

Before the  
Pennsylvania Public Utility Commission

**ROSEVILLE 138/69 kV TAP  
AND  
NEFFSVILLE #1 AND #2  
138/69 kV TAPS**

**EXHIBITS AND APPENDICES IN SUPPORT OF THE  
Letter of Notification**

Application Docket No. \_\_\_\_\_

Submitted by: PPL Electric Utilities Corporation

## SUMMARY

This 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 construct approximately 145 feet of new Roseville 138/69 kV Tap Line and relocate approximately 475 feet of the Neffsville #2 138/69 kV Tap Line. PPL Electric is also requesting approval to increase the operating voltage of the existing Roseville 138/69 kV Tap and the existing Neffsville #1 69 kV Tap from 69 kV to 138 kV operation. At the conclusion of this project all of the above referenced transmission lines will have the ability to operate at 138 kV although, initially, they will operate at 69 kV. This project is located in the Township of Manheim, Lancaster County. PPL Electric is proposing to have this project in service by November, 2010. This filing is the second in a series of related filings seeking PUC approval.<sup>1</sup> Future filings, which will address other portions of the Lancaster 69 kV to 138 kV conversion, will be submitted to the PUC.

This project is required to improve reliability and operating flexibility of PPL Electric's system. The future conversion from 69 kV to 138 kV will help meet the increasing demand for electricity in the Lancaster area. Converting the existing 69 kV facilities along this corridor to 138 kV operation is PPL Electric's long range plan for the heavily loaded core service area of the Lancaster region. Increasing the operating voltage from 69 kV to 138 kV will double the capacity of the existing transmission lines and enable PPL Electric to continue to provide reliable service to its customers without establishing additional major transmission corridors.

The total estimated cost of the proposed transmission line work is \$820,000. In addition, PPL Electric estimates that it will spend \$6.1 million (including the transformer cost) for the modifications of the Roseville and Neffsville Substations. Construction is scheduled to begin as soon as possible to support the project's in-service date of November, 2010.

This document, which describes the need for the project and discusses the engineering and siting analysis for the proposed construction, consists of the following exhibits and appendices:

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<sup>1</sup> The first project in the plan for converting transmission facilities serving the core service area of the Lancaster region was described in the Letter of Notification for the West Hempfield-Dillerville #1 and #2 138 kV Tie and Dillerville #1 and #2 138/69 kV Tap in the City of Lancaster, Lancaster County that was filed with the PUC on April 13, 2009, at Docket No. A-2009-2100767 and approved by the Commission in an Order entered on June 25, 2009.

- Exhibit "A" - Necessity Statement
- Exhibit "B" - Engineering Description
- Exhibit "C" - Environmental Assessment

- Appendix A - PPL Electric Design Criteria and Safety Practices
- Appendix B - Magnetic Field Management at PPL Electric
- Appendix C - List of Property Owners
- Appendix D - List of Involved Governmental Agencies, Municipalities, and Other Public Entities

# PPL ELECTRIC UTILITIES SERVICE TERRITORY



# Exhibit

# A

**EXHIBIT "A"**  
**ROSEVILLE 138/69 kV TAP**  
**AND**  
**NEFFSVILLE #1 AND #2 138/69 kV TAPS**  
**NECESSITY STATEMENT**

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**MAP**

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**EXHIBIT "A"**  
**ROSEVILLE 138/69 kV TAP**  
**AND**  
**NEFFSVILLE #1 AND #2 138/69 kV TAPS**  
**NECESSITY STATEMENT**

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**A. INTRODUCTION**

With Commission approval, PPL Electric plans to increase the operating voltage of a portion of the transmission system that supplies the highly developed central core of Lancaster County from 69 kV to 138 kV. As the second phase of an integrated overall conversion plan, PPL Electric proposes to upgrade the existing Roseville 138/69 kV Tap and Neffsville #1 and #2 69 kV Taps to 138 kV to support the conversion from the 69 kV voltage level. The Taps will be converted to 138 kV design standards and rearranged to improve operating and maintenance flexibility. The Roseville and Neffsville #1 and #2 Taps will remain energized at 69 kV until the final phase of the integrated 138 kV conversion plan is approved by the Commission and placed in-service.

As part of the 138 kV conversion preparation work, the Roseville 138/69 kV Tap will be rearranged to be sourced from the South Akron-South Manheim #2 69 kV Transmission Line. In addition, a new 138/69 kV section of transmission line, approximately 145 feet in length, will be constructed to directly supply the second transformer at the Roseville 69-12 kV Substation. The new section of line will be supplied from the existing Roseville 138/69 kV Tap. The Neffsville #1 69 kV Tap, which is currently insulated for 69 kV operation, will be reinsulated to meet PPL Electric's 138 kV design standards. The Neffsville #2 69 kV Tap will be relocated east of the Neffsville Substation and constructed for future 138 kV operation. The Roseville 138/69 kV Tap (existing and proposed sections) and the Neffsville #1 and #2 138/69 kV Taps are the subjects of this filing. This project is required as one part of an integrated plan to resolve violations to PPL Electric planning guidelines, increase reliability, and improve operating flexibility in the central core of the Lancaster region. It will also help to meet the increasing demand for electrical power in this area.

In future filings, PPL Electric plans to request Commission approval to convert the remaining 69 kV transmission facilities along the South Akron – Dillerville corridor to 138 kV operation that will complete the 69kV to 138 kV conversion.

**B. EXISTING SYSTEM (see Figure 1)**

The Roseville 69–12 kV Substation is normally supplied from the South Akron 230–138-69 kV Substation, with alternate supply capability from the South Manheim 230–69 kV Substation. Supply is transmitted from the South Akron 230-138-69 kV Substation to the Roseville 69-12 kV Substation by the South Akron-South Manheim #2 69 kV Transmission Line which feeds the Neffsville #2 69 kV Tap Line which in turn feeds the Roseville 138/69 kV Tap. The existing transformers at the Roseville 69–12 kV Substation are supplied by the existing single-circuit Roseville 138/69 kV Tap. The transformers share substation high side facilities; most notably, the high side transformer protection. Approximately 4,600 customers are normally served from Roseville 69–12 kV Substation.

The existing Roseville 138/69 kV Tap was designed and constructed for 138 kV operation but is currently operated at 69 kV. This line was placed in-service in the mid 1970's and predates the requirements for PUC approval of new or rebuilt transmission lines designed to operate at 100 kV or greater. Therefore, the PUC has not previously approved these transmission facilities under 52 Pa. Code §§57.71 through 57.77.

The Neffsville 69–12 kV Substation is normally supplied from the South Akron 230–138-69 kV Substation, but also has alternate supply capability from the South Manheim 230–69 kV Substation. The existing Neffsville #1 and #2 69 kV Taps are supplied by the South Akron–South Manheim #1 and #2 69 kV lines, respectively. The Neffsville #1 and #2 Taps, which are constructed and insulated for 69 kV operation, each supply one 69 – 12 kV transformer at Neffsville Substation. In total, approximately 4,900 customers are served from this area supply facility. The Taps need to be upgraded in preparation for the proposed 138 kV conversion project.

The South Akron – South Manheim #1 and #2 Transmission Lines, the Neffsville #1 and #2 Taps, and the Roseville Tap are electrically connected at a transmission structure approximately 500 feet from Neffsville 69 – 12 kV Substation.

**C. DEFINITION OF THE PROBLEM**

PPL Electric's transmission system serving the core service area of the Lancaster region does not meet PPL Electric's design and planning standards. During periods of high demand, the loss of the double-circuit Dillerville #1 and #2 138/69 kV Taps would interrupt approximately 60 MW of load. Following PPL Electric's Reliability Principles and Practices (RP&P), the maximum amount of load that can be interrupted due to a double-circuit line outage is 45 MW after all allowable switching moves have been made. The service interruption would affect approximately 1,400 customers supplied from the PPL Electric distribution system and two large transmission customers. PPL Electric's ability to transfer the load served by the Dillerville 69-12 kV Substation to other nearby distribution substations is limited during these peak loading conditions due to the existing 12 kV transfer capability. It should also be noted that due to the nature of the load at the large transmission customer facilities connected to the double-circuit Dillerville #1 and #2 138/69 kV Taps, the load remains near peak levels consistently. Therefore, service to these customers could be interrupted until line repairs could be made.

The Neffsville #1 and #2 69 kV Taps are constructed and insulated for 69 kV operation only. These Taps need to be upgraded to 138 kV prior to the actual conversion of this section of the Lancaster 69 kV transmission system to 138 kV. If certain portions of the Neffsville and Roseville rearrangement projects are not completed, the final phase to convert the South Akron–South Manheim #1 and #2 69 kV lines to 138 kV operation cannot occur.

An additional concern deals with the two existing 10 MVA transformers installed at the Roseville 69–12 kV Substation. Because they share the same high side transformer protection, multiple failure modes exist such that the entire substation could be interrupted until the damaged equipment is isolated and repairs or replacement of the damaged equipment occurred.

**D. PROPOSED SOLUTION (see Figure 2)**

In order to resolve the load loss issues cited above, PPL Electric plans to temporarily transfer the Dillerville Substation source from the South Akron-South Manheim #1 and #2 69 kV Transmission Lines to the West Hempfield-Prince #1 and #2 138 kV Transmission Lines via the West Hempfield-Dillerville #1 and #2 138 kV Ties. The West Hempfield-Dillerville #1 and #2 138 kV Ties were the subject of a previous PUC filing which has been approved (Docket No. A-2009-2100767). The West Hempfield-Dillerville 138 kV Ties will be temporary because, in the final phase of this 138 kV conversion of the transmission system serving the central core of the Lancaster region, the double-circuit Dillerville 138/69 kV Taps will be transferred to the 138 kV Transmission Lines that will be created from the existing South Akron – South Manheim #1 and #2 Transmission Lines. In future filings, PPL Electric plans to request Commission approval to convert the remaining 69 kV transmission facilities along the South Akron – Dillerville corridor to 138 kV operation, which will complete the approvals for the 69 kV to 138 kV conversion. After the completion of the 138 kV conversion, the final arrangement of the double-circuit Dillerville #1 and #2 138/69 kV Taps will provide sufficient transfer capabilities such that violation of the PPL Electric Reliability Principles and Practices will be avoided.

In order to prepare for the South Akron-South Manheim #1 and #2 Transmission Line's 138 kV conversion, PPL Electric plans to transfer the Roseville 138/69 kV Tap source from the Neffsville #2 69 kV Tap to the South Akron-South Manheim #2 69 kV Transmission Line. The transfer will be accomplished by relocating a portion of the Neffsville #2 69 kV Tap east of the Neffsville Substation and supply it from the South Akron-South Manheim #2 69 kV Transmission Line. This Tap will be renamed the Neffsville #2 138/69 kV Tap and be designed and constructed for 138 kV operation although, initially, it will operate at 69 kV. The remaining portion of the old Neffsville #2 Tap currently connected to the South Akron-South Manheim #2 69 kV Transmission Line will then become part of the Roseville 138/69 kV Tap. Therefore, the Roseville 138/69 kV Tap will be sourced from the South Akron-South Manheim #2 69 kV Transmission Line (refer to Figure 2). This work will be completed on property owned in fee by PPL Electric.

To accommodate the future upgrade from 69 kV to 138 kV operation, the existing Neffsville #1 69 kV Tap will also be reinsulated for 138 kV operation. This line will now be called the Neffsville #1 138/69 kV Tap.

In addition, approximately 145 feet of a new 138kV transmission line will be constructed from the existing Roseville 138/69 kV Tap Line to an existing deadend structure at Roseville 69-12 kV Substation. In conjunction with the required substation work, the transmission source will provide a second supply with independent transformer protection to Roseville Substation. The work associated with the second transmission line will be located completely within the boundaries of the PPL Electric property. This new section of line will be designed for single-circuit 138 kV operation, but will initially be operated at 69 kV.

The transmission upgrades to the Roseville 138/69 kV Tap and the Neffsville #1 and #2 138/69 kV Taps will increase reliability and improve operating and maintenance flexibility to maintain reliable service to the 9,500 customers served from Roseville and Neffsville Substations. In addition, by providing the second transmission source and independently protecting each transformer at Roseville, substation reliability will improve.

