Appendix G

Feasibility Study

pjm

VIA FEDERAL EXPRESS
Confidential

January 11, 2010

Mr. Scott Haffner
Northwest Ohio Wind Energy
c/o National Wind, L.L.C.
3033 Excelsior Blvd, Suite 525
Minneapolis, MN 55416

Dear Scott

HAVILAND 138kV 150 MW (V1-011) FEASIBILITY STUDY

Attached is a report documenting the results of the Haviland 138kV (V1-011) Feasibility Study. The results of this Feasibility Study are predicated on a year 2013 transmission system based upon PJM's best assumptions at the present time for load growth and connection of proposed new generation additions. The project was evaluated for system normal conditions and single contingency outage conditions. In addition, tower line outages, which are anticipated to have a significant cost or timing impact on the interconnection of the project, were assessed. Short circuit analysis was performed and stability analysis was not performed.

Feasibility studies are performed to provide the generation developer with ballpark reinforcement cost and timing information concerning both direct connection facilities and potential transmission network upgrades. The analysis inherently has to include assumptions regarding existing uncertainties; therefore, the results should be used in this context.

Pursuant to Section 204 of the PJM Tariff, enclosed is a copy of an Impact Study Agreement for your consideration. The Agreement must be executed within thirty days **(by close of business on February 11, 2010)** to maintain the project's position in the queue. In order to expedite initiation of the Impact Study, please provide the information requested on this link, http://www.pjm.com/planning/form-impact-study-data.html, and submit it electronically. We will need this information by **February 11, 2010.**

The cost for the Feasibility Study is being tabulated and you will receive an invoice in the near future.

The following information is provided for wire transfers: Bank: PNC Bank, NA, New Jersey; ABA Number: 031-207-607; Account Number: 8013589826. Please e-mail Jeannette Mittan at mittaj@pjm.com with the project name, queue number, date and amount of wire.

Sincerely,

John W. Fedorko
Sr. Consultant/Engineer
System Planning Department

JWF\nbm #574593
Attachments

cc: Via U.S. Mail (w/attachment):
Craig Lockwood – AEP

PJM Office of the Interconnection (w/attachment):
Rob Price - PJM

PJM Generator Interconnection Request
Queue #V1-011
Haviland 138kV
Feasibility Study

574579
January 2010

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.

V1-011 Haviland 138kV Feasibility Study

General

Northwest Ohio Wind Energy (Northwest) proposes to install PJM Project #V1-011, a 150 MW generating facility comprised of 75 Suzlon S88 2.1 MW wind turbine generators. This generation facility would connect to the American Electric Power (AEP) Haviland 138 kV Station. The proposed locations of the generating facilities are located in Paulding and Van Wert counties (See Exhibit 1). The projected in-service date is requested for Febuary 2011.

Direct Connection

The proposed generation project will be connected at Haviland Station via a new 138 kV circuit breaker (See Exhibit 2). Additional protection schemes will need to be added at the station and 138 kV metering will need to be installed.

It is understood that Northwest will be responsible for the all costs associated with construction, as well as facilities associated with connecting their 150 MW generation to Haviland Station. Note that Northwest station facilities and any facilities outside of Haviland station were not included in the cost estimates. These are assumed to be Northwest's responsibility.

The AEP construction scope for the attachment facilities:

- Construction of a new 138 kV circuit breaker and associated equipment at Haviland Station, including 138 kV metering and relaying. It is expected that substantial line and bus work will need to be completed at Haviland Station to facilitate the new 138 kV circuit breaker.
  Estimated Cost (2009 Dollars): $3,500,000

Total Attachment Facilities Cost*: **$3,500,000**

*The 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. It will take approximately 12-18 months after obtaining the authorization to construct the facilities as outlined above.

Network Impacts

The Queue Project #V1-011 was studied as a(n) 150.0MW(Capactiy19.5MW) injection at Haviland_138kV substation in the AEP area. Project #V1-011 was evaluated for compliance with reliability criteria for summer peak conditions in 2013. Potential network impacts were as follows:

Generator Deliverability

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

No problems were identified.

Multiple Facility Contingency

(Double Circuit Tower Line contingencies only for the full energy output. Stuck breaker and bus fault contingencies will be performed for the Impact Study)

1. The T-131 Tap –North Delphos 138 kV line (from bus 924420 to bus 23181 ckt 1) loads to 132.27% (DC power flow) of its normal rating (192 MVA) for the tower line contingency outage of the Tillman-S73 and Lincoln-S73 138kV circuits. This project contributes approximately 40.35 MW to cause the thermal violation

2. (Identified by AEP) The North Delphos 138/69 kV transformer is overloaded to 116% of its 120 MVA emergency rating for a tower outage impacting both the Haviland – East Lima 138 kV line and the East Side – Sterling 138 kV line. This project contributes approximately 8.5 MVA to the thermal violation.

Short Circuit

No problems identified.

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. The T-131 Tap-North Delphos 138 kV line (from bus 924420 to bus 23181 ckt 1) loads from 111.26% to 132.27% (DC power flow) of its normal rating (192 MVA) for the tower line contingency ('TILLMAN-S73_LINCOLN-S73'). This project contributes approximately 40.35 MW to cause the thermal violation.

2. The Lincoln-Anthony 138 kV line (from bus 23476 to bus 23411 ckt 1) loads from 100.3% to 101.04% (DC power flow) of its normal rating (201 MVA) for the tower line contingency ('D|05ALLEN-05ROB PK-05CONVOY-345'). This project contributes approximately 9.28 MW to cause the thermal violation.

3. (Identified by AEP) The Haviland – Paulding 69 kV line is overloaded to 112% of its 50 MVA emergency rating for the Antwerp – R48 69 kV line outage. This project contributes approximately 10 MVA to cause the thermal violation.

New System Reinforcements

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

1. The overload on the T131-North Delphos line can be alleviated by rebuilding approximately 25 miles (depending upon the location of the T131 interconnection) of

138kV line between T131 and North Delphos. The rebuild requires new line conductor and replacement of 16 miles of existing tower structures. The estimated cost in 2009 dollars is **$33 million****. The 138kV risers also need to be replaced at the North Delphos station. The estimated cost in 2009 dollars is **$10,000.**

**This estimate is preliminary in nature, as it was determined without the benefit of detailed engineering studies. It is possible that detailed engineering studies would show that a larger conductor can be used on the existing towers. Final estimates will require an on-site review and coordination to determine final construction requirements. It will take approximately 18-24 months after obtaining a signed agreement to construct the facilities as outlined above.

2. The overload on the North Delphos transformer can be alleviated by replacing the transformer and associated equipment with that of a higher rating. The estimated cost in 2009 dollars is **$2 million.**

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)

1. The overload on the T131-North Delphos line can be alleviated by rebuilding approximately 25 miles (depending upon the location of the T131 interconnection) of 138kV line between T131 and North Delphos. The rebuild requires new line conductor and replacement of 16 miles of existing tower structures. The estimated cost in 2009 dollars is **$33 million****. The 138kV risers also need to be replaced at the North Delphos station. The estimated cost in 2009 dollars is **$10,000.**

**This estimate is preliminary in nature, as it was determined without the benefit of detailed engineering studies. It is possible that detailed engineering studies would show that a larger conductor can be used on the existing towers. Final estimates will require an on-site review and coordination to determine final construction requirements. It will take approximately 18-24 months after obtaining a signed agreement to construct the facilities as outlined above.

1. The overload on the Lincoln-Anthony 138kV circuit can be alleviated by replacing 138 kV circuit breaker "D" and associated equipment at Lincoln Station. The existing circuit breaker is only rated for 201 MVA and needs to be upgraded to accommodate PJM Project #R03 and #S73. The control relay for the circuit breaker as well as the control cables will also need to be upgraded as part of this project. (Network Upgrade # n1028)

   Estimated Cost (2009 Dollars)*: **$269,000**

1. The overload on the Haviland-Paulding 69kV circuit can be alleviated by rebuilding 10.72 miles of 69 kV line between Haviland and Paulding Stations. (Network Upgrade #n1469)

Estimated Cost (2009 Dollars)*: **$3,870,000**

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. The S73A -Lincoln 138 kV line (from bus 90794 to bus 23476 ckt 1) loads from 137.79% to 165.41% (DC power flow) of its rating (192 MVA) for the single line contingency ('5205_B2_TOR769_S73A'). This project contributes approximately 53.03 MW to cause the thermal violation.

