Warwick FURNACE Weapons: Lost and found using UAS Magnetometer and 3D ELECTROMAGNETICS

*Gregory Schultz, White River Technologies Inc., Lebanon, NH, USA*

*Martin Helmke, Groundwater and Environmental Services, Inc., Exton, PA*

*Zack McGuire, White River Technologies Inc., Lebanon, NH, USA*

*Michael Gunnels, White River Technologies Inc., Lebanon, NH, USA*

Some of the oldest military weapons and unexploded ordnance in North America lie buried and dormant since they were produced in the mid-to-late 18th century. Prior to and during the Revolutionary War cannon, cannon balls, and proving materiel were cast at the Warwick Furnace and then, in the midst of the 1777 British advance on Philadelphia, hastily buried in order to prevent them from falling into British hands. Beginning in 2021, geophysical surveys were commissioned in an attempt to explore areas near the furnace and surrounding farm. The thickly vegetated fields, dense woods, and creek wetlands where cannons were suspected to be buried were not amenable to vehicle-based geophysical equipment. Therefore, the mission to rediscover them led to a series of unconventional geophysics-based surveys that included unmanned aerial system (UAS) magnetometry and three-dimensional electromagnetic (3DEM) induction technologies. Areal surveying of approximately 23 acres was conducted with the drone-based MAGPI atomic magnetometer payload yielding magnetic anomaly maps. Anomalies were investigated using UAS magnetometer data processing and inversion techniques. A subset of anomalies with dipole magnetic moments that fit most closely with the sought after cannons were further interrogated with the APEX 3DEM array using dynamic cueing methods. APEX data were inverted using advanced geophysical classification, and time-domain polarizabilities were assessed and ranked to form a dig list. Cannons were uncovered during intrusive excavation at the first four locations identified on the dig list. The four nearly identical cannons are over 7 feet long, weigh over 4,500 pounds, and were made to fire 18-pound balls. Two of the cannons were found with cannonballs and other associated relics. We present the approach used to discover and locate the artifacts using data from the unmanned aerial investigations and focused cued surveys using APEX. We also project potential transition of this sequenced and scaled approach to similar challenges in modern munitions response or mixed munitions-archeological exploration.