Generation Interconnection

System Impact Study Report

for

Queue Project AF1-071

COLLEGE CORNER 138 KV

7.6 MW Capacity / 20 MW Energy

August, 2020

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1 Introduction

This System Impact Study has been prepared in accordance with the PJM Open Access Transmission Tariff, 205, as well as the System Impact Study Agreement between the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is AEP.

2 Preface

The intent of the System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.

In some instances an Interconnection Customer may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection or merchant transmission upgrade, may also contribute to the need for the same network reinforcement. The possibility of sharing the reinforcement costs with other projects may be identified in the Feasibility Study, but the actual allocation will be deferred until the System Impact Study is performed.

The System Impact Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. The project developer is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

The Interconnection Customer seeking to interconnect a wind or solar generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per Schedule H to the Interconnection Service Agreement and Section 8 of Manual 14D.

An Interconnection Customer with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.

3 General

The Interconnection Customer (IC) has proposed an uprate to a planned/existing Solar generating facility located in Preble, Ohio. This project is an increase to the Interconnection Customer's AC2-111 project, which will share the same point of interconnection. The AF1-071 queue position is a 20 MW uprate (7.6 MW Capacity uprate) to the previous project. The total installed facilities will have a capability of 100 MW with 38 MW of this output being recognized by PJM as Capacity.

The proposed in-service date for this uprate project is July 01, 2019. This study does not imply a TO commitment to this in-service date.

The objective of this System Impact Study is to determine budgetary cost estimates and approximate construction timelines for identified transmission facilities required to connect the proposed generating facilities to the ITO transmission system. These reinforcements include the Attachment Facilities, Local Upgrades, and Network Upgrades required for maintaining the reliability of the ITO transmission system.

Queue Number	AF1-071
Project Name	COLLEGE CORNER 138 KV
State	Ohio
County	Preble
Transmission Owner	AEP
MFO	100
MWE	20
MWC	7.6
Fuel	Solar
Basecase Study Year	2023

Any new service customers who can feasibly be commercially operable prior to June 1st of the basecase study year are required to request interim deliverability analysis.

4 Point of Interconnection

AF1-071 will interconnect with the AEP transmission system via a direct connection to the College Corner 138 kV substation utilizing the same generation lead as previous queue position AC2-111 (see Attachment 1).

Note: It is assumed that the 138 kV revenue metering system, gen lead and Protection & Control Equipment that will be installed for AC2-111 will be adequate for the additional storage facility connection requested in AF1-071. Depending on the timing of the completion of the AF1-071 interconnection construction relative to the AC2-111 completion, there may (or may not) be a need to review and revise relay settings for the increased generation of AF1-071.

5 Cost Summary

The AF1-071 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$0
Direct Connection Network Upgrade	$0
Non Direct Connection Network Upgrades	$45,000
Allocation for New System Upgrades*	$0
Contribution to Previously Identified Upgrades*	$4,935,000
Total Costs	**$4,980,000**

*As your project progresses through the study process and other projects modify their request or withdraw, then your cost allocation could change.

The estimates provided in this report are preliminary in nature, as they were determined without the benefit of detailed engineering studies. Final estimates will require an on-site review and coordination to determine final construction requirements. In addition, Stability analysis will be completed during the Facilities Study stage. It is possible that a need for additional upgrades could be identified by these studies.

This cost excludes a Federal Income Tax Gross Up charges. This tax may or may not be charged based on whether this project meets the eligibility requirements of IRS Notice 88-129. If at a future date it is determined that the Federal Income Tax Gross charge is required, the Transmission Owner shall be reimbursed by the Interconnection Customer for such taxes.

Note 1: PJM Open Access Transmission Tariff (OATT) section 217.3A outline cost allocation rules. The rules are further clarified in PJM Manual 14A Attachment B. The allocation of costs for a network upgrade will start with the first Queue project to cause the need for the upgrade. Later queue projects will receive cost allocation contingent on their contribution to the violation and are allocated to the queues that have not

closed less than 5 years following the execution of the first Interconnection Service Agreement which identifies the need for this upgrade.

