Archaeological Remote Sensing of the Oatlands Historical Area

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Abstract

Oatlands Plantation is one of 19 historic properties of the United States National Trust for Historic Preservation and is located south of Leesburg, Virginia. Ninety percent of the original Oatlands property was sold during the past 150 years. Unfortunately, the original plantation was never mapped, and the location of many of the numerous structures, including the Oatlands Mills village, the slave quarters, and the slave cemetery are unknown. Analysis of multi-sensor imagery to locate and map plantation features was conducted during 1998–99 and again in 2004–05. Imagery sources included 25 meter resolution (m) Landsat satellite multispectral imagery (MSI), 8m RadarSat International satellite Synthetic Aperture Radar (SAR), 1m VARGIS aerial color infrared imagery, 1m Positive Systems ADAR 5500 aerial MSI, 2.5m Intermap aerial SAR, 4m NASA AVIRIS aerial hyper-spectral imagery (HSI), and 2.4m DigitalGlobe Quickbird MSI. Analysis of the multi-sensor imagery yielded a large number of soil and vegetation marks that when combined, appear to map out multiple buildings and a network of roads between them. Field investigations were conducted and correlated with image signatures and collateral data such as 19th century Civil War maps and modern geological survey maps. Soil moisture models were used to predict and verify otherwise hidden image features that were seen as a result of differential drying after rainfall. There is no question that the signatures found in the imagery represent pre-existing roads, ditches, and structures in the Oatlands area. It is difficult, however, to conclusively date the stone roads and artifacts that were found during the field investigations because of 20th century farming and artificial wetlands construction.

Introduction

Figure 1. Oatlands Plantation mansion and gardens (image courtesy of Event Rentals).

Oatlands Plantation is one of 19 historic properties of the United States National Trust for Historic Preservation and is located south of Leesburg, Virginia. Construction of the main house was started in 1804 by George Carter, the great grandson of the early Virginia settler, Robert "King" Carter. The plantation prospered, and a miller's residence, brick manufactory, blacksmith shop, store, school and church soon followed as Oatlands quickly grew into a 3,000-acre working plantation. Other structures built by Carter include the stone and brick staircases and walls, a smoke house, a brick greenhouse with a hot-water heating system, and a granary. Oatlands's gardens were also designed by George Carter, who constructed ingenious connecting terraces which, by sheltering the area from wind, extended the growing season to supply food for the plantation.

Oatlands fared well during the Civil War compared to many other plantations, but after the war the Carters were beset by mounting debts and numerous dependents, and began operating Oatlands as a summer boarding house and a country retreat for affluent Washingtonians. Bricks and stones from many of the buildings, including the slave cemetery grave markers, were sold to raise funds. These actions did not produce the income needed to sustain a great home like Oatlands, and in 1897 they were forced to sell. Oatlands was briefly owned by the founder of the *Washington Post*, Stilson Hutchins, who never lived on the property. In 1903 Oatlands was sold to William Corcoran Eustis, grandson of banker and philanthropist William Wilson Corcoran, who restored Oatlands to its former splendor.

William Eustis died in 1921, and his wife remained at Oatlands until her death in 1964. The Eustis daughters presented the estate (which had been reduced to 261 acres), house, and furnishings to the National Trust for Historic Preservation in 1965. Oatlands was designated a National Historic Landmark in 1972. Unfortunately, the original plantation was never mapped, and the location of many of the numerous structures, including the Oatlands Mills village, the slave quarters, and the slave cemetery are unknown.

The site of the Oatlands Mill, a complex established by George Carter in the early 19th century, is at the southern end of the historic district along Goose Creek. The large mill was destroyed in 1905, leaving today only a small ruin and extensive archaeological remains. Surviving from the village of Oatlands near to the mill are several houses and the Episcopal Church of Our Savior, a simple brick structure erected in 1878. The precise location and extent of Oatlands Mills village is unknown, but it was large enough to have had several stores and its own post office. The village dates from at least 1816, and had several mills, including ones for grain, plaster, wool carding, and lumber.

Figure 2. Oatlands Mill (c. 1890; image courtesy of the National Register of Historic Places).

