

Before the
Pennsylvania Public Utility Commission

**STEEL CITY-QUARRY #1 & #2
230 kV LINE RELOCATION**

**ATTACHMENTS IN SUPPORT OF THE
Letter of Notification**

Application Docket No. _____

Submitted by: PPL Electric Utilities Corporation

SUMMARY

A Letter of Notification is being submitted by PPL Electric Utilities Corporation (PPL Electric) pursuant to the Pennsylvania Public Utility Commission's (PUC or the Commission) regulations at 52 Pa. Code §§ 57.71 through 57.77 for approval to relocate approximately 0.68 miles of the double circuit Steel City – Quarry #1 and #2 230 kV Transmission Line. This portion of the line, once relocated, will be 0.72 miles in length. This line relocation is required to accommodate the future operations at the IESI PA Bethlehem Landfill Corporation property. The portion of the Line to be relocated is located in Lower Saucon Township, Northampton County.

The estimated cost to design, relocate and construct this section of the existing 230 kV transmission line is approximately \$3.4 million and will be borne by the IESI PA Bethlehem Landfill Corporation. PPL Electric will construct, own and operate the line. The project has a scheduled construction start date in the fall of 2013 to meet the scheduled in-service date in the fall of 2014.

This document, which describes the need for the project and discusses the engineering and siting analysis for the proposed reconstruction, consists of the following attachments:

Attachment "1"	Necessity Statement
Attachment "2"	Engineering Description
Attachment "3"	Environmental Assessment
Attachment "4"	PPL Electric Design Criteria and Safety Practices
Attachment "5"	PPL Electric Magnetic Field Management Program
Attachment "6"	List of Owners of Property Within the Right-of-Way
Attachment "7"	List of Involved Governmental Agencies, Municipalities and Other Public Entities

PPL ELECTRIC UTILITIES SERVICE TERRITORY



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**ATTACHMENT 1
STEEL CITY – QUARRY #1 AND #2 230 kV LINE RELOCATION
NECESSITY STATEMENT**

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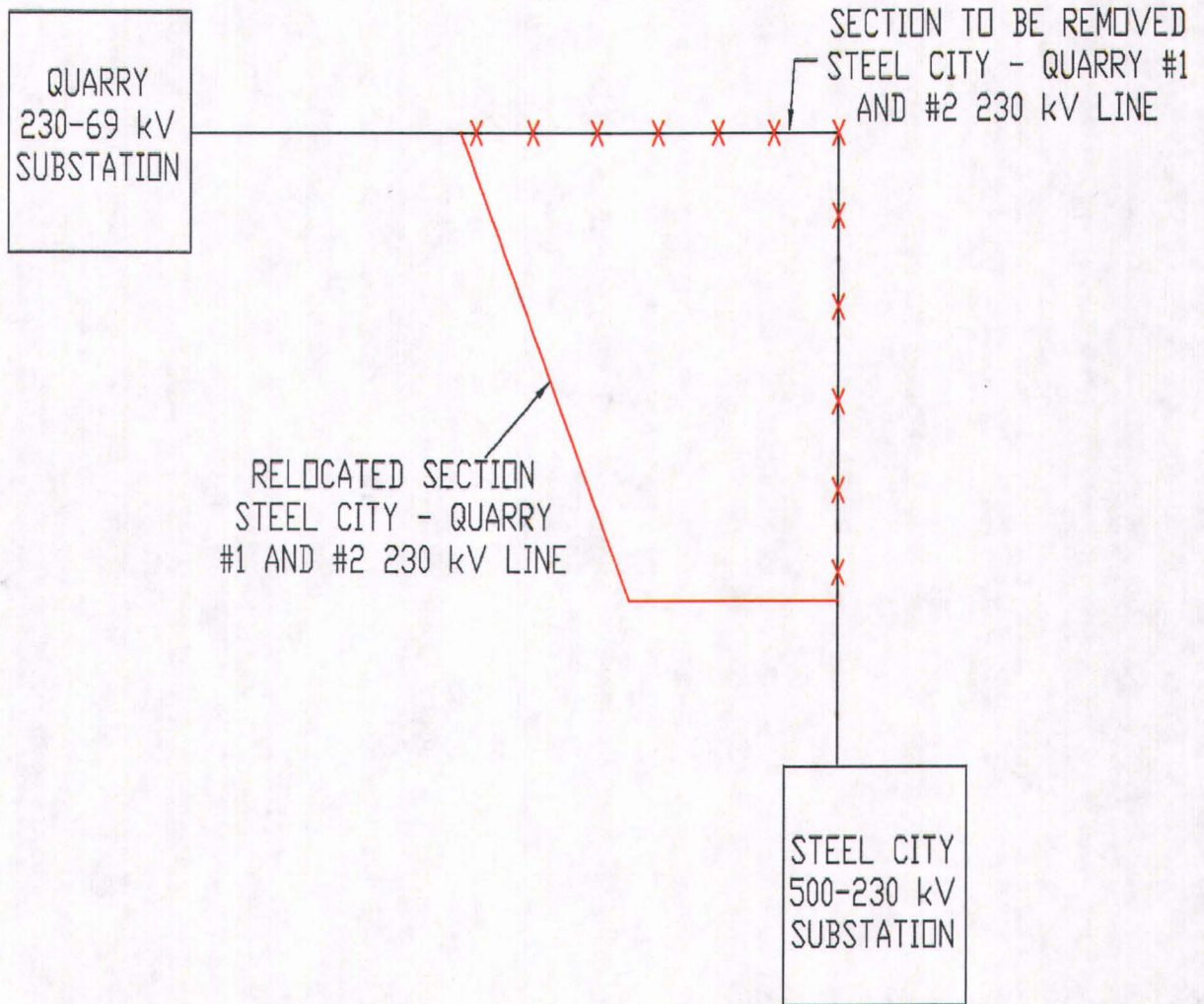
ATTACHMENT 1
STEEL CITY – QUARRY #1 AND #2 230 kV LINE RELOCATION
NECESSITY STATEMENT

A. PROJECT NECESSITY

IESI PA Bethlehem Landfill Corporation has requested that PPL Electric relocate a section of the existing Steel City – Quarry #1 and #2 230 kV Transmission Line to the southern and western portion of its property. The relocation of the transmission line will enable the landfill to expand its operation. The proposed relocation will not change the functionality of the transmission system as shown on the one line diagram provided in Figure 1 on page 2 of Attachment “1”.

The estimated cost to design, relocate and construct this section of the existing 230 kV line is approximately \$3.4 million and will be borne by the IESI PA Bethlehem Landfill Corporation. PPL Electric will construct, own and operate the line. The project has a scheduled construction start date of Fall 2013 to meet the scheduled in-service date of Fall 2014.

A PPL Electric System Map showing existing transmission facilities with a design voltage of 35 kV or greater is included in Attachment “1” map pocket. This filing addresses only the existing and proposed 230 kV bulk transmission system in the Lower Saucon Township Area.



- EXISTING TRANSMISSION LINE
- X — X — X — X — EXISTING TRANSMISSION LINE TO BE REMOVED
- PROPOSED TRANSMISSION LINE

NOTE: NOT TO SCALE

FIGURE 1 – FUNCTIONAL ONE-LINE DIAGRAM

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ATTACHMENT 2
STEEL CITY – QUARRY #1 AND #2 230 kV LINE RELOCATION
ENGINEERING DESCRIPTION

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ATTACHMENT 2
STEEL CITY – QUARRY #1 AND #2 230 kV LINE RELOCATION
ENGINEERING DESCRIPTION

A. PROPOSED LINE DESIGN

PPL Electric proposes to relocate a section of the existing Steel City – Quarry #1 and #2 230 kV Transmission Line to accommodate the proposed expansion of the landfill at the IESI PA Bethlehem Landfill Corporation property located in Lower Saucon Township, Northampton County. This project involves the removal of a 0.68 mile section of the existing 230 kV transmission line. The portion of the transmission line that will be removed is presently supported by steel pole structures with an average height of approximately 135 feet and average span of approximately 763 feet. The relocated transmission line will be approximately 0.72 miles long. Most of the relocated line will be supported by single-shaft steel pole structures equipped with upswept steel arms (Figure 1). Angle structures will support the remainder of the line. The angle structures may consist of single or two-pole structures depending on the severity of the angle. All proposed poles will be placed on foundations. Altogether, this project requires the installation of 10 new poles with an average height of 135 feet. The average span of the relocated section of the line will be 764 feet.