6 Transmission Owner Scope of Work

6.1 Attachment Facilities

The total preliminary cost estimate for the Attachment work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
Total Attachment Facility Costs	**$0**

6.2 Direct Connection Cost Estimate

The total preliminary cost estimate for the Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
Total Direct Connection Facility Costs	**$0**

6.3 Non-Direct Connection Cost Estimate

The total preliminary cost estimate for the Non-Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
Review and revise protections and controls settings for the increased generation of AF1-071	$45,000
Total Non-Direct Connection Facility Costs	**$45,000**

7 Incremental Capacity Transfer Rights (ICTRs)

None

8 Schedule

It is anticipated that the time between receipt of executed Agreements and Commercial Operation may range from 12 to 18 months if no line work is required. If line work is required, construction time would generally be between 24 to 36 months after Agreement execution.

9 Interconnection Customer Requirements

It is understood that the Interconnection Customer is responsible for all costs associated with this interconnection. The costs above are reimbursable to the Interconnected Transmission Owner. The cost of the Interconnection Customer's generating plant and the costs for the line connecting the generating plant to the Interconnected Transmission Owner's Transmission circuit are not included in this report; these are assumed to be the Interconnection Customer's responsibility.

The Generation Interconnection Agreement does not in or by itself establish a requirement for the Interconnected Transmission Owner to provide power for consumption at the developer's facilities. A separate agreement may be reached with the local utility that provides service in the area to ensure that infrastructure is in place to meet this demand and proper metering equipment is installed. It is the responsibility of the developer to contact the local service provider to determine if a local service agreement is required.

Requirement from the PJM Open Access Transmission Tariff:

1. An Interconnection Customer entering the New Services Queue on or after October 1, 2012 with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.
2. The Interconnection Customer may be required to install and/or pay for metering as necessary to properly track real time output of the facility as well as installing metering which shall be used for billing purposes. See Section 8 of Appendix 2 to the Interconnection Service Agreement as well as Section 4 of PJM Manual 14D for additional information.

10 Revenue Metering and SCADA Requirements

10.1 PJM Requirements

The Interconnection Customer will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Section 8 of Attachment O.

10.2 Meteorological Data Reporting Requirements

The solar generation facility shall provide the Transmission Provider with site-specific meteorological data including:

- Back Panel temperature (Fahrenheit)
- Irradiance (Watts/meter^2)
- Ambient air temperature (Fahrenheit) – (Accepted, not required)
- Wind speed (meters/second) – (Accepted, not required)
- Wind direction (decimal degrees from true north) – (Accepted, not required)

10.3 Interconnected transmission Owner Requirements

The IC will be required to comply with all Interconnected Transmission Owner's revenue metering requirements for generation interconnection customers located at the following link:

http://www.pjm.com/planning/design-engineering/to-tech-standards/

11 Summer Peak Analysis

The Queue Project AF1-071 was evaluated as a 20.0 MW (Capacity 7.6 MW) injection as an uprate to AC2-111 at the College Corner 138 kV substation in the AEP area. Project AF1-071 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-071 was studied with a commercial probability of 100.0 %. Potential network impacts were as follows:

11.1 Generation Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection)

None

11.2 Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output)

None

11.3 Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC| DC	MW IMPACT
40966905	243262	05COLLCO	138.0	AEP	250001	08COLINV	138.0	DEO&K	1	DEOK_P7-1_C5 4504MFTANNERS4512EBTANNERS	tower	167.0	113.48	116.02	AC	4.47
41497944	243262	05COLLCO	138.0	AEP	250001	08COLINV	138.0	DEO&K	1	AEP_P4_#10527_05BLUFFP 138_B2	breaker	167.0	101.13	103.79	AC	4.66
41497945	243262	05COLLCO	138.0	AEP	250001	08COLINV	138.0	DEO&K	1	DEOK_P2-3_C2 1403_MIAMIFORT	breaker	167.0	108.21	110.73	AC	4.43
41775343	243262	05COLLCO	138.0	AEP	250001	08COLINV	138.0	DEO&K	1	AEP_P2-2_#2812_05TANNER 345_2	bus	167.0	104.12	107.12	AC	5.31

11.4 Steady-State Voltage Requirements

None

11.5 Potential Congestion due to Local Energy Deliverability

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection

Request, a subsequent analysis will be performed which shall study all overload conditions associated with the overloaded element(s) identified.

