The Subsurface Mysteries of Wardenclyffe Revealed

Peter J. Hutchinson and Alex Balog

Abstract

Before the turn of the twentieth century, Nikola Tesla experimented with inducing a frequency into the earth to transmit electric current, wirelessly, to distant receivers. Tesla built a laboratory and tower with underground tunnels in the town of Shoreham, New York, from 1902 to 1903. He called the site Wardenclyffe, but the nature and purpose of the underground tunnels to the 57-m-tall tower remain a mystery to this day.

Electrical imaging and microgravity measurements provide definitive evidence for the location of four orthogonally placed tunnels and two support tunnels. Electromagnetic terrain conductivity measurements, however, provided no information as to the presence of the tunnels leading from the shaft and only imaged the cement grout used to seal the shaft. The tower footing, imaged with a proton precession magnetometer, consists of an extensive ferrous infrastructure within the concrete footing and possibly a landing to the stairway that reportedly extended to the base of the shaft.

Ultimately, the presence of support structures and deeper tunnels is confirmed through geophysical methods. Although speculation still remains as to their full purpose, the deep tunnels seem to have been constructed to increase earth coupling for grounding and/or to initiate standing waves for the projection of electricity to remote locations.

Starting in 1900, Nikola Tesla began construction of an imposing tower over the landscape of eastern Long Island, New York (figure 1). Wardenclyffe (or Wardencliff)[1] was eponymously named after the former owner of the property, James S. Warden, and was originally designed to compete with Guglielmo Marconi in the race to transmit wireless messages across the Atlantic, a race that Marconi probably won in 1901. However, while Marconi's intent only went so far as the wireless

Figure 1. Wardenclyffe Tower with laboratory in foreground, 1904 *(view from north)*. Arthur B. Reeve, "Tesla and his Wireless Age," *Popular Electricity* 4, no. 2 (1911): 97.

Peter J. Hutchinson and Alex Balog, "The Subsurface Mysteries of Wardenclyffe Revealed," *IA: The Journal of the Society for Industrial Archeology* 42, no. 1 (2016): 55–67.

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transmission of information, Tesla aimed to build a system that could transmit wireless information and electrical energy at global scales.[2]

In order to finance his ambitious plans for Wardenclyffe, Tesla turned to one of the most prominent financiers and bankers of the time, J.P. Morgan, and eventually convinced him to invest $150,000 in the project.[3] Eager to invest in the newly emerging wireless technology, Morgan may have viewed Tesla as a viable alternative after negotiations to purchase Marconi's American patents fell through.[4] Tesla, however, hoping to expand on his earlier research in his Colorado Springs Experimental Station, found that financing would become a major obstacle as he attempted to bring his idea into reality. Perhaps foreshadowing the eventual fate of the Wardenclyffe project, the Colorado Springs Electrical Company sued Tesla for unpaid power consumption and sold the lumber and piping at that site to service the $180 judgement.[5]

Although Tesla never explicitly described how his Wardenclyffe facility would operate, his 1905 patent application indicates that it would operate in a manner similar to the Colorado Springs facility.[6] Wardenclyffe included a series of transformers, capacitors, and controls in the adjacent laboratory that allowed Tesla to send variable frequency, high voltage current to his tower via underground conduits (figure 2). At the Wardenclyffe tower site, the current was magnified by a transmitter and pumped into an extensive subsurface grounding system with the intention of generating many kilometer-long standing waves in the earth.