Ninety percent of the original Oatlands property was sold during the past 150 years, primarily for farming. A portion of the former Oatlands property was later sold to the Dulles Greenway Toll Road Investors Partnership to build an artificial wetlands to mitigate loss of wetlands during the construction of

the road project. Wetlands construction began in 1994 with bulldozing to scoop out a bowl shape with top soil placed to one side. A pond was constructed, the soil replaced, and seeds from native grasses and trees were planted. Courtland Woods, a 200-acre private development to build 277 homes, is under construction to the east of the wetlands.

Initial Imagery Analysis

Analysis of multi-sensor imagery over the Oatlands area began in 1998 with a primary focus on a field to the north of the mansion known as the llama field (figure 3), and to fields north of the mansion. Initial efforts were directed toward gleaning information that might lead to confirmation that the building adjacent to the llama field was the original brickworks, as well as any information that might shed some light on the location of the slave quarters and the slave cemetery. Results of this initial research were presented for the author by Failmezger (1999) and by this author as part of another paper (Faintich 2003).

Multiple types of imagery were used in the analysis, including 25 meter resolution (m) Landsat satellite multispectral imagery (MSI), 8m RadarSat International satellite Synthetic Aperture Radar (SAR), 1m VARGIS aerial color infrared (IR) imagery, 1m Positive Systems ADAR 5500 aerial MSI, 2.5m Intermap aerial SAR, and 4m NASA AVIRIS aerial hyper-spectral imagery (HSI). The 25m and 8m imagery proved to be useful only for general landscape analyses and did not have enough spatial resolution to support archaeological analyses. Computer image enhancement and analysis of the March 1995 IR imagery revealed various patterns in the llama field (figure 4), but it could not be ascertained to what extent they were due to natural processes or human activity.

Figure 3. Llama field (image courtesy of Positive Systems).

Figure 4. Llama field patterns (image courtesy of VARGIS).

Computer processing and analysis of the 1m multispectral and 2.5m SAR imagery, however, did highlight some interesting features in the llama field. Several bright lines traversing the llama field near the suspected brickworks can be seen in the near IR band of the multispectral image (figure 5), with corresponding, but lower resolution, dark lines in the SAR image (figure 6). Differential vegetative health will result in reflection differences when viewed at near IR wavelengths, with the brighter lines indicating enhanced growth. Dark lines in SAR imagery can result from soil or vegetation differences, or by increased absorption of the radar energy by greater soil moisture. Subsequent excavation of portions of the llama field determined that the enhanced vegetation resulted from increased soil moisture due to fill soil in trenches dug in the high clay content field, thereby providing fairly conclusive evidence that clay was being dug for bricks and mortar for processing in the adjacent building. Clay is now taken from the llama field for restoration work on the plantation.

Figure 5. Bright lines in llama field appear in the IR image band (image courtesy of Positive Systems).

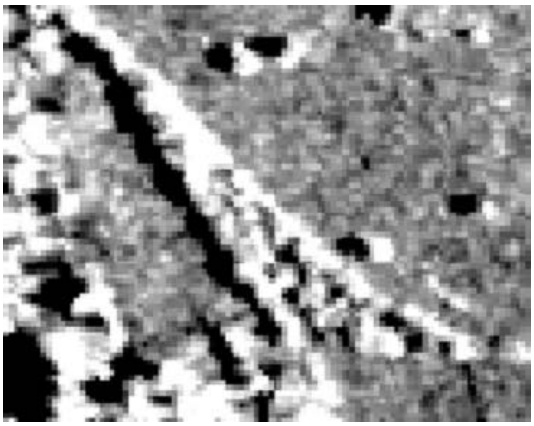

Figure 6. Dark lines in llama field appear in the SAR image band (image courtesy of Intermap).

Automatic computer feature classification of the four band ADAR multispectral image provided less information about the trench lines than could be seen by visual inspection of the IR band. Inclusion of the SAR image as an additional band in the classification yielded only marginally better results, although misclassified shadows in the four band results were separated out when SAR was included (figure 7).

