



Before the
Pennsylvania Public Utility Commission

**BREINIGSVILLE-ALBURTIS 500 kV
REBUILD PROJECT**

**ATTACHMENTS IN SUPPORT OF THE
LETTER OF NOTIFICATION**

Application Docket No. _____

Submitted by: PPL Electric Utilities Corporation

Table of Contents

1.0	INTRODUCTION	1
2.0	TRANSMISSION SYSTEM PLANNING PROCESS	1
3.0	DEFINITION OF THE PROBLEM.....	4
3.1	Existing System	4
3.2	Reliability Risks.....	5
4.0	PROPOSED SOLUTION	6

List of Figures

Figure 1-1: Existing One-Line 500 kV Configuration

Figure 1-2: Existing System Map

Figure 1-3: Proposed One-Line 500 kV Configuration

Figure 1-4: Proposed System Map

1.0 INTRODUCTION

PPL Electric Utilities Corporation (“PPL Electric”) is seeking approval from the Pennsylvania Public Utility Commission (“Commission”) to rebuild the existing single-circuit Breinigsville-Alburtis 500 kV Transmission Line to a double-circuit configuration (the “Project”). The Breinigsville-Alburtis 500 kV Transmission Line extends approximately 6 miles from the Breinigsville 500-138-69 kV Substation in Upper Macungie Township, Lehigh County to the Alburtis 500-230 kV Substation in Lower Macungie Township, Lehigh County. As explained below, the Project is required to improve reliability and operational performance, reduce the potential for and duration of outages, and increase system operability in Lehigh County. Upon completion, the new double-circuit 500 kV line will be designated as the Breinigsville-Alburtis #1 & #2 500 kV Transmission Line.

Subject to the Commission’s approval, construction is scheduled to begin May 2018 with a project in service date of March 2019. The total estimated cost of the Project is \$33M.¹

2.0 TRANSMISSION SYSTEM PLANNING PROCESS

The nation’s interconnected transmission grid serves as the backbone for the safe and reliable delivery of large amounts of electricity from generating stations over substantial distances to customers served by transmission and local distribution systems. It is critically important that this interconnected transmission system (transmission grid) be planned and designed to be highly reliable so that reliable electric service can be provided under peak and all loading conditions and when certain elements of the system are out of service (system contingencies) due to planned or unplanned outages.

¹ The estimated cost for the proposed Project is an order-of-magnitude estimate developed using averages of recent costs for similar projects and without an in-depth analysis of field investigation. The estimated cost is subject to change as the constructability of the Project, sequence of construction, and other factors that may affect cost are identified and analyzed as the Project progresses.

The entire cost for this transmission line Project will be paid by PPL Electric. The costs and cost recovery of this transmission line Project is subject to the regulatory jurisdiction of the Federal Energy Regulatory Commission (“FERC”).

System Planning is the process that assures that the transmission system can supply electricity to all customer loads in a manner that is reliable and economical. This System Planning process assures that both the Bulk Electric System (“BES”)² and non-Bulk Electric System (“non-BES”)³ are planned and constructed so that:

- They are able to accommodate forecasted system flows during summer and winter peak load;
- They can adequately serve each customer’s need with regard to capacity, voltage and reliability for all load levels throughout the daily load cycle;
- They can sustain probable contingencies and disturbances with minimal customer service interruptions; and
- They are in conformance with North American Electric Reliability Corporation (“NERC”), PJM Interconnection, LLC (“PJM”), and the Transmission Owner’s reliability criteria for all normal and emergency operating conditions.

PJM is a FERC-approved Regional Transmission Organization (“RTO”) charged with ensuring the reliability of the electric transmission system under its functional control (100 kV and above), and coordinating the movement of electricity in all or parts of thirteen states and the District of Columbia, including most of Pennsylvania. In order to ensure reliable transmission service, PJM prepares an annual Regional Transmission Expansion Plan (“RTEP”)⁴ to identify system reinforcements that are required to, among other things, meet the NERC Reliability Standards, PJM reliability planning criteria, and Transmission Owner reliability criteria.

² Bulk Electric System (BES) – Includes transmission facilities operated at voltages of 100 kV or higher.

³ Non-Bulk Electrical System (non-BES) – Includes transmission facilities operated at voltages less than 100 kV.

⁴ PJM’s RTEP process is currently set forth in Schedule 6 of PJM’s Amended and Restated Operating Agreement (“Schedule 6”). Schedule 6 governs the process by which PJM’s members rely on PJM to prepare an annual regional plan for the enhancement and expansion of the transmission facilities to ensure long-term, reliable electric service consistent with established reliability criteria. In addition, Schedule 6 addresses the procedures used to develop the RTEP, the review and approval process for the RTEP, the obligation of transmission owners to build transmission upgrades included in the RTEP, and the process by which interregional transmission upgrades will be developed.

PJM conducts RTEP studies in conjunction with its Transmission Owners and applies NERC, regional, and Transmission Owner reliability criteria to specific conditions on the transmission system. PJM's RTEP is an annual process that encompasses a comprehensive series of detailed analyses to ensure power continues to flow reliably to customers under stringent reliability criteria set by NERC. PJM's manual 14B⁵ outlines the RTEP process and reliability criteria use for this process. As mentioned in manual 14B, every year PJM perform various reliability tests such as Baseline Thermal, Baseline Voltage, Load Deliverability, Generation Deliverability and Baseline Stability to ensure safe, reliable operation of the electric grid.

When the studies show an inability of the transmission system to meet specific reliability criteria under these conditions, PJM opens an RTEP Window in accordance with FERC Order 1000⁶ to identify the optimal solution to resolve the criteria violation.

PPL Electric, as a Transmission Owner and member of PJM, undertakes an independent analysis of both its BES transmission facilities, and its non-BES transmission facilities in concert with the PJM RTEP process. PPL Electric identifies all conditions where the future system does not meet the NERC criteria, PJM reliability criteria, or PPL Electric Transmission Owner criteria. In this way, PPL Electric actively participates in the PJM RTEP process, and through this participation PPL Electric provides results of its independent studies to PJM for consideration and inclusion in the PJM RTEP.

Alternatives that can mitigate violations to the reliability criteria are developed and analyzed to ensure that the PPL Electric transmission system meets the reliability criteria. Estimated costs and lead times to implement the reinforcements are prepared. PPL Electric then proposes solutions to PJM through an RTEP window. If the project is awarded to PPL Electric, it then becomes a baseline RTEP project.

PPL Electric's Transmission Owner criteria address thermal, voltage, short circuit, and stability limits specific to the PPL Electric zone and also ensure compliance with NERC and PJM

⁵ PJM Manual 14B is available at <http://www.pjm.com/~media/documents/manuals/m14b.ashx>

⁶ <http://www.ferc.gov/industries/electric/indus-act/trans-plan.asp>

reliability criteria. These criteria ensure adequate and appropriate levels of electric service to PPL Electric customers in accordance with good utility practices. In addition to these criteria, PPL Electric plans the system according to its own Transmission System Development Standards.

In addition to NERC, PJM, and Transmission Owner criteria-based projects, PPL Electric also initiates projects based on the Transmission System Development Standards. These projects address local load growth, provide load restoration flexibility, improve operational performance, and replace poor performing transmission assets in order to provide an advanced level of reliability on the local system.

PPL Electric's Transmission System Development Standards also consider transmission needs to support the development of the distribution system. When the distribution system needs to either expand existing distribution substations with new transformation or install new distribution substations to support local load growth on the distribution system, new transmission facilities are required to accommodate that expansion.

Projects created to support PPL Electric's Transmission System Development Standards are presented to PJM stakeholders at either a Transmission Expansion Advisory Committee (TEAC) or Sub-Regional RTEP meeting and are assigned a Supplemental project number in the RTEP. PJM incorporates these projects into the power flow model which they use to perform various reliability analyses for the RTEP.

3.0 DEFINITION OF THE PROBLEM

3.1 Existing System

The existing Wescosville 500-138-69 kV Substation is part of the bulk power transmission system. The existing Wescosville 500-138-69 kV Substation serves customers in parts of Lehigh County, Pennsylvania and is powered by a single 500 kV tap, the Susquehanna-Wescosville 500 kV Transmission Line, which limits PPL Electric's ability to restore customers for various reliability and resiliency events.

The Susquehanna-Wescosville 500 kV Transmission Line extends from the Susquehanna 500-230 kV Substation to the tap point with the Wescosville 500-138-69 kV Substation. From the tap point, the 500 kV line continues to the Breinigsville 500-138-69 kV Substation (this segment is referred to as the Wescosville-Breinigsville 500 kV Transmission Line). The Breinigsville 500-138-69 kV Substation is also interconnected with the existing single-circuit Breinigsville-Alburtis 500 kV Transmission Line that extends approximately 6 miles from the Breinigsville 500-138-69 kV Substation to the Alburtis 500-230 kV Substation.

A one-line diagram and map of the existing system are provided as **Figure 1-1** and **Figure 1-2**, respectively.

3.2 Reliability Risks

PPL Electric’s system planning studies identified unacceptable low voltage and unacceptable voltage drop for an N-1-1 contingency.⁷ Specifically, PPL Electric’s studies have determined that the loss of two of the 500 kV lines in the area of the Wescosville and Breinigsville Substations creates an unacceptable voltage drop⁸ and low voltage⁹ on the 138 kV and 69 kV transmission lines supplied by the Wescosville 500-138-69 kV Substation and the Breinigsville 500-138-69 kV Substation.

In addition, the Wescosville 500-138-69 kV Substation is the only 500 kV substation in PPL Electric’s service territory that doesn’t meet the PPL Electric Substation Design Standard. The 500 kV yard has a 500-138 kV transformer that is directly tapped off the Susquehanna-Wescosville 500 kV Transmission Line, which is a non-standard design. The Susquehanna-

⁷ An N-1-1 contingency involves the loss of one system element followed by manual system readjustments, and then the loss of a second system element, *e.g.*, outage of one transmission line followed by switching moves and then the loss of a second transmission line. These contingencies are referred to as the “N minus 1 minus 1” or “N-1-1” criteria.

⁸ As per PPL Electric Transmission Owner (TO) Criteria, more than 8% voltage drop is not allowed on the 138 kV Transmission System post N-1-1 contingency event. Similarly more than 7.5% voltage drop is not allowed on the 69 kV system post N-1-1 contingency event. The TO Criteria has been filed with the FERC and PJM under Form 715. A copy of TO Criteria is available at <http://www.pjm.com/~media/planning/plan-standards/private-ppl/point-of-contact-requirements.ashx>. Table 4.2-2 on page 15 shows the PPL Electric Voltage Drop Criteria.

⁹ PPL Electric TO Criteria doesn’t allow lower than 0.92 and 0.90 per unit voltage on 138 kV and 69 kV system respectively post N-1-1 contingency event.

Wescosville 500 kV Transmission Line is approximately 67 miles long, which puts the line at high risk of exposure to faults. A fault on the Susquehanna-Wescosville 500 kV Transmission Line would trip the 500-138 kV transformer, which is the single 500 kV source for the Wescosville 500-138-69 kV Substation. A fault on this line would remove one of the 500 kV sources to the Breinigsville 500-138-69 kV Substation.

4.0 PROPOSED SOLUTION

To resolve these low voltage and voltage drop concerns on the 138 kV and 69 kV systems caused by the N-1-1 contingency described above, PPL Electric proposes to build a more reliable double bus double breaker 500 kV yard at the Wescosville 500-138-69 kV Substation¹⁰ and to rebuild the existing single-circuit Breinigsville-Alburtis 500 kV Transmission Line to a double-circuit configuration.

The proposed Project will extend approximately 6 miles from the Breinigsville 500-138-69 kV Substation to the Alburtis 500-230 kV Substation. The rebuilt double-circuit Breinigsville-Alburtis 500 kV Transmission Line will be on the same structure alignment and in the same right-of-way (ROW) as the existing single-circuit Breinigsville-Alburtis 500 kV Transmission Line. The existing 500 kV circuit will be replaced and a second new 500 kV circuit will be added as part of the rebuild Project. However, the existing structures cannot support the double-circuit configuration and will be replaced as part of this Project. Detailed descriptions of the new structure types and locations are provided in **Attachments 2 and 3**.

This proposed electric reinforcement will resolve the low voltage and voltage drop caused by the N-1-1 contingency described above. The proposed reinforcement also will improve the reliability of Breinigsville 500-138-69 kV Substation by providing a third 500 kV source. The existing substation currently has only two 500 kV sources: the Wescosville-Breinigsville and

¹⁰ The 500-138 kV transformer will be rearranged and will no longer be directly tapped from the Susquehanna-Wescosville 500 kV Transmission Line. The Susquehanna-Wescosville 500 kV Transmission Line will be terminated into the new 500 kV yard as the Susquehanna-Wescosville and Wescosville-Breinigsville 500 kV Transmission Lines. As a result, the 500-138 kV transformer will still remain in service after the loss of the Susquehanna-Wescosville 500 kV Transmission Line.

Breinigsville-Alburtis 500 kV Transmission lines. During maintenance scenarios when one of the two 500 kV transmission lines is taken out of service for maintenance and a fault occurs on the other 500 kV transmission line that remains in service, the entire Breinigsville 500-138-69 kV Substation would lose power. The addition of the second 500 kV circuit to the existing Breinigsville-Alburtis 500 kV Transmission Line will provide a third 500 kV source, which will avoid any interruptions during maintenance of the 500 kV transmission lines and for any N-1-1 contingency events.

The proposed Project is necessary to improve reliability and operational performance, reduce the potential for and duration of outages, and increase system operability in Lehigh County. The proposed Project has been presented at the PJM Mid-Atlantic Sub-Regional RTEP stakeholder meeting on April 9, 2015 and has been approved as supplemental project S0864 in the PJM RTEP.

A one-line diagram and map of the proposed Project are provided as **Figure 1-3** and **Figure 1-4**, respectively.