Finally, the two existing 10 MVA 69 – 12 kV transformers in service at the Roseville Substation will be replaced and upgraded to 35 MVA 138 – 12 kV transformers as part of the 138 kV conversion. The two existing 20 MVA 69 – 12 kV transformers in service at Neffsville Substation will be replaced and upgraded to 35 MVA units. The additional 80 MVA of transformer capacity will essentially double the local transformer capacity available to supply the increasing electrical demand in the central core of the Lancaster region. Per PPL Electric's RP&P, it is anticipated that the existing Roseville transformers would need to be upgraded in the near future as a separate project. The proposed solution improves the utilization and cost effectiveness of engineering and physical resources, alleviates the forecasted transformer overload, and allows for future distribution growth in this highly developed area of Lancaster County.

The total estimated cost for the proposed solution is \$6.9 million, which includes \$6.1 million for the substation modifications (including transformer cost) and \$820,000 for the transmission work. This filing covers only the proposed transmission modifications, which are the only part of the project that requires PUC approval. The proposed transmission line construction will begin as soon as possible after PUC approval is obtained in order to support the project's required in-service date of November, 2010.

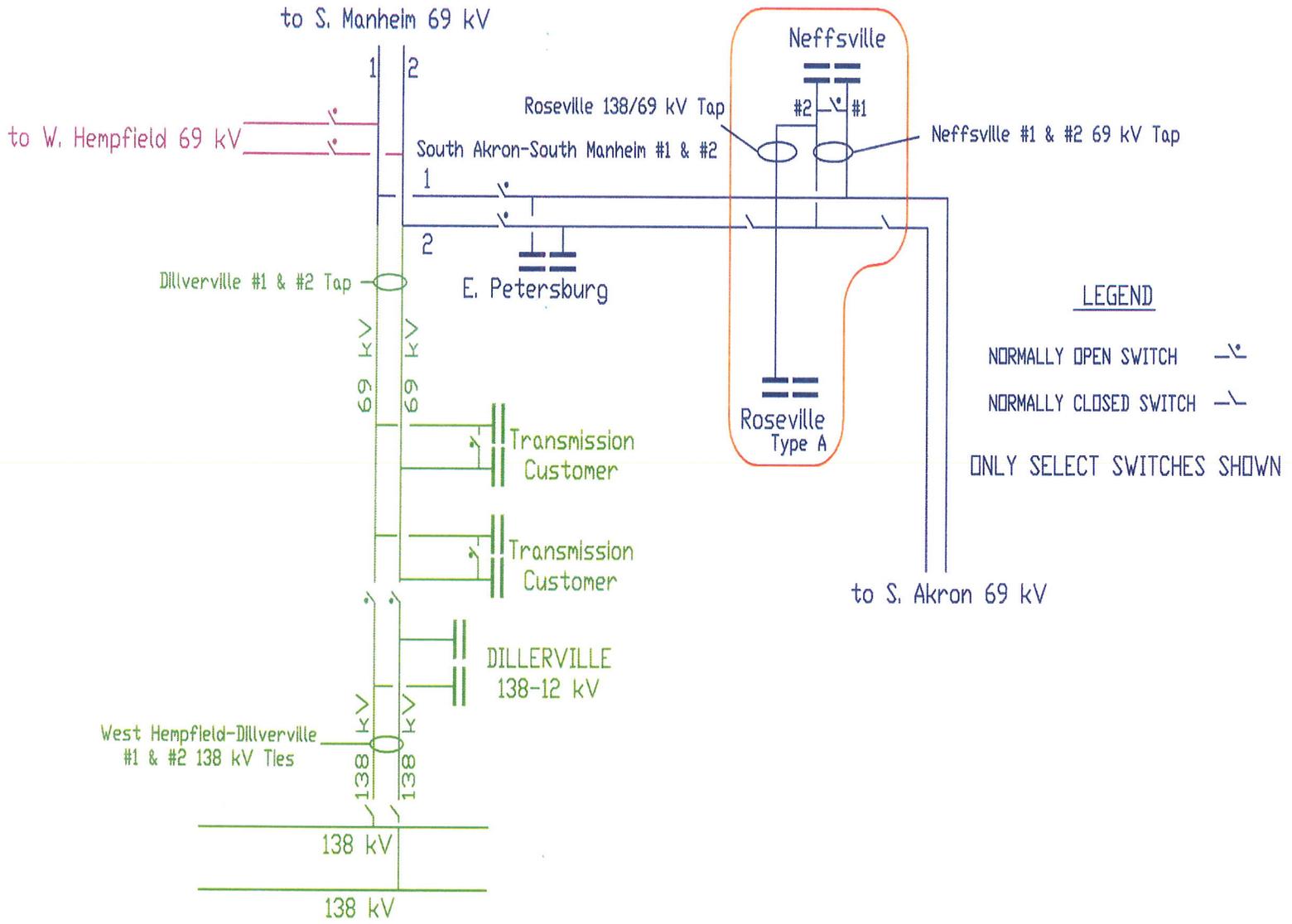
A PPL Electric system map showing the existing transmission line facilities with a design voltage of 35 kV or greater is included in the Exhibit "A" map pocket. This filing addresses only the existing and proposed 138 kV regional transmission system in the Manheim and Dillerville areas.

**E. FUNCTIONAL ALTERNATIVES**

No other reasonably economical functional alternatives were identified that would completely resolve the problems outlined above. The 138 kV conversion is PPL Electric's long range plan for the heavily loaded core service area of the Lancaster region. This conversion will further expand the existing 138 kV system and allow more operating flexibility between the West Hempfield and South Akron Substations.

Raising the operating voltage from 69 kV to 138 kV will double the capability of the existing transmission lines. In combination, this project allows PPL Electric to provide increased reliability and operating flexibility while meeting increasing demand for electricity without establishing additional major transmission corridors.

Figure 1 – Existing Transmission System Configuration



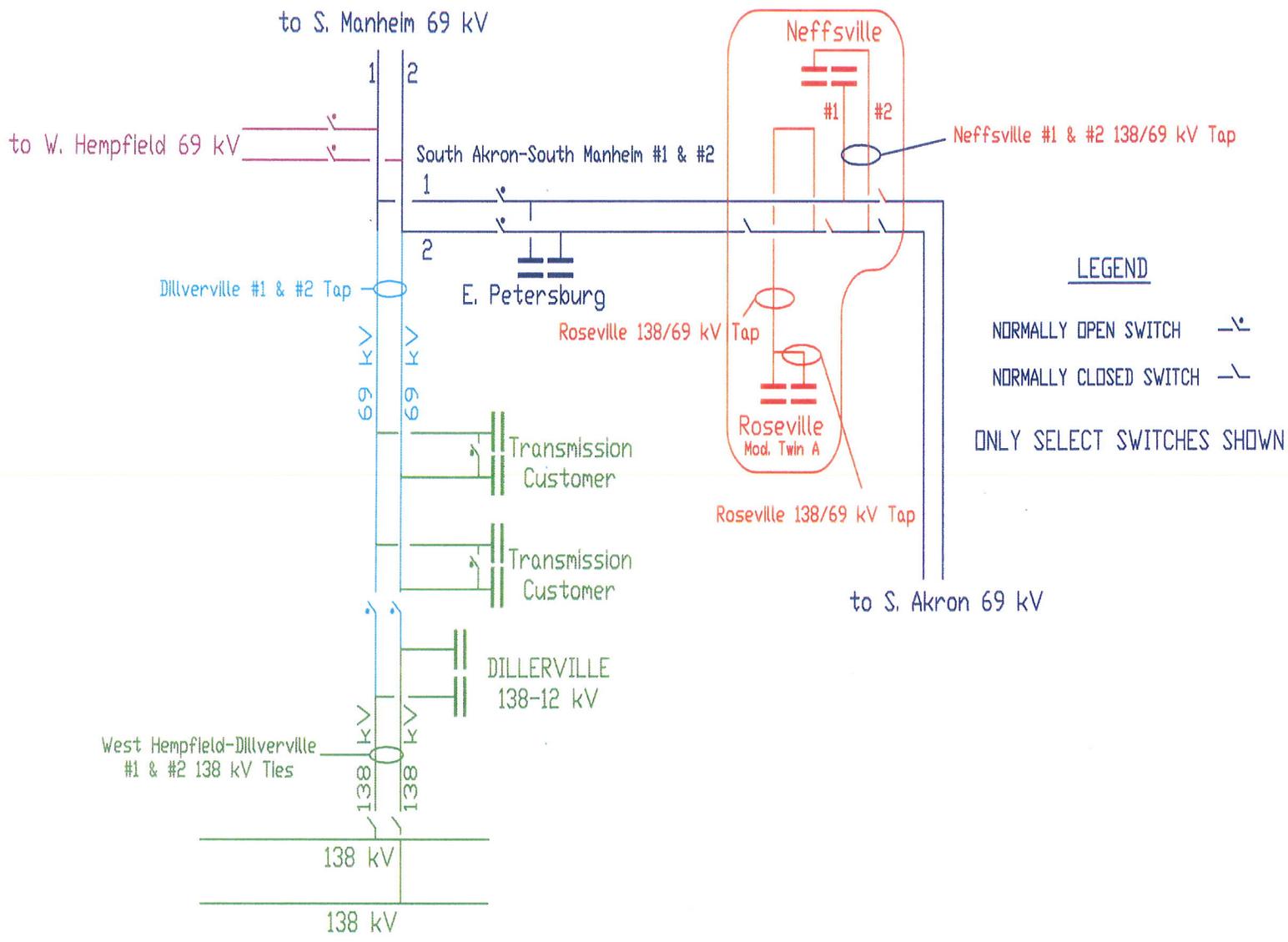
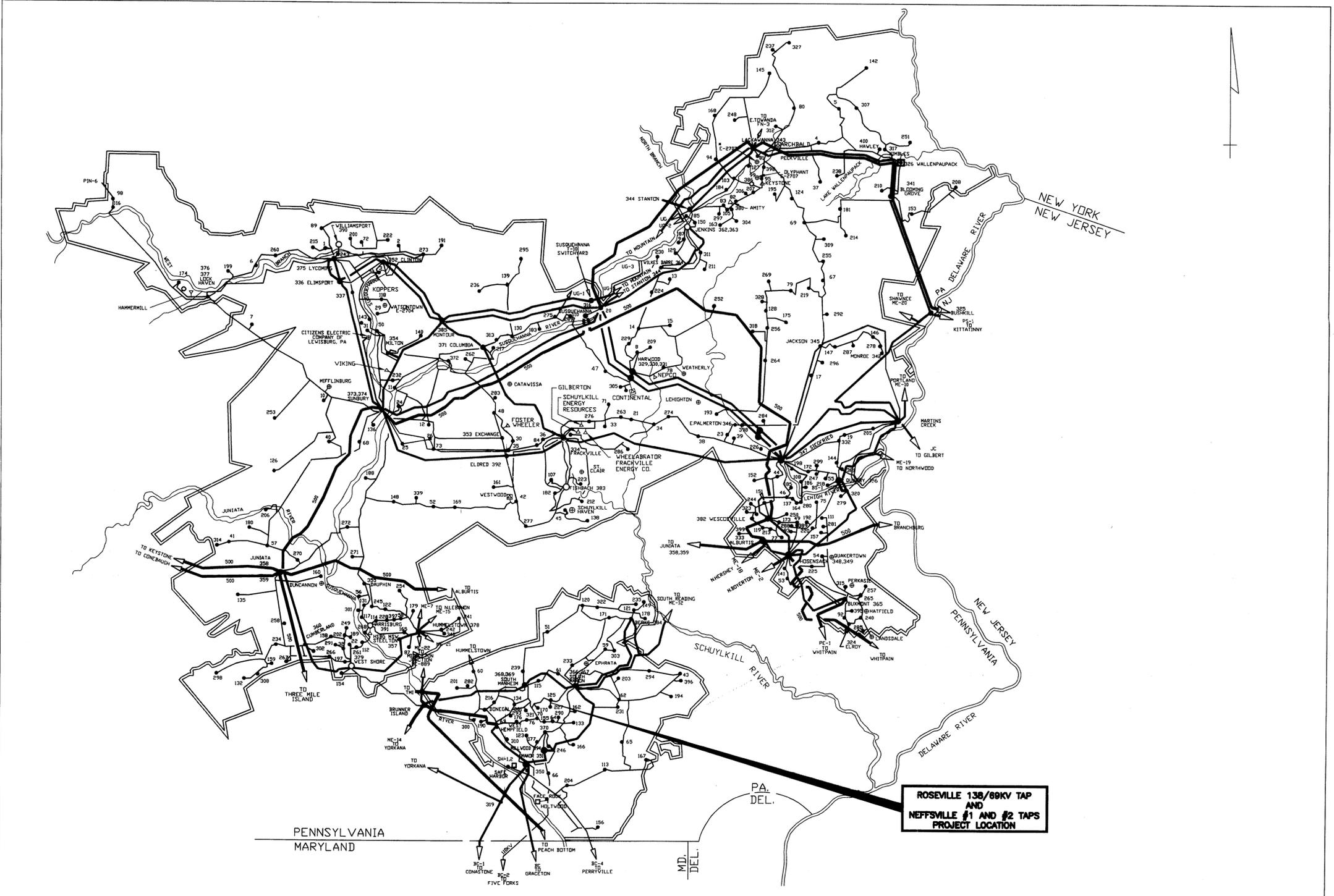