The relocated section of transmission line will be designed to meet, and generally exceed, National Electrical Safety Code (“NESC”) minimum standards. Additional design criteria and safety rules practiced by PPL Electric are included in Attachment 4. Six power conductors and two overhead ground wires will be installed. The power conductors will be 1590 kcmil (thousands of circular mils)¹ 45/7 stranding ACSR². There will be two overhead ground wires. One overhead ground wire (OHGW) will be 1/2-inch diameter extra high-strength steel while the other will be 0.791 inch diameter optical ground wire (OPGW). They will provide lightning protection for the relocated line section and communications between PPL Electric Substations.

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

² Aluminum conductor steel reinforced.

The minimum conductor-to-ground clearance will be 32 feet for the relocated transmission line. This minimum clearance occurs at a maximum thermal conductor temperature of 125°C. Table 1 shows the designed minimum conductor clearances and Table 2 shows the conductor thermal ratings of the proposed transmission line.

**TABLE 1
DESIGN MINIMUM CONDUCTOR CLEARANCES
FOR 159 KCMIL 45/7 STRAND ACSR**

<u>Condition</u>	<u>Double Circuit 230 kV Clearance-to-Ground</u>
Normal load; average weather (16°C ambient, 60°F temperature)	38.0 feet
Predicted extreme thermal load (125°C conductor, 257°F temperature)	32.0 feet
Predicted NESC extreme wind load conditions (25 lbs., 16°C, 60°F temperature)	41.9 feet
Predicted extreme weather conditions (1-inch ice, 4 lbs. wind, -18°C, 0°F temperature)	37.2 feet
	* Clearances based on a maximum tension of 18,000 pounds and a ruling span of 450 feet

**TABLE 2
CONDUCTOR THERMAL RATING
1590 KCMIL 45/7 ACSR
125°C MAXIMUM CONDUCTOR TEMPERATURE**

<u>Condition</u>	<u>Ambient Temperature °C</u>	<u>Wind Speed Knots</u>	<u>Ampacity Amps</u>
Summer Normal	35	0	1640
Winter Normal	10	0	1861
Summer Emergency	35	1.5	1990
Winter Emergency	10	1.5	2220

B. MAGNETIC FIELD MANAGEMENT

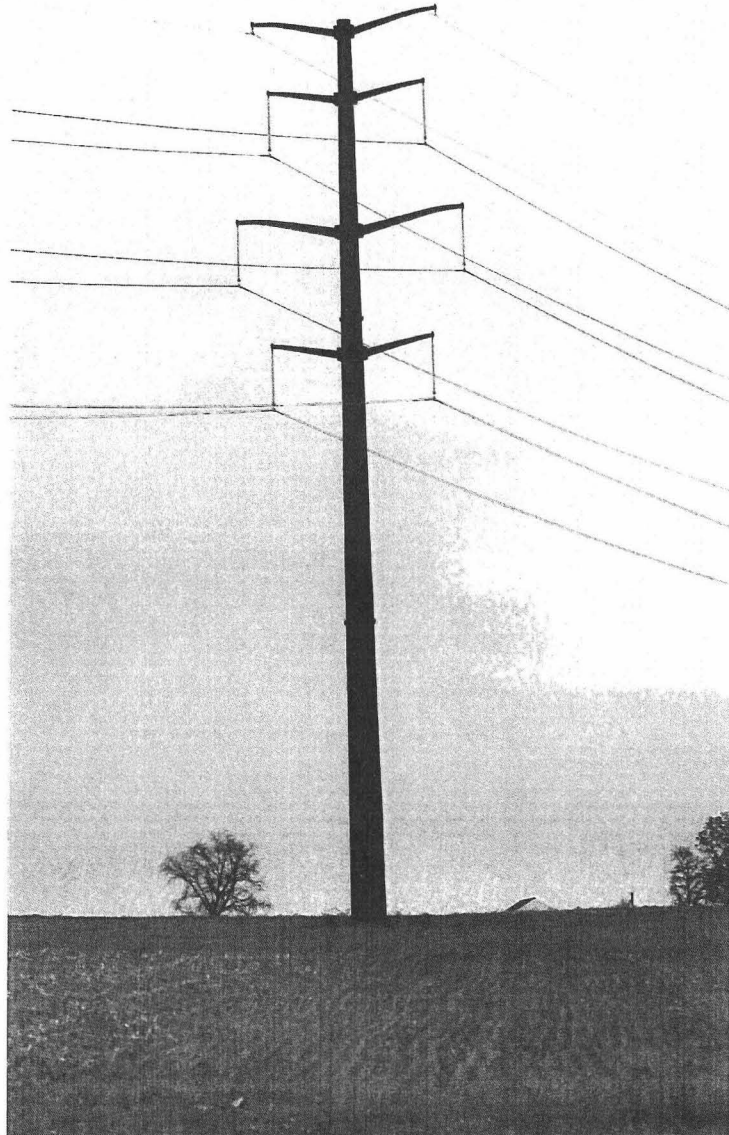
PPL Electric's Magnetic Field Management Program is summarized in Attachment 5 and will be applied to reconstruction and new line projects, including this reconstruction of a portion of the Steel City #1 & #2 230 kV Transmission Line. In order to reduce magnetic field exposures, the program generally prescribes a line design that provides 5 feet higher ground clearances than required under the NESC 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 will be considered, provided those modifications can be made at low or no cost and will not interfere with the operation of the line.

Consistent with the program, PPL Electric will construct the new line section for five feet higher ground clearance than NESC standards to reduce magnetic field exposures. In addition, reverse phasing will continue to be utilized to reduce magnetic field exposures.

C. RIGHT-OF-WAY STATUS

IESI PA Bethlehem Landfill Corporation owns all of the land on which the relocated section of the Steel City-Quarry #1 & #2 230 kV Transmission Line will be situated. As part of this project, IESI PA Bethlehem Landfill Corporation will grant adequate right-of-way for the relocated transmission line. No other right-of-way is required for the relocation of a portion of the Line. The proposed right-of-way is shown on the Aerial Exhibit contained in Attachment "2" map pocket.

**FIGURE 1
PROPOSED 230 kV DOUBLE CIRCUIT
SINGLE POLE STRUCTURE**

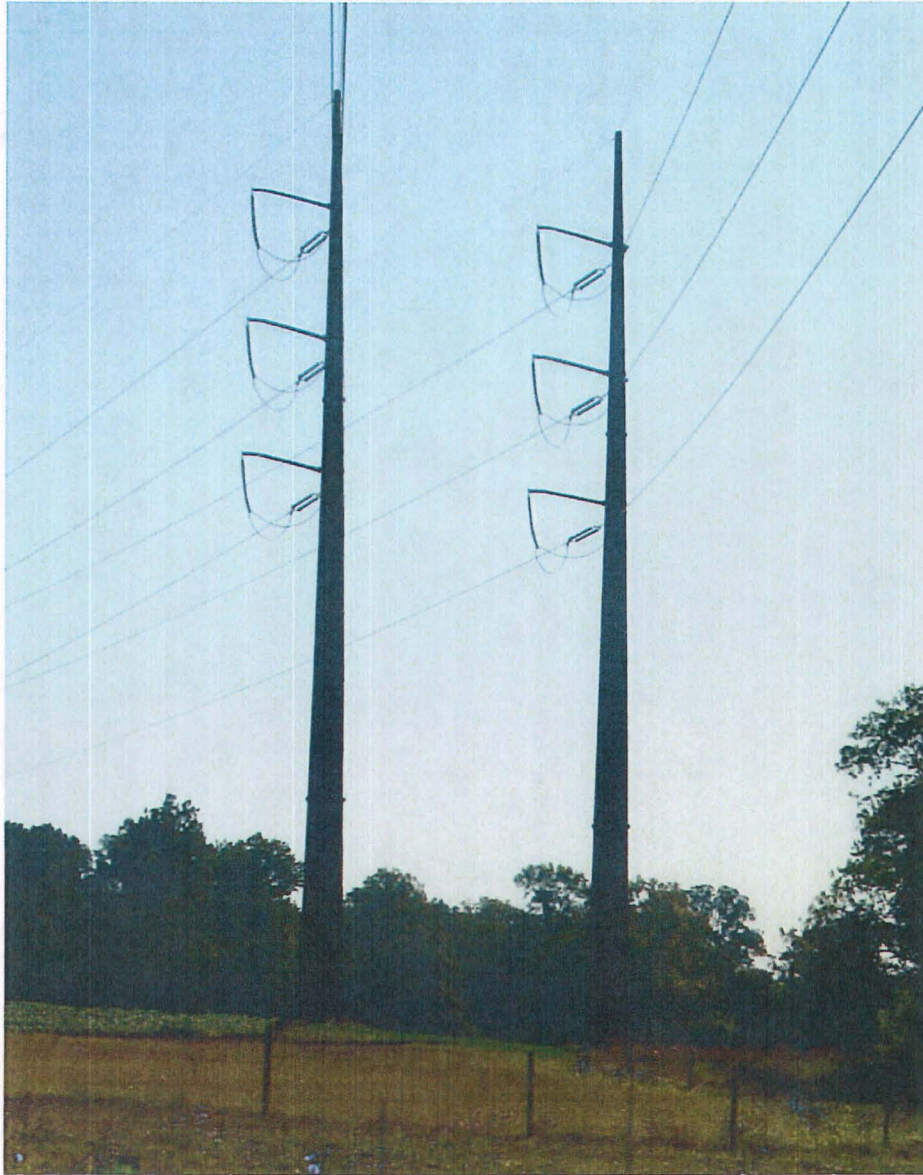


POLE STATISTICS

Average Height – 135 Feet
Shield Wire Arm Length – 14.5 Feet
Top Phase Arm Length – 12 Feet
Middle Phase Arm Length – 17.5 Feet
Bottom Phase Arm Length – 12 Feet

