



Before the
Pennsylvania Public Utility Commission

MILTON SUBSTATION UPGRADE PROJECT

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

Application Docket No. _____

Submitted by: PPL Electric Utilities Corp.

Attachment 1

ATTACHMENT 1
MILTON SUBSTATION UPGRADE
PROJECT NECESSITY STATEMENT

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A. INTRODUCTION

PPL Electric Utilities Corporation (“PPL Electric”) is requesting Pennsylvania Public Utility Commission (“PUC” or the “Commission”) approval to re-terminate the existing Montour-Sunbury 230 kV Transmission Line into an upgraded Milton 230-69 kV Substation located in West Chillisquaque Township, Northumberland County, Pennsylvania (the Project). As explained below, the Project is required to resolve reliability and planning violations, and to maintain reliable electric service to approximately 13,000 customers served from the Milton 230-69 kV Substation. The proposed Project will result in a more reliable configuration that complies with both the PPL Electric and PJM Interconnection, LLC (“PJM”) design standards and criteria.

The estimated cost to re-terminate the existing Montour-Sunbury 230 kV Transmission Line into the upgraded Milton 230-69 kV Substation is approximately \$2.2 million.¹ Subject to the Commission’s approval, construction is scheduled to begin in September 2017, to support the Project’s scheduled in-service date of December 2017.

B. 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.

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 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.

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>

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 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, 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 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.

C. DEFINITION OF THE PROBLEM

The Montour-Sunbury 230 kV Transmission Line extends approximately 22.9 miles between the Montour Substation and the Sunbury Substation. Near the half-way point, the Montour-Sunbury 230 kV Transmission Line is also connected to the Milton 230-69 kV Substation via a 300-foot single tap line. The Milton Substation is about 12.6 miles south of the Montour Substation and about 10.3 miles north of the Sunbury Substation. The Milton 230-69 kV Substation, originally built in 1973, is located in West Chillisquaque Township, Northumberland County.

Approximately 13,000 customers in Northumberland County are presently served by the Milton 230-69 kV Substation.

As explained above, the Montour-Sunbury 230 kV Transmission Line currently terminates and is directly connected to three substations: the Montour, Milton, and Sunbury Substations. PPL Electric's standard design is for all 230 kV lines to terminate into only two substations, with one substation at either end. This standard enhances system reliability by simplifying interconnections and makes it easier for PPL Electric to isolate system faults, which helps prevent faults from spreading and affecting other segments of the electrical system. The Montour-Sunbury 230 kV Transmission Line does not comply with PPL Electric's design standard for 230 kV lines.

Currently, the 230-69 kV transformer at the Milton 230-69 kV Substation is connected directly to the Montour-Sunbury 230 kV Transmission Line. However, there currently is no interrupting device for the Montour-Sunbury 230 kV Transmission Line at the Milton 230-69 kV Substation. If the 230-69 kV transformer at the Milton 230-69 kV Substation were to experience an outage, electrical service would be interrupted for all 13,000 customers currently served by the Milton 230-69 kV Substation. For increased electrical service reliability reasons, PPL Electric's design standard is to connect a transformer to a transmission line through an interrupting device, such as a circuit breaker. This (1) prevents a transformer failure from interrupting service along the entire transmission line and (2) prevents a line outage from interrupting the transformer. The existing configuration at the Milton 230-69 kV Substation does not comply with PPL Electric's design standard.

The Montour-Sunbury 230 kV and Sunbury-Milton 69 kV Transmission Lines share the same series of transmission line structures (meaning these lines occupy double-circuit structures with the Montour-Sunbury 230 kV Transmission Line on one side of the tower structure and the Sunbury-Milton 69 kV Transmission Line on the other side). If a tower failure on the Montour-Milton 230 kV Transmission Line and Sunbury-Milton 69 kV Transmission Line were to occur, this could cause a voltage violation on the 69 kV bus at the Milton 230-69 kV Substation. This contingency event would cause all 13,000 customers served from the Milton 230-69 kV

Substation to experience low voltage.⁷ In addition, this contingency event would cause the Danville-Milton 69 kV Transmission Line to become loaded to 102% of the emergency rating.

To temporarily resolve the low voltage and overload concerns, a special protection scheme was installed at the Milton 230-69 kV Substation. This protection scheme will detect the loss of Montour-Milton 230 kV Transmission Line and Sunbury-Milton 69 kV Transmission Line (due to a tower failure) and drop all customer load at the Milton 230-69 kV Substation to prevent the voltage and overload concerns described above. However, this will result in a loss of approximately 70 MW of load, and all 13,000 customers served by the Milton 230-69 kV Substation will experience an electrical outage until repairs can be made. The amount of load loss due to the special protection scheme at the Milton 230-69 kV Substation is a violation of PPL Electric's Transmission System Development Standards, which provide that "A Special Protection System scheme (SPS) can be applied as a temporary measure to restore facility loadings to within applicable emergency ratings until a permanent transmission facility upgrade can be implemented." Similarly, the PJM Manual 7, section 17.2 states that "Special Protection Schemes should not be installed as a substitute for good system design or operating practices. Their implementation is generally limited to temporary conditions involving the outage of critical equipment."

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

D. PROPOSED SOLUTION

To resolve the reliability concerns and violations explained above, PPL Electric proposes to upgrade the Milton 230-69 kV Substation to a standard configuration, which will include the installation of an interrupting device, and re-terminate the Montour-Sunbury 230 kV Transmission Line into the upgraded Milton 230-69 kV Substation.