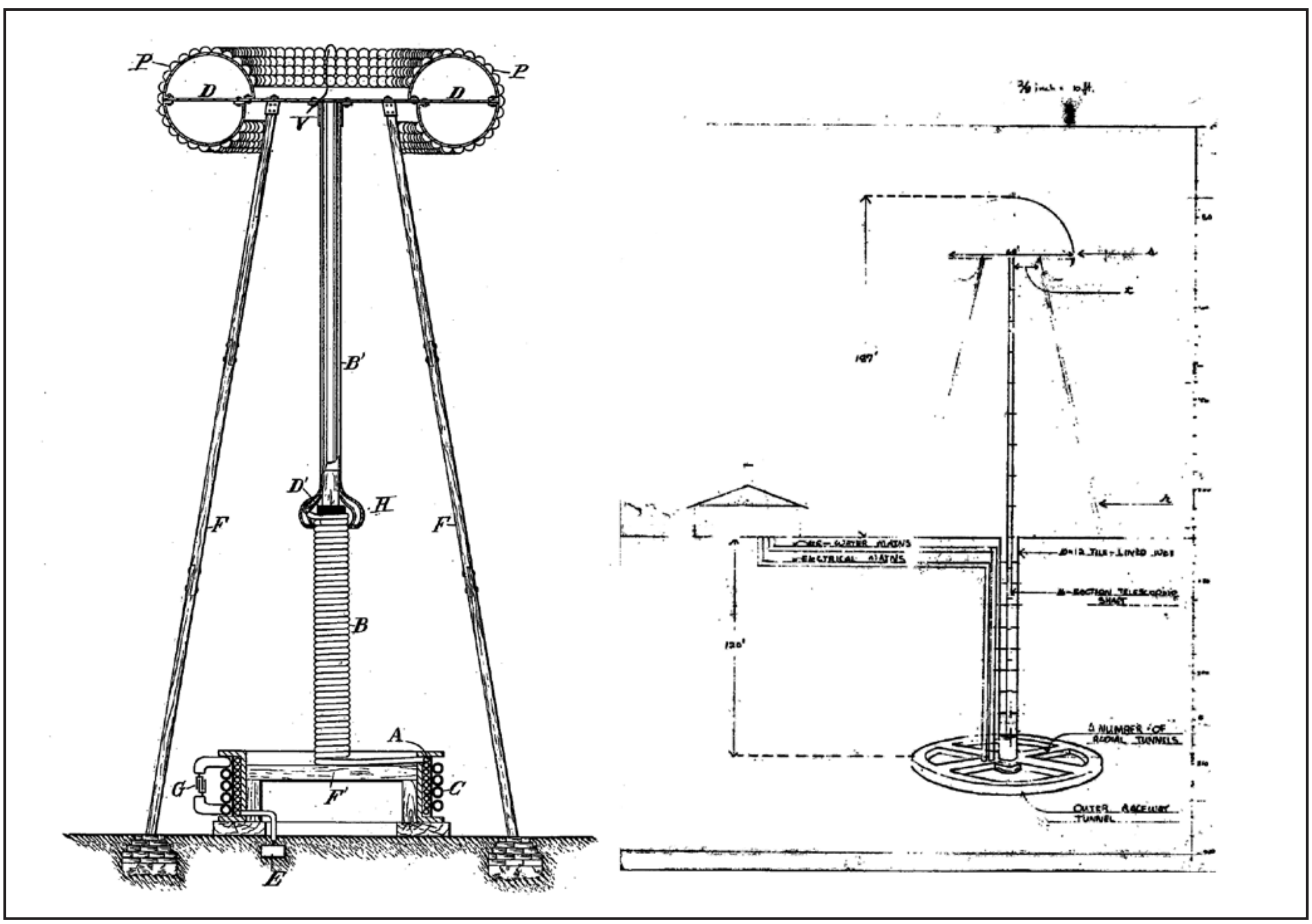

Figure 2. Hand-drawn sketch (*right*) possibly by Tesla with schematic (*left*) for Tesla's magnifying transmitter in "Apparatus for transmitting electrical energy." US Patent 1,119,732, filed January 18, 1902.

According to Tesla's 1914 patent, a magnifying transmitter was installed at the base of the tower. Additionally, wireless telegraphy could be achieved with a microphone/telegraph key connected to the magnifying transmitter primary coil to produce variations in intensity of the waves on the order of approximately 200 kw. The biography of Tesla composed by his lifelong friend, John J. O'Neill, explains how Tesla envisioned his tower would function: Tesla theorized that a current wave would travel through the earth in a straight path from his station to a receiver. If the current wave was at the earth's resonant frequency, this flow would produce an accompanying standing wave of current along the earth's surface. Once the earth was vibrating at its resonant frequency, power and telegraphy could be picked up wirelessly by simply connecting a receiver to the ground.[7]

The 57-m tall Wardenclyffe tower was topped with a 21-m diameter metallic hemisphere.[8] To support this 242,000-kg structure, an octagonal tower design was selected and built with pine timbers to insulate the elevated metallic hemisphere from the ground. While the above-ground structures are well documented in photographs, the more intricate and ultimately expensive subsurface components of the Wardenclyffe facility beneath the tower remain poorly documented.[9]

In an attempt to increase the potential reach of wireless power and telegraphy from the tower, Tesla extended the "height" of his tower by excavating a shaft directly beneath it. Tesla's prior research showed him that the length of the secondary in his magnifying transmitter was directly proportional to the wavelength it could produce.[10] Since longer frequency wavelengths can travel further through the earth with lower attenuation, increasing the secondary length at Wardenclyffe through a shaft allowed Tesla's tower to have a greater reach.

To accomplish this increase in the length, a 3.7-m^2 shaft was dug to 36.6 m below grade directly beneath the tower. The walls of the shaft were lined with 20-cm thick timbers and finished with brick and cement. A winding staircase descended to the base of the shaft. To properly initiate a stationary wave, Tesla grounded the tower with sixteen 100-m-long iron pipes pushed radially out from the center of the base of the shaft.[11]

Six tunnels composed of brick (clay), cement, ferrous metal, and wood, were constructed at Wardenclyffe from 1901–1902. Four man-sized tunnels of conflicting reported lengths were dug from the bottom of the excavation and sloped up towards the surface. The purpose of these sloping tunnels has been a matter of some debate—and indeed, Tesla himself fueled speculation by refusing to explain the tower and installation.[12] Numerous suggestions, however, have been proposed: the tunnels were filled with warm water to increase grounding of the facility; they were safety valves to allow excess pressure to escape from the subsurface; they helped to resonate the aquifer below the tower; and/or they simply served as an alternative access to the base of the tower.[13]

In addition to these four tunnels, Tesla's 1922 court appeal proceedings for the eventual debt-related issues surrounding the Wardenclyffe site revealed that there were two more tunnels connecting the main laboratory building to the tower. While one of these tunnels housed the large electrical mains that supplied power to the tower, the other was used for a variety of purposes, including "communicating, for bringing into the tower compressed air and water and such things as I might have needed for operations."[14]

Unfortunately, Tesla's financing ended before he could finish the construction. The Wardenclyffe facility was never put into operation, and the tower was razed in 1917. Since then, researchers have puzzled over the nature, extent, and purpose of the subsurface installations.

Site History: Post-Tower Construction

Although the lapse in funding by 1906 prevented Tesla's facility from ever reaching completion, Tesla's tower loomed over the landscape of northern Long Island for another dozen years. While Tesla was beginning to have trouble with funding the completion of Wardenclyffe, he mortgaged the property in 1904 and again in 1908 to George C. Boldt, owner of the Waldorf-Astoria Hotel in New York City, to cover his living expenses in the hotel. By 1915, Tesla had accumulated $20,000 in debt to the hotel, and had to relinquish the deed for Wardenclyffe as payment. In 1917, Boldt had the tower demolished (figure 3).[15] Rumors claimed that the military, concerned that the tower could be used by spies, requested to have the tower removed as part of the United States' involvement in the First World War.[16] In reality, the tower was destroyed to salvage the scrap, likely to partially recoup Boldt's financial losses. Perhaps a testament to the structural integrity of the tower, the initial dynamite blasts intended to bring the tower down merely caused it to tilt, and it took more than a month to demolish it completely.[17] The final link of Tesla's ownership of the Wardenclyffe site came to an end after he lost a 1922 appeal of judgment on Boldt's foreclosure of the property (figure 4).[18]

The property was mostly idle until 1939, when Peerless Photo Products, Inc. (subsequently Agfa-Gaevert, Inc.) used the facility to process photographic materials. From 1939–1979, untreated photochemical process water was discharged into several 244 × 8-m recharge basins located just north of the original laboratory. The shaft below the tower may also have been used to dispose of unknown chemicals. Manufacturing activities at the site were discontinued in 1987 and chemical processing equipment at the site was either cleaned or removed altogether.[19] Friends of Science East, Inc., after an extensive grassroots campaign, purchased the property in May 2013 and established the Tesla Science Center at Wardenclyfffe.[20]