2. The S73A -Lincoln 138 kV line (from bus 90794 to bus 23476 ckt 1) loads from 126.63% to 152.78% (DC power flow) of its normal rating (156 MVA) for non-contingency condition. This project contributes approximately 40.8 MW to cause the thermal violation.

3. The Milan-Harper 138 kV line (from bus 23487 to bus 23457 ckt 1) loads from 125.07% to 151.93% (DC power flow) of its normal rating (143 MVA) for the single line contingency ('5206_B2_TOR770_WOMOAB_S73B'). This project contributes approximately 38.41 MW to cause the thermal violation.

4. The Milan-Harper 138 kV line (from bus 23487 to bus 23457 ckt 1) loads from 125.07% to 151.93% (DC power flow) of its normal rating (143 MVA) for the single line contingency ('5209_B2_TOR770C_MOAB'). This project contributes approximately 38.41 MW to cause the thermal violation.

5. The Milan-Harper 138 kV line (from bus 23487 to bus 23457 ckt 1) loads from 89.46% to 109.28% (DC power flow) of its normal rating (111 MVA) for non-contingency condition. This project contributes approximately 22 MW to cause the thermal violation.

6. The Tillman-Milan 138 kV line (from bus 23519 to bus 23487 ckt 1) loads from 106.77% to 127.65% (DC power flow) of its normal rating (184 MVA) for the single line contingency ('5209_B2_TOR770C_MOAB'). This project contributes approximately 38.41 MW to cause the thermal violation.

7. The Tillman-Milan 138 kV line (from bus 23519 to bus 23487 ckt 1) loads from 106.77% to 127.65% (DC power flow) of its normal rating (184 MVA) for the single line contingency ('5206_B2_TOR770_WOMOAB_S73B'). This project contributes approximately 38.41 MW to cause the thermal violation.

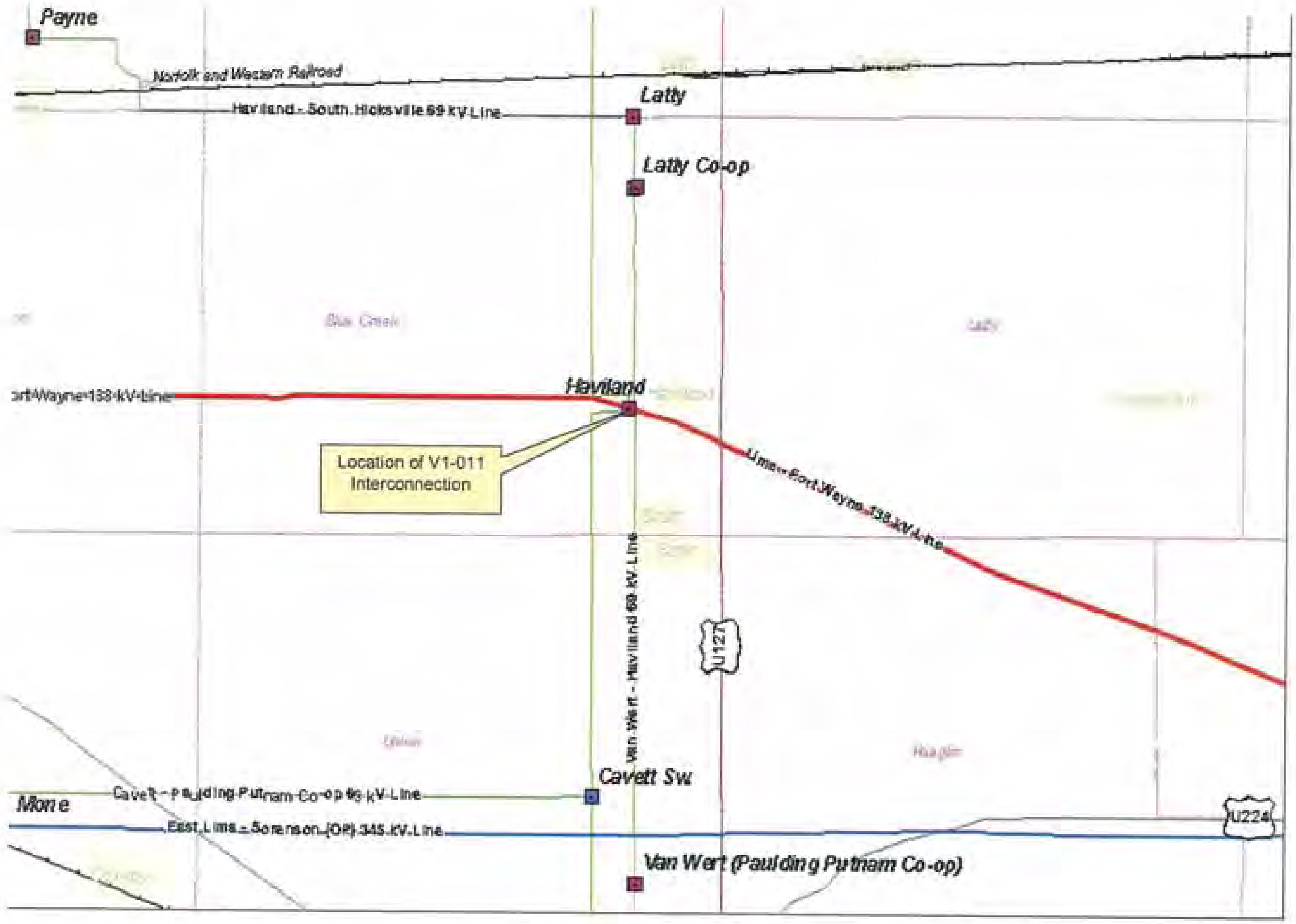

Exhibit 1: Interconnection location of the proposed facilities

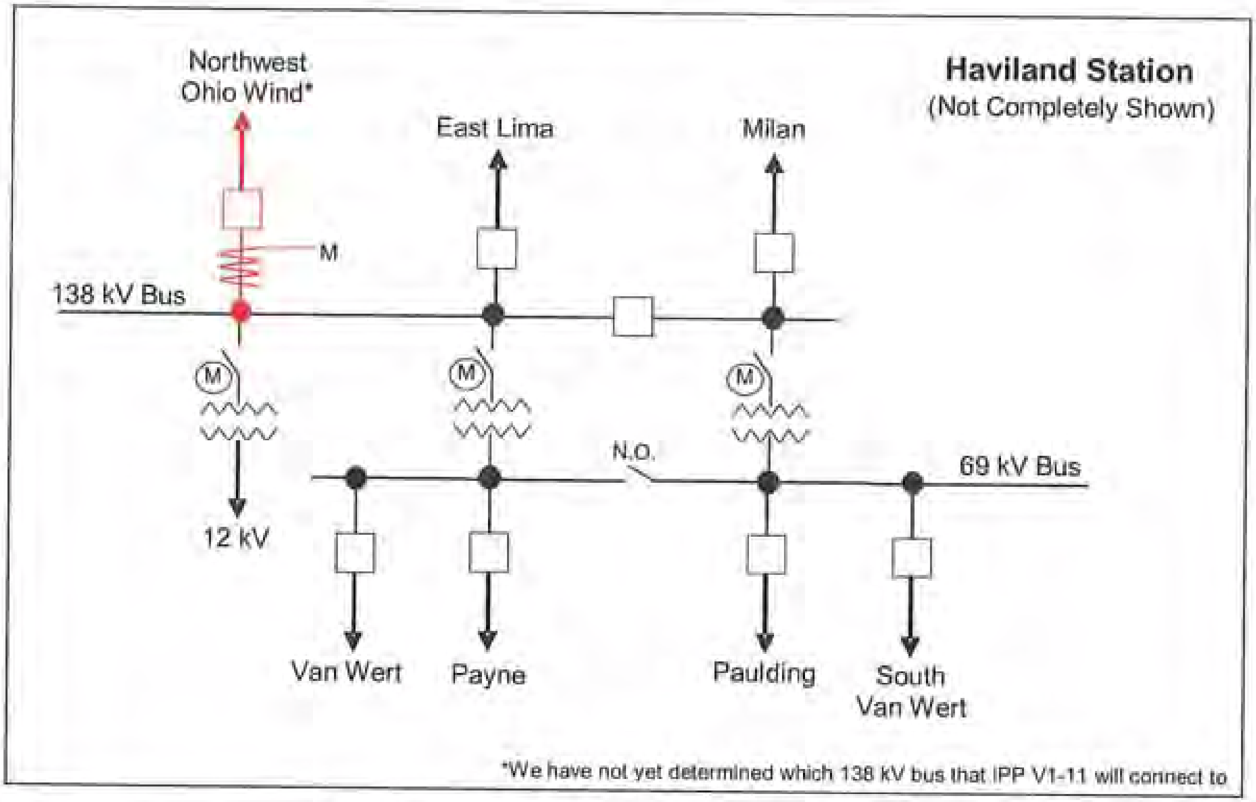

Exhibit 2: Simplified diagram of proposed 138 kV connection to Haviland Station

Appendix H

System Impact Study

VIA FEDERAL EXPRESS
Confidential

December 6, 2012

Mr. Marcus daCunha
National Wind
706 2nd Ave South, Suite 1200
Minneapolis, MN 55402

