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A comprehensive study of the historical Blue Sulphur Hotel Resort through remote sensing, photogrammetry, and GIS

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A COMPREHENSIVE STUDY OF THE HISTORICAL BLUE SULPHUR HOTEL RESORT THROUGH REMOTE SENSING, PHOTOGRAMMETRY, AND GIS

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By

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DEDICATIONS

This thesis is dedicated to my family. For my parents, Liz and Greg, who supported me and helped me any way they could. To my only niece, Savannah, thank you for showing me persistence. To my nephews Cordell and Hayden, thank you for your resilience and determination. For my husband, Chris, who had patience and a shoulder during frustration, it meant more to me than you know. Most of all, this thesis is for Sydnie, Madeline, and Charlotte to show them that with hard work, determination, and patience, anything is possible.

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I want to express my gratefulness to the faculty members of the Department of Geography for helping me reach further than I thought possible. This thesis would never have begun without the patience and encouragement of each of you. Dr. Anita Walz and Larry Evans have been invaluable teachers, mentors, and friends during the project. A special thanks to Nick Schaer at the WVDEP for his help during the site visit and for the data he gathered to get the project off the ground. Also, I would like to thank Dr. Godwin Djietror for the incredible assistance with my final revisions. Lastly, I would like to say thank you to Ms. Amber Miller for her boldness in not letting me shy away from the challenge when the nights grew later and the data grew messy. My sincere thanks to all those involved in the creation of this work.

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ABSTRACT

This research examines the location of the 19th century historic Blue Sulphur hotel and sulphur springs resort located in Cabell County, West Virginia. This area has suffered degradation and modifications due to human activities. The objective of this study was to examine the location of the Blue Sulphur Springs Resort Hotel and springs, and utilize the remote sensing and GIS techniques in researching and locating structures that no longer exist or features that no longer are visible. The study integrated and utilized data from various sources and used different methods and approaches to analyze the changes to the Blue Sulphur site over approximately 140 years in order to find the location of the hotel and sulphur spring. These approaches included gathering field notes, evaluating and comparing historical surveys and documents, exploring and collecting archived data, using photogrammetric techniques to analyze aerial photography, and combining georeferenced images with satellite imagery to examine land changes. Also, socioeconomic information was used as secondary data to explain the influential factors in the growth and decline of the resort at Blue Sulphur. The results indicate the sulphur spring location was behind the hotel.

CHAPTER I

INTRODUCTION AND LITERATURE REVIEW

1.1 Introduction

The Blue Sulphur spring was a sulphurated upwelling gaining its name from the noted odor of sulphur, however, no chemical analysis has ever been conducted to provide a profile of the spring waters. It is within an unincorporated area along Route 60 in Cabell County, West Virginia which is the site of an ancient lake bed during the last glaciation period in North America. There are many famous springs that have been capitalized upon and resorts tended to develop and flourish in the surrounding areas. Using GIS (Geographic Information Systems) in archeology and historical research is relatively new and has begun to give a new spatial perspective to battles, buildings, and places that have been shrouded in the use of old maps, drawings, and description. Using remote sensing techniques, it is possible to uncover scenes that the eye cannot see without computer aided technology. The Blue Sulphur Hotel and Spa was the area of interest in this study because of its significant historical past in the local area, but due to the hydrological feature being a stratigraphically originating upwelling that has not been found since its burial during the hotel demolition.

1.2 Baths and Spas

When in Rome, do as the Romans do. Thermae, also known as bath houses, did not start out the way they were when Baths of Titus were constructed (c. AD 81), but rather developed from a history of bath houses built in civilizations such as the Egyptians and continuing to Knossos (c.1700BC) (Thermae, 2015). However, Baths of Titus were a significant turning point in bath house design and architecture. These thermae were the center of towns, sought out by all citizens, public or private, and some charged a fee.

The Victorian passion for the spa towns echoed throughout Europe as lavish spas were created one after another, drawing initially the more wealthy population but this was not to last. The Everyman visiting the baths created more of a social atmosphere and less of a medicinal or therapeutic visitation. Wealthy and elite persons made their way to the springs so frequently that the wagons were said to “waddle” through the ruts along the roadways to the springs (Steen, 1981). Spa towns grew in countless numbers to capitalize on the fashionable trend.

The Town of Bath, also known as Berkeley Springs in present day West Virginia, was the first spa town to develop in the United States. Being the sister town of the popular Bath, England spa town, Berkeley Springs grew and became popular as an elite resort location when George Washington, who had spent some time there helping with the surveying of the lands, decidedly established a private spa in the area. The town, established as the county seat of Morgan County in 1776, was most widely known as Warm Springs through the mid-18th century.

Before West Virginia became a state, the idea of balneotheraputic resort locations was already popular and spreading through the northeastern United States. The immigration from European countries had many cultural ideas tagging along with the populations who were stretching their reach into virgin lands in rural western Virginia and West Virginia. Clothing styles, food preparations, and even popular past times were trending, changing, and adapting to the new onslaught of people, as did the landscape. There was a delay in popularity due to the travel time across the Atlantic Ocean, as well as a delay in the decline of popularity as trending culture changed from one fad to another. This was the case with the spa trend incorporating into the lives of settlers in Virginia.

The Blue Sulphur Hotel was built to capitalize off the trending spa town market. The factor that sets the Blue Sulphur location apart from other locations is that there was not another spa resort in the area for several hundred miles. As travelers passed through the area, this became a luxury destination. When the railroad took interest in spa resorts, it opened a new door for Blue Sulphur, creating a significant influx of people from near and far on a daily basis.

1.3 Study Location

1.3.1 Early settlements

The earliest European immigrants to the area were trekking through the location in the 1700's. Rice and Brown (1993:47) claim that after the Revolutionary War, there was a 317 percent increase in population between 1790 and 1830. The first documented permanent building in the Blue Sulphur study location, other than the farms dotting the landscape, was the Mud River Baptist Church in 1807 (Burdette,1925). There were

several noted settlers in the *History of Ona Community* by Frank Burdette. There, he described the critical beginnings of the small town's geographical location, roadways, gives names and descriptions of the earliest European settlers in the area, as well as doctors, schools and teachers, and even managed to add notable historical events occurring within several miles of the Blue Sulphur location. According to Lewis, "the river bottomland was unsurpassed for farming of all kinds: grain, fruit, and livestock" (1904:383-384).The Sulphur spring played a direct role in the development of the area and would soon bring tourists from near and far, creating growth in a young economy.