Site investigations and remediation were completed between 1994 and 2008 under the New York State Department of Environmental Conservation's inactive hazardous waste site program. These remedial measures were aimed at removing or isolating heavy metal contamination linked to the photochemical process water including cadmium, chromium, mercury, and silver. Contaminated soils in the recharge basin and at the Tesla tower base were excavated and disposed off-site. Environmental Protection Agency (EPA) documents indicated that the internal portion of the tower base was excavated to *c.*10 m below grade with the depth determined by the maximum digging depth of the machinery.[21]

Throughout the twentieth century, several encounters with Tesla's subsurface structures were reported. In early 1979, a volunteer fireman for the Rocky Point Fire Department substation located just east of the Wardenclyffe tower site "stumbled across a dome made of bricks in the ground" in a wooded field.[22] As a safety measure, the fire department requested that the Brookhaven Town Highway Superintendent Harold Malkmes fill in the hole. Prior to complying with this request, and at the protest of the Suffolk County Archeological Association, he first excavated alongside the structure and discovered that the dome was "the top of an 8-foot-deep shaft lined with bricks" and a "stone floor."[23]

Reporting for this discovery in *Newsday* prompted several other accounts to surface involving the subsurface structures. On property where the tower once stood, Peerless Photo's maintenance manager told fire department officials that the tunnels "were thought to have caused several cave-ins in the area."[24] These cave-ins would be consistent with the tunnels' aging brick support structures built in the loose, unconsolidated sediment found under the Wardenclyffe facility.

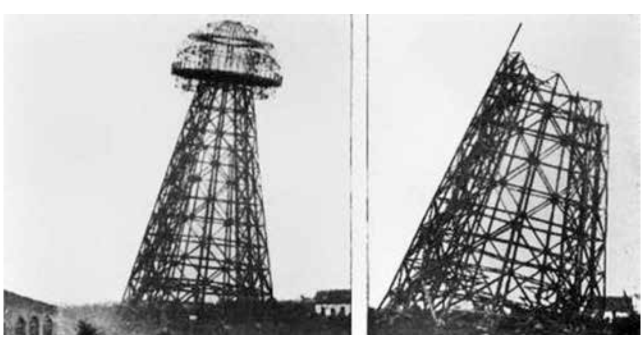

Figure 3. Photo of the partial demolition of the tower at Wardenclyffe, July 1917. Initial dynamite blasts failed to bring the tower down; it took until September 1917 to raze it completely. *The Literary Digest* 55, no. 8 (1917): 25.

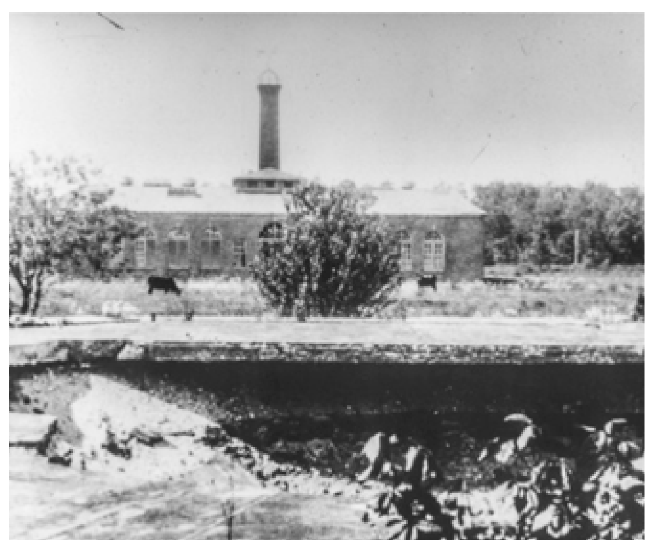

Figure 4. Photo of the laboratory from the foundation of the demolished Tower. Note the excavated shaft (*foreground*) near the foundation. WP025, Tesla Wardenclyffe Project Photo Archives, Shoreham, Long Island, NY.

Further, Edwin J. Binney, a senior resident of the area, recalled exploring what was likely the main central shaft near the tower base with some friends around 1920 (figure 4). Binney claimed they used a rope to lower themselves into a deep hole that was shored up by rotting timbers. They found some pipes at the bottom.[25] These pipes may have been part of the sixteen 100-m-long iron pipes pushed radially out from the center of the base of the shaft.[26] *Newsday* reported that Binney had a written account from a boyhood friend stating that he “dropped a steel tape down and it showed it was 112 feet deep.”[27] This is only approximately 2.5 m less than the depth reported by Tesla during his 1922 foreclosure appeal, which would be consistent with accumulated debris from the tower demolition and minor collapse from deterioration.[28]

Geophysical Methods

Prior to this investigation, a systematic geophysical examination had not been deployed to resolve the extent and nature of the subsurface construction. At some point *c.*2010, a limited ground penetrating radar (GPR) survey was performed by an unknown party.[29] The results, however, were reportedly equivocal as the GPR survey imaged to a depth of less than 2 m. No additional information is available.

We are providing here the results of four different extensive and detailed near-surface geophysical surveys that were integrated with a differential global positioning system (DGPS): electrical resistivity imaging (EI); frequency-domain electromagnetic terrain conductivity (FDEM); magnetometer (MM); and microgravity (GRAV). These surveys were initiated by and conducted for the History Channel and the Tesla Museum, presumably to be presented as a television show. These surveys have helped to elucidate the subsurface structures, although it should be noted that the findings may have been adversely impacted by urban noise and some of the data generated may be spurious.

The surface features visible throughout much of Long Island, including the Wardenclyffe facility, are largely the result of the most recent pulses of the Wisconsinan glaciation that occurred *c.*21,000 years ago. The Ronkonkoma and Harbor Hill terminal moraines mark the extent of the glacial ice sheet, where the accumulation of rock debris along the melting fronts formed a pair of roughly parallel ridges along the length of Long Island.[30] The Wardenclyffe tower site is situated just south of the Harbor Hill Moraine along the northern shore.

