Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AA2-148

Madison-Tanners Creek 138 kV

October 2015

Preface

The intent of the feasibility study is to determine a plan, with ballpark cost and construction time estimates, to connect the subject generation to the PJM network at a location specified by the Interconnection Customer. The Interconnection Customer may request the interconnection of generation as a capacity resource or as an energy-only resource. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: (1) Direct Connections, which are new facilities and/or facilities upgrades needed to connect the generator to the PJM network, and (2) Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system.

In some instances a generator interconnection may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection, 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 impact study is performed.

The Feasibility 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.

General

The Interconnection Customer (IC) proposes to connect Project #AA2-148, a 175 MW (22.75 Capacity) wind generating facility to the American Electric Power (AEP) Transmission system at the in-line switching station proposed to be built as an attachment facility for PJM queue positions W4-004 and W4-008. The new switching station is located between Madison and Tanners Creek 138 kV stations (see Figure 1 and Figure 2). The total MFO of the PJM Project Queue #AA2-148 is 175 MW and the location of the proposed wind generating facility is in Henry County, IN.

The requested in-service date is 12/31/ 2017.

The objective of this Feasibility Study is to determine budgetary cost estimates and approximate construction timelines for identified transmission facilities required to connect the proposed generating facilities to the AEP Transmission System. These reinforcements include the Attachment Facilities, Local Upgrades, and Network Upgrades required to maintain the reliability of the AEP Transmission System. Stability analysis is not included as part of this study.

Attachment Facilities

(Expanding the proposed PJM Project #W4-004 Switching Station (see Figure 1))

The proposed in-line switching station identified as an attachment facility for PJM project #W4-004/-008 will be expanded to accommodate the interconnection of PJM project #AA2-148. Two (2) additional 138 kV circuit breakers will be required. The expanded switching station will be physically arranged for ultimate expansion to a breaker and one half bus arrangement initially operated as a ring bus (see Figure 1). The expanded station also includes the addition of the required 138 kV metering, SCADA, disconnect switches and other associated equipment.

The IC is required to construct all connection facilities in accordance with AEP published standards.

Direct Connection Cost Estimate

For AEP building Direct Connection cost estimates:

Description	Estimated Cost
Expand the proposed in-line switching station identified as an attachment facility for PJM project #W4-004/-008. Add two (2) 138 kV circuit breakers. The expanded switching station will have a configuration of a breaker and one half bus arrangement. Associated disconnect switches, bus work, SCADA and 138 kV revenue metering will also be required.	$1,600,000
Line protection and controls will need to be installed at the newly expanded 138 kV switching station.	$300,000
Total	**$1,900,000**

Table 1

Non-Direct Connection Cost Estimate

For AEP building Non-Direct Connection cost estimates:

Description	Estimated Cost
Update relay settings at Madison 138 kV station	$50,000
Update relay settings at Tanners Creek 138 kV station.	$50,000
Total	**$100,000**

Table 2

Additional Limitations of Concern

Numerous conditions were identified at full output that don't require mitigation per the PJM tariff, but may subject the AA2-148 project to curtailment in actual operation. See **Tables 4a** and **Tables 4b** for a list of identified contingencies and mitigations respectively.

Description	Estimated Cost
Replace Madison 800A Wave trap	$200,000
Madison Bus/Riser (switch to bus)	$200,000
Madison Riser (switch to line)	$200,000
A Sag Study will be required on the 25 mile section of line to mitigate the overload on the Madison – W4-004 138 kV line. Depending on the sag study results,	The estimated cost for this upgrade is expected to be between $100,000 (no clearance remediation required, just sag study and documentation) and $37.5 Million (complete line rebuild required).
Total	**$700,000**

Table 3

PJM project AA2-148 also has a contribution towards baseline project (b2634) as shown in Appendix 1 of this report. The baseline project will eliminate the identified overload. The scheduled in service date for b2634 is 06/01/2018. The IC has the option of expediting the baseline project, but will be financially responsible for the accelerated costs.

Schedule

It is anticipated that the time between receipt of executed agreements and Commercial Operation may range from 24 to 36 months.

Conclusion

Based upon the results of this Feasibility Study, the construction of The IC's (PJM Project #AA2-148) wind generating project connecting to the AEP Madison – Tanners Creek 138 kV circuit will require additional interconnection charges.

Estimated Station Cost: **$1,600,000**

Estimated Protection and Relaying Cost: **$400,000**

Estimated Network upgrade cost: **$700,000**

Total Estimated Cost for Project AA2-148: **$2,700,000**

These estimates 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.