Figure 1-1 - Existing One-Line 500 kV Configuration

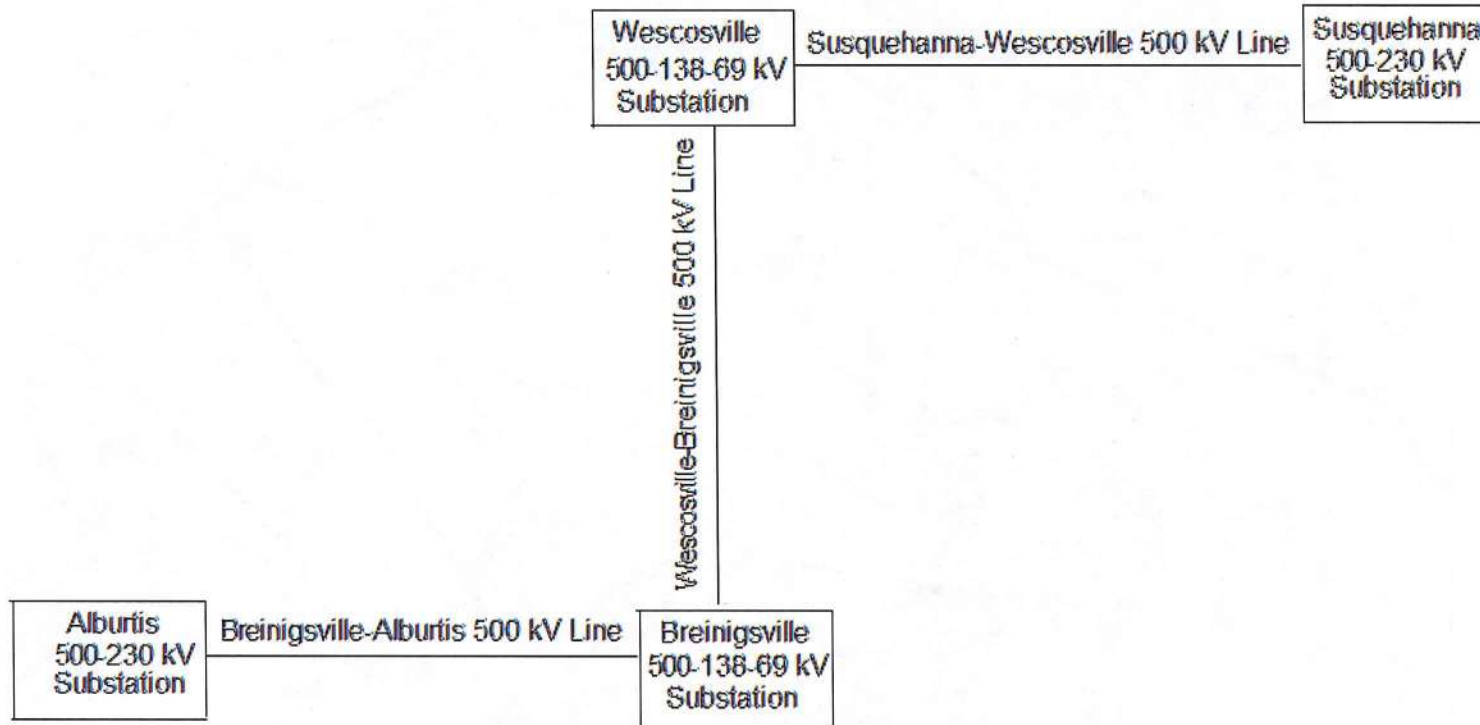


Figure 1-2 - Existing System Map

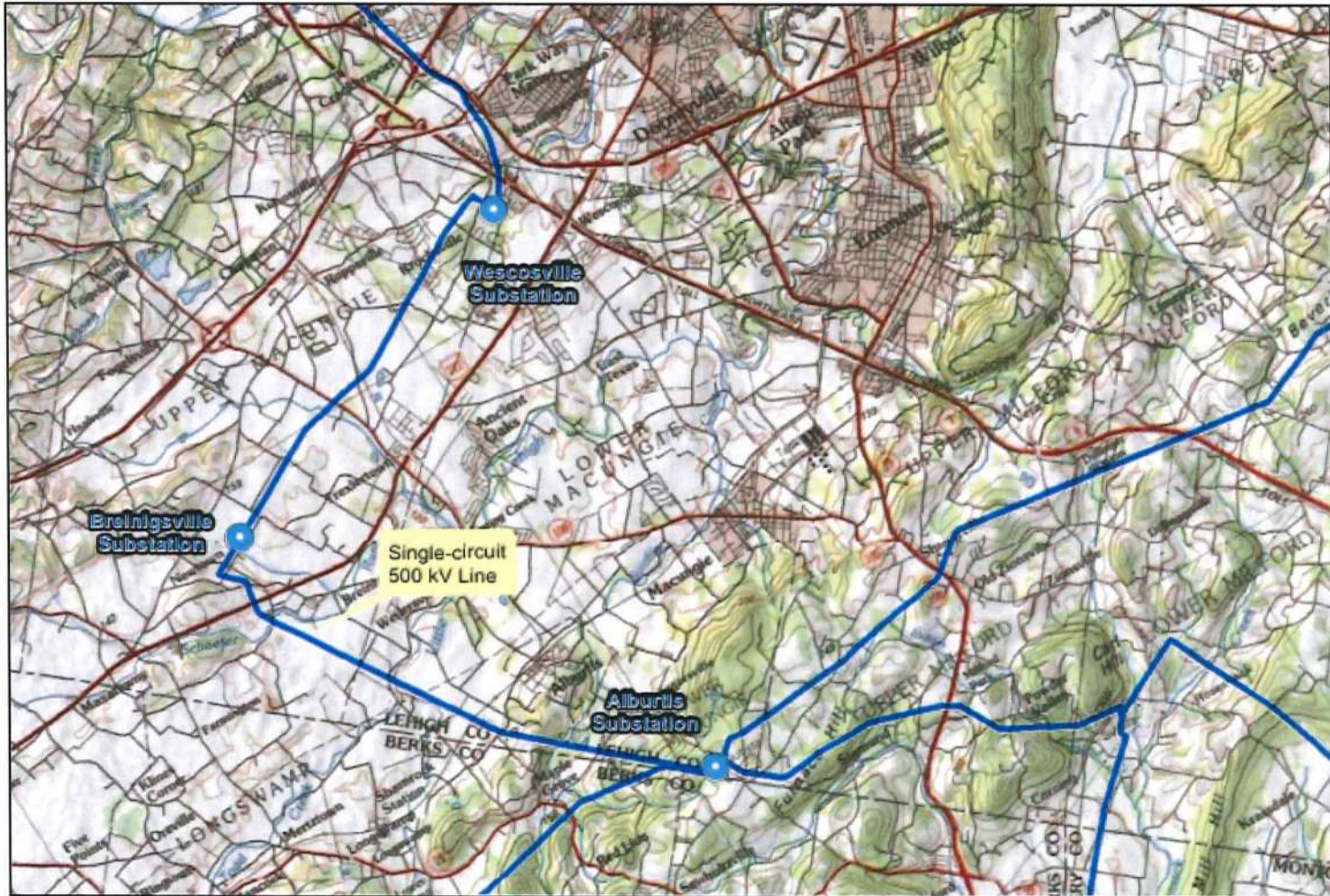


Figure 1-3 - Proposed One-Line 500 kV Configuration

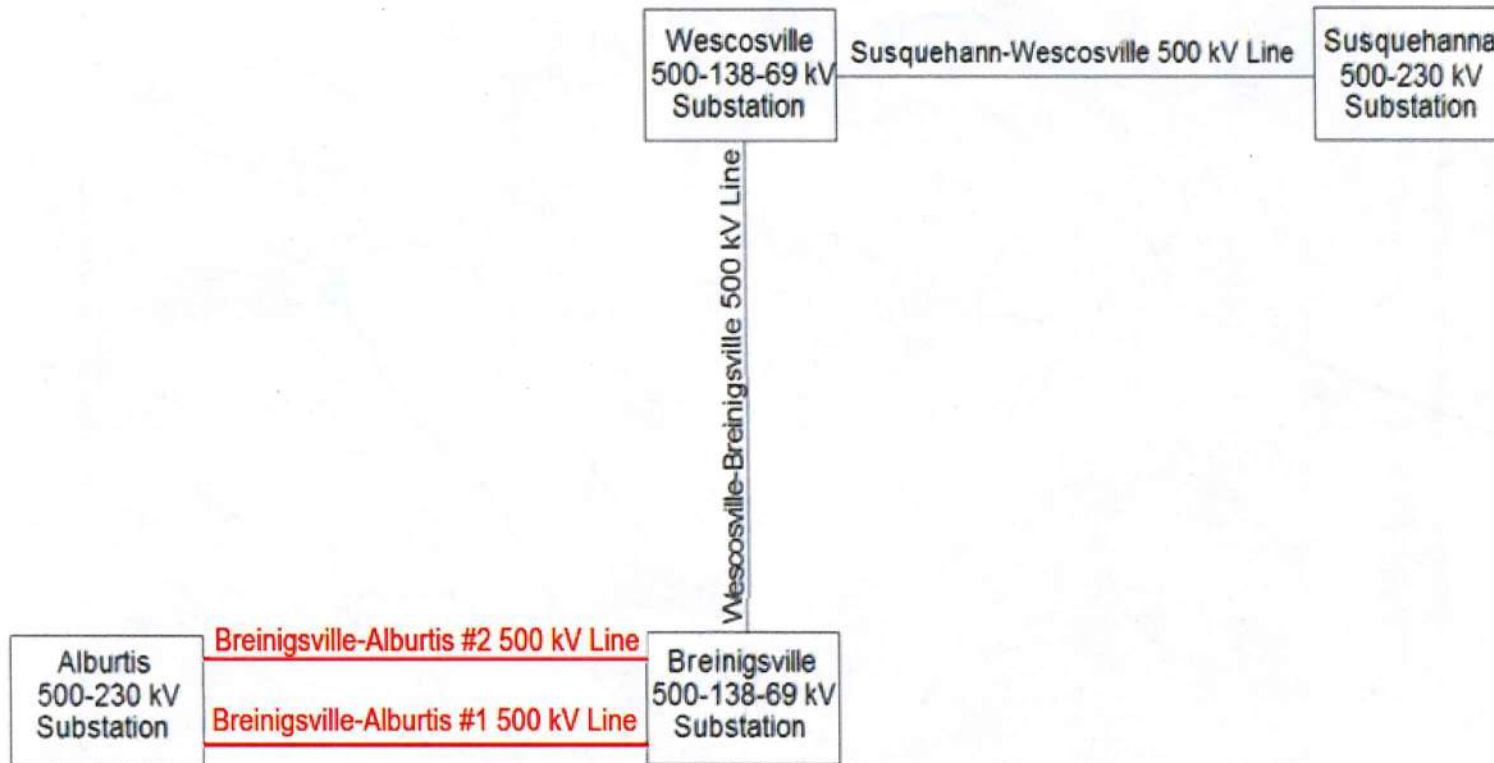


Figure 1-4 - System Map of Proposed 500 kV Line

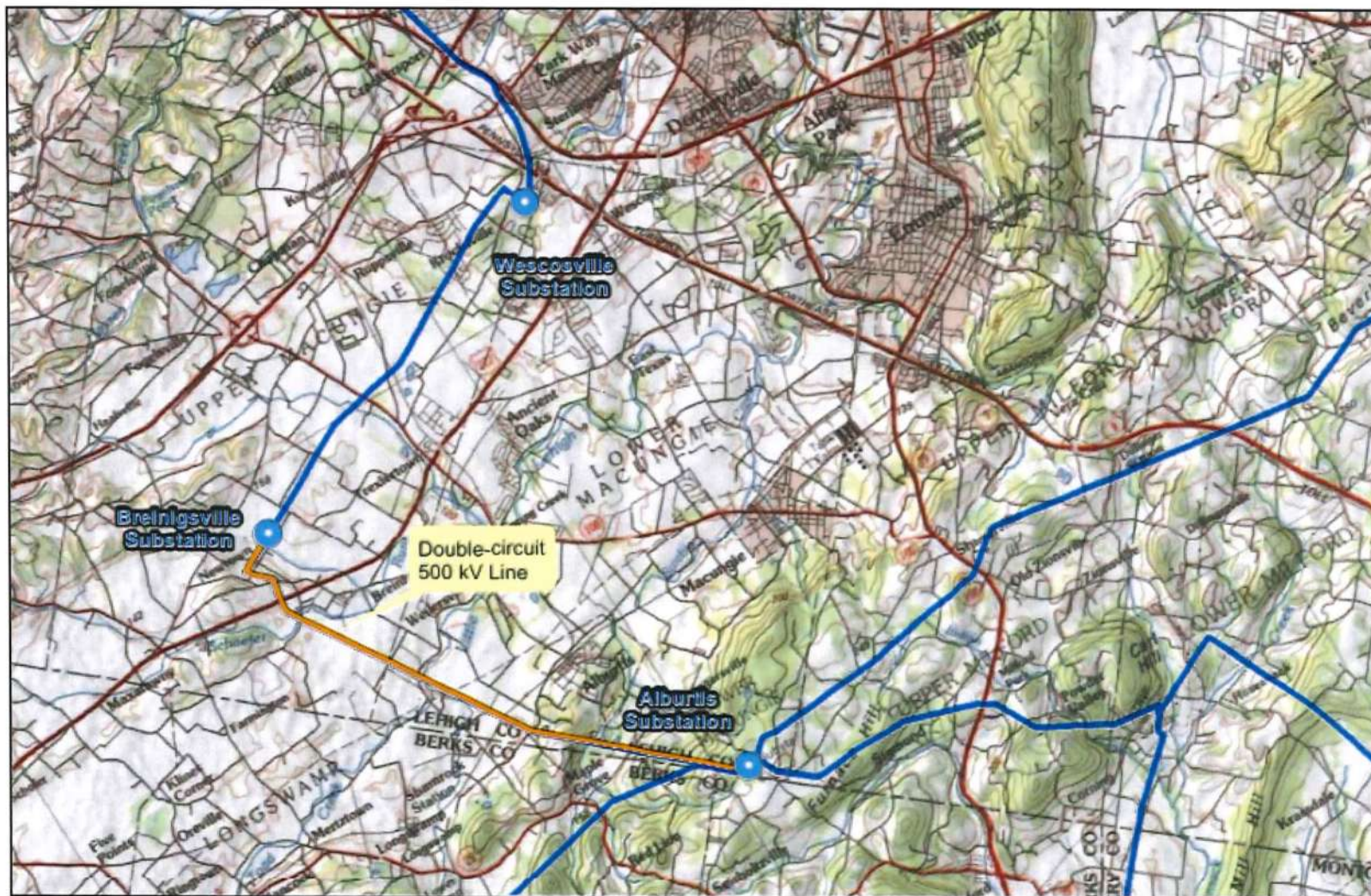


Table of Contents

1.0	DESCRIPTION OF THE PROPOSED 500 kV LINE AND STRUCTURES	1
2.0	MAGNETIC FIELD MANAGEMENT	5

List of Tables

Table 2-1: Design Minimum Conductor Clearances

Table 2-2: ACSR Conductor Thermal Rating

Table 2-3: ACAR Conductor Thermal Rating

List of Figures

Figure 2-1: Typical Double-Circuit H-frame ROW Cross-Section

Figure 2-2: Typical Single-Circuit H-Frame Dead-end ROW Cross-Section

Figure 2-3: Typical Double-Circuit 2-Pole Dead-end Angled Structure ROW Cross Section

Figure 2-4: Typical Double-Circuit 2-Pole Dead-end Structure ROW Cross Section

Figure 2-5: Typical Double-Circuit 2-Pole Dead-end Angled Structure ROW Cross Section

Figure 2-6: Typical Double-Circuit 2-Pole Dead-end Structure ROW Cross Section

1.0 DESCRIPTION OF THE PROPOSED 500 kV LINE AND STRUCTURES

As explained in **Attachment 1**, PPL Electric Utilities Corporation (“PPL Electric”) is requesting Pennsylvania Public Utility Commission (“PUC” or the “Commission”) approval to rebuild the existing single-circuit Breinigsville-Alburtis 500 kV Transmission Line to a double-circuit configuration (the “Project”). A detailed map of the proposed double-circuit Breinigsville-Alburtis 500 kV Transmission Line is provided in **Figure 3-1** to **Attachment 3**. Upon completion, the new double-circuit 500 kV line will be designated as the Breinigsville-Alburtis #1 & #2 500 kV Transmission Line.

The existing single-circuit Breinigsville-Alburtis 500 kV Transmission Line extends approximately 6 miles from the Breinigsville 500-138-69 kV Substation to the Alburtis 500-230 kV Substation. The existing 500 kV circuit will be replaced and a second new 500 kV circuit will be added as part of the rebuild Project.

The configuration of conductor and overhead ground wire (OHGW) varies along the circuit due to audible noise constraints and the varying fiber path taken along the circuit. From the Alburtis 500-230 kV Substation to Structure 1 (approximately 400 feet), the new 500 kV conductors will consist of double bundle 2493 kcmil¹ 54/37 ACAR² with two 0.572”, 19#9 Alumoweld overhead ground wires (“OHGW”). From Structure 1 to Structure 27 (approximately 5.8 miles), the new 500 kV conductors will consist of triple bundle 1590 kcmil 54/19 “Falcon” ACSR³ with two 0.572”, 19#9 Alumoweld OHGWs from Structure 1 to Structure 2 and two 0.791”, 144-Fiber optical ground wires (“OPGW”) from Structure 2 to Structure 27. From Structure 27 to the Breinigsville 500-138-69 kV Substation (approximately 2,200 feet), the new 500 kV conductors will consist of double bundle 2493 kcmil 54/37 ACAR with one 0.572”, 19#9 Alumoweld OHGW and one 0.791”, 144-Fiber OPGW. A second 144-Fiber OPGW will be strung to replace the existing OHGW along the outside of the existing single-circuit H-frame dead-end structures between Structure 27 and the Breinigsville 500-138-69 kV Substation. The double-circuit

¹ kcmil stands for thousand circular mils. Kcmil wire size is the equivalent cross sectional area in thousands of circular mils. A circular mil is the area of a circle with a diameter of one thousandth (0.001) of an inch.

² ACAR stands for aluminum conductor aluminum alloy reinforced.

³ ACSR stands for aluminum conductor steel reinforced.

double bundle design between the Alburdis 500-230 kV Substation and Structure 1 and between the Breinigsville 500-138-69 kV Substation and Structure 27 will utilize six (6) conductors that make up three (3) double bundle phases and two (2) OHGW per circuit for a total of twelve (12) conductors and four (4) OHGWs. The double-circuit triple bundle design between Structure 1 and Structure 27 will utilize nine (9) conductors that make up three (3) triple bundle phases and one (1) OPGW per circuit for a total of eighteen (18) conductors and two (2) OPGWs. .

The conductors will be strung to PPL Electric wire tension limits that will meet or exceed the National Electrical Safety Code (“NESC”) and maintain safe operating conditions. The OHGWs and OPGWs will be strung so they are no greater than 80% of the conductor sag with both at the 60°F, no wind, no ice, final (creep) condition.

The rebuilt double-circuit Breinigsville-Alburdis 500 kV Transmission Line will be on the same structure alignment and in the same right-of-way (“ROW”) as the existing single-circuit Breinigsville-Alburdis 500 kV Transmission Line. However, the existing structures cannot support the additional circuit or meet required clearances with the additional circuit and will be replaced as part of this Project.

The existing Breinigsville-Alburdis 500 kV Transmission Line currently utilizes a total of 29 structures:

- 23 double-circuit H-frame structures with an average height of 145 feet;
- 3 angle structures with a two-pole design and average height of 125 feet;
- 2 single-circuit H-frame structures (Structures 28 and 28A) at the Breinigsville 500-138-69 kV Substation with an average height of 115 feet (these will not be replaced); and
- 1 monopole structure (Structure 1) at the Alburdis 500-230 kV Substation with a height of 185 feet.

The location of each of these 29 structures is shown in **Figure 3-1 to Attachment 3**.

To rebuild the existing Breinigsville-Alburdis 500 kV Transmission Line, PPL Electric will:

- Replace 21 existing H-frame structures with 21 new H-frame structures;
- Replace 2 H-frame structures with new two-pole structures;
- Install 2 new H-frame structures at the Breinigsville 500-138-69 kV Substation;

- Replace 3 two-pole structures with 3 new two-pole structures; and
- Replace 1 monopole at the Alburtis 500-230 kV Substation with a new two-pole structure.

In total, the Project will require the replacement of 23 existing structures within the ROW, and the replacement of 4 existing structures and the installation of 2 new structures on substation properties as further described below.

The existing 21 H-frame structures currently support one circuit and will need to be replaced with 21 new double-circuit H-frame structures to accommodate the addition of the second 500 kV circuit (**Figure 2-1**). In addition, 2 new single-circuit H-frame structures (Structures 28B and 28C in **Figure 3-1 to Attachment 3**) will be installed at the Breinigsville 500-138-69 kV Substation to support the interconnection of the new 500 kV circuit with the substation (**Figure 2-2**). The new double-circuit H-frame structures will consist of two parallel tubular steel poles with outboard davit arms and connected by two tubular steel cross arms. The new single-circuit H-frame structures will consist of two parallel tubular steel poles with outboard davit arms and connected by one tubular steel cross arm. These structures will be installed on concrete caisson foundations. The new single-circuit H-frame structures will have an average height of approximately 115 feet while the new double-circuit H-frame structures will have an average height of approximately 160 feet. Each of these structure types will meet all NESC and PPL Electric clearance requirements.

In addition, 2 existing H-frame structures (Structures 9 and 11 in **Figure 3-1 to Attachment 3**) will be replaced with 2 new two-pole structures (**Figure 2-3**) to accommodate the addition of the second 500 kV circuit. Also, 3 existing angle structures currently with a two-pole design (Structures 23, 25 and 27 in **Figure 3-1 to Attachment 3**) will be replaced with 3 new two-pole angle structures (**Figure 2-4 and Figure 2-5**) to accommodate the addition of the second 500 kV circuit. The two-pole structures will consist of self-weathering tubular steel structures equipped with straight arms and installed on concrete caisson foundations. The two-pole structures will have an average height of approximately 190 feet and will meet all NESC and PPL Electric clearance requirements.

Finally, 1 existing monopole structure (Structure 1 in **Figure 3-1** to **Attachment 3**) at the Alburdis 500-230 kV Substation will be replaced with a new two-pole structure. The new two-pole structure is needed to provide the clearance required between facilities and to interconnect the new 500 kV circuit with the substation. The new two-pole structure will consist of self-weathering tubular steel structures equipped with straight arms and installed on concrete caisson foundations. The new two-pole structure will have an average height of approximately 195 feet and will meet all NESC and PPL Electric clearance requirements (**Figure 2-6**).

All replaced structures will be located entirely within the existing right-of-way, and placed in generally the same location as the existing structures (within 20 feet). All new structures will be located entirely on PPL Electric-owned properties for the Breinigsville 500-138-69 kV Substation or Alburdis 500-230 kV Substation. A detailed description of the location of the new and replaced structures is provided in **Attachment 3** and **Figure 3-1**.

The new Breinigsville-Alburdis #1 & #2 500 kV Transmission Line will be designed to meet, and generally exceed, NESC minimum standards. Design specifications and safety rules practiced by PPL Electric are included in **Attachment 4**. The designed minimum conductor clearances and conductor thermal ratings are set forth in **Table 2-1**, **Table 2-2**, and **Table 2-3** below.

TABLE 2-1: DESIGN MINIMUM CONDUCTOR CLEARANCES*

Condition	Design Clearance-to-Ground
Normal load; average weather (16°C ambient temperature)	45.0 feet
Predicted extreme thermal load (125°C conductor temperature)	40.0 feet
Predicted extreme wind load (90 mph, 16°C)	50.5 feet
Predicted extreme weather conditions (1.0" Ice, 0 mph, 32°C)	44.5 feet
*Clearances based on a maximum tension of 16,500 pounds at .5 inch ice, 0° F, 4# wind and a ruling span of 982 feet (Span from STR #2 to STR #3).	

