



Before the
Pennsylvania Public Utilities Commission

**Manor-Graceton 230kV Line Reconductor
Project**

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

Submitted by: PPL Electric Utilities Corp.

TABLE OF CONTENTS

Attachment 1	Necessity Statement
Attachment 2	Engineering Description
Attachment 3	Description of the Project Area
Attachment 4	PPL Electric Design Criteria and Safety Practices

Attachment

1

ATTACHMENT 1

MANOR-GRACETON 230 KV LINE RECONDUCTOR PROJECT

NECESSITY STATEMENT

TABLE OF CONTENTS

<u>SECTION</u>	<u>TOPIC</u>	<u>PAGE</u>
1.0	INTRODUCTION.....	1-1
2.0	TRANSMISSION SYSTEM PLANNING PROCESS.....	1-1
3.0	EXISTING SYSTEM.....	1-3
4.0	DEFINITION OF THE PROBLEM	1-4
5.0	PROPOSED SOLUTION.....	1-4

LIST OF FIGURES

- Figure 1-1 Existing Facilities
- Figure 1-2 One-Line Diagram of Existing Facilities
- Figure 1-3 Aerial River Crossing
- Figure 1-4 Existing Else Island Structure

ATTACHMENT 1

MANOR-GRACETON 230 KV LINE RECONDUCTOR PROJECT

1.0 INTRODUCTION

PPL Electric Utilities Corporation (“PPL Electric”) is requesting Pennsylvania Public Utility Commission (“PUC” or the “Commission”) approval to reconductor an approximately 1.12 mile section of the existing double-circuit Manor-Graceton 230kV Transmission Line located in Lancaster and York Counties (the “Project”). As explained below, the proposed Project is required to relieve transmission line congestion identified by the PJM Interconnection, LLC (“PJM”) in the 2014 RTEP Market Efficiency Analysis. PPL Electric successfully submitted and was awarded the proposed Project, which is a baseline project approved in the PJM 2015 RTEP.

The estimated cost to site, permit, and re-conductor the existing Manor – Graceton 230 kV Transmission Line is approximately \$2.2 million.¹ Subject to the Commission’s approval, construction is scheduled to begin in October 2017 to support the Project’s scheduled in-service date of November 2017.

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.

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;

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.

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.

- 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.

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 of 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.

In addition to the reliability analysis, PJM also performs a Market Efficiency Analysis to identify congestion on transmission lines and improvements to transmission economic efficiencies. The Market Efficiency Analysis is performed over a 24-month planning cycle, and PJM opens an RTEP Window every other year to identify the most economical solution to relieve congestion on the transmission facilities. PJM’s Market Efficiency Analysis is currently set forth in the section 1.5.2 of PJM Manual 14 B.

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

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.

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>

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 or transmission congestion identified by PJM 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.

As explained below, the proposed Project is necessary to address transmission line congestion identified by PJM in the 2014 RTEP Market Efficiency Analysis. PPL Electric successfully submitted and was awarded the proposed Project through the FERC Order 1000 Market Efficiency Long Term Proposal Window in 2015. The proposed Project has been presented to various stake holders in the Transmission Expansion Advisory Committee (“TEAC”) meeting on September 10, 2015 and has been approved as baseline project b2690 in the PJM 2015 RTEP.

3.0 EXISTING SYSTEM

The Manor – Graceton 230 kV Transmission Line is a 15.85-mile tie line connecting PPL Electric’s Manor Substation located in Manor Township, Pennsylvania to the Baltimore Gas & Electric Company (“BG&E”) owned Graceton Substation located in Graceton, Maryland. PPL Electric owns 14.28 miles from the Manor Substation to the Pennsylvania/Maryland border, and BG&E owns the remaining 1.57 miles from the Pennsylvania/Maryland border to the Graceton Substation.

The Manor- Graceton 230 kV Transmission Line currently traverses the Susquehanna River near the Manor Substation. The river crossing is approximately 1.12 miles in length and traverses the Lancaster County/York County border. The river crossing starts at the Manor Substation using a 3-pole steel structure and continues south approximately 2,990 feet to a steel lattice tower on Else Island, and then continues south approximately 2,897 feet to a 3-pole steel structure located on the opposite side of the river.

With the exception of the 1.12-mile river crossing, PPL Electric rebuilt the Pennsylvania portion of the Manor – Graceton 230 kV Transmission Line in 2012 with high capacity 1590 kcmil ACSR 45/7 “Lapwing” conductors.⁷ The 1.12-mile river crossing currently utilizes lower capacity 795 kcmil ACSR 30/19 “Mallard” conductors.