Revenue Metering and SCADA Requirements

For PJM: The IC will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for The IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Sections 24.1 and 24.2.

For AEP:

AEP will install primary and backup revenue metering at the Interconnection Customer's termination in the transmission switching substation as shown in Schedule B. AEP will submit all real and reactive power generation data to PJM as per PJM Manual 14 D.

The Interconnection Customer is responsible for installing equipment assuring that the following real time data is transmitted to PJM as per PJM Manual 14D

a. Instantaneous net MW for the plant.
b. Instantaneous net MVAR for the plant.

The Interconnection Customer is responsible for installing equipment assuring the following non real-time data is transmitted to PJM as per PJM Manual 14D

a. Hourly compensated MWh delivered by the plant.
b. Hourly compensated MWh received by the plant.
c. Hourly compensated MVARh delivered by the plant.
d. Hourly compensated MVARh received by the plant.

The Interconnection Customer will be required to install telemetry and communication equipment to provide real-time telemetry data to PJM as well as having the ability to receive and respond to PJM operational command and control signals. The requirements for this equipment are listed in Appendix 2, Section 8 of Attachment O to the PJM Tariff, as well as PJM Manuals 01 and 14D.

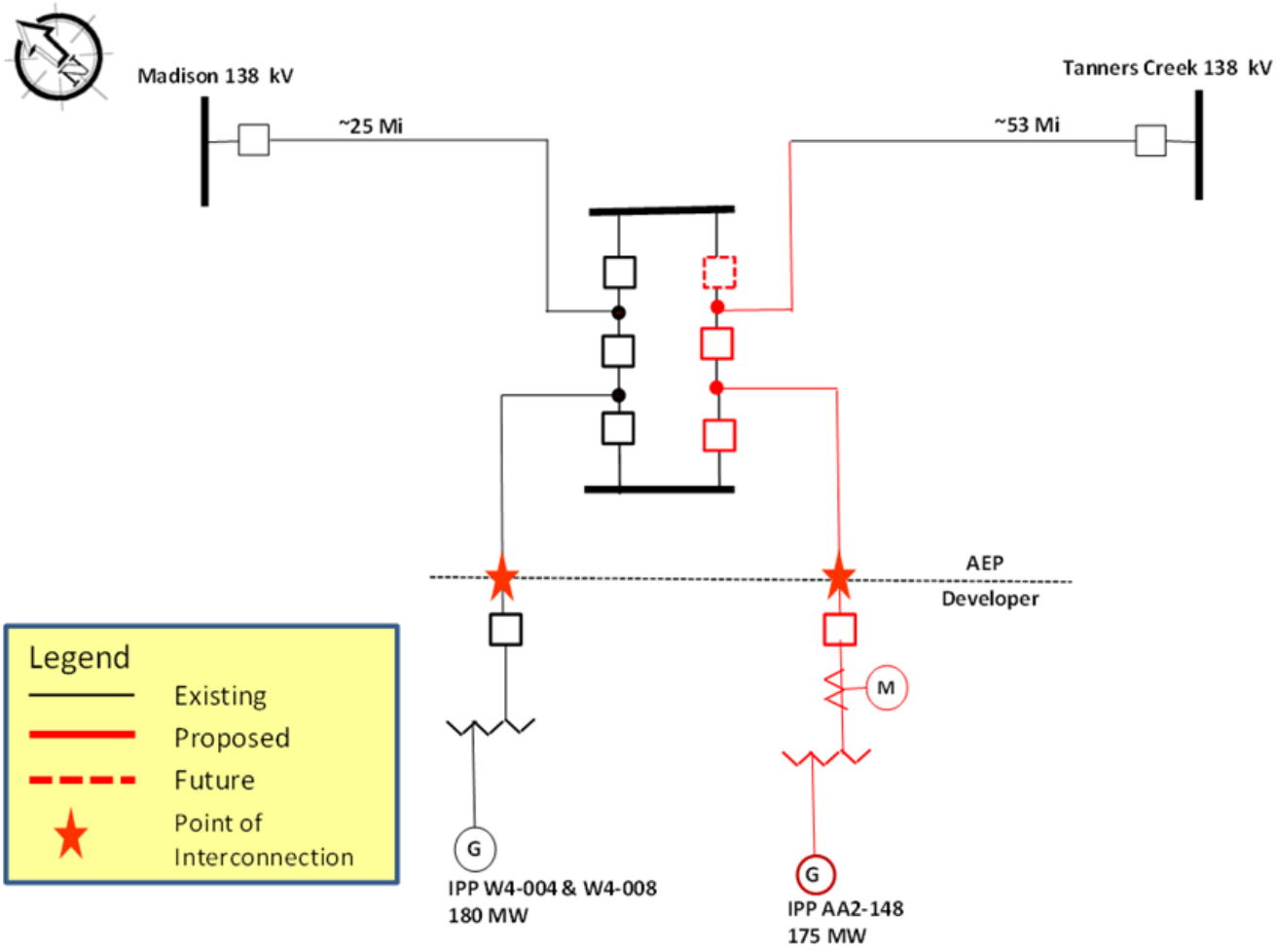

Figure 1. Single Line Diagram

Network Impacts

The Queue Project AA2-148 was evaluated as a 174.2 MW (Capacity 22.8 MW) injection at W4-004 138kV substation in the AEP area. Project AA2-148 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AA2-148 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis - 2019

System Reinforcement responsible by Transmission Owner

1. Existing Baseline project

(This project contributes to the following contingency overloads, and there are existing PJM baseline projects to fix the following overloads. If a customer desires to expedite the required date for the existing PJM baseline projects, the customer will be financially responsible)