1.3.2 The Blue Sulphur Springs Hotel

Cabell County was established in 1809 with Barboursville being declared the county seat in 1814 (Kentucky Ohio West Virginia Genealogical Society, 1996). The county seat became a booming town known for its manufacturing of goods varying from barge bottoms sent to Indiana, furs and linens traded between New York and Pennsylvania, and the production of a 'cash-crop' of hogs (Miller, 1925) With the springs just a few miles away, there was plenty of opportunity to frequent the mineral waters. George J. Floding purchased two tracts of adjacent land 20 acres each, which contained the sulphurated springs (CCDB 22:195; 24:537). According to G.E. Walton's *Mineral Springs of the United States and Canada, With Analysis and Notes on the Prominent Spas of Europe, and a List of Sea-side Resorts, "*In sulphur-waters a characteristic odor is always present, that of sulphuretted hydrogen. When waters are highly charged …the odor is perceptible for considerable distance from the spring" (Walton, 1873). When the upwelling contains the monosulphuret of sodium, the odor is much weaker than the

highly charged waters. Even though there was never a chemical analysis done, it is hard to mistake the smell of sulphurous odor.

The springs were known in the area, however, no accommodations were in place for visitors to utilize (Crook 1899:522). The Post Office was named Floding Springs from 1882-1891 (Kentucky Ohio West Virginia Genealogical Society, 1996), and is documented on the R.L. Polk & Co. map of 1895 (Polk 1895-1896: n.p.) signifying an identity or establishing a sense of place and significance of Floding's investment in the local area.

Floding built the Blue Sulphur Springs Hotel, originally the Floding Springs Hotel, in 1883, to "rival" the Greenbrier at White Sulphur Springs (McKernon, 1987:79), then remodeled it in 1885, with a large Fourth of July celebration (Hardin, 1976:3). The Barboursville and Blue Sulphur Springs area would have been an economic hub, providing the nearby traffic needed to successfully establish a hotel at the Blue Sulphur site due to the amount of through traffic connecting the East coast to the Ohio River. In 1902, Floding donated $4000.00 towards the WV Colored Orphans Home and Industrial School for purchase of the hotel and left them responsible for the remaining $2000.00. They could not meet the requirements and fulfil the contract, so Floding regained ownership less than one year later, in 1903 (CCDB 65:480, 71:6; CCTDB 49:360)

1.3.3 Transportation

One of the earliest routes spanning the area between eastern Virginia and the Ohio River was the James River & Kanawha Turnpike, authorized by the Virginia legislature in 1785 (Cohen 1987:187). According to Mathews, "the turnpike had toll gates every four miles" and was nearly "impassable for other traffic due to east-bound livestock

herds” (Mathews, 1950:275). This did not stop the flow of travelers moving through the area. This was a way to move products between the east coast and the Ohio River, so when the railroad was established to help transport passengers and goods, it alleviated the stress along the turnpike. This was especially the case when the Covington & Ohio Railroad Company (C&O) was chartered by Virginia legislation to lay track through the western region of Virginia (Turner1986:42-43), into the Blue Sulphur area.

There was interest in using the railroad to bring passengers to the resort spa locations, and Blue Sulphur Springs was no exception. There was a train stop located approximately 100 feet in front of the hotel entrance, allowing easy access to all who visited the resort. Times were changing and the infrastructure of the area was rapidly growing and changing to meet increasing demands of the people. This gave an economic boost to Barboursville and to Huntington when the area was “almost inaccessible” (Wallace, 1947:67). The construction of the railroad brought jobs into the area, which led to an increase in population (Gunter, 1986:21, 22). In 1890, Huntington’s population was already over 10,000 (Casto 1997:35). By 1900, the town of Huntington was boasting a population of nearly 20,000 (C&O 1906:187).

An impact left by the railway was the incredible strengthening of the coal industry's rise. This would open up development for many rural locations in the area, but in 1906 the coal profits soared past the $19 million mark while passenger service only rose to $4.2 million (Beedle, 1999). The climbing profits of the coal industry now towering over the once booming tourist and passenger industry, led to the decision to remove the train stop and eventually change the route of the train altogether. The railroad moved to the north side of Mud River, while the hotel and spring remained south without means to

transport guests in a convenient way, creating a huge financial setback for the hotel. Figure 1 show the train track on the United States Geological Survey (USGS) maps.

Figure 1: Left- 1902 USGS map showing the railroad South of Mud River, Right- USGS map showing the railroad at its current location, North of Mud River.

Floding had to close the hotel, but reopened the hostelry in 1910 once more, ultimately having to sell the property to Don Chaffin, the dubious ‘Czar’ sheriff from Logan County, in 1923 sinking money into completely remodeling the hotel and then entrusting his brother-in-law, Walter Fraser, to run the business for him. With rumors of illegally allowing alcoholic beverages to be consumed during a period of prohibition, the decline of the popular resort visits, and lack of a train station for patrons to access services, it was not long before the stress took hold of Sheriff Chaffin’s wallet and sunk the hotel permanently in the early 1930’s. In 1959, W.J. and Norma Ellis bought and begun

removal of the Blue Sulphur Springs Hotel from the land. The entire hotel was demolished before 1971.

1.4 Remote Sensing Applications

The use of remote sensing and photogrammetry underwent a dramatic change when the use of photoreconnaissance surged during WWII, as the needs for better aerial platforms and technologies emerged. Remotely sensed images give a unique vantage point over a landscape, and with the right techniques, historians and researchers can now observe how landscapes and scenes have changed over time, which can be measured or analyzed to answer countless questions. For example, where were the battle lines, how large is the footprint of the city, and how much vegetation has been lost are some of the most basic questions that could be answered with various photogrammetric techniques. Remote sensing for historical purposes assists in providing resources to guide the structure of the study while aiding in the determination of hotel and sulphur spring location since the hotel and spring are no longer visible.

This study uses historical maps, and aerial photographs to pinpoint a location that has been forgotten by most. The aerial photos alone hold such a significant story, while the area of interest is such a small footprint within the photograph and it holds a valuable tale of its own. The process of georeferencing, masking and clipping, creating contours and slopes, and other image analysis techniques allow the data to be represented in such a way as to highlight the various changes in land and structure within the Blue Sulphur Hotel area of interest.

Remote sensing has become a new skill set for historians and archaeologists to shed new light on significant historical events in a spatial perspective. Using satellite and aerial remote sensing techniques in historical research is still in its early phase of development with some of the leaders in the academic setting beginning approximately 10-15 years ago. For example, Parcak (2009) describes types of satellite imagery and several remote sensing techniques covering the," discovery, preservation, and management of archaeological sites". She wrote *Satellite Remote Sensing for Archaeology* in 2009 due to the lack of sufficient comprehensive manuals. It was the first of its kind.

Due to satellites having an advantage over the human eye with the on board sensors capable of seeing beyond the human visual range in the electromagnetic spectrum, a large range of data can be recorded and analyzed for numerous purposes. Parcak notes the sensors capabilities in helping archaeologists to," reconstruct how past landscapes may have looked, and thereby allows a better understanding of past human occupations of those landscapes" (Parcak, 2009). This was the intention of the study of Blue Sulphur by using the remote sensing applications in a historical context. Clark, Garrod, and Pearson conducted a study demonstrating how, "remote sensing can be used to aid the general approach of landscape archaeology…attempting to elucidate links and controls between environmental change and long-term social change in southern Madagascar" (Clark, 1998). This study of landscapes changing over time due to human interactions and impact on the lands in Madagascar can be used as a guide to establish connections between human developments and interactions on an environment in other locations, such as the Blue Sulphur location changing due to the

development of the spring location, hotel construction and demolition, and eventually the bridge construction over Mud River.