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
4115709 2	24326 2	05COLLC O	138. 0	AEP	25000 1	08COLIN V	138. 0	DEO& K	1	AEP_P1 - 2_#637 2	operatio n	167.0	100.69	103.57	AC	5.11

11.6 System Reinforcements

<table>
<tr><th>ID</th><th>Idx</th><th>Facility</th><th>Upgrade Description</th><th>Cost</th><th>Cost Allocated to AF1-071</th><th>Upgrade Number</th></tr>
<tr><td>41775343,40966905,41497944,41497945</td><td>1</td><td>05COLLCO 138.0 kV - 08COLINV 138.0 kV Ckt 1</td><td>AEP end:
AE- end SE rating is 167 MVA.
Limiting element is ACSR ~ 397.5 ~ 30/7 ~ LARK - Conductor section 1. A Sag Study will be required on the 0.15 mile section of line to mitigate the overload. Depending on the sag study results, cost for this upgrade is expected to be between $20,000 (no remediation required just sag study) and $0.3 million (complete line reconductor/rebuild required). New AEP SE rating to be 245 MVA. PJM Network Upgrade N6123.
Sag Study: 6 to 12 months.
Rebuild: The standard time required for construction differs from state to state. An approximate construction time would be 24 to 36 months after signing an interconnection agreement.

A prior queue cycle is presently responsible for this upgrade/cost.

DEOK end:
DEOK-end SE rating is 178 MVA.
Rebuild 11.87 miles of the DEOK portion of line. $24.164 M. 36 months from ISA. New DEOK SE rating to be 239 MVA. PJM Network Upgrade N6284.

The cost allocation is as follows:

<table><tr><th>Queue</th><th>MW contribution</th><th>Percentage of Cost</th><th>$ cost ($24.164 M)</th></tr><tr><td>AE2-090</td><td>11.3</td><td>43.55%</td><td>10.522</td></tr><tr><td>AE2-219</td><td>9.4</td><td>36.03%</td><td>8.706</td></tr><tr><td>AF1-071</td><td>5.3</td><td>20.42%</td><td>4.935</td></tr></table></td><td>$20 K + $24.164 M</td><td>$0 + $4.935 M</td><td>N6123
N6284</td></tr>
<tr><td></td><td></td><td></td><td>Total Cost</td><td>$24,184,000</td><td>$4,935,000</td><td></td></tr>
</table>

Note : For customers with System Reinforcements listed: If your present cost allocation to a System Reinforcement indicates $0, then please be aware that as changes to the interconnection process occur, such as prior queued projects withdrawing from the queue, reducing in size, etc, the cost responsibilities can change and a cost allocation may be assigned to your project. In addition, although your present cost allocation to a System Reinforcement is presently $0, your project may need this system reinforcement

completed to be deliverable to the PJM system. If your project comes into service prior to completion of the system reinforcement, an interim deliverability study for your project will be required.

11.7 Flow Gate Details

The following indices contain additional information about each facility presented in the body of the report. For each index, a description of the flowgate and its contingency was included for convenience. The intent of the indices is to provide more details on which projects/generators have contributions to the flowgate in question. All New Service Queue Requests, through the end of the Queue under study, that are contributors to a flowgate will be listed in the indices. Please note that there may be contributors that are subsequently queued after the queue under study that are not listed in the indices. Although this information is not used "as is" for cost allocation purposes, it can be used to gage the impact of other projects/generators. It should be noted the project/generator MW contributions presented in the body of the report are Full MW Impact contributions which are also noted in the indices column named "Full MW Impact", whereas the loading percentages reported in the body of the report, take into consideration the PJM Generator Deliverability Test rules such as commercial probability of each project as well as the ramping impact of "Adder" contributions. The MW Impact found and used in the analysis is shown in the indices column named "Gendeliv MW Impact".

11.7.1 Index 1

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
40966905	243262	05COLLCO	AEP	250001	08COLINV	DEO&K	1	DEOK_P7-1_C5 4504MFTANNERS4512EBTANNERS	tower	167.0	113.48	116.02	AC	4.47