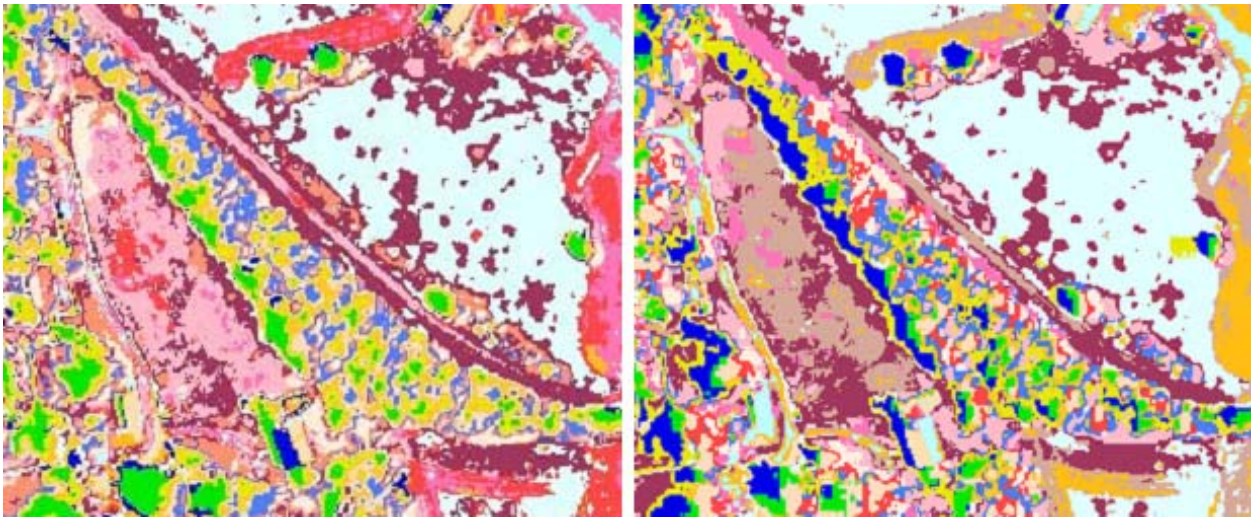

Figure 7. Four band automatic feature classification (left) and with added SAR band (right). Note the clearer trench line in the llama field and shadow areas (blue) in the right image.

An area to the north of the mansion was reported as a possible location for the slave cemetery. Image enhancement of the color IR image revealed some interesting field markings (figure 8), and the AVIRIS HSI was processed to show surface material differences (figure 9), but the initial phase of this project ended before any field results were obtained in this part of the plantation. It is unclear if the field markings and differences are due to natural phenomena or human activity. Some of the white lines seen in the color IR imagery are soil disturbances from current equestrian trails.

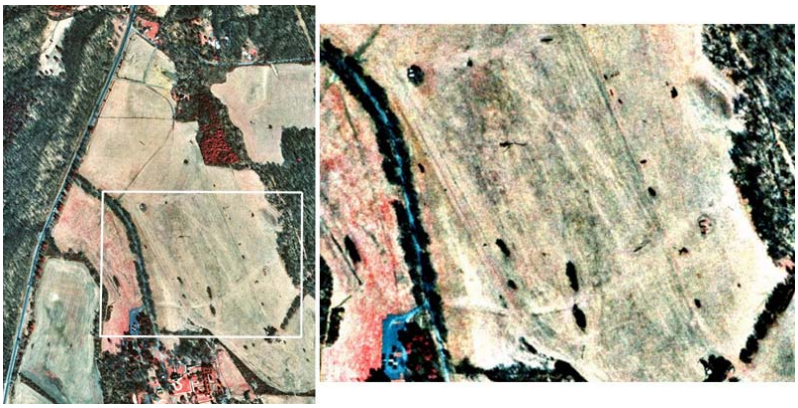

Figure 8. Color IR imagery to the north of the mansion (image courtesy of VARGIS).

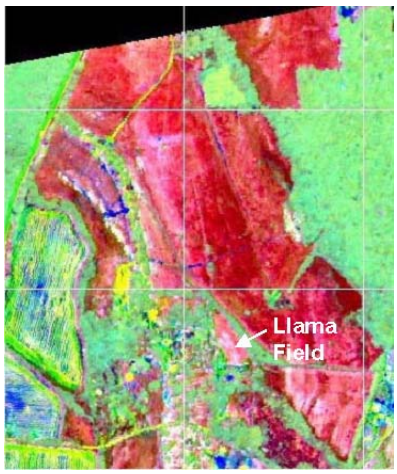

Figure 9. Processed AVIRIS HSI.