1. (DEO&K - DEO&K) The 08M.FTHS 345/138 kV transformer (from bus 249568 to bus 250057 ckt 9) loads from 97.78% to 100.35% (**DC power flow**) of its emergency rating (475 MVA) for the line fault with failed breaker contingency outage of '6870_C2_05TANNER 345-Q1'. This project contributes approximately 14.35 MW to the thermal violation.

CONTINGENCY '6870_C2_05TANNER 345-Q1'
OPEN BRANCH FROM BUS 243233 TO BUS 248001 CKT Z1 / 243233 05TANNER 345 248001 06DEARB1 345 Z1
OPEN BRANCH FROM BUS 243233 TO BUS 249565 CKT 1 / 243233 05TANNER 345 249565 08EBEND 345 1
OPEN BRANCH FROM BUS 243233 TO BUS 247515 CKT 2 / 243233 05TANNER 345 247515 V4-033 C 345 2
OPEN BRANCH FROM BUS 248000 TO BUS 248001 CKT 1 / 248000 06CLIFTY 345 248001 06DEARB1 345 1
OPEN BRANCH FROM BUS 248001 TO BUS 248013 CKT 1 / 248001 06DEARB1 345 248013 06PIERCE 345 1
END

Please refer to Appendix 1 for a table containing the generators having contribution to this flowgate.

PJM baseline project (b2634) will eliminate the identified overload. The scheduled in service date for b2634 is 06/01/2018.

Generator Deliverability

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

None

Multiple Facility Contingency

(Double Circuit Tower Line contingencies only with full energy output. Stuck Breaker and Bus Fault contingencies will be applied during the Impact Study)

None

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.)

None

Short Circuit

(Summary of impacted circuit breakers)

None

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. "Network Impacts", initially caused by the addition of this project generation)

None

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)

None

Steady-State Voltage Requirements

(Results of the steady-state voltage studies should be inserted here)

To be determined

Short Circuit

(Summary of impacted circuit breakers)

To be determined

Affected System Analysis & Mitigation

To be determined

Energy Portion of Interconnection Request

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.

Only the most severely overloaded conditions are listed. 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 will study all overload conditions associated with the overloaded element(s) identified.