⁷ Low voltage scenarios result in "brown-outs" and can cause damage to commercial and personal electronic facilities and equipment.

To connect the Montour-Sunbury 230 kV Transmission Line with the upgraded Milton 230-69 kV Substation, PPL Electric proposes to: (1) remove the existing 300-foot single tap 230 kV line between the Montour-Sunbury 230 kV Transmission Line and the Milton 230-69 kV Substation; (2) split the Montour-Sunbury 230 kV Transmission Line into two different lines near the upgraded Milton 230-69 kV Substation, creating the Montour-Milton 230 kV Transmission Line and the Milton-Sunbury 230 kV Transmission Line; and (3) re-terminate each new 230 kV transmission line into the Milton 230-69 kV Substation.

To re-terminate the new 230 kV transmission lines with the upgraded Milton 230-69 kV Substation, PPL Electric proposes to construct two new, 300-foot taps between the new the Montour-Milton and Milton-Sunbury 230 kV Transmission Lines and the Milton 230-69 kV Substation (one 300-foot tap will connect the Montour-Milton 230 kV Transmission Line into the substation and the second 300-foot tap will connect the Milton-Sunbury 230 kV Transmission Line into the substation). In addition, PPL Electric proposes to re-conductor the first approximately 450 feet of the Montour-Milton and Milton-Sunbury 230 kV Transmission Lines (the first span from the new tap points) to accommodate the new termination into the Milton 230-69 kV Substation. In total, PPL Electric proposes to construct approximately 600 feet of new transmission line and re-conductor approximately 900 feet of transmission line within the existing right-of-way (total of approximately 0.3 miles). This proposed work will be located on property owned in fee by PPL Electric for the Milton 230-69 kV Substation (80%) and within the existing right-of-way for the Montour-Sunbury 230 kV Transmission line (20%). No additional rights-of-way are required for the proposed Project.

The proposed Project will ensure that each of the two, new 230 kV lines will terminate into only two substations, with one substation at either end of the 230 kV lines, as opposed to the three substations under the current configuration. The new substation configuration at the Milton 230-69 kV Substation will consist of a fault interrupting device between the 230 kV transformer and each of the two, new 230 kV transmission lines. This new configuration will meet the standard configuration for a new 230 kV substation as required by PPL Electric's Transmission System Development Standards. The proposed Project will create two 230 kV sources to the Milton 230-69 kV substation, which will resolve the low voltage and overload concerns associated with

a potential transmission tower failure on the existing Montour-Sunbury 230 kV and Sunbury-Milton 69 kV Transmission Lines. Further, having the two new 230 kV transmission lines and the two transformers at Milton 230-69 kV Substation will prevent all 13,000 customers from being interrupted from a single transformer outage. Finally, the proposed Project will allow for the removal of the special protection scheme at the Milton 230-69 kV Substation, which is consistent with PPL Electric's and PJM's design standards.

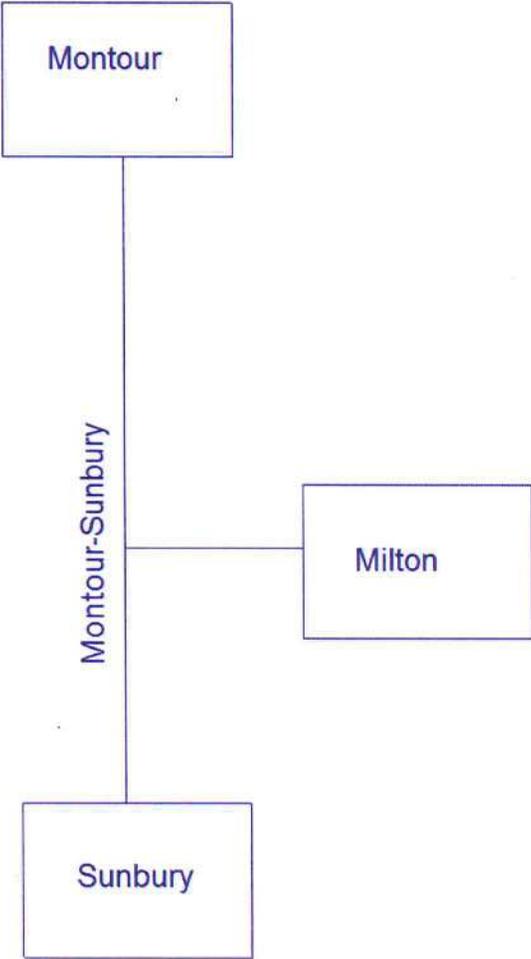
A one-line diagram and an aerial map depicting the proposed facilities are provided as **Figure 1-3** and **Figure 1-4** to this Attachment, respectively