Figure 2 – Proposed Transmission System Configuration

# SUBSTATION LISTING

1 WEST WILLIAMSPORT	151 CRACKERSPORT	301 CENTER CITY
2 FAIRFIELD	152 HEMLOCK	302 NEW KINGSTOWN
3 MONTGOMERY	153 MI. ALLEN	303 REAMSTOWN
4 VARDEN	154 HONESDALE	304 DUPONT
5 HONESDALE	155 JERSEY SHORE	305 PRINCE
6 LOGANTON	156 RIVER	306 WAKEFIELD
7 RIVER	157 LIMESTONE	307 COOPERSBURG
8 NORTHUMBERLAND	158 REED	308 VERTZVILLE
9 WRIGHT	159 FREELAND	309 WEST CARLISLE
10 ST. JOHNS	160 GILBERT	310 BENVENUE
11 FREELAND	161 CHERRY HILL	311 NORTH MOUNTAIN
12 GILBERT	162 SUSQUEHANNA 230KV	312 LEDLA
13 TAMANEND	163 WHITE HILL	313 YATESVILLE
14 HAMILTON	164 HUNTER	314 CENTRAL ALLENTOWN
15 HUNTER	165 FAIRVIEW	315 OBERLIN
16 MOUNT PUMP	166 MT. CARMEL	316 STRASBURG
17 KELLY	167 GREENWOOD	317 BROOKSIDE
18 MAHANY CITY	168 HAMLIN	318 WILLIAMSTOWN
19 GREENWOOD	169 SOUTH SLATINGTON	319 E. PETERSBURG
20 MOVY	170 SOUTH MIDDLEBURG	320 WERNERSVILLE
21 YAMOUNT	171 WALKER	321 N. BETHLEHEM
22 HAMLIN	172 MORGANTOWN	322 V. ALLENTOWN
23 ALMFIELD	173 FRAYLEY	323 FLEMINGTON
24 SOUTH SLATINGTON	174 MORGANTOWN	324 MECKESVILLE
25 SOUTH MIDDLEBURG	175 EAST LEBANON	325 JENERSVILLE
26 WALKER	176 MORGANTOWN	326 MILLERSVILLE
27 MORGANTOWN	177 MORGANTOWN	327 SHILLINGTON
28 EGYPT	178 MORGANTOWN	328 MCALLISTERVILLE
29 MORGANTOWN	179 MORGANTOWN	329 NEWFUNDLAND
30 MORGANTOWN	180 MORGANTOWN	330 HARWOOD CTG
31 MORGANTOWN	181 MORGANTOWN	331 HARWOOD 69/12KV
32 MORGANTOWN	182 MORGANTOWN	332 NAZARETH
33 MORGANTOWN	183 MORGANTOWN	333 ALBURTIS
34 MORGANTOWN	184 MORGANTOWN	334 FRACKVILLE
35 MORGANTOWN	185 MORGANTOWN	335 CLIMPSPORT
36 MORGANTOWN	186 MORGANTOWN	336 ALLENWOOD
37 MORGANTOWN	187 MORGANTOWN	337 ALLENWOOD
38 MORGANTOWN	188 MORGANTOWN	338 ALLENWOOD
39 MORGANTOWN	189 MORGANTOWN	339 GRATZ
40 MORGANTOWN	190 MORGANTOWN	340 HOCKESSVILLE
41 MORGANTOWN	191 MORGANTOWN	341 BLOOMING GROVE
42 MORGANTOWN	192 MORGANTOWN	342 MONROE
43 MORGANTOWN	193 MORGANTOWN	343 LACKAWANNA #
44 MORGANTOWN	194 MORGANTOWN	344 STANTON
45 MORGANTOWN	195 MORGANTOWN	345 JACKSON
46 MORGANTOWN	196 MORGANTOWN	346 EAST PALMERTON
47 MORGANTOWN	197 MORGANTOWN	347 SIEGFRIED
48 MORGANTOWN	198 MORGANTOWN	348 HOESACK 230/69KV
49 MORGANTOWN	199 MORGANTOWN	349 HOESACK 500KV
50 MORGANTOWN	200 MORGANTOWN	350 CONESTOGA
51 MORGANTOWN	201 MORGANTOWN	351 MANDR
52 MORGANTOWN	202 MORGANTOWN	352 CLINTON
53 MORGANTOWN	203 MORGANTOWN	353 EXCHANGE
54 MORGANTOWN	204 MORGANTOWN	354 MILTON
55 MORGANTOWN	205 MORGANTOWN	355 DALPHIN
56 MORGANTOWN	206 MORGANTOWN	356 QUARRY SUB.
57 MORGANTOWN	207 MORGANTOWN	357 STEELTON
58 MORGANTOWN	208 MORGANTOWN	358 JUNIATA 500/230KV
59 MORGANTOWN	209 MORGANTOWN	359 JUNIATA 230/69KV
60 MORGANTOWN	210 MORGANTOWN	360 CUMBERLAND
61 MORGANTOWN	211 MORGANTOWN	361 DONEGAL
62 MORGANTOWN	212 MORGANTOWN	362 JENKINS 230/69KV
63 MORGANTOWN	213 MORGANTOWN	363 JENKINS CTG
64 MORGANTOWN	214 MORGANTOWN	364 WILKES-BARRE
65 MORGANTOWN	215 MORGANTOWN	365 BUXMONT
66 MORGANTOWN	216 MORGANTOWN	366 SOUTH AKRON 230/138/69KV
67 MORGANTOWN	217 MORGANTOWN	367 SOUTH AKRON 69/12KV
68 MORGANTOWN	218 MORGANTOWN	368 SOUTH MANHEIM 69/12KV
69 MORGANTOWN	219 MORGANTOWN	369 SOUTH MANHEIM 230/69KV
70 MORGANTOWN	220 MORGANTOWN	370 ENGLESLIDE
71 MORGANTOWN	221 MORGANTOWN	371 COLUMBIA
72 MORGANTOWN	222 MORGANTOWN	372 DANVILLE
73 MORGANTOWN	223 MORGANTOWN	373 SUNBURY
74 MORGANTOWN	224 MORGANTOWN	374 HUMMELS WHARF
75 MORGANTOWN	225 MORGANTOWN	375 LYCOMING
76 MORGANTOWN	226 MORGANTOWN	376 LOCK HAVEN CTG
77 MORGANTOWN	227 MORGANTOWN	377 LOCK HAVEN 69/12KV
78 MORGANTOWN	228 MORGANTOWN	378 HUMMELSTOWN
79 MORGANTOWN	229 MORGANTOWN	379 WEST SHORE
80 MORGANTOWN	230 MORGANTOWN	380 MONTAGE
81 MORGANTOWN	231 MORGANTOWN	381 SOUTH FARMERSVILLE
82 MORGANTOWN	232 MORGANTOWN	382 WESCOVILLE
83 MORGANTOWN	233 MORGANTOWN	383 FISHBACH
84 MORGANTOWN	234 MORGANTOWN	384 BERKS
85 MORGANTOWN	235 MORGANTOWN	385 MONTGOMERY
86 MORGANTOWN	236 MORGANTOWN	386 SUBURBAN YARD
87 MORGANTOWN	237 MORGANTOWN	387 * EDLA
88 MORGANTOWN	238 MORGANTOWN	388 * MACK
89 MORGANTOWN	239 MORGANTOWN	389 WILLIAMSPORT
90 MORGANTOWN	240 MORGANTOWN	390 HARRISBURG
91 MORGANTOWN	241 MORGANTOWN	391 HARRISBURG
92 MORGANTOWN	242 MORGANTOWN	392 ELDRID
93 MORGANTOWN	243 MORGANTOWN	393 * MILLWOOD
94 MORGANTOWN	244 MORGANTOWN	394 TELFORD
95 MORGANTOWN	245 MORGANTOWN	395 TWIN VALLEY
96 MORGANTOWN	246 MORGANTOWN	396 DEVONSHIRE
97 MORGANTOWN	247 MORGANTOWN	397 JESSUP
98 MORGANTOWN	248 MORGANTOWN	398 BELTZVILLE
99 MORGANTOWN	249 MORGANTOWN	399 SCHENCK
100 MORGANTOWN	250 MORGANTOWN	400 HAWLEY

\* - SUBSTATIONS THAT HAVE BEEN RETIRED.  
 ## - SITE OF THE EXISTING 230KV SUBSTATION AND PROPOSED 500KV SUBSTATION



## INTERCONNECTIONS

PS PUBLIC SERVICE ELECTRIC AND GAS CO. OF N.J.  
 ME METROPOLITAN EDISON CO. (FIRST ENERGY)  
 PE PHILADELPHIA ELECTRIC CO. (PECO ENERGY)  
 BC BALTIMORE GAS AND ELECTRIC CO.  
 SH SAFE HARBOR WATER POWER CORPORATION  
 UG THE UNITED GAS IMPROVEMENT CO. - LUZERNE ELECTRIC DIVISION  
 PN PENNSYLVANIA ELECTRIC CO. (FIRST ENERGY)  
 JC JERSEY CENTRAL POWER AND LIGHT CO. (FIRST ENERGY)

- COMBUSTION TURBINE
- HYDRO ELECTRIC
- COMBINATION
- FIRM SALES
- SUBSTATION / SWITCHING STATION
- STEAM ELECTRIC
- NON-UTILITY GENERATION
- INDEPENDENT POWER PRODUCERS

- 500KV OPERATION
- 230KV OPERATION
- 138KV OPERATION
- 69KV OPERATION

**ROSEVILLE 138/69KV TAP AND NEFFSVILLE #1 AND #2 TAPS PROJECT LOCATION**

NO.	DATE	ACCT.	DESCRIPTION	BY	REVIEWED	APPROVED
56	3/13/09	161666	ADDED WEST HEMPFIELD-DILLERVILLE #1 & #2 AND DILLERVILLE #1 & #2 138/69KV TAP.	RRC	JW	
59	7/28/09	161667	ADDED ROSEVILLE 138/69KV TAP & NEFFSVILLE #1 & #2 138/69KV TAPS.	RRC	JW	
58	5/21/09	161748	ADDED HAWLEY 138/69KV TAP LINE.	RRC	JW	
57	4/24/09	169996	HARRISBURG-WALNUT 138/69KV LINE.	RRC	DLH	

ACCT - 805201  
 SCALE - NONE  
 BY - CDW

ELECTRICAL SYSTEM MAP  
 ROSEVILLE 138/69KV TAP AND  
 NEFFSVILLE #1 AND #2 138/69KV TAP

APPROVED: G. HAJUN III DATE: 7/1/09  
 PPL DRAWING NO. D191830 SHEET NO. 1 REV. 59

Exhibit

B

**EXHIBIT "B"**  
**ROSEVILLE 138/69 kV TAP**  
**AND**  
**NEFFSVILLE #1 AND #2 138/69 kV TAPS**  
**ENGINEERING DESCRIPTION**

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**MAP**

MAP 1	AERIAL EXHIBIT – DRAWING.....	EXHIBIT "B" MAP POCKET
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**EXHIBIT "B"**  
**ROSEVILLE 138/69 kV TAP**  
**AND**  
**NEFFSVILLE #1 AND #2 138/69 kV TAPS**  
**ENGINEERING DESCRIPTION**

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**A. DESCRIPTION OF PROPOSED LINE**

PPL Electric proposes to construct a new section of 138 kV transmission line, approximately 145 feet in length (two spans), to supply electricity directly to the second transformer at the Roseville 69-12 kV Substation and relocate the Neffsville #2 Tap. In addition, PPL Electric is seeking approval to increase the operating voltage of the existing Roseville 138/69 kV Tap and Neffsville #1 69 kV Tap from 69 kV to 138 kV. This project is required to improve reliability and operating flexibility in the Lancaster area. Additionally, the project is in preparation for the future 69 kV to 138 kV conversion of transmission facilities in this area of Lancaster County. The 69 kV to 138 kV conversion will provide additional capacity to meet increasing demand for electricity in the area. This project is located in Manheim Township, Lancaster County. A plot plan for the transmission line project is provided in the Exhibit "B" map pocket.