1.5 Problem Statement and Justification

The historical hotel at Blue Sulphur is a significant part of local history. The hotel itself has been nearly lost except for a few aerial photos beginning in the 1950's through the early 1960's when the hotel was demolished. The hotel would not have existed without the spring, and there are no records or surveys that can give a precise location of the spring. The only documented instance that comes close to the location of the spring, still only gives a general location of the spring being behind the hotel and in the flood plain of the Mud River. This research uses remote sensing and GIS to look into the past to find the missing history of Blue Sulphur, Cabell County, and West Virginia. It is not only important to note the historical value of the springs, but to take into account where a bridge is constructed on a site of which an exact location of the spring has not been established, potentially imposing challenges or hazards due to the subterranean hydrological feature. Future damages or failures in the structural integrity or stability of the bridge may result.

There are other implications to be considered with the area of interest (AOI) and potential home values and mineral rights of the immediate surrounding lands and structures. The potential of providing a more precise location of the hotel and spring could suggest a possible re-evaluation of the property as a historic site. As of present day, the site is not protected from future construction or destruction. The hotel may be

lost, however the spring is potentially still usable, and may even be an indicator for underlying embedded resources such as coal, oil, and natural gas.

1.6 Research Objectives

The overall objective of this study is to model the past and current location of the Blue Sulphur Springs Resort Hotel and springs, to explore and utilize the various remote sensing techniques in researching and locating structures or features that no longer exist, and to make recommendations for further applications of remote sensing for locating structural and natural footprints of occurring phenomena under study.

The specific objectives of this study are:

1. to collect and integrate various scanned maps, conventional data, and satellite images since the 1880's to present.
2. to explore reasons the hotel and springs were fatally affected surrounding the shift of the railway to the northern side of Mud River.
3. to demonstrate the utility of remote sensing and GIS techniques in identifying the location of artifacts of historical significance.

CHAPTER II

STUDY AREA AND RESEARCH METHODOLOGY

2.1 Study Area Physical Geography

2.1.1 Geographical location

Blue Sulphur is located within Cabell County, on the western side of West Virginia. This is to the west of the Appalachian Mountains and approximately 20 miles east of Huntington and the Ohio River. The Blue Sulphur area of interest (AOI) is adjacent to the Midland Trail, also known as Route 60, separating it from the historic Mud River Baptist Church. Figure 2 shows the study area of interest.

Figure 2:2009 Orthophotograph of the Blue Sulphur area of intrest

2.1.2 Climate conditions

The Cabell County area has a similar rainfall and temperature throughout, and does not have any topological anomalies to cause oddities or significant variation within the county. For the state of West Virginia, the distribution of mean annual precipitation is more variable. This climate pattern occurs due to the air masses moving from west to east along the continental US. Cabell County is adjacent to the Ohio River, therefore it isn't subject to the orographic lift that occurs as the air mass continues east into the Appalachian mountain region. This orographic lift causes the moisture to condense out of the air mass and create more precipitation in the mountainous region of the State, however this does not seem to have a significant observable impact on the climate in Cabell County.

Precipitation patterns in the area can be a concern when researching an area with a hydrological feature within a flood plain. It is important to establish when a significant dry period will allow for field work. When field work was conducted for this study, there was no rain the day of the field visit, however there had been a significant wet winter season so the ground was moist with two to three areas with pooling water on the surface approximately 3 inches deep at center. Also, flood events occurring during the hotel operation would have impacted the hotel and the spring since the spring was well known for being in the flood plain of the river.

2.1.3 Soil and geology

The soil type of the Blue Sulphur area is Kanawha loam, with a range of 3-8% slopes. It is also considered to be in an urban land use area even though this was not always the case. The Blue Ridge springs were created from the," Oriskany sandstone and the Helderberg limestone at their outcrops on the limbs of anticlines…a broad upward fold of rock strata" (Cohen 1991: vi). As precipitation percolates outcrops mentioned above, is acts as a solvent and collects minerals and particles along the way down into the lower outcrop elevation. According to Cohen, there are six types of springs: saline, chalybeate, alkaline, calcic, thermal, and Sulphur (1991: vii). Dr. John J. Moorman, a resident physician at White Sulphur Springs also noted the red or blue color associated with the sulphur spring stating the changes were, " occasioned from the influence of light or shade; or by chemical changes produced by contact with foreign bodies" (Moorman 1859:30). He spoke of the chronic diseases that could be treated or cured by sulphurous waters, such as mild skin infections, rheumatism, and opthalmia, within 'two to three weeks' (1859:46). Since the properties and benefits of a sulphurous upwelling was already well established in several journals, articles, and historical accounts, it would have been relatively easy to give the Blue Sulphur spring a visual and olfactory check to realize the pungent odor was, in fact, sulphurous in origin.

2.1.4 Land Use

The Blue Sulphur area was used for the healing waters, and this is what prompted the construction of the hotel. There was no planning commission to zone land use in the area, so that left the area to develop and grow naturally rather than in a pre-planned blueprint type of growth. As the hotel was in its decline, houses were in the process of developing nearby in the Indian Meadows neighborhood and the surrounding area. Other businesses did not flourish in the immediate area and once the railroad had moved to the northern side of Mud River, no other businesses were established in the AOI. The destruction of the hotel allowed the land to be used for miscellaneous fill dirt and materials. Eventually the West Virginia Department of Highways sought to build a new bridge in the area. They conducted a study on the area to ensure that they would not be encroaching on historical sites or destructing/damaging the historical property. Since they concluded that the area did not meet criteria to be placed on the historic preservation list, they could build a new bridge in the proposed bridge site.

2.2 Material and Methods

The study integrated and utilized data from various sources and used different methods and approaches to analyze the changes to the Blue Sulphur site over approximately 140 years. These approaches included gathering field work notes, historical surveys and documents, archived data, aerial photography, and satellite imagery. The other source of some of the most valuable information to this research was aerial photographs and automated maps retrieved from the USGS Earth Explorer site. Also, socioeconomic information and climate data from the National Climate Data Center were used as secondary data to explain the influential factors in the growth and decline

of the resort at Blue Sulphur. Field work was conducted during January, 2015 for leaf off conditions and reduced shadowing from any tree canopy covering and increasing visibility of the site location. ESRI (Environmental Systems Research Institute) ArcGIS (10.1 and 10.2.2) was utilized for image analysis, thematic map production, and for creating a database. Microsoft Excel was used for simple data management in organizing temporal information.

