the following are recommended for fuel breaks:

- Although the Hock fuelbreak extended along Misty Road and greatly improved the safety of emergency access in the eastern 2/3 of the North Ranch community, some additional thinning along access roads in North Ranch should be undertaken. This recommendation may also be found on page 15 of this report.
- The homes in the Bear Paw community are located almost exclusively mid-slope on steep faces, some up to 60% slope, in continuous fuel beds of FM8 and FM10. Although the majority of the timber is in lodgepole pine stands, these are likely more hazardous than the fire behavior model would suggest due to heavy dead and down materials. As is typical with lodgepole stands, there is a lack of fine fuels in the understory that makes this fuel type more difficult to ignite. Once ignited, however, the fire intensity and resonance time are likely to be highly damaging to this area. Thinning fuels along Golden Gate Canyon Road may reduce the likelihood of roadside ignition sources threatening this community, however this effort will probably not result in the best cost-benefit ratio. A better tactic would be to thin the downhill side of Bear Paw Road to a distance of 175 to 200 feet and the uphill side to a distance of approximately 50 feet, from its junction with Golden Gate Canyon road to the end of Mouse Ear Lane. This would anchor the fuelbreak at Golden Gate Road and in a large meadow at the end of Mouse Ear Lane. This fuelbreak combined with ignition resistant construction and

extended defensible spaces for all of the homes in Bear Paw will go a long way toward reducing the hazard in this area. Although there may be too few homes here now to warrant such an effort, the high probability of continuing development makes this project worthy of consideration.

- The Geneva Glen community is also located in an area of steep slopes and heavy, hazardous fuels. The topography and lack of good anchor points in this area severely limits the options for effective fuelbreaks. Our recommendation for this area would be to thin fuels along Drew Hill Road, Geneva Road and Ralston Creek Road to the standards proposed for the Bear Paw community (see above). The construction of fuelbreaks along these roads combined with extended defensible space treatments for all homes will improve life safety in the event of an evacuation and reduce fire intensity in this community.
- Many of the homes in the Douglas Mountain-South community that are located on the north and west aspects are constructed above chimneys and steep slopes with heavy loads of FM 8, 9 and 10. The most notably threatened are homes located on Doggie Spur, Coyote Spur and Badger Spur. Fire behavior modeling suggests that even under moderate burning conditions high fire intensities and rapid rates of spread are probable in this area. In addition to extended defensible space treatments, thinning the heavy pockets of fuels along Douglas Mountain Road, Doggie Spur, Coyote Spur and Badger Spur where they exist below homes, will improve life safety for residents and responders as well as reduce fire intensities in this area. Homes in this area are generally close enough together that linking defensible spaces into a mid-slope fuelbreak will also be an effective tactic if homeowners are receptive. As with all fuelbreaks, good anchor points should be selected. This should not be a problem in this area as the heaviest fuels exist primarily in drainages and natural breaks in the fuel continuity exist.
- There are some communities in the study area that have a notable amount of standing dead and diseased trees. We recommend annual insect and disease surveys take place in any area exhibiting signs or symptoms of attacks. Insect surveys should be conducted in between an insect's flight periods to identify newly attacked trees. All newly attacked trees should be removed and treated prior to the beginning of the insect's next flight period. For example, mountain pine beetle (*Dendroctonus ponderosae*) should be surveyed for between the months of October and June. Mountain pine beetle infested trees should be removed and treated prior to July 1 of the following year. Cooperation between public and private landowners will be required to achieve the maximum effectiveness of these recommendations.

Water Supply FMU

In the study area, like many of the mountainous areas of Colorado, water is a critical fire suppression issue. Although there are no traditional fire hydrants, Golden Gate does have a network of tanks, cisterns, dry hydrants and seasonal draft ponds. Approximate locations of water sources within the study area are shown in Figure 14.