*Based on 1590 kcmil 54/19 stranding ACSR "Falcon"

TABLE 2-2: ACSR CONDUCTOR THERMAL RATING*

Condition	Ambient Temperature °C	Wind Speed ft/sec	Rating (Amps)
Summer Normal	35	0	5013
Winter Normal	10	0	5775
Summer Emergency	35	2.533	6189
Winter Emergency	10	2.533	6969

*Based on triple bundle 1590 kemil 54/19 stranding ACSR "Falcon" (257°F) 125°C Maximum Conductor

TABLE 2-3: ACAR CONDUCTOR THERMAL RATING**

Condition	Ambient Temperature °C	Wind Speed ft/sec	Rating (Amps)
Summer Normal	35	0	3394
Winter Normal	10	0	4178
Summer Emergency	35	2.533	4310
Winter Emergency	10	2.533	5108

**Based on double bundle 2493 kemil 54/37 Stranding ACAR (212°F) 100°C Maximum Conductor

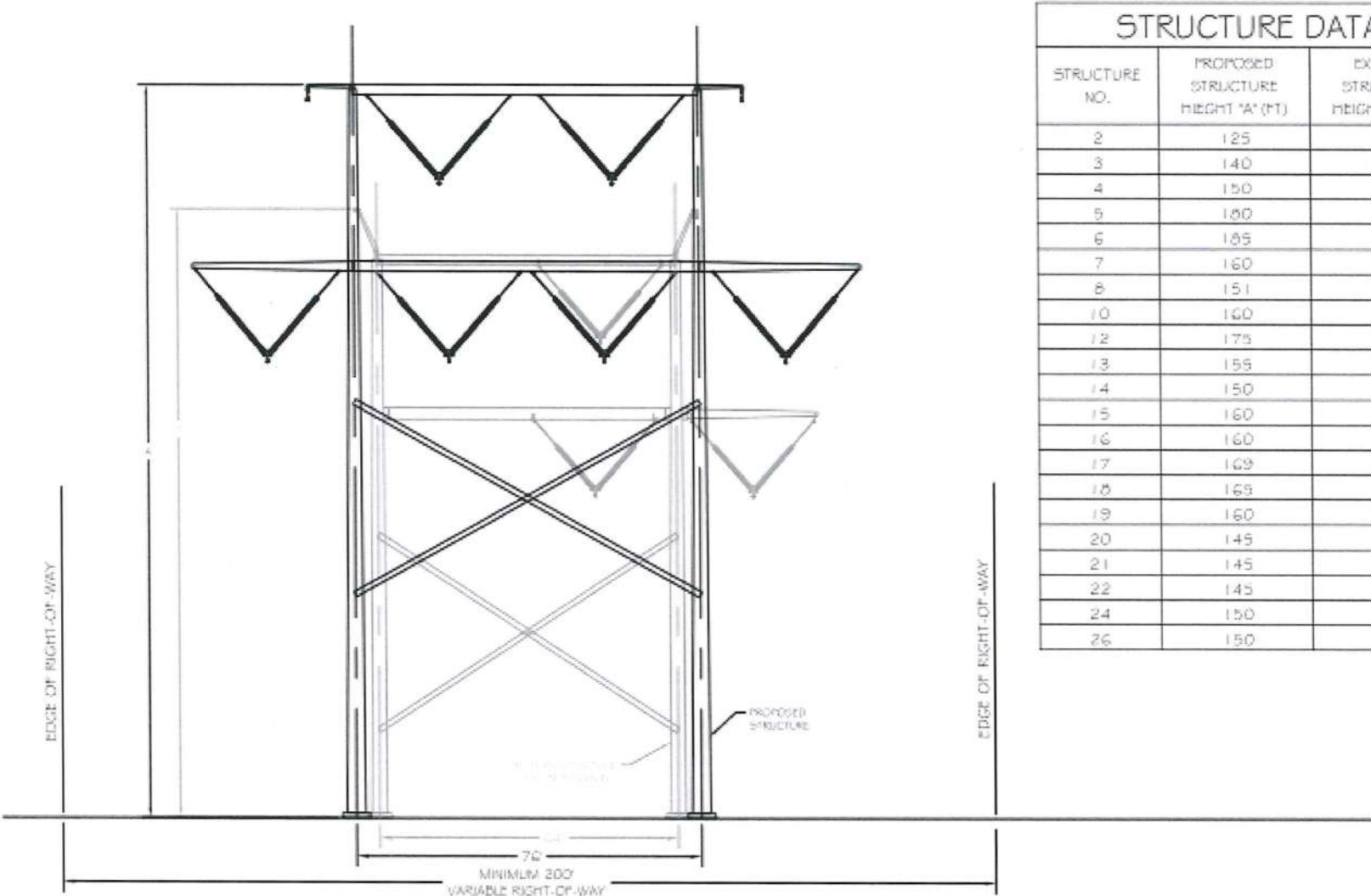
2.0 MAGNETIC FIELD MANAGEMENT

PPL Electric’s Magnetic Field Management Program is applied to new and reconstructed transmission line projects. The Company does not believe that the current scientific evidence demonstrates that magnetic fields cause any adverse health effects or pose a health or safety danger to the public. Nevertheless, PPL Electric has determined, as a matter of policy, to design its new and rebuilt transmission lines to reduce magnetic fields when that can be done at low or no cost and consistent with functional requirements. PPL Electric’s Magnetic Field Management Program has been developed to implement that policy decision. To reduce magnetic field exposures, the program generally prescribes the use of a line design with ground clearance that is five feet higher than NESC standards and reverses phasing of new double-circuit lines where it is feasible to do so at low or no cost.

The Project will be designed with structures that have a ground clearance that is eleven feet higher than NESC standards. In addition, the rebuilt 500 kV transmission line will be double-

circuit configuration that will use phasing specifically designed to minimize electro-magnetic fields at ground level as well as at the right-of-way edge.

Figure 2-1: Typical Double-Circuit H-frame ROW Cross-Section



STRUCTURE DATA		
STRUCTURE NO.	PROPOSED STRUCTURE HEIGHT 'A' (FT)	EXISTING STRUCTURE HEIGHT 'B' (FT)
2	125	125
3	140	120
4	150	175
5	160	175
6	165	170
7	160	165
8	151	175
10	160	135
12	175	145
13	155	135
14	150	135
15	160	150
16	160	150
17	169	150
18	165	155
19	160	145
20	145	135
21	145	130
22	145	135
24	150	140
26	150	120



Figure 2-2: Typical Single-Circuit H-Frame Dead-end ROW Cross-Section

STRUCTURE DATA		
STRUCTURE NO.	PROPOSED STRUCTURE HEIGHT 'A' (FT)	EXISTING STRUCTURE HEIGHT 'B' (FT)
28	NA	110'
28A	NA	120'
28B	110'	NA
28C	117	NA

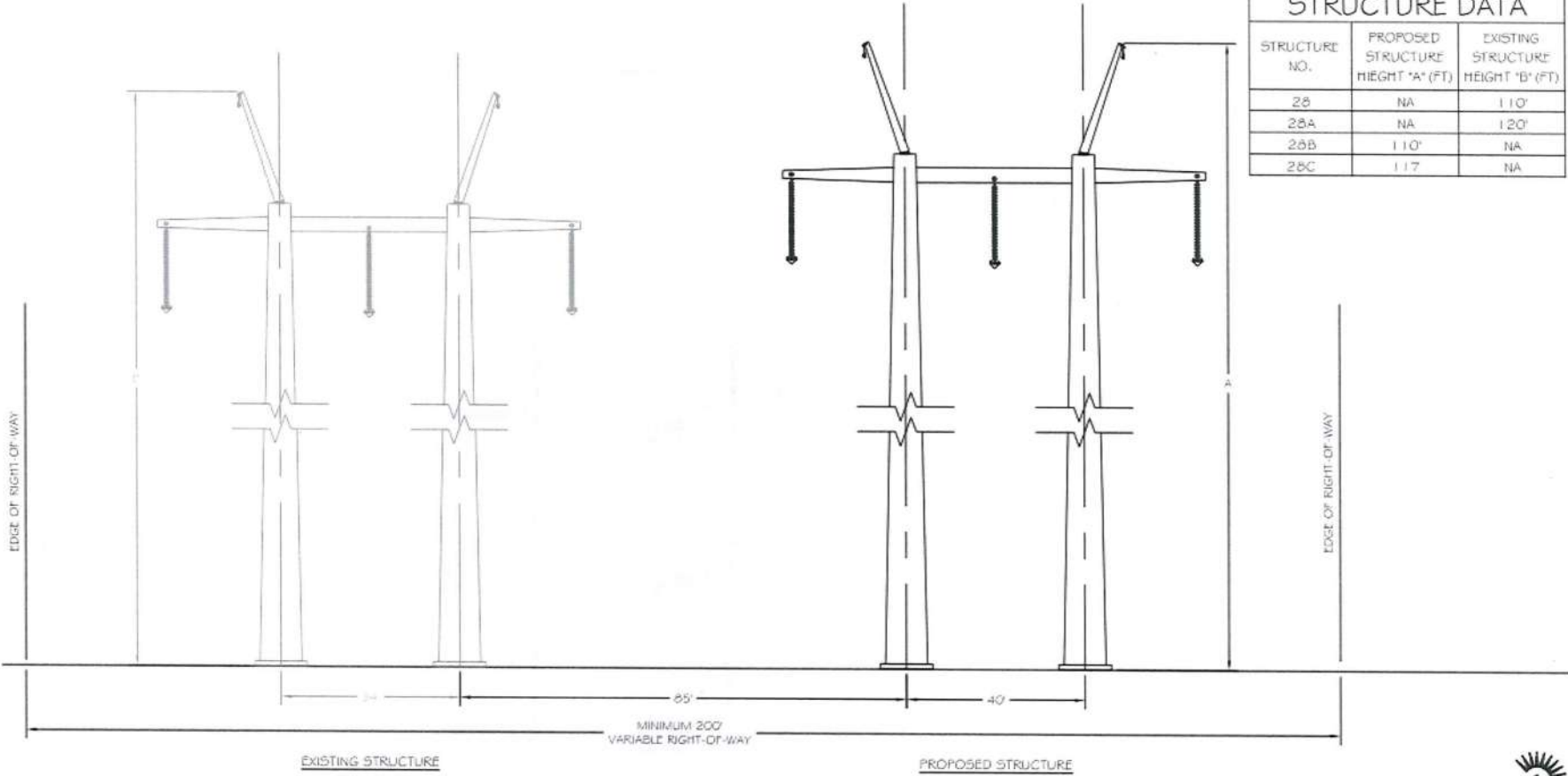


Figure 2-3: Typical Double-Circuit 2-Pole Dead-end Angled Structure ROW Cross Section

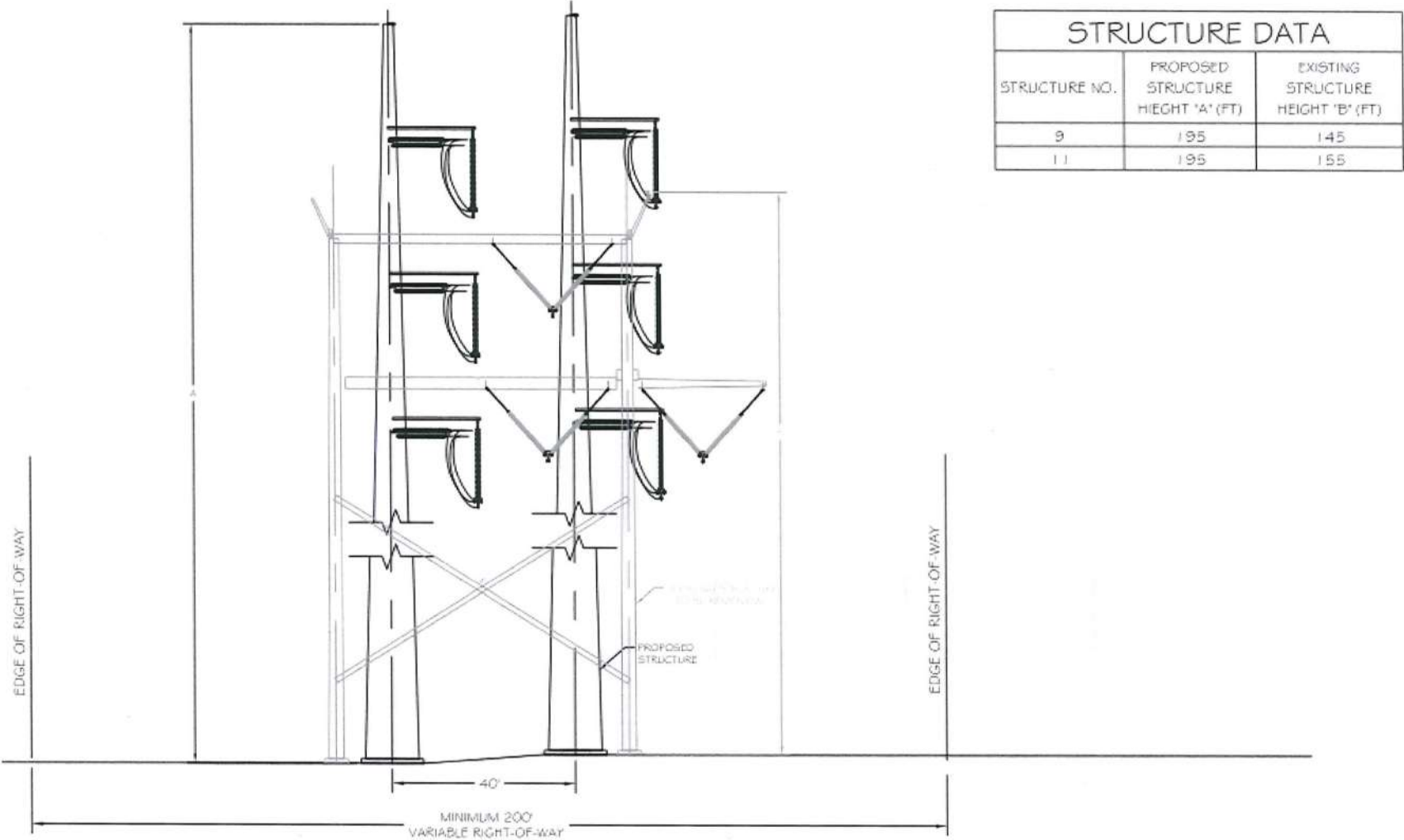
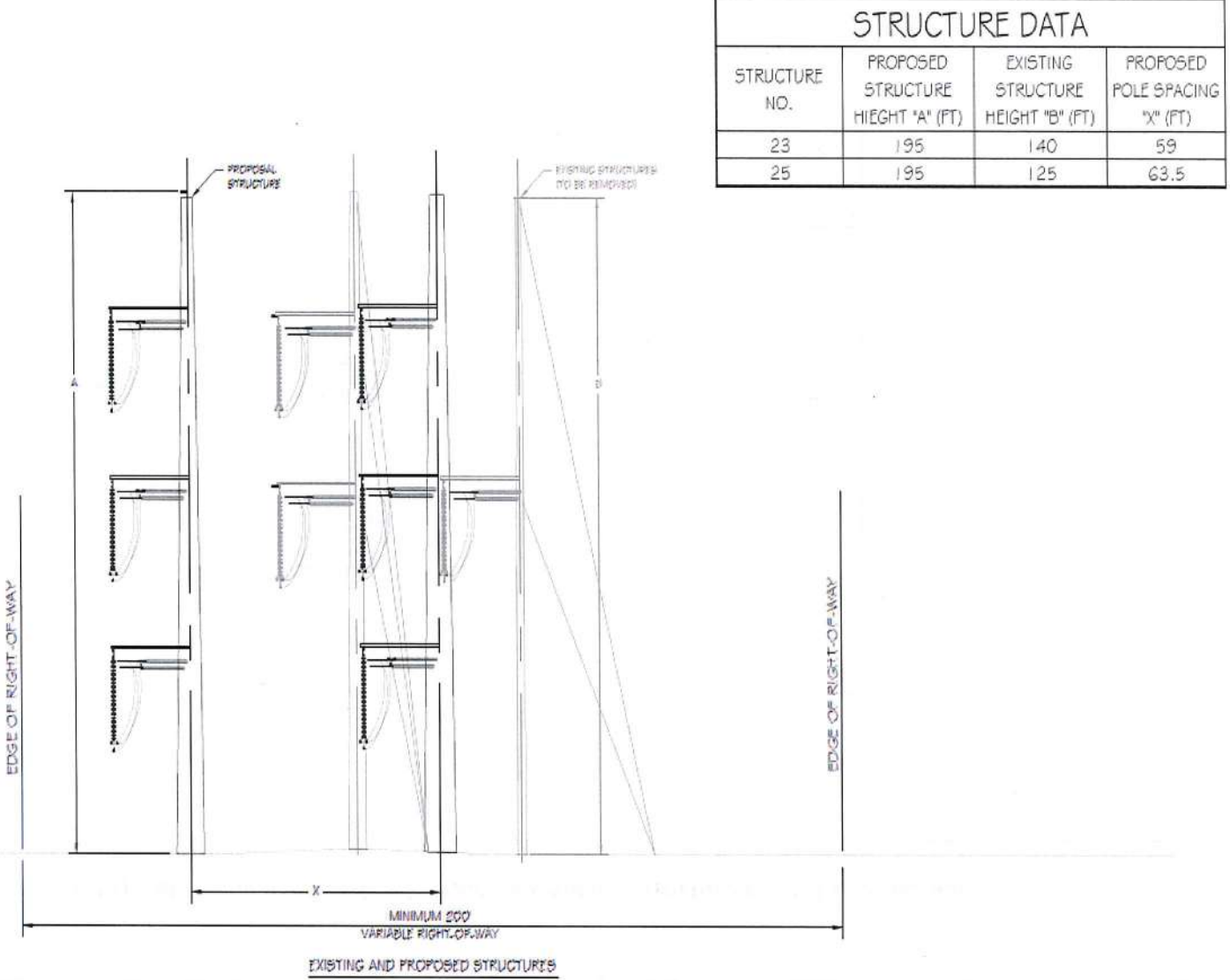


Figure 2-4: Typical Double-Circuit 2-Pole Dead-end Structure ROW Cross Section



STRUCTURE DATA			
STRUCTURE NO.	PROPOSED STRUCTURE HEIGHT "A" (FT)	EXISTING STRUCTURE HEIGHT "B" (FT)	PROPOSED POLE SPACING "X" (FT)
23	195	140	59
25	195	125	63.5

Figure 2-5: Typical Double-Circuit 2-Pole Dead-end Angled Structure ROW Cross Section

