Appendix A

Potential Fire Behavior

Station Fire
Afternoon/Evening of August 26, 2009

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General Setting

The terrain below the Angeles Crest Highway near the Angeles Crest Fire Station on the Angeles National Forest is fairly rugged and steep. The slope percentage from the highway to the creek bottom ranges from 33 percent to 67 percent along a 0.5 mile section of the highway centered on the fire station. Several narrow ravines facing east occur along this section of the highway. The slopes below the highway range from 900 to 1,680 feet in length. The vegetation is mature mixed chaparral 6 to 8 feet tall and was at least 50 years old. In contrast, much of the chaparral vegetation on the 2006 Esperanza incident on the San Bernardino National Forest probably ranged from 4 to 6 feet in height. Live fuel moisture is routinely monitored on the Angeles National Forest and in Los Angeles County as a measure of fire danger. Observed live fuel moisture content measured 5 to 7 days prior was 63 percent for chamise, 67 percent for ceanothus, and 89 percent for manzanita. Weather observations at the Little Tujunga weather station (11.4 miles) for 1:00 p.m. included air temperature of 99 ° F, relative humidity of 7 percent, and wind speed of 8 mph. Weather observations at Clear Creek weather station (3.2 miles) included temperature of 89 °F, relative humidity of 11 percent, and wind speed equal to 10 mph. From these observations, predicted fuel moisture of the one hour time lag fuels (easily ignitable grasses, pine needles, small branches) was 1 percent. Moisture content of the larger 10 and 100 hour fuels were 2 and 6 percent, respectively. The spot weather forecast produced at 5:20 p.m., indicated night time temperatures around 74 °F and maximum relative humidity of 17 percent. Maximum observed relative humidity at the two weather stations on the night of August 26 did not exceed 17 percent.

Fuel Conditions

The observed afternoon fuel moisture contents were typical for this time of year; however, the fact that the humidity was not predicted to increase very much on the night of August 26 meant the fuel moistures would stay relatively low throughout the night and that fires would continue to burn actively through the night. Live fuel moisture content was normal for this time of year based on long term means measured by Los Angeles County Fire Department. However, the moisture content in chamise was approaching 60 percent which is considered a critical level for fire behavior. Based on the fire behavior tables found in Appendix B of the

[3] National Wildfire Coordinating Group (NWCG). 2006. NWCG Fireline Handbook, Appendix B; Fire behavior. PMS 410-2, NFES 2165. Boise, ID

Appendix A (continued)

Fireline Handbook[3], fuel moisture of the unshaded 1 hour fuels would increase to a maximum of 4 percent by 8:00 a.m. the next morning; however, the equilibrium moisture content associated with 17 percent relative humidity and 74 °F is only 2 percent. The very low moisture content of the fine fuels (1 percent) indicates that these fuels could be easily ignited. This ignition potential was indicated by the forecasted Ignition Component of 100 and the calculated probability of ignition of 1[4]. The fuel conditions described for the Station Fire are similar to conditions associated with the 1968 Canyon Fire fatalities which occurred on August 24, 1968[5]. These investigators hypothesized that a fire whirl occurred near a ridge top and cast a firebrand down slope into a narrow ravine. The resulting upslope fire run lasted 30 seconds and overtook the crew. The fuel age where these fatalities occurred was estimated to be 50 to 80 years.

Anticipated Fire Behavior

Several options are available to estimate the potential fire behavior that the initial attack firefighters would have experienced from a fire that started in the chaparral below the Angeles Crest highway. All of these options are based on the Rothermel fire spread model[6]. Most of the versions describe chaparral as 6 feet deep. Cohen developed a variant called FIRECAST[7] that contained fuel models specific to chamise and mixed chaparral of various heights and ages. I used FIRECAST to estimate the flame length, fireline intensity, and rate of spread for the forecasted night time conditions (dead fuel moistures: 1 hour equal to 1, 10 hour equal to 2, Slope equal to 50 percent, midflame wind speed of 6, 8, and 10 mph, live fuel moisture of 63 percent, and percentage of fuel bed that was dead of 30 and 50 percent). Predicted spread rates for these conditions ranged 0.75 to 1.5 mph, flame length ranged from 18 to 30 feet and fireline intensity ranged from 2,900 to 8,400 BTU/ft/s. The spread rates and flame lengths are similar to the fire behavior anticipated by the fire danger indices calculated for the Clear Creek and Little Tujunga stations using the weather data collected at 1:00 p.m., on August 26, 2009.