An aerial map and one-line diagram depicting the existing transmission facilities are provided as Figures 1-1 and 1-2. An aerial map of the river crossing is provided as Figure 1-3, and a photograph of the Else Island structure is provided as Figure 1-4.

⁷ See Letter of Notification of PPL Electric Utilities Corporation filed pursuant to 52 Pa. Code Chapter 57 for approval of the reconstruction of the Pennsylvania portion of the Manor-Graceton 230 kV transmission line in Manor Township, Lancaster County and in Chanceford, Lower Chanceford and Peach Bottom Townships in York County, Pennsylvania, Docket No. A-2011-2219913 (Order entered Oct. 14, 2011).

4.0 DEFINITION OF THE PROBLEM

With the exception of the 1.12-mile river crossing, the Pennsylvania Portion of the Manor- Graceton 230 kV Transmission Line was rebuilt in 2012 with high capacity 1590 kcmil⁸ 45/7 ACSR⁹ “Lapwing”¹⁰ conductors. The 1.12-mile river crossing was not rebuilt and currently utilizes lower capacity 795 kcmil 30/19 ACSR “Mallard”¹¹ conductors. The rebuilt conductors have a higher ampacity rating than the conductors on the river crossing section of the Manor- Graceton 230 kV Transmission Line. The 1.12-mile river crossing section of the Manor-Graceton 230 kV Transmission Line limits the rating of the entire line.

In the 2014 Market Efficiency Analysis, PJM identified the Manor-Graceton 230 kV Transmission Line to be congested due to a binding constraint at the river crossing. Specifically, PJM found that this binding constraint produces Market Congestion of approximately \$7.9 million and \$5.2 million using the 2019 and 2022 forecasts respectively. These congestions costs increase the amounts paid by ratepayers for delivery of electric service.

5.0 PROPOSED SOLUTION

In response to PJM’s 2014 Market Efficiency Analysis findings and to resolve the congestion violations explained above, PJM opened a proposal window (FERC 1000 Proposal Window 3) in November of 2014 for proposers to bid on solutions to resolve the market congestion. PPL Electric submitted a proposal in the 2015 FERC Order 1000 Market Efficiency Long Term Proposal Window to reconductor the river crossing section of the Manor – Graceton 230 kV Transmission Line and to upgrade the terminal equipment at the Manor Substation. PPL Electric’s proposal was selected by PJM as the winning bid¹² because it provides the highest benefit to cost ratio of 14.42.¹³ The proposed Project has been presented to various stake holders in the TEAC meeting on September 10, 2015 and has been approved as baseline project b2690 in the PJM 2015 RTEP. Pursuant to Schedule 6 of the Operating Agreement with PJM (after given construction responsibility, the Transmission Owner is obligated to construct the project), as the successful bidder, PPL Electric must complete the baseline project.

PPL Electric herein seeks Commission approval to reconductor the approximately 1.12-mile river crossing section of the Manor- Graceton 230kV Transmission Line with high capacity conductors. An engineering description of the reconducted line is provided in Attachment 2.

⁸ 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 on thousandth (0.001) of an inch.

⁹ ACSR stands for aluminum conductor steel reinforced.