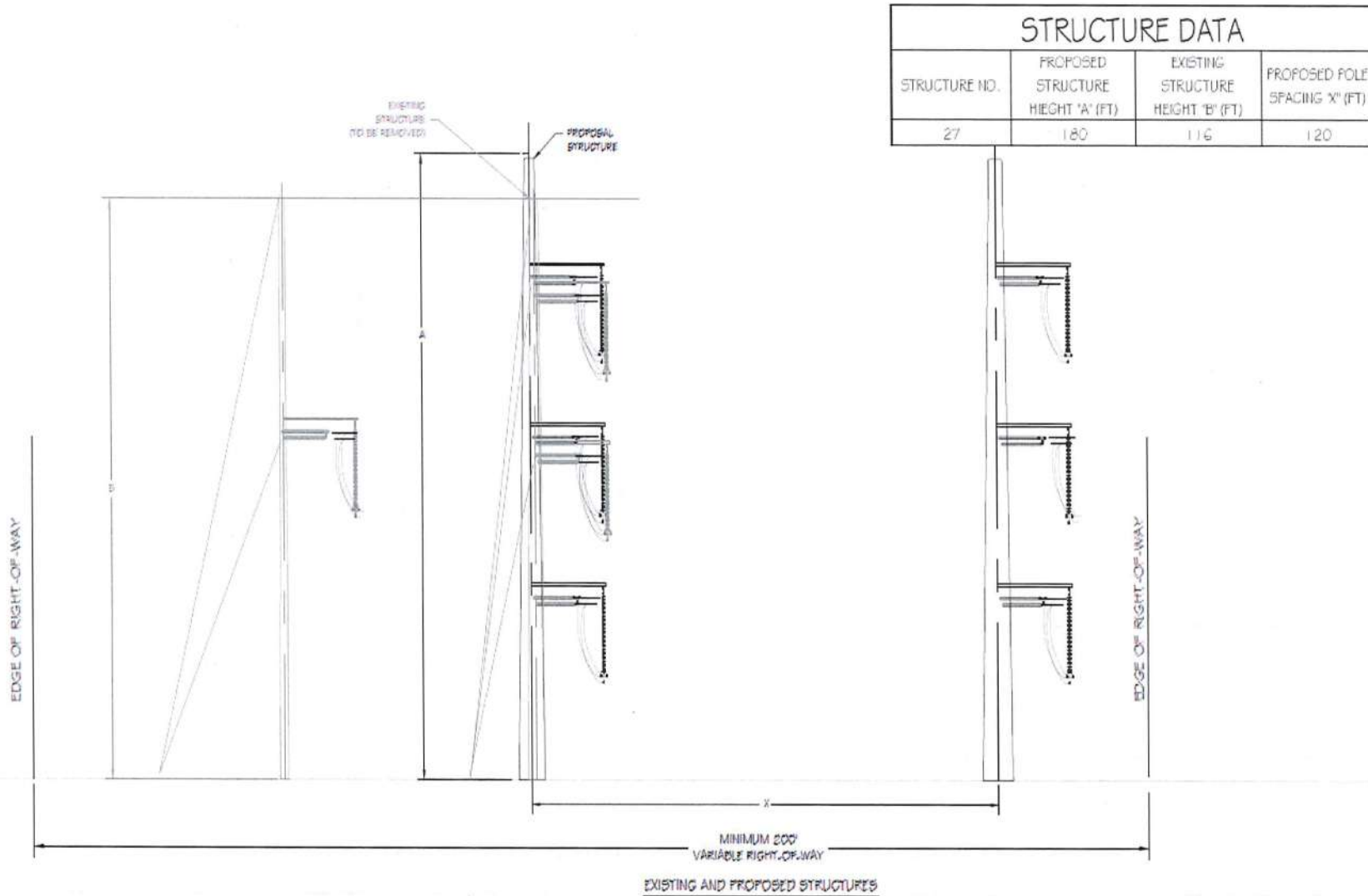


Figure 2-6: Typical Double-Circuit 2-Pole Dead-end Structure ROW Cross Section

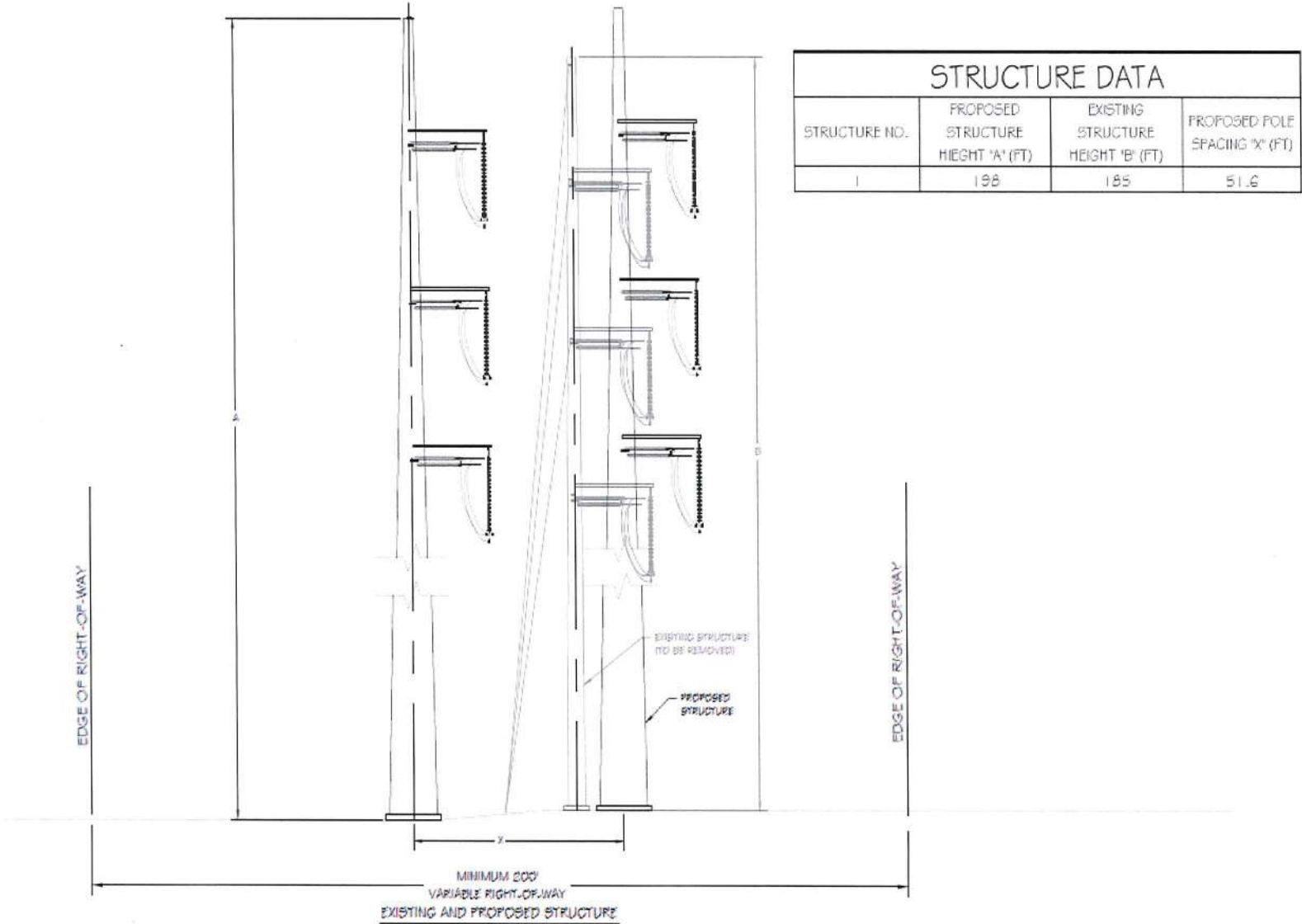


Table of Contents

1.0	DESCRIPTION OF PROJECT AREA.....	1
2.0	LAND USE.....	3
3.0	ENVIRONMENTAL FACTORS	5

List of Figures

Figure 3-1 - Aerial Map of the Project

1.0 DESCRIPTION OF PROJECT AREA

As explained in **Attachment 1**, PPL Electric Utilities Corporation (“PPL Electric”) is requesting Pennsylvania Public Utility Commission (“PUC” or the “Commission”) approval to rebuild the existing single-circuit Breinigsville-Alburtis 500 kV Transmission Line to a double-circuit configuration (the “Project”). The Breinigsville-Alburtis 500 kV Transmission Line extends approximately 6 miles from the existing Breinigsville 500-138-69 kV Substation in Upper Macungie Township, Lehigh County, to the existing Alburtis 500-230 kV Substation in Lower Macungie Township, Lehigh County (the “Project”).

The rebuilt double-circuit Breinigsville-Alburtis 500 kV Transmission Line will be on the same structure alignment and in the same right-of-way (“ROW”) as the existing single-circuit Breinigsville-Alburtis 500 kV Transmission Line. However, the existing structures cannot support the second circuit and will be replaced as part of this Project. As further explained in **Attachment 2**, PPL Electric will:

- Replace 21 existing H-frame structures with 21 new H-frame structures;
- Replace 2 H-frame structures with 2 new two-pole structures;
- Install 2 new H-frame structures at the Breinigsville 500-138-69 kV Substation;
- Replace 3 two-pole structures with 3 new two-pole structures; and
- Replace 1 monopole at the Alburtis 500-230 kV Substation with 1 new two-pole structure.

In total, the Project will require the replacement of 27 existing structures and the installation of two new structures. The entire Project will be constructed entirely within the existing ROW or on PPL Electric’s property for the Breinigsville 500-138-69 kV and Alburtis 500-230 kV Substations. A detailed map of the proposed rebuilt double-circuit Breinigsville-Alburtis 500 kV Transmission Line and associated structures are provided in **Figure 3-1**.

From the Breinigsville 500-138-69 kV Substation, the Project travels in a southwesterly direction through agricultural fields before turning sharply to the southeast and proceeding primarily across agricultural fields and adjacent to forested lands, but also extending through several residential areas

before reaching the Alburtis 500-230 kV Substation as shown in **Figure 3-1**. The ROW for the Project is further described below:

- From the Breinigsville 500-138-69 kV Substation, the rebuilt 500 kV line will extend southwest approximately 1,200 feet using 2 new H-frame structures (Map 1, Structures 28B and 28C in **Figure 3-1**). The 2 new H-frame structures will be located entirely on PPL Electric's substation property.
- From Structure 28C, the rebuilt 500 kV line will traverse 1,000 feet across PPL Electric property and onto an existing 375-foot wide ROW to a new two-pole angle structure (Map 2, Structure 27 in **Figure 3-1**) that will be located entirely within the existing ROW and in close proximity to the existing two-pole angle structure.
- At the new two-pole angle structure (Structure 27), the rebuilt 500 kV line turns sharply south using an existing 200-foot wide ROW and extends 480 feet to a replaced H-frame structure (Map 2, Structure 26 in **Figure 3-1**) and then proceeds 1,020 feet to a replaced two-pole angle structure (Map 2, Structure 25 in **Figure 3-1**). Both structures will be located entirely within the existing ROW and in close proximity to the existing structures.
- At the two-pole angle structure (Structure 25), the rebuilt 500 kV line turns sharply southwest using an existing 200-foot wide ROW and extends approximately 820 feet to a replaced H-frame structure (Map 3, Structure 24 in **Figure 3-1**) and then proceeds 1,000 feet to a replaced two-pole angle structure (Map 3, Structure 23 in **Figure 3-1**). Both structures will be located entirely within the existing ROW and in close proximity to the existing structures.
- At the two-pole angle structure (Structure 23), the rebuilt 500 kV line turns slightly east and continues approximately 15,200 feet, using an existing 200-foot wide ROW, to an H-framed structure (Map 10, Structure 11 in **Figure 3-1**) that will be replaced by a new two-pole structure. The intervening H-frame structures (Map 3 to Map 10, Structures 22-12 in **Figure 3-1**) will also be replaced with new H-framed structures. All of the replacement structures will be located entirely within the existing ROW and in close proximity to the existing structures.
- From the new two-pole structure (Structure 11), the new 500 kV line turns more east within an existing 200-foot wide ROW and extends approximately 1,200 feet to a replaced H-frame structure (Map 11, Structure 10 in **Figure 3-1**) and then proceeds 1,200 feet to an H-frame

structure (Map 11, Structure 9 in **Figure 3-1**) that will be replaced by a new two-pole structure. Both structures will be located entirely within the existing ROW and in close proximity to the existing structure.

- From the new two-pole structure (Structure 9), the new 500 kV line continues southeast approximately 9,300 feet, using an existing 200 to 350-foot wide ROW, to a single monopole structure (Map 16, Structure 1 in **Figure 3-1**) located at the Alburtis 500-230 kV Substation that will be replaced by a new two-pole structure. The intervening H-frame structures (Map 15 to Map 16, Structures 8-2 in **Figure 3-1**) will also be replaced with new H-frame structures. All of the replacement structures will be located entirely within the existing ROW or on PPL Electric-owned property and in close proximity to the existing structure.

The entire Project is located within an existing ROW or on PPL Electric-owned property. Two new and four replacement structures will be located entirely on the PPL Electric-owned properties for the Breinigsville 500-138-69 kV Substation or Alburtis 500-230 kV Substation. The remaining 23 replacement structures will be located in close proximity to the existing structures and within PPL Electric's existing ROW. Finally, a network of existing access roads or temporary roads across agricultural lands will be utilized during construction of the new structures and the installation of the second 500 kV circuit.

2.0 LAND USE

Evaluation of the existing land uses reviewed the uses on the PPL Electric owned properties, within the existing 200-foot wide right-of-way, and within 0.25 mile (1,320 feet) outside of the right-of-way. This broader area was reviewed to provide a sense of the landscape in which the Project is located. Land uses were determined based on review of the 2011 National Land Cover Data ("NLCD").

Assessment of the data shows that agricultural areas are the dominant land use, accounting for over 50% of the review area, with the primary component being cultivated crops. Forested areas bordering the Project right-of-way accounts for 30% of the review area. Low to moderate density development and associated open space is noted across 20% the review area.

Impacts to land use are anticipated to be minimal because the proposed Project will be constructed within existing right-of-way or within portions of lands owned by PPL Electric around each of the substations. This Project will be accessed through use of the surrounding state and secondary roads at locations where they intersect the right-of-way. A few temporary access roads will be necessary outside the right-of-way to reach several structure locations. PPL Electric will use and update previously established access roads within the right-of-way for construction to the extent practical to further reduce interference with existing land uses.

State and Conserved Lands

During evaluation for State-owned lands, no impacts were identified along the right-of-way. The Lehigh County Conservation District Interactive Watershed Map was utilized to identify one (1) farm preserved through the Lehigh County Farmland Preservation Program that is crossed by the Project right-of-way. Three existing structures are located on this preserved farmland that will be replaced in generally the same location. Impacts to these conserved lands are anticipated to be minimal.

Airports

The Lehigh Valley International Airport is located approximately 12.5 miles northeast of the Breinigsville 500-138-69 kV Substation. PPL Electric does not anticipate any interference with airport operations because the Project is located in an area where there are existing electrical facilities and because the seven replacement poles and three new poles will be a similar height as the existing facilities. However, PPL Electric will file any required documentation with the Federal Aviation Administration and the Pennsylvania Department of Transportation, Bureau of Aviation.

Cultural Resources

PPL Electric is in the initial stage of coordination with the Pennsylvania Historical and Museum Commission (“PHMC”) for the construction of the new 500 kV line. This coordination will be required for the permits necessary to construct the Project and will be conducted in the near future.

Based upon the response provided by PHMC, PPL Electric will perform any reviews and field survey/sampling work required to avoid, minimize, and mitigate impacts to archaeological or historic architectural resources that may be located within the Project area.

3.0 ENVIRONMENTAL FACTORS

Environmental factors reviewed for the Project included unique natural features, soils, waterways, wetlands, 100-year floodplains, vegetation, and threatened and endangered species.

Unique Natural Features

No unique geological, scenic, or natural areas are located within the Project review area.

Soils

Erosion and sedimentation control plans will be developed and implemented for the Project that will minimize the displacement of soils. These plans will require prior approval from the local county conservation district. National Pollutant Discharge Elimination System (“NPDES”) permits will also be required from the Pennsylvania Department of Environmental Protection (“PADEP”) as needed. Any conditions of the NPDES permit will be adhered to as part of the construction process. As such impacts to local soil resources are anticipated to be minimal.

Waterways

The existing Breinigsville-Alburtis 500 kV Transmission Line spans four (4) mapped waterways as it extends from the Breinigsville 500-138-69 kV Substation in the northwest to the Alburtis 500-230 kV Substation termination point in the southeast.

Breinig Run, Schaefer Run, Little Lehigh Creek, and Swabia Creek have a PADEP designated classification of High Quality-Cold Water Fishes (“HQ-CWF”), which is an anti-degradation special protection classification for surface waters having quality which exceeds levels necessary to support

propagation of fish, shellfish, and wildlife. These streams also have a PADEP designated classification of Migratory Fisheries (“MF”), which is an anti-degradation special protection classification for surface waters which provide habitat for the passage, maintenance and propagation of anadromous and catadromous fishes and other fishes which move to or from flowing waters to complete their life cycles in other waters. Additionally, all of these streams are also classified as Wild Trout (Natural Reproduction) Streams, which are flowing waters in Pennsylvania that support naturally reproducing populations of trout. Little Lehigh Creek and Swabia Creek are Approved Trout Streams (stocked).

These streams currently are spanned by the existing single-circuit Breinigsville-Alburtis 500 kV Transmission Line and will be spanned by the proposed second 500 kV circuit. No permanent impacts to these streams are anticipated since new culverts or bridges will not be required. Permits to span these creeks with the new 500 kV circuit wires will be obtained from PADEP, if required. Construction activities will also be conducted using a state approved erosion and sedimentation control plan to minimize the effects of stormwater runoff. PPL Electric will obtain all approvals and permits necessary for the construction of the Project, and will comply with any conditions placed on those permits.

Wetlands

Based on review of the U.S. Fish and Wildlife Service’s (“USFWS”) National Wetlands Inventory (“NWI”), the existing Breinigsville-Alburtis 500 kV Transmission Line right-of-way crosses several wetland systems. These systems are characterized as palustrine emergent (“PEM”), palustrine forested (“PFO”), and palustrine open water (“POW”) wetlands.

The NWI only provides a general overview of the potential wetlands that may be located within an area. For federal and state permitting purposes, the wetlands and waterways within the Project area were delineated, surveyed, and illustrated according to regulatory standards. Five (5) wetlands were field identified within the Project right-of-way. All of these wetlands are classified as PEM wetlands.

PADEP Chapter 105 (Dam Safety and Waterway Management) regulations stipulate that wetlands located in or along the floodplain of a wild trout stream or waters listed as Exceptional Value (“EV”) and the floodplain of streams tributary thereto, be considered EV wetlands (25 Pa. Code § 105.171(iii)). Of the wetlands identified within the right-of-way of this Project, three (3) are located within the floodplain of Wild Trout Waters (Breinig Run, Schaefer Run, and Swabia Creek) and are therefore classified as EV wetlands. PPL Electric will avoid impacts to wetlands and streams where possible by aerially spanning these features. PPL Electric will obtain all necessary permits from the PADEP and the United States Army Corps of Engineers and will comply with all of the terms and conditions placed on those permits.

100-year Floodplains

The National Flood Hazard Layer (“NFHL”) for Pennsylvania was obtained through the Pennsylvania Spatial Data Access (“PASDA”) database and analyzed for 100-year floodplains within the Project area and surrounding landscape. The NFHL data incorporates all Flood Insurance Rate Map (“FIRM”) databases published by the Federal Emergency Management Agency (“FEMA”), and any Letters of Map Revision (“LOMRs”) that have been issued against those databases since their publication date.

The existing Breinigsville-Alburtis 500 kV Transmission Line spans the 100-year floodplains associated with several streams along the alignment. Presently, no existing poles proposed for replacement are located within the FEMA 100-year floodplain. Coordination with PADEP regarding this potential impact will be conducted during the permitting phase of the Project.

Vegetation

Vegetative cover bordering the northern and central sections of the Project right-of-way has been influenced by agricultural and rural residential development. Large areas of the natural vegetative cover in these sections have been removed for conversion to farms and pastures. Additionally, some of this agricultural land is undergoing conversion to residential development, further reducing the

natural vegetative cover. The southern end of the Project area right-of-way is bordered by woodlands, which have been impacted by scattered residential development.