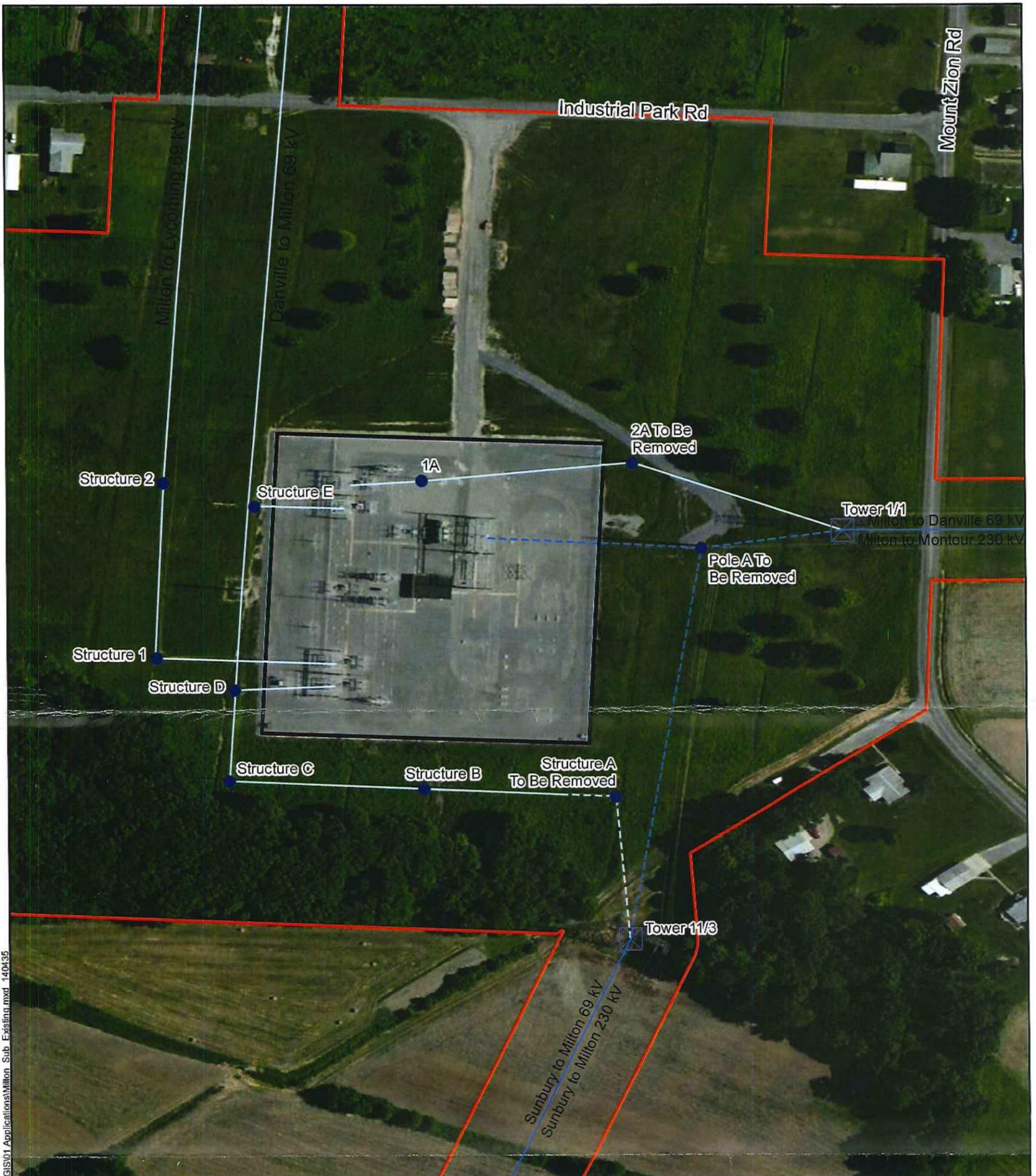
PPL Electric submitted the proposed Project to PJM for review and inclusion in the RTEP. The Project was presented before TEAC stakeholders and approved by the PJM Board as supplemental project s0857.

Subject to the Commission's approval, construction is scheduled to begin in September 2017 to support the Project's scheduled in-service date of December 2017. The scheduled in-service date is the date that the proposed facilities can reasonably be installed based on normal construction schedules, and can be affected by ever growing equipment availability timeframes which must be considered.⁸

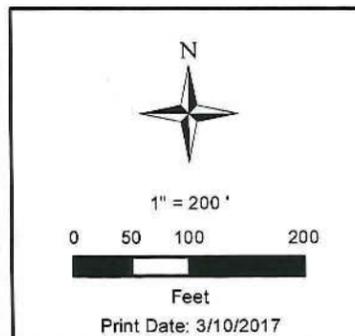
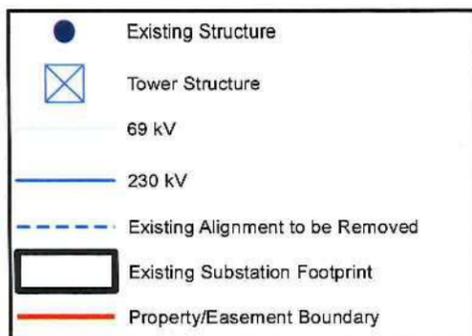
⁸ The required in-service date is the date that the proposed facility must be placed in service to minimize extended service interruptions to customers. In the event that the required in-service date is after the scheduled in-service date, then remedial action is required to mitigate damage caused by the violation.