ArcMap does not readily accept the current USGS files until they are converted into a useable format. To solve this issue a simple script was written and a .bat file was created to convert the majority of the data. Then, there was still a problem with a projection that ArcMap will not use. After many unsuccessful attempts at writing a script to extract the reference points, the data was added to a Global Mapper program that allowed the conversion.

2.2.1 Remotely sensed data

Images, whether by satellite or aircraft, have various temporal dates and vary in scale. The prime situation for this area would be cloud free and leaf off to allow the best possible view of the ground and all data collected at the same scale. This is not the case, however. Some of the available aerial photos were not usable due to cloud coverage creating limited visibility and the satellite images had similar problems. It was not feasible to try to collect and manipulate every image available for the AOI, nor was it necessary. Therefore, the collection of data was limited to a temporal series of aerial photographs (see Appendix), digitized and georeferenced hard maps, and Lidar data. Once the images were collected, the various formats had to be converted into geotiff format for ArcMap to be able to utilize the image and data. The projection used for this

analysis was Universal Transverse Mercator, zone 17 north. The images were checked for spatial distortions and anomalies, georeferenced, and then checked again. This was very difficult for the automated maps, since they have several types of error (i.e. observation and recording on the original document and automation/georeferencing errors) that could have been introduced prior to this study.

The usable maps were only those that had coverage of the entire Blue Sulphur area, had surrounding features that could be georeferenced, and had a resolution that would not cause severe pixilation when zoomed into the AOI. The visual data began in 1898 and included United States Geological Survey maps from 1898, 1902, 1935, 1958, while the aerial photography dates were 1955, 1956, 1957, 1967, and 1971. The 1967 image was not usable due to image clarity when zoomed in on the Blue Sulphur location.

There were also four geotagged photos logged during the field visit: two photos of the wall remnants of the hotel and two of a potential newer upwelling of a spring. These locations were added to the ArcMap document and used as reference points for ground truthing the images against what was on the ground visible on the site location. The images were checked for any visual anomalies. A flood zone map was created using the elevation contours from the 2009 lidar image. The ground filter was used to reduce ‘noise’ from other objects picked up on the lidar return. Then just using a simple hillshade, and changing the color scheme to make the map easier to interpret, the flood stages were set based on how high the level rose out of the bank, approximately 6 foot intervals, and up to the rear of the hotel. This was due to the previous descriptions

designation the location of the spring as being behind the hotel but within the flood plain of the Mud River.

All images were checked for a reoccurring or consistent anomaly behind the spring and along the bank of the river, within the flood designated area. This allowed for a more narrowed and precise location of the potential spring location. When cross referenced with the aerial maps, the catchment area was easier to determine.

CHAPTER III

RESULTS

The analyses of aerial photos of the area studied to determine the location of the Blue Sulphur Springs Hotel and spring revealed that there were slight shifts in in coverage. This posed some difficulty in pin-pointing an absolute location of the hotel and spring. Once the images were georeferenced, the separate layers were viewed with transparency of the aerial images set to 40 percent, allowing the images to be imposed on top of each other giving a ‘peek-a-boo’ look at where the resort location was and how it has changed in time. This suggested the location of the hotel on the LIDAR data and this created a more precise set of images with an established footprint of the true location of the hotel and spring.

The underpass that existed beneath the railway for some of the earliest passengers of the C&O stopping at Blue Sulphur walking to the Hotel for their social or therapeutic visits was filled and now is a drainage point beneath US Route 60 and into the Mud River. Evidence of the passage is still visible in LIDAR imagery and even through direct observation. This underpass is significant to determination of the alignment of the hotel and the topography of the land. The passageway is visible in every image and is documented on the 1958 USGS survey map of Milton West Virginia. (see Figure 3).

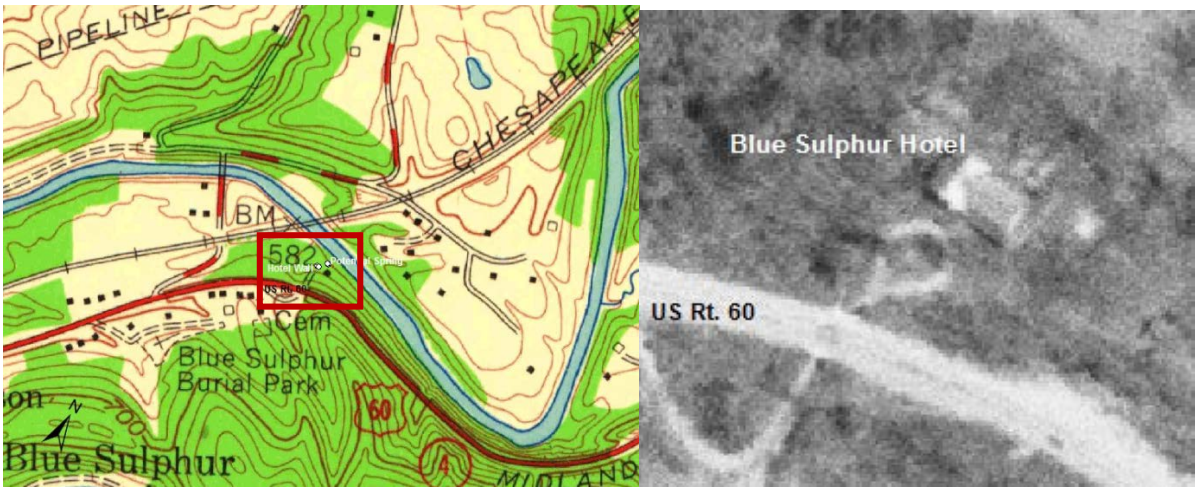

Figure 3: Milton 1958 USGS with a USGS aerial 1956 indicating the area of interest when the passage was still under Rt. 60

This passageway also allowed the analysis of the images additionally to assist in the determination of the Sulphur spring location. According to the historical records previously mentioned, the original owner of the land and hotel constructed a small catchment area behind the hotel, where the spring was located, in order to protect it from the flood waters of the Mud River so as to protect his investment. After careful analysis and adjustments to the contrast, brightness, and gamma levels of each of the aerial black and white photographs, there is a small anomaly present in each of the images of the area behind the hotel and within the floodplain (see Figure 4) of the Mud River, just north of the back of the hotel (see Figures 4 and 5). This anomaly seems linear and can be difficult to see in the pixelated photographs. The images show the temporal sequence of aerial photographs with labels indicating the hotel and potential catchment areas and newspaper photographs in temporal sequence (see Figure 6).

The images also indicate that the topography of the land has changed significantly in the immediate area, however, with detailed visual analysis of the images, and

manipulation of changes to the gamma, contrast, and brightness of the images to highlight the hotel and surrounding landscape, the alterations to the study site are now visible. With the historical records indicating the approximate location of the spring, the images indicating a suggested location of the hotel, and lidar data retrieved from the USGS Earth explorer site, the creation of a historical account was achieved. The hotel, according to this study, was located slightly further North West than originally indicated in the 1996 or 2009 lidar image, meaning the spring would also shift in accordance with the hotel. This shift brought to light a previously unnoticed anomaly in the aerial images, a linear shadow possibly indicating the catchment area, leading to the potential rediscovery of the old sulphur spring.