Limited vegetation management will be required to modify the existing single-circuit Breinigsville-Alburtis 500 kV right-of-way for double-circuit operation. The existing right-of-way is currently maintained in accordance with PPL Electric's Vegetation Management Program. Only minimal vegetation removal is anticipated because the Project is being completed within existing PPL Electric right-of-way, which is currently cleared of trees for safety and maintenance reasons. In areas where vegetation management is required, PPL Electric will apply its "*Specifications for Transmission Vegetation Management LA-79827*" to minimize any potential impacts.

Natural Areas Inventory

The *Natural Areas Inventory for Lehigh County*, prepared by the Pennsylvania Natural Heritage Program ("PNHP"), identified one (1) State ranked site within the Project area. The Little Lehigh Grassland is a site dominated by active agriculture with row crops, hay fields and some fallow areas, and provides habitat for two (2) unnamed sensitive species of concern. Project related construction activities will occur within the boundary of this natural area.

Threatened and Endangered Species

Review of the threatened and endangered species that may be encountered within and along the Breinigsville-Alburtis 500 kV right-of-way includes evaluation of the natural areas identified in the Project area, as well as the Project related Pennsylvania Natural Diversity Inventory ("PNDI") responses provided by federal and state agencies that have protective jurisdiction over the surrounding animals, plants, and ecological communities.

A Project Environmental Review of the PNDI database was conducted for the Project area (PNDI #20150908530801). The PNDI results indicated Potential Impacts with the Pennsylvania Game Commission ("PGC"), the Pennsylvania Fish and Boat Commission ("PFBC"), and the USFWS.

The Pennsylvania Department of Conservation and Natural Resources (“DCNR”) responded that there was no known impact to plant species under their jurisdiction, and no further review by their agency was required.

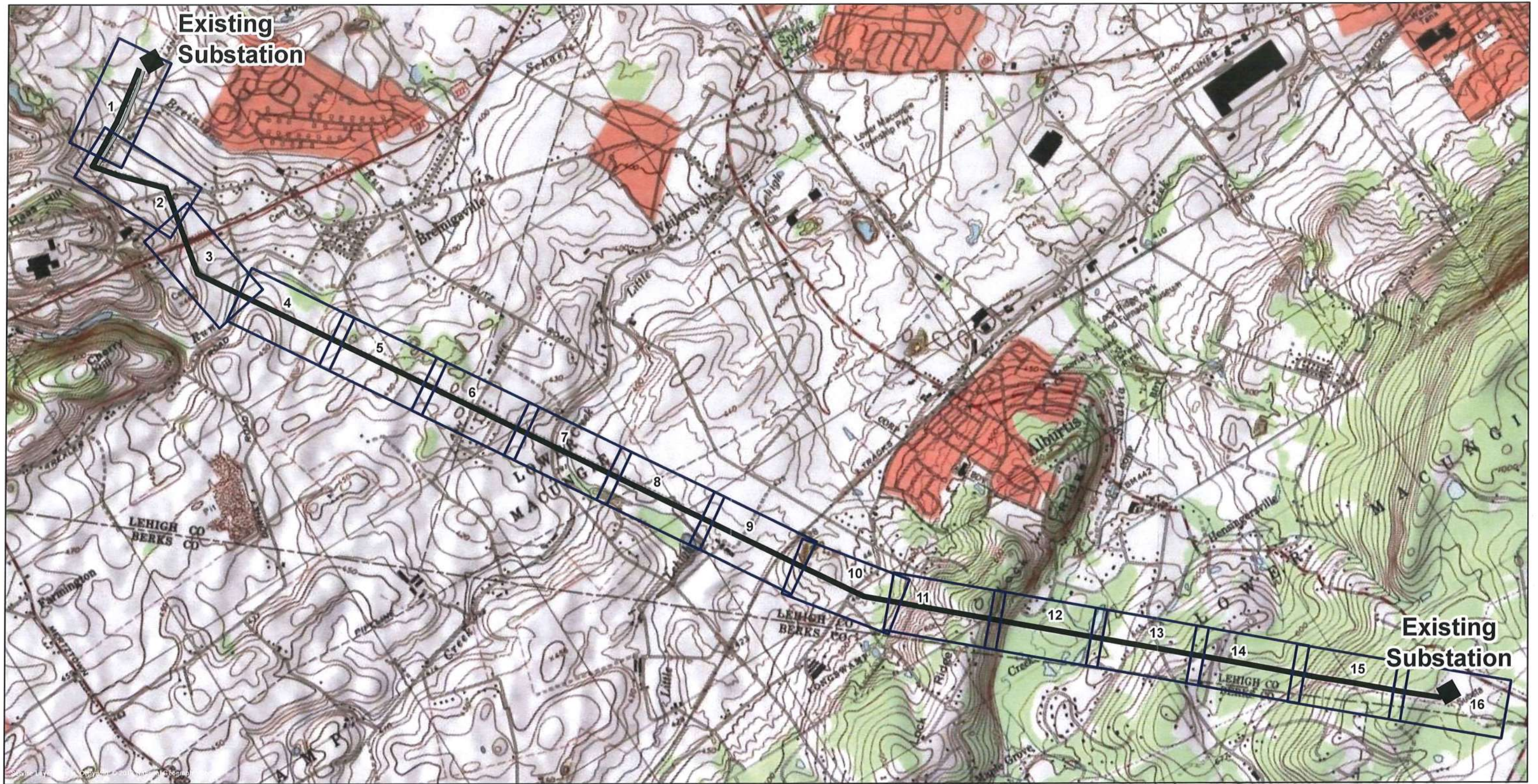
The PFBC noted that there is potential that habitat for the State-threatened Eastern Spadefoot Toad (*Scaphiopus holbrookii*) exists within the proposed disturbance area and requested that a habitat assessment be completed to characterize and determine if potential habitat exists within the vicinity of the proposed Project area. PPL Electric has conducted the required habitat survey and has coordinated with PFBC to incorporate acceptable avoidance measures into the Project.

The USFWS noted that the proposed Project is located within the known range of the federally threatened Bog Turtle (*Clemmys muhlenbergii*). In addition, USFWS provided information on the presence of a known Bog Turtle wetland located within the Project area. Based on further coordination with USFWS, PPL Electric conducted a Phase I habitat assessment of the wetlands within the Project area, which concluded that potential habitat does exist at specific wetlands. The Phase I report and a map of the wetlands and proposed work within 300 feet of these wetlands has been submitted to USFWS. PPL Electric notes that some of the proposed work will be conducted within close proximity to several of these wetlands. Coordination with USFWS has determined that a qualified biologist will need to be on-site during work that is being conducted within 300-feet of the identified potential habitat areas.

The PGC noted that their records indicate species or resources of concern located in the vicinity of the Project. However, PGC has determined that no impact is likely, based on the submitted Project information, and no further coordination with PGC will be necessary at this time.

PPL Electric will continue to consult with the jurisdictional agencies regarding potential impacts to protected species. PPL Electric will obtain all approvals and permits necessary for the construction of the Project, and will comply with any conditions placed on those permits.

FIGURES



Legend

- Existing Transmission Line Centerline
- Minor Centerline Adjustment
- Extent Grids

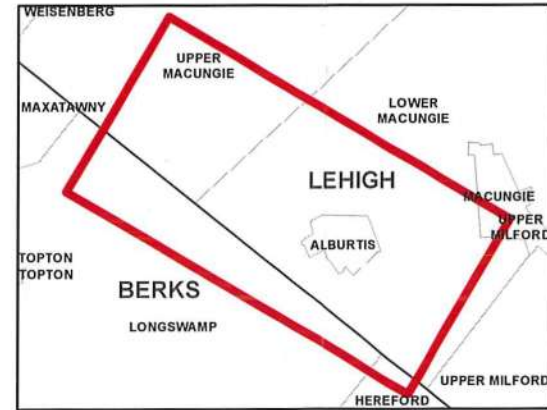
Notes

- Existing Project Centerline and Existing Poles digitized from files received from PPL in June 2014.
- Proposed Pole locations digitized from files received from PPL in August 2017

NAD 1983 State Plane
 Pennsylvania North FIPS 3701
 Projection: Lambert Conformal Conic
 Linear Unit: US Foot

References:
 NAIP Imagery Basemap (2015)
 Lehigh Parcel Data (2017)

0 1,000 2,000 4,000
 Feet
 1 inch = 2,000 feet



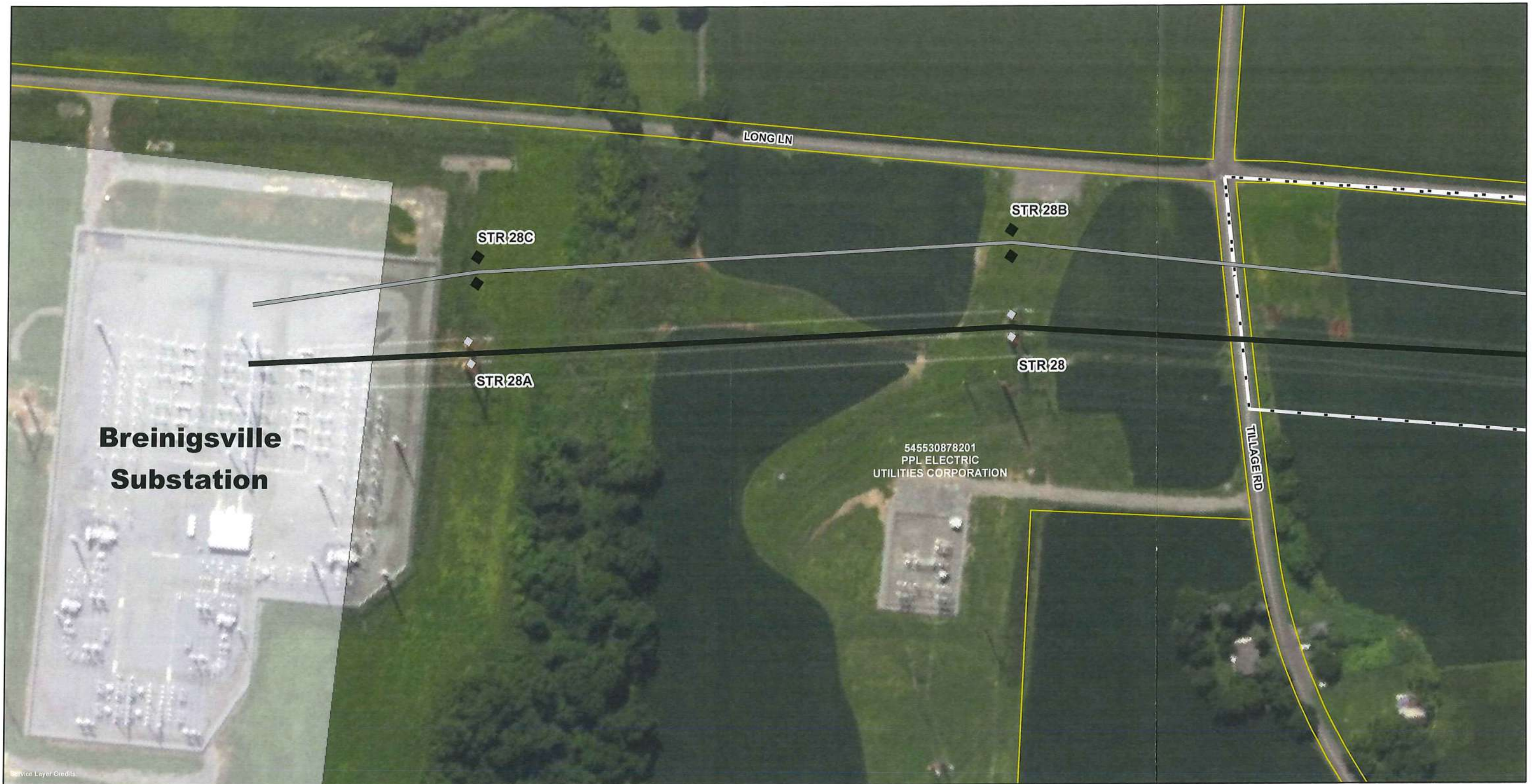
AECOM

**Figure 3-1: Overview Map
 Breinigsville-Alburtis
 500 kV Rebuild Project**

Lehigh County, Pennsylvania

PPL Electric Utilities
 Allentown, Pennsylvania

Prepared By: ND	Checked By: DY
Job: Susquehanna-Jenkins	Date: 9/18/2017



Legend

- Proposed Structure Locations
- Existing Structure Locations
- Existing PPL ROW
- Existing Transmission Line Centerline
- Minor Centerline Adjustment
- ▭ Parcel Boundary

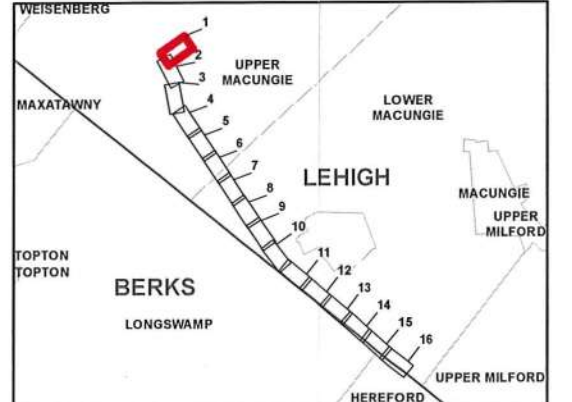
Notes

- Existing Project Centerline and Existing Poles digitized from files recieved from PPL in June 2014.
- Proposed Pole locations digitized from files recieved from PPL in August 2017

NAD 1983 State Plane
Pennsylvania North FIPS 3701
Projection: Lambert Conformal Conic
Linear Unit: US Foot

References:
NAIP Imagery Basemap (2015)
Lehigh Parcel Data (2017)

0 75 150 300
Feet
1 inch = 150 feet



AECOM

**Figure 3-1: Aerial Overview Map
Breinigsville-Alburtis
500 kV Rebuild Project**

Extent Map 1 of 16
Lehigh County, Pennsylvania

PPL Electric Utilities
Allentown, Pennsylvania

Prepared By: NB	Checked By: DY
Job: Susquehanna-Jenkins	Date: 9/15/2017



Legend

- Proposed Structure Locations
- Existing Structure Locations
- ⚡ Existing PPL ROW
- ⚡ Existing Transmission Line Centerline
- ⚡ Minor Centerline Adjustment
- ▭ Parcel Boundary

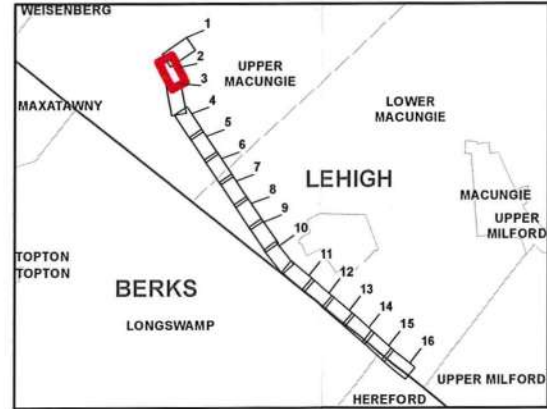
Notes

- Existing Project Centerline and Existing Poles digitized from files received from PPL in June 2014.
- Proposed Pole locations digitized from files received from PPL in August 2017

NAD 1983 State Plane
 Pennsylvania North FIPS 3701
 Projection: Lambert Conformal Conic
 Linear Unit: US Foot

References:
 NAIP Imagery Basemap (2015)
 Lehigh Parcel Data (2017)

0 75 150 300
 Feet
 1 inch = 150 feet



AECOM

**Figure 3-1: Aerial Overview Map
 Breinigsville-Alburtis
 500 kV Rebuild Project**

Extent Map 2 of 16
 Lehigh County, Pennsylvania

PPL Electric Utilities
 Allentown, Pennsylvania

Prepared By: IIB	Checked By: DY
Job: Susquehanna-Jenkins	Date: 9/15/2017



Legend

- Proposed Structure Locations
- Existing Structure Locations
- Existing PPL ROW
- Existing Transmission Line Centerline
- ▭ Parcel Boundary

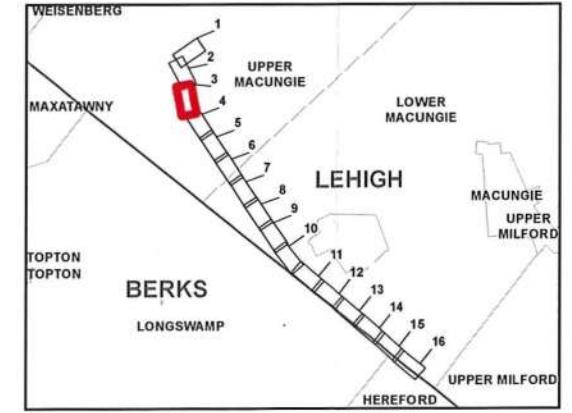
Notes

- Existing Project Centerline and Existing Poles digitized from files received from PPL in June 2014.
- Proposed Pole locations digitized from files received from PPL in August 2017

NAD 1983 State Plane
 Pennsylvania North FIPS 3701
 Projection: Lambert Conformal Conic
 Linear Unit: US Foot

References:
 NAIP Imagery Basemap (2015)
 Lehigh Parcel Data (2017)

0 75 150 300
 Feet
 1 inch = 150 feet



AECOM

**Figure 3-1: Aerial Overview Map
 Breinigsville-Alburtis
 500 kV Rebuild Project**

Extent Map 3 of 16
 Lehigh County, Pennsylvania

PPL Electric Utilities
 Allentown, Pennsylvania

Prepared By: NIB	Checked By: DY
Job: Susquehanna-Jenkins	Date: 9/15/2017



Legend

- Proposed Structure Locations
- Existing Structure Locations
- Existing PPL ROW
- Existing Transmission Line Centerline
- ▭ Parcel Boundary

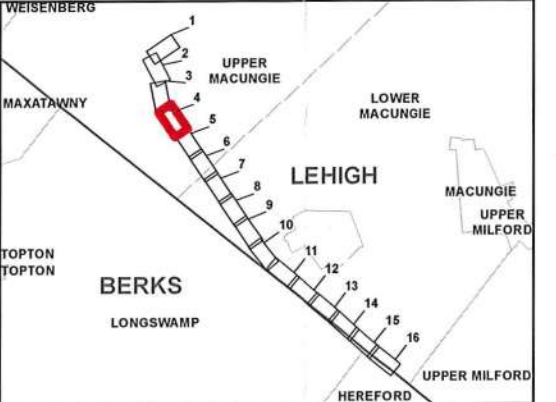
Notes

- Existing Project Centerline and Existing Poles digitized from files received from PPL in June 2014.
- Proposed Pole locations digitized from files received from PPL in August 2017

NAD 1983 State Plane
 Pennsylvania North FIPS 3701
 Projection: Lambert Conformal Conic
 Linear Unit: US Foot

References:
 NAIP Imagery Basemap (2015)
 Lehigh Parcel Data (2017)