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
243415	05WWVSTA	2.5783	50/50	2.5783
247288	05RICHG1	0.8526	50/50	0.8526
247289	05RICHG2	0.8526	50/50	0.8526
247929	S-071 E	5.8507	Adder	6.88
932841	AC2-111 C O1	6.7883	50/50	6.7883
932842	AC2-111 E O1	11.0757	50/50	11.0757
934961	AD1-128 C	3.9162	Adder	4.61
934962	AD1-128 E	6.3896	Adder	7.52
940991	AE2-090 C	10.5667	50/50	10.5667
940992	AE2-090 E	7.0445	50/50	7.0445
942071	AE2-219 C	3.2223	Adder	3.79
942072	AE2-219 E	4.4498	Adder	5.24
944031	AF1-071 C	1.6971	50/50	1.6971
944032	AF1-071 E	2.7689	50/50	2.7689
945561	AF1-221 C O1	25.3521	50/50	25.3521
945562	AF1-221 E O1	7.6203	50/50	7.6203
WEC	WEC	0.2240	Confirmed LTF	0.2240
LGEE	LGEE	0.0131	Confirmed LTF	0.0131
CBM-W2	CBM-W2	3.9722	Confirmed LTF	3.9722
NY	NY	0.0492	Confirmed LTF	0.0492
TVA	TVA	0.2520	Confirmed LTF	0.2520
O-066	O-066	0.6048	Confirmed LTF	0.6048
CBM-S1	CBM-S1	1.2780	Confirmed LTF	1.2780
G-007	G-007	0.0936	Confirmed LTF	0.0936
MADISON	MADISON	9.7232	Confirmed LTF	9.7232
MEC	MEC	0.9725	Confirmed LTF	0.9725
CATAWBA	CATAWBA	0.0084	Confirmed LTF	0.0084
CBM-W1	CBM-W1	7.3058	Confirmed LTF	7.3058

11.8 Queue Dependencies

The Queue Projects below are listed in one or more indices for the overloads identified in your report. These projects contribute to the loading of the overloaded facilities identified in your report. The percent overload of a facility and cost allocation you may have towards a particular reinforcement could vary depending on the action of these earlier projects. The status of each project at the time of the analysis is presented in the table. This list may change as earlier projects withdraw or modify their requests.

Queue Number	Project Name	Status
AC2-111	College Corner 138kV	Active
AD1-128	Modoc 138 kV	Active
AE2-090	Randolph-Hodgin 138 kV	Active
AE2-219	Bluff Point-Randolph 138 kV	Active
AF1-071	College Corner 138 kV	Active
AF1-221	College Corner-Drewersburg 138 kV	Active

11.9 Contingency Descriptions

Contingency Name	Contingency Definition
AEP_P1-2_#6372	CONTINGENCY 'AEP_P1-2_#6372' OPEN BRANCH FROM BUS 243262 TO BUS 250168 CKT 1 / 243262 05COLLCO 138 250168 08TRENT2 138 1 OPEN BRANCH FROM BUS 250168 TO BUS 250106 CKT 1 / 250168 08TRENT2 138 250106 08TODHJT 138 1 END
DEOK_P2-3_C2 1403_MIAMIFORT	CONTINGENCY 'DEOK_P2-3_C2 1403_MIAMIFORT' OPEN BRANCH FROM BUS 243233 TO BUS 249567 CKT 1 / 243233 05TANNER 345 249567 08M.FORT 345 1 OPEN BRANCH FROM BUS 249567 TO BUS 251950 CKT 7 / 249567 08M.FORT 345 251950 08M.FRT7 22.0 7 END
AEP_P4_#10527_05BLUFFP 138_B2	CONTINGENCY 'AEP_P4_#10527_05BLUFFP 138_B2' OPEN BRANCH FROM BUS 243253 TO BUS 243319 CKT 1 / 243253 05BLUFFP 138 243319 05JAY 138 1 OPEN BRANCH FROM BUS 243253 TO BUS 246014 CKT 1 / 243253 05BLUFFP 138 246014 05BLUFFPNT 69.0 1 END
Base Case	
DEOK_P7-1_C5 4504MFTANNERS4512EBTANNERS	CONTINGENCY 'DEOK_P7-1_C5 4504MFTANNERS4512EBTANNERS' OPEN BRANCH FROM BUS 243233 TO BUS 249567 CKT 1 / 243233 05TANNER 345 249567 08M.FORT 345 1 OPEN BRANCH FROM BUS 243233 TO BUS 249565 CKT 1 / 243233 05TANNER 345 249565 08EBEND
AEP_P2-2_#2812_05TANNER 345_2	CONTINGENCY 'AEP_P2-2_#2812_05TANNER 345_2' OPEN BRANCH FROM BUS 243233 TO BUS 249567 CKT 1 / 243233 05TANNER 345 249567 08M.FORT 345 1 OPEN BRANCH FROM BUS 243233 TO BUS 243382 CKT 5 / 243233 05TANNER 345 243382 05TANNER 138 5 END

12 Light Load Analysis

Not Required.