Geophysical Signatures

The archaeology of the Oatlands area was revisited under the geophysical intelligence internal research and development program sponsored by Northrop Grumman beginning in late 2004. All human activity leaves direct physical evidence in the earth and affects earth systems dynamics that may be manifested as signatures in the soil, vegetation, geologic surfaces, water, and atmosphere. Geophysical intelligence is defined as information about current and previous human activity gleaned from these signatures. Geophysical signatures may be visible only under certain conditions, such as time of day, time of year, during specific stages of vegetative growth, during specific times after rainfall, and when there is light snow cover. The key is to model the earth systems dynamic processes to understand when and how to look for these signatures. Modeling these signatures involves the fusion of multiple technical disciplines such as soil pedometrics, botany, geophysics, hydrology, and meteorology. Geophysical intelligence is extremely useful for discovering archaeological features.

Commercial satellite MSI of the Oatlands area shows soil and vegetation marks indicative of former roads, drainage ditches, and plantation building structures. Based on these geophysical intelligence signatures, predictions of the location of some buildings and the transportation network between the plantation main house, Oatlands Mills village, and surrounding properties were made. Civil War era military maps and USGS geological maps added collateral information to the analyses. Permission was granted by the Dulles Greenway Toll Road Investors Partnership and other landowners to conduct field investigations, but the Courtland Woods site was not examined in the field. The investigations verified the existence of some of these features, although some of the signatures may be the result of abandoned farm or construction roads that were built over 19th century stone roads.

Figure 10 shows a 1988 USGS panchromatic image and a 2003 DigitalGlobe 2.4m Quickbird multispectral image of the wetlands area before and after construction, respectively. The white circle drive of the Oatlands mansion is visible in the upper left hand corner of each image. Bright white horizontal lines in the 1988 image are most likely reflection of sunlight from standing water in vehicle tracks.

Figure 10. Wetlands area (Quickbird image courtesy of DigitalGlobe).

Close inspection of the southeast corner of the wetlands area reveals multiple parallel linear and polygonal soil marks (figure 11). A soil moisture model study confirmed that the multispectral image was acquired when the soil was in the stage 2 drying phase (Aydin 2005) when otherwise hidden features might be seen as a result of differential drying. Some of the soil marks are also visible in the 1988 panchromatic image, and the standing water in vehicle tracks indicates recent rainfall at the time of imaging. Inspection of a 1937 aerial photo also showed portions of some of these linear soil marks; however, none of the roads were shown on a 1926 postal delivery map. Therefore, as it is unlikely that these roads were constructed after 1926 and abandoned before 1937, one can conclude that at least some of the roads pre-date 1926 and may have had a 19th century origin.

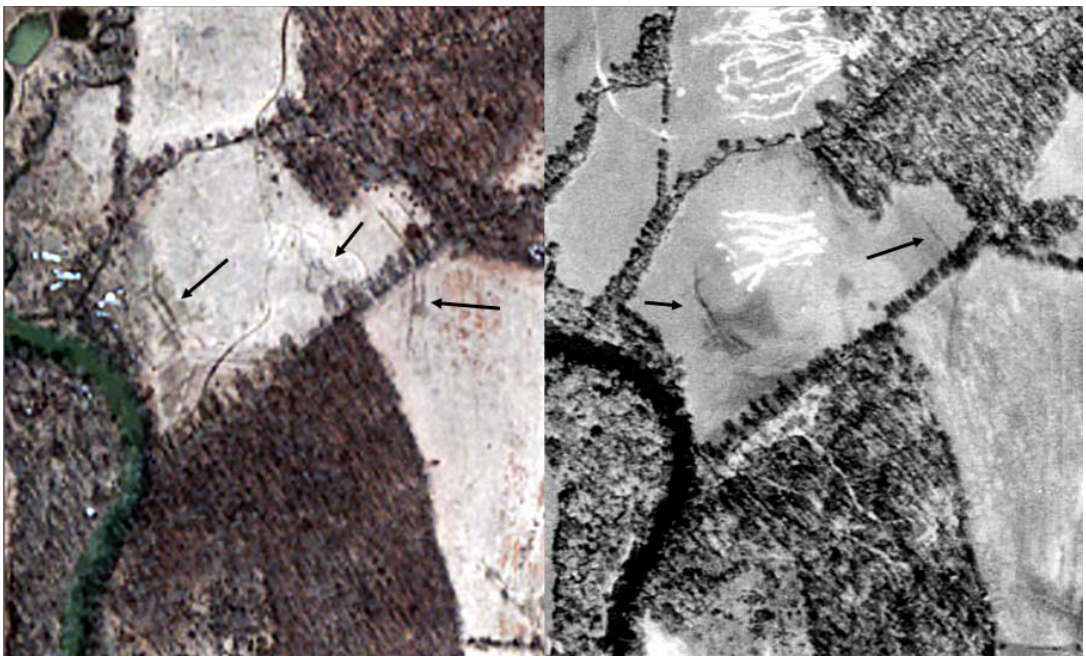

Figure 11. Soil marks.