Dear Marcus:

HAVILAND 138kV 100 MW (V1-011) IMPACT STUDY (RE-TOOL)

Enclosed is a report documenting the results of the V1-011 Haviland 138kV Impact Study. The results of this Impact Study are predicated on a year 2014 transmission system based upon PJM's best assumptions at the present time for load growth and connection of proposed new generation additions. The project was evaluated for system normal conditions, single contingency, second contingency after readjustment and multiple facility outages as defined in the Reliability Criteria.

Impact studies are performed to define the reinforcement cost and timing for both direct connection facilities and transmission network upgrades required for reliable interconnection of a generation project to the transmission system.

The direct connection costs and timing for the V1-011 Haviland 138kV project described in the enclosed report are based upon estimates given to PJM by AEP and are your responsibility as the project developer.

The Impact Study network evaluation has identified that there are network reinforcements required for the V1-011 Haviland 138kV project.

Pursuant to Section 206 of the PJM Tariff, a Facilities Study Agreement, defining the estimated cost and duration for the engineering design of the required network facilities, is included with this letter. The Agreement must be executed, and a **$112,400** deposit needs to be forwarded to PJM Interconnection, LLC within thirty days (no later than close of business on **January 7, 2013**) of receipt, in order to maintain the project's position in the queue.

As a reminder, there are specific milestones, which must be met within 60 days of receipt of the Facilities Study report, described in Section 212.4 and 212.5 of the PJM Tariff. These include returning the tendered Interconnection Service Agreement, and demonstrating that you have (i) entered a fuel delivery agreement and water agreement, if necessary, and that you control any necessary rights-of-way for fuel and water interconnections, (ii) obtained any necessary local, county, and state site permits, and (iii) signed a memorandum of understanding for the acquisition of major equipment.

The following information is provided for wire transfers: Bank: PNC Bank, NA, New Jersey; ABA Number: 031-207-607; Account Number: 8013589826. Please e-mail Jeannette Mittan at mittaj@pjm.com with the project name, queue number, date and amount of wire.

Letters of Credit ("L/C"): The Letter of Credit will only be accepted from U.S.-based financial institutions or U.S. branches of foreign financial institutions that have a minimum corporate debt rating of "A" by Standard & Poor's or Fitch Ratings, or "A2" from Moody's Investors Service, or an equivalent short term rating from one of these agencies. PJM will consider the lowest applicable rating to be the rating of the financial institution. If the rating of a financial institution providing a Letter of Credit is lowered below A/A2 by any rating agency, then PJM may require the Participant to provide a Letter of Credit from another financial institution that is rated A/A2 or better, or to provide a cash deposit. If a Letter of Credit is provided from a U.S. branch of a foreign institution, the U.S. branch must itself comply with the terms of this credit policy, including having its own acceptable credit rating. Any questions regarding whether a financial institution is acceptable or not should be addressed to: Jay Niemeyer (niemej@pjm.com). **You may access the Standard Letter of Credit through the PJM webpage under Planning/RTEP Development/Expansion Planning Process.** Any deviation from the standard Letter of Credit form must be approved by PJM before the Letter of Credit is executed. Please allow at least two weeks for Letter of Credit review if any changes from the standard form are requested. If there are any questions, please contact Jeannette Mittan at mittaj@pjm.com or 610-666-3158.

Sincerely,

John W. Fedorko
Sr. Consultant/Engineer
System Planning Department

JWF\dml: #695059 V2
Enclosures

cc: Via U.S. Mail (w/enclosures):
Jon Riley – AEP

PJM Office of the Interconnection Staff (w/enclosures):
Jay Liu
File

PJM Generator Interconnection Request Queue #V1-011 Haviland 138kV Impact Study Report

(Retool after project reduced from 150 MW to 100 MW)

September 2012
#695430 v2

V1-011 Haviland 138kV Impact Study

(Retool after project reduced from 150 MW to 100 MW)

General

Northwest Ohio Wind Energy (Northwest) originally proposed to install PJM Project #V1-011, a 150 MW (19.5 MW capacity) wind generating facility. This report evaluates the project after a reduction of 50 MW to 100 MW. The point of interconnection evaluated is a single 138 kV breaker at Haviland 138 kV Station (Figure 2). The location of the wind generating facility is in Haviland, Ohio (Figure 1).

The requested in service date is July 1, 2013.

The intent of the Impact study is to determine system reinforcements and associated costs and construction time estimates required to facilitate the addition of the new generating plant to the transmission system. The reinforcements include the direct connection of the generator to the system and any network upgrades necessary to maintain the reliability of the transmission system.

Direct Connection

The interconnection evaluated is a single radial connection to a 138 kV circuit breaker connecting at Haviland 138 kV Station (Figure 2). Protection schemes will need to be modified and 138 kV revenue metering will need to be installed. Substantial line and bus work will need to be completed at Haviland Station to facilitate the new 138 kV circuit breaker. Northwest will be required to provide the necessary facilities from the project collector station to connect to the Haviland 138kV station.

The following work is required to connect to the Haviland 138 kV station:

- Install a new 138 kV breaker, disconnect switches, protective relaying, SCADA, 138 kV revenue metering, and associated equipment. Estimated Cost (2012 Dollars): $3,500,000.

Total Estimated Interconnection Cost (2012 Dollars): $3,500,000*

It is understood that Northwest will be responsible for all costs associated with connecting their 150 MW generation at Haviland 138 kV Station. Note that Northwest station facilities and any facilities outside of Haviland Station were not included in the cost estimates. These are assumed to be Northwest's responsibility. It will take

* The 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.

approximately 18 months after obtaining the authorization to construct the facilities as outlined above.

AEP Local Network Impacts

The impact of the proposed generating facility on the AEP System was assessed for adherence with applicable reliability criteria. AEP planning criteria require that the transmission system meet single contingency performance criteria in accordance with the AEP FERC Form 715. Therefore, this criterion was used to assess the impact of the proposed facility on the AEP System. Northwest project V1-011 was studied as a 100 MW (13 MW capacity) wind generating facility consistent with the interconnection application. Project #V1-011 was evaluated for compliance with reliability criteria for summer peak conditions in 2014. Potential network impacts were as follows:

Normal System – Capacity Output (2014 Summer Conditions Capacity Level)

- No problems identified.

Single Contingency (2014 Summer Conditions Capacity Level)

- No problems identified.

Multiple Contingency (2014 Summer Conditions Full Output)

- No problems identified

Short Circuit Analysis

- See results under Network Impacts.

Stability Analysis

- . See results under Network Impacts.

Normal System (2014 Summer Conditions Full Output)

- Tillman – R49 (Timber Switch) 138 kV line loads from 93.7% to 104.6% of its normal rating of 167 MVA for non-contingency condition.
    - The 397.5 ACSR conductor section 1 is the limiting element.
    - The overload on this line will expose project V1-011 to curtailment for summer peak conditions. Northwest Ohio Wind Energy can choose to upgrade the equipment to mitigate this overload.

- Milan - Harper 138 kV line loads from 93.0% to 105.3% of its normal rating 146 MVA for non-contingency condition.
    - The Milan riser and Milan switch (600A) are the limiting elements.

- The overload on this line will expose project V1-011 to curtailment for summer peak conditions. Northwest Ohio Wind Energy can choose to upgrade the equipment to mitigate this overload.