AA2-148 Delivery of Energy Portion of Interconnection Request

Item	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Loading % Initial	Loading % Final	Rating Type	Rating MVA	MW Contribution
1	N-1	4817_B2_TOR6341	AEP - AEP	05DESOTO-05SORENS 345 kV line	243218	243232	100.74	103.06	NR	971	22.50
2	N-1	8702_B2_TOR2543	AEP - AEP	05KEYSTN-05SORENS 345 kV line	243225	243232	126.52	128.99	NR	897	22.19
3	N-1	674_B3_05DESOTO 345-1_WOMOP	AEP - AEP	05HOGAN-05DELAWR 138 kV line	243311	243275	105.97	112.1	ER	179	12.91
4	Non	None	AEP - AEP	05HOGAN-05DELAWR 138 kV line	243311	243275	90.01	100.12	NR	138	16.19
5	N-1	8181_B2_TOR13901756	AEP - AEP	W4-004 C-05MADISO 138 kV line	247588	243333	80.63	158.74	ER	223	174.2
6	Non	None	AEP - AEP	W4-004 C-05MADISO 138 kV line	247588	243333	78.7	139.26	NR	191	115.67
7	N-1	8182_B2_TOR14001756	AEP - AEP	W4-004 C-05TANNER 138 kV line	247588	243382	87.71	172.68	ER	205	174.2
8	N-1	8468_B2	OVEC - AEP	06KYGER-05SPORN 345 kV line	248005	242528	104.21	105.35	NR	1017	13.57
9	N-1	349_B2_TOR21	OVEC - AEP	06KYGER-05SPORN 345 kV line	248005	242528	114.21	115.39	NR	971	13.57
10	N-1	8182_B2_TOR14001756	AEP - AEP	TANNER-W4-004 C 138 kV line	243382	247588	87.0	215.1	ER	205	262.61
11	N-1	8181_B2_TOR13901756	AEP - AEP	MADISON-W4-004C 138 kV line	243333	247588	91.6	187	ER	223	212.74
12	N-1	362_B2_TOR1680	AEP - AEP	MADISON-W4-004 C 138 kV line	243333	247588	66.0	116.6	ER	223	112.84
13	LFFB	8713	AEP - AEP	MADISON-W4-004 C 138 kV line	243333	247588	75.0	125.5	ER		
14	LFFB	6871_C2_05DESOTO 345-C2’	AEP - AEP	MADISON-W4-004 C 138 kV line	243333	247588	67.0	117.8	ER		
15	Non	None	AEP - AEP	CROSSS-MADISON 138 kV line	243270	243333	106.6	116.2	NR	167	16.03
16	N-1	8702_B2_TOR2543’	AEP - AEP	KEYSTONE-SORENSON 345 kV line	243225	243232	107.6	110.8	NR	897	27.70

Table 4a

AA2-148 Delivery of Energy Portion of Interconnection Request						
Item	**Name**	**Contingency Description**	**Overloaded Facility Description**	**Limiting Element**	**Mitigation**	**EstimatedCost**
1	4817_B2_TOR6341	OPEN BRANCH FROM BUS 243225 TO BUS 243232 CKT 1 / 243225 05KEYSTN 345 243232 05SORENS 345 1 END	(AEP - AEP) The 05DESOTO-05SORENS 345 kV line (from bus 243218 to bus 243232 ckt 2) loads from 100.74% to 103.06% (DC power flow) of its normal rating (971 MVA) for the single line contingency outage of '4817_B2_TOR6341'. This project contributes approximately 22.5 MW to the thermal violation.	ACSR/PE ~ 1414 ~ 62/19 ~ Conductor section 1	This overload will expose project AA2-148 to curtailment for the summer peak conditions. The IC may choose to upgrade the ACSR 1414 conductor section 1 to mitigate this overload.	
2	8702_B2_TOR2543	OPEN BRANCH FROM BUS 243218 TO BUS 243232 CKT 2 / 243218 05DESOTO 345 243232 05SORENS 345 2 END	(AEP - AEP) The 05KEYSTN-05SORENS 345 kV line (from bus 243225 to bus 243232 ckt 1) loads from 126.52% to 128.99% (DC power flow) of its normal rating (897 MVA) for the single line contingency outage of '8702_B2_TOR2543'. This project contributes approximately 22.19 MW to the thermal violation.	ACSR/PE ~ 1275 ~ 54/19 Conductor section 1	This overload will expose project AA2-148 to curtailment for the summer peak conditions. The IC may choose to upgrade the ACSR 1275 conductor section 1 to mitigate this overload.	
3	674_B3_05DESOTO 345-1_WOMOP	CONTINGENCY '674_B3_05DESOTO 345-1_WOMOP' OPEN BRANCH FROM BUS 243218 TO BUS 243278 CKT 1 / 243218 05DESOTO 345 243278 05DESOTO 138 1 END	Hogan-Delaware 138 kV	tbd	tbd	
4	None	None	Hogan-Delaware 138 kV	tbd	tbd	
5	8181_B2_TOR13901756	OPEN BRANCH FROM BUS 243382 TO BUS 247588 CKT 1 / 243382 05TANNER 138 247588 W4-004 C 138 1 END	(AEP - AEP) The W4-004 C-05MADISO 138 kV line (from bus 247588 to bus 243333 ckt 1) loads from 80.63% to 158.74% (DC power flow) of its emergency rating (223 MVA) for the single line contingency outage of '8181_B2_TOR13901756'. This project contributes approximately 174.2 MW to the thermal violation.	Madison Bus/Riser (switch to bus), Madison Wavetrap, Madison Riser (switch to line), and ACSR 636 conductor section 1	This overload will expose project AA2-148 to curtailment for the summer peak conditions. The IC may choose to upgrade the Madison Bus/Riser (switch to bus), Madison Wavetrap, Madison Riser (switch to line), and ACSR 636 conductor section 1 to mitigate this overload.	
6	None	None	(AEP - AEP) The W4-004 C-05MADISO 138 kV line (from bus 247588 to bus 243333 ckt 1) loads from 78.7% to 139.26% (DC power flow) of its normal rating (191 MVA) for non-contingency condition. This project contributes approximately 115.67 MW to the thermal violation.	Madison Bus/Riser (switch to bus), Madison Wavetrap, Madison Riser (switch to line), and ACSR 636 conductor section 1	This overload will expose project AA2-148 to curtailment for the summer peak conditions. The IC may choose to upgrade the Madison Bus/Riser (switch to bus), Madison Wavetrap, Madison Riser (switch	