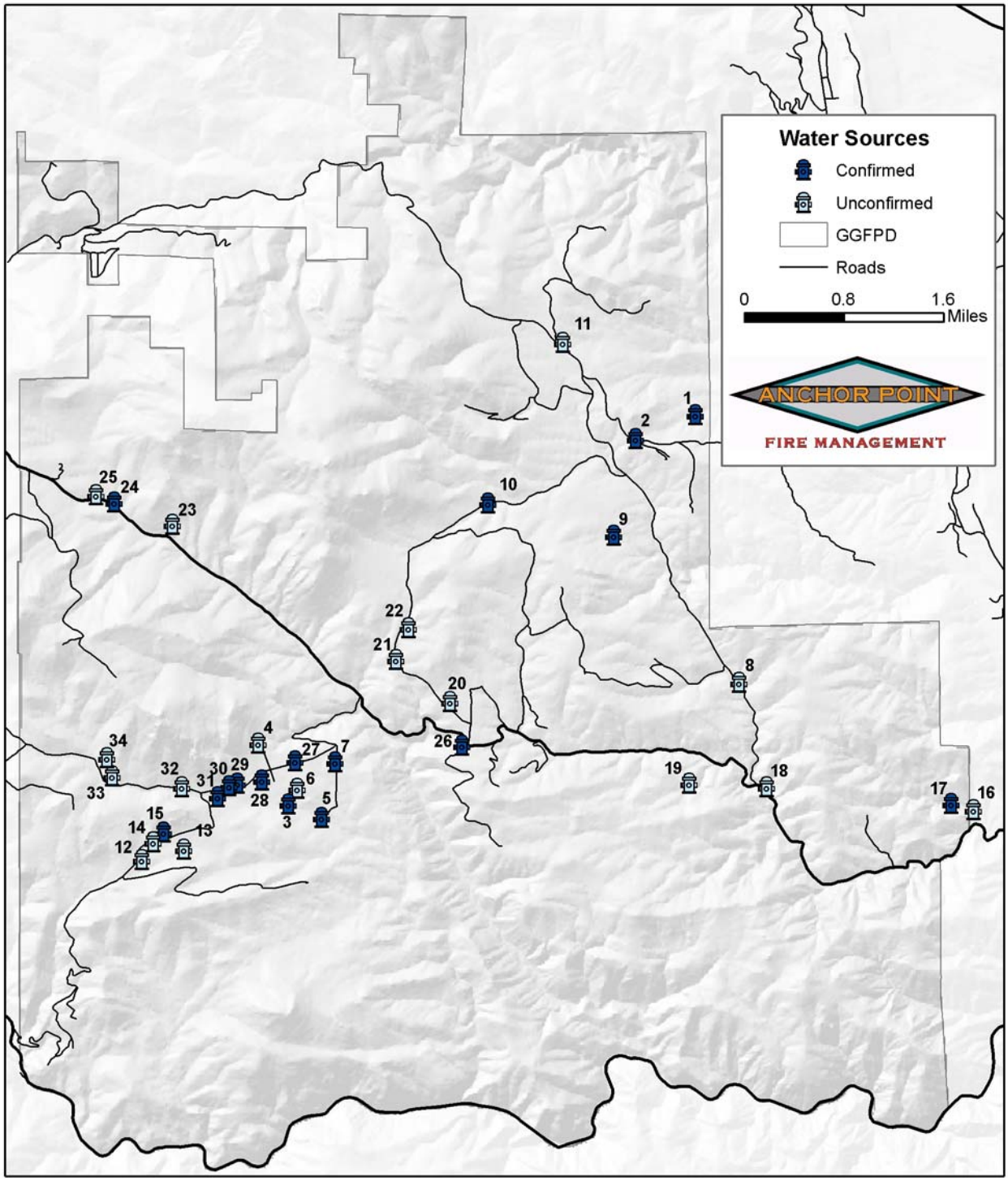


Figure 14: Water Supply Locations in the Study Area

ID	ADDRESS	CAPACITY	TYPE	DELIVERY	CONFIRMED
1	26883 Belcher Hill Road	4,000	Tank & Pond	Pumphouse behind home/ pond below home	Yes
2	27003 Belcher Hill Road	30,000	Tank	Draft 2.5"	Yes
3	4603 Calle Louisa	Unknown	Pond	Draft	Yes
4	4883 Calle Louisa	10,000	Tank	Unknown	No
5	4277 Camino Perdido	Unknown	Pond	Draft/Dip	Yes
6	4627 Camino Perdido	4,000	Tank	Unknown	No
7	4707 Camino Perdido	6,000	Tank	Draft 2.5"	Yes
8	5226 Crawford Gulch Road	4,000	Cistern	Draft	No
9	5957 Crawford Gulch Road	16,000	Tank	Draft 2.5" (1/4 turn valve above connection)	Yes
10	6587 Crawford Gulch Road	Unknown	Pond	Draft	Yes
11	7446 Crawford Gulch Road	6,000	Tank	Draft	No
12	3884 Douglas Mountain Road	4,000	Tank	Unknown	No
13	3944 Douglas Mountain Road	10,000	Tank	Unknown	No
14	4011 Douglas Mountain Road	10,000	Tank	Unknown	No
15	4015 Douglas Mountain Road	4,000	Tank	Draft 2.5"	Yes
16	22001 Golden Gate Canyon Road	Unknown	Pond	Draft	No
17	22441 Golden Gate Canyon Road	2,000	Pond	Draft	Yes
18	25311 Golden Gate Canyon Road	10,000	Tank	Unknown	No
19	26102 Golden Gate Canyon Road	8,000	Tank	Unknown	No
20	29485 Golden Gate Canyon Road	13,000	Tank	Unknown	No
21	29497 Golden Gate Canyon Road	2,000	Cistern	Unknown	No
22	29497 Golden Gate Canyon Road	14,000	Cistern	Unknown	No
23	33351 Golden Gate Canyon Road	4,000	Cistern	Unknown	No
24	33871 Golden Gate Canyon Road	Unknown	Ponds (2)	Draft/Dip	Yes
25	33871 Golden Gate Canyon Road	4,000	Tank	Draft 2.5"	No
26	Guy Hill Road and GG Canyon Road	Unknown	Tank	Draft 2.5"	Yes