0 75 150 300
 Feet
 1 inch = 150 feet



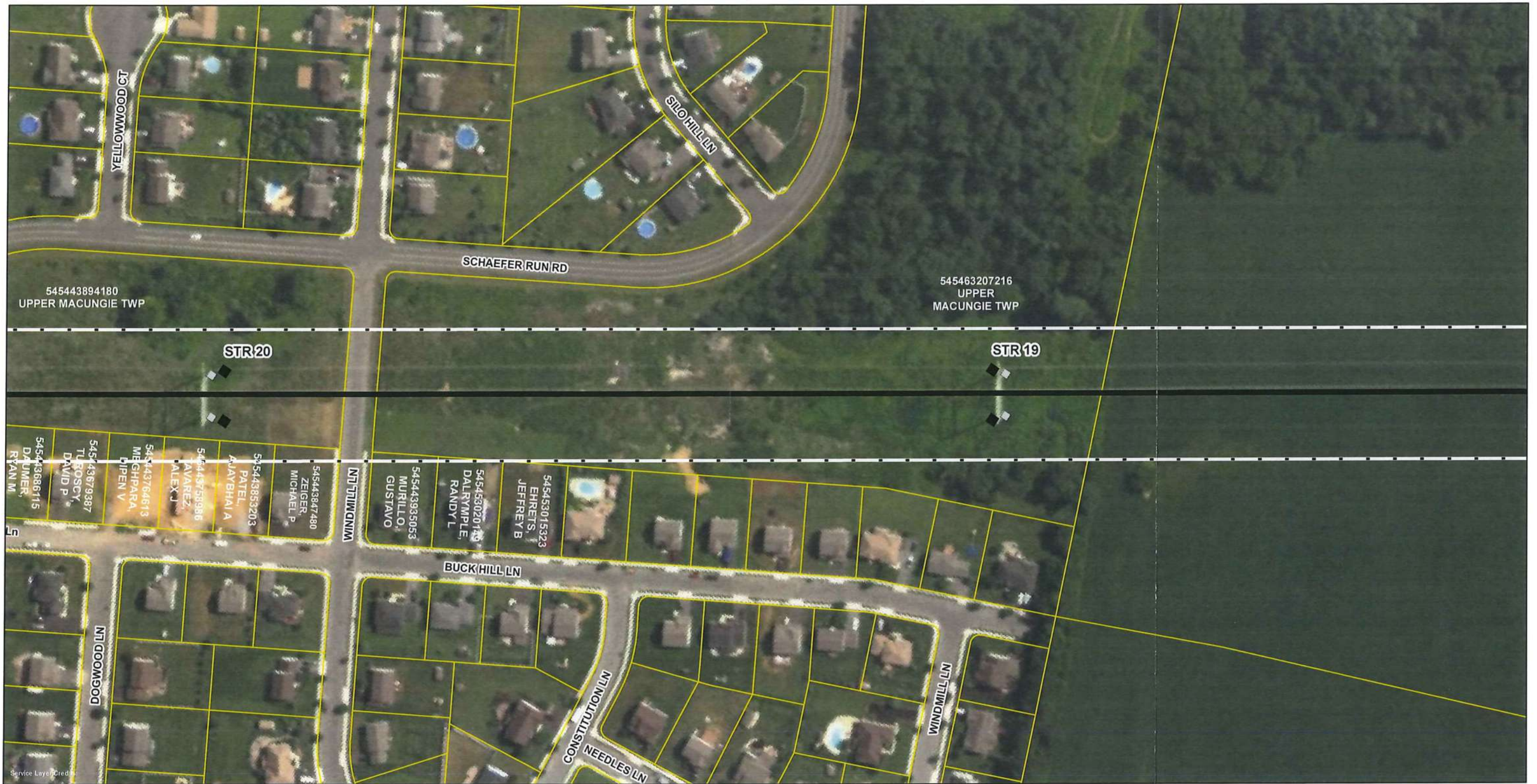
AECOM

**Figure 3-1: Aerial Overview Map
 Breinigsville-Alburtis
 500 kV Rebuild Project**

Extent Map 4 of 16
 Lehigh County, Pennsylvania

PPL Electric Utilities
 Allentown, Pennsylvania

Prepared By: HB	Checked By: DY
Job: Susquehanna-Jenkins	Date: 9/15/2017



Legend

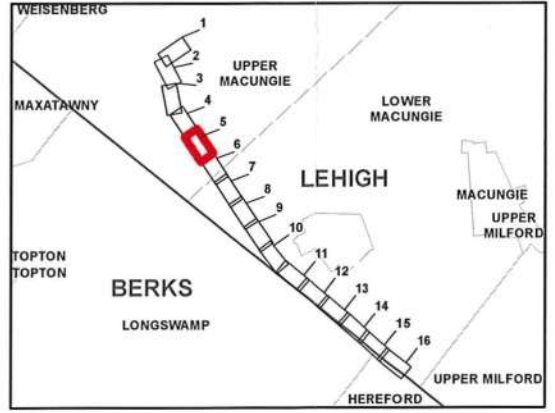
- Proposed Structure Locations
- Existing Structure Locations
- Existing PPL ROW
- Existing Transmission Line Centerline
- ▭ Parcel Boundary

Notes

- Existing Project Centerline and Existing Poles digitized from files received from PPL in June 2014.
- Proposed Pole locations digitized from files received from PPL in August 2017

NAD 1983 State Plane
 Pennsylvania North FIPS 3701
 Projection: Lambert Conformal Conic
 Linear Unit: US Foot

References:
 NAIP Imagery Basemap (2015)
 Lehigh Parcel Data (2017)



AECOM

**Figure 3-1: Aerial Overview Map
 Breinigsville-Alburtis
 500 kV Rebuild Project**

Extent Map 5 of 16
 Lehigh County, Pennsylvania

PPL Electric Utilities
 Allentown, Pennsylvania

Prepared By: NB	Checked By: DY
Job: Susquehanna-Jenkins	Date: 9/15/2017



Legend

- Proposed Structure Locations
- Existing Structure Locations
- ⚡ Existing PPL ROW
- ⚡ Existing Transmission Line Centerline
- ▭ Parcel Boundary

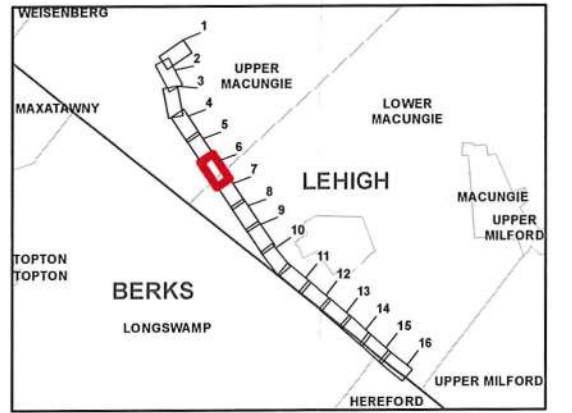
Notes

- Existing Project Centerline and Existing Poles digitized from files received from PPL in June 2014.
- Proposed Pole locations digitized from files received from PPL in August 2017

NAD 1983 State Plane
Pennsylvania North FIPS 3701
Projection: Lambert Conformal Conic
Linear Unit: US Foot

References:
NAIP Imagery Basemap (2015)
Lehigh Parcel Data (2017)

0 75 150 300
Feet
1 inch = 150 feet



AECOM

**Figure 3-1: Aerial Overview Map
Breinigsville-Alburtis
500 kV Rebuild Project**

Extent Map 6 of 16
Lehigh County, Pennsylvania

PPL Electric Utilities
Allentown, Pennsylvania

Prepared By: NB	Checked By: DY
Job: Susquehanna-Jenkins	Date: 9/15/2017



Service Layer Credits:

Legend

- Proposed Structure Locations
- Existing Structure Locations
- Existing PPL ROW
- Existing Transmission Line Centerline
- ▭ Parcel Boundary

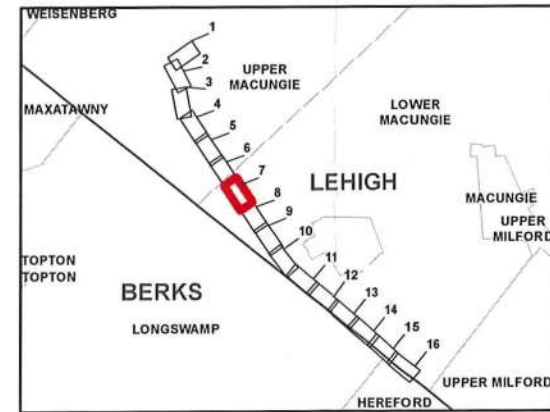
Notes

- Existing Project Centerline and Existing Poles digitized from files received from PPL in June 2014.
- Proposed Pole locations digitized from files received from PPL in August 2017

NAD 1983 State Plane
Pennsylvania North FIPS 3701
Projection: Lambert Conformal Conic
Linear Unit: US Foot

References:
NAIP Imagery Basemap (2015)
Lehigh Parcel Data (2017)

0 75 150 300
Feet
1 inch = 150 feet



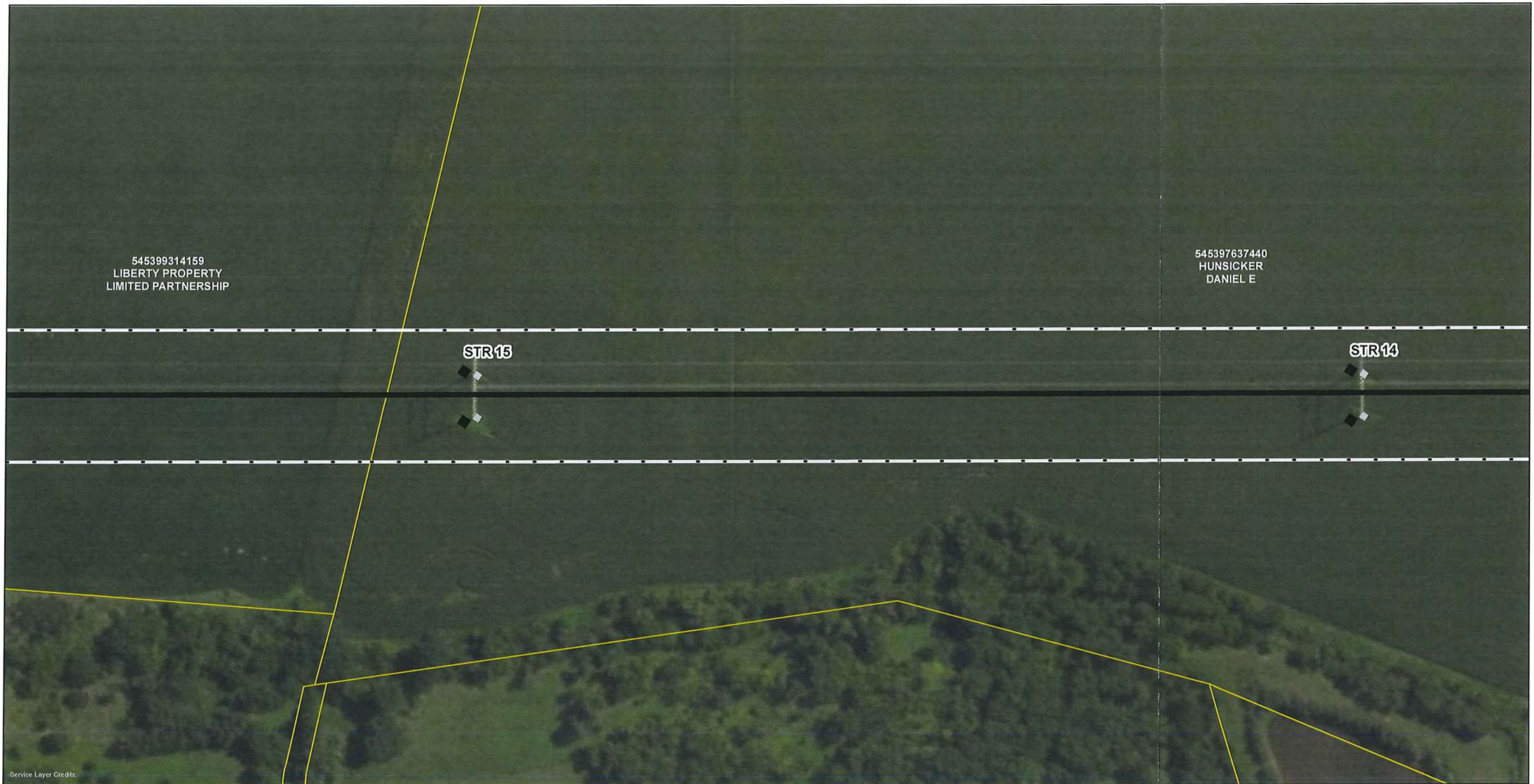
AECOM

**Figure 3-1: Aerial Overview Map
Breinigsville-Alburtis
500 kV Rebuild Project**

Extent Map 7 of 16
Lehigh County, Pennsylvania

PPL Electric Utilities
Allentown, Pennsylvania

Prepared By: NB	Checked By: DY
Job: Susquehanna-Jenkins	Date: 9/15/2017



Legend

- Proposed Structure Locations
- Existing Structure Locations
- Existing PPL ROW
- Existing Transmission Line Centerline
- ▭ Parcel Boundary

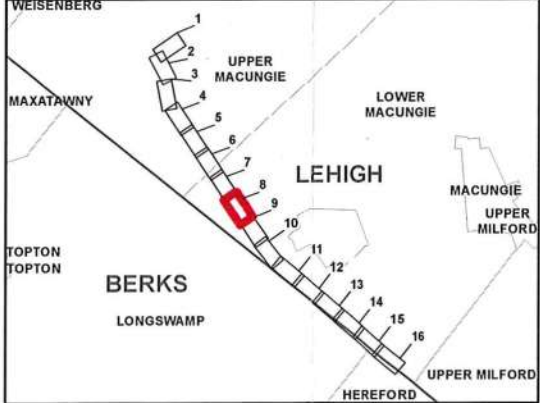
Notes

- Existing Project Centerline and Existing Poles digitized from files received from PPL in June 2014.
- Proposed Pole locations digitized from files received from PPL in August 2017

NAD 1983 State Plane
Pennsylvania North FIPS 3701
Projection: Lambert Conformal Conic
Linear Unit: US Foot

References:
NAIP Imagery Basemap (2015)
Lehigh Parcel Data (2017)

0 75 150 300
Feet
1 inch = 150 feet



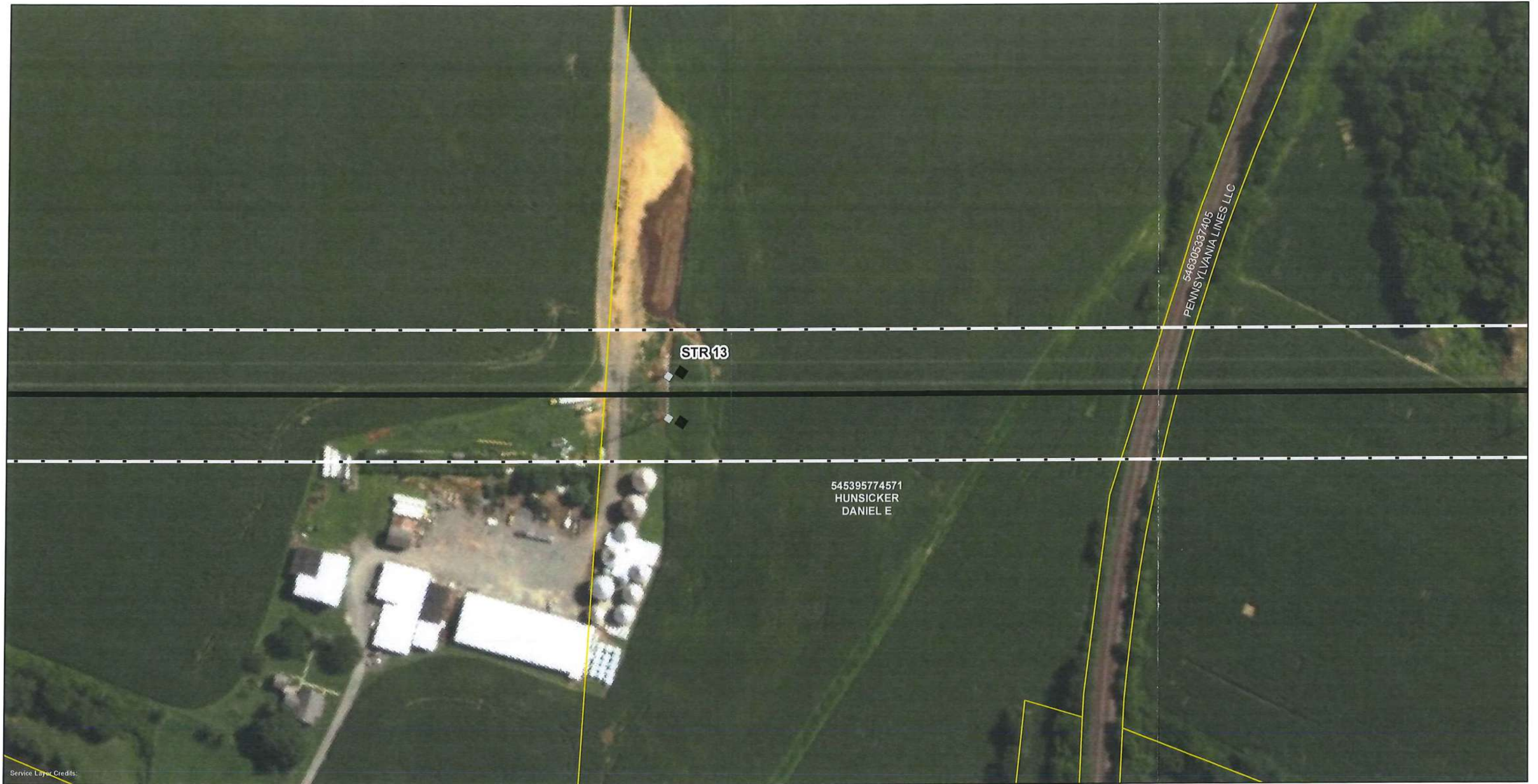
AECOM

**Figure 3-1: Aerial Overview Map
Breinigsville-Alburtis
500 kV Rebuild Project**

Extent Map 8 of 16
Lehigh County, Pennsylvania

PPL Electric Utilities
Allentown, Pennsylvania

Prepared By: NB	Checked By: DY
Job: Susquehanna-Jenkins	Date: 9/15/2017



Legend

- Proposed Structure Locations
- Existing Structure Locations
- Existing PPL ROW
- Existing Transmission Line Centerline
- ▭ Parcel Boundary

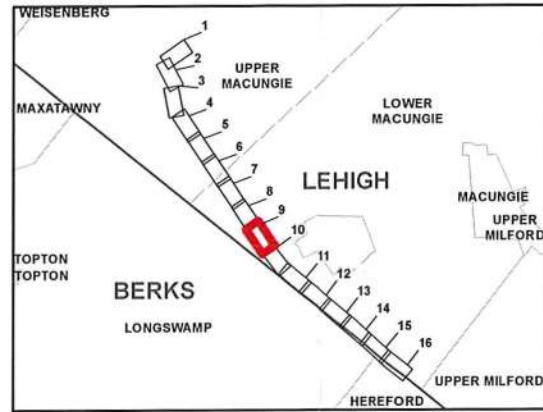
Notes

- Existing Project Centerline and Existing Poles digitized from files received from PPL in June 2014.
- Proposed Pole locations digitized from files received from PPL in August 2017

NAD 1983 State Plane
 Pennsylvania North FIPS 3701
 Projection: Lambert Conformal Conic
 Linear Unit: US Foot

References:
 NAIP Imagery Basemap (2015)
 Lehigh Parcel Data (2017)