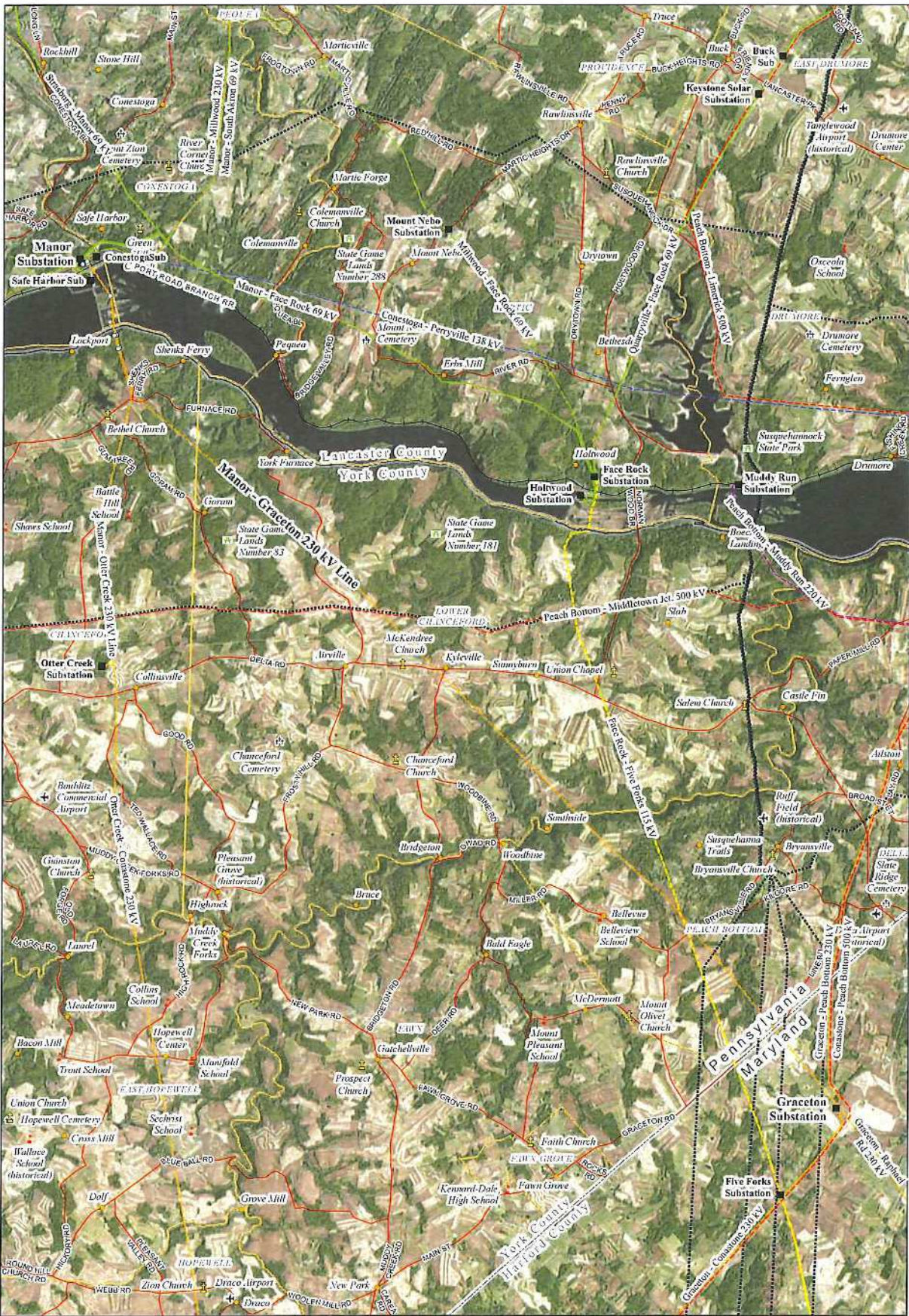
¹⁰ Lapwing is a technical term for a for a 1590 kcmil 54/19 ACSR conductor as defined in the American Society for Testing and Materials.

¹¹ Mallard is a technical term for a for a 795 kcmil 30/19 ACSR conductor as defined in the American Society for Testing and Materials.

¹² See Slide #13, <http://www.pjm.com/~media/committees-groups/committees/teac/20150910/20150910-market-efficiency-update.ashx>

¹³ See Slide #15, <http://www.pjm.com/~media/committees-groups/committees/teac/20150910/20150910-market-efficiency-update.ashx>

Subject to the Commission's approval, construction is scheduled to begin in October 2017 to support the Project's scheduled in-service date of November 2017.



Legend

○ Proposed Structure	— Existing T-Line 69 kV	● City/Town	— State Road
■ Existing Substation	— Existing T-Line 115 kV	✈ Airport	— Railroad
⋯ Natural Gas Pipeline	— Existing T-Line 138 kV	✠ Cemetery	— Municipality Boundary
	— Existing T-Line 220 kV	✠ Church	— County Boundary
	— Existing T-Line 230 kV	⊕ Park	— State Boundary
	— Existing T-Line 500 kV	✠ School	