When George Carter married in 1832, his new bride preferred not to travel on muddy roads, and Carter had his slaves quarry rock and build a network of roads within the plantation grounds. Typical stone roads of the period were 18 to 24 feet wide, made with flat stones, and crowned with ditches on each side to collect horse droppings washed from the roads when it rained. Presumably, many of the parallel linear soil marks seen in the imagery show the locations of the road ditches. Even though most of the stones have been removed or have been plowed under, and the ground flattened, the higher organic content of the soil where the road ditches existed can result in differential soil moisture during stage 2 drying after rainfall.

Analysis of multiple images, including those from the initial research plus the newer Quickbird MSI, yielded a large number of soil and vegetation marks that when combined, appear to map out multiple buildings and a network of roads between them. Figure 12 shows the extracted soil and vegetation marks, correlation with features in an 1862 map compiled by the Topographical Engineers Office at the Division Head Quarters of General Irvin McDowell, and a photo of the remains of the mill at Goose Creek and Route 15, which is labeled on the map as Carter's Mill. Note the three buildings labeled Oatlands Mills on the 1862 map. Whether these buildings are mills or other types of buildings is unclear, but the existence of the Oatlands Mills structures shown on the 1862 map was previously unknown to the current directors and staff of the Oatlands Historic District. It appears from the geophysical signatures that the Oatlands Mills village may have been located on both sides of Big Branch (Lambert's) Creek and within parts of the current wetlands and the Courtland Woods properties (see figure 13).

