Fire Specialist Report

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Subject: Discussion about spotting distance and probability of ignition

Wildfire generally burns/spreads in three ways. 1) Direct heat transfer when a flaming front comes into direct contact with unburned fuel. 2) Radiant heat transfer from a flaming front to unburned fuel across an open space and by 3) spotting. Spotting is the mass transfer of firebrands ahead of a flaming front into unburned fuels and the maximum distance that one can expect potential spot fires from a firebrand. Often, the firebrands are hidden by the smoke column created by the fire. A spot fire is a smaller fire that starts from sparks and firebrands thrown in the air by the main fire.

Wind, terrain and fuel height contribute to spotting distance. Wind can cause spot fires by pushing firebrands over containment lines, terrain and fuel height increases spotting distance. In other words, the higher the hill, and the taller the vegetation or the windier the conditions the further the spotting distance will be. The fuel in the project area is primarily a grass-shrub vegetation characterized by a sagebrush overstory and a cheatgrass understory. The terrain is undulating with slight elevation differences (+/-15 feet). Therefore, spotting distance from a wind driven surface fire was used to calculate spotting distance in the BEHAVE Plus4.

Not all firebrands start a spot fire. The probability of ignition (POI) from spotting is directly tied to the fuel continuity and the fine dead fuel moisture (1 hour-fuels) of the fuel where the firebrands lands. The fuel that the firebrand lands in is termed a receptive or unreceptive fuel. An example of a receptive fuel would be a grass-dominated site. This is because an area with a dominate grass fuel/vegetation component is continuous and has low 1-hour fuel moistures. Conversely, a Forage kochia area would be termed an unreceptive fuel/vegetation due to its low fuel continuity and live fuel moisture content. As a general rule, ash and small firebrands travel further but are less likely to start a spot fire since most of the fuel component has been burned and the amount of heat they possess (direct heat transfer) is not enough to ignite the vegetation where it lands. Generally, a grass fire will produce many more firebrands then a grass-shrub fire but is less likely to start a spot fire since most of the material in a grass fire is consumed before it lands on the ground. Conversely, a grass-shrub fire is more likely to cause a spot fire since the shrub component is less likely to be consumed by the fire before it lands on the ground.

A limitation of the spot fire module in BEHAVE is that it tends to overestimate spotting distance and POI for grass and shrubland type vegetation/fuel model. This is because the modules were designed for timber vegetation/fuel types where the average firebrands are larger (pinecones, twigs, pine needles, etc) and the fuel is more receptive (logs, twigs, pine needles, duff etc) thus the higher POI.

Since larger firebrands in a grass-shrub fuel model fall closer to the flaming front then the smaller ash component the likelihood of a spot fire being started beyond the width of the Forage kochia fuel break is relatively low.

The table below is a summarization of calculations made using the wildfire behavior program BEHAVES PLUS 3.

Forage Kochia fuel model		Fuel Model Grass Shrub 2			
	Flame length spotting distance in miles		**Flame length** spotting distance in miles		
Wind speed MPH	**1 foot**	Wind speed MPH	**12ft**	**19ft**	**23ft**
10	0.1	10	0.3	0.5	0.5
20	0.1	20	0.5	0.7	0.8
30	0.1	30	0.7	0.9	1.1
40	0.2	40	0.8	1.1	1.3

Probability of ignition for all fuel models from a fire brand				
	Air temperature (F)			
1 hour fuel moisture (%)	80	85	90	95
1	100	100	100	100
3	86	88	89	91
4	75	77	78	79
5	66	67	68	69
12	24	25	25	26
20	6	6	6	7