INVESTIGATING EXTENT OF AN UNDERGROUND COAL MINE FIRE USING AIRBORNE INFRARED THERMOGRAPHY GEOREFERENCED TO LIDAR BASEMAP[1]

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Abstract. The Office of Surface Mining (OSM) has completed numerous abandoned mine land (AML) closures of coal-mine features in Cougar Mountain Regional Wildland Park just southeast of Bellevue, Washington. This park exists in an area with extensive coal mining (on seven coal seams) between the late 1860s to early 1950s. Several historical mine fires have been documented in the vicinity between 1890s and 1950s. The project site was originally observed to have venting steam in the early 1980s. In the late 1990s a linear band of fallen trees was observed in the area of the venting steam. In 2002, site investigations indicated that elevated ground temperatures corresponded with the No. 3 Seam crop line. Investigations in 2002 also recorded near-surface ground temperatures as high as 118 degrees Fahrenheit (ground temperature probe) at isolated locations near venting steam. Typical forest fuel ignition temperature is 302 degrees, so forest fire was not perceived to be an immediate risk. However, progress of the fire could lead to increased risk of ground subsidence and injury to park users. Typical ground temperatures measured with the probe were 10 to 30 degrees above ambient ground temperatures of around 50 degrees (at time of measurement). A hand-held infrared (IR) camera was also used to observe isolated areas of elevated ground temperatures.

After reviewing various investigation methods, it was decided to utilize airborne-georeferenced IR to establish a baseline ground temperature map to facilitate tracking the apparent underground mine fire. A helicopter gimbal-mounted IR camera, DGPS, and inertial navigation unit (INU) were utilized to georeference IR ground temperature data to a LiDAR based digital elevation model (DEM). The resulting ground temperature data overlaid onto the LiDAR topographic map was cross checked with ground locations and temperature targets. Airborne IR ground surface temperature readings and locations corresponded well to those on the ground, but, as expected, were lower than subsurface ground temperatures measured with a probe. Some small elevated temperature locations were obscured by vegetation, but the overall pattern of elevated ground temperature was more apparent utilizing the airborne IR data.

Additional Key Words: DEM, DGPS, ground temperature.

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