Despite excavating to an impressive depth of 36.6 m for his shaft, Tesla’s subterranean structures were contained entirely in unconsolidated glacial outwash sediments, consisting of sand, gravel, and loose rock deposited from glacial meltwater in thick, outwash plains that fanned-out south of the glacier.[31] The shaft was reported by Tesla to have reached water at approximately 24 m below grade when excavating his tower base (current measured water levels are approximately 9 m below grade).[32]

We conducted four geophysical tests consisting of ER, MM, GRAV, and FDEM surveys at the Wardenclyffe site to image the possible subsurface structures installed in support of Tesla’s wireless transmitter device. Two of the tests, MM and FDEM, are non-contact continuous surveys, where the operator collects data by walking the subject area in a dense grid while the MM and FDEM meters collect and compile the data with the DGPS data. The ER survey is a contact survey and collects data for the construction of a two-dimensional geo-electrical profile. The GRAV uses a sounding meter that is stationed, laboriously levelled, and stabilized at a point prior to data collection.

The FDEM data were collected to image the subsurface for conductive soils and ferrous metal. We used an Overhauser precession MM in a gradiometer mode to detect ferrous metal in the subsurface. These two tools have no vertical acuity. The ER survey is collected in a fixed geometry and the presentation is a geo-electrical cross section of the site. The GRAV meter has limited vertical acuity but has excellent capabilities in detecting minor changes in subsurface density.

An FDEM meter is used to measure the electrical conductivity of subsurface soil, rock, and ground water. The electrical conductivity (or its inverse, resistivity) is a function of the porosity, permeability, and the fluids in the pore spaces.[33] Sand, for example, does not affect the electrical conductivity reading because it is electrically neutral and therefore has no impact on the results. The absolute values of conductivity obtained in a survey are not necessarily diagnostic but the variations in conductivity can be used to identify anomalies.

The FDEM tool consists of a transmitter coil that radiates an electromagnetic field. The electromagnetic field induces eddy currents in the earth that generate a secondary electromagnetic field proportional to the magnitude of the current flowing within the coil. Quadrature component of the secondary magnetic field is captured by the receiver in the form of an output voltage that is linearly related to subsurface conductivity. The terrain conductivity value is an average conductivity of the 6-m effective depth of the survey tool.[34]

The Overhauser-effect proton free-precession resonance MM operates by applying a radio frequency-induced magnetic field to a coil in a proton-rich fluid. In simple terms the magnetic field induces protons to align themselves to the new magnetic field direction. When the applied field is discontinued, the excited protons precess to the ambient field at the Larmor precession frequency, which is proportional to the magnetic field strength; and this realignment emphasizes anomalies from shallow targets and minimizes noise from long-wavelength features.[35]

The resonance MM was deployed in a gradiometric mode for the survey. Gradiometers work by measuring the difference in the magnetic field strength between two identical precession-type magnetometers separated vertically by a small distance (i.e., 1 m). The advantage to this type of survey is that it collects differential measurements with both sensors operating at the same time, so there is no need for a diurnal variation correction.[36]

The measure of the resistance along a linear distance of a material with a known cross-sectional area is referred to as apparent resistivity and is measured in ohm-meters. Such data can be presented as two-dimensional geo-electrical profiles known as tomographs, of modeled resistivity versus depth. Electrolytic conductivity is the dominant material property, of the three material properties that influence the apparent resistivity values collected by this method. Consequently, apparent resistivity values decrease in water-bearing rocks and soil with increasing fractional volume of the rock occupied by groundwater, total dissolved solid and chloride content of the groundwater, permeability of the pore spaces, and temperature.[37]

GRAV measurements, unlike the other tools used in this survey, are not readily impacted by cultural noise. Consequently, GRAV measurements can be collected in buildings and adjacent to urban development. GRAV has been used for many geologic purposes, but the environmental geophysicist uses it to determine the presence of subsurface voids, to image subsurface bedrock topography, and to find the depth of waste. GRAV measures the acceleration due to the earth's gravitational field using an astatic spring mechanism. Small changes in rock density produce small changes in the gravity field that can be measured by the GRAV. These readings change from day to day due to tidal response and lunar pull, among other phenomena, that have an impact on the earth's gravitational flux. Raw gravity readings are corrected for latitude, elevation, Bouguer (measurement height and the attraction of the terrain), tidal, and terrain and are presented in units of acceleration.[38] These corrections are fairly complex and a discussion of the processing of GRAV data is beyond the scope of this manuscript.

Discoveries at Wardenclyffe

In an urban setting, geophysical data can be rife with spurious noise. Consequently, data collection must be done in areas with the least potential for the introduction of noise into the data set. Good collection techniques require avoiding these data traps although with limited space that is often difficult. Most commonly with FDEM, the tool will saturate on a metal fence or from metal on the ground. With EI, the measurement of the earth's response to the injection of current can be adversely impacted by stray current from poor grounding of buildings and other urban structures. The magnetometer's measurement of the earth's magnetic flux can be disturbed by surface metal and structures such as buildings and fences.

Despite the pitfalls of data collection, these surveys were collected at Wardenclyffe with the utmost care so as to avoid urban noise. The 1.4-ha (hectare) area of interest is located between the former Tesla laboratory to the north, State Route 25A to the south, and Tesla Street to the east (figure 5). The subject area includes the Wardenclyffe tower foundation or, more appropriately termed, its footing.

The tower foundation is an octagon, 28 m edge-to-edge (i.e., diameter) and each edge is approximately 11 m long. Exposed at each of the vertices are 50 cm^2 granite blocks buried into the ground to an unknown depth. The center of each edge also contains a granite block of similar dimensions. The stub of a 5-cm diameter rebar is vertically exposed in the center of each of the sixteen blocks. The blocks are connected by weathered concrete curbs of an unknown depth that are each *c.*10 m long and 50 cm wide.

The MM and FDEM surveys were initially performed at the Wardenclyffe site due to their ease of deployment as continuous measurements when integrated with DGPS. These surveys imaged, respectively, the presence of ferrous metal and conductive soils that were only found within the tower footprint (figure 6). Despite the shallow focus of the MM and the FDEM tools, these methods can detect foundations and near-surface phenomena.

The MM survey covered the entire 1.5-ha area of interest but only detected ferrous metal within the tower footprint. This survey indicates that the footing for the octagonal Wardenclyffe tower contains a significant but indeterminate concentration of ferrous metal. The MM clearly imaged the stub of a vertical rebar within each of the sixteen granite blocks. The presence of the evenly spaced metal around the perimeter confirms the complexity of the footing that supported the tower. While metal was only visually observed as a vertical stub in the center of the granite blocks, we can conclude that the footing consists of reinforced concrete.