27	31349 Robinson Hill Road	6,000	Tank	Draft 2.5"	Yes
28	31820 Robinson Hill Road	10,000	Tank	Unknown	Yes
29	32019 Robinson Hill Road	6,000	Tank	Draft 2.5"	Yes
30	32229 Robinson Hill Road	6,000	Tank	Draft (no vent)	Yes
31	32360 Robinson Hill Road (Fire Station #1)	6,000	Cistern	Draft (in front of Sta. #1)	Yes

32	32779 Robinson Hill Road	4,000	Cistern	Unknown	No
33	33779 Robinson Hill Road	3,000	Cistern	Unknown	No
34	33799 Robinson Hill Road	1,000	Tank & Cistern	Unknown	No

Table 4: Reference Table of Water Sources. (Locations listed in red are unconfirmed.)

Several water sources listed in Golden Gate Fire Department records were inaccessible for field verification. The locations of these water sources are listed in red in Table 4.

The mid-level assessment revealed several communities in the study area where easily accessible water sources for fire suppression are not present. These communities include:

- Bear Paw
- Geneva Glen
- Douglas Mountain-South
- The Grange Area
- Drew Hill

There are other communities in the study area that rely on seasonal ponds or other water sources that may not be reliable. There are also communities in the study area where the water supply is inadequate, either because of size, distance, accessibility factors, or the number of homes being served. These communities include:

- North Ranch
- Horseradish Gulch
- Window Rock

The communities listed above are, or could be under certain circumstances, a considerable distance from reliable water sources for fire suppression. Improvement of the water supply in these communities constitutes an important FMU.