Single Contingency (2014 Summer Conditions Full Output)

- Tillman – R-049 (Timber Switch) 138 kV line loads from 93.7% to 110.9% of its emergency rating of 201 MVA for contingency 5206_B2.
    - The 397.5 ACSR conductor section 1 is the limiting element.
    - The overload on this line will expose project V1-011 to curtailment for summer peak conditions. Northwest Ohio Wind Energy can choose to upgrade the equipment to mitigate this overload.

Multiple Contingency (2014 Summer Conditions Full Output)

- See results under Network Impacts.

Contribution to Previously Identified Overloads (2014 Summer Conditions Full Output)

- Haviland 138 kV – Haviland 1 69 kV (Haviland #3 138/69/13 kV Transformer) transformer loads from 189% to 221.9% of its emergency rating (53 MVA) for the tower line contingency outage of Tillman –R49 138 kV line and Lincoln – T131 138 kV line.
    - Baseline upgrade. The in-service date for the new 90 MVA transformer is 12/31/2013.

- Tillman – Milan 138 kV line loads from 103.3% to 115.6% of its normal rating of 148 MVA for non-contingency condition.
    - The 397.5 ACSR conductor section 1, Milan riser, and Milan switch (600A) are the limiting elements.
    - The overload on this line will expose project V1-011 to curtailment for summer peak conditions. Northwest Ohio Wind Energy can choose to upgrade the equipment to mitigate this overload.

- Tillman – Milan 138 kV line loads from 110.5% to 131.4% of its emergency rating of 167 MVA for contingency 5206_B2.
    - The 397.5 ACSR conductor section 1, Milan riser, and Milan switch (600A) are the limiting elements.
    - The overload on this line will expose project V1-011 to curtailment for summer peak conditions. Northwest Ohio Wind Energy can choose to upgrade the equipment to mitigate this overload.

- Milan - Harper 138 kV line loads from 100.2% to 120.9% of its emergency rating of 167 MVA for contingency 5206_B2.

- The 397.5 ACSR conductor section 1, Milan riser, and Milan switch (600A) are the limiting elements.
- The overload on this line will expose project V1-011 to curtailment for summer peak conditions. Northwest Ohio Wind Energy can choose to upgrade the equipment to mitigate this overload.

Local/Network Upgrades

See network upgrades under the "Network Impacts" section.

Network Impacts

The Queue Project #V1-011 was studied as a(n) 100.0MW(Capacity 13.0MW) injection at Haviland 138 kV substation in the AEP area. Project #V1-011 was evaluated for compliance with reliability criteria for summer peak conditions in 2014. Potential network impacts were as follows:

Generator Deliverability

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

No problems identified.

Multiple Facility Contingency

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

1. The Haviland-East Lima 138 kV line (from bus 243017 to bus 242989 ckt 1) loads from 72.39% to 98.19% (AC power flow) of its emergency rating (205 MVA) for the tower line contingency outage of CONTINGENCY DESCRIPTION ('TILLMAN-R49_LINCOLN-T131'). This project contributes approximately 45.14 MW to the thermal violation.

   The Haviland-East Lima 138kV line becomes overloaded by the V1-012 project. Due to cost allocation rules, responsibility for network upgrades under $5 million are allocated to all projects in the queue in which the overload occurs.

2. The S-073A-North Delphos 138 kV line (from bus 290794 to bus 243051 ckt 1) loads from 84.64% to 106.33% (AC power flow) of its emergency rating (192 MVA) for the tower line contingency outage of CONTINGENCY DESCRIPTION ('TILLMAN-R49_LINCOLN-T131'). This project contributes approximately 34.64 MW to the thermal violation.

3. The Lincoln-Anthony 138 kV line (from bus 243330 to bus 243245 ckt 1) loads to 101.79% (AC power flow) of its emergency rating (201 MVA) for the tower line contingency outage of Allen to Sorenson 345 kV line and Convoy to Robison

Park 345 kV line ('419'). This project contributes approximately 5.79 MW to the thermal violation

Short Circuit

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

The following two circuit breakers were identified as over-dutied after the addition of the V1-011 project.

BUS_NO	BUS	BREAKER	Rating Type	Duty Percent With V1-011_AEP	Duty Percent Without V1-011_AEP	Duty Percent Difference	Note
0	05HAVILN 138.kV	I	T	[illegible]	[illegible]	21.30%	New Over-duty
0	05HAVILN 138.kV	H	T	[illegible]	[illegible]	19.80%	New Over-duty

Stability & LVRT Analysis

The original stability analysis is still valid and is included here.

PJM queue projects V1-011 and V1-012 are two new 150 MW interconnection requests tapping the existing Haviland 138 kV substation in the AEP system. They are GE 1.5 MW based wind farms each with 100 generators.

Stability analysis for the V1-011 and V1-012 queue projects was performed at <u>2014 light and peak</u> load conditions. The range of contingencies evaluated was limited to that necessary to assess compliance with the MAAC criteria used by AEP. Simulation time was limited to 10 seconds for all faults.

Three fault types were considered in this study:

- Type A: Three-phase faults (3ph) with primary clearing time
- Type B: Stuck breaker fault cleared with backup clearing time
- Type C: Zone 2 faults cleared with secondary protection

Specific fault descriptions and breaker clearing times used for this study are provided in Appendix A.

Results

Transient Stability:

For all cases studied, transient stability is maintained with all oscillations stabilized in less than 10 seconds. Also, the voltage levels returned to normal for all cases following the fault clearance. Hence, no transient stability issues were concluded.

The maximum angle deviations for all three fault types are shown in Tables I - VI.

Table-I Maximum angle deviation for type A faults
(2014 Light Load Conditions)

Fault	Chan	Bus	ID	Initial Angle	Max Deviation	Time
1A	412	243440	1	118.0	-2.601	0.7126
2A	412	243440	1	118.0	-2.927	0.7292
3A	412	243440	1	118.0	-2.674	0.7126
4A	412	243440	1	118.0	-3.081	0.7167
5A	412	243440	1	118.0	-2.785	0.7126
6A	413	243441	2	113.6	-4.005	1.2168
7A	413	243441	2	113.6	-4.099	1.2168
8A	324	242895	1	104.9	-3.818	0.4292
9A	413	243441	2	113.6	-4.003	1.2168
10A	413	243441	2	113.6	-3.896	1.1959
11A	413	243441	2	113.6	-4.025	1.2168
12A	413	243441	2	113.6	-4.026	1.2168
13A	413	243441	2	113.6	-3.999	1.2168
14A	413	243441	2	113.6	-4.005	1.2168

Table-II Maximum angle deviation for type A faults
(2014 Summer Peak Load Conditions)

Fault	Chan	Bus	ID	Initial Angle	Max Deviation	Time
1A	389	243225	3	54.11	-2.772	1.2168
2A	389	243225	3	54.11	-2.865	1.2168
3A	389	243225	3	54.11	-2.751	1.2168
4A	389	243225	3	54.11	-3.305	1.2376
5A	389	243225	3	54.11	-2.921	1.2168
6A	456	930074	1	18.63	5.425	1.5293
7A	456	930074	1	18.63	5.434	1.5293
8A	456	930074	1	18.63	5.421	1.5293
9A	456	930074	1	18.63	5.425	1.5293
10A	456	930074	1	18.63	5.423	1.5293
11A	456	930074	1	18.63	5.427	1.5293
12A	456	930074	1	18.63	5.427	1.5293
13A	456	930074	1	18.63	5.427	1.5293

Table-II Maximum angle deviation for type A faults
(2014 Summer Peak Load Conditions)

Fault	Chan	Bus	ID	Initial Angle	Max Deviation	Time
14A	456	930074	1	18.63	5.431	1.5293

Table-III Maximum angle deviation for type B faults
(2014 Light Load Conditions)