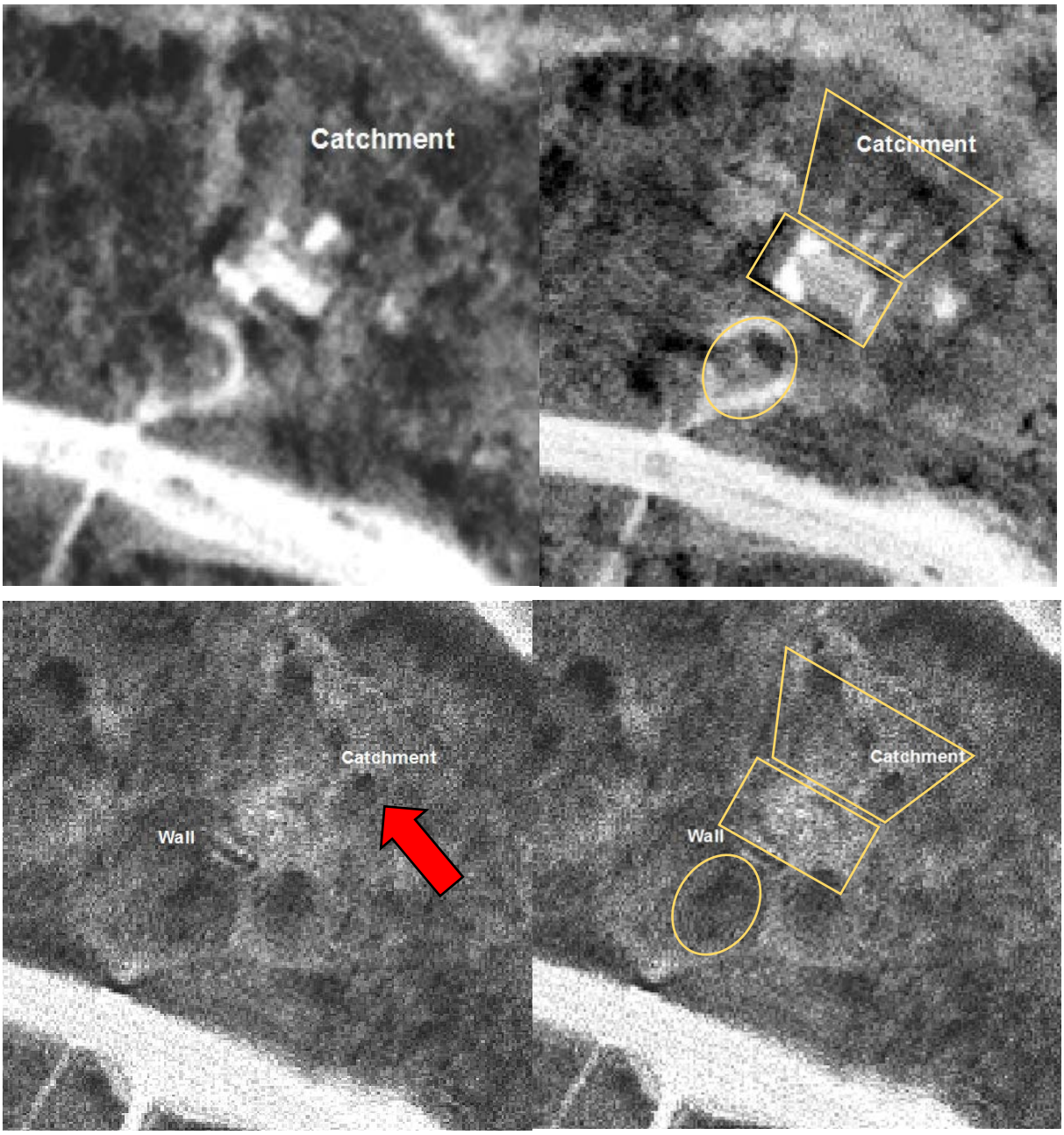

Figure 4: Temporal sequence of visible changes in landscape: A) Top left-USGS 1955 aerial photograph, B) Top right-USGS 1956 aerial photograph, C) Bottom left- USGS 1971 aerial photograph with arrow indicates spring location, D) Bottom right- USGS 1971

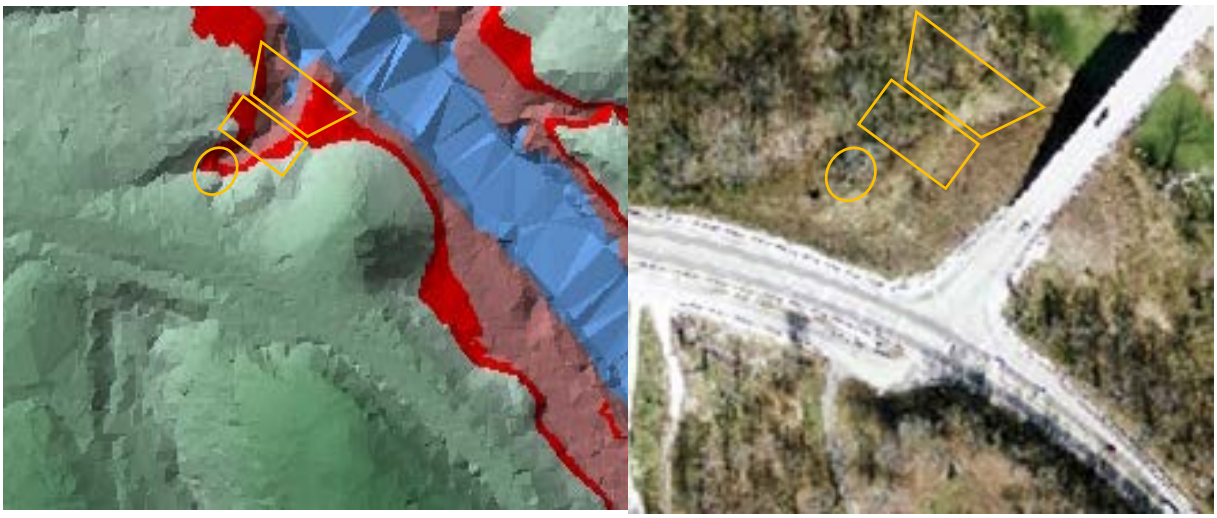

Figure 5: 2009 USGS Lidar with flood zones and resort footprint indicated (left), 2009 ortophotograph with resort footprint (right)