Terrain Effects

The area below the highway is relatively steep and thus difficult to walk up. The slopes in the 1948 Mann Gulch Fire[8] fatalities and the 1994 South Canyon Fire[9] fatalities were 44 to 76 percent and 55 to 80 percent, respectively. In the 1968 Canyon Fire which occurred 17 miles east of the Station Fire

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[4] Bradshaw, L.S.; Deeming, J.E.; Burgan, R.E.; Cohen, J.D., compilers. 1984. The 1978 National Fire Danger Rating System: technical documentation. Gen. Tech. Rep. INT-169. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 44 p.

[5] Countryman, C.M., McCutchan, M.H., Ryan, B.C. 1969. Fire weather and fire behavior at the 1968 Canyon Fire. Res. Pap. PSW-55. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. 20 p.

[6] Rothermel, R.C. 1972. A mathematical model for predicting fire spread in wildland fuels. Res. Pap. INT-115, Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 40 p.

[7] Cohen, J. D. 1986. Estimating fire behavior with FIRECAST: user's manual. Gen. Tech. Rep. PSW-90. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. 11 p.

[8] Rothermel, R. C. 1993. Mann Gulch fire: a race that couldn't be won. Gen. Tech. Rep. INT-299. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 10 p.

[9] Butler, B.W.; Bartlette, R.A.; Bradshaw, L.S.; Cohen, J.D.; Andrews, P.L.; Putnam, T.; Mangan, R. J. 1998. Fire behavior associated with the 1994 South Canyon Fire on Storm King Mountain, Colorado. Res. Pap. RMRS-RP-9. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 82 p.

in chaparral in the foothills above Sierra Madre, CA, the fire behavior that resulted in the deaths of 7 Los Angeles County firefighters was dominated by fuel conditions and topography. Observed fire behavior included backing down slope in chaparral followed by intense upslope runs in steep, narrow ravines. The crew was overrun during one of these upslope runs.

Night Time Fire Behavior

The fire behavior predicted to occur during the evening and night was active primarily for one reason, no humidity recovery. Typically at night, temperatures drop and relative humidity increases resulting in an increase in fuel moisture. The increased fuel moisture causes fire behavior to moderate. However, relative humidity was not forecast to increase appreciably due to the nature of the air mass over the Station Fire. Fuel moistures stayed low and fire behavior did not moderate. Spot fires could have spread successfully at night since fine fuel moisture content was low.

Interpretation of Fire Behavior

Guidelines for suppression activities that are appropriate for different levels of fire behavior have been developed over the years. Flame length, rate of spread, and fire intensity are the fire behavior indicators typically used and can be displayed on a fire characteristics chart. The predicted fire behavior was plotted on the attached fire characteristics chart. Note that the total amount of energy released did not change as the spread rate changed. The * indicates that chaparral with 30 percent dead material and the * indicates chaparral with 50 percent dead material. Fireline intensity describes the rate at which the energy is released which has been correlated with flame length. Fireline intensities < 100 BTU/ft/s or flame lengths < 4 ft can be directly attacked by firefighters with hand tools. Flame lengths 5 to 8 feet generally require some sort of ground-based vehicle attack (engine, bulldozer). For the Station Fire, the predicted fire behavior far exceeds any kind of firefighting capabilities that ground-based resources might have.

Summary

Predicted fire behavior potentially encountered by initial attack forces on the Station Fire was typical for August. This fire behavior is extreme and not amenable to attack by hand crews or fire engines. Predicted fuel moisture conditions had a high probability of supporting easy ignition of fine fuels by spot fires, fast spread rates, and large flames. Terrain was very steep and difficult to traverse on foot, which has been typical of areas where firefighter fatalities have occurred.

[10] Andrews, P.L.; Rothermel, R. C. 1981. Charts for interpreting wildland fire behavior characteristics. Gen. Tech. Rep. INT-131. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 21 p.

[11] Byram, G.M. 1959. Forest fire behavior. Pp. 90-123 In: Forest fire: control and use. Edited by K.P. Davis. McGraw-Hill, New York.