Fault	Chan	Bus	ID	Initial Angle	Max Deviation	Time
1B	412	243440	1	118.0	-5.558	9.8757
2B	346	242933	1	91.98	-4.832	9.9799
3B	346	242933	1	91.98	-10.27	9.9799
4B1	412	243440	1	118.0	-2.415	0.8251
4B2	346	242933	1	91.98	-3.739	4.6462
5B1	412	243440	1	118.0	-6.384	9.8966
5B2	412	243440	1	118.0	-4.061	0.8334
6B1	346	242933	1	91.98	-4.985	0.7876
6B2	346	242933	1	91.98	-5.276	0.7834
7B	346	242933	1	91.98	-5.100	0.7876
8B1	346	242933	1	91.98	-4.875	0.7876
8B2	346	242933	1	91.98	-5.14	0.7834
9B	346	242933	1	91.98	-4.869	0.7876
10B1	346	242933	1	91.98	-4.702	0.7876
10B2	346	242933	1	91.98	-4.623	0.7876
11B1	346	242933	1	91.98	-4.935	0.7876
11B2	346	242933	1	91.98	-4.801	0.7876
12B1	346	242933	1	91.98	-4.839	0.7876
12B2	346	242933	1	91.98	-4.804	0.7876
13B	346	242933	1	91.98	-4.76	0.7876
14B1	413	243441	2	113.6	-3.976	1.3293
14B2	346	242933	1	91.98	-4.110	0.7792

Table-IV Maximum angle deviation for type B faults
(2014 Summer Peak Load Conditions)

Fault	Chan	Bus	ID	Initial Angle	Max Deviation	Time
1B	346	242933	1	41.29	-3.323	9.9799

Table-IV Maximum angle deviation for type B faults
(2014 Summer Peak Load Conditions)

Fault	Chan	Bus	ID	Initial Angle	Max Deviation	Time
2B	346	242933	1	41.29	-2.974	9.9799
3B	346	242933	1	41.29	-6.268	9.9799
4B1	389	243225	3	54.11	-1.565	1.2084
4B2	389	243225	3	54.11	-2.430	1.4584
5B1	346	242933	1	41.29	-3.700	9.9799
5B2	389	243225	3	54.11	-2.480	1.3334
6B1	346	242933	1	41.29	-3.547	0.7667
6B2	346	242933	1	41.29	-3.875	0.7667
7B	346	242933	1	41.29	-3.82	0.7626
8B1	346	242933	1	41.29	-3.339	0.7667
8B2	346	242933	1	41.29	-3.663	0.7626
9B	346	242933	1	41.29	-3.520	0.7667
10B1	346	242933	1	41.29	-3.215	0.7667
10B2	346	242933	1	41.29	-3.158	0.7667
11B1	346	242933	1	41.29	-3.455	0.7667
11B2	346	242933	1	41.29	-3.365	0.7709
12B1	346	242933	1	41.29	-3.381	0.7667
12B2	346	242933	1	41.29	-3.366	0.7709
13B	346	242933	1	41.29	-3.327	0.7709
14B1	346	242933	1	41.29	-2.666	0.7626
14B2	346	242933	1	41.29	-2.981	0.7626

Table-V Maximum angle deviation for type C faults
(2014 Light Load Conditions)

Fault	Chan	Bus	ID	Initial Angle	Max Deviation	Time
1C	413	243441	2	113.6	-1.218	1.5085
5C	413	243441	2	113.6	-0.9816	1.5626
6C	346	242933	1	91.98	-1.351	1.4876
7C	346	242933	1	91.98	-2.356	1.5001
8C	413	243441	1	113.6	1.183	9.5841
9C	346	242933	1	91.98	-1.209	1.4960
10C	346	242933	1	91.98	-2.253	1.4876
11C	346	242933	1	91.98	-5.535	1.5168
12C	346	242933	1	91.98	-6.251	1.5168
13C	346	242933	1	91.98	-2.074	1.4918

Table-VI Maximum angle deviation for type C faults
(2014 Summer Peak Load Conditions)

Fault	Chan	Bus	ID	Initial Angle	Max Deviation	Time
1C	389	243225	3	54.11	-0.6224	1.8460
5C	401	243243	1	76.80	0.5707	9.9799
6C	346	242933	1	41.29	-0.6952	1.5126
7C	422	243654	3	69.62	-2.565	4.7921
8C	346	242933	1	41.29	1.4970	9.9799
9C	346	242933	1	41.29	-0.6747	1.5043
10C	346	242933	1	41.29	-1.238	1.4751
11C	346	242933	1	41.29	-3.278	1.5126
12C	346	242933	1	41.29	-3.636	1.5168
13C	346	242933	1	41.29	-1.200	1.4876

Low Voltage Ride-Through (LVRT): For all cases studied, the V1-011 and V1-012 queue projects ride through the faults specified in Section A.4 thus meeting the LVRT test specified in FERC order 661 and 661A.

The low voltage ride through capability of the GE WTG was tested by applying a three-phase 9-cycle fault at Haviland 138 kV bus and, as well as, a three-phase 9-cycle fault at the 34.5 kV collector buses of V1-011 and V1-012. It is noted that the V1-011 and V1-012 facilities stayed connected to the grid during these disturbances.

Note: While the stability analysis has been performed at extreme system conditions, there is a potential that evaluation at a different level of generator MW and/or MVAR output at different system load levels and operating conditions may disclose unforeseen stability problems. The regional reliability analysis routinely performed to test all system changes will include one such evaluation. Any problems uncovered in that or other operating or planning studies will need to be resolved.

Moreover, when the proposed generating station is designed and plant specific dynamics data for the plant and its controls are available, and if it is different than the data provided for this study, a transient stability analysis at a variety of expected operating conditions using the more accurate data shall be performed to verify impact on the dynamic performance of the system. As more accurate or unit specific dynamics data for the proposed facility, as well as plant layout become available, it must be forwarded to PJM.

Contribution to Previously Identified Overloads

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

None

System Reinforcements

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

1. S-073 – NorthDelphos 138 kV Upgrade: The North Delphos 138 kV 600 A switch and the 397 ACSR (section 1) of the conductor are the limiting elements for the S073 – North Delphos 138 kV line. Replace the North Delphos 600A switch. Estimated Cost (2012 Dollars) for the switch replacement: **$200,000**. A sag check will be required for the 397 ACSR conductor section 1 to determine if the line section can be operated above its emergency rating of 167 MVA. The results of the sag study could prove that no additional upgrades are necessary, that some upgrades on the circuit are necessary, or that the entire 18.7 mile line section will need to be rebuilt. Estimated cost (2012 Dollars) for the sag study: **$74,800**. If the entire line section rebuild (approximately 18.7 miles depending on the location of S073) of 138 kV line between North Delphos and S073 is required then the estimated cost (2012 Dollars) for the line rebuild is $22,440,000. (Network Upgrade# 3231)

2. Haviland – East Lima 138 kV Upgrade: The East Lima 800A wavetrap, and the Haviland 800A wavetrap are the limiting elements on the Haviland – East Lima 138 kV the line. Estimated Cost (2012 Dollars) to replace both wavetraps: **$100,000**. (Network Upgrade# 3232)

3. Lincoln – Anthony Tap 138 kV line: The Lincoln 138 kV Breaker D (800A Oil) is the limiting element for the Lincoln – Anthony Tap 138 kV line. Estimated Cost (2012 Dollars) for Breaker replacement: **$550,000**. (Network Upgrade#3233)

- Replace 138kV circuit breaker "I" at Haviland Station. (Network Upgrade #n3234) Estimated cost is **$550,000.**

- Replace 138kV circuit breaker "H" at Haviland Station. (Network Upgrade #n3235) Estimated cost is **$550,000.**

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

MISO Impacts

Impacts on the MISO system will be determined in the Facilities Study.

ATSI Integration

Due to the recent integration of the ATSI transmission area into PJM, PJM is reviewing contingencies in the ATSI territory for all the queue projects in T, U, V, W1, W2, W3 queues that could affect ATSI facilities. Several violations due to contingencies in the ATSI area have been found. PJM is currently working with ATSI in resolving these issues. V2-001 could have some cost responsibility for the fixes to these violations. This analysis is ongoing and will be completed during the Facilities Study. Preliminary results show that the V2-001 project does not have any thermal impacts in the ATSI area.

Duke Integration

Due to the recent integration of the Duke transmission area into PJM, PJM is reviewing contingencies in the Duke territory for all the queue projects in T, U, V, W1, W2, W3 queues that could affect Duke facilities. Several violations due to contingencies in the Duke area have been found. PJM is currently working with Duke in resolving these issues. V2-001 could have some cost responsibility for the fixes to these violations. This analysis is ongoing and will be completed during the Facilities Study

Light Load Analysis

Due to extreme loading from wind projects causing congestion during light load conditions an analysis analysis is being done to determine what impacts each wind project may have under these conditions. This analysis will be completed during the Facilities Study.