AA2-148 Delivery of Energy Portion of Interconnection Request						
Item	**Name**	**Contingency Description**	**Overloaded Facility Description**	**Limiting Element**	**Mitigation**	**EstimatedCost**
					to line), and ACSR 636 conductor section 1 to mitigate this overload.	
7	8182_B2_TOR14001756	OPEN BRANCH FROM BUS 243333 TO BUS 247588 CKT 1 / 243333 05MADISO 138 247588 W4-004 C 138 1 END	(AEP - AEP) The W4-004 C-05TANNER 138 kV line (from bus 247588 to bus 243382 ckt 1) loads from 87.71% to 172.68% (DC power flow) of its emergency rating (205 MVA) for the single line contingency outage of '8182_B2_TOR14001756'. This project contributes approximately 174.2 MW to the thermal violation.	Tanners Creek Riser (to breaker), Tanners Creek Wavetrap, Tanners Creek Riser (to line), Tanners Creek Bus/Riser (to breaker), and ACSR 636 conductor section 1	This overload will expose project AA2-148 to curtailment for the summer peak conditions. The IC may choose to upgrade the Tanners Creek Bus/Riser (to breaker), Tanners Creek Wavetrap, Tanners Creek Riser (to line), Tanners Creek Riser (to breaker), and ACSR 636 conductor section 1 to mitigate this overload.	
8	8468_B2	OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 2 / 242528 05SPORN 345 248005 06KYGER 345 2 END	(OVEC - AEP) The 06KYGER-05SPORN 345 kV line (from bus 248005 to bus 242528 ckt 1) loads from 104.2% to 105.34% (DC power flow) of its normal rating (1017 MVA) for the single line contingency outage of '8468_B2'. This project contributes approximately 13.57 MW to the thermal violation.	Kyger Creek Riser	This overload will expose project AA2-148 to curtailment for the summer peak conditions. The IC may choose to upgrade the Kyger Creek Riser to mitigate this overload.	
9	349_B2_TOR21	OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 1 / 242528 05SPORN 345 248005 06KYGER 345 1 END	(OVEC - AEP) The 06KYGER-05SPORN 345 kV line (from bus 248005 to bus 242528 ckt 2) loads from 114.2% to 115.38% (DC power flow) of its normal rating (971 MVA) for the single line contingency outage of '349_B2_TOR21'. This project contributes approximately 13.57 MW to the thermal violation.	ACSR/PE ~ 1414 ~ 62/19 ~ conductor section 1, OVEC conductor section 2, and Kyger Creek Risers	This overload will expose project AA2-148 to curtailment for the summer peak conditions. The IC may choose to upgrade the Kyger Creek Riser, and ACSR 1414 conductor section 1 to mitigate this overload. PJM will have to coordinate with OVEC to address their violations since this is a tie-line.	
10	8182_B2_TOR14001756	END	OPEN BRANCH FROM BUS 243333 TO BUS 247588 CKT 1 / 243333 05MADISO 138 247588 W4-004 C 138 1 END	Tanners Creek Riser (to breaker), Tanners Creek Wavetrap, Tanners Creek Riser (to line), Tanners Creek Bus/Riser (to breaker), Tanners Creek Switch, and ACSR 636 conductor section 1,	This overload will expose project AA2-148 to curtailment for the summer peak conditions. The IC may choose to upgrade the Tanners Creek Bus/Riser (to breaker), Tanners Creek Wavetrap, Tanners Creek Riser (to line), Tanners Creek Riser (to breaker), Tanners Creek Switch, and ACSR 636 conductor section 1 to mitigate this overload.	