Figure 1-1 - Existing Configuration





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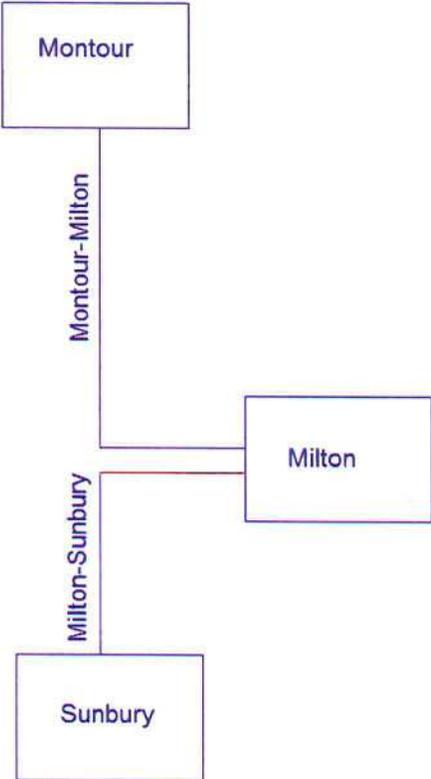


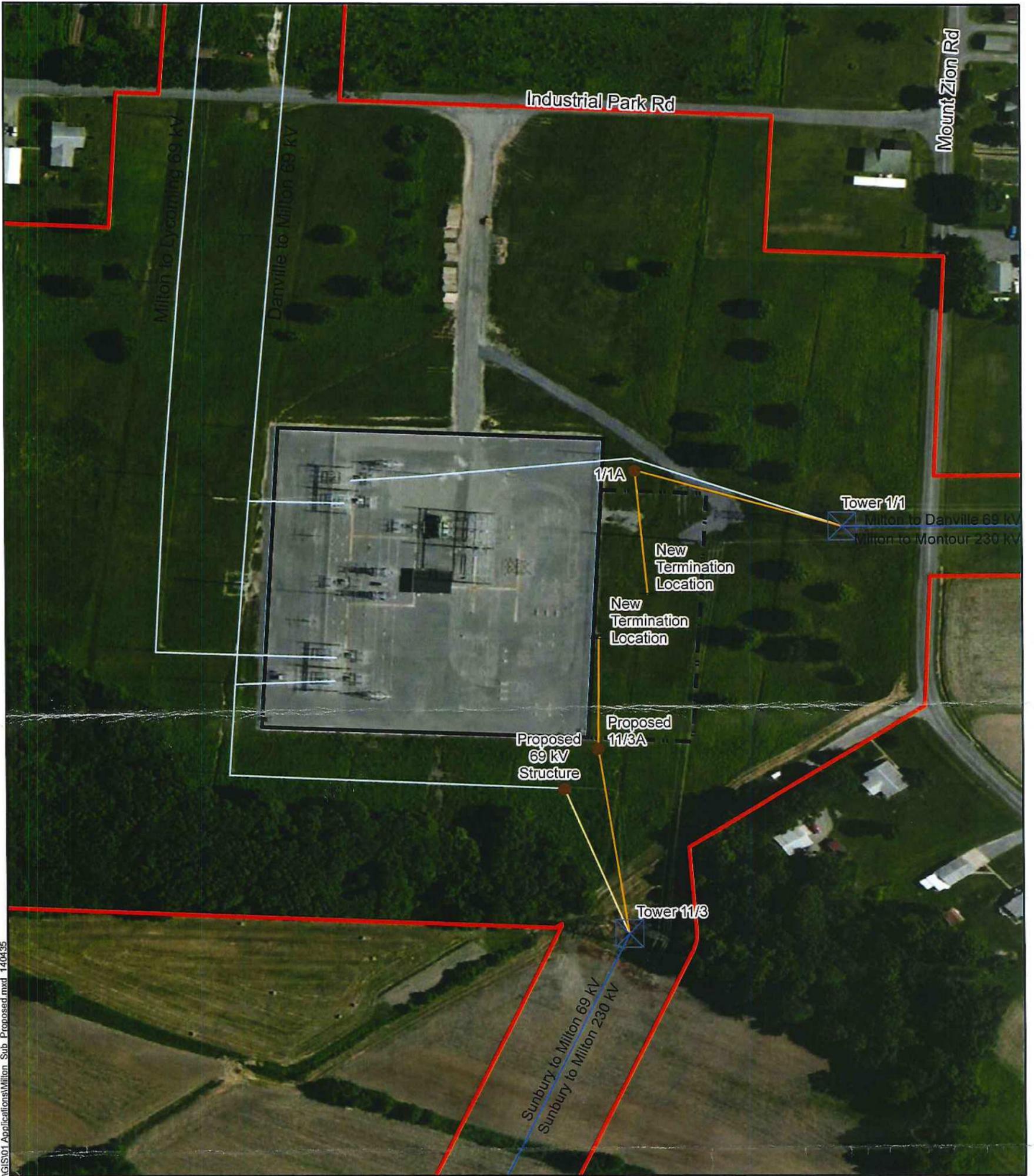
Milton 230/69 kV Substation Upgrade Project

Figure 1-2 - Existing Facilities Aerial

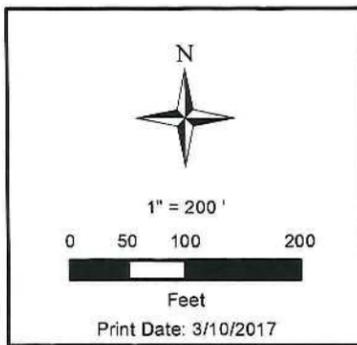
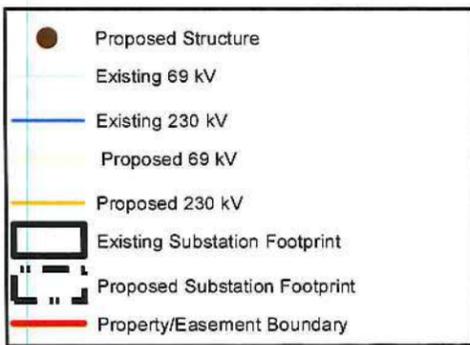