Vertical Spacing:
Overhead Shield Wire to Top Phase – 20 ft
Conductor Attachment Spacing – 20 ft

**FIGURE 2
PROPOSED 230 kV DOUBLE CIRCUIT
TWO POLE STRUCTURE**



POLE STATISTICS

Average Height – 135 Feet

Pole separation 40 – 55 ft

Vertical Spacing:

Overhead Shield Wire to Top Phase – 20 ft

Conductor Attachment Spacing – 20 ft

Pole Separation varies based on severity of horizontal angle.

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ATTACHMENT 3
STEEL CITY – QUARRY #1 AND #2 230 kV LINE RELOCATION
ENVIRONMENTAL ASSESSMENT

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ATTACHMENT 3
STEEL CITY – QUARRY #1 AND #2 230 kV LINE RELOCATION
ENVIRONMENTAL ASSESSMENT

A. INTRODUCTION

At the IESI PA Bethlehem Landfill Corporation's request to accommodate future expansion of the landfill at its property, PPL Electric is proposing to relocate a portion of the existing Steel City – Quarry #1 and #2 230 kV Transmission Line to the southern and western portion of IESI PA Bethlehem Landfill Corporation's property. The Project involves the removal of 0.68 miles of existing transmission line supported by steel pole structures and the installation of 0.72 miles of new transmission line supported by single shaft steel pole structures as well as one or two pole angle structures. The transmission line will be designed by PPL Electric for double circuit 230 kV operation, consistent with the existing transmission line.

PPL Electric provided information describing the Project to Lower Saucon Township and Northampton County, and neither the Township nor the County objected to the Project. A list of involved governmental agencies, municipalities, and other public entities is presented in Attachment 6.

B. LAND USE

The entire proposed relocated section of the Steel City – Quarry #1 and #2 230 kV Transmission Line will be located on property already owned by IESI PA Bethlehem Landfill Corporation. The proposed relocated transmission line will be generally located in wooded and open areas. Some of the open areas are currently used for agricultural purposes. In addition, there are a few currently occupied residences near to but outside the proposed right-of-way. These residences are also on land owned by the IESI PA Bethlehem Landfill Corporation. The proposed relocation of a portion of the Steel City – Quarry #1 and #2 230 kV Transmission Line will not require the residents to relocate.

This area is currently zoned Light Manufacturing and Rural Agriculture.

No nearby railroads, communication towers, pipelines or other utilities will be affected by the proposed Project. Lehigh Valley International Airport is the nearest airport and is located approximately six miles to the north of the Project site. PPL Electric will file the appropriate documentation with both the Federal Aviation Administration and the PennDOT Bureau of Aviation, if necessary, to confirm that the proposed transmission line will not be a hazard to the airport's flight operations. It is not anticipated that the relocation will adversely affect aviation operations because the Project involves replacing poles with new poles with similar heights and because the new poles will be further from the Lehigh Valley International Airport.

A combination of new and existing access roads will be used to access the proposed construction areas. The new access roads will have minimal incremental impacts on the tract of land where the line will be located.

C. CULTURAL RESOURCES

Martin and Martin, Incorporated, on behalf of IESI PA Bethlehem Landfill Corporation has coordinated with the Pennsylvania Historical and Museum Commission (PHMC) to obtain information regarding historic properties/places and archaeological sites in close proximity to the Project area (ER#2001-3804-095-I). In correspondence dated May 10, 2011, the PHMC indicated that additional consultation is required due to potential impacts on the Applebutter Road Historic District. In addition, PPL Electric has coordinated with the PHMC in regards to historic properties/places and archaeological sites in close proximity to the Project area (File No. ER 2012-2350-095-A). Correspondence dated September 5, 2012 from the PHMC indicated potential impacts to archaeological resources and historic structures. As a result, any required PHMC conflicts will need to be resolved by IESI PA Bethlehem Landfill Corporation prior to PPL Electric starting construction on the transmission line. PPL Electric will not initiate work until all required conflicts are fully resolved.

D. NATURAL FEATURES

The Project will not affect any unique geological, scenic, or natural areas. The recreational areas located closest to the Project site include:

- Lehigh River - located approximately 0.42 miles north of the Project site
- Saucon Park - located approximately 1.8 miles west of the Project site

Impacts to these features would be primarily visual. Impacts to these features are not anticipated, however, for the following reasons:

- The topography between these features and the Project area is undulating and includes a topographic crest that runs along the northern portion of the IESI PA Bethlehem Landfill Corporation property paralleling the Lehigh River. The proposed relocated line is situated to the south of the crest and the line will be shielded by it.
- The distances from the Project area to the recreational areas are substantial.
- The Project is located in an area which contains existing utility facilities.
- Existing vegetation provides a buffer between the Project area and the recreational areas.

Tree clearing will be required along sections of the proposed line route. PPL Electric will apply its “Specifications for Initial Clearing and Control of Vegetation on or Adjacent to Electric Right-of-Way Through Use of Herbicides, Mechanical, and Hand Clearing Techniques” to mitigate impacts while clearing the new right-of-way.

The relocated section of transmission line will span existing wetland areas and watercourses. PPL Electric will obtain all necessary permits from the Pennsylvania Department of Environmental Protection and the United States Army Corps of Engineers and will comply with all conditions placed on the permits. In addition, PPL Electric will acquire any required soil erosion and sedimentation control permits and will comply with all conditions placed on those permits.

E. THREATENED AND ENDANGERED SPECIES

Martin and Martin, Incorporated and Roemer Ecological Services, Inc., on behalf of IESI PA Bethlehem Landfill Corporation have coordinated with different state and federal agencies to obtain information regarding threatened and endangered species in close proximity to the Project area. An initial review of the Pennsylvania Natural Diversity Inventory (“PNDI”) records indicates that the *Ellisia nyctelea* (Ellisia) and *Myotis septentrionalis* (Northern Myotis) may be present within or near the Project area (PNDI Search ID: 20110609301533). In addition, although the initial PNDI review did not identify the *Glyptemys muhlenbergii* (bog turtle) as being present within or near the Project area, Northampton County is a designated bog turtle County. Therefore, any on site wetlands were surveyed for potential bog turtle habitat.

Correspondence from the Pennsylvania Game Commission (PGC) dated September 6, 2011 indicates that no impacts are anticipated to the Northern Myotis or any other species or resources of concern under the jurisdiction of the PGC. No further coordination with the PGC is necessary for the Project.

Additional correspondence from the Department of Conservation and Natural Resources dated August 10, 2011, in reference to the Ellisia, indicates that the *Myriophyllum sibiricum* (Northern Water-milfoil), *Cuscuta compacta* (Compact Dodder), and *Cyperus schweinitzil* (Schweinitz’s Flatsedge) are located within the Project vicinity. Based on the potential presence of the Ellisia, Northern Water-milfoil, Compact Dodder, Schweinitz’s Flatsedge, and bog turtle, Roemer Ecological Services, Inc. conducted surveys of the Project area to identify whether these species were present. It has determined that these species are not present within or near the proposed Project area. Roemer Ecological Services, Inc. is preparing the appropriate survey reports for submission to the corresponding agencies once finalized. Any conflicts with species of concern will be resolved by IESI PA Bethlehem Landfill Corporation prior to PPL Electric starting construction of the transmission line.