The presence of metal within the interior of the Wardenclyffe tower footprint may also suggest the presence of the metal platform or other supporting structures. Reports indicate that there was a platform for the stairway into the central shaft: “In the centre of the wide concrete platform which serves as the base for the structure there is a wooden affair very much like the companionway on an ocean steamer.” While workers for Tesla tried to claim that this was merely for “a small drainage passage built for the purpose of keeping the ground about the tower dry,” locals believed that it led

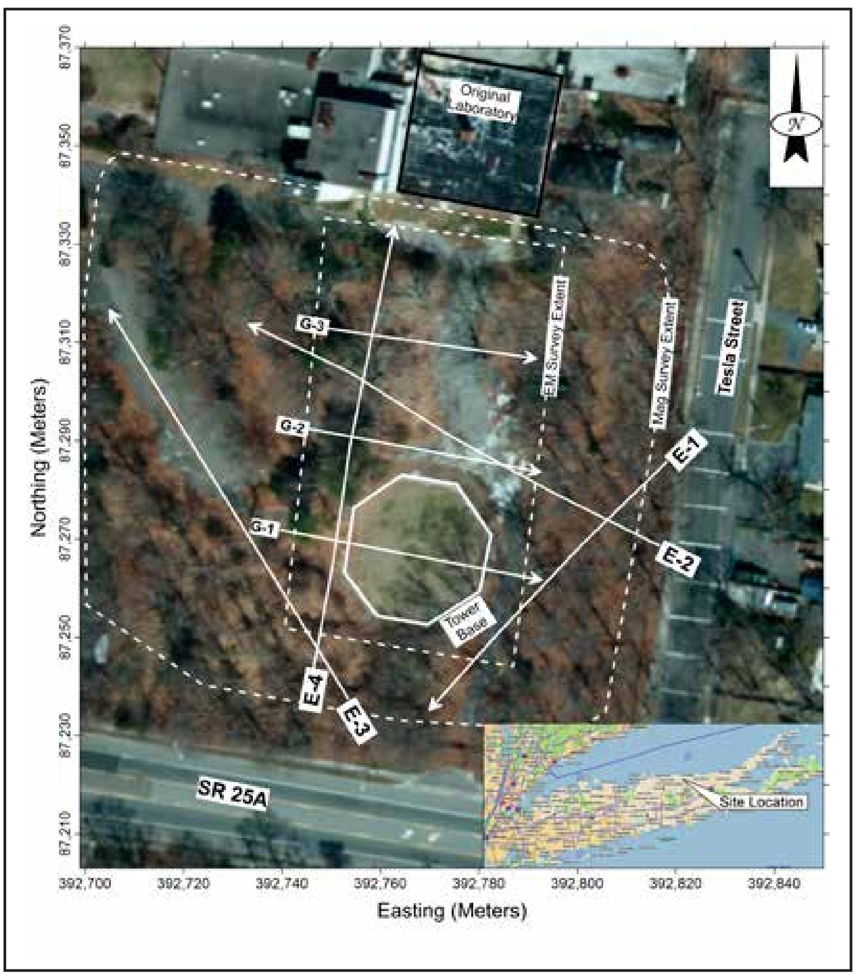

Figure 5. Wardenclyffe plan map showing data collection areas and profile locations. Arrows point in direction of profile data collection. Base map from USGS Earth Explorer (2014) set to Long Island State Plane coordinate system in meters with inset of Long Island, NY.

to a "well-like structure as deep as the tower is high" and that at the bottom of the spiral staircase within it, "tunnels have been built in all directions, until the entire ground below the little plain on which the tower is raised has been honeycombed with subterranean passages" where Tesla spent much of his time while working at the site.[39] During the remediation of the site the central shaft was excavated to 10 m below grade and backfilled with grout cement.[40] Consequently, there should be no evidence of metal within the shaft. The metal within the footprint of the footing, then, may represent the remanence of the stair platform or the foundation of a support structure for the magnifying transmitter.

The 0.4-ha FDEM survey was conducted ostensibly to image the reported tunnels that traversed the area between the tower and the laboratory. The low conductivity anomaly within the footprint of the tower was the only anomaly detected at the site. Unfortunately, the FDEM only images to 6 m below grade and did not detect the reported tunnels.

During the remedial study of the site in the 1990s, the central vertical shaft was discovered to be the site for the disposal of metallic waste. The presence of the conductive material as detected by the FDEM is consistent with documents that indicate the shaft was backfilled with a cement grout. The amoeboid-like shape to the anomaly is an artifact from data collection. No other metallic or conductive subsurface anomalies, respectively, within the capabilities of the MM and the FDEM, were detected at the site (figure 6).

The historical record mentions six tunnels associated with the tower.[41] Two of the tunnels communicated with the laboratory to the north. Four tunnels radiated from the base of the tower and angled up to the surface, an unknown distance away from the tower and terminated in four small dome-shaped structures.[42] Three gravity profiles collected to image the tunnel voids did indicate the presence of areas of low density that are interpreted to be tunnels (figure 7).

Gravity Profile 1 traversed the tower footprint from west to east and shows low density on the either end of the profile and higher density material within the center of the profile. The elevated density within the center of the profile and within the footprint of the tower reflects the reported excavation of 10 m of material from the center of the tower and back filling with a cement grout. The density of a cement grout (*c.*2.7 g/cm) is much higher than that of the surrounding till (less than 2.0 g/cm).[43] The low-density portions at the