Figure 1-3 - Proposed Configuration





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Milton 230/69 kV Substation Upgrade Project

Figure 1-4 - Proposed Facilities Aerial

Attachment 2

ATTACHMENT 2
MILTON SUBSTATION UPGRADE
PROJECT ENGINEERING DESCRIPTION

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A. DESCRIPTION OF THE PROPOSED PROJECT

PPL Electric Utilities Corporation (“PPL Electric”) is requesting Pennsylvania Public Utility Commission (“PUC” or the “Commission”) approval to re-terminate the existing Montour-Sunbury 230 kV Transmission Line into an upgraded Milton 230-69 kV Substation located in West Chillisquaque Township, Northumberland County, Pennsylvania (the Project). As explained in Attachment 1, the Project is required to resolve reliability and planning violations, and to maintain reliable electric service to approximately 13,000 customers in Northumberland County.

As explained in Attachment 1, to re-terminate the Montour-Milton 230 kV Transmission Line and the Milton-Sunbury 230 kV Transmission Line into the Milton 230-69 kV Substation, PPL Electric proposes to remove the existing single 300-foot tap line, and construct two new 230 kV tap lines that will each extend approximately 300 feet between the new the Montour-Milton and Milton-Sunbury 230 kV Transmission Lines and the Milton 230-69 kV Substation. These two new taps will be located entirely on property owned in fee by PPL Electric for the Milton 230-69 kV Substation. In addition, PPL Electric proposes to reconductor the first approximately 450 feet of the Montour-Milton and Milton-Sunbury 230 kV Transmission Lines (the first span from the new tap points) to accommodate the new termination into the Milton 230-69 kV Substation. This proposed work will be located on property owned in fee by PPL Electric for the Milton 230-69 kV Substation (80%) and within the existing right-of-way for the Montour-Sunbury 230 kV Transmission line (20%). No additional rights-of-way are required for the proposed Project.

The proposed Project involves the removal of one existing steel pole structure, and installation of two new steel monopole dead-end structures. The existing steel pole being removed has a height of 125 feet. The two new steel monopole dead-end structures will be installed on concrete caisson foundations and will have an average height of approximately 115 feet. Depictions of the two steel monopole dead-end structures to be used for this Project are provided in **Figures 2-1** and **2-2** the end of this Attachment.

The two new 230 kV tap lines and reconducted segments of the new Montour-Milton and Milton-Sunbury 230 kV Transmission Lines will utilize three power conductors and one

overhead ground wire. The power conductors will be 1590 kcmil¹ ACSR² conductors. The overhead ground wire will be 144 count, 0.791-inch diameter fiber optical ground wires and will provide lightning protection and communication between circuit breakers that remove the line from service should a fault on the line be detected. The minimum conductor-to-ground clearance will be 50 feet, which occurs at a maximum conductor temperature of 140°C.

The estimated cost to site, relocate and re-terminate the existing Montour- Sunbury 230 kV transmission line into the upgraded Milton 230-69 kV substation is approximately \$2.2 million.

B. MAGNETIC FIELD MANAGEMENT

PPL Electric's Magnetic Field Management Program is applied to new and reconstructed transmission line projects. PPL Electric 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.

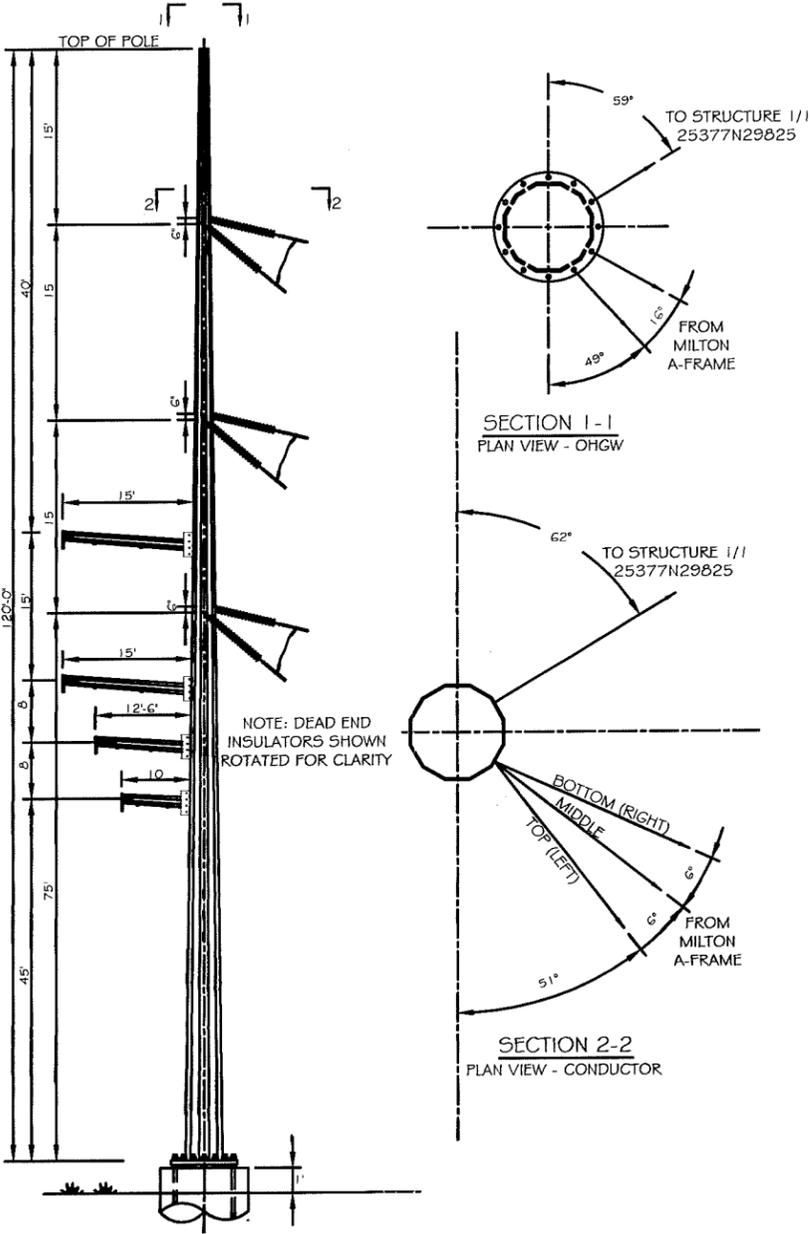
PPL Electric's Magnetic Field Management Program has been developed to implement that policy decision. To reduce magnetic field exposures, the program generally prescribes the use of a line design that provides five feet higher ground clearance than NESC standards, and reverse phasing of new double-circuit lines where it is feasible to do so at low or no cost.