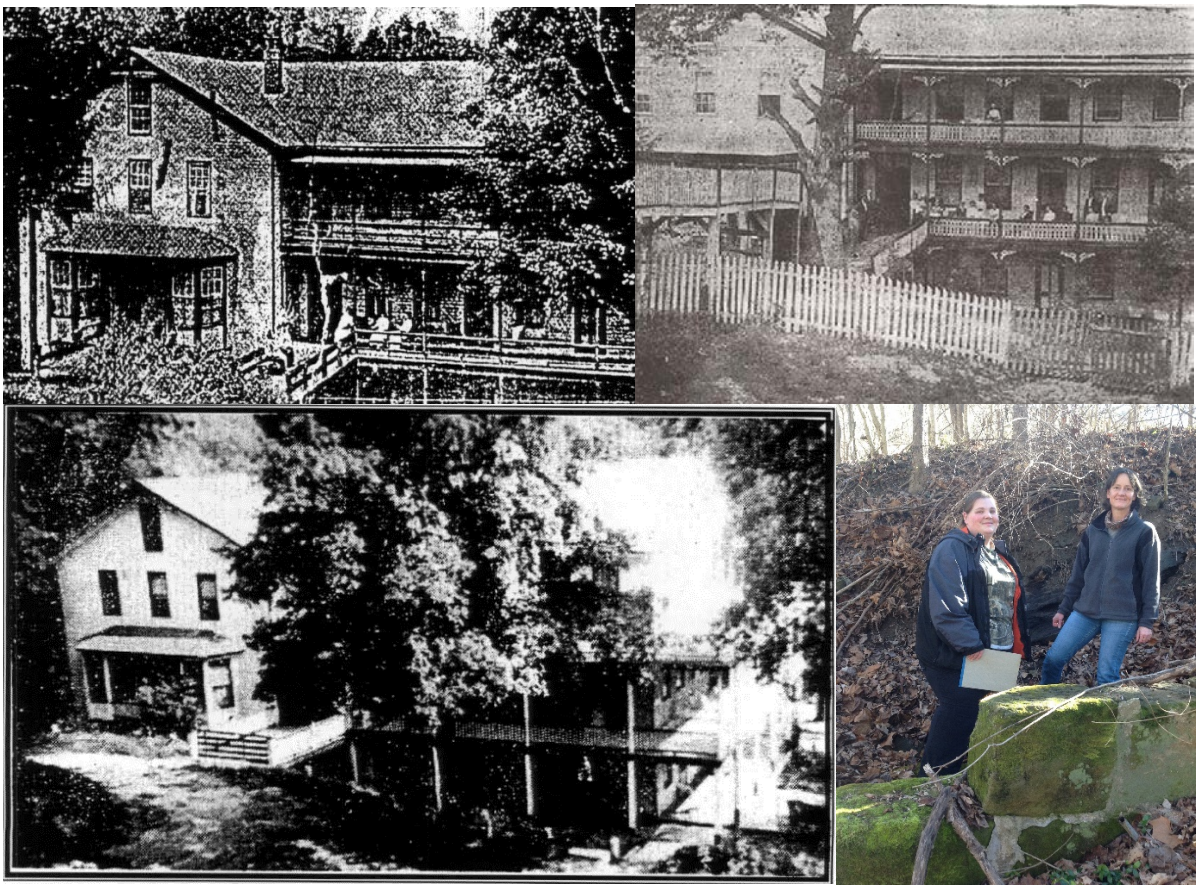

Figure 6: Hotel (top left) date unknown, Hotel (top right) date 1901, Hotel (bottom left) 1940, Hotel wall remnants (bottom right) 2015 field visit

Another significant source for finding the spring and the hotel was the Department of Transportation archeological survey conducted in 1999 by Michael Baker and Associates. Figures 7 and 8 show the proposed bridge construction site on the Blue Sulphur area of interest. When the images were georeferenced and then overlayed with the lidar data and aerial photos to align the hotel and spring footprint, the determined site boundary for the State survey was incorrect. The hotel was, in fact shifted to the east of the set boundary. The elevation recorded by the archeological site survey was determined to be approximately 560 feet above mean sea level.

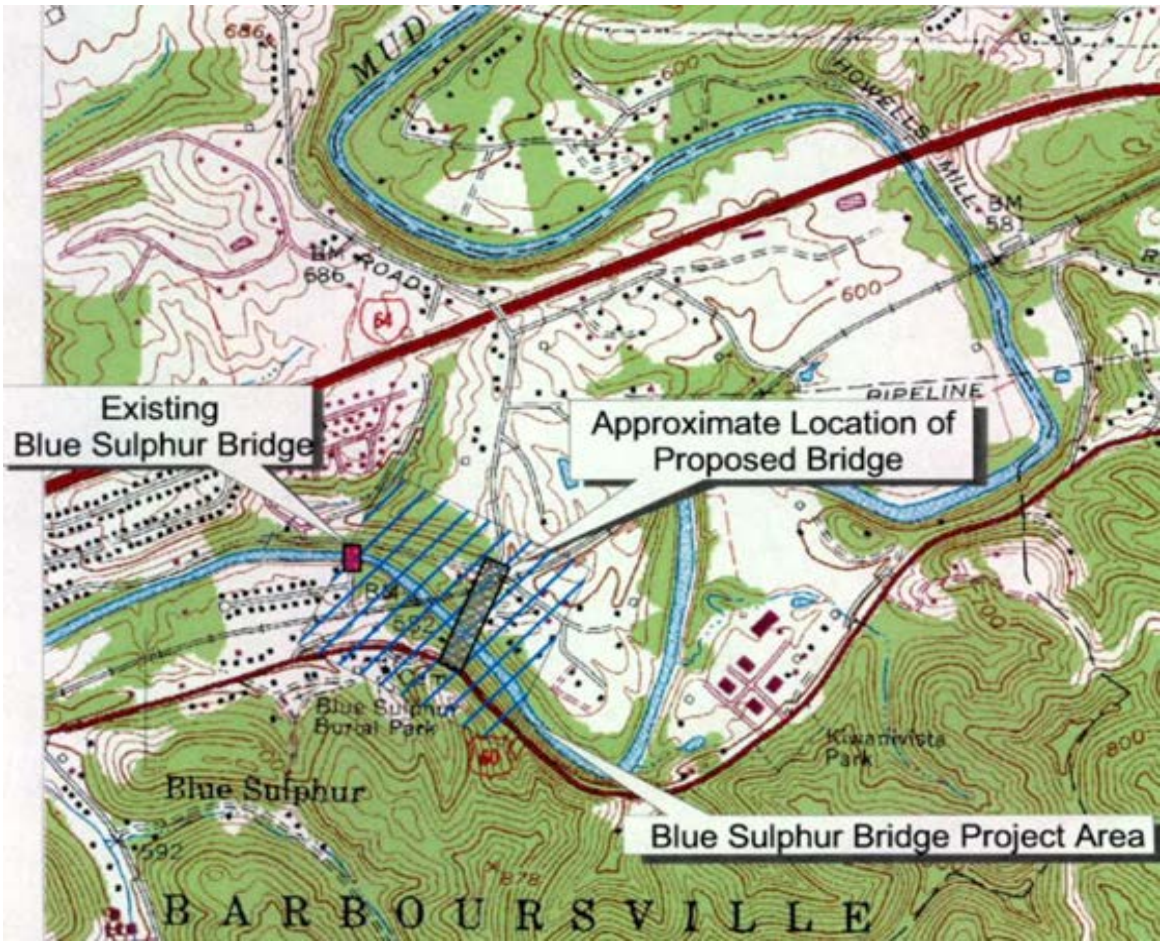

Figure 7: 1979 USGS Milton Quad proposed bridge location, Department of Transportation