A new section of 138 kV transmission line, approximately 145 feet in length, will be constructed to supply electricity directly to the second transformer at the Roseville Substation. This construction will require the installation of two steel pole structures which will be approximately 75-80 feet in height. The steel poles will be direct embedded and guyed. The new section of transmission line into Roseville Substation will consist of three 556.5 thousand circular mills (kcmil)<sup>2</sup>, 24/7 stranding, aluminum conductor steel reinforced ("ACSR") power conductors. One 3/8 inch steel overhead ground wire will be installed to provide lightning protection for the proposed line. This line will be sourced off of the existing Roseville 138/69 kV Tap.

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<sup>2</sup> KCMIL wire size is the equivalent cross sectional area in thousands of circular mils. A circular MIL (CMIL) is the area of a circle with a diameter of one thousandth (0.001) of an inch.

The existing Roseville 138/69 kV Tap Line is currently constructed for double-circuit 138 kV operation although currently only one circuit is installed and that circuit is operated at 69 kV. Therefore, no additional work is required along the existing section of the Roseville 138/69 kV Tap to convert it from 69 kV to 138 kV.

To relocate the existing Neffsville #2 69 kV Tap, PPL Electric will need to remove approximately 475 feet of the existing Neffsville #2 69 kV Tap. A new tap point will be established east of the existing Neffsville 69-12 kV Substation off of the existing South Akron-South Manheim #2 69 kV Transmission Line. The new tap line requires the installation of two steel pole structures which will be approximately 80-85 feet in height. One of the steel poles will be a direct embedded and guyed structure. The other steel pole will be set on a foundation. Three new power conductors will be installed. The conductors will be 556.5 kcmil, 24/7 stranding, ACSR conductor. One 3/8 inch steel overhead ground wire will be installed to provide lightning protection for the proposed line. The existing angle structure into the Neffsville Substation, which will remain in place, will be reinsulated with 138 kV insulators.

To convert the existing Neffsville #1 69 kV Tap from 69 kV to 138 kV, the tap line will be reinsulated for 138 kV. This is the only work required along the Neffsville #1 Tap Line to convert it from 69 kV to 138 kV. The existing Neffsville #1 69 kV Tap is approximately 190 feet in length.

The proposed new line sections will be designed to, and generally exceed, National Electrical Safety Code (NESC) minimum standards. Design specifications and safety rules practiced by PPL Electric are included in Appendix A. The minimum conductor to ground clearance will be 36 feet for the new section of the Roseville 138/69 kV Tap. The minimum conductor to ground clearance will be 37 feet for the relocated section of the Neffsville #2 138/69 kV Tap. Both of these clearances occur at the maximum thermal conductor temperature of 125 degrees Celsius.

The designed minimum conductor clearances and conductor thermal ratings for the line are as follow:

**TABLE 1  
DESIGN MINIMUM CONDUCTOR CLEARANCES  
FOR 556.5 KCMIL 24/7 STRANDING ACSR\***

<u>Condition</u>	<u>New Section of Roseville 138/69 kV Tap Line Single-Circuit Design Clearance-to-Ground</u>	<u>Relocated Section of Neffsville #2 138/69 kV Tap Line Single-Circuit Design Clearance-to-Ground</u>
Normal load; average weather (16°C ambient, 60°F temperature)	37 feet	39.6 feet
Predicted extreme thermal load (125°C conductor, 257°F temperature)	36 feet	37 feet
Predicted NESC extreme wind load conditions (25 lbs., 16°C, 60°F temperature)	37 feet	38.9 feet
Predicted extreme weather conditions (1-inch ice, 4 lbs. wind, -10°C, 15°F temperature)	37 feet	39.5 feet

\* Clearances based on a maximum tension of 2,000 pounds and a ruling span of 90 feet

\* Clearances based on a maximum tension of 3,540 pounds and a ruling span of 290 feet

**TABLE 2  
CONDUCTOR THERMAL RATING  
556.5 KCMIL 24/7 STRANDING ACSR  
(257°F) 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	815
Winter Normal	10	0	926
Summer Emergency	35	1 1/2	1,041
Winter Emergency	10	1 1/2	1,163

**B. MAGNETIC FIELD MANAGEMENT**

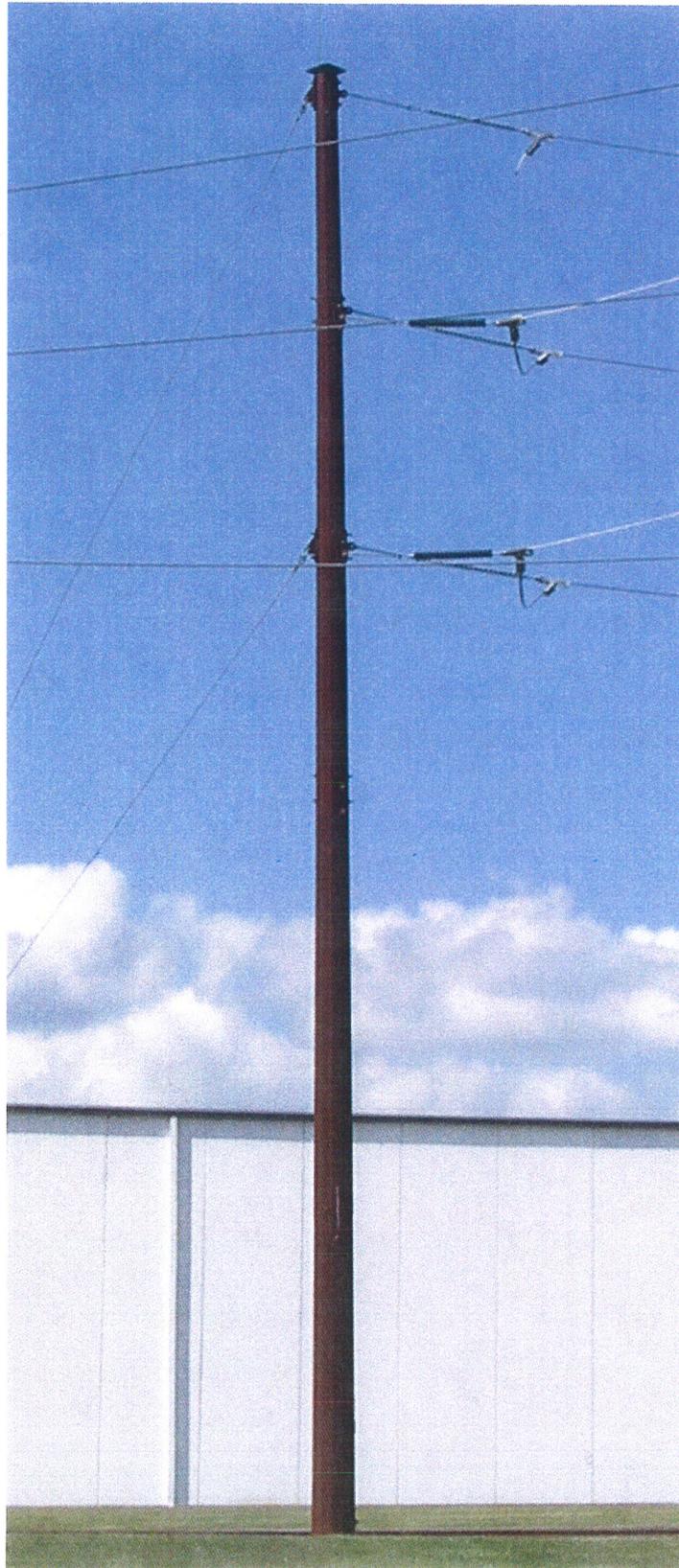
PPL Electric's Magnetic Field Management Program, summarized in Appendix B, is applied to new and reconstructed transmission line projects. To reduce magnetic field exposures, the program generally prescribes the use of a line design that provides five feet higher ground clearance and reverse phasing of new double-circuit lines where it is feasible to do so at low or no cost. The implementation of additional modifications will be considered, provided those modifications can be made at low or no cost.

Increased structure height will be utilized on the new line sections to reduce magnetic field exposures. Reverse phasing cannot be utilized because the new line sections are being constructed as single-circuit lines. Reverse phasing requires a double-circuit line.

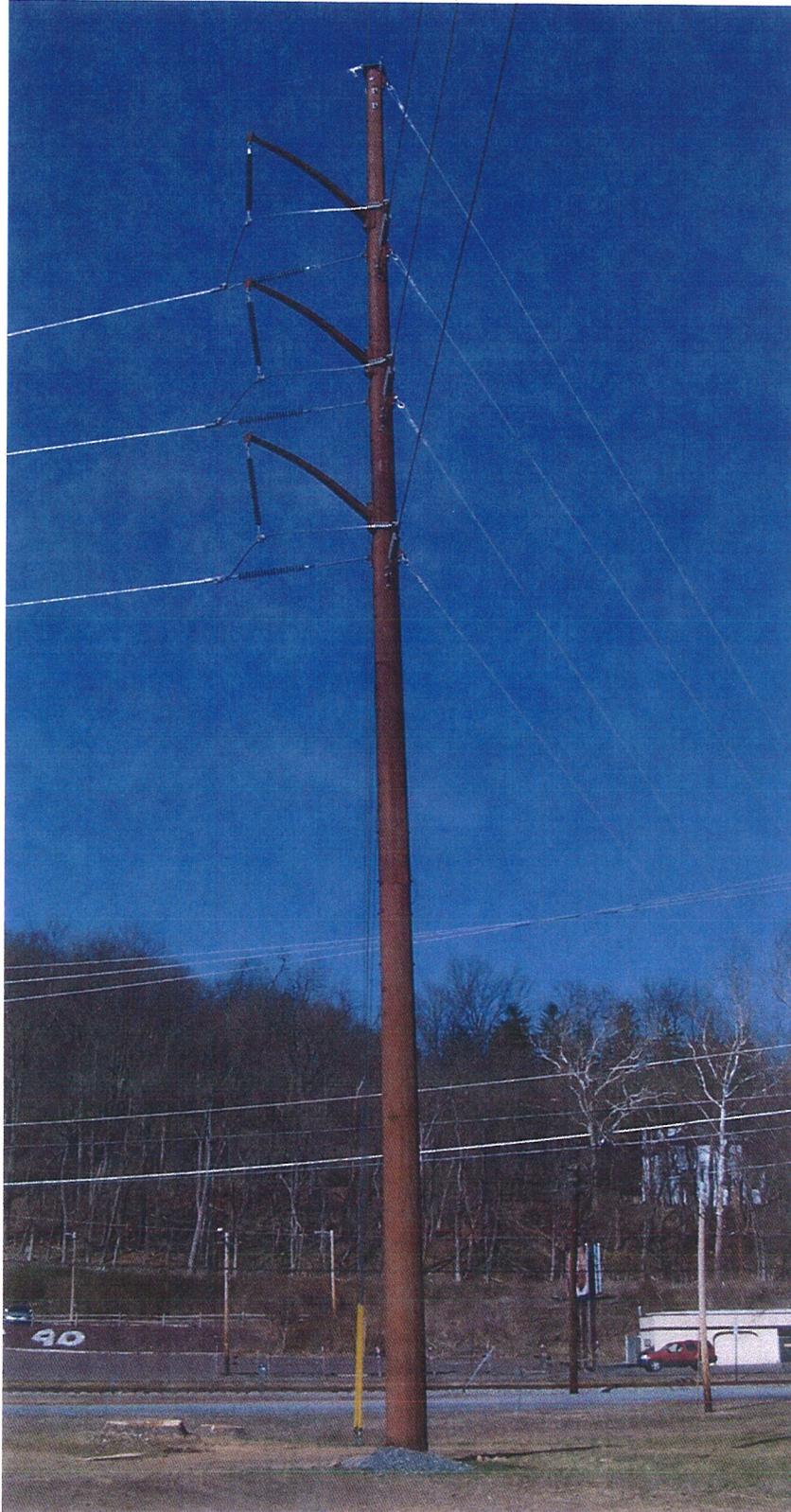
**C. RIGHT-OF-WAY STATUS**

The project is located entirely on property owned in fee by PPL Electric and/or within existing PPL Electric Rights-of-Way. No additional Right-of-Way is required. Appendix C contains a list of properties crossed by the existing Right-of-Way.