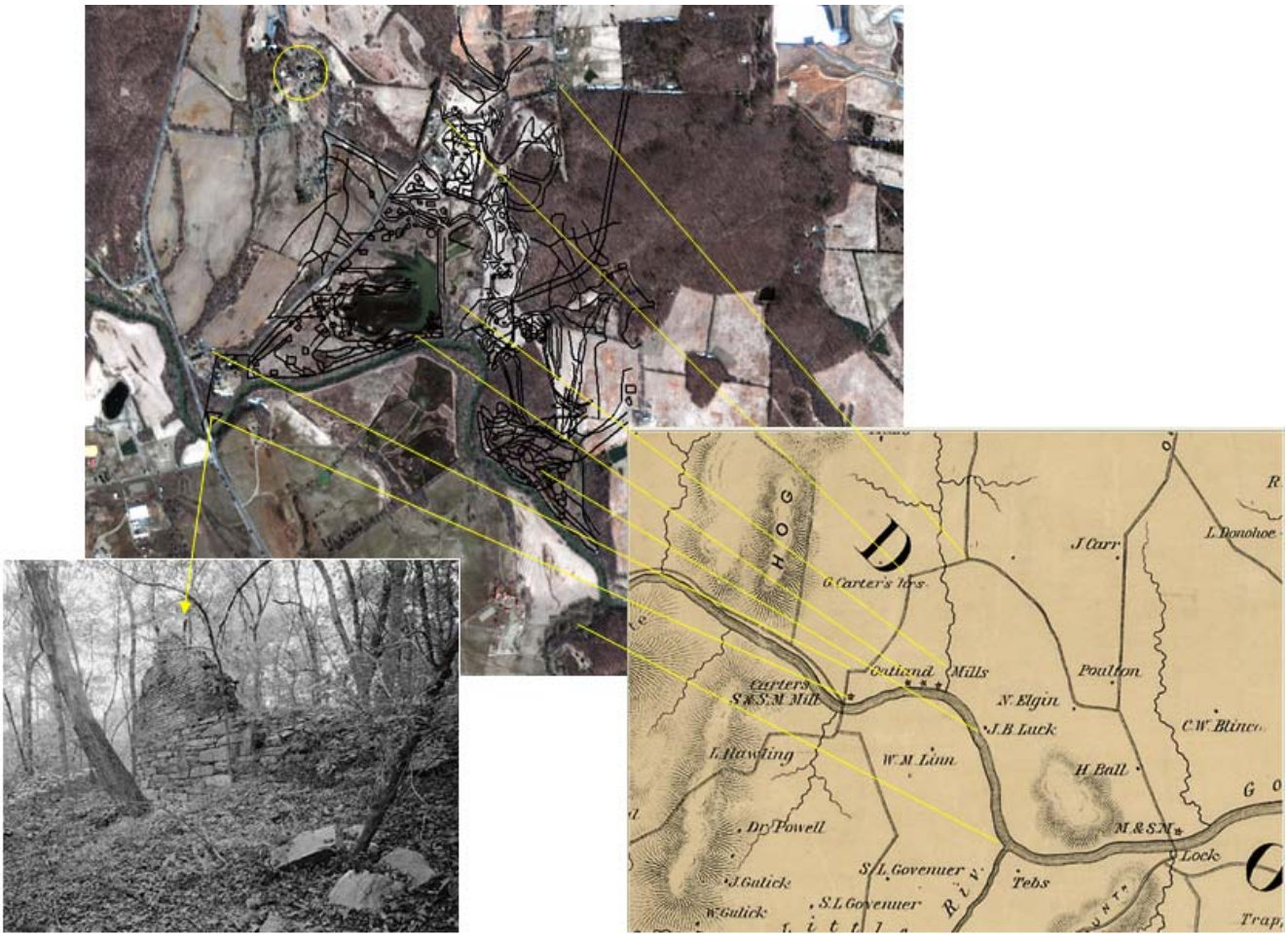

Figure 12. Extracted signatures. Oatlands mansion is highlighted by the yellow circle (mill and map images courtesy of the Library of Congress, Prints & Photographs and Geography & Map Divisions).

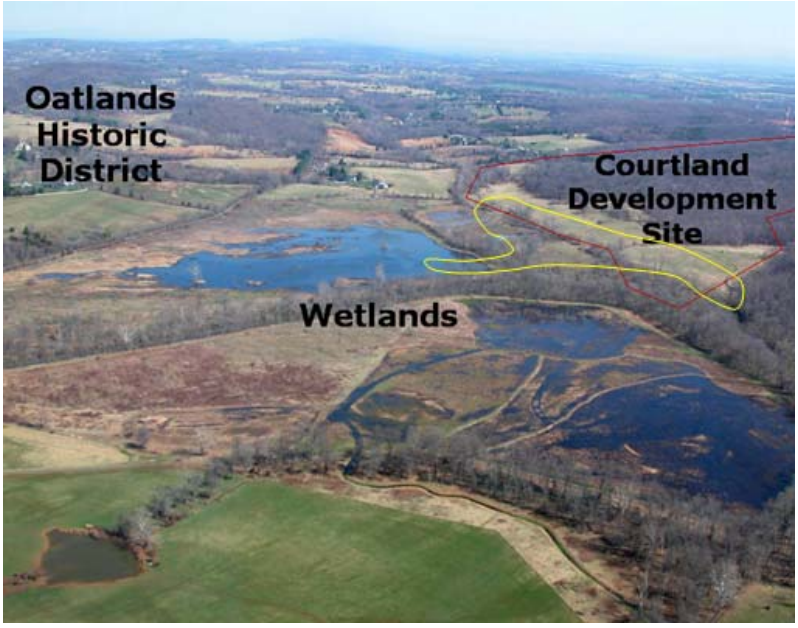

Figure Figure 13. Oatlands Mills Village (yellow outline)? (Base image courtesy of the Piedmont Environmental Council).

The Oatlands Mills post office is shown next to the Oatlands (Carter) mansion and to the west of Big Branch Creek on an 1863 map compiled by order of Lt. Col. Wm. P. Smith, Chief Engineer Topographical Office, Army of Northern Virginia (figure 14), but to the east of the creek on another 1863 map compiled by the Engineer Department, Army of the Potomac (figure 15), with a point location that corresponds to Elgin on the Smith map. This highlights the difficulty in obtaining accurate historical information, and at the same time provides a clue that some structures did exist at that time to the east of the creek, although perhaps to the north of the current Courtland Woods area. The 1862 map (figure 12), however, shows Elgin much farther south, nearer to Goose Creek, and in the Courtland Woods area.