Energy Portion of Interconnection Request

(PJM also studied the delivery of the energy portion of the surrounding generation. Any potential 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 Transmission Interconnection request.
Note: 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 analyzes all overload conditions associated with the overloaded element(s) identified. As a result of the aggregate energy resources in the area, the following violations were identified.)

1. The Milan-Harper 138 kV line (from bus 243342 to bus 243306 ckt 1) loads from 118.43% to 137.23% (AC power flow) of its emergency rating (143 MVA) for the single line contingency outage of CONTINGENCY DESCRIPTION ('5206_B2_TOR770_WOMOAB_S73C'). This project contributes approximately 26.91 MW to the thermal violation.

2. The Milan-Harper 138 kV line (from bus 243342 to bus 243306 ckt 1) loads from 102.13% to 118.26% (AC power flow) of its normal rating (111 MVA) for non-contingency condition. This project contributes approximately 18.37 MW to the thermal violation.

3. The Tillman-Milan 138 kV line (from bus 243383 to bus 243342 ckt 1) loads from 101.21% to 115.83% (AC power flow) of its emergency rating (184 MVA) for the single line contingency outage of CONTINGENCY DESCRIPTION ('5206_B2_TOR770_WOMOAB_S73C'). This project contributes approximately 26.91 MW to the thermal violation.

4. The Tillman-Milan 138 kV line (from bus 243383 to bus 243342 ckt 1) loads from 83.55% to 95.03% (AC power flow) of its normal rating (156 MVA) for non-contingency condition. This project contributes approximately 18.37 MW to the thermal violation.

5. The R-049-Tillman 138 kV line (from bus 296589 to bus 243383 ckt 1) loads from 94.43% to 107.82% (AC power flow) of its emergency rating (201 MVA) for the single line contingency outage of CONTINGENCY DESCRIPTION ('5206_B2_TOR770_WOMOAB_S73C'). This project contributes approximately 26.91 MW to the thermal violation.

6. The R-049-Tillman 138 kV line (from bus 296589 to bus 243383 ckt 1) loads from 80.2% to 90.92% (AC power flow) of its normal rating (167 MVA) for non-contingency condition. This project contributes approximately 18.37 MW to the thermal violation.

Figure 1: V1-011 Point of Interconnection

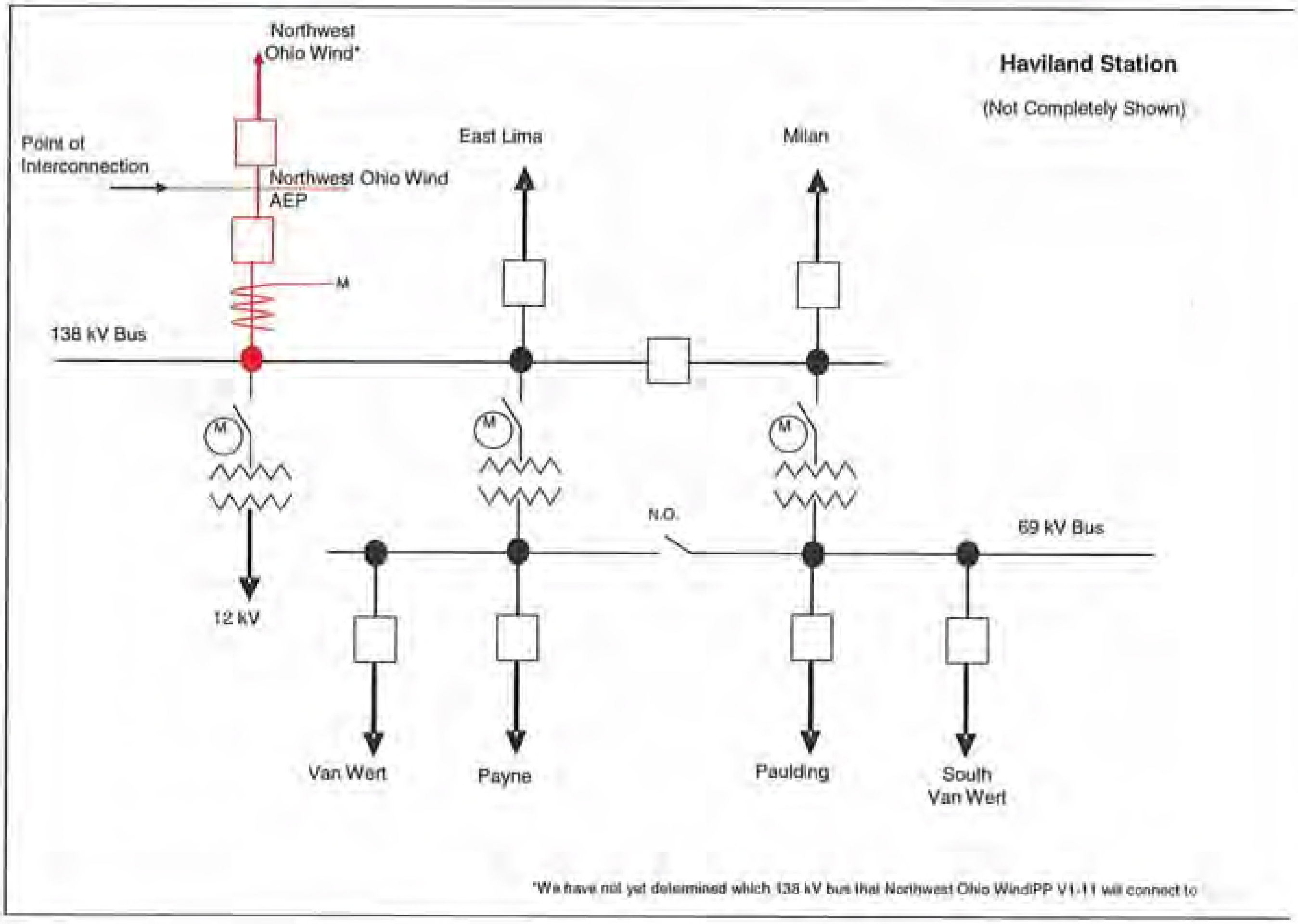

Figure 2: Point of Interconnection at Haviland 138 kV Station

APPENDIX A
V1-011 and V1-012
(Haviland 138 kV)

A.1) POWER FLOW CONDITIONS

2014 Light Load Base Case

A.2) BREAKER CLEARING TIMES (CYCLES)

Table A.1. AEP Clearing Times (Cycles)

Station	Primary (3ph/slg)	Stuck Breaker (Total)	Zone 2 (Total)	Re-closing
500 kV	4	14	4	N/A
345 kV	4	15	4	N/A
230 kV	5	15	5	N/A
115kV & 138 kV	5	18	63	N/A

A.3) NETWORK CONDITIONS

All facilities in service (base case)

A.4) FAULTS CONSIDERED

Note: For simplicity of fault type identification, PJM *has adopted the following notation:*

A faults: *three-phase faults with normal clearing time*
B faults: *slg faults due to stuck breaker with delayed clearing time*
C faults: *slg faults with delayed clearing time due to protection system failure*

This notation is for internal purposes only, and does not necessarily correspond with the NERC category definition stated in TPL-001.