0 75 150 300
 Feet
 1 inch = 150 feet



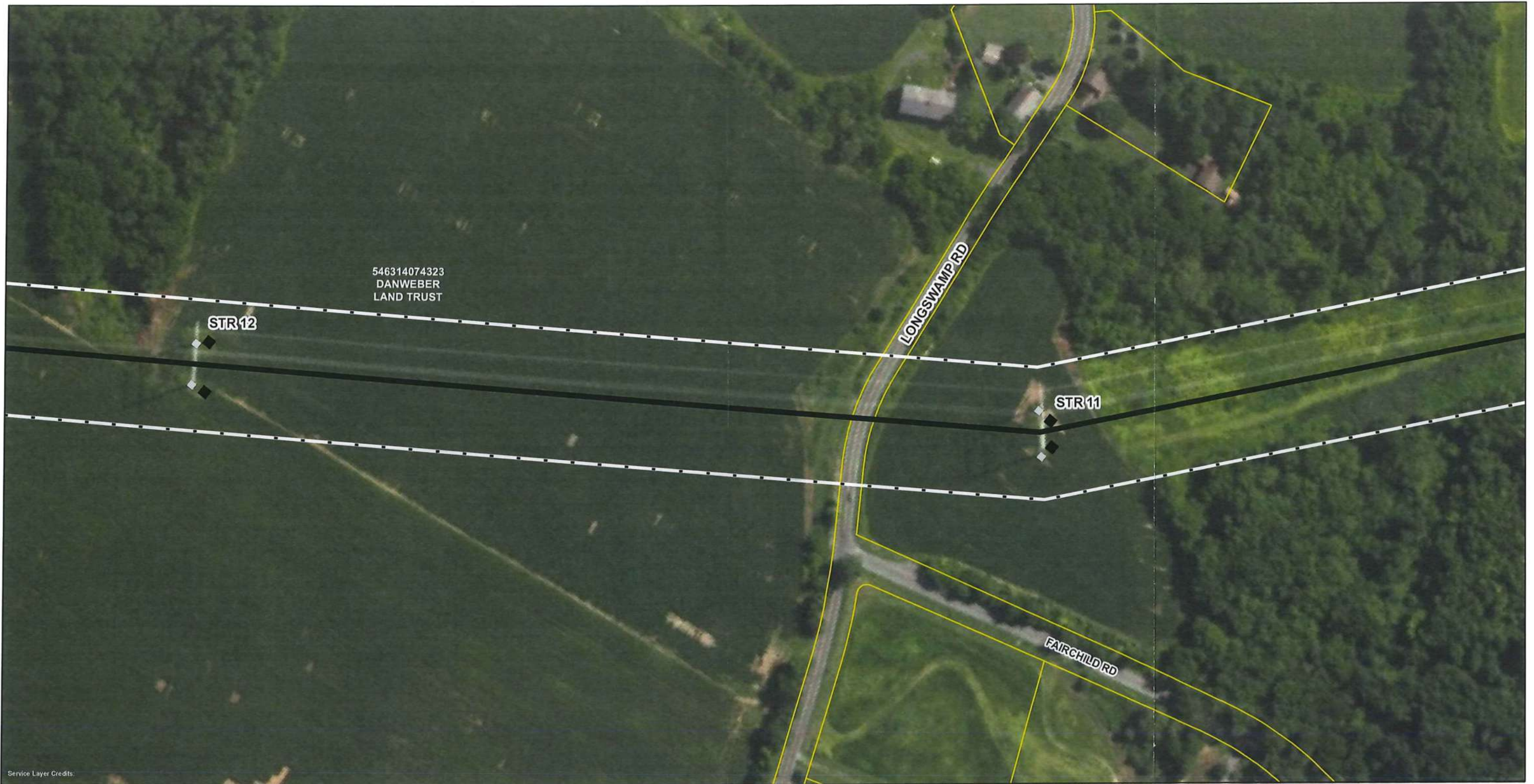
AECOM

**Figure 3-1: Aerial Overview Map
 Breinigsville-Alburtis
 500 kV Rebuild Project**

Extent Map 9 of 16
 Lehigh County, Pennsylvania

PPL Electric Utilities
 Allentown, Pennsylvania

Prepared By: NB	Checked By: DY
Job: Susquehanna-Jenkins	Date: 9/15/2017



Service Layer Credits:

Legend

- Proposed Structure Locations
- Existing Structure Locations
- ⚡ Existing PPL ROW
- Existing Transmission Line Centerline
- ▭ Parcel Boundary

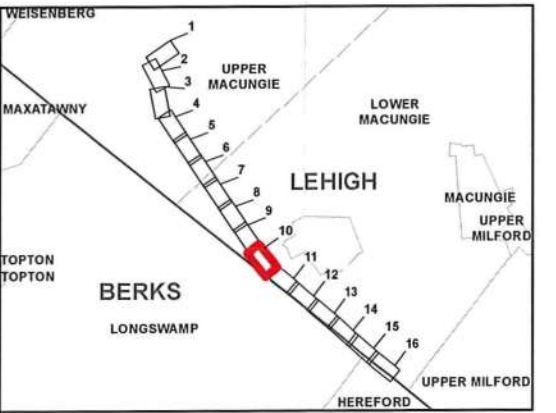
Notes

- Existing Project Centerline and Existing Poles digitized from files recieved from PPL in June 2014.
- Proposed Pole locations digitized from files recieved from PPL in August 2017

NAD 1983 State Plane
 Pennsylvania North FIPS 3701
 Projection: Lambert Conformal Conic
 Linear Unit: US Foot

References:
 NAIP Imagery Basemap (2015)
 Lehigh Parcel Data (2017)

0 75 150 300
 Feet
 1 inch = 150 feet



**Figure 3-1: Aerial Overview Map
 Breinigsville-Alburtis
 500 kV Rebuild Project**

Extent Map 10 of 16
 Lehigh County, Pennsylvania

PPL Electric Utilities
 Allentown, Pennsylvania

Prepared By: NB	Checked By: DY
Job: Susquehanna-Jenkins	Date: 9/15/2017



Legend

- Proposed Structure Locations
- Existing Structure Locations
- Existing PPL ROW
- Existing Transmission Line Centerline
- ▭ Parcel Boundary

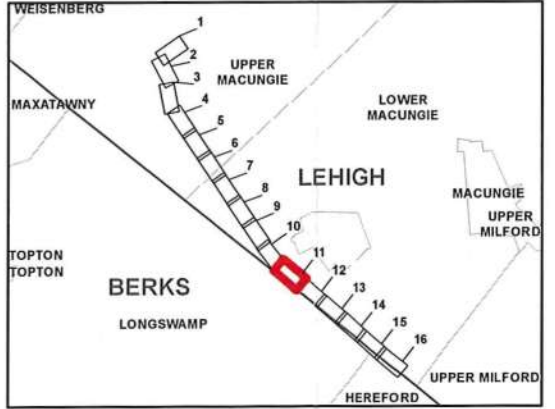
Notes

- Existing Project Centerline and Existing Poles digitized from files recieved from PPL in June 2014.
- Proposed Pole locations digitized from files recieved from PPL in August 2017

NAD 1983 State Plane
Pennsylvania North FIPS 3701
Projection: Lambert Conformal Conic
Linear Unit: US Foot

References:
NAIP Imagery Basemap (2015)
Lehigh Parcel Data (2017)

0 75 150 300
Feet
1 inch = 150 feet



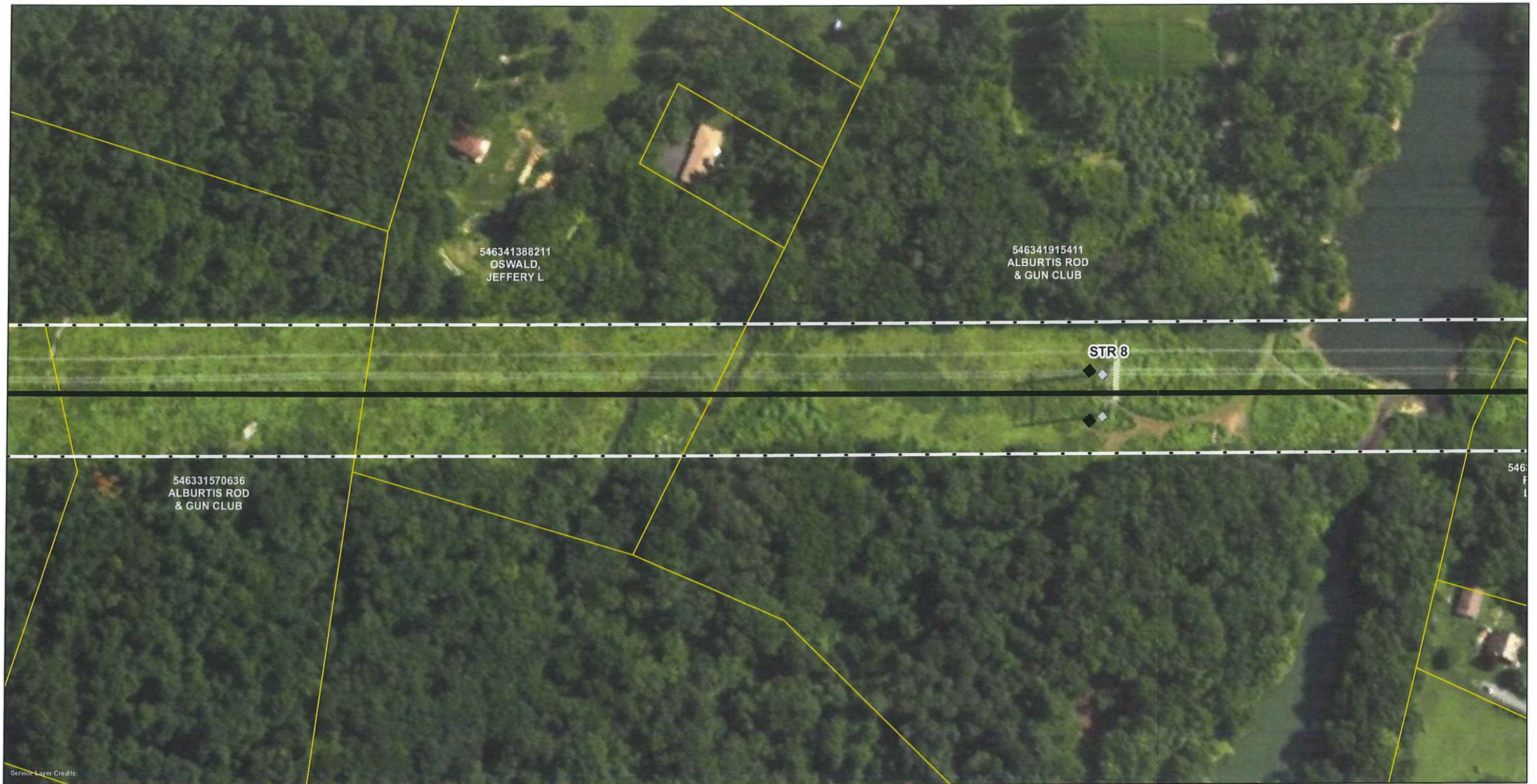
AECOM

**Figure 3-1: Aerial Overview Map
Breinigsville-Alburtis
500 kV Rebuild Project**

Extent Map 11 of 16
Lehigh County, Pennsylvania

PPL Electric Utilities
Allentown, Pennsylvania

Prepared By: NB	Checked By: DY
Job: Susquehanna-Jenkins	Date: 9/15/2017



Legend

- Proposed Structure Locations
- Existing Structure Locations
- Existing PPL ROW
- Existing Transmission Line Centerline
- ▭ Parcel Boundary

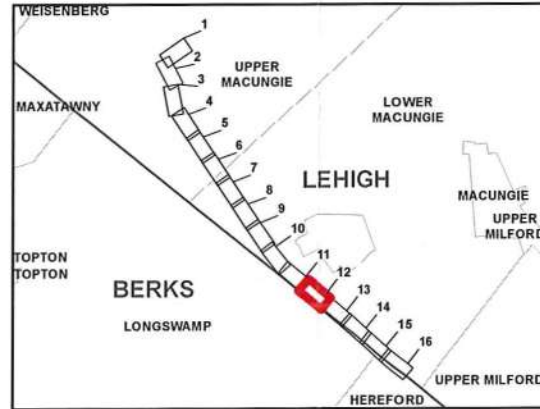
Notes

- Existing Project Centerline and Existing Poles digitized from files received from PPL in June 2014.
- Proposed Pole locations digitized from files received from PPL in August 2017

NAD 1983 State Plane
 Pennsylvania North FIPS 3701
 Projection: Lambert Conformal Conic
 Linear Unit: US Foot

References:
 NAIP Imagery Basemap (2015)
 Lehigh Parcel Data (2017)

0 75 150 300
 Feet
 1 inch = 150 feet



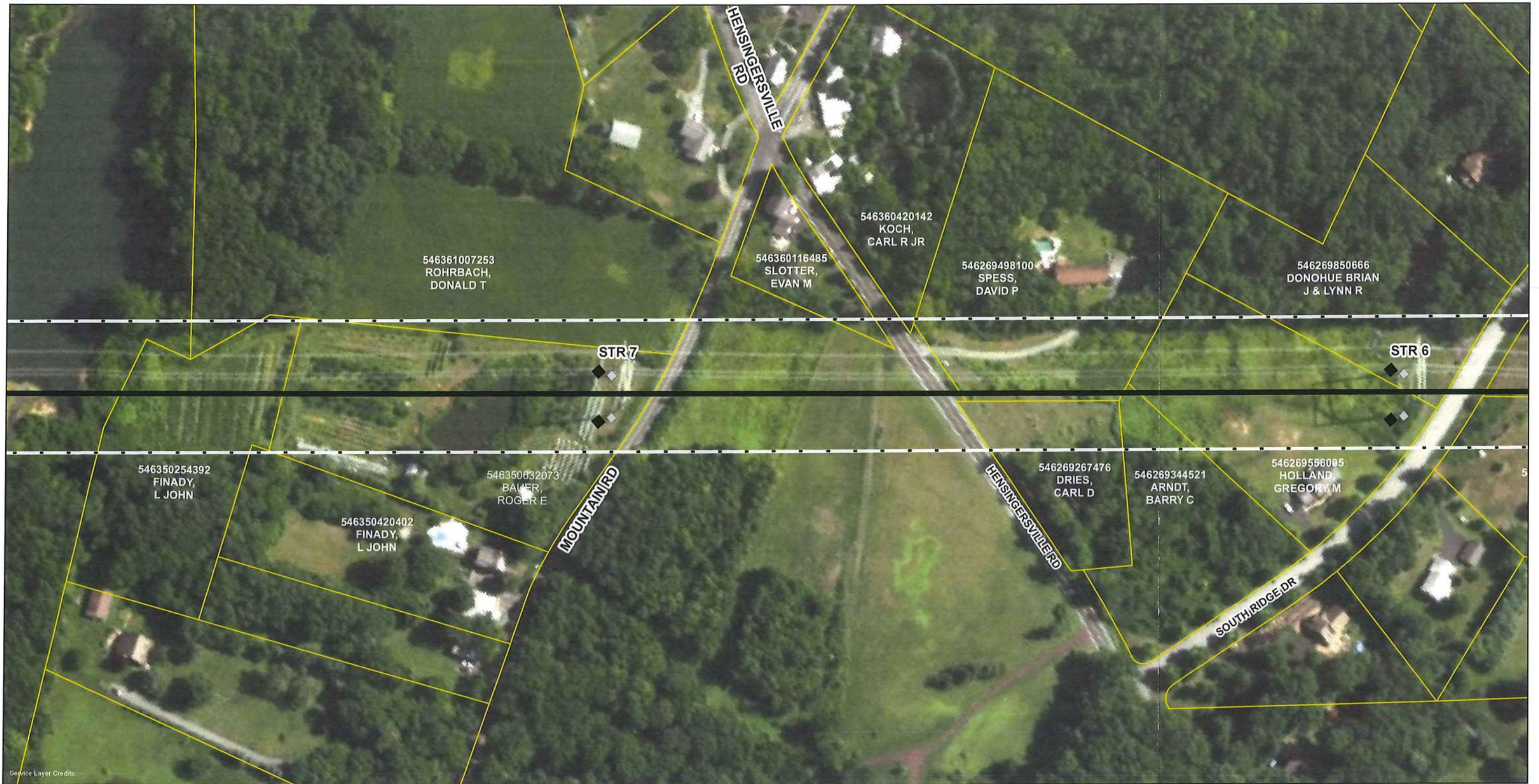
AECOM

**Figure 3-1: Aerial Overview Map
 Breinigsville-Alburtis
 500 kV Rebuild Project**

Extent Map 12 of 16
 Lehigh County, Pennsylvania

PPL Electric Utilities
 Allentown, Pennsylvania

Prepared By: HB	Checked By: DY
Job: Susquehanna-Jenkins	Date: 9/15/2017



Legend

- Proposed Structure Locations
- Existing Structure Locations
- Existing PPL ROW
- Existing Transmission Line Centerline
- ▭ Parcel Boundary

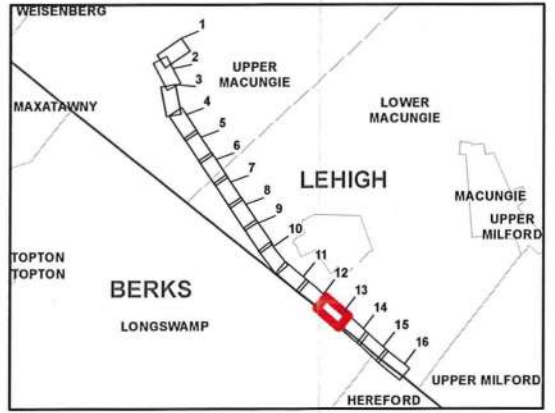
Notes

- Existing Project Centerline and Existing Poles digitized from files received from PPL in June 2014.
- Proposed Pole locations digitized from files received from PPL in August 2017

NAD 1983 State Plane
 Pennsylvania North FIPS 3701
 Projection: Lambert Conformal Conic
 Linear Unit: US Foot

References:
 NAIP Imagery Basemap (2015)
 Lehigh Parcel Data (2017)