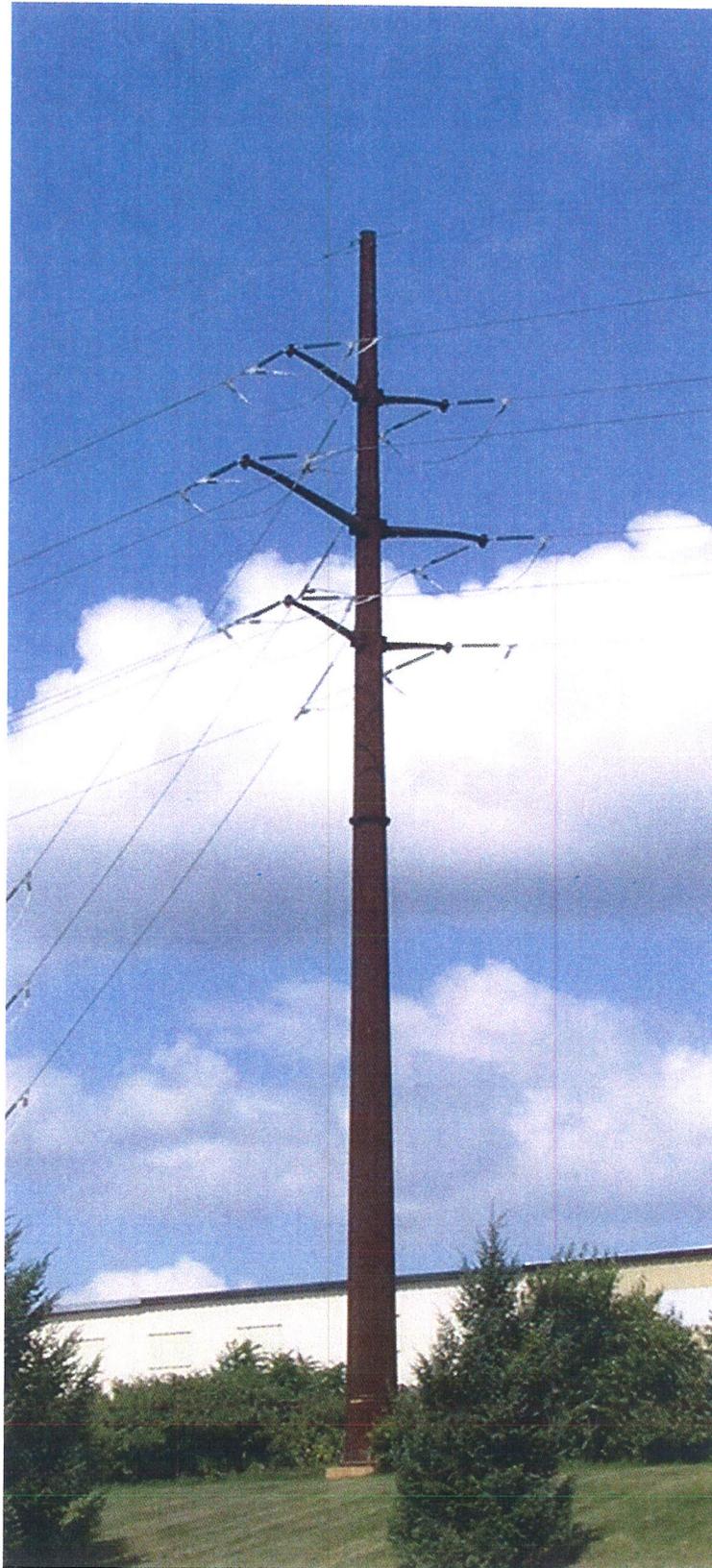
**FIGURE 1**  
PROPOSED 138/69 kV ANGLE STRUCTURE WITHOUT ARMS



**FIGURE 2**  
PROPOSED 138/69 kV ANGLE STRUCTURE WITH ARMS



**FIGURE 3**  
PROPOSED 138/69 kV TAP STRUCTURE



**LEGEND**

- EXISTING TRANSMISSION LINE
- EXISTING TRANSMISSION LINE TO BE REMOVED
- PROPOSED TRANSMISSION LINE
- PROPERTY LINE
- EXISTING RIGHT-OF-WAY
- EXISTING TRANSMISSION POLE
- EXISTING TRANSMISSION TOWER
- PROPOSED TRANSMISSION STRUCTURE

Line Number	Property Owner	Line Number	Property Owner
1	PP&L INC 2 N. NINTH STREET ALLENTOWN, PA 18101	12	CHRISTOPHER F. GEHMAN ET AL 756 WALLINGFORD RD. LITITZ, PA 17543
2	KISSEL HILL COMMONS LOA 616 PAXTON PLACE LITITZ, PA 17543	13	JOHN M & RUTH A WADDELL 752 WALLINGFORD ROAD LITITZ, PA 17543
3	JENNIFER HORSWELL 29 SEMPLE COURT LITITZ, PA 17543	14	TERI L GOOD 748 WALLINGFORD RD. LITITZ, PA 17543
4	BRIAN G. DOMBROSKI 1 SEMPLE COURT LITITZ, PA 17543	15	JOHN GADE 744 WALLINGFORD RD. LITITZ, PA 17543
5	KISSEL HILL COMMONS LOA 616 PAXTON PLACE LITITZ, PA 17543	16	TIMOTHY SHULTZ 740 WALLINGFORD RD. LITITZ, PA 17543
6	KISSEL HILL COMMONS LOA 616 PAXTON PLACE LITITZ, PA 17543	17	WOLF TTT LLC 360 STEEL WAY LANCASTER, PA 17601
7	KISSEL HILL COMMONS LOA 616 PAXTON PLACE LITITZ, PA 17543	18	JOHN J BECK SR 611 THORNBERRY LANE LITITZ, PA 17543
8	JOHN P. SAUDER 604 WAGONWHEEL RD. LITITZ, PA 17543	19	WOLF MOUL GROUP PO BOX 5037 LANCASTER, PA 17606
9	KISSEL HILL COMMONS LOA 616 PAXTON PLACE LITITZ, PA 17543	20	KISSEL HILL LP 616 PAXTON PL SUITE 100 LITITZ, PA 17543
10	WOLF MOUL GROUP PO BOX 5037 LANCASTER, PA 17606	21	KISSEL HILL COMMONS LOT OWNER 616 PAXTON PLACE LITITZ, PA 17543
11	DAVID R. GOODE 760 WALLINGFORD ROAD LITITZ, PA 17543	22	DANIEL R & HOLLY ANN GELATT 501 PROVIDENCE COURT LITITZ, PA 17543

**EXHIBIT B**

**AERIAL EXHIBIT**  
SHEET 1 OF 4

**ROSEVILLE 138/69KV TAP**  
AND  
**NEFFSVILLE #1 AND #2 138/69KV TAPS**  
MANHEIM TWP.  
LANCASTER COUNTY, PA.

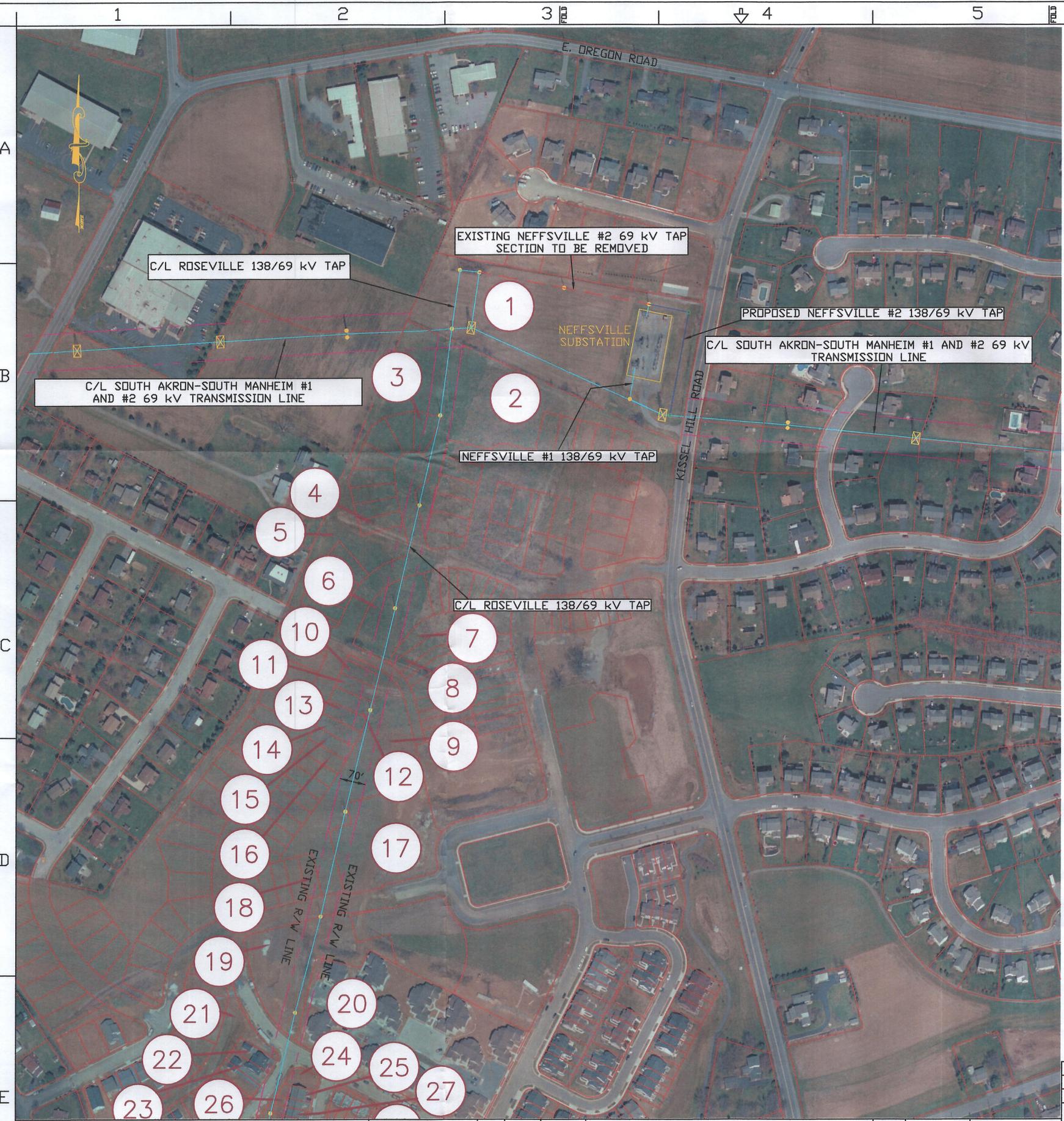
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PPL ELECTRIC UTILITIES CORP.