RECOMMENDATIONS

- Contact landowners of unconfirmed water sources and verify the availability of water for suppression resources. If any of these water sources are available, they should be mapped with accurate (GPS) locations. All unconfirmed water sources found to be unavailable or out of service should be removed from the list.

- A large (10,000 to 20,000 gallon) cistern should be located, preferable near the intersection of Bear Paw Road and Seldom Seen Road, in the Bear Paw community. This cistern could be used to provide a water supply for homes on Bear Paw Road, Seldom Seen Road, Lone Eagle Road and the northwestern portion of Golden Gate Canyon Road. If development continues along the southern portion of Bear Paw Road a second cistern located near the intersection of Bear Paw Road and Mouse Ear Lane would be advisable.

- One or two large (10,000 to 20,000) gallon cisterns should be added in Geneva Glen. There are some ponds along Drew Hill Road that may be suitable for drafting, but these are located inside Golden Gate State Park and are limited in size. Most of the other areas along Ralston Creek would be difficult to access for drafting. The grade along Geneva Road is reported to be as high as 30% along some sections. The steep grades and heavy fuel loads make the need of on-site water critical. It would be desirable to locate one cistern on Geneva Road near its intersection with Baker Road or Kunst Road and the other on Spirit Horse Trail.

- A large, 10,000 to 20,000 gallon cistern should be located, preferably near the intersection of Doggie Spur and Douglas Mountain Road, in the Douglas Mountain-South community. Considering the housing density, steep road grades and dangerous topography it would be desirable to add a second water supply of this size near Badger Spur.

- There are several homes located above the Grange Hall that have no access to water for fire suppression. Although there is a water supply located on Golden Gate Canyon Road near the Grange, the steep narrow road, grades of up to 25%, make a tender shuttle undesirable. A large (10,000 to 20,000) cistern should be located somewhere along the ridge top near the road.

- Individual cisterns (typically 1,800 to 3,000 gallons) may be the best approach for improving the water supply needs in the Drew Hill community. Many of the homes are located on long narrow driveways with no or poor turnarounds making on-site water highly desirable. One or two large (10,000 to 30,000 gallon) cisterns should be planned for the Spirit Mountain Ranch development depending on the final structure density.
- There is only one 10,000 gallon cistern for the North Ranch Community and it does not appear on the GGFD list of water sources. This cistern needs to be marked and mapped. Most ponds in this area do not appear to be reliable or easily accessed. Many of the lots in this area are sold and a considerable increase in housing density should be anticipated. Considering the dangerous fuels, topography and access to this area, at least one large (10,000 to 20,000 gallon) cistern should be added near the northern terminus of Homestead Road.
- There is a 30,000 gallon cistern located at the entrance to the Window Rock community that does not have a fire department connection and is therefore useless for fire suppression. Even though there are two smaller cisterns located across Belcher Hill Road from this community, the large cistern should be considered the primary water source. This cistern must be fitted with a proper fire department connection and valve.
- Although there is a water supply location indicated on the north end of Horseradish Gulch Road, at least two more are advisable. One should be located on Tourmaline Lane and the other on Mica Mountain Road. Due to the relatively low structure density in this area, these could be smaller (3,000 to 5,000 gallon) cisterns.
- Standardize connection size, sex and thread type for dry hydrants and cisterns. A standard for new construction and refitting of existing water supplies, where possible, is recommended. Standardization would result in a smoother, faster and more reliable connection. In most areas the water district supplying service to the area specifies fitting sizes and types. A standard should be adopted by a cooperative effort between the water district, GGFD and mutual aid agencies. Our recommendation would be to use the construction standards proposed in the Summit County Dry Hydrant Manual. This manual was developed specifically for rural fire protection in the mountains of Colorado. A copy of the manual has been included with this report.