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ATTACHMENT 4
STEEL CITY – QUARRY #1 AND #2 230 kV LINE RELOCATION
PPL ELECTRIC DESIGN CRITERIA AND SAFETY PRACTICES

The National Electrical Safety Code (NESC) is a set of rules to safeguard people during the installation, operation, or 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 provisions 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 such things 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

<u>Surface Underneath Conductors</u>	<u>Vertical Clearance to Ground</u>	
	<u>NESC Standard</u>	<u>PPL Electric 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	31 Ft.	35 Ft.

230 kV

<u>Surface Underneath Conductors</u>	<u>Vertical Clearance to Ground</u>	
	<u>NESC Standard</u>	<u>PPL Electric 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.	36 Ft.

500 kV

<u>Surface Underneath Conductors</u>	<u>Vertical Clearance to Ground</u>	
	<u>NESC Standard</u>	<u>PPL Electric 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	38 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. Numerous 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.

ATTACHMENT

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**MAGNETIC
FIELD
MANAGEMENT**
PPL Electric Utilities
Corporation

DECEMBER 2004

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INTRODUCTION

At PPL Electric Utilities Corp. (PPL EU), magnetic field management means investigating and implementing methods at low or no cost to reduce magnetic fields in new or rebuilt transmission and distribution lines. This document explains PPL EU's Magnetic Field Management Program, which is part of PPL EU's larger Electric and Magnetic Fields (EMF) policy.

PPL EU's View

Some people are worried that electric and magnetic fields are harming their health. Others think the scientific research does not show a problem at all, and still others believe there's just too much scientific uncertainty to draw any conclusions.

Here's what we do know now. Various panels of scientists that have reviewed the EMF research generally have drawn two main conclusions. First, the large body of evidence does not demonstrate that EMF are harmful. Second, additional research is recommended to explore questions raised in some studies.

Given these conclusions, PPL EU is taking a reasoned approach in responding to the EMF issue. PPL EU's approach to the EMF issue consists of five elements:

- Providing EMF information to customers and employees
- Providing magnetic field measurements
- Establishing and implementing a magnetic field management program to reduce magnetic fields in new or rebuilt facilities when it can be done at no, or low, cost
- Integrating EMF in the public involvement process that PPL EU undertakes in the siting of transmission lines
- Have supported additional research

EMF Are All Around Us

Electric and magnetic fields occur in nature and in all living things. The earth, for instance, has a magnetic field, which makes the needle on a compass point north.

Electric fields and magnetic fields of a different type also surround every wire that carries electricity. In everyday life, these EMF arise from several basic sources, including power lines, electrical appliances, home and building wiring, other utility lines and cables, and currents flowing on water pipes. Though they often occur together, EMF are made up of two separate components:

Electric Fields

Electric fields are produced by the voltage—or electrical pressure—on a wire. The higher the voltage, the higher the electric field. As long as a wire is energized—has voltage present—an electric field is present (see Figure 1). In other words, an appliance, or an electric power line, doesn't actually have to be turned on to create an electric field. It just has to be plugged in. Electric fields diminish with distance and can be blocked or partially shielded by objects such as trees and houses.

Magnetic Fields

Magnetic fields are created by the current or flow of electricity through a wire. Generally speaking, the higher the current, the higher the magnetic field. Because they only occur when current is flowing, magnetic fields are present only when the power is turned on (see Figure 1). Magnetic fields also diminish with distance, but—unlike electric fields—are not blocked by common objects. In recent years, public and scientific interest has turned toward the magnetic field component of EMF because of some scientific studies regarding these fields.

Figure 1

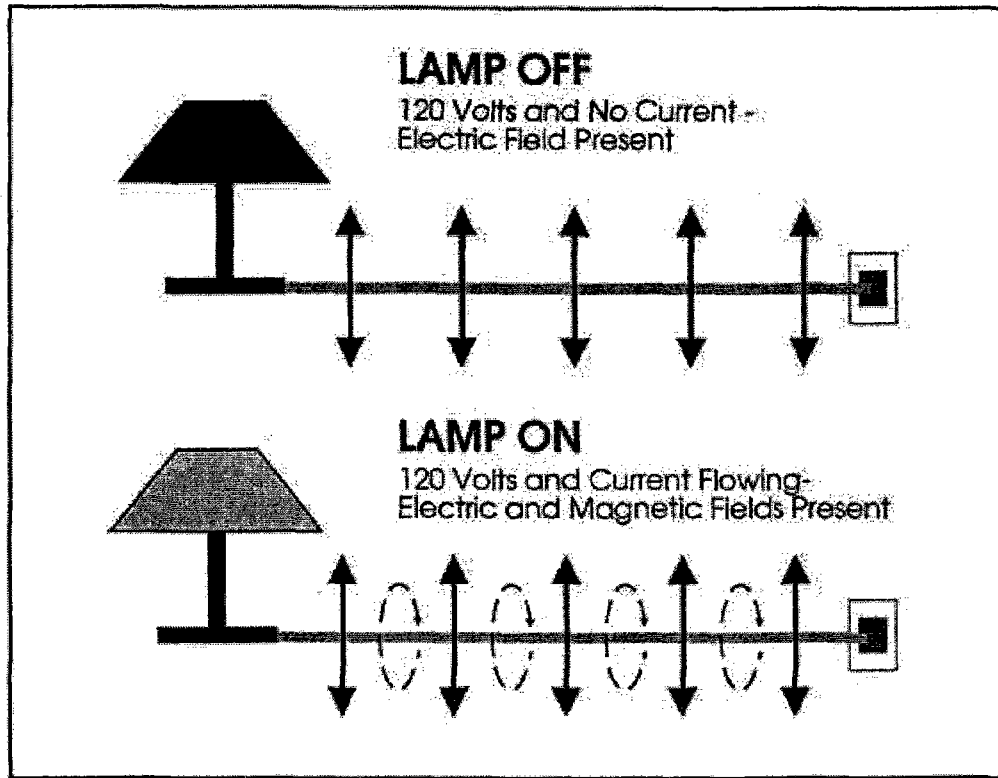


Figure 2









Magnetic field strengths decrease with distance Magnetic fields are measured in milligauss:		Source: "EMF in Your Environment", U.S. Environmental Protection Agency 1992		
		At 6 inches	At 1 foot	At 2 feet
Clothes dryer		2 to 10	* to 3	*
Microwave oven		100 to 300	1 to 200	1 to 30
Toaster		5 to 20	* to 7	*
Power drill		100 to 200	20 to 40	3 to 6
Can opener		500 to 1500	40 to 300	3 to 30
Mixer		30 to 600	5 to 100	* to 10
Hair dryer		1 to 700	* to 70	* to 10
Color television		Data not available	* to 20	* to 8

FIGURE 2 * The magnetic field measurement at this distance from the operating appliance could not be distinguished from background measurements taken before the appliance had been turned on.

Measuring Magnetic Fields

Magnetic fields usually are measured in a unit called a milligauss. Magnetic field levels found in the living areas of homes typically range from less than 1 milligauss to about 4 milligauss according to the U.S. Environmental Protection Agency. They can be higher in some cases. The levels next to appliances can exceed 1,000 milligauss (1 gauss). Figures 2 and 3 show how the strength of the field falls off as you move away from the source, just as the heat of a campfire grows weaker as you walk away from it. For overhead power lines, the strength of the magnetic fields is dependent upon a number of factors that will be explained later. Those factors produce a magnetic field that drops off rapidly as you move away from the power line.

Figure 3

Sample Magnetic Field Levels in Milligauss				
Type of Overhead Power Line	Distance from the line			
	Under the line	50 ft.	100 ft.	200 ft.
220 kV and 500 kV	5-400	5-250	1-75	0.5-20
69 kV and 138 kV	3-80	0.5-2.5	0.1-10	0.1-3
12 kV and below	0.4-20	0.1-1	-	-

The magnetic field values provided in this table represent a general range of values associated with the types of overhead power lines listed and are provided for illustration. There will be circumstances in which there will be magnetic field levels above or below the range of values provided due to variations in such factors as height of the wires, current flow and so on.

DEVELOPMENT OF PPL EU's MAGNETIC FIELD MANAGEMENT PROGRAM

One element of our response to EMF concerns expressed by some of our customers is PPL EU's Magnetic Field Management Program. The program was initiated in March 1991 because PPL EU believes it makes good sense, as a matter of policy, to respond to the concerns expressed by some of our customers and to reduce magnetic fields in new and rebuilt facilities where it can be done with either no-cost or low-cost design changes.