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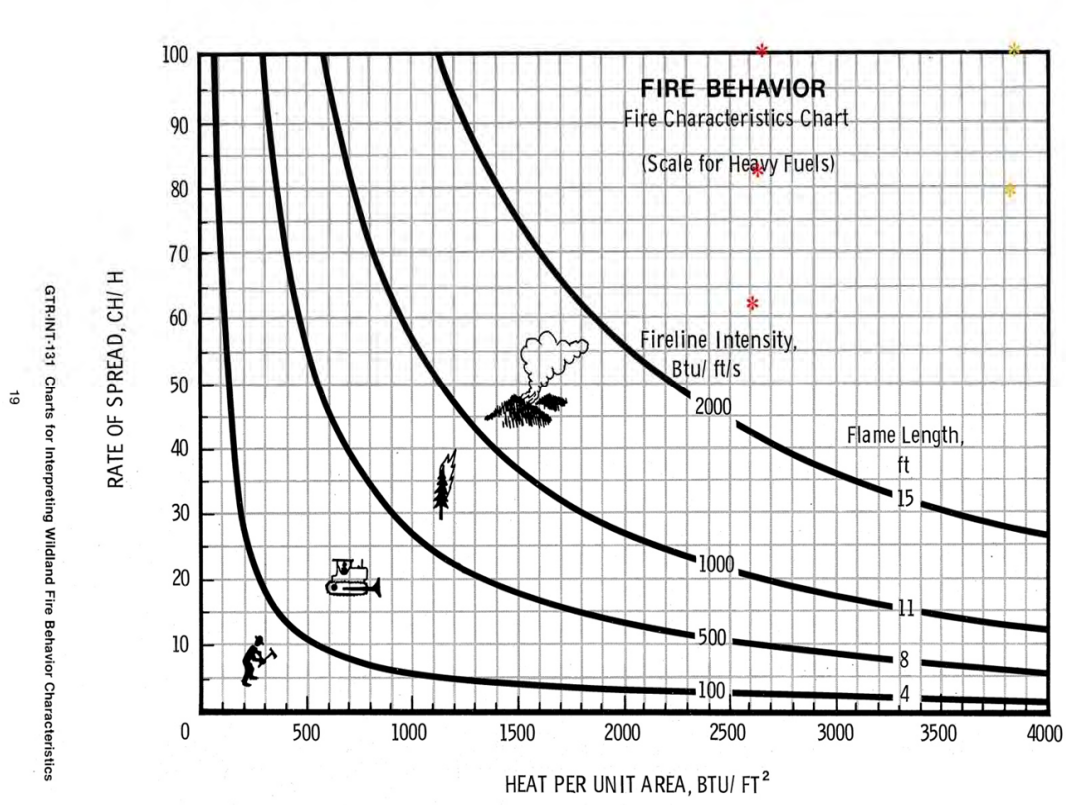
Appendix A—Interpretation of Fire Behavior



Predicted fire characteristics associated with potential spot fires occurring below the Angeles Crest Highway, near Angeles Crest Fire Station, August 26, 2009. Red stars are for fuel beds with 30 percent dead material, orange are for 50 percent dead materials

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Appendix B

Station Fire
Photographs of Area of Initial Attack

Photograph 1. Small, unnamed spur canyon (center) within Woodwardia Canyon, location of the initial perimeter of the Station Fire on August 26, 2009. Point-of-origin located near dirt turnout along Highway 2 in foreground. Photo taken from Civilian Conservation Corps Ridge, location of the original Incident Command Post, looking west-southwest. (Angeles National Forest, Los Angeles River Ranger District. Photo taken on October 21, 2009, after first significant post-fire rainfall. Strong red coloration from retardant somewhat diminished from upper canyon and side ridges.)

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Photograph 2. Small, unnamed spur canyon (center) within Woodwardia Canyon, location of the initial perimeter of the Station Fire on August 26, 2009. Area to lower-left of center (exposed highway cut) is where the Station Fire spotted east (down canyon) across Highway 2 during the early morning hours of August 27, 2009. Photo taken from Civilian Conservation Corps Ridge, location of the original Incident Command Post, looking west-southwest. (Angeles National Forest, Los Angeles River Ranger District. Note: Photo taken on October 21, 2009, after first significant post-fire rainfall. Strong red coloration from retardant somewhat diminished from upper canyon and side ridges.)

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Photograph 3. Looking north along S.R. 2 (Angeles Crest Highway). Southern edge of original Station Fire perimeter on ridge to left. During the early morning hours of August 27, 2009, down canyon winds carried embers from this ridge to unburned vegetation on the downhill (east) side of S.R. 2 to the right. Photo taken on October 21, 2009.

Photograph 4. Looking east-southeast across S.R. 2 (Angeles Crest Highway) from within the original Station Fire perimeter. From this location, down canyon winds carried embers across S.R. 2 (east) into the vegetation below. Photo taken on October 21, 2009.

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Photograph 5. Looking upslope to the west into the initial footprint of the Station Fire. Photo taken along S.R. 2 (Angeles Crest Highway) from turnout near where the fire began on August 26, 2009. Photo taken on October 21, 2009.

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Photograph 6. Steep slopes with nearly impenetrable chaparral vegetation within the initial footprint of the Station Fire. Photo taken looking west from along S.R. 2 (Angeles Crest Highway) near where the fire began on August 26, 2009. Photo taken on October 21, 2009.

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