Haviland 138 kV
(assumed V1-011 and V1-012 are connected to different bus sections)

1a 3ph fault @ Haviland 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: Haviland - East Lima 138 kV ckt 1

1b slg fault @ Haviland 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: Haviland - East Lima 138 kV ckt 1
Breaker Failure

slg fault @ Haviland 138 kV
Fault cleared within 138 kV breaker backup clearing time
Loss of: Haviland 138 kV Bus (section)
V1-012
Haviland 138/69 kV transformer

1c slg fault @ 80% of Haviland - East Lima 138 kV ckt 1
East Lima beakers tripped within 138 kV primary time
Haviland breaker tripped within 138 kV secondary time
Loss of: Haviland - East Lima 138 kV ckt 1

2a 3ph fault @ Haviland 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: Haviland - S73 Tap 138 kV ckt 1

2b slg fault @ Haviland 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: Haviland - S73 Tap 138 kV ckt 1
Breaker Failure
slg fault @ Haviland 138 kV
Fault cleared within 138 kV breaker backup clearing time
Loss of: Haviland 138 kV Bus (section)
V1-011
Haviland 138/69 kV transformer

3a 3ph fault @ Haviland 138 kV
Fault cleared within 138 kV (& 69 kV) breaker primary clearing time
Loss of: Haviland 138/69 kV transformer #3

3b slg fault @ Haviland 138 kV
Fault cleared within 138 kV (& 69 kV) breaker primary clearing time
Loss of: Haviland 138/69 kV transformer #3
Breaker Failure
slg fault @ Haviland 138 kV
Fault cleared within 138 kV breaker backup clearing time
Loss of: Haviland 138 kV
V1-011 and V1-012

S73 Tap 138 kV

4a 3ph fault @ S73 Tap 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: S73 - Tillman- Milan 138 kV ckt 1
Tillman 138 kV

4b1 slg fault @ S73 Tap 138 kV

Fault cleared within 138 kV breaker primary clearing time
Loss of: Tillman - Milan 138 kV ckt 1
Breaker Failure
slg fault @ S73 Tap 138 kV
Fault cleared within 138 kV breaker backup clearing time
Loss of: S73 - R49 138 kV
S73 - Tillman 138 kV ckt 1

4b2 slg fault @ S73 Tap 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: Tillman - Milan 138 kV ckt 1
Breaker Failure
slg fault @ S73 Tap 138 kV
Fault cleared within 138 kV breaker backup clearing time
Loss of: S73 - Lincoln 138 kV ckt 1
S73 - Tillman 138 kV ckt 1

5a 3ph fault @ S73 Tap 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: S73 - N. Delphos - East Lima - Sterling 138 kV ckt 1

5b1 slg fault @ S73 Tap 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: East Lima - Sterling 138 kV ckt 1
Breaker Failure
slg fault @ S73 Tap 138 kV
Fault cleared within 138 kV breaker backup clearing time
Loss of: S73 - N. Delphos - East Lima138 kV ckt 1
S73

5b2 slg fault @ S73 Tap 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: East Lima - Sterling 138 kV ckt 1
Breaker Failure
slg fault @ S73 Tap 138 kV
Fault cleared within 138 kV breaker backup clearing time
Loss of: S73 - N. Delphos - East Lima 138 kV ckt 1
S73 - R49 138 kV ckt 1

5c slg fault @ 80% of S73 - N. Delphos - East Lima - Sterling 138 kV ckt 1
Sterling beakers tripped within 138 kV primary time
S73 breaker tripped within 138 kV secondary time
Loss of: S73 - N. Delphos - East Lima - Sterling 138 kV ckt 1

East Lima 138 kV

6a 3ph fault @ East Lima 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: East Lima - New Liberty 138 kV ckt 1

6b1 slg fault @ East Lima 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: East Lima - New Liberty 138 kV ckt 1
Breaker Failure
slg fault @ East Lima 138 kV
Fault cleared within 138 kV breaker backup clearing time
Loss of: East Lima - Rockhill 138 kV ckt 1

6b2 slg fault @ East Lima 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: East Lima - New Liberty 138 kV ckt 1
Breaker Failure
slg fault @ East Lima 138 kV
Fault cleared within 138 kV breaker backup clearing time
Loss of: East Lima - U1-060 138 kV ckt 1

6c slg fault @ 80% of East Lima - New Liberty 138 kV ckt 1
New Liberty beaker tripped within 138 kV primary time
East Lima breakers tripped within 138 kV secondary time
Loss of: East Lima - New Liberty 138 kV ckt 1

7a 3ph fault @ East Lima 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: East Lima - U1-060 138 kV ckt 1

7b slg fault @ East Lima 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: East Lima - U1-060 138 kV ckt 1
Breaker Failure
slg fault @ East Lima 138 kV
Fault cleared within 138 kV breaker backup clearing time
Loss of: None

7c slg fault @ 80% of East Lima - U1-060 138 kV ckt 1
U1-060 beaker tripped within 138 kV primary time
East Lima breakers tripped within 138 kV secondary time
Loss of: East Lima - U1-060 138 kV ckt 1

8a 3ph fault @ East Lima 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: East Lima - North Woodcock - North Findlay 138 kV ckt 1
North Findlay 138/34 kV transformer #1

8b1 slg fault @ East Lima 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: North Woodcock - North Findlay 138 kV ckt 1
Breaker Failure
slg fault @ East Lima 138 kV
Fault cleared within 138 kV breaker backup clearing time
Loss of: East Lime - North Woodcock 138 kV ckt 1
North Findlay 138/34 kV transformer #1
East Lima - Haviland 138 kV ckt 1

8b2 slg fault @ East Lima 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: North Woodcock - North Findlay 138 kV ckt 1
Breaker Failure
slg fault @ East Lima 138 kV
Fault cleared within 138 kV breaker backup clearing time
Loss of: East Lime - North Woodcock 138 kV ckt 1
North Findlay 138/34 kV transformer #1
East Lima - U1-060 138 kV ckt 1

8c slg fault @ 80% of East Lima - North Woodcock - North Findlay 138 kV ckt 1
North Findlay 138 kV breaker tripped within 138 kV primary time.
East Lima breaker tripped within 138 kV secondary time
Loss of: East Lime - North Woodcock - North Findlay 138 kV ckt 1
North Findlay 138/34 kV transformer #1

9a 3ph fault @ East Lima 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: East Lima - Rockport- Riley - East Leipsic 138 kV ckt 1

9b slg fault @ East Lima 138 kV
Fault cleared within 138 kV breaker primary clearing time.
Loss of: Riley - East Leipsic 138 kV ckt 1
Breaker Failure
slg fault @ East Lima 138 kV
Fault cleared within 138 kV breaker backup clearing time
Loss of: East Lima - Rockport- Riley 138 kV ckt 1
East Lima 138/69 kV transformer
East Lima capacitor bank
East Lima - Thayer 138 kV ckt 1

9c slg fault @ 80% of East Lima - Rockport- Riley - East Leipsic 138 kV ckt 1
East Leipsic 138 kV breaker tripped within 138 kV primary time.
East Lima breaker tripped within 138 kV secondary time
Loss of: East Lima - Rockport- Riley - East Leipsic 138 kV ckt 1

10a 3ph fault @ East Lima 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: East Lima - Northeast Lima - Woodlawn -West Lima 138 kV ckt 1

10b1 slg fault @ East Lima 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: Woodlawn -West Lima 138 kV ckt 1
Breaker Failure
slg fault @ East Lima 138 kV
Fault cleared within 138 kV breaker backup clearing time
Loss of: East Lima - Northeast Lima - Woodlawn 138 kV ckt 1
East Lima 345/138 kV transformers #2A and 2B

10b2 slg fault @ East Lima 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: Woodlawn -West Lima 138 kV ckt 1
Breaker Failure
slg fault @ East Lima 138 kV
Fault cleared within 138 kV breaker backup clearing time
Loss of: East Lima - Rockport 138 kV ckt 1
East Lima - Thayer 138 kV ckt 1
East Lima 138/69 kV transformer

10c slg fault @ 80% of East Lima - West Lima 138 kV ckt 1
West Lima 138 kV breaker tripped within 138 kV primary time.
East Lima breaker tripped within 138 kV secondary time
Loss of: East Lima - Northeast Lima - Woodlawn -West Lima 138 kV ckt 1

11a 3ph fault @ East Lima 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: East Lima - Rockhill 138 kV ckt 1

11b1 slg fault @ East Lima 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: East Lima - Rockhill 138 kV ckt 1
Breaker Failure
slg fault @ East Lima 138 kV
Fault cleared within 138 kV breaker backup clearing time
Loss of: East Lima - New Liberty 138 kV ckt 1

11b2 slg fault @ East Lima 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: East Lima - Rockhill 138 kV ckt 1
Breaker Failure
slg fault @ East Lima 138 kV

Fault cleared within 138 kV breaker backup clearing time
Loss of: East Lima - Rockport 138 kV ckt 1
East Lima - Thayer 138 kV ckt 1
East Lima 138/69 kV transformer

11c slg fault @ 80% of East Lima - Rockhill 138 kV ckt 1
Rockhill 138 kV breaker tripped within 138 kV primary time.
East Lima breaker tripped within 138 kV secondary time
Loss of: East Lima - Rockhill 138 kV ckt 1

12a 3ph fault @ East Lima 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: East Lima - Ford Lima 138 kV ckt 1