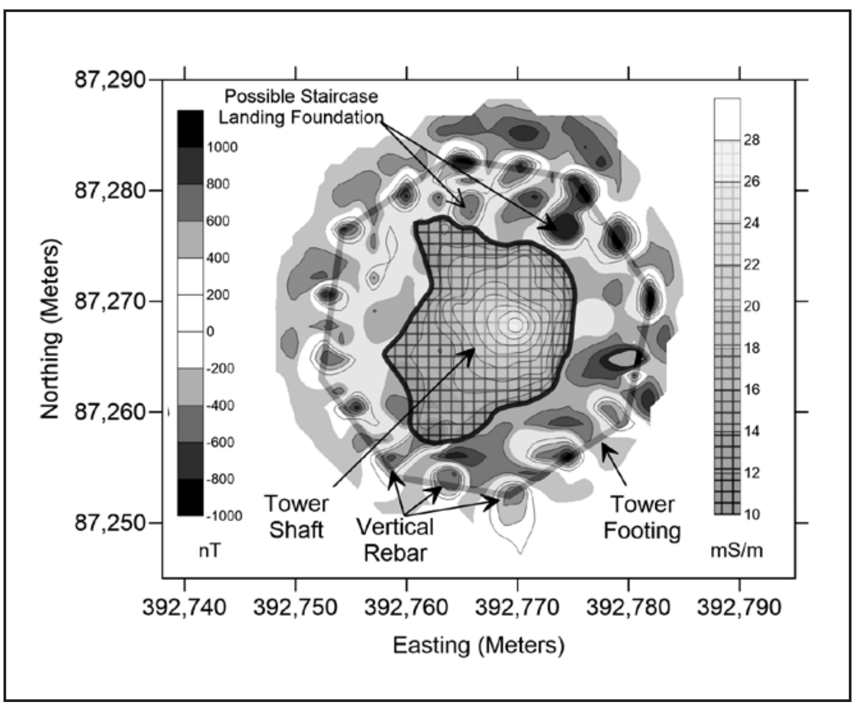

Figure 6. Plan map showing the magnetic susceptibility (nT *in solid grayscale*) and bulk terrain conductivity (mS/m *in crosshatched grayscale*) of the octagonal foundation to the Wardenclyffe Tower foundation.

beginning and end of this profile are interpreted to represent the lateral tunnels emanating from the base of the tower. Unfortunately, no depth can be modelled from this data set.

Gravity Profiles 2 and 3 were collected from the west to east between the former Tesla laboratory and the tower foundation in an attempt to image the horizontal tunnels that connect the tower to the laboratory (figure 7). These profiles detected low density zones consistent with the reported location of two tunnels used for power, water, and air that traversed the site from the laboratory to the tunnel. The narrow (*c.*1-m wide) T-1 exit tunnel may have also been detected within the middle of Gravity Line 3. The coarse data collection (3 m) was unable to clarify the width of these tunnels, probably because the tunnels have collapsed and, based upon density, the loose material from adjacent areas infilled the tunnels and increased their width.

EI survey was constrained at the site due to potential noise from buried electrical wires, increased conductance near chain-link fencing, and the physical limitations of the area. Further, EI is based upon geometric measurements such that the ends of each profile do not reach the full depth of the profile's central readings (figure 8). Nevertheless, four geo-electric profiles were collected and, while not located in the most ideal positions, were more focused towards maximizing the length of the profile, and thus the depth of penetration, and less so to detect subsurface features in a specific area.

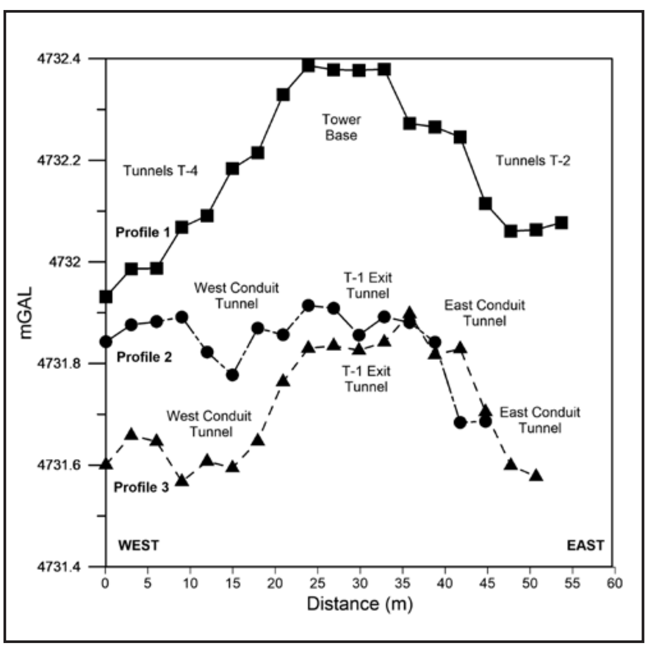

Figure 7. Microgravity profiles showing lower density portions of each profile that are interpreted to be the location of tunnels.

The elevated apparent resistivity as depicted in the geo-electrical profiles of the subsurface is interpreted to represent fresh water within the quartz-rich till (figure 8). The till is interpreted to have minimal to no clay or conductive (i.e., salt) water. The conductive regions of each profile are interpreted to be clay (from mortar or bricks), wood, or metal within the resistive matrix. Four EI profiles collected at the site document the location and depths, to some extent, of the six clay-, wood-, and steel-lined tunnels located at the Wardenclyffe site.

EI line E-1, the eastern-most profile, may have detected the presence of exit tunnel T-2 at a depth of greater than 15 m below grade. Vertical stoping from the collapse of the tunnel or perhaps the construction of the top of the tunnel was imaged at the base of this profile as can be noted with a change in lithology from resistive sand/fresh water to conductive clay/metal. The location of this anomaly—26 m to the east of the tower and at a depth of more than 15 m—is consistent with reports of the presence of one of four radial tunnels from the central shaft that probably surfaced just west of the Rocky Point Fire Department substation (figure 5).[44]

EI line E-2 shows what is likely vertical stoping from exit tunnel T-1, to the north, at *c.*19 m below grade at a distance of 21 m from the tower shaft. Exit tunnel T-1, at 19 m from the shaft, is close to the projected depth of exit tunnel T-2 at a distance of 26 m from the shaft (i.e., more than 20 m below grade). Geometric projections now verify that exit tunnel T-2 occurs at 22 m below grade and 26 m from the shaft.

EI line E-2 also shows the presence of the much shallower east and west conduit support tunnels that provided air, water, and power to the tower. The east tunnel occurs at a shallower depth with the bottom of the tunnel at *c.*6 m below grade. The east conduit tunnel is interpreted to be narrower than 5 m, although this determination is interpretive as noise is present on this profile.

The bottom of the west conduit tunnel, as depicted on profile line E-2, is 10 m below grade and is interpreted to be 8 m wide. This tunnel is most likely the main communication tunnel between the tower and the laboratory. Further, this profile appears to show the collapse of the west tunnel since the "interior" of the tunnel has elevated apparent resistivity readings.