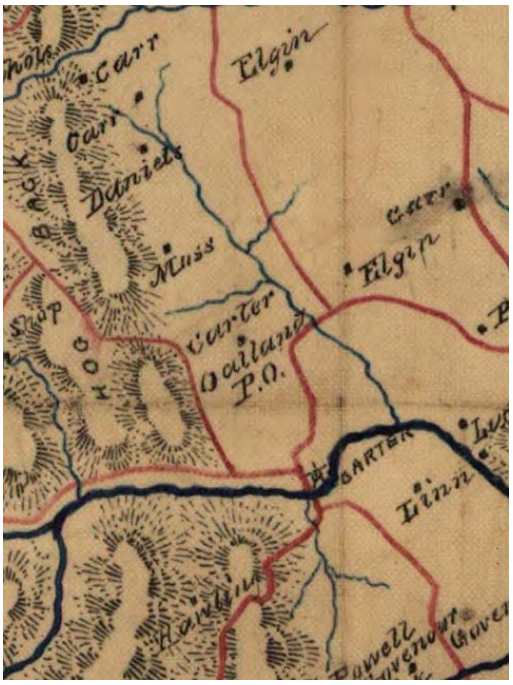

Figure 14. Oatlands Post Office to the west (map courtesy of the Library of Congress, Geography & Map Division).

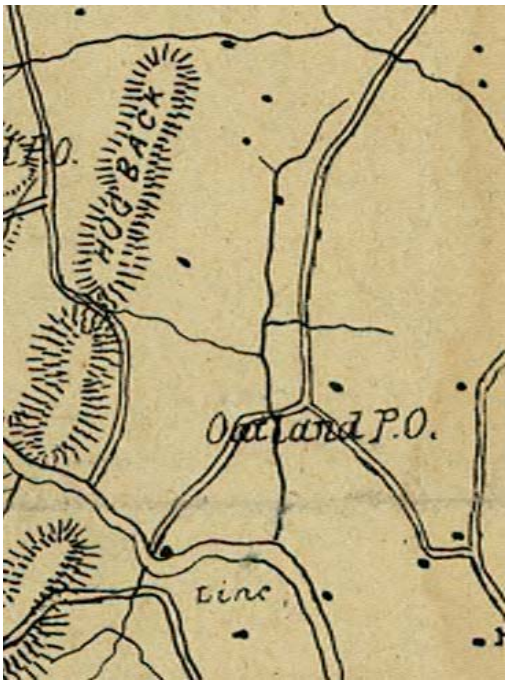

Figure 15. Oatlands Post Office to the east (map courtesy of the Library of Congress, Geography & Map Division).

Several soil marks are visible in the IR (figure 16) and HSI (figure 17) of the pasture just to the north of the wetlands. This field is reported by some to have been the location of the slave cemetery, and perhaps a prior native American Indian burial ground. A known stone road from the Oatlands Plantation leads directly to this field.

Figure 16. Pasture soil marks in IR imagery (image courtesy of VARGIS).

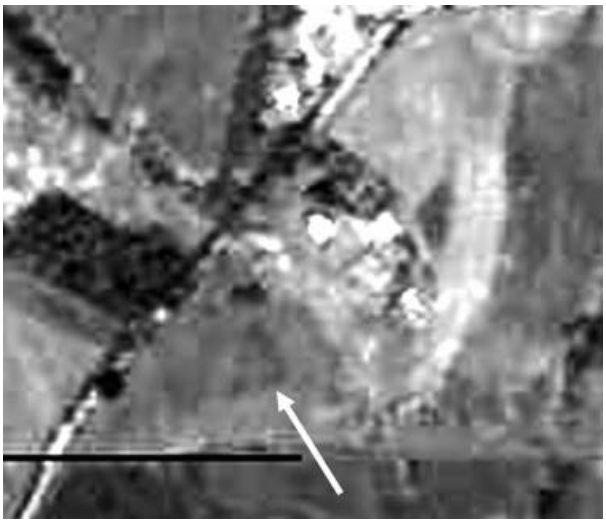

Figure 17. Pasture soil marks in the HSI.