12b1 slg fault @ East Lima 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: East Lima - Ford Lima 138 kV ckt 1
Breaker Failure
slg fault @ East Lima 138 kV
Fault cleared within 138 kV breaker backup clearing time
Loss of: East Lima 345/138 kV transformer #1

12b2 slg fault @ East Lima 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: East Lima - Ford Lima 138 kV ckt 1
Breaker Failure
slg fault @ East Lima 138 kV
Fault cleared within 138 kV breaker backup clearing time
Loss of: East Lima - Rockport 138 kV ckt 1
East Lima - Thayer 138 kV ckt 1
East Lima 138/69 kV transformer

12c slg fault @ 80% of East Lima - Ford Lima 138 kV ckt 1
Ford Lima 138 kV breaker tripped within 138 kV primary time.
East Lima breaker tripped within 138 kV secondary time
Loss of: East Lima - Ford Lima 138 kV ckt 1

13a 3ph fault @ East Lima 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: East Lima - Sterling 138 kV ckt 1
Thayer 138 kV
Hanthorn 138 kV
Sterling 138/34 kV transformer (parallel to other)

13b slg fault @ East Lima 138 kV
Fault cleared within 138 kV breaker primary clearing time

Loss of: East Lima - Sterling 138 kV ckt 1
Breaker Failure
slg fault @ East Lima 138 kV
Fault cleared within 138 kV breaker backup clearing time
Loss of: Thayer 138 kV
Hanthorn 138 kV
East Lime capacitor bank
East Lima 138/69 kV transformer
Sterling 138/34 kV transformer (parallel to other)
East Lima - Rockport 138 kV ckt 1

13c slg fault @ 80% of East Lima - Sterling 138 kV ckt 1
Sterling 138 kV breaker tripped within 138 kV primary time.
East Lima breaker tripped within 138 kV secondary time
Loss of: East Lima - Sterling 138 kV ckt 1
Thayer 138 kV
Hanthorn 138 kV
Sterling 138/34 kV transformer (parallel to other)

14a 3ph fault @ East Lima 138 kV
Fault cleared within 138 kV breaker primary clearing time
Loss of: East Lima 345/138 kV transformers 2A and 2B

14b1 slg fault @ East Lima 138 kV
Fault cleared within 345 kV breaker primary clearing time
Loss of: East Lima 345/138 kV transformers 2A and 2B
Breaker Failure
slg fault @ East Lima 138 kV
Fault cleared within 138 kV breaker backup clearing time
Loss of: East Lima - Northwest Lima 138 kV ckt 1

14b2 slg fault @ East Lima 138 kV
Fault cleared within 345 kV breaker primary clearing time
Loss of: East Lima 345/138 kV transformers 2A and 2B
Breaker Failure
slg fault @ East Lima 138 kV
Fault cleared within 138 kV breaker backup clearing time
Loss of: East Lima - U1-060 138 kV ckt 1

A.4.1) Maintenance outage faults

No faults with outages due to maintenance were studied.

A.5) Reinforcements

The following reinforcements were considered in the study:

U4-003, V1-010

APPENDIX B
Project Data

B.1.1) Wind farm and wind turbine data

Queue Letter/Position/Unit ID: ______ V1-011/Wind Farm

Wind farm data

Primary Fuel Type: ______ Wind

Maximum Net MW Output: ______ 100

Maximum Gross MW Output: ______ 100

Station Service Load in MW/MVAR: ______ N/A

Number of Turbines: ______ 67

Wind turbine data

MW Size: ______ 1.5

MVA Base: ______ 1.67

Nominal Power Factor: ______ N/A

Terminal Voltage (kV): ______ 0.575

Type of Turbine: ______ GE 1.5MW

Control Mode: ______ Voltage

Additional Capacitor: ______ N/A

B.1.2) Generator data

Loadflow information

Rg	0.00000	Generator Resistance in Loadflow (pu)
Xg	0.80000	Generator Reactance in Loadflow (pu)

Dynamic data

- Due to confidentiality agreement, dynamic data has not been included.

B.1.3) Unit GSU data

Generator Step-up Transformer MVA Base: ____ 1.75

Generator Step-up Transformer Impedance (R+jX, or %, on transformer MVA Base): ____ 5.75%

Generator Step-up Transformer Reactance-to-Resistance Ratio (X/R): ____ 7.5

Generator Step-up Transformer Rating (MVA): ____ 1.75

Generator Step-up Transformer Low-side Voltage (kV): ____ 0.575

Generator Step-up Transformer High-side Voltage (kV): ____ 34.5

Generator Step-up Transformer Off-nominal Turns Ratio: ____ N/A

Generator Step-up Transformer Number of Taps and Step Size: ____ 5 taps of 2½%

Transformer Low-side Voltage Winding Connection: ____ N/A

Transformer High-side Voltage Winding Connection: ____ N/A

Transformer Tertiary-side Voltage Winding Connection: ____ N/A

B.1.4) Main transformer data

Transformer MVA Base: ____ 105

Transformer Impedance (R+jX, or Z in %): ____ 8.0%

Transformer Reactance-to-Resistance Ratio (X/R): ____ 40

Transformer Rating (MVA): ____ 105/140/175

Transformer Low-side Voltage (kV): ____ 34.5

Transformer High-side Voltage (kV): ____ 138

Transformer Tertiary Voltage (kV): ____ N/A

Transformer Off-nominal Turns Ratio: ____ N/A

Transformer Number of Taps and Step Size: ____ 2, ±2.5%

Transformer Low-side Voltage Winding Connection: ____ Delta

Transformer High-side Voltage Winding Connection: ____ Wye gnd

Transformer Tertiary-side Voltage Winding Connection: ____ N/A

B.1.1) Wind farm and wind turbine data

Queue Letter/Position/Unit ID: ______________________ V1-012/Wind Farm

Wind farm data

Primary Fuel Type: ______________________ Wind

Maximum Net MW Output: ______________________ 150

Maximum Gross MW Output: ______________________ 150

Station Service Load in MW/MVAR: ______________________ N/A

Number of Turbines: ______________________ 100

Wind turbine data

MW Size: ______________________ 1.5

MVA Base: ______________________ 1.67

Nominal Power Factor: ______________________ N/A

Terminal Voltage (kV): ______________________ 0.575

Type of Turbine: ______________________ GE 1.5MW

Control Mode: ______________________ Voltage

Additional Capacitor: ______________________ N/A

B.1.2) Generator data

Loadflow information

Rg	0.00000	Generator Resistance in Loadflow (pu)
Xg	0.80000	Generator Reactance in Loadflow (pu)

Dynamic data

- Due to confidentiality agreement, dynamic data has not been included.

B.1.3) Unit GSU data

Generator Step-up Transformer MVA Base: ______ 1.75

Generator Step-up Transformer Impedance (R+jX, or %, on transformer MVA Base): ___ 5.75%

Generator Step-up Transformer Reactance-to-Resistance Ratio (X/R): ______ 7.5

Generator Step-up Transformer Rating (MVA): ______ 1.75

Generator Step-up Transformer Low-side Voltage (kV): ______ 0.575

Generator Step-up Transformer High-side Voltage (kV): ______ 34.5

Generator Step-up Transformer Off-nominal Turns Ratio: ______ N/A

Generator Step-up Transformer Number of Taps and Step Size: ______ 5 taps of 2½%

Transformer Low-side Voltage Winding Connection: ______ N/A

Transformer High-side Voltage Winding Connection: ______ N/A

Transformer Tertiary-side Voltage Winding Connection: ______ N/A

B.1.4) Main transformer data

Transformer MVA Base: ______ 105

Transformer Impedance (R+jX, or Z in %): ______ 8.0%

Transformer Reactance-to-Resistance Ratio (X/R): ______ 40

Transformer Rating (MVA): ______ 105/140/175

Transformer Low-side Voltage (kV): ______ 34.5

Transformer High-side Voltage (kV): ______ 138

Transformer Tertiary Voltage (kV): ______ N/A

Transformer Off-nominal Turns Ratio: ______ N/A

Transformer Number of Taps and Step Size: ______ 2, ±2.5%

Transformer Low-side Voltage Winding Connection: ______ Delta

Transformer High-side Voltage Winding Connection: ______ Wye gnd

Transformer Tertiary-side Voltage Winding Connection: ______ N/A