13 Short Circuit Analysis

The following Breakers are overdutied

None.

14 Stability and Reactive Power

To be determined in the Facilities Study Phase.

15 Affected Systems

15.1 TVA

TVA Impacts to be determined during later study phases (as applicable).

15.2 Duke Energy Progress

Duke Energy Progress Impacts to be determined during later study phases (as applicable).

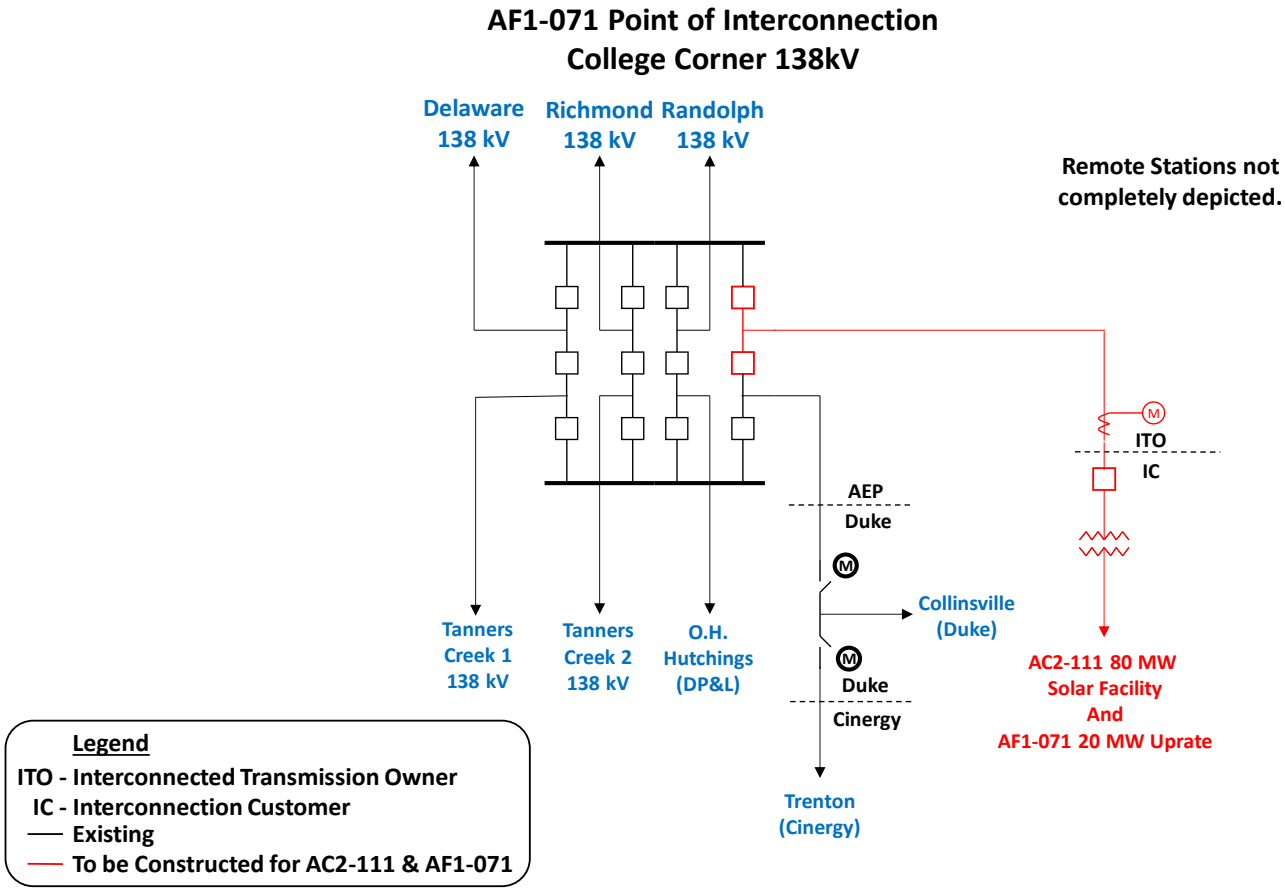
15.3 MISO

MISO Impacts to be determined during later study phases (as applicable).

15.4 LG&E

LG&E Impacts to be determined during later study phases (as applicable).

16 Attachment 1: One-Line Diagram



17 Attachment 2: Site Location