Scale: 0 0.75 1.5 2.25 Miles
1 inch = 1.25 miles

Print Date: 9/2/2018

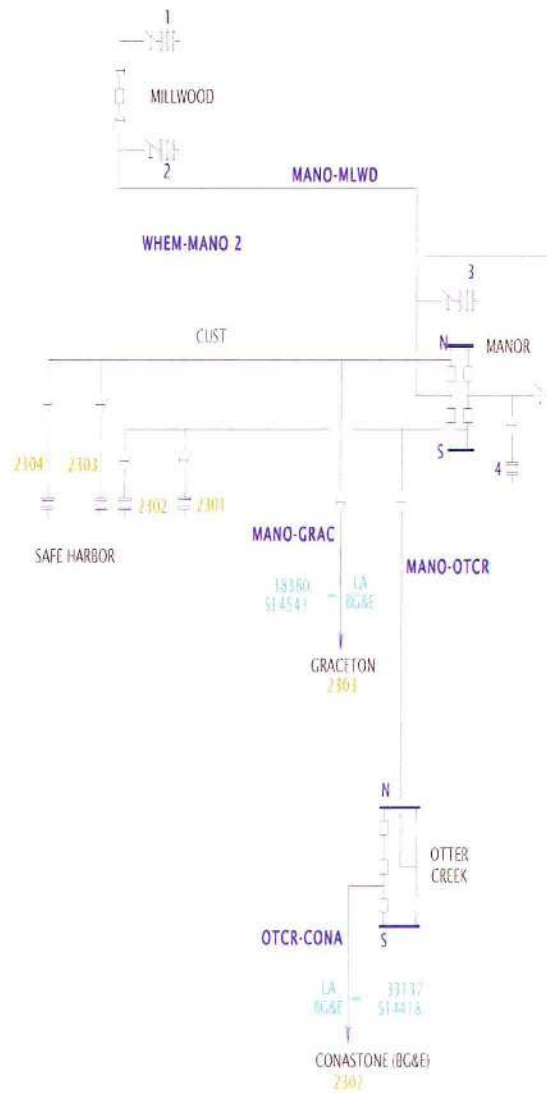
Manor-Graceton 230 kV Line Reconstructor Project

Figure 1-1 Existing Facilities

ppi POWER ENGINEERS



Before the Pennsylvania Public Utilities Commission
Manor-Graceton 230kV line Project
ATTACHMENTS IN SUPPORT OF THE
LETTER OF NOTIFICATION

Figure 1-2 – One-Line Diagram of Existing Facilities





Legend	● Proposed Structure	N
■ Existing Substation	— 230 kV Manor to Gracelon Existing/Proposed Centerline	0 250 500 750 Feet 1 inch = 500 Feet
		Print Date: 8/17/2016

230 kV Line Reconductor Project
Figure 1-3 River Crossing
 

Before the Pennsylvania Public Utilities Commission
Manor-Graceton 230kV line Project
ATTACHMENTS IN SUPPORT OF THE
LETTER OF NOTIFICATION