Consistent with its Magnetic Field Management Program, PPL Electric will construct the new 230 kV transmission lines for ground clearances that are a minimum of five feet higher than the required NESC minimum ground clearance for 230 kV lines. Because the new segments of the new Montour-Milton and Milton-Sunbury 230 kV Transmission Lines will be constructed as single circuits, these new segments cannot be reversed phased.

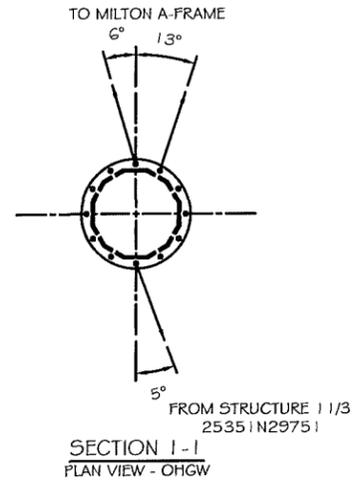
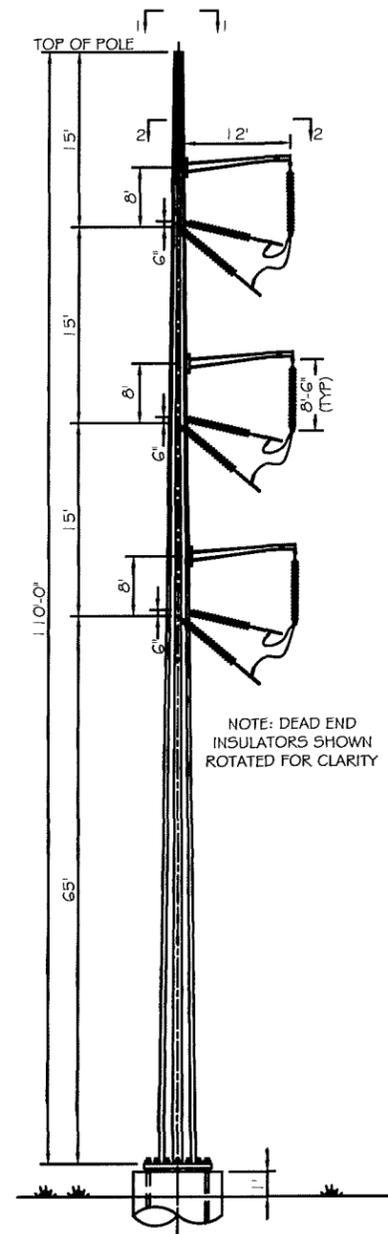
¹ A kcmil or circular mil is the cross-sectional area of a wire one mil in diameter, where 1 kcmil = 0.5067 mm².

² ACSR stands for aluminum conductor steel reinforced.

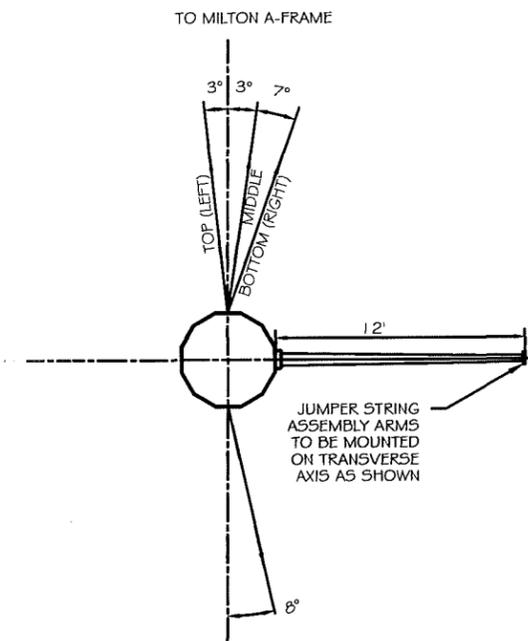
MILTON SUBSTATION TRANSMISSION LINE RECONFIGURATION: STR 1/1A



MILTON SUBSTATION TRANSMISSION LINE RECONFIGURATION: STR 1 1/3A



SECTION 1-1
PLAN VIEW - OHGW



SECTION 2-2
PLAN VIEW - CONDUCTOR

FROM STRUCTURE 1 1/3
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Attachment 3