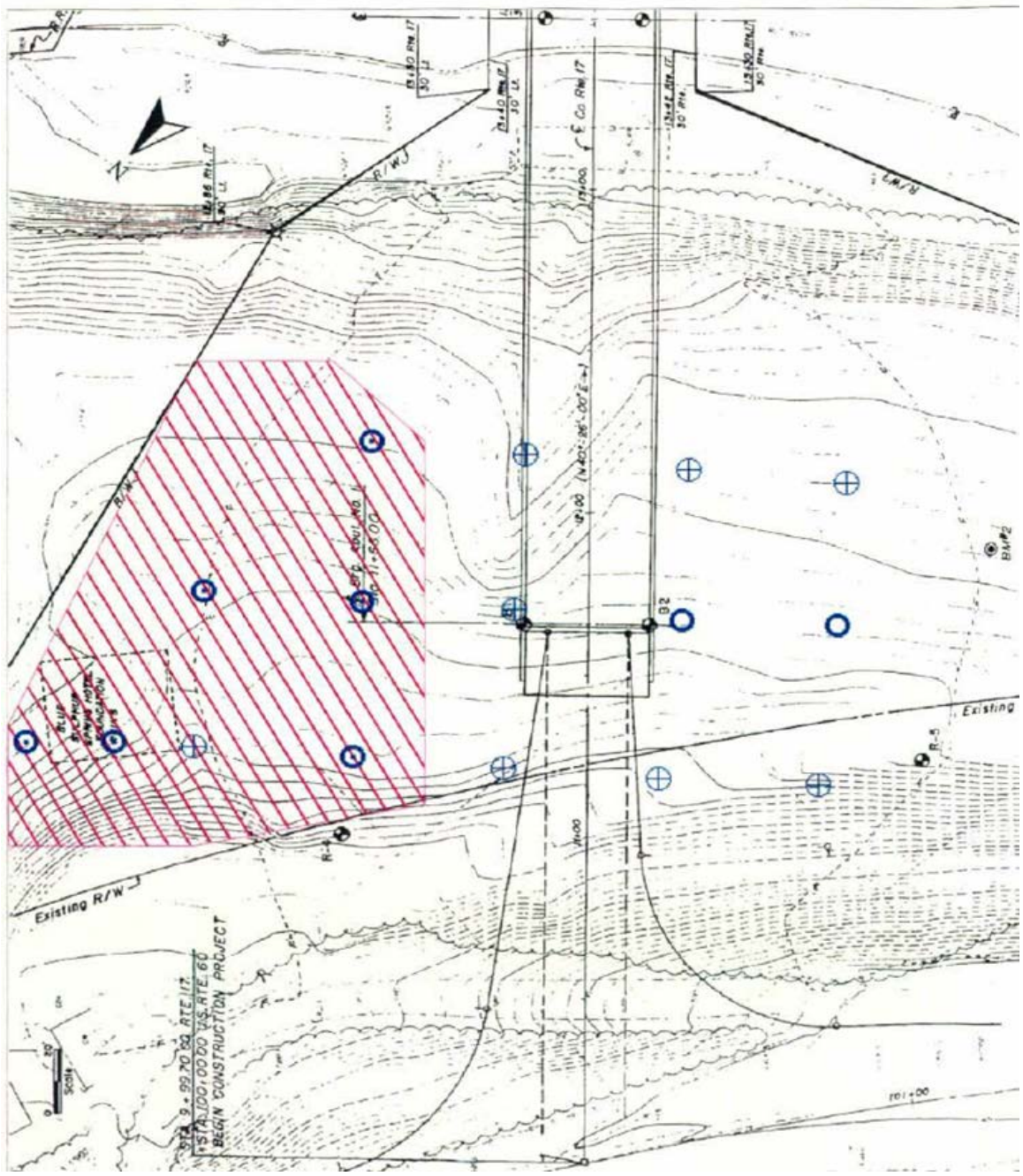

Figure 8: Figure 8: 1999 Archeological Survey of AOI, Department of Transportation: Red hashed area is historic site boundary, Blue circles with dotted center are positive probes (artifacts found), Blue circles with no fill are negative probes (artifacts not found), Blue circles with plus symbol in center is area that isn't probed due to constraints in field work done by the archeological surveying team

Based on the analysis of the aerial images and the Lidar data, a footprint of the hotel and passage were created. This allowed for further insight in locating the historical upwelling. The anomaly in the aerial photographs fell within the area between the Mud River and Blue Sulphur hotel. This is where the study indicates the historical spring, located at 38 ° 25’ 7.79” N and 82 ° 14’ 17.21” W. The elevation at the spring location is 548 feet above mean sea level. Figures show the precise location of the hotel and the spring.

CHAPTER IV

DISCUSSION

When the hotel was demolished and the property sat vacant, the land partially weathered and became overgrown with shrubby trees and brush. It wasn't long before no one recalled where exactly the hotel sat and where the regionally known springs once ran. Data collection was difficult due to the lack of recorded history in the area; therefore, aerial photographs have been an invaluable source of input data for this study in that they helped narrate a brief locational history of the empty hotel and lost spring. Anyone who was old enough to remember visiting the spa has seen approximately 60-75 years pass since the hotel last stood, which introduced many possibilities of recall error into the oral accounts used to corroborate the documented data sources.

The difficulty in this study was the problems getting the data to work with ArcMap. This study provides evidence to show the approximate location of the erstwhile Blue Sulphur Spring Hotel and that of the Sulphur springs that was behind the hotel according to historical documents. A great deal of change has occurred in the landscape of the surrounding area of the lost Sulphur spring, once highly prized for its unpalatable waters. These changes are most notable in the 1971 aerial photograph of the site where the hotel once stood (Figure 6), which revealed a landscape devoid of any cultural artifacts.

The location of the spring is still not as absolute or dramatic as that of the hotel. However, this research has put forth a case for potential future research in refining its conclusion about the spring's location, including possibly conducting chemical analyses

of the waters at the site of the hotel. Determining the exact location of the spring would benefit a variety of interested parties, such as landowners, environmental agencies, and local historians, for a host of reasons ranging from mineral rights to historical site preservation.