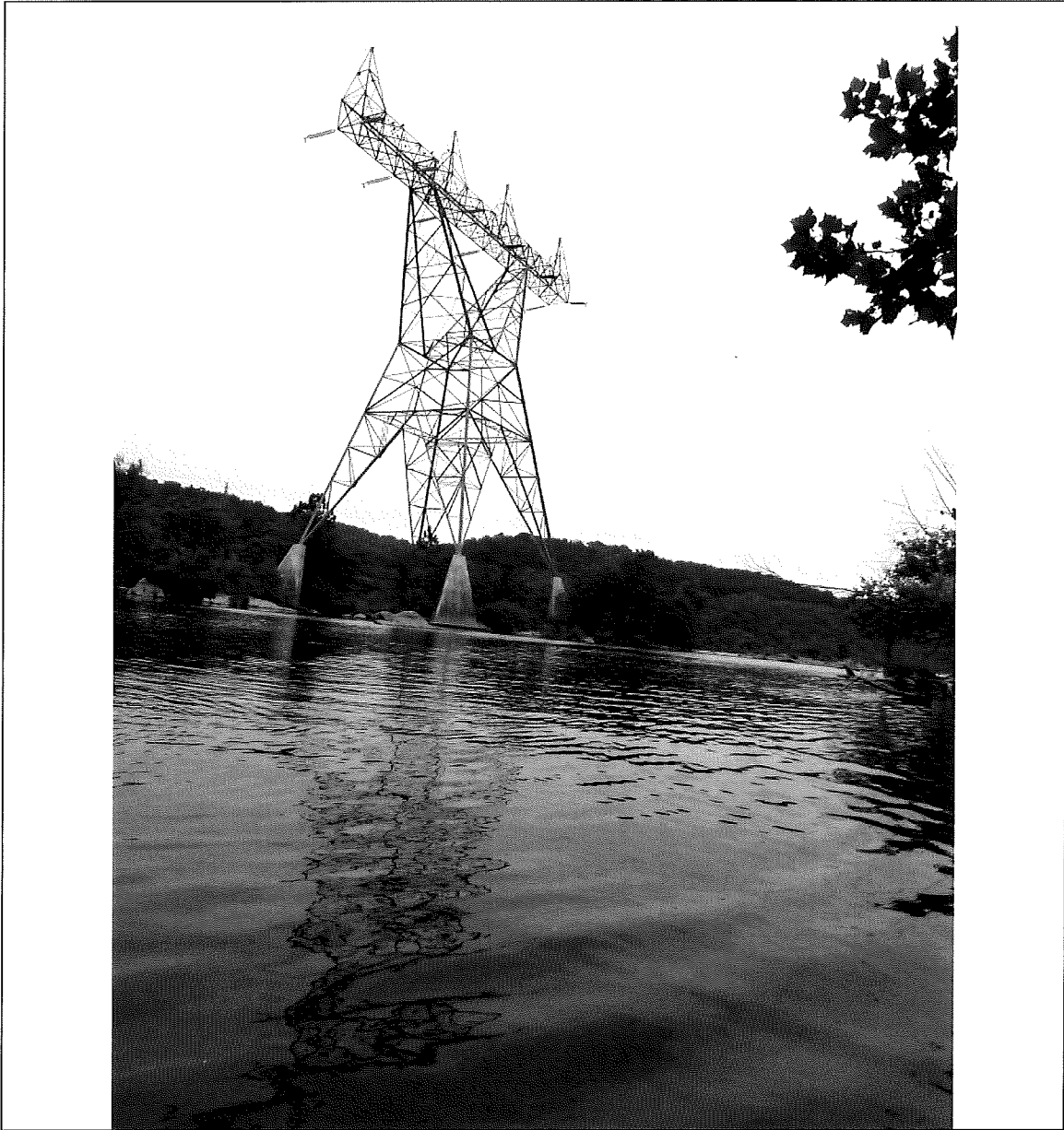


Figure 1-4 - Existing Structure on Else Island (#38165S21622). The photo was taken from the South side of the tower in the Susquehanna River.

Attachment

2

ATTACHMENT 2
MANOR-GRACETON 230KV LINE RECONDUCTOR PROJECT
ENGINEERING DESCRIPTION

TABLE OF CONTENTS

<u>SECTION</u>	<u>TOPIC</u>	<u>PAGE</u>
1.0	DESCRIPTION OF THE PROPOSED LINE.....	2-1
2.0	MAGNETIC FIELD MANAGEMENT.....	2-1

ATTACHMENT 2

MANOR-GRACETON 230KV LINE RECONDUCTOR PROJECT

ENGINEERING DESCRIPTION

1.0 DESCRIPTION OF THE PROPOSED LINE

PPL Electric Utilities Corporation (“PPL Electric”) is requesting Pennsylvania Public Utility Commission (“PUC” or the “Commission”) approval to reconductor an approximately 1.12-mile river crossing section of the existing double-circuit Manor-Graceton 230kV Transmission Line located in Lancaster and York Counties (the “Project”). As explained in Attachment 1, the Project is required to relieve transmission line congestion identified by the PJM Interconnection, LLC (“PJM”) in the 2014 RTEP Market Efficiency Analysis.

To resolve the transmission line congestion identified by PJM, PPL Electric herein seeks Commission approval to reconductor the approximately 1.12-mile river crossing section of the Manor- Graceton 230kV Transmission Line with high capacity conductors. The existing conductors will be removed and replaced with new high capacity conductors using the existing tower structures. No new structures will be installed. The existing overhead ground wire, shield wires, and marker balls along the river crossing spans will remain in place and continue to be used upon completion of the Project.

The double-circuit 230 kV design will utilize three power conductors per circuit. The new conductors will be 1033 kcmil¹⁴ 54/19 ACCR¹⁵ “Curlew”¹⁶ conductors. The overhead ground wire that will remain is 48 count, 0.752-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 32 feet, which occurs at a maximum conductor temperature of 200° C.

The estimated total cost to re-conductor the river crossing section of the double-circuit Manor-Graceton 230kV Transmission Line is approximately \$2.2 million.

2.0 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

¹⁴ A kcmil or circular mil is the cross-sectional area of a wire one mil in diameter, where 1 kcmil = 0.5067 mm².

¹⁵ ACCR stands for aluminum conductor composite reinforced.