ATTACHMENT 3
MILTON SUBSTATION UPGRADE
PROJECT DESCRIPTION OF THE
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A. INTRODUCTION

PPL Electric Utilities Corporation (“PPL Electric”) is requesting Pennsylvania Public Utility Commission (“PUC” or the “Commission”) approval to re-terminate the existing Montour-Sunbury 230 kV Transmission Line into an upgraded Milton 230-69 kV Substation located in West Chillisquaque Township, Northumberland County, Pennsylvania (the Project). As explained in Attachment 1, the Project is required to resolve reliability and planning violations, and to maintain reliable electric service to approximately 13,000 customers in Northumberland County.

Aerial facilities maps are provided at the end of Attachment 1.

B. THE RIGHT-OF-WAY DESCRIPTION

PPL Electric proposes to construct two new 230 kV tap lines that will extend approximately 300 feet between the new the Montour-Milton and Milton-Sunbury 230 kV Transmission Lines and the Milton 230-69 kV Substation. In addition, PPL Electric proposes to reconductor the first approximately 450 feet of the existing lines (the first span from the new tap points) to accommodate the new termination into the Milton 230-69 kV Substation.

Both of the new taps and will be located entirely on property owned in fee by PPL Electric for the Milton 230-69 kV Substation. Approximately 80% of the reconducted segments will be located on property owned in fee by PPL Electric for the Milton 230-69 kV Substation, and the remaining 20% will be located within the existing right-of-way for the Montour-Sunbury 230 kV Transmission line. No additional rights-of-way are required to construct, operate, or maintain the proposed new re-terminated transmission lines. Further, all new structures (the two new dead-end structures) will be located entirely on PPL Electric’s property for the Milton 230-69 kV Substation.

C. LAND USE AND ENVIRONMENTAL

Impacts to land use are anticipated to be minimal because the work will be performed entirely on PPL Electric's property owned in-fee for the Milton 230-69 kV Substation and

within the existing right-of-way for the Montour-Sunbury 230 kV Transmission line. Interference with existing land uses will be further minimized because, where possible, PPL Electric will use previously established access roads for construction.

Although two new dead-end structures will be required, impacts will be minimal because each of these new structures will be located entirely on PPL Electric's property for the Milton 230-69 kV Substation. In addition, the two new structures will be approximately 115 feet tall (height above ground), whereas the existing structure to be removed is 125 feet tall. Further, no new poles will be placed on any property that currently does not have an existing pole.

No nearby communication towers, pipelines, or other utilities will be affected by the proposed Project. The closest airport includes the Sunbury Airport, a private, which is located approximately 6.5 miles southeast of the project area. PPL Electric does not anticipate any interference with airport operations because of the distance from the project area, the presence of existing electrical facilities in the Project area, and the relatively similar height of the new facilities and the existing facilities. However, if needed PPL Electric will file any required documentation with both the Federal Aviation Administration and the Pennsylvania Department of Transportation Bureau of Aviation.

The Project (both the 230 kV transmission lines segments and the upgraded Milton 230-69 kV Substation) required and was permitted under the General National Pollution Discharge Elimination System ("NPDES") Permit for Stormwater Discharges Associated with Construction Activities on March 7, 2016. In addition, the Project required and was permitted on September 8, 2016 under the PA DEP Chapter 105 Joint Permit for Wetland Encroachment. Specifically, a PA DEP Chapter 105 Joint Permit for Wetland Encroachment was required because the Project will permanently disturb 0.23 acres of wetland and temporarily disturbs 0.21 acres of wetland. To mitigate these impacts, PPL Electric will construct and replicate the permanently disturbed wetland area on-site at a 1:1 replacement ratio.

PPL Electric has been in consultation with the Pennsylvania Historical and Museum Commission ("PHMC") for the construction of the 230 kV substation upgrade and the new 230 kV transmission line segments. The PHMC has advised that there are no cultural resource

concerns associated with the Project, and that the Project is cleared for work. As a result, no further PHMC consultation or cultural resources work is required.

The proposed Project will not affect any unique geological or scenic areas. Further, there are no state lands, national parks, state parks, local parks, recreational areas or natural landmarks located within the Project area.

A Pennsylvania Natural Diversity Inventory (“PNDI”) search for the Project required clearances from PA Department of Conservation and Natural Resources (“DCNR”) and PA Fish and Boat Commission (“PFBC”). DCNR required a field survey be conducted to evaluate if the plant species False Loosestrife Seedbox exists on site. A field survey of the project site was conducted and the plant species was not found. As a result, a clearance was obtained from DCNR on August 26, 2015. The PFBC required a field survey be conducted to evaluate the project area for Eastern Spadefoot habitat. A field survey was conducted in April of 2015 with no suitable habitat found within the project area. A clearance was obtained from PFBC on June 17, 2015. No further PNDI and agency consultations or field surveys are required.