AA2-148 Delivery of Energy Portion of Interconnection Request						
Item	**Name**	**Contingency Description**	**Overloaded Facility Description**	**Limiting Element**	**Mitigation**	**EstimatedCost**
11	8181_B2_TOR13901756	'8181_B2_TOR13901756'	OPEN BRANCH FROM BUS 243382 TO BUS 247588 CKT 1 / 243382 05TANNER 138 247588 W4-004 C 138 1 END	The MADISON (243333) to W4-004 C (247588)138 kV line loads from 91.6% 187% of its emergency rating (223 MVA) for the single line contingency outage of '8181_B2_TOR13 901756'	Madison Bus/Riser (switch to bus), Madison Wavetrap, Madison Riser (switch to line), Madison Switch, Madison Riser (switch to breaker), and ACSR 636 conductor section 1	
12	362_B2_TOR1680	OPEN BRANCH FROM BUS 243207 TO BUS 243208 CKT 1 / 243207 05GRNTWN 765 243208 05JEFRSO 765 1 END	The MADISON (243333) to W4-004 C (247588)138 kV line loads from 66.0% 116.6% of its emergency rating (223 MVA) for the single line contingency outage of '362_B2_TOR1680'	Madison Bus/Riser (switch to bus), Madison Wavetrap, Madison Riser (switch to line), and ACSR 636 conductor section 1	This overload will expose project AA2-148 to curtailment for the summer peak conditions. The IC may choose to upgrade the Madison Bus/Riser (switch to bus), Madison Wavetrap, Madison Riser (switch to line), and ACSR 636 conductor section 1 to mitigate this overload.	
13	8713	OPEN BRANCH FROM BUS 243218 TO BUS 243232 CKT 2 / 243218 05DESOTO 345 243232 05SORENS 345 2 OPEN BRANCH FROM BUS 243218 TO BUS 247508 CKT 1 / 243218 05DESOTO 345 247508 U2-090 C 345 1 OPEN BRANCH FROM BUS 243218 TO BUS 247508 CKT 2 / 243218 05DESOTO 345 247508 U2-090 C 345 2 END	The MADISON (243333) to W4-004 C (247588)138 kV line loads from 75.0% 125.5% of its emergency rating for breaker contingency outage of '8713'	Madison Bus/Riser (switch to bus), Madison Wavetrap, Madison Riser (switch to line), and ACSR 636 conductor section 1	Replace Madison Wavetrap, Madison Bus/Riser (switch to bus), Madison Riser (switch to line), and a sag study will be required for the ACSR 636 conductor section 1	
14	6871_C2_05DESOTO 345-C2'	OPEN BRANCH FROM BUS 243218 TO BUS 247508 CKT 2 / 243218 05DESOTO 345 247508 U2-090 C 345 2 OPEN BRANCH FROM BUS 243218 TO BUS 243278 CKT 1 / 243218 05DESOTO 345 243278 05DESOTO 138 1 END	The MADISON (243333) to W4-004 C (247588) 138 kV line loads from 67.0% 117.8% of its emergency rating for breaker contingency outage of '6871_C2_05DESOTO 345-C2'	Madison Bus/Riser (switch to bus), Madison Wavetrap, Madison Riser (switch to line), and ACSR 636 conductor section 1	Replace Madison Wavetrap, Madison Bus/Riser (switch to bus), Madison Riser (switch to line), and a sag study will be required for the ACSR 636 conductor section 1	
15	None	None	The CROSSS (243270) to HOGAN (243311) 138 kV line loads from 99.9% to 109.4 of its normal rating (167 MVA) for non-contingency condition.	ACSR ~ 397.5 ~ 30/7 ~ LARK Conductor section 1	This overload will expose project AA2-148 to curtailment for the summer peak conditions. The IC may choose to upgrade the ACSR 397 conductor section 1 to mitigate this overload.	

AA2-148 Delivery of Energy Portion of Interconnection Request						
Item	**Name**	**Contingency Description**	**Overloaded Facility Description**	**Limiting Element**	**Mitigation**	**EstimatedCost**
16	8702_B2_TOR2543’	OPEN BRANCH FROM BUS 243218 TO BUS 243232 CKT 2 / 243218 05DESOTO 345 243232 05SORENS 345 2 END	The KEYSTONE (243225) to SORENSON (243232) 345 kV line loads from 107.6% to 110.8% of its normal rating (897 MVA) for single line contingency outage of ‘8702_B2_TOR2543’	ACSR/PE ~ 1275 ~ 54/19 Conductor section 1	This overload will expose project AA2-148 to curtailment for the summer peak conditions. The IC may choose to upgrade the ACSR 1275 conductor section 1 to mitigate this overload.	