¹⁶ Curlew is a technical term for a for a 1033 kcmil 54/19 ACCR conductor as defined in the American Society for Testing and Materials.

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 the use of 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 to maintain existing ground clearances that are a minimum of five feet higher than the required NESC minimum ground clearance for 230 kV lines. Phasing will not be modified because a second circuit has not been added and no structure modifications are anticipated as part of this project. PPL Electric will consider reverse phasing if and when a second circuit is added.

Attachment

3

ATTACHMENT 3
MANOR-GRACETON 230KV LINE RECONDUCTOR PROJECT
DESCRIPTION OF THE PROJECT AREA

TABLE OF CONTENTS

<u>SECTION</u>	<u>TOPIC</u>	<u>PAGE</u>
1.0	INTRODUCTION	3-1
2.0	DESCRIPTION OF THE RIVER CROSSING	3-1
3.0	LAND USE AND ENVIRONMENTAL	3-1
4.0	VEGETATION MANAGEMENT	3-2

LIST OF FIGURES

Figure 3-1 Site Location Constraints

ATTACHMENT 3
MANOR-GRACETON 230KV LINE RECONDUCTOR PROJECT
DESCRIPTION OF THE PROJECT AREA

1.0 INTRODUCTION

PPL Electric Utilities Corporation (“PPL Electric”) is requesting Pennsylvania Public Utility Commission (“PUC” or the “Commission”) approval to reconductor an approximately 1.12 mile river crossing section of the existing double-circuit Manor-Graceton 230kV Transmission Line located in Lancaster and York Counties (the “Project”). As explained in Attachment 1, the Project is required to relieve transmission line congestion identified by PJM Interconnection, LLC (“PJM”) in the 2014 RTEP Market Efficiency Analysis

An aerial map and one-line diagram depicting the transmission facilities are provided as Figures 1-1 and 1-2 to Attachment 1. An aerial map of the river crossing is provided as Figure 1-3 to Attachment 1, and a photograph of the Else Island structure is provided as Figure 1-4 to Attachment 1.

2.0 DESCRIPTION OF THE RIVER CROSSING

The Manor- Graceton 230 kV Transmission Line currently traverses the Susquehanna River near the Manor Substation. The river crossing is approximately 1.12 miles in length and traverses the Lancaster County/York County border. The river crossing starts at the Manor Substation using a 3-pole steel structure and continues south approximately 2,990 feet to a steel lattice tower on Else Island, and then continues south approximately 2,897 feet to a 3-pole steel structure located on the opposite side of the river.

The proposed Project will be located entirely within the existing right-of-way for the Manor- Graceton 230 kV Transmission Line and a Submerged Lands License Agreement for the aerial river crossing. No additional right-of-way is required to accommodate the operation and maintenance of the reconducted segment of the Manor- Graceton 230 kV Transmission Line.

3.0 LAND USE AND ENVIRONMENTAL

Impacts to land use and the environment are anticipated to be minimal because the reconducted segment of the Manor- Graceton 230 kV Transmission Line will use the existing tower structures. No additional tower structures are required for the proposed Project. Interference with existing land uses will be further minimized because PPL Electric will use existing and previously established access roads for construction. See Figure 3-1, Site Location Constraints.

No nearby communication towers, pipelines or other utilities will be affected by the proposed Project. It does cross over an existing 69 kV transmission line (part of the Conastoga – Perryville owned by PPL Electric). On the north side of the river crossing near the Manor Substation, the reconducted segment

will traverse (aerially) an existing Pennsylvania railroad line and the Enola Low Grade Trail located on an abandoned railway bed. The facilities are currently traversed by the existing 230 kV line and will not be impacted by the recoductoring of the Manor- Graceton 230 kV Transmission Line river crossing.

The closest airports include: the historical Central Manor Airport (possibly non-operational) located approximately 6.2 miles northwest of the project; Baublitz Commercial Airport, a public facility located approximately 6.4 miles southwest of the project; historical Manor Knoll Personal Use Airport (private and possibly non-operational) approximately 6.8 miles northwest; Muddy Run Airport, a private facility located approximately 7.4 miles southeast; and D. Evans Farm Airport, a private facility located approximately 8.5 miles northwest of the proposed project. 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 use of the existing tower structures. However, PPL Electric will coordinate will file any required documentation with both the Federal Aviation Administration and the Pennsylvania Department of Transportation Bureau of Aviation.