This document updates the original program which has been revised several times since 1991. These guidelines were developed by PPL EU's EMF Working Group.

VARIABLES THAT AFFECT MAGNETIC FIELDS

Magnetic fields from transmission and distribution lines are a function of a number of design variables. The following parameters affect the magnetic field levels produced by transmission and distribution lines:

- Current
- Height of conductors above ground
- Configuration of conductors
- Distance from the line

EFFECT OF PHASE CURRENT ON MAGNETIC FIELDS

At power frequencies (i.e., 60 hertz), the magnetic field level is a function of the current or flow of electricity through a wire. Keeping all other parameters the same, the magnetic field is proportional to the current. Hence, if the current increases by 25 percent, the resulting magnetic field level will increase by 25 percent.

The overall load current on any line varies with the demand for power. It's usually highest during daytime hours and lowest at night. There also are weekly, monthly, seasonal and yearly variations.

The difference in the currents between each phase in a multiphase line also can affect the magnetic field. This difference is called phase unbalance. For a constant load, a statistical analysis of this phase unbalance can be made to determine its effect on the magnetic field. Close to the line, there is very little effect. However, the phase unbalance slows the rate at which the magnetic field decreases with distance from the line.

EFFECT OF CONDUCTOR CONFIGURATION ON MAGNETIC FIELDS

In the transmission and distribution of power, utilities like PPL EU presently use both three-phase and single-phase lines. Each phase on a three-phase power line has either a single conductor or a bundle of two or more conductors. In a three-phase system, the ground-level magnetic field is a result of the fields produced by the currents in each of the phases. Placing the three phases as close together as possible (compaction) creates some field cancellation, and the ground-level magnetic field is reduced. However, appropriate phase separation is required for the reliable operation of the line. In addition, the arrangement of the phases can create some; field cancellation and reduction of the ground-level magnetic field.

EFFECT OF DISTANCE FROM THE MAGNETIC FIELD SOURCE

Magnetic field strength diminishes with the vertical and lateral distances from the magnetic field source. Increasing the height of the conductors above ground is useful for magnetic field reduction at ground level, but may result in increased structure costs and increased aesthetic impact of the structures. Another possible method of increasing the distance to the magnetic field source is to increase the right-of-way requirements. By keeping buildings off increased rights of way, thereby requiring the public to live and work further away from lines, exposure to magnetic fields produced by the lines can be reduced. Increases in right of way are not always practical and may increase costs significantly, however.

SUMMARY OF PPL EU's MAGNETIC FIELD MANAGEMENT PROGRAM

Under its Magnetic Field Management Program, PPL EU has changed the way it builds and rebuilds some of its transmission and distribution lines. These design changes reduce magnetic field levels (assuming balanced circuit loadings and phase currents) by up to 69 percent in most of the company's new transmission lines. These guidelines now are being applied to new and reconstructed transmission facilities, based on this program.

The distribution component of the program focuses on 12 kV lines, the company's standard distribution voltage. It concentrates on the three-phase, primary 12 kV lines, since these are the most heavily loaded facilities and often are located in densely populated areas. The guidelines in this program are being applied to these three-phase, primary 12 kV lines.

A maximum 3-5 percent change in estimated cost was used as the limit for the guidelines since this value is consistent with low cost, is within estimating accuracy and is likely to have little impact on overall line costs.

The magnetic field calculations used in this document for the design of PPL EU's overall magnetic field management plan assume balanced load conditions among the phases and a fixed level of current, not necessarily representative of specific transmission or distribution lines. These levels were calculated using the Electric Power Research Institute's ENVIRO computer program. Under actual operating conditions, the magnetic field levels that result may vary due to such things as actual load per circuit, overall current on each phase conductor and the electrical configuration and operation of each line.

MAGNETIC FIELD MANAGEMENT PROGRAM GUIDELINES

The guidelines for magnetic field management are noted below, with discussion points for each.

OVERHEAD LINES

NEW OR REBUILT TRANSMISSION LINES

1. **Balance transmission circuit loads and phase currents as much as possible.**
 - PPL EU should continue to make every effort to balance loadings between the two circuits of a double circuit line when planning new or rebuilt facilities to maximize the effects of reverse phasing.
 - PPL EU should continue the practice of balancing single-phase loads across the three phases of the distribution system. (Unbalanced phase currents on the distribution system are reflected through to the transmission system.)
 - Unbalanced phase currents result in higher magnetic fields that do not drop off as quickly with distance as do the fields resulting from balanced phase currents.
 - For a 5 percent phase current unbalance, the magnetic field 50 feet from the centerline of a single circuit 138 kV line could be more than twice the value than if the same line had balanced phase circuits.
 - Balanced phase currents on each three-phase distribution circuit also reduce magnetic fields from the distribution circuits themselves. In addition, they reduce magnetic fields on the transmission system from which the distribution system circuits are supplied and connected through substations.
 - Apart from magnetic field considerations, balanced phase currents on each three-phase distribution circuit also reduce line losses and improve the system voltage.

2. Continue with the present practice of using long-span construction as the PPL EU 138/69 kV standard

- Structure designs for short-span and long-span construction are illustrated on Charts I and II, respectively.
 - Short-span design does not significantly reduce magnetic fields when compared to long-span design even though it is more compact than long-span design. Comparison of the magnetic field values from Chart III indicates essentially the same values. Therefore, short-span design should not be used solely to reduce magnetic fields.
 - PPL EU will continue to use long-span construction for 138/69 kV double-circuit lines and for single-circuit/future-double-circuit lines.
 - For single-circuit/future-double-circuit lines, PPL EU will continue to install two conductors on the top positions and one in the middle position as shown in Chart IV.
 - This arrangement minimizes magnetic fields as shown in Chart V by placing the three initial conductors higher on the structure, which increases the ground clearances, and by placing the conductors in a triangular configuration.

3. Compact design structures are not a low-cost alternative and should be used for magnetic field reduction only in special applications.

Chart VI illustrates the compact design structure.

- The compact design increases the initial installation costs by 79 percent when compared to the long-span design but reduces the magnetic field from 9 mG to 3 mG (about 67 percent) at the edge of the 100-foot-wide right of way as shown on Chart III.

4. Reverse phase new or rebuilt double-circuit transmission lines for all voltage levels.

- Reverse phasing was adopted by PPL EU in March 1991 for double-circuit 138/69 kV transmission lines and in April 1992 for all other double circuit transmission lines. Reverse phasing is shown in Chart VII. Reverse phasing will reduce the magnetic fields when the current flow on both circuits is in the same

direction. Calculated values contained here are based on balanced and equal phase currents on both circuits.

- Reverse phasing reduces the magnetic field of a double circuit 138 kV single pole transmission line from 29 mG to 9 mG (about 69 percent) at the edge of the 100-foot-wide right of way as shown on Chart III.
- Reverse phasing reduces the magnetic field of a double circuit 230 kV single pole transmission line from 49 mG to 16 mG (about 67 percent) at the edge of the 150-foot-wide right of way as shown on Chart VIII.
- Reverse phasing reduces the magnetic field of a double-circuit 500 kV single pole transmission line from 37 mG to 21 mG (about 43 percent) at the edge of the 200-foot-wide right of way as shown on Chart IX.
- When new or rebuilt double-circuit lines require tapping existing double-circuit lines, PPL EU will review the existing lines to determine if reverse phasing can be provided at low cost.
- Computer modeling is required to develop the optimum phasing and overall conductor arrangements for lines added to, or rebuilt in, multiple-line corridors.
 - Merely adding a reverse-phase double-circuit line to an existing transmission line corridor or reverse phasing a rebuilt line in the multiple-line corridor will not necessarily produce lower magnetic field levels at the edge of the corridor right of way.
 - The corridor must be computer modeled with all the lines, existing phase conductor locations and currents. Then, magnetic field calculations must be made varying the phase arrangements of the new or reconstructed line to determine the appropriate phasing arrangement.
 - Current flow direction on a line also must be considered. For example, a reverse-phased line should have the current flowing in the same direction on both circuits. If the current flow is in the opposite direction for one circuit, reverse phasing will not produce the lowest magnetic field and another phase arrangement that produces lower fields may need to be utilized.