Table 4b

Light Load Analysis - 2019

Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B).

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Additional Interconnection Customer Responsibilities:

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.

3. The Interconnection Customer seeking to interconnect a wind generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per item 5.iv. of Schedule H to the Interconnection Service Agreement.

Appendices

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gage other generators impact.

It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

Appendix 1

(DEO&K - DEO&K) The 08M.FTHS 345/138 kV transformer (from bus 249568 to bus 250057 ckt 9) loads from 97.78% to 100.35% (**DC power flow**) of its emergency rating (475 MVA) for the line fault with failed breaker contingency outage of '6870_C2_05TANNER 345-Q1'. This project contributes approximately 14.35 MW to the thermal violation.

CONTINGENCY '6870_C2_05TANNER 345-Q1'
OPEN BRANCH FROM BUS 243233 TO BUS 248001 CKT Z1 / 243233 05TANNER 345 248001 06DEARB1 345 Z1
OPEN BRANCH FROM BUS 243233 TO BUS 249565 CKT 1 / 243233 05TANNER 345 249565 08EBEND 345 1
OPEN BRANCH FROM BUS 243233 TO BUS 247515 CKT 2 / 243233 05TANNER 345 247515 V4-033 C 345 2
OPEN BRANCH FROM BUS 248000 TO BUS 248001 CKT 1 / 248000 06CLIFTY 345 248001 06DEARB1 345 1
OPEN BRANCH FROM BUS 248001 TO BUS 248013 CKT 1 / 248001 06DEARB1 345 248013 06PIERCE 345 1
END

Bus Number	*Bus Name*	*Full Contribution*
243226	*05LAWBG1*	*9.43*
243227	*05LAWBG2*	*9.43*
243233	*05TANNER*	*136.02*
243382	*05TANNER*	*43.77*
251949	*08M.FRT6*	*-22.32*
247920	*U2-090 E*	*11.84*
247543	*V3-007 C*	*1.77*
247935	*V3-007 E*	*11.84*
247544	*V3-008 C*	*1.77*
247936	*V3-008 E*	*11.84*
247545	*V3-009 C*	*1.77*
247937	*V3-009 E*	*11.84*
247515	*V4-033 C*	*2.65*

247923	*V4-033 E*	*17.75*
247588	*W4-004 C*	*0.96*
247946	*W4-004 E*	*6.45*
247589	*W4-008 C*	*0.96*
247953	*W4-008 E*	*6.45*
913222	*Y1-054 E*	*-1.08*
916182	*Z1-065 E*	*0.47*
920501	*AA2-148 C OP*	*1.87*
920502	*AA2-148 E OP*	*12.47*

Sensitivity Analysis for Option 2 - A Direct Connection to Madison 138 kV Substation

Network Impacts

The Queue Project AA2-148 was evaluated as a 174.2 MW (Capacity 22.8 MW) injection at Madison 138 kV substation in the AEP area. Project AA2-148 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AA2-148 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis - 2019

Generator Deliverability

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

None

Multiple Facility Contingency

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

None

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)

1. (AEP - AEP) The 05DESOTO-05JAY 138 kV line (from bus 243278 to bus 243319 ckt 1) loads from 120.2% to 123.33% (**DC power flow**) of its emergency rating (302 MVA) for the tower line contingency outage of '6872'. This project contributes approximately 11.1 MW to the thermal violation.

CONTINGENCY '6872'
OPEN BRANCH FROM BUS 243218 TO BUS 243225 CKT 1 / 243218 05DESOTO 345 243225 05KEYSTN 345 1
OPEN BRANCH FROM BUS 243218 TO BUS 243232 CKT 2 / 243218 05DESOTO 345 243232 05SORENS 345 2
OPEN BRANCH FROM BUS 243218 TO BUS 247508 CKT 1 / 243218 05DESOTO 345 247508 U2-090 C 345 1
END

Please refer to Appendix 1 for a table containing the generators having contribution to this flowgate.

Steady-State Voltage Requirements
(Results of the steady-state voltage studies should be inserted here)

To be determined

Affected System Analysis & Mitigation

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

Delivery of Energy Portion of Interconnection Request
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.
Only the most severely overloaded conditions are listed. 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 will study all overload conditions associated with the overloaded element(s) identified.

1. (AEP - AEP) The 05DESOTO-05SORENS 345 kV line (from bus 243218 to bus 243232 ckt 2) loads from 100.77% to 103.37% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '4817_B2_TOR6341'. This project contributes approximately 25.21 MW to the thermal violation.