Exit tunnel T-4 is displayed on EI line E-3 at *c*.16 m below grade at a distance of 34 m from the shaft. The depth and distance measurements are consistent with geometric projections of where the tunnel should be found (figure 9).

Possible portions of the presumed collapsed west conduit tunnel, as depicted on EI line E-4 occur 35–45 m from the shaft at a depth of *c*.10 m (figure 8). Since this profile is adjacent to and parallels the interpreted location of the west conduit there is only minimal evidence of the tunnel. However, if the tunnel collapsed, which is very likely, the signature on EI line E-4 could well be the remnant of that tunnel.

Anecdotal data that addressed the tunnels includes the Rocky Point Fire Department discovery of a brick dome in the field on the east side of Tesla Street.[45] Additionally, a void was reportedly encountered during construction of the sewer line in the highway (SR-25A) and is inferred to be exit tunnel T-3 that we interpret to have surfaced on the south side of SR-25A.[46] Our geophysical model coupled with these anecdotal reports help establish the length, location and orientation of the tunnels. The tunnels are interpreted to be 75 m long and dip 30 degrees from the horizontal.

Conclusion

At the turn of the twentieth century, Nikola Tesla began the construction of a facility and tower to energize the world with electricity. This facility, called Wardenclyffe, was Tesla's first major step toward solving the world's energy supply needs with a wireless transmitter. Unfortunately, we may never know exactly how Tesla planned to electrify the earth. Plagued by financial issues (many of his own making), the project was never completed. Further, vandals accessed the laboratory at Wardenclyffe sometime between its abandonment and its demolition and destroyed any documents that might have helped to elucidate the facility's opera-

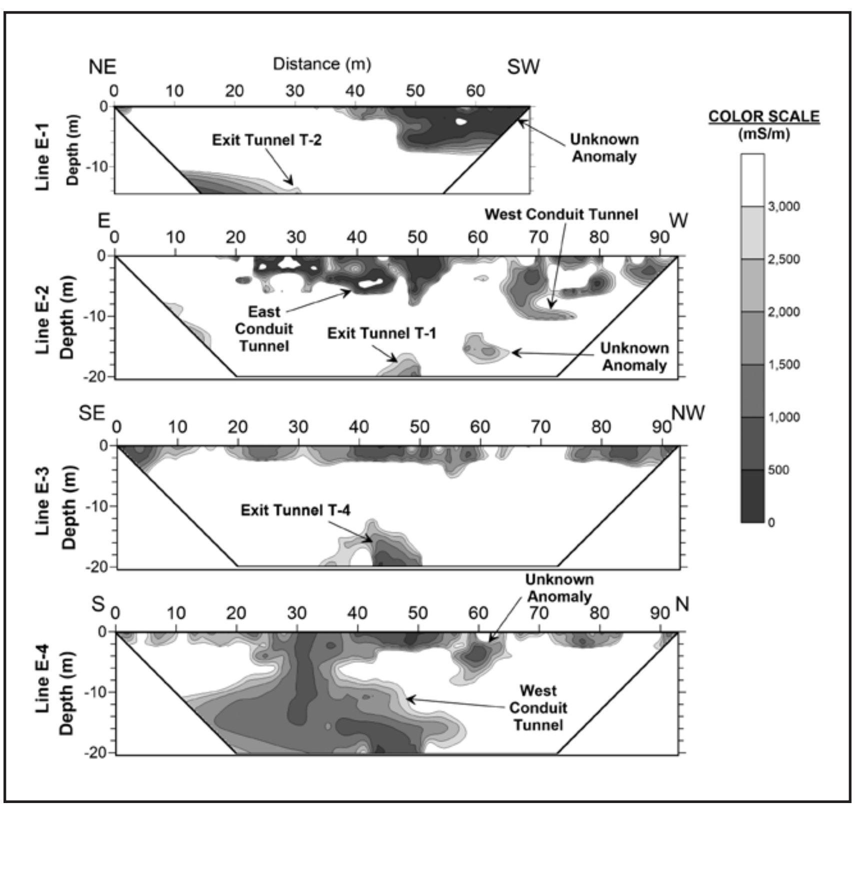

Figure 8. Electrical imaging tomographs showing low conductivity zones interpreted to be brick-lined tunnels. No vertical exaggeration.

tion. As such, forensic investigations through court testimony, interviews, hearsay, and geophysics are the only resources for exploring what Tesla was attempting to complete at Wardenclyffe.

The Wardenclyffe tower stood over a series of subsurface tunnels and grounding rods. The locations and depths of the six tunnels provided in this report match the anecdotal information found in Tesla's testimony, bibliographies, and the EPA's RCRA reports (figure 9).[47] While the presence of the grounding rods remains a mystery, the presence and location of the tunnels are not.

These tunnels, in unconsolidated sediment, have obviously experienced some collapse since their abandonment, but their geophysical signature remains to this day. These tunnels were located through the use of four near-surface geophysical methods. While TDEM and MM were only capable of imaging the footing to the tower, the GRAV and EI surveys identified the horizontal location and approximate depth of the tunnels in the subsurface.

The east and west conduit tunnels connect the laboratory with the tower foundation (figure 9). The east conduit tunnel, as interpreted from the GRAV and the EI surveys, is 5 m wide and the tunnel floor is 6 m below grade. This tunnel is interpreted to have been used for the electrical mains that supported the tower's operation. The west conduit tunnel is interpreted to