PPL Electric has been in consultation with the Pennsylvania Historical and Museum Commission (“PHMC”) for the proposed project. PPL Electric will continue to work with the PHMC and perform any reviews and field survey/sampling work required to avoid, minimize, and mitigate impacts to archaeological or historic architectural resources located within the project area. No impacts to cultural resources are anticipated.

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

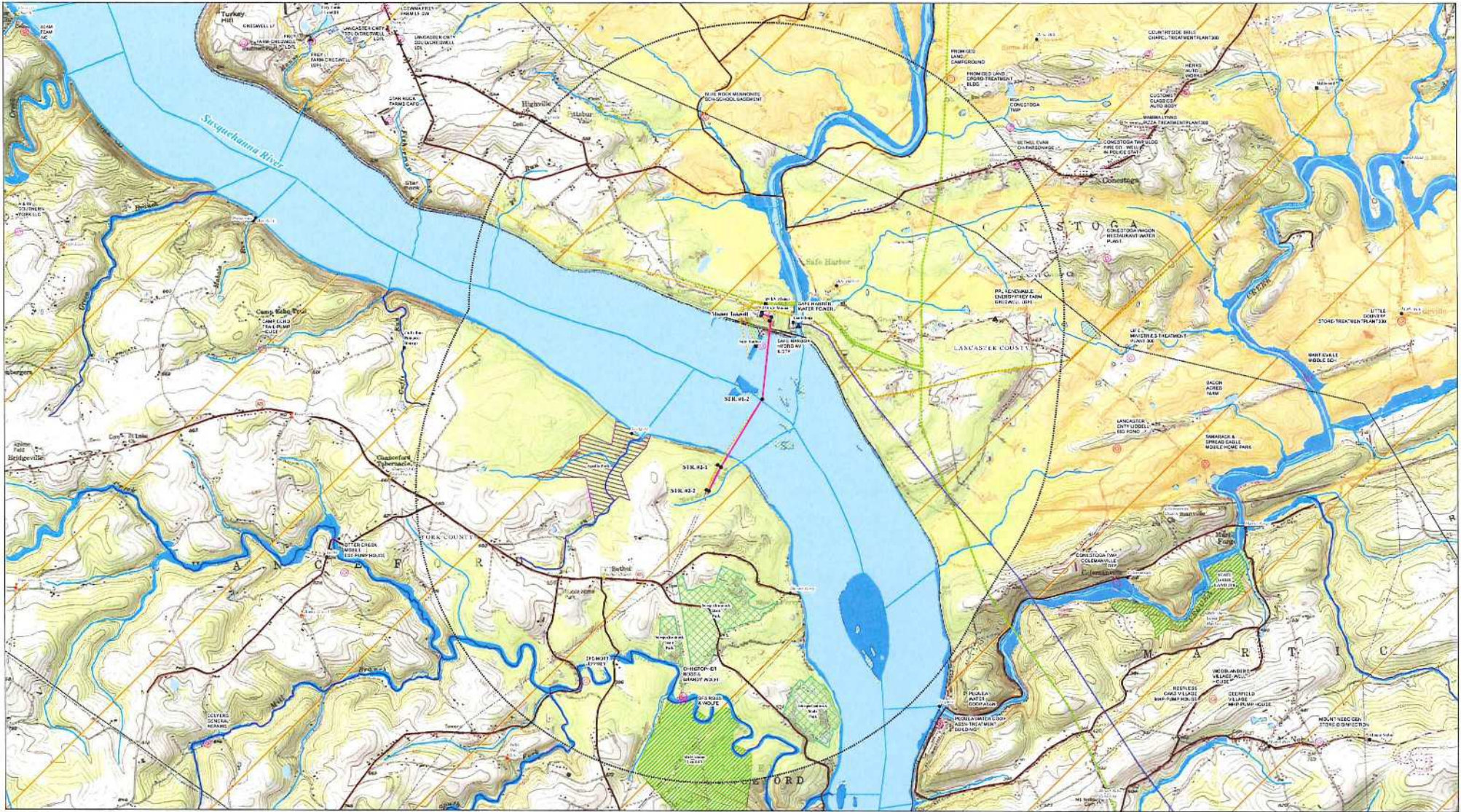
The proposed Project will cross the Susquehanna River at the existing crossing location. PPL Electric will confirm total anticipated impacts, obtain permits and other authorizations from the County Conservation District, Pennsylvania Department of Environmental Protection and the United States Army Corps of Engineers, as needed, and will comply with all of the terms and conditions placed on those permits or authorizations. PPL Electric also will comply with soil erosion and sedimentation control permits, as needed, and will comply with any conditions placed on those permits.