CONTINGENCY '4817_B2_TOR6341'
OPEN BRANCH FROM BUS 243225 TO BUS 243232 CKT 1 / 243225 05KEYSTN 345 243232 05SORENS 345 1
END

2. (AEP - AEP) The 05KEYSTN-05SORENS 345 kV line (from bus 243225 to bus 243232 ckt 1) loads from 126.55% to 129.32% (**DC power flow**) of its normal rating (897 MVA) for the single line contingency outage of '8702_B2_TOR2543'. This project contributes approximately 24.87 MW to the thermal violation.

CONTINGENCY '8702_B2_TOR2543'
OPEN BRANCH FROM BUS 243218 TO BUS 243232 CKT 2 / 243218 05DESOTO 345 243232 05SORENS 345 2
END

3. (AEP - AEP) The 05HOGAN-05DELAWR 138 kV line (from bus 243311 to bus 243275 ckt 1) loads from 104.75% to 115.55% (**DC power flow**) of its emergency rating (179 MVA) for the single

line contingency outage of '674_B3_05DESOTO 345-1_WOMOP'. This project contributes approximately 19.34 MW to the thermal violation.

CONTINGENCY '674_B3_05DESOTO 345-1_WOMOP'
OPEN BRANCH FROM BUS 243218 TO BUS 243278 CKT 1 / 243218 05DESOTO 345 243278 05DESOTO 138 1
END

4. (AEP - AEP) The 05HOGAN-05DELAWR 138 kV line (from bus 243311 to bus 243275 ckt 1) loads from 89.65% to 106.88% (**DC power flow**) of its normal rating (138 MVA) for non-contingency condition. This project contributes approximately 23.79 MW to the thermal violation.

5. (OVEC - AEP) The 06KYGER-05SPORN 345 kV line (from bus 248005 to bus 242528 ckt 1) loads from 104.19% to 105.19% (**DC power flow**) of its normal rating (1017 MVA) for the single line contingency outage of '8468_B2'. This project contributes approximately 11.94 MW to the thermal violation.

CONTINGENCY '8468_B2'
OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 2 / 242528 05SPORN 345 248005 06KYGER 345 2
END

6. (OVEC - AEP) The 06KYGER-05SPORN 345 kV line (from bus 248005 to bus 242528 ckt 2) loads from 114.19% to 115.23% (**DC power flow**) of its normal rating (971 MVA) for the single line contingency outage of '349_B2_TOR21'. This project contributes approximately 11.94 MW to the thermal violation.

CONTINGENCY '349_B2_TOR21'
OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 1 / 242528 05SPORN 345 248005 06KYGER 345 1
END

Light Load Analysis - 2019

Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B).

System Reinforcements

Short Circuit
(Summary form of Cost allocation for breakers will be inserted here if any)

Bus Number	Bus Name	BREAKER	Rating Type	Breaker Capacity (Amps)	Duty Percent With AA2-148_AEP_opt2	Duty Percent Without AA2-148_AEP_opt2	Duty Percent Difference
1177	05MADISO 138.kV	V	T	19999.8	104.40%	90.11%	14.29%

Stability and Reactive Power Requirement

(Results of the dynamic studies should be inserted here)

To be determined

Appendices

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gage other generators impact.

It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

Appendix 1

(AEP - AEP) The 05DESOTO-05JAY 138 kV line (from bus 243278 to bus 243319 ckt 1) loads from 120.2% to 123.33% (**DC power flow**) of its emergency rating (302 MVA) for the tower line contingency outage of '6872'. This project contributes approximately 11.1 MW to the thermal violation.

CONTINGENCY '6872'
OPEN BRANCH FROM BUS 243218 TO BUS 243225 CKT 1 / 243218 05DESOTO 345 243225 05KEYSTN 345 1
OPEN BRANCH FROM BUS 243218 TO BUS 243232 CKT 2 / 243218 05DESOTO 345 243232 05SORENS 345 2
OPEN BRANCH FROM BUS 243218 TO BUS 247508 CKT 1 / 243218 05DESOTO 345 247508 U2-090 C 345 1
END

Bus Number	Bus Name	Full Contribution
247914	05WLD G1 E	4.26
247958	05WLD G2 E	4.47
247920	U2-090 E	11.06
247543	V3-007 C	1.65
247935	V3-007 E	11.06
247544	V3-008 C	1.65
247936	V3-008 E	11.06
247545	V3-009 C	1.65
247937	V3-009 E	11.06
247515	V4-033 C	2.36
247923	V4-033 E	15.82
920501	AA2-148 C OP	1.45
920502	AA2-148 E OP	9.65