In conclusion, the location of the Blue Sulphur Springs Resort Hotel in Cabell County, West Virginia, which has for a long time only been rather hazy, can now be referred to with a good degree of accuracy. While the pin-point location of the basis of the hotel's primary business – the Sulphur spring – remains unknown, this study has made a significant first step for determining its exact location if appropriate data become available in the future. Remote sensing and GIS techniques are of tremendous utility, as demonstrated in this study, for analyzing such data.

The importance of finding the location of the spring cannot be over-emphasized in light of the individual, public (government), and corporate interests mentioned above. As well, there are health considerations that make determining its exact location a worthwhile exercise. As the long-practiced tradition of balneotherapy continues to catch the attention of people seeking alternative medicine, particularly in this era of growing public interest in the widely believed healing benefits of therapeutic landscapes (Gesler, 1992), the need to know where "lost" Sulphur springs in the nation, such as the Blue Sulphur springs in Barboursville, West Virginia, are located, will continue to be paramount.

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APPENDIX A

MARSHALL UNIVERSITY
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Office of Research Integrity
Institutional Review Board

February 25, 2015

Lora Meadows
83 William Rice Ln
Wayne, WV 25570

Dear Ms. Meadows:

This letter is in response to the submitted thesis abstract to examine the location of the 19th century historic Blue Sulphur Hotel and Sulphur Springs Resort located in Cabell County, West Virginia. After assessing the abstract it has been deemed not to be human subject research and therefore exempt from oversight of the Marshall University Institutional Review Board (IRB). The Code of Federal Regulations (45CFR46) has set forth the criteria utilized in making this determination. Since the information in this study does not involve human subjects as defined in the above referenced instruction it is not considered human subject research. If there are any changes to the abstract you provided then you would need to resubmit that information to the Office of Research Integrity for review and a determination.

I appreciate your willingness to submit the abstract for determination. Please feel free to contact the Office of Research Integrity if you have any questions regarding future protocols that may require IRB review.

Sincerely,

Bruce F. Day, ThD, CIP
Director

APPENDIX B

Entity ID	AR1VED000010047	AR1VBPE00010054	AR1VCOZ00010114	AR1VCOZ00010196	AR1VMF000050046	AR1VMF000050047	AR1VED000010018
Recording Technique	Vertical Cartographic	Vertical Cartographic	Vertical Cartographic	Vertical Cartographic	Vertical Cartographic	Vertical Cartographic	Vertical Cartographic
Project	VED00	VBPE0	VCOZ0	VCOZ0	VMF00	VMF00	VED00
Acquisition Date	4/8/1955	3/30/1967	4/16/1971	4/16/1971	4/21/1956	4/21/1956	4/8/1955
Scale	31000	24000	24000	24000	31000	31000	31000
Image Type	Black & White	Black & White	Black & White	Black & White	Black & White	Black & White	Black & White
Quality	Good	Good	Good	Good	Good	Good	Good
Cloud Cover	0 to 9% Cloud Cover	0 to 9% Cloud Cover	0 to 9% Cloud Cover	0 to 9% Cloud Cover	0 to 9% Cloud Cover	0 to 9% Cloud Cover	0 to 9% Cloud Cover
Photo ID	1VED000010047	1VBPE00010054	1VCOZ00010114	1VCOZ00010196	1VMF000050046	1VMF000050047	1VED000010018
Flying Height in Feet	15500	12000	12000	12000	15500	15500	15500
Film Length and Width	229mm x229mm	229mm x229mm	229mm x229mm	229mm x229mm	229mm x 229mm	229mm x 229mm	229mm x 229mm
Focal Length	154.28 mm	152.57 mm	152.57 mm	152.57 mm	152.23 mm	152.23 mm	154.28 mm
Stereo Overlap	60 Percent	60 Percent	60 Percent	60 Percent	60 Percent	60 Percent	60 Percent
Center Latitude	38°23'42.53"N	38°25'06.74"N	38°26'16.38"N	38°24'45.78"N	38°26'12.95"N	38°24'30.15"N	38°26'11.69"N
Center Longitude	82°14'54.93"W	82°14'16.18"W	82°14'25.03"W	82°14'44.47"W	82°13'53.15"W	82°13'51.38"W	82°14'32.47"W
NW Corner Lat	38°25'35.89"N	38°26'34.99"N	38°27'41.20"N	38°26'09.41"N	38°28'09.55"N	38°26'30.67"N	38°27'55.22"N
NW Corner Long	82°17'14.82"W	82°16'03.85"W	82°16'17.09"W	82°16'37.95"W	82°16'08.73"W	82°16'01.27"W	82°17'04.24"W
NE Corner lat	38°25'32.63"N	38°26'31.45"N	38°27'44.51"N	38°26'15.06"N	38°27'59.59"N	38°26'12.36"N	38°28'11.07"N
NE Corner Long	82°12'30.88"W	82°12'24.01"W	82°12'37.18"W	82°12'58.19"W	82°11'24.89"W	82°11'18.21"W	82°12'20.83"W
SE Corner Lat	38°21'49.27"N	38°23'38.55"N	38°24'51.61"N	38°23'22.22"N	38°24'16.44"N	38°22'29.74"N	38°24'28.24"N
SE Corner Long	82°12'35.15"W	82°12'28.59"W	82°12'33.04"W	82°12'51.08"W	82°11'37.67"W	82°11'41.60"W	82°12'00.82"W
SW Corner Lat	38°21'52.53"N	38°23'42.09"N	38°24'48.29"N	38°23'16.57"N	38°24'26.39"N	38°22'48.04"N	38°24'12.42"N
SW Corner Long	82°17'18.84"W	82°16'08.29"W	82°16'12.80"W	82°16'30.69"W	82°16'21.27"W	82°16'24.42"W	82°16'43.99"W
Center Latitude dec	38.395148	38.418539	38.437882	38.412718	38.43693	38.408376	38.436581
Center Longitude dec	-82.248591	-82.237829	-82.240285	-82.245687	-82.23143	-82.23094	-82.242352
NW Corner Lat dec	38.426636	38.443054	38.461444	38.435947	38.46932	38.441854	38.46534
NW Corner Long dec	-82.287449	-82.267737	-82.271413	-82.277208	-82.269093	-82.26702	-82.28451
NE Corner Lat dec	38.42573	38.442069	38.462365	38.437518	38.466554	38.436766	38.469741
NE Corner Long dec	-82.208579	-82.206669	-82.210327	-82.216164	-82.190248	-82.188393	-82.205786
SE Corner Lat dec	38.363686	38.394041	38.414335	38.389505	38.404566	38.374927	38.407845
SE Corner Long dec	-82.209765	-82.207941	-82.209177	-82.214188	-82.193798	-82.19489	-82.200228
SW Corner Lat dec	38.364593	38.395025	38.413415	38.387935	38.407331	38.380011	38.403449
SW Corner Long dec	-82.288567	-82.268969	-82.270223	-82.275191	-82.272576	-82.27345	-82.278886