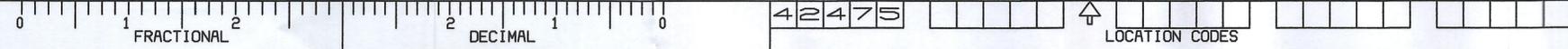


ACCT- 161667	ROSEVILLE 138/69KV TAP AND NEFFSVILLE #1 AND #2 138/69KV TAPS	
SCALE- 1"=200'	MANHEIM TWP. LANCASTER CO., PA.	
BY- RRC	APPROVED <i>Justin B. Wehr</i>	DATE 7/28/09
REVIEWED	PPL ELECTRIC UTILITIES	
PPL DRAWING NO.	SHEET NO.	REV.
<b>EXHIBIT B</b>	<b>1</b>	<b>0</b>
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REFERENCE TITLE	NUMBER	NO.	DATE	ACCT.	REVISION	BY	REVIEWED	APPROVED
			4/24/09	161667				

PPL EU FORM 4874 (7/03)



**LEGEND**

- EXISTING TRANSMISSION LINE
- EXISTING TRANSMISSION LINE TO BE REMOVED
- PROPOSED TRANSMISSION LINE
- PROPERTY LINE
- EXISTING RIGHT-OF-WAY
- EXISTING TRANSMISSION POLE
- EXISTING TRANSMISSION TOWER
- PROPOSED TRANSMISSION STRUCTURE

Line Number	Property Owner
23	CHARLES J & LOURENE P REYNOLDS 503 PROVIDENCE COURT LITITZ, PA 17543
24	WOLF MOUL GROUP PO BOX 5037 LANCASTER, PA 17606
25	JONATHAN R HOXWORTH 650 COURTHOUSE CIRCLE LITITZ, PA 17543
26	JAN & WIOLETTA K MARZEC 682 JAKE LANDIS RD LITITZ, PA 17543
27	PATRICK W TRIMBLE 724 WOODFIELD DRIVE LITITZ, PA 17543
28	JASON W KNOX 644 COURTHOUSE CIRCLE LITITZ, PA 17543
29	WOLF MOUL GROUP PO BOX 5037 LANCASTER, PA 17606
30	GARY M LONGO JR 510 PROVIDENCE COURT LITITZ, PA 17543
31	JAN & WIOLETTA K MARZEC 682 JAKE LANDIS RD LITITZ, PA 17543
32	PATRICK W TRIMBLE 724 WOODFIELD DRIVE LITITZ, PA 17543

Line Number	Property Owner
33	REBECCA DEIBLER 512 PROVIDENCE COURT LITITZ, PA 17543
34	LINDA C AMATUCCI & BRADLEY L KREIDER 514 PROVIDENCE COURT LITITZ, PA 17543
35	KAREN A THOMSEN 638 COURTHOUSE CIRCLE LITITZ, PA 17543
36	CHERYL J HARTMAN 636 COURTHOUSE CIRCLE LITITZ, PA 17543
37	KISSELL HILL COMMONS LOT OWNER 616 PAXTON PLACE LITITZ, PA 17543
38	THOMAS E & KATHLEEN A GARNER 509 AMESBURY RD LANCASTER, PA 17606
39	KISSELL HILL COMMONS LOT OWNER 616 PAXTON PLACE LITITZ, PA 17543
40	FRANCIS C & EUGENIA B SCHRADER 532 WALLINGFORD RD LANCASTER, PA 17601
41	PP&L INC 2 NORTH NINTH STREET ALLENTOWN, PA 18101

**EXHIBIT B**

**AERIAL EXHIBIT  
SHEET 2 OF 4**

**ROSEVILLE 138/69KV TAP  
AND  
NEFFSVILLE #1 AND #2 138/69KV TAPS**  
MANHEIM TWP.  
LANCASTER COUNTY, PA.

SCALE: 1" = 200'



**ppl** PREPARED BY:  
PPL ELECTRIC UTILITIES CORP.  
PPL ELECTRIC UTILITIES



ACCT-	161667
SCALE-	1"=200'
BY-	RRC
REVIEWED	
PPL DRAWING NO.	

**ROSEVILLE  
138/69KV TAP AND  
NEFFSVILLE #1 AND #2  
138/69KV TAPS**  
MANHEIM TWP. LANCASTER CO., PA.

APPROVED *Foster B. Wehr* DATE 7/28/09 PPL ELECTRIC UTILITIES

EXHIBIT B SHEET NO. 2 REV. 0



REFERENCE TITLE	NUMBER	ND.	DATE	ACCT.	REVISION	BY	REVIEWED	APPROVED



4	2	4	7	5
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LOCATION CODES								
PC CAD								

PPL E.U. FORM 4874 (7/00)

EXHIBIT B\_5002.DWG/TIF



**LEGEND**

- EXISTING TRANSMISSION LINE
- EXISTING TRANSMISSION LINE TO BE REMOVED
- PROPOSED TRANSMISSION LINE
- PROPERTY LINE
- EXISTING RIGHT-OF-WAY
- EXISTING TRANSMISSION POLE
- EXISTING TRANSMISSION TOWER
- PROPOSED TRANSMISSION STRUCTURE

Line Number	Property Owner
42	PETER J STEWART & CAO HUYEN V 260 VALLEY RD LANCASTER, PA 17601
43	PETER J STEWART & CAO HUYEN V 260 VALLEY RD LANCASTER, PA 17601
44	ROBERTA E BARNES C/O LAURA HEIKKINEN 636 COBBLESTONE LN LANCASTER, PA 17601
45	MANHEIM TOWNSHIP 1840 MUNICIPAL LANCASTER, PA 17601

**EXHIBIT B**

**AERIAL EXHIBIT**  
SHEET 3 OF 4

**ROSEVILLE 138/69KV TAP**  
AND  
**NEFFSVILLE #1 AND #2 138/69KV TAPS**  
MANHEIM TWP.  
LANCASTER COUNTY, PA.

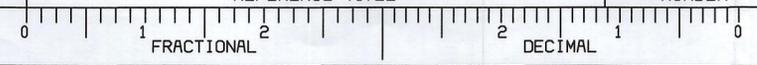
SCALE: 1" = 200'

**PREPARED BY:**  
PPL ELECTRIC UTILITIES CORP.  
PPL ELECTRIC UTILITIES

ACCT- 161667	<b>ROSEVILLE 138/69KV TAP AND NEFFSVILLE #1 AND #2 138/69KV TAPS</b>		
SCALE- 1"=200'	MANHEIM TWP. LANCASTER CO., PA.		
BY- RRC	APPROVED <i>Fustin B. Wehr</i>	DATE 7/28/09	PPL ELECTRIC UTILITIES
REVIEWED	PPL DRAWING NO.	SHEET NO.	REV.
	<b>EXHIBIT B</b>	<b>3</b>	<b>0</b>
	C	EXHIBIT B_5003.DWG/TIF	

PPL EU FORM 4874 (7/03)

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				42475				



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D  
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PC CAD

**LEGEND**

- EXISTING TRANSMISSION LINE
- EXISTING TRANSMISSION LINE TO BE REMOVED
- PROPOSED TRANSMISSION LINE
- PROPERTY LINE
- EXISTING RIGHT-OF-WAY
- EXISTING TRANSMISSION POLE
- EXISTING TRANSMISSION TOWER
- PROPOSED TRANSMISSION STRUCTURE

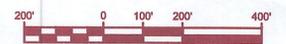
Line Number	Property Owner
46	JOSEPH T DALEY MOST REV TR C/O ST JOHN CHURCH 601 E DELP RD LANCASTER, PA 17601
47	RLPS PARTNERS II LP 1910 HARRINGTON DR LANCASTER, PA 17601
48	PP&L INC 2 NORTH NINTH STREET ALLENTOWN, PA 18101

**EXHIBIT B**

**AERIAL EXHIBIT**  
SHEET 4 OF 4

**ROSEVILLE 138/69KV TAP**  
AND  
**NEFFSVILLE #1 AND #2 138/69KV TAPS**  
MANHEIM TWP.  
LANCASTER COUNTY, PA.

SCALE: 1" = 200'



PREPARED BY:  
PPL ELECTRIC UTILITIES CORP.  
PPL ELECTRIC UTILITIES

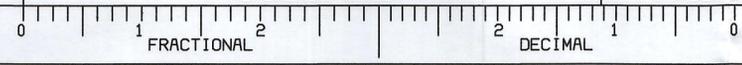


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BY- RRC	MANHEIM TWP.	LANCASTER CO., PA.
REVIEWED	APPROVED <i>Frederic B. Wehr</i>	DATE 7/28/09
PPL DRAWING NO.	EXHIBIT B	SHEET NO.
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		EXHIBIT B_5004



REFERENCE TITLE	NUMBER	NO.	DATE	ACCT.	REVISION	BY	REVIEWED	APPROVED
				42475				

PPL EU FORM 4874 (7/03)



LOCATION CODES

PC CAD

A B C D E MF D E

# Exhibit C

**EXHIBIT "C"**  
**ROSEVILLE 138/69 kV TAP**  
**AND**  
**NEFFSVILLE #1 AND #2 138/69 kV TAPS**  
**ENVIRONMENTAL ASSESSMENT**

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**TABLE OF CONTENTS**

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C.	CULTURAL RESOURCES.....	2
D.	NATURAL FEATURES.....	2
E.	THREATENED AND ENDANGERED SPECIES.....	3

**EXHIBIT "C"**  
**ROSEVILLE 138/69 kV TAP**  
**AND**  
**NEFFSVILLE #1 AND #2 138/69 kV TAPS**  
**ENVIRONMENTAL ASSESSMENT**

---

**A. INTRODUCTION**

PPL Electric is proposing to construct a new section of Roseville 138/69 kV Tap Line, approximately 145 feet in length, to supply electricity directly to the second transformer at the Roseville Substation and relocate the Neffsville #2 Tap. In addition, PPL Electric is seeking approval to increase the operating voltage of the existing Roseville 138/69 kV Tap and the Neffsville #1 69 kV Tap from 69 kV to 138 kV. At the conclusion of this project, the above mentioned lines will have the ability to operate at 138 kV although, initially, they will operate at 69 kV. This project is necessary to improve reliability and operating flexibility in this area. Additionally, the project is in preparation for the future 69 kV to 138 kV conversion in this area of Lancaster County. The 69 kV to 138 kV conversion will provide additional capacity to meet increasing demand for electricity in the area.

The proposed project was reviewed with Manheim Township and Lancaster County. Neither the Township nor the County has any objection. A list of involved governmental agencies, municipalities and other public entities is presented in Appendix D.

**B. LAND USE**

The project is located entirely on property owned in fee by PPL Electric and/or within existing PPL Electric Rights-of-Way. Both the property owned in fee and the Rights-of-Way contain existing electrical facilities. All construction activities associated with the project will occur on property owned in fee by PPL Electric. The existing Neffsville #1 69 kV Tap is located entirely on land owned by PPL Electric.

Forty-Five (45) properties, across which PPL Electric has existing Rights-of-Way, are traversed by the existing Roseville 138/69 kV Tap Line, which PPL Electric proposes to operate in the future at 138 kV. There will be no construction activities for this increase in operating voltage.

Land use in the area is a mix of agricultural, residential, and wooded sites. Land use impacts are anticipated to be minimal due to the small scope of the project and the fact that the project is located in and along existing PPL Electric facilities.

No nearby communication towers, pipelines or other utilities will be affected by the proposed project. The Lancaster Airport (LNS) is approximately 0.60 miles from the project location. PPL Electric will file the appropriate documentation with both the Federal Aviation Administration and the PennDOT Bureau of Aviation to ensure that the proposed line section is not a hazard to the airport's flight operations. Existing access roads, where possible, will be used for construction.