5. Increase the minimum ground clearance for all new transmission lines.

138/69 kV Transmission Lines

- Increasing the minimum line design ground clearance from 25 feet to 30 feet may add up to about 5 percent to the installed cost of a new double-circuit single pole 138/69 kV line. For a given project, such cost may be substantially less, however. In fact, PPL EU frequently uses higher-than-minimum ground clearances due to such features as road crossings, line crossings and site-specific terrain. With long-span reverse-phase design, the magnetic field is reduced from 9 mG to 7 mG (about 22 percent) at the edge of a 100-foot-wide right of way as shown in Chart X.
 - In the actual design of transmission lines to include higher minimum ground clearances, there may be limited segments (such as highway crossings, severe slopes and transmission line crossing locations) where National Electrical Safety Code (NESC) minimum ground clearances may need to be used. The NESC minimum ground clearances are less than the increased ground clearance discussed previously.

230 kV Transmission Lines

- Increasing the minimum line design ground clearances from 27 feet to 32 feet may add up to about 5 percent to the cost of a single-circuit single-pole line (current standard). For a given project, such cost may be substantially less, however. In fact, PPL EU frequently uses higher-than-minimum ground clearances due to such features as road crossings, line crossings and site-specific terrain. By increasing the clearances, the magnetic field is reduced from 30 mG to 28 mG (about 7 percent) at the edge of a 150-foot-wide right of way.
- Increasing clearances from 27 feet to 32 feet could theoretically add up to about 2.8 percent to the cost of a double-circuit single-pole line (current standard) and reduce the magnetic field of a reverse-phase line from 16 mG to 15 mG (about 6 percent) at the edge of a 150-foot-wide right of way. Chart XI is a summary of this data.
- Studies are required for each new 230 kV line to determine optimum structure types, ground clearances, configurations and designs to reduce field levels. Such

studies could include analysis of reduction measures such as additional minimum ground clearances, increasing conductor tensions, using reduced phase spacing (a "Delta" configuration on a single-circuit line), installing the second circuit initially, and/or adding a second set of conductors that are reverse phased and operated in parallel with the first set (bundled/split phase).

500 kV Transmission Lines

- Increasing ground clearances from 33 feet to 53 feet may add up to about 4.5 percent to the cost of a single-circuit "H-frame" line (current standard). For a given project, such cost may be substantially less, however. In fact, PPL EU frequently uses higher-than-minimum ground clearances due to such features as road crossings, line crossings and site-specific terrain. By increasing the clearances, the magnetic field is reduced from 42 mG to 35 mG (about 17 percent) at the edge of a 200-foot-wide right of way.
- Increasing ground clearances from 33 feet to 53 feet could theoretically add up to 2.8 percent to the cost of a double-circuit "H-frame" line (current standard) and reduces the magnetic field of a reverse-phase line from 21 mG to 16 mG (about 24 percent) at the edge of a 200-foot-wide right of way. Chart XII is a summary of this data.
- Studies are required for each new 500 kV line to determine optimum structure types, ground clearances, configurations and designs to reduce field levels. Such studies could include analysis of reduction measures such as additional minimum ground clearances, increasing conductor tensions, using reduced-phase spacing (a "Delta" configuration on a single circuit line), installing the second circuit initially, and/or adding a second set of conductors that are reverse phased and operated in parallel with the first set (bundled/split phase).

RECONDUCTORING OR ADDING ADDITIONAL CIRCUITS TO EXISTING TRANSMISSION LINES

When reconductoring or adding additional circuits to existing transmission lines, PPL EU will evaluate low-cost or no-cost options for magnetic field management on a case-by-case basis.

When reconductoring existing transmission lines or adding additional circuits, low-cost alternatives may not exist; however, the following steps will be taken:

- For a single-circuit line, the use of a Delta arrangement or other modifications on the existing structure, with reduced-phase spacing, will be evaluated.
- For double-circuit lines, application of reverse phasing may reduce the magnetic field under the line and within the right of way and will be evaluated.
- For single- and double-circuit lines, evaluate using higher conductor tensions that can increase the minimum line design ground clearance.

DISTRIBUTION LINES

At the 12 kV distribution level, new main three-phase lines will continue to be constructed with five feet of additional ground clearance.

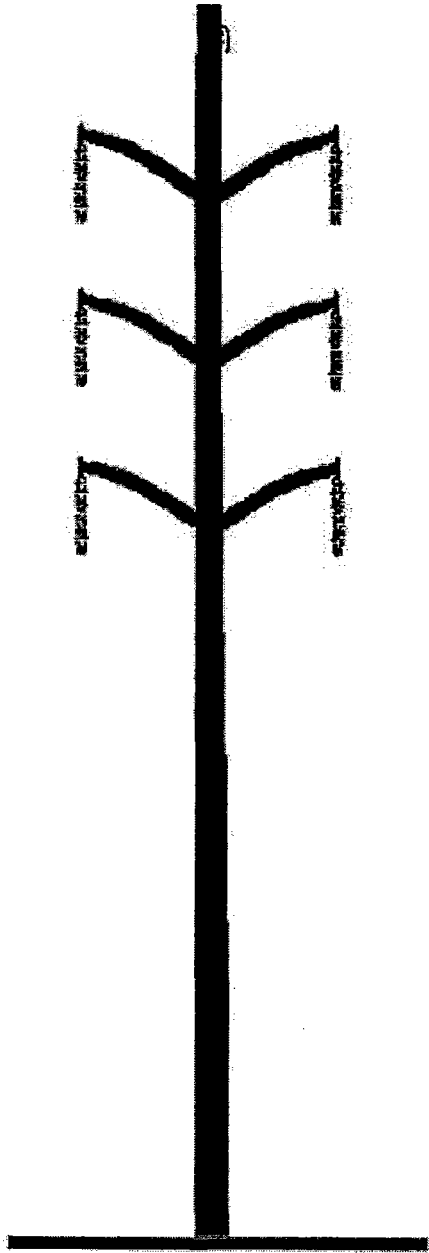
- Main lines are the most heavily loaded sections of a distribution line and therefore have the highest magnetic fields associated with them.
- Increasing the ground clearance by five feet reduces the magnetic field under the line from 14 mG to 11 mG using the standard eight-foot crossarm design. These values are based on increasing pole heights from 45 feet to 50 feet and a typical operating current of 300 amps per phase.
- Chart XIII is a summary of this data. Increasing ground clearance by five feet could theoretically add about 5 percent to the cost of a typical distribution line.

UNDERGROUND TRANSMISSION LINES

Underground transmission lines are required due to environmental or land use factors or restrictions on available clearances, PPL EU will evaluate options for magnetic field management techniques on a case-by-case basis.

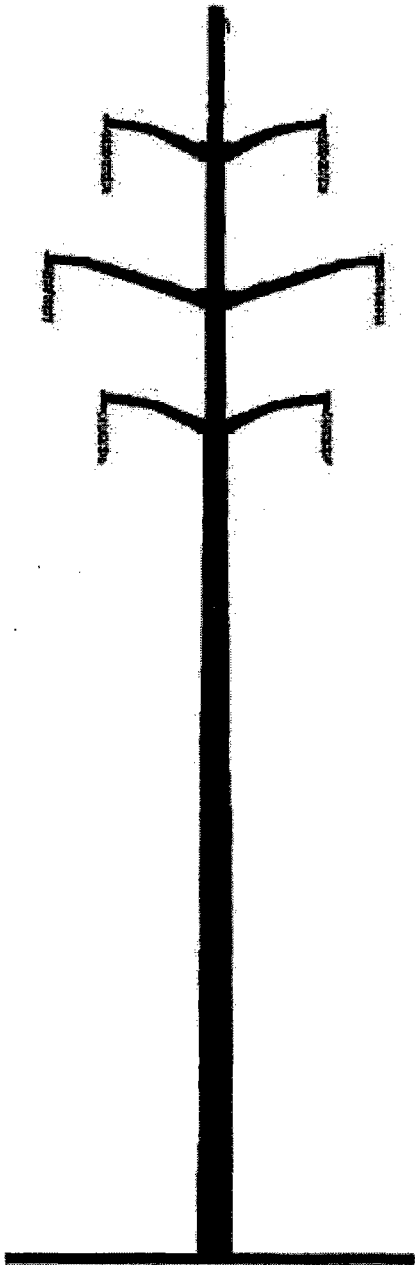
- The phase arrangement that produces the lowest field will be determined.
- The depth of burial of the line will be determined considering the cost of excavation and the location of other buried utilities in the area.
- The use of steel pipe ferromagnetic shielding that reduces magnetic fields will be evaluated.