D. VEGETATION MANAGEMENT

The Project is being completed entirely on PPL Electric’s property owned in fee for the Milton 230-69 kV Substation and within the existing right-of-way for the Montour-Sunbury 230 kV Transmission line. These areas have already been cleared of vegetation for the existing electrical facilities. However, in order to accommodate the construction of the new and reconductored segments of the new Montour-Milton and Milton-Sunbury 230 kV Transmission Lines and to maintain proper clearances between the 230 kV conductors and vegetation in the area, limited vegetation management may be required. In areas where vegetation management is required to complete the transmission line relocation, PPL Electric will apply its “Specifications for Transmission Vegetation Management LA-79827” to mitigate any impacts.

Attachment 4

ATTACHMENT 4

**MILTON SUBSTATION UPGRADE
PROJECT PPL ELECTRIC UTILITIES
DESIGN CRITERIA AND SAFETY
PRACTICES**

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A. DESIGN CRITERIA AND SAFETY PRACTICES

The National Electrical Safety Code (“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 Utilities Corporation (“PPL Electric”) has developed design specifications and safety rules which meet or surpass all requirements specified by the NESC.

Engineering Design Criteria and Parameters

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 were developed to ensure public safety and welfare.

PPL Electric transmission line design standards meet or surpass the NESC standards. For example, the relative order of grades of construction for conductors and supporting structures is B, C, and N; Grade B being the highest. According to the NESC standards, construction Grades B, C, or N may be used for transmission lines (except at crossings of railroad tracks and limited access highways where Grade B construction is specified). However, PPL Electric designs all of its transmission lines for Grade B construction. The use of Grade B design and construction specifies enhancements such as larger-minimum crossarm dimensions, larger-minimum conductor size, and increased safety factors.

Another example is the design parameters utilized to account for ice and wind loadings on the overhead ground wire (“OHGW”) and power conductors. The NESC standard ice and wind

design magnitudes for the PPL Electric territory are 0.5 inch thickness of radial ice combined with four pounds per square foot horizontal wind pressure (equivalent to 40-mile per hour wind velocity). The conductor sags and tensions used in line designs are the result of various ice and wind combinations, depending on the elevation at the line location and line design voltage. The conductor sags and tensions used in the design of all PPL Electric transmission lines are at least 0.5-inch ice combined with eight pounds wind pressure (equivalent to 57 miles per hour wind velocity). This means that PPL Electric lines are designed to operate safely and reliably during inclement weather even more severe than assumed by the NESC. In addition, PPL Electric transmission lines are designed with more clearance to the ground than required by the NESC. The tables below compare PPL Electric and NESC ground clearances for lines of various voltages.

138 kV

	VERTICAL CLEARANCE TO GROUND	
	NESC Standard	PPL Design
Surface Underneath Conductors		
Roads, streets, alleys	21 feet	30 feet
Other land traversed by vehicles (cultivated field, forest, etc.)	21 feet	30 feet
Spaces accessible to pedestrians only	17 feet	30 feet
Railroad tracks	31 feet	35 feet

230 kV

	VERTICAL CLEARANCE TO GROUND	
	NESC Standard	PPL Design
Surface Underneath Conductors		
Roads, streets, alleys	23 feet	32 feet
Other land traversed by vehicles (cultivated field, forest, etc.)	23 feet	32 feet
Spaces accessible to pedestrians only	19 feet	32 feet
Railroad tracks	31 feet	36 feet

500 kV

	VERTICAL CLEARANCE TO GROUND	
	NESC Standard	PPL Design
Surface Underneath Conductors		
Roads, streets, alleys	28 feet	53 feet
Other land traversed by vehicles (cultivated field, forest, etc.)	28 feet	53 feet
Spaces accessible to pedestrians only	24 feet	53 feet
Railroad tracks	38 feet	53 feet

A relay protection system is used to protect the public safety and welfare as well as equipment and 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.

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 and structure climbing patrols. A number of helicopter patrols are performed on all lines annually. The two-man helicopter crew flies parallel, to the left, 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. Foot and structure climbing patrol programs for a transmission line begin approximately three to five years after the line is energized, unless a helicopter patrol reports a need for earlier action. The frequency of foot patrols varies from once every year to once every several years depending on line type and age.

An assigned foot patroller checks right-of-way conditions, including access roads, bridges, pole washouts, tower footers, vegetation height and clearance to conductors, pole and tower deterioration and, with the use of binoculars, insulators, and condition of hardware. Identified problems are included in a report that is forwarded to the appropriate department for



corrective action. A scheduled line outage is required to perform an overhead patrol because of "hands-on" inspection of hardware. Overhead patrols are conducted on a schedule determined by line age, operating record, and observed general condition. The necessary repairs are also done during the inspection outage.

Personnel Safety Rules

The following are a few of the PPL Electric safety rules that demonstrate the Company's concern for employee 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 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 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. The conductor size and attachment clamps of temporary safety grounds must be capable of conducting anticipated fault currents. Rubber gloves, rubber sleeves, and additional rubber protective equipment are used as required when applying or removing temporary safety grounds to or from the lines or apparatus to be grounded. An approved nonconductive working stick of sufficient length to allow workers to maintain the following required minimum clearances is used to test that the line has been de-energized and to apply temporary safety grounds:

PPL ELECTRIC UTILITIES CORPORATION
ATTACHMENT 4 – DESIGN CRITERIA AND SAFETY PRACTICES
MILTON SUBSTATION UPGRADE PROJECT

VOLTAGE – kV	MINIMUM CLEARANCE
138	3 feet 7 inches
230	5 feet 3 inches
500	11 feet 3 inches

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. When ground pins are used to establish proper ground points, they are driven to a depth of not less than four feet as near vertical as possible.

- 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.