Field Investigations

A few of the areas where geophysical signatures can be seen in the imagery were visited to conduct field investigations. Finding 19th century artifacts near to the image signatures would help to confirm our hypotheses about the road network and historical structures.

Several trips were made to the Oatlands plantation and surrounding areas. Metal detecting equipment was used to search for buried evidence of 19th century artifacts that might be associated with the geophysical signatures (figure 18). During the spring and summer months of 2005, most of the wetlands was covered with boggy soil, chest high grasses, thorn bushes, poison ivy, ticks, and snakes which made the field investigations difficult at best. During November 2005, most of the vegetation had died back, making it easier to investigate the ground and search for sub-surface metallic responses.

Figure 18. Field work.

It appears that the 19th century sale of bricks and stones combined with 20th century farming and wetlands construction has removed or deeply buried most traces of the Oatlands Village within the wetlands area. Surface and sub-surface flat stones of iron-rich basalt, as well as an old horseshoe, were found where road features are seen in the imagery (figure 19). Non-ferrous stones were also found, and although it is difficult to date the placement of the stones, some of them appear to be associated with either modern farming or wetlands construction, and others might well be from the 1832 road construction.

Figure 19. Flat stones.

The pasture where the slave cemetery was reported to have been located was also explored. Field investigations uncovered a few artifacts that may have been 19th century objects, but the shallow depth of the soil to bedrock makes this field unlikely as a burial site (figure 20).

Figure 20. Pasture – inset shows shallow depth to bedrock.

As part of the field work, a suspected and abandoned quarry that was located on the original Oatlands Plantation grounds was investigated (figure 21). Large, flat basalt stones were found in the quarry that resemble a number of the stones in the plantation building foundations and walls, as well as some of the stones found in the roads. Large areas of the original plantation contain various types of basalt bedrock, but it does not appear to be indigenous to the wetlands area.

Figure 21. Quarry – inset shows a portion of a wall in front of the Oatlands mansion.

For the past century, this quarry has been used as a dump. Curiously, a large cylindrical-shaped block of concrete was found in the quarry that had bricks and pottery embedded in one end (figure 22).

One of the pieces of pottery is stamped "GALLOWAY," presumably indicating the Galloway Terra Cotta Company of Philadelphia, and dating the pottery to the early 20th century.

Figure 23 shows this piece of pottery in greater detail, along with a rotated and enlarged pottery piece located nearby.

Figure 22. Concrete block with embedded artifacts.

Figure 23. Enlarged views of pottery pieces embedded in the concrete.

Conclusions

There is no question that the geophysical signatures found in the imagery represent pre-existing roads, ditches, and structures in the Oatlands area. It is difficult, however, to conclusively date the stone roads and artifacts that were found during the field investigations because of 20th century farming, and even more so because of the wetlands construction. It appears that the most likely area where we might find conclusive evidence of the Oatlands Mills village is in the Courtland Woods property.

Of additional interest is if some of the stones found in former roads in the wetlands match up with the basalt deposits found in the 19th century quarry. Although this would not be conclusive evidence that the road stones were placed there in the 19th century, it would be an additional consideration. USGS geological maps indicate both Hickory Grove and Mt. Zion basalt bedrock within the original Oatlands Plantation boundary (figure 24). Unfortunately, we have not yet been able to ascertain if the loose stones found in the quarry that match up with plantation foundations and walls were originally there, or were dumped into the quarry. A different type of basalt outcropping was found in our one trip to the quarry. Furthermore, current USGS maps describe the quarry site as a gravel pit, and show a quarry in a different location.

The Oatlands historical area proved to be an excellent site to test geophysical intelligence concepts, including signature processing, imagery analysis, historical intelligence, ground truthing, and collateral data assessment. Our limited analyses provided some additional insights about this area, and the information was greatly appreciated by the Oatlands staff.

Figure 24. Quarry site, basalt bedrock (yellow and orange areas), and road stones (crosses).

Acknowledgments

The author wishes to thank research team members, Mr. Douglas Howard and Mr. Barry Elliot, for their contributions to the theoretical research and field work. Appreciation is noted for all of the ground level, aerial, and satellite imagery providers, and to Mrs. Helen Wilson and to the Dulles Greenway Toll Road Investors Partnership for permission to conduct field investigations on their properties. Special thanks go to Mr. David Boyce, executive director of Oatlands, for his support, historical tours, and permission to conduct the research at Oatlands.

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