0 75 150 300
 Feet
 1 inch = 150 feet



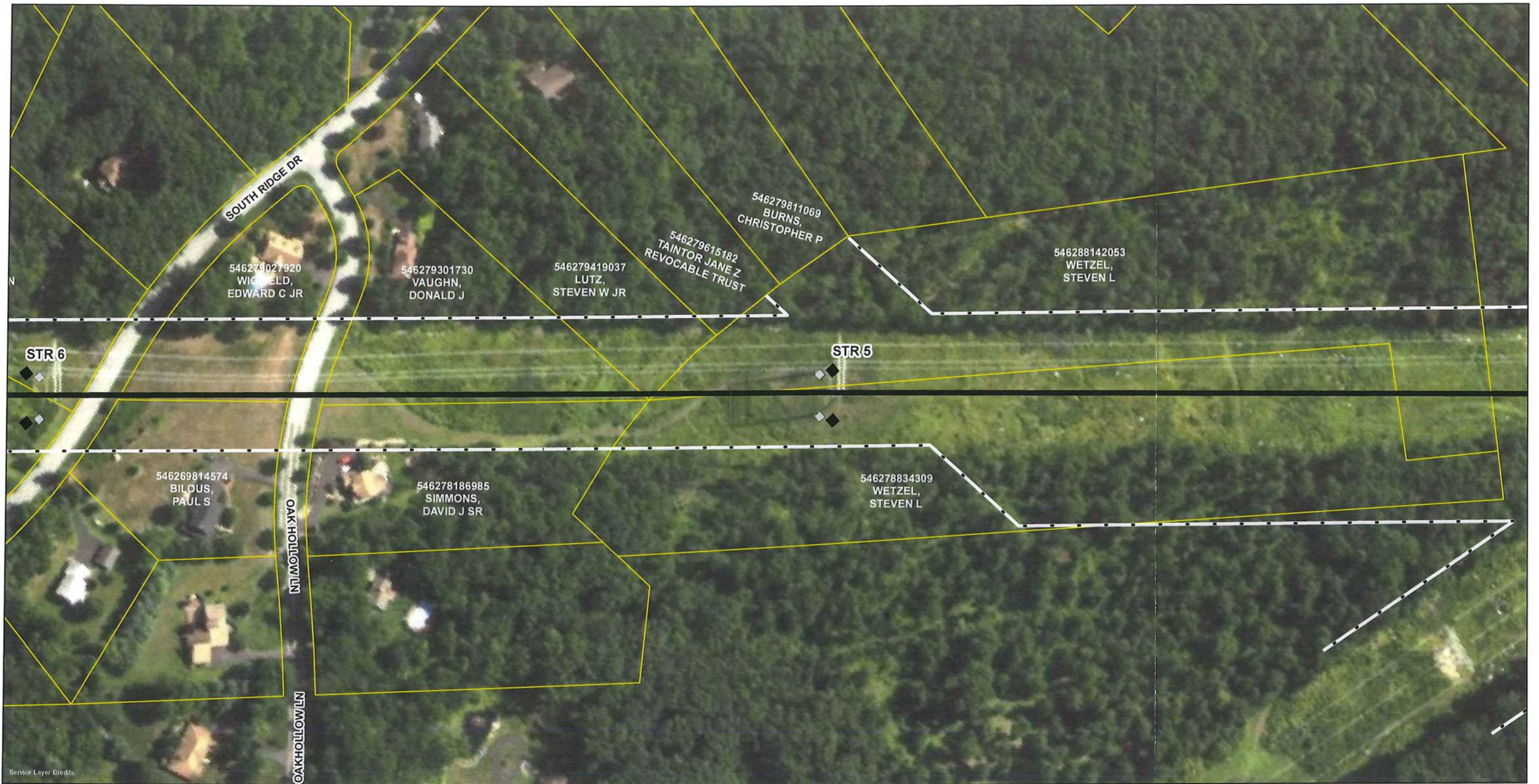
AECOM

**Figure 3-1: Aerial Overview Map
 Breinigsville-Alburtis
 500 kV Rebuild Project**

Extent Map 13 of 16
 Lehigh County, Pennsylvania

PPL Electric Utilities
 Allentown, Pennsylvania

Prepared By: NB	Checked By: DY
Job: Susquehanna-Jenkins	Date: 9/15/2017



Legend

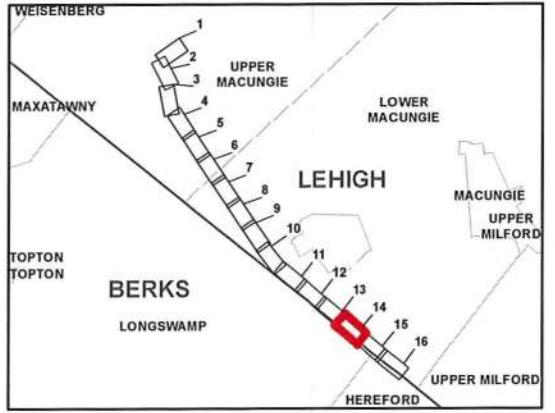
- Proposed Structure Locations
- Existing Structure Locations
- Existing PPL ROW
- Existing Transmission Line Centerline
- ▭ Parcel Boundary

Notes

- Existing Project Centerline and Existing Poles digitized from files received from PPL in June 2014.
- Proposed Pole locations digitized from files received from PPL in August 2017

NAD 1983 State Plane
 Pennsylvania North FIPS 3701
 Projection: Lambert Conformal Conic
 Linear Unit: US Foot

References:
 NAIP Imagery Basemap (2015)
 Lehigh Parcel Data (2017)



AECOM

**Figure 3-1: Aerial Overview Map
 Breinigsville-Alburtis
 500 kV Rebuild Project**

Extent Map 14 of 16
 Lehigh County, Pennsylvania

PPL Electric Utilities
 Allentown, Pennsylvania

Prepared By: NIB	Checked By: DY
Job: Susquehanna-Jenkins	Date: 9/15/2017



Service Layer Credits:

Legend

- Proposed Structure Locations
- Existing Structure Locations
- ⋯ Existing PPL ROW
- ⚡ Existing Transmission Line Centerline
- ▭ Parcel Boundary

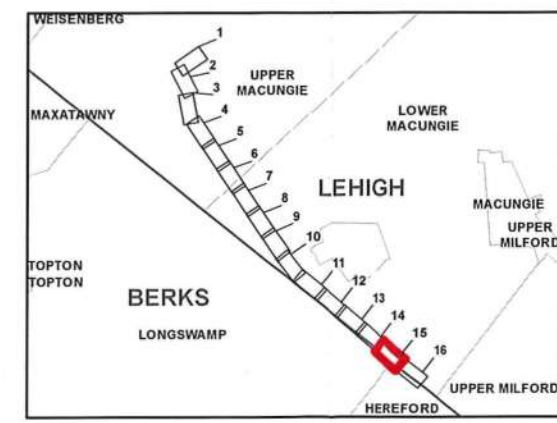
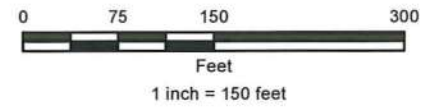
Notes

- Existing Project Centerline and Existing Poles digitized from files received from PPL in June 2014.
- Proposed Pole locations digitized from files received from PPL in August 2017



NAD 1983 State Plane
 Pennsylvania North FIPS 3701
 Projection: Lambert Conformal Conic
 Linear Unit: US Foot

References:
 NAIP Imagery Basemap (2015)
 Lehigh Parcel Data (2017)

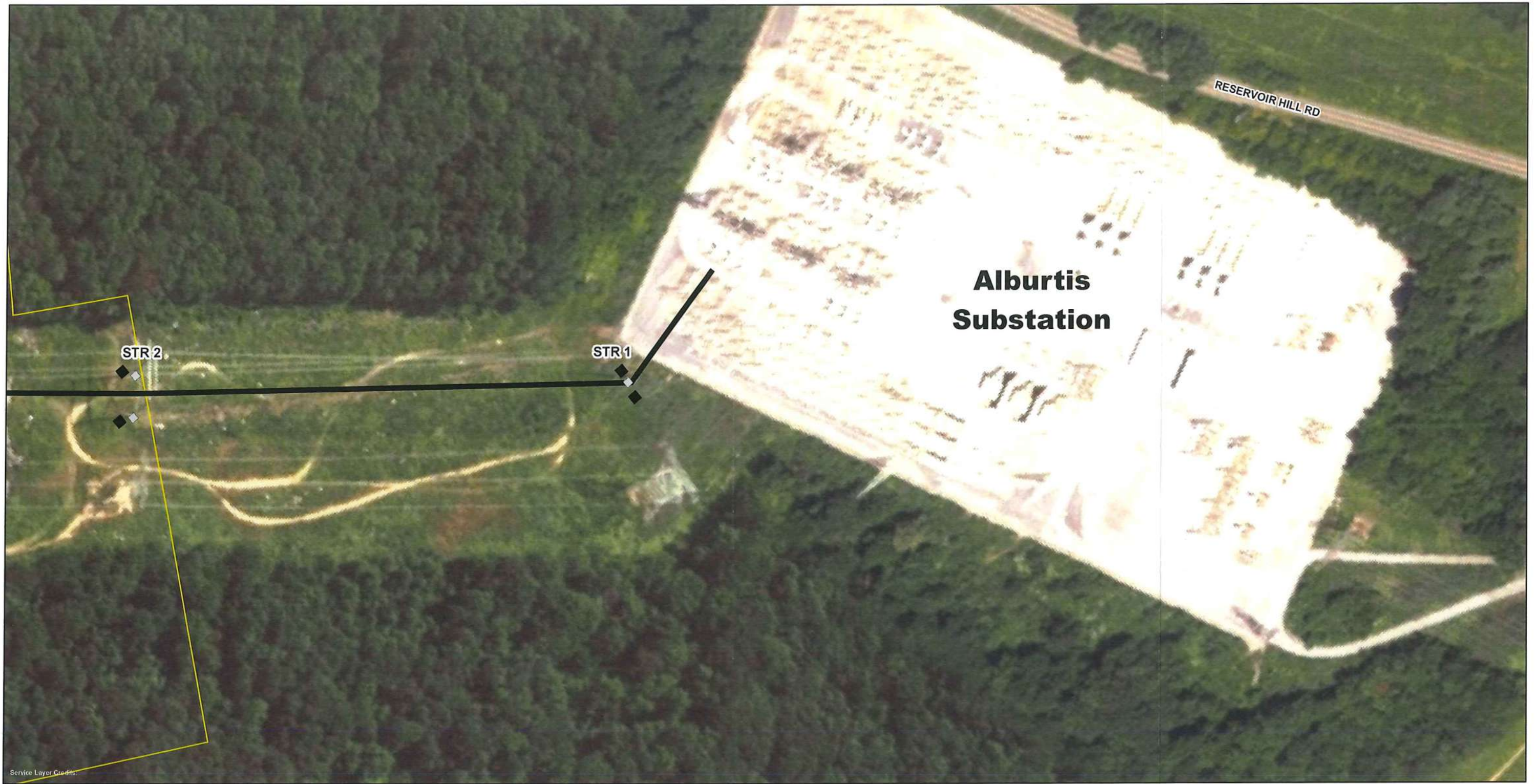


**Figure 3-1: Aerial Overview Map
 Breinigsville-Alburtis
 500 kV Rebuild Project**

Extent Map 15 of 16
 Lehigh County, Pennsylvania

PPL Electric Utilities
 Allentown, Pennsylvania

Prepared By: NB	Checked By: DY
Job: Susquehanna-Jenkins	Date: 9/15/2017



Legend

- Proposed Structure Locations
- Existing Structure Locations
- Existing Transmission Line Centerline
- ▭ Parcel Boundary

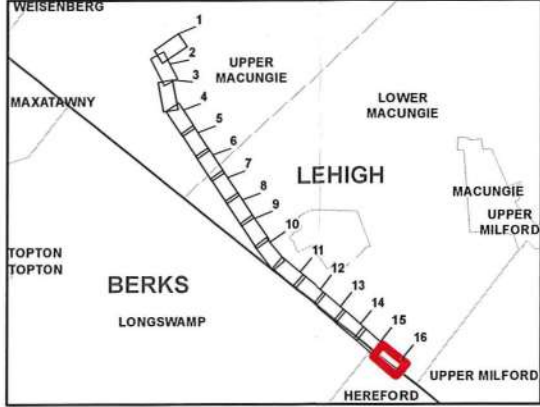
Notes

- Existing Project Centerline and Existing Poles digitized from files received from PPL in June 2014.
- Proposed Pole locations digitized from files received from PPL in August 2017

NAD 1983 State Plane
 Pennsylvania North FIPS 3701
 Projection: Lambert Conformal Conic
 Linear Unit: US Foot

References:
 NAIP Imagery Basemap (2015)
 Lehigh Parcel Data (2017)

0 75 150 300
 Feet
 1 inch = 150 feet



AECOM

**Figure 3-1: Aerial Overview Map
 Breinigsville-Alburdis
 500 kV Rebuild Project**

Extent Map 16 of 16
 Lehigh County, Pennsylvania

PPL Electric Utilities
 Allentown, Pennsylvania

Prepared By: NB	Checked By: DY
Job: Susquehanna-Jenkins	Date: 9/15/2017

Table of Contents

1.0	DESIGN CONSIDERATIONS	1
2.0	PERIODIC MAINTENANCE PROGRAM ON ALL TRANSMISSION LINES	3
3.0	PERSONNEL SAFETY RULES.....	4
4.0	MAGNETIC FIELD MANAGEMENT PLAN	5

List of Tables

Table 4-1: 69 kV Vertical Clearance to Ground

Table 4-2: 138 kV Vertical Clearance to Ground

Table 4-3: 230 kV Vertical Clearance to Ground

Table 4-4: 500 kV Vertical Clearance to Ground

1.0 DESIGN CONSIDERATIONS

PPL Electric’s new and rebuilt transmission lines are designed according to, and generally exceed, all NESC minimum standards. The NESC is a set of rules to safeguard people during the installation, operation, and maintenance of electric power lines. The NESC contains the basic provisions considered necessary for the safety of employees and the public. Although it is not intended as a design specification, its provisions establish minimum design requirements. PPL Electric has developed design specifications and safety rules which meet or surpass all requirements specified by the NESC.

The NESC includes loading requirements and clearances for the design, construction, and operation of power lines. The "loads" on conductors and supporting structures are the mechanical forces that develop from the weight of the conductors, the weight of ice on the conductors, plus wind pressure on the conductors and supporting structures. Loading requirements are the loads on the conductors and structures that are anticipated assuming certain ice and wind conditions. Loading requirements always contain "safety factors" to allow for unknown or unanticipated contingencies. The clearances and loading requirements contained in the NESC are designed to maintain public safety.

PPL Electric’s transmission line design standards meet or surpass the NESC clearances and loading requirements.

For example, the NESC specifies strength and loading rules based on three different “grades of construction” for conductors and supporting structures:

- Grade B – This grade of construction provides the highest margin of safety and is required when the pole supports spans that cross limited access highways, railroads, and waterways.
- Grade C – This grade of construction is most common and provides a basic margin of safety. It is often utilized for the typical power and joint-use distribution pole.
- Grade N – This is the lowest grade of construction and is most often used for emergency and temporary construction.

PPL Electric designs all of its transmission lines for Grade B construction. The use of Grade B design and construction translates to higher levels of structural reliability and safety to withstand the environmental conditions of ice and/or wind loading, which provides a higher margin of safety.

Another example is the design parameters utilized to account for ice and wind loadings on the wires and structure. The conductor sags and tensions along with the structure loading used in line designs are the result of various ice and wind combinations. PPL Electric’s transmission lines are designed to exceed NESC requirements by accounting for additional load cases due to various ice and wind loading conditions not required by NESC. This means that PPL Electric lines are designed to operate safely and reliably during extreme inclement weather. In addition, where practicable, PPL Electric transmission lines are designed with more clearance to the ground than required by the NESC. The tables below compare PPL Electric’s general conductor to ground design and the NESC minimum ground clearances for lines of various voltages.

TABLE 4-1: 69 kV Vertical Clearance to Ground

Surface Underneath Conductors	NESC Standard Clearance	PPL Conductor Clearances
Roads, streets, alleys	19.2 Ft.	30 Ft.
Other land traversed by vehicles (such as cultivated field, forest, etc.)	19.2 Ft.	30 Ft.
Spaces accessible to pedestrians only	15.2 Ft.	30 Ft.
Railroad tracks	27.2 Ft.	31.5 Ft.

TABLE 4-2: 138 kV Vertical Clearance to Ground

Surface Underneath Conductors	NESC Standard Clearance	PPL Conductor Clearances
Roads, streets, alleys	20.6 Ft.	31 Ft.
Other land traversed by vehicles (such as cultivated field, forest, etc.)	20.6 Ft.	31 Ft.
Spaces accessible to pedestrians only	16.6 Ft.	31 Ft.
Railroad tracks	28.6 Ft.	35 Ft.

TABLE 4-3: 230 kV Vertical Clearance to Ground

Surface Underneath Conductors	NESC Standard Clearance	PPL Conductor Clearances
Roads, streets, alleys	22.4 Ft.	33 Ft.
Other land traversed by vehicles (such as cultivated field, forest, etc.)	22.4 Ft.	33 Ft.
Spaces accessible to pedestrians only	18.4 Ft.	33 Ft.
Railroad tracks	30.4 Ft.	35 Ft.

TABLE 4-4: 500 kV Vertical Clearance to Ground

Surface Underneath Conductors	NESC Standard Clearance	PPL Conductor Clearances
Roads, streets, alleys	28.4 Ft.	40 Ft.
Other land traversed by vehicles (such as cultivated field, forest, etc.)	28.4 Ft.	40 Ft.
Spaces accessible to pedestrians only	24.4 Ft.	40 Ft.
Railroad tracks	36.4 Ft.	53 Ft.

A relay protection system is also used on PPL Electric’s transmission lines to protect the public safety, as well as the equipment on the transmission system. Relay protection is installed for all transmission lines to automatically de-energize the line in the unlikely event that the line or supporting structure fails and the line contacts the ground.

2.0 PERIODIC MAINTENANCE PROGRAM ON ALL TRANSMISSION LINES

To ensure continued public safety and integrity of service, a periodic maintenance and inspection program is implemented for every transmission line. The program is administered through the use of helicopter patrols, with supplemental foot patrols as needed. Helicopter patrols are performed on

all lines on a predetermined frequency, depending on voltage level. The two-man helicopter crew flies parallel and above the line so that the observer can look for signs of line damage or deterioration and observe clearances between vegetation and conductors. The observations are included in a report that is forwarded to the appropriate department for corrective action.

3.0 PERSONNEL SAFETY RULES

Overall PPL Electric designs and constructs projects with high regards to both public and employee safety, and follows or exceeds all codes and requirements. The following are a few, but not all, of the PPL Electric safety rules that demonstrate the Company's dedication to employee and contractor safety:

- Work procedures have been developed to allow work to be performed on energized facilities in a safe manner. When lines or apparatus are removed from service to be worked on, the Energy Control Process system is applied. This system provides that a red tag must be physically placed on the control handle of the de-energized equipment.
- The red tag may be removed only after proper authorization to energize the equipment.
- Various other tags are used for limited operations and informational purposes.
- Employees or contractors will not apply or remove a tag or change the status of tagged equipment unless authorized.
- Temporary safety grounds are used on de-energized facilities for employee lineman safety during maintenance, construction, or reconstruction work. Safety grounds are wires connecting the de-energized facility to an electrical ground. If the facility should be energized, the safety grounds will divert the current directly to ground and reduce the likelihood of personal injury.
- Before applying grounds, a test is done to confirm that the line is de-energized. The voltage test device is checked before and after use to assure reliability.
- Poles or structures are inspected and examined for structural integrity before climbing. If there is any reason to believe that a pole is unsafe, it is stabilized before work is performed.

Appropriate safety gear in the form of body belts, safety straps, hard hats, gloves, etc., is worn by linemen during line work activity.

4.0 MAGNETIC FIELD MANAGEMENT PLAN

PPL Electric's Magnetic Field Management Program is applied to new and reconstructed transmission line projects. In order to lower magnetic field exposures, the program generally prescribes the use of a line design that provides ground clearances higher than the required minimum NESC ground clearance and reverse phasing of new double circuit lines where it is feasible to do so at low or no cost. The implementation of additional modifications to reduce magnetic field levels, are considered, provided those modifications can be made at low or no cost and will not interfere with the operation of the line.