#### **C. CULTURAL RESOURCES**

The project was reviewed with the Pennsylvania Historical and Museum Commission (PHMC). PHMC has determined that "there are no National Register eligible or listed historic or archaeological properties in the area of this proposed project" (File No. ER 2009-1163-071-A). Therefore, there are no anticipated impacts to these resources and no further investigations are required.

#### **D. NATURAL FEATURES**

The proposed project will not affect any unique geological, scenic, or natural areas. Located approximately 2.25 miles west of the project is the Fruitville Quarry Fossil Site. This feature will not be affected due to its distance from the project location, the extensive development between the feature and the project location, and the small size of the proposed project. No National Natural Landmarks, parks, recreational facilities, or natural areas are located near the project area.

Minimal tree clearing is required along the section of new transmission line, and PPL Electric will apply its “Specifications for Initial Clearing and Control of Vegetation On or Adjacent to Electric Line Right-of-Way Through Use of Herbicides, Mechanical and Hand Clearing Techniques” to mitigate any impacts. The line will not cross any wetlands or other aquatic resources. PPL Electric will acquire all required soil, erosion and sedimentation control permits and comply with all conditions imposed by the issuing agencies on such permits conditions.

**E. THREATENED AND ENDANGERED SPECIES**

PPL Electric has coordinated with different state and federal agencies to obtain information regarding endangered and threatened species in close proximity to the project area. A review of the Pennsylvania Natural Diversity Inventory (PNDI) records indicates that there are no potential impacts for species of special concern and resources within, or in close proximity to, the project area.

# Appendices

## LIST OF APPENDICES

- APPENDIX A - PPL Electric Design Criteria and Safety Practices
- APPENDIX B - Magnetic Field Management at PPL Electric
- APPENDIX C - List of property owners
- APPENDIX D - List of Involved Governmental Agencies, Municipalities, and Other Public Entities

## APPENDIX A

### 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, 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 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. 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.



**MAGNETIC  
FIELD  
MANAGEMENT**  
PPL Electric Utilities  
Corporation

**APPENDIX B**

**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

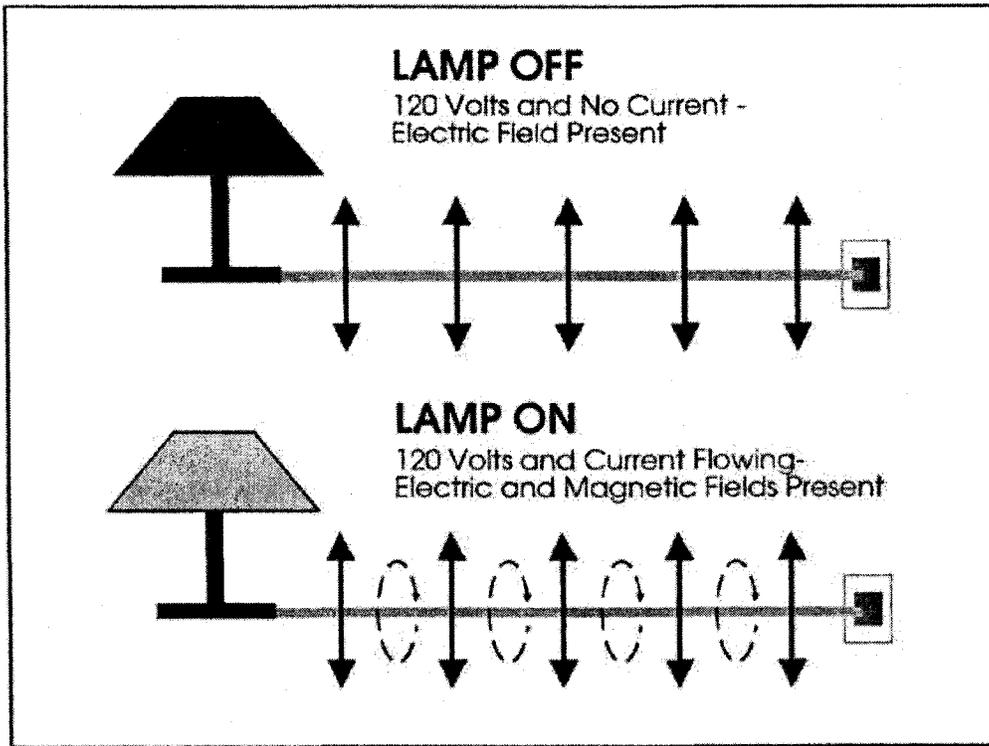


Figure 2

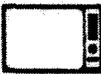
Magnetic field strengths decrease with distance Magnetic fields are measured in milligauss		Source: "EMF in Your Environment", U.S. Environmental Protection Agency 1992		
		At 6 inches	At 1 foot	At 2 feet
Clothes dryer		2 to 10	* to 3	*
Microwave oven		100 to 300	1 to 200	1 to 30
Toaster		5 to 20	* to 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

<b>Sample Magnetic Field Levels in Milligauss</b>				
<b>Type of Overhead Power Line</b>	<b>Distance from the line</b>			
	<b>Under the line</b>	<b>50 ft.</b>	<b>100 ft.</b>	<b>200 ft.</b>
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**

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### **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.

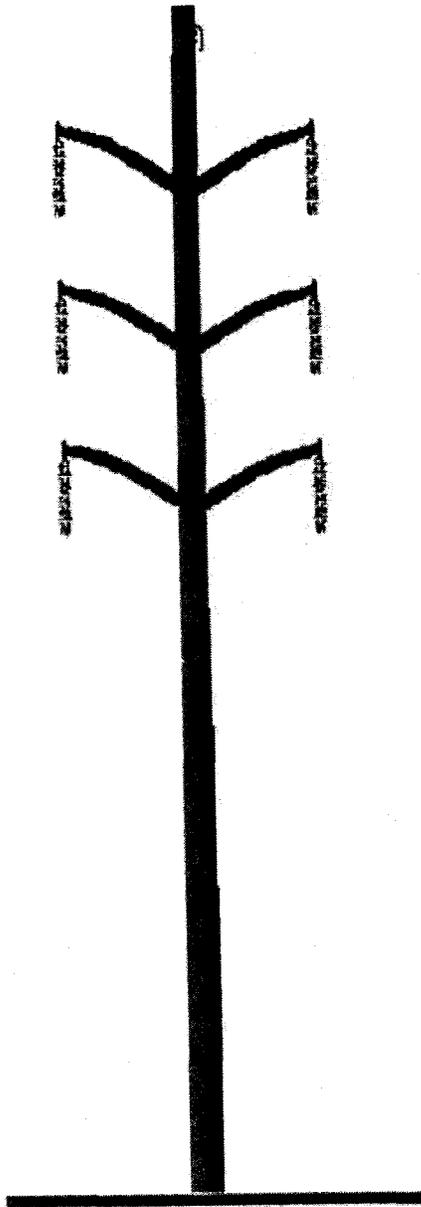
## **UNDERGROUND TRANSMISSION LINES**

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**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.**

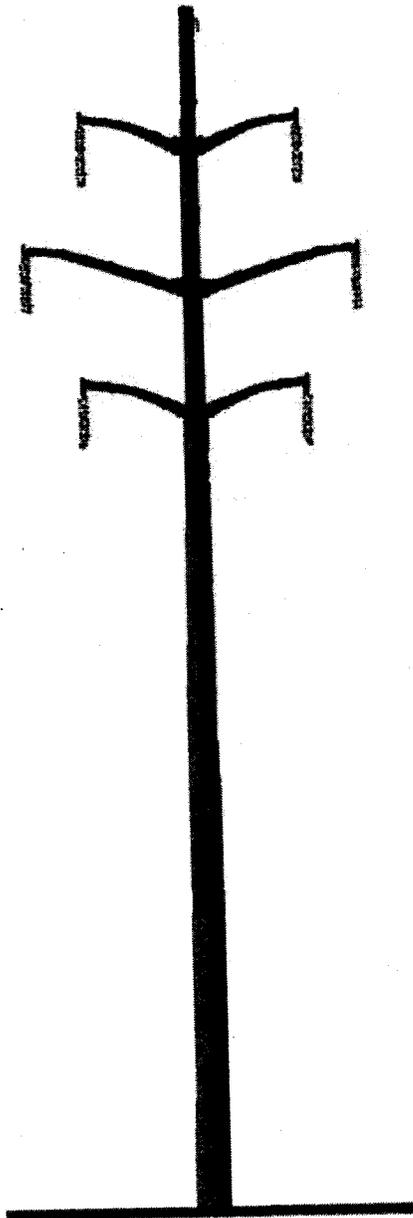
- The phase arrangement that produces the lowest field will be determined.
- The depth of burial of the line will be determined considering the cost of excavation and the location of other buried utilities in the area.
- The use of steel pipe ferromagnetic shielding that reduces magnetic fields will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



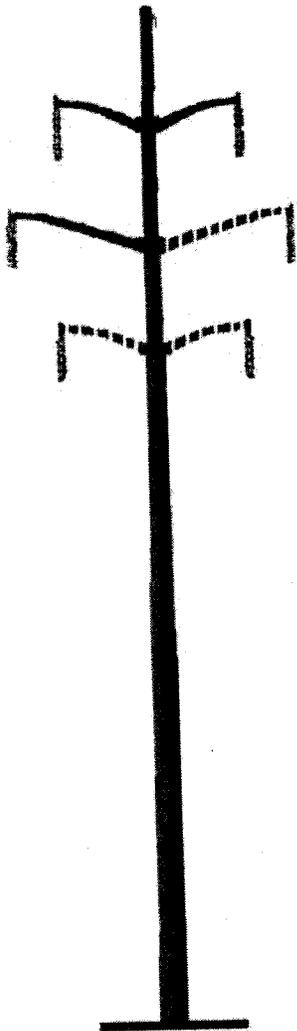
- Lower cost alternative
- Reduces magnetic fields due to higher structures
- Typical conductor data:
  - 1 3/8" HS steel overhead ground wire - 17.3 feet sag
  - 6-556.5 KCMIL 24/7 ACSR power conductors - (PARAKEET) 23.0 feet sag
  - Average span - 600 feet

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

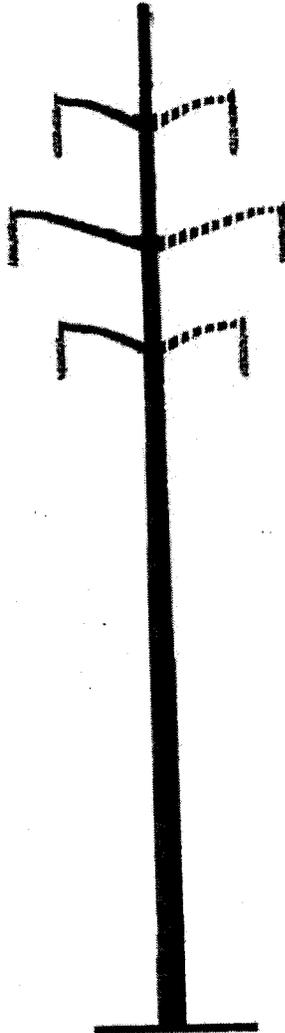
TYPE CONSTRUCTION	MAGNETIC FIELD IN MILLIGAUSS AT THE EDGE OF THE RIGHT OF WAY
SHORT SPAN (CHART I)	30
SHORT SPAN (REVERSE PHASE)	8
LONG SPAN (CHART II)	29
LONG SPAN (REVERSE PHASE)	9
COMPACT (CHART VI)	14
COMPACT (REVERSE PHASE)	3

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.