Short-Span Construction



- **More compact design**
- **Should not be used solely to reduce magnetic fields**
- **Typical conductor data:**
 - 1 3/8" HS steel overhead ground wire - 7.3 feet sag
 - 6-556.5 KCMIL 24/7 ACSR power conductors - (PARAKEET) 10.0 feet sag
 - Average span - 400 feet

Long-Span Construction Remains PPL EU 138 kV Standard



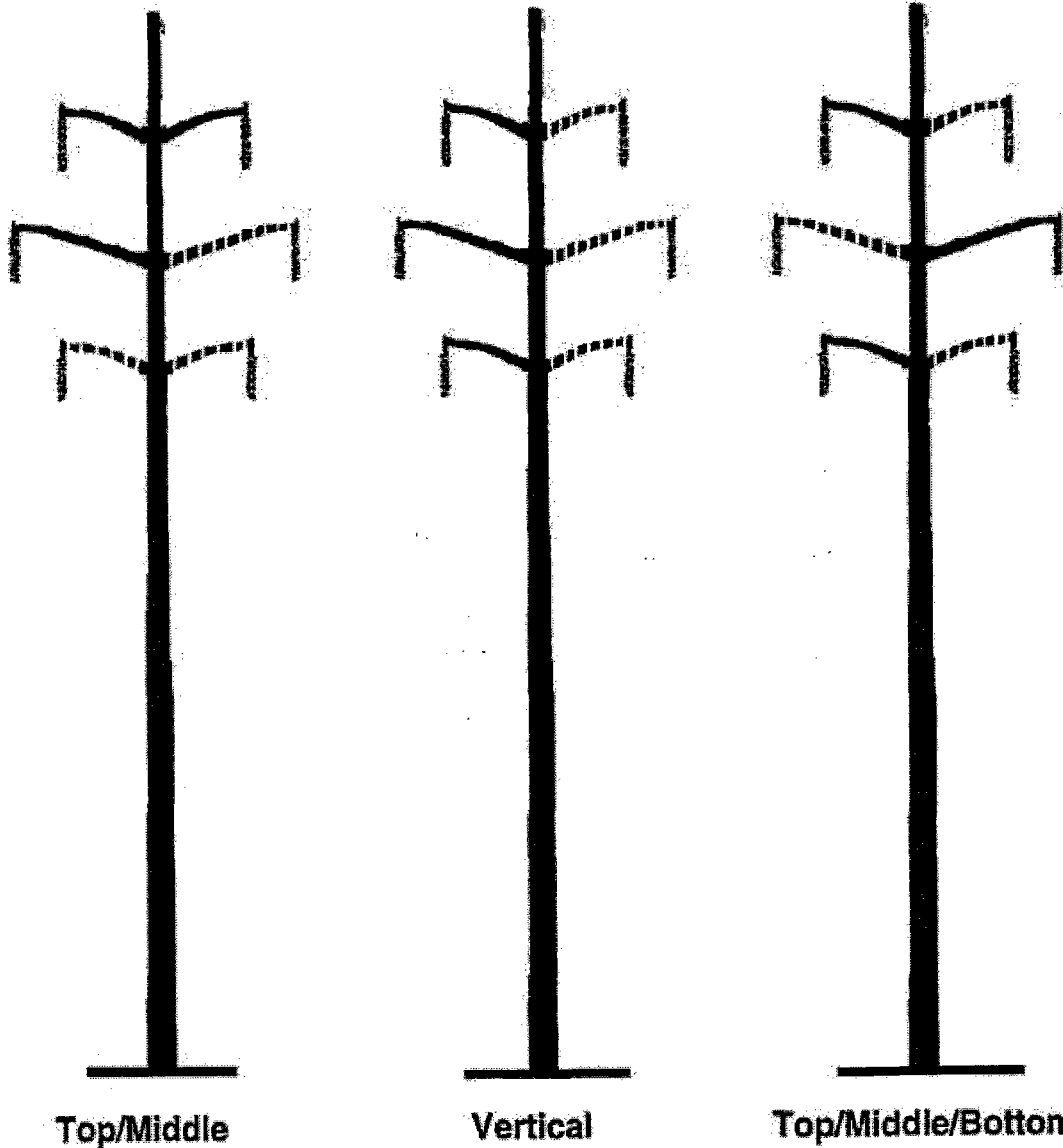
- Lower cost alternative
- Reduces magnetic fields due to higher structures
- Typical conductor data:
 - 1 3/8" HS steel overhead ground wire - 17.3 feet sag
 - 6-556.5 KCMIL 24/7 ACSR power conductors - (PARAKEET) 23.0 feet sag
 - Average span - 600 feet

**138/69 kV REVERSE-PHASE TRANSMISSION LINES
CALCULATED MAGNETIC FIELDS AT 400 AMPERES**

TYPE CONSTRUCTION	MAGNETIC FIELD IN MILLIGAUSS AT THE EDGE OF THE RIGHT OF WAY
SHORT SPAN (CHART I)	30
SHORT SPAN (REVERSE PHASE)	8
LONG SPAN (CHART II)	29
LONG SPAN (REVERSE PHASE)	9
COMPACT (CHART VI)	14
COMPACT (REVERSE PHASE)	3

The edge of right of way is 50 feet from the line centerline.
 The 400 ampere phase current is balanced between phases.
 Calculations are based on a minimum ground clearance of 25 feet.
 LONG SPAN, SHORT SPAN and COMPACT are double-circuit lines.

Typical Single-Circuit Structure Designs



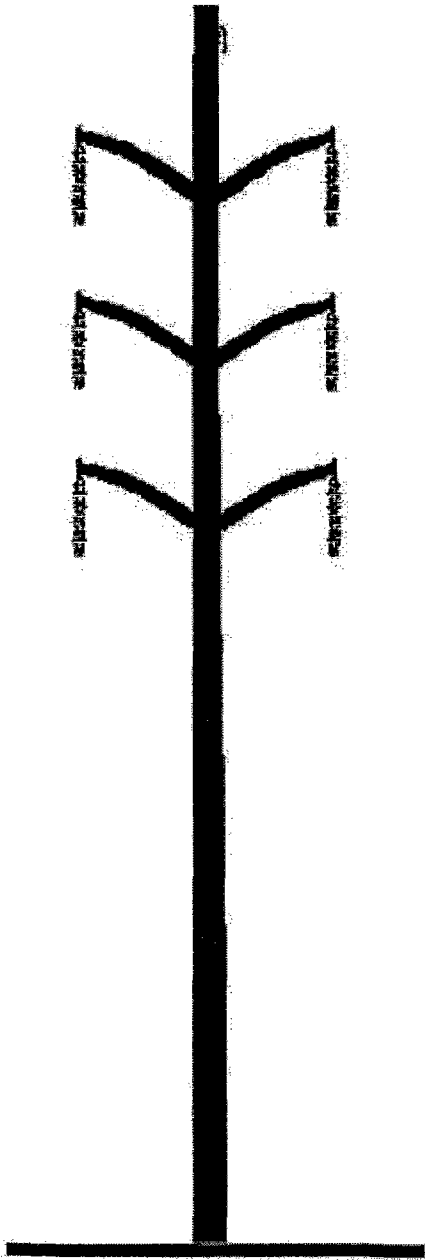
——— initial single circuit
- - - - future second circuit

**138/69 KV SINGLE CIRCUIT TRANSMISSION LINES
CALCULATED MAGNETIC FIELDS AT 400 AMPERES**

TYPE CONSTRUCTION	MAGNETIC FIELD IN MILLIGAUSS AT THE EDGE OF THE RIGHT OF WAY
TOP/MIDDLE/BOTTOM	20
VERTICAL	17
TOP/MIDDLE	12