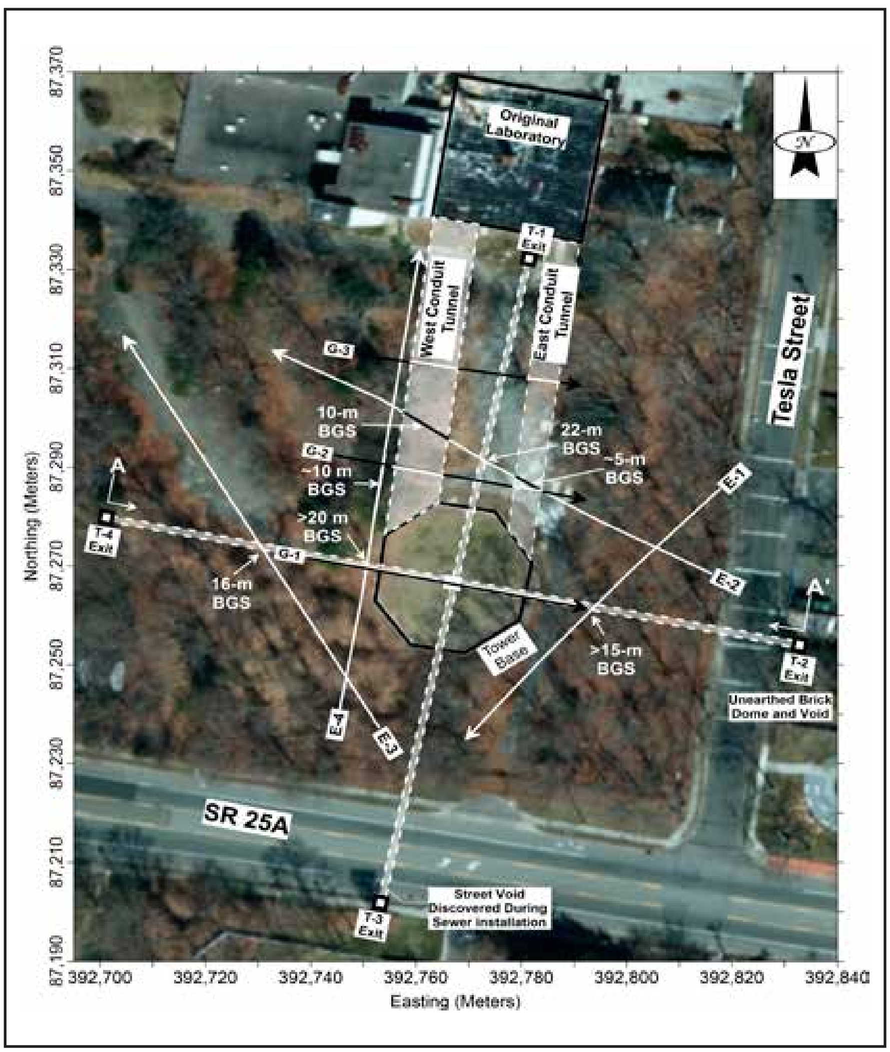

Figure 9. Map of interpreted tunnel locations *(dashed white outline)* as determined through EI (*white*) and microgravity *(black)* mapping with depths shown where detected. West-east profile A–A' located through the tower base (see fig. 10). Base map from USGS Earth Explorer (see fig. 5).

be slightly deeper at 10 m below grade and 8 m wide. This tunnel's interpreted purpose was to provide air, water, mechanical, and other functions as needed. While the depth of the tunnels is anchored by these geophysical surveys, the true width of the tunnels is difficult to measure since the walls have collapsed into these tunnels, expanding the tunnels' lateral geophysical signature.

Though the purpose of the four tunnels that angle upwards from the base of the shaft remain a mystery, these geophysical surveys have uncovered their three-dimensional location (figure 10). The geophysical surveys indicate that the tunnels were originally narrow, probably not much bigger than 1 m^2 and orthogonally spaced around the central shaft. Because these tunnels do not appear to contain support structures and are too small for convenient human access, their purpose remains an enigma. As with other attempts to determine how Tesla's Wardenclyffe facility was to operate, this study also fails to determine how the facility was to generate wireless energy on a global scale. Nevertheless, the location and three-dimensional visualization should help other researchers to discover the mystery of how Wardenclyffe functioned.

Acknowledgements

The authors wish to thank Jane Alcorn, Chris Wesselborg, and the staff at the Tesla Museum for their help with this project. Lucky 8 Production Company provided some of the funding, and the staff at Lucky 8 provided much needed field work support. We are indebted to Dr. Jana M. Bridwell for her helpful review of this manuscript.

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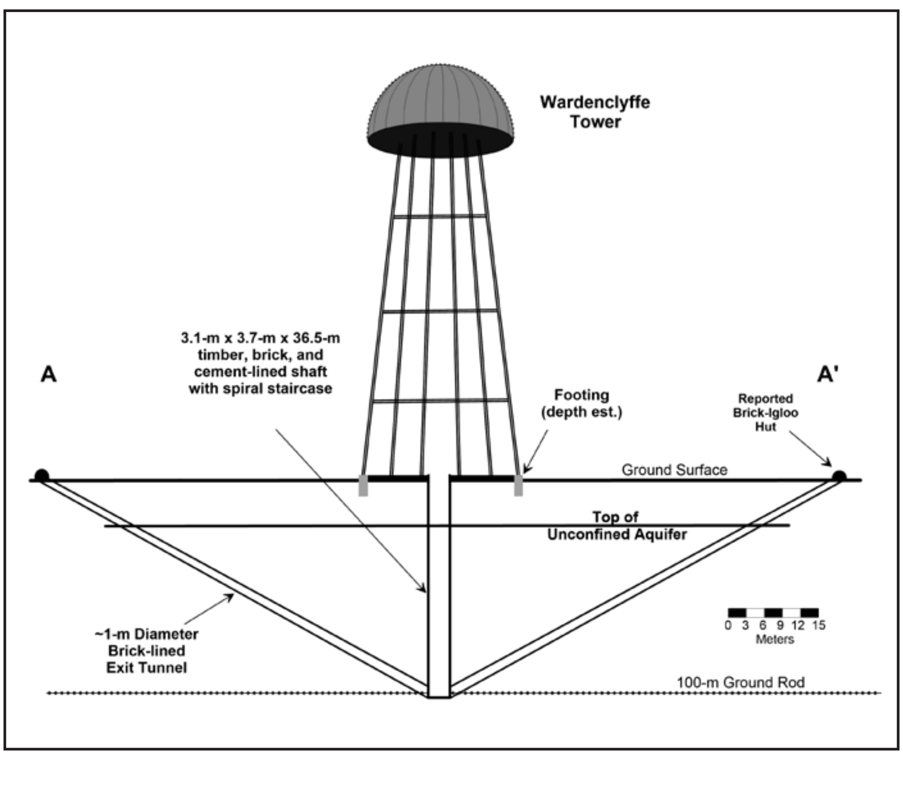

Figure 10. Cross section A–A' showing interpreted location of exit tunnels and vertical shaft beneath the Wardenclyffe Tower.

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