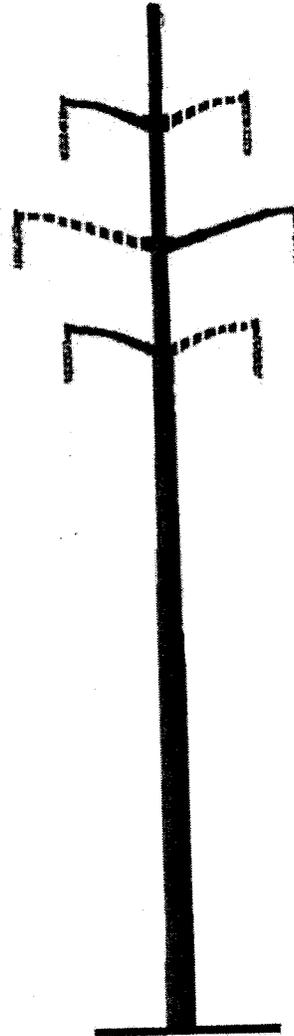
# Typical Single-Circuit Structure Designs



Top/Middle



Vertical



Top/Middle/Bottom

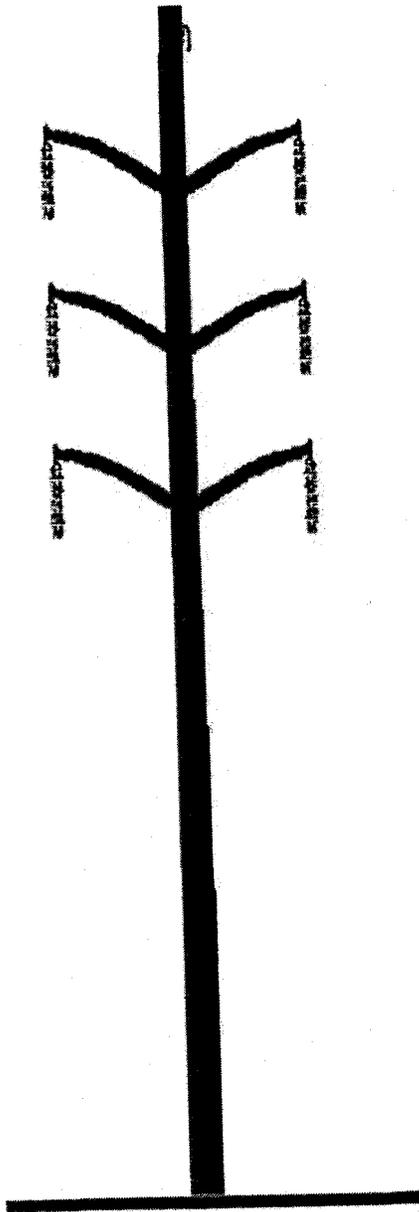
——— initial single circuit  
- - - - - future second circuit

**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

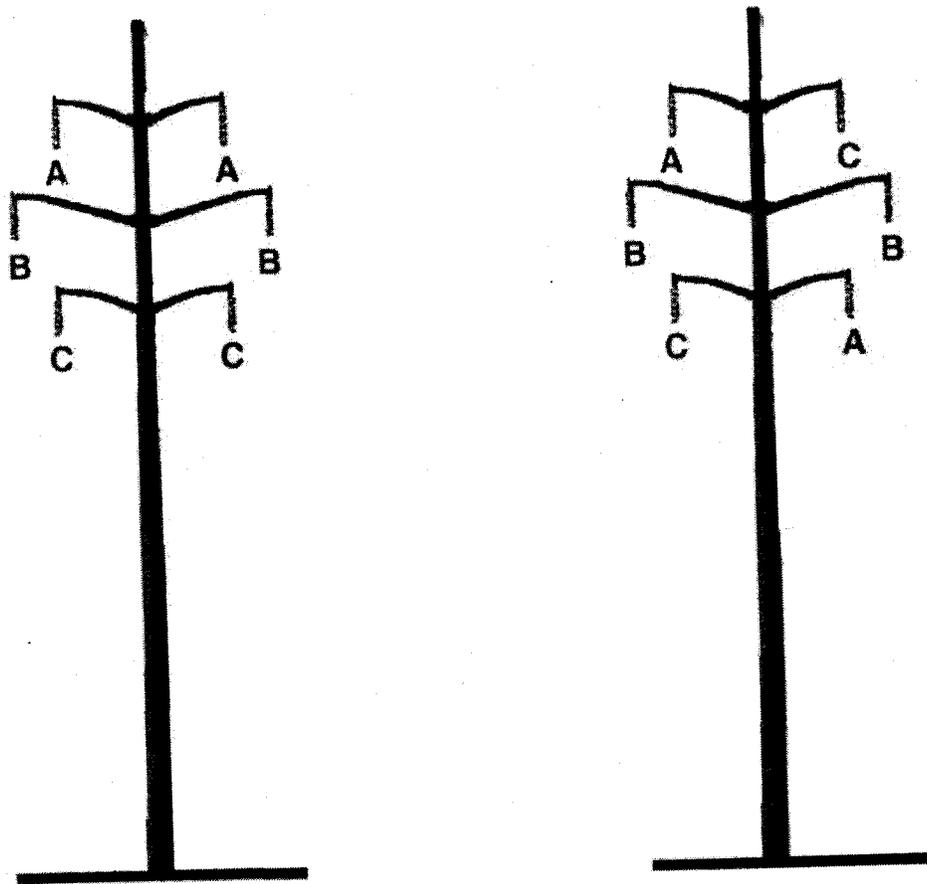
The edge of right of way is 50 feet from the line centerline.  
The 400 ampere phase current is balanced between phases.  
Calculations are based on a minimum ground clearance of 25 feet.

# 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:  $\longrightarrow \longrightarrow \longrightarrow \longrightarrow$  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.

## APPENDIX C

### LIST OF PROPERTY OWNERS

1. PP&L INC.  
2 NORTH NINTH STREET  
ALLENTOWN, PA 18101
2. KISSEL HILL COMMONS LOA  
616 PAXTON PLACE  
LITITZ, PA 17543
3. JENNIFER HORSWELL  
29 SEMPLE COURT  
LITITZ, PA 17543
4. BRIAN G. DOMBROSKI  
1 SEMPLE COURT  
LITITZ, PA 17543
5. KISSEL HILL COMMONS LOA  
616 PAXTON PLACE  
LITITZ, PA 17543
6. KISSEL HILL COMMONS LOA  
616 PAXTON PLACE  
LITITZ, PA 17543
7. KISSEL HILL COMMONS LOA  
616 PAXTON PLACE  
LITITZ, PA 17543
8. JOHN P. SAUDER  
604 WAGONWHEEL ROAD  
LITITZ, PA 17543
9. KISSEL HILL COMMONS LOA  
616 PAXTON PLACE  
LITITZ, PA 17543
10. WOLF MOUL GROUP  
PO BOX 5037  
LANCASTER, PA 17606
11. DAVID R. GOODE  
760 WALLINGFORD ROAD  
LITITZ, PA 17543
12. CHRISTOPHER F. GEHMAN ET AL  
756 WALLINGFORD ROAD  
LITITZ, PA 17543
13. JOHN M & RUTH A WADDELL  
752 WALLINGFORD ROAD  
LITITZ, PA 17543
14. TERI L. GOOD  
748 WALLINGFORD ROAD  
LITITZ, PA 17543
15. JOHN GADE  
744 WALLINGFORD ROAD  
LITITZ, PA 17543
16. TIMOTHY SHULTZ  
740 WALLINGFORD ROAD  
LITITZ, PA 17543
17. WOLF III LLC  
360 STEEL WAY  
LANCASTER, PA 17601
18. JOHN J. BECK SR.  
611 THORNBERRY LANE  
LITITZ, PA 17543
19. WOLF MOUL GROUP  
PO BOX 5037  
LANCASTER, PA 17606
20. KISSEL HILL LP  
616 PAXTON PL SUITE 100  
LITITZ, PA 17543
21. KISSELL HILL COMMONS LOT OWNER  
616 PAXTON PLACE  
LITITZ, PA 17543
22. DANIEL R. & HOLLY ANN GELATT  
501 PROVIDENCE COURT  
LITITZ, PA 17543

23. CHARLES J. & LOURENNE P. REYNOLDS  
503 PROVIDENCE COURT  
LITITZ, PA 17543
24. WOLF MOUL GROUP  
PO BOX 5037  
LANCASTER, PA 17606
25. JONATHAN R. HOXWORTH  
650 COURTHOUSE CIRCLE  
LITITZ, PA 17543
26. JAN & WIOLETTA K. MARZEC  
682 JAKE LANDIS ROAD  
LITITZ, PA 17543
27. PATRICK W. TRIMBLE  
724 WOODFIELD DRIVE  
LITITZ, PA 17543
28. JASON W. KNOX  
644 COURTHOUSE CIRCLE  
LITITZ, PA 17543
29. WOLF MOUL GROUP  
PO BOX 5037  
LANCASTER, PA 17606
30. GARY M. LONGO JR.  
510 PROVIDENCE COURT  
LITITZ, PA 17543
31. JAN & WIOLETTA K. MARZEC  
682 JAKE LANDIS ROAD  
LITITZ, PA 17543
32. PATRICK W. TRIMBLE  
724 WOODFIELD DRIVE  
LITITZ, PA 17543
33. REBECCA DEIBLER  
512 PROVIDENCE COURT  
LITITZ, PA 17543
34. LINDA C. AMATUCCI &  
BRADLEY L. KREIDER  
514 PROVIDENCE COURT  
LITITZ, PA 17543
35. KAREN A. THOMSEN  
638 COURTHOUSE CIRCLE  
LITITZ, PA 17543
36. CHERYL J. HARTMAN  
636 COURTHOUSE CIRCLE  
LITITZ, PA 17543
37. KISSELL HILL COMMONS LOT OWNER  
616 PAXTON PLACE  
LITITZ, PA 17543
38. THOMAS E. & KATHLEEN A. GARNER  
509 AMESBURY ROAD  
LANCASTER, PA 17606
39. KISSELL HILL COMMONS LOT OWNER  
616 PAXTON PLACE  
LITITZ, PA 17543
40. FRANCIS C. & EUGENIA B. SCHRADER  
532 WALLINGFORD ROAD  
LANCASTER, PA 17601
41. PP&L INC.  
2 NORTH NINTH STREET  
ALLENTOWN, PA 18101
42. PETER J. STEWART & CAO HUYEN V  
260 VALLEY ROAD  
LANCASTER, PA 17601
43. PETER J. STEWART & CAO HUYEN V  
260 VALLEY ROAD  
LANCASTER, PA 17601
44. ROBERTA E. BARNES C/O  
LAURA HEIKKINEN  
636 COBBLESTONE LANE  
LANCASTER, PA 17601
45. MANHEIM TOWNSHIP  
1840 MUNICIPAL DRIVE  
LANCASTER, PA 17601
46. JOSEPH T. DALEY MOST REV TR  
C/O ST. JOHN CHURCH  
601 E. DELP ROAD  
LANCASTER, PA 17601

47. RLPS PARTNERS II LP  
1910 HARRINGTON DRIVE  
LANCASTER, PA 17601

48. PP&L INC  
2 NORTH NINTH STREET  
ALLENTOWN, PA 18101

## APPENDIX D

### **LIST OF INVOLVED GOVERNMENTAL AGENCIES, MUNICIPALITIES AND OTHER PUBLIC ENTITIES**

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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. McLearn, Chief
2. Pennsylvania Department of Transportation  
Commonwealth Keystone Building  
400 North Street, 8<sup>th</sup> Floor  
Harrisburg, Pennsylvania 17120  
Attn: The Honorable Allen D. Biehler, P.E., Secretary
3. Department of Environmental Protection  
P.O. Box 2063  
Market Street State Office Building  
Harrisburg, Pennsylvania 17105-2063  
Attn: Office of Field Operations
4. Lancaster County Planning Commission  
150 North Queen Street, Suite 320  
Lancaster, PA 17603  
Attn: James Cowhey, Executive Director
5. Lancaster County Commissioner  
50 North Duke Street  
P.O. Box 83480  
Lancaster, PA 17608-3480  
Attn: Dennis Stuckey, Chairman
6. Manheim Township Planning Commission  
1840 Municipal Drive  
Lancaster, PA 17601  
Attn: Jeffrey Sturla, Chairperson
7. Manheim Township Board of Commissioners  
1840 Municipal Drive  
Lancaster, PA 17601  
Attn: Lawrence Downing, President

8. Manheim Township  
1840 Municipal Drive  
Lancaster, PA 17601  
Attn: Michael Rimer, Secretary