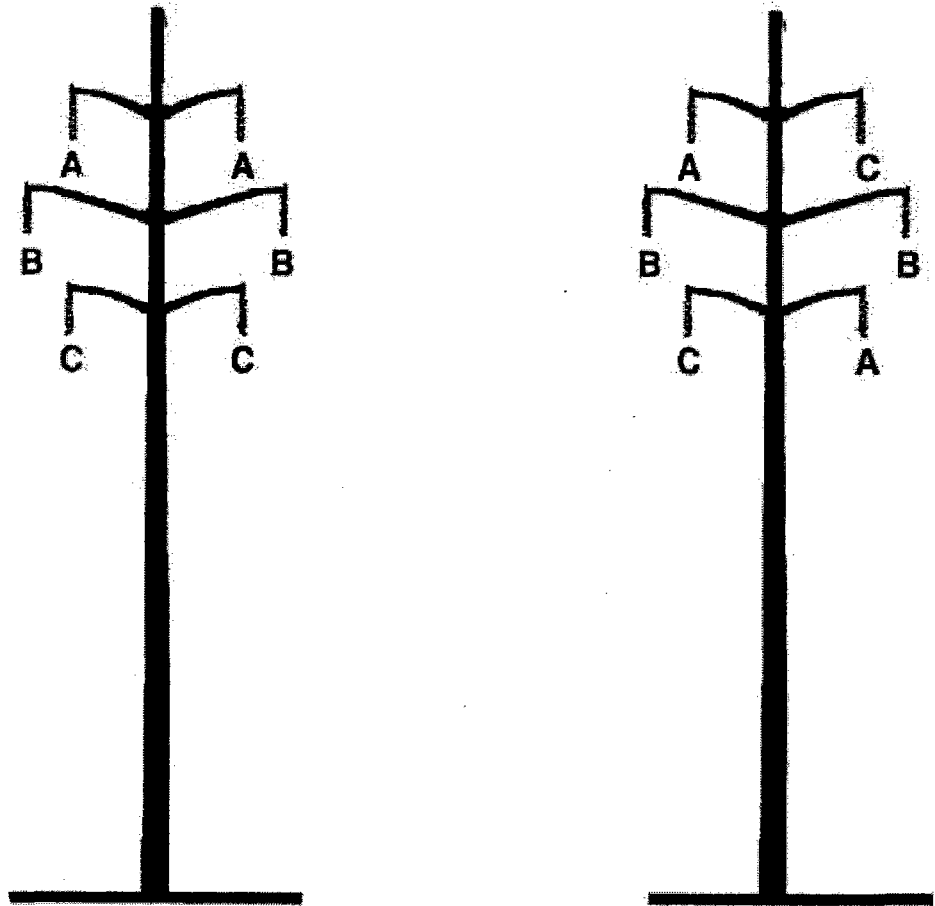
The edge of right of way is 50 feet from the line centerline.
The 400 ampere phase current is balanced between phases.
Calculations are based on a minimum ground clearance of 25 feet.

Compact Design Structure



- Minimize magnetic fields due to compact design
- Not a low-cost alternative
- Typical conductor data:
 - 1 3/8" HS steel overhead ground wire - 9.0 feet sag
 - 6-556.5 KCMIL 24/7 ACSR power conductors - (PARAKEET) 9.0 feet sag
 - Average span - 300 feet

Reverse Phasing of Double-Circuit Transmission Lines



From: → → → → To:

Reverse phasing also can be one of the following phase arrangements:

A	B		B	A		B	C		C	A		C	B
C	C	or	C	C	or	A	A	or	B	B	or	A	A
B	A		A	B		C	B		A	C		B	C

**230 kV REVERSE-PHASE TRANSMISSION LINES
CALCULATED MAGNETIC FIELDS AT 800 AMPERES**

TYPE CONSTRUCTION	MAGNETIC FIELD IN MILLIGAUSS AT THE EDGE OF THE RIGHT OF WAY
DOUBLE CIRCUIT POLE	49
DOUBLE CIRCUIT POLE (REVERSE-PHASE)	16

The edge of right of way is 75 feet from the line centerline.
The 800 ampere phase current is balanced between phases.
Calculations are based on a minimum ground clearance of 27 feet.

**500 kV REVERSE-PHASE TRANSMISSION LINES
CALCULATED MAGNETIC FIELDS AT 1100 AMPERES**

TYPE CONSTRUCTION	MAGNETIC FIELD IN MILLIGAUSS AT THE EDGE OF THE RIGHT OF WAY
DOUBLE CIRCUIT POLE	37
DOUBLE CIRCUIT POLE (REVERSE PHASE)	21

The edge of right of way is 100 feet from the line centerline.
The 1,100 ampere phase current is balanced between phases.
Calculations are based on a minimum ground clearance of 33 feet.

**INCREASED 138/69 kV MINIMUM GROUND CLEARANCE
CALCULATED MAGNETIC FIELDS AT 400 AMPERES**

TYPE CONSTRUCTION	MINIMUM GROUND CLEARANCE FEET	MAGNETIC FIELD IN MILLIGAUSS AT THE EDGE OF THE RIGHT OF WAY
SINGLE CIRCUIT TOP/MIDDLE	25	12
SINGLE CIRCUIT TOP/MIDDLE	30	10
LONG SPAN	25	29
LONG SPAN	30	26
LONG SPAN (REVERSE PHASE)	25	9
LONG SPAN (REVERSE PHASE)	30	7

The edge of right of way is 50 feet from the line centerline.
The 400 ampere phase current is balanced between phases.

**INCREASED 230 kV MINIMUM GROUND CLEARANCE
CALCULATED MAGNETIC FIELDS AT 800 AMPERES**

TYPE CONSTRUCTION	MINIMUM GROUND CLEARANCE FEET	MAGNETIC FIELD IN MILLIGAUSS AT THE EDGE OF THE RIGHT OF WAY
SINGLE CIRCUIT TOP/MIDDLE	27	30
SINGLE CIRCUIT TOP/MIDDLE	32	28
DOUBLE CIRCUIT POLE	27	49
DOUBLE CIRCUIT POLE	32	46
DOUBLE CIRCUIT POLE (REVERSE PHASE)	27	16
DOUBLE CIRCUIT POLE (REVERSE PHASE)	32	15

The edge of right of way is 75 feet from the line centerline.
The 800 ampere phase current is balanced between phases.

**INCREASED 500 KV MINIMUM GROUND CLEARANCE
CALCULATED MAGNETIC FIELDS AT 1,100 AMPERES**

TYPE CONSTRUCTION	MINIMUM GROUND CLEARANCE FEET	MAGNETIC FIELD IN MILLIGAUSS AT THE EDGE OF THE RIGHT OF WAY
SINGLE CIRCUIT "H" STRUCTURE	33	42
SINGLE CIRCUIT "H" STRUCTURE	53	35
DOUBLE CIRCUIT POLE	33	37
DOUBLE CIRCUIT POLE	53	31
DOUBLE CIRCUIT POLE (REVERSE PHASE)	33	21
DOUBLE CIRCUIT POLE (REVERSE PHASE)	53	16

The edge of right of way is 100 feet from the line centerline.
The 1,100 ampere phase current is balanced between phases.

**12 kV DISTRIBUTION LINES
CALCULATED MAGNETIC FIELDS AT 300 AMPERES**

TYPE CONSTRUCTION	POLE HEIGHT FEET	MAGNETIC FIELD IN MILLIGAUSS*	
		AT CENTERLINE	AT 30 FEET FROM CENTERLINE
STANDARD CROSSARM	45	14	7
STANDARD CROSSARM	50	11	6

* Field level under the line at mid-span based on 300 amps, balanced loading, one meter above ground level.

ATTACHMENT

6

ATTACHMENT 6
STEEL CITY – QUARRY #1 AND #2 230 kV LINE RELOCATION
LIST OF OWNERS OF PROPERTY WITHIN THE RIGHT-OF-WAY

Property Identification Number
(as shown on Aerial Exhibit)

Property Owner and Mailing Address

1

IESI PA Bethlehem Landfill Corporation
2335 Applebutter Road
Bethlehem, PA 18015

ATTACHMENT

7

ATTACHMENT 7
STEEL CITY – QUARRY #1 AND #2 230 kV LINE RELOCATION
LIST OF INVOLVED GOVERNMENTAL AGENCIES, MUNICIPALITIES AND
OTHER PUBLIC ENTITIES

1. Pennsylvania Historical and Museum Commission
Bureau for Historic Preservation
Commonwealth Keystone Building, Second Floor
400 North Street
Harrisburg, Pennsylvania 17120-0053
Attn: Mr. Douglas C. McLearen, Chief

2. Honorable Barry Schoch, P.E., Secretary
Pennsylvania Department of Transportation
c/o Office of Chief Counsel
Commonwealth Keystone Building
400 North Street, 9th Floor
Harrisburg, PA 17120
ATTN: Andrew Gordon, Esquire

3. Department of Environmental Protection
P.O. Box 2063
Market Street Office Building
Harrisburg, Pennsylvania 17105-2063
Attn: Office of Field Operations

4. Lehigh Valley Planning Commission
961 Marcon Boulevard - Suite 310
Allentown, Pennsylvania 18109
Attn: Mr. Michael Kaiser, AICP

5. Northampton County Council
699 Washington Street
Easton, PA 18042-7475
Attn: John Cusick, President

6. Lower Saucon Township Council
3700 Old Philadelphia Pike
Bethlehem, PA 18015
Attn: Glenn Kern, President

7. Lower Saucon Township Planning Commission
3700 Old Philadelphia Pike
Bethlehem, PA 18015
Attn: John Landis, Chairperson