PPL Electric has been coordinating with state and federal agencies to obtain information regarding threatened and endangered species within or in close proximity to the project area. In April 2016, PPL Electric reviewed the Pennsylvania Natural Diversity Inventory (“PNDI”) records under the jurisdiction of the Pennsylvania Department of Conservation and Natural Resources, the Pennsylvania Fish and Boat Commission, the Pennsylvania Game Commission, and the U.S. Fish and Wildlife Service. Based on this review, the proposed Project may have impacts on some threatened and endangered species and/or special concern species and resources. However, any such impacts will be avoided by observing time of year restrictions on construction. To minimize the potential for any such impacts, all construction activities for this Project will take place between August 16 and February 14 only. No other impacts are anticipated and the above agencies have confirmed no additional consultation is required.

4.0 VEGETATION MANAGEMENT

The Project is being completed within existing river crossing and transmission line corridor. These areas currently are cleared of vegetation for the existing electrical facilities, and no other vegetation clearing is proposed. However, in the event vegetation management is required to complete the proposed Project,

PPL Electric will apply its “Specifications for Transmission Vegetation Management LA-79827” to mitigate any impacts.



Legend		Existing Utilities		Land Use/Cover		Hydrologic		Environmental/Biological		Ownership/Land Cover/Geology		Political Boundaries	
• Structure	State Road	• Substation	+ Airport	Wetland	Intermittent	EPA Facility Registry Service Facility	DCNR State Parks	City/Town	N W E S				
— Centerline	Local Road	— <100 kV	Ⓜ Cemetery	FEMA	Perennial	Superfund Site	County Park	Municipality Boundary					
⊞ 2 mile Buffer	Railroad	— 100-161 kV	Ⓜ Hospital	Waterbody	Stream (303d)	Trout Natural Reproduction Stream	State Game Land	County Boundary					
		— 230-300 kV	Ⓜ Park		Stream (305B)	Indiana Bat Range	NLCD Forested Area						
		— Natural Gas Pipeline	Ⓜ School		Stream (CH 93)		Karst						
			Ⓜ Trail										

Manor-Graceton 230 kV Line Reconstructor Project

Figure 3-1 Site Location Constraints



Attachment

4

ATTACHMENT 4
MANOR-GRACETON 230KV LINE RECONDUCTOR PROJECT
PPL ELECTRIC DESIGN CRITERIA AND SAFETY PRACTICES

TABLE OF CONTENTS

<u>SECTION</u>	<u>TOPIC</u>	<u>PAGE</u>
1.0	DESIGN CRITERIA AND SAFETY PRACTICES	4-1

ATTACHMENT 4

MANOR-GRACETON 230KV LINE RECONDUCTOR PROJECT

PPL ELECTRIC DESIGN CRITERIA AND SAFETY PRACTICES

1.0 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 Corp. ("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.

138kV

<u>Surface Underneath Conductors</u>	<u>Vertical Clearance to Ground</u>	
	<u>NESC Standard</u>	<u>PPL Design</u>
Roads, streets, alleys	21 Ft.	30 Ft.
Other land traversed by vehicles (such as cultivated field, forest, etc.)	21 Ft.	30 Ft.
Spaces accessible to pedestrians only	17 Ft.	30 Ft.
Railroad tracks	29 Ft.	32 Ft.

230kV

<u>Surface Underneath Conductors</u>	<u>Vertical Clearance to Ground</u>	
	<u>NESC Standard</u>	<u>PPL Design</u>
Roads, streets, alleys	23 Ft.	32 Ft.
Other land traversed by vehicles (such as cultivated field, forest, etc.)	23 Ft.	32 Ft.
Spaces accessible to pedestrians only	19 Ft.	32 Ft.
Railroad tracks	31 Ft.	34 Ft.

500kV

<u>Surface Underneath Conductors</u>	<u>Vertical Clearance to Ground</u>	
	<u>NESC Standard</u>	<u>PPL Design</u>
Roads, streets, alleys	28 Ft.	53 Ft.
Other land traversed by vehicles (such as cultivated field, forest, etc.)	28 Ft.	53 Ft.
Spaces accessible to pedestrians only	24 Ft.	53 Ft.
Railroad tracks	36 Ft.	53 Ft.

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:

<u>Voltage-kV</u>	<u>Minimum Clearance</u>
138	3' – 7"
230	5' – 3"
500	11' – 3"

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.