

***Generation Interconnection
System Impact Study Report***

For

***PJM Generation Interconnection Request
Queue Position AA2-114***

Furnace Brook-Hazen Switch Point 34kV

April 2016

Preface

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

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

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

General

Amergin BES1 LLC, the Interconnection Customer (IC), has proposed a storage facility located in Union County, NJ. The installed facilities will have a total capability of 20 MW with 0 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is April 2016. **This study does not imply a Jersey Central Power & Light Company (JCPL) commitment to this in-service date.**

Point of Interconnection

AA2-114 will interconnect with the JCPL system along the Pequest River-Washington (C705) 34kV line

Cost Summary

The AA2-114 project will be responsible for the following costs:

Description	Cost
Attachment Facilities	\$ 426,000
Direct Connection Network Upgrades	\$ 0
Non Direct Connection Network Upgrades	\$ 12,900
Allocation for New System Upgrades	\$ 905,100
Contribution for Previously Identified Upgrades	\$ 0
Total Costs	\$ 1,344,000

Attachment Facilities

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

Description	Activity Cost	Tax (if applicable)	Total Cost
Oxbow 34.5 kV. Tap C705-6 (Oxbow Quarry Switch-Oxbow Quarry) and extend to proposed battery storage site off Mount Pisgah Avenue in Oxford Township, Warren County, NJ, AA2-114 Solar. (n4960)	\$ 426,000	\$ 138,300	\$ 564,300
Total Attachment Facility Costs	\$ 426,000	\$ 138,300	\$ 564,300

Direct Connection Cost Estimate

No Direct Connection facilities are required to support this interconnection.

Non-Direct Connection Cost Estimate

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

Description	Activity Cost	Tax (if applicable)	Total Cost
Adjust Remote Relay Settings (n4961)	\$ 12,900	\$ 4,200	\$ 17,100
Total Non-Direct Facility Costs	\$ 12,900	\$ 4,200	\$ 17,100

Transmission Owner Scope of Work

The proposed AA2-114 project site will be located at a point approximately 300 feet from the existing Oxford Quarry tap of the Pequest River – Washington (C705) 34.5 kV line. The primary direct connection of this project will be accomplished by tapping the Oxford Quarry tap of the Pequest River – Washington (C705) 34.5 kV line. The Interconnection Customer will be responsible for acquiring all easements, properties and permits that may be required to construct the associated attachment facilities.

Schedule

Based on the extent of the JCP&L primary direct connection and system upgrades required to support the AA2-114 Generation Project, it is expected to take a minimum of 15 months from the date of a fully executed Interconnection Construction Service Agreement to complete the installation. This includes the requirement that the Interconnection Customer will provide all rights-of-way, permits, easements, etc. that will be needed. A further assumption is that there will be no environmental issues with any of the new properties associated with this project, that there will be no delays in acquiring the necessary permits for implementing the defined direct connection, and that all system outages will be allowed when requested.

System Protection Analysis

An analysis was conducted to assess the impact of the generation project on the system protection requirements in the area. The results of this review have identified the following:

The Interconnection Customer will need two independent high speed zones of protection installed at the POI for the 20 MW AA2-114 project that will also need to be maintained to sense and clear faults on the customer's side of the POI. Any changes to the protection at the POI needs to be reviewed by FirstEnergy to determine whether it coordinates with the FirstEnergy protection. Also, generation facilities that comply with IEEE-1547 and are UL 1741 certified or provide documentation by a third party testing organization of successful testing of the proposed inverter equipment in accordance with IEEE-1547.1 that are connected to the FE Transmission System below 100 kV are required to have intertie relays installed as stated in Section 14.5 of the FE "Requirements for Transmission Connected Facilities" document.

JCP&L Facility Upgrades and Costs

The results of the FE analysis of the less than 100 kV transmission system show that transmission thermal violations occur while the AA2-114 generation project battery installation absorbs energy from the JCP&L transmission system. Therefore The Interconnection Customer will have an allocated cost responsibility for the transmission network upgrades required to mitigate the violations. The upgrades are as follows.

- Pequest River - Hazel Switch Point 34.5 kV line (C705) – Reconductor approximately 1.37 miles with 556 ACSR conductor.
- Adjust Remote Relay Settings at Pequest River 34.5 kV substation.

Interconnection Customer Requirements

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.
4. The purchase and installation of fully rated 34.5 kV circuit breaker on the high side of the AA2-114 step-up transformers.
5. The purchase and installation of the minimum required FE generation interconnection relaying and control facilities. This includes over/under voltage protection, over/under frequency protection, and zero sequence voltage protection relays.
6. The purchase and installation of a 34.5 kV interconnection metering package. FE will provide the ratio and accuracy specifications.
7. The purchase and installation of supervisory control and data acquisition (“SCADA”) equipment to provide information in a compatible format to the FE Transmission System Control Center.

8. The establishment of dedicated communication circuits for SCADA to the FE Transmission System Control Center.
9. A compliance with the FE and PJM generator power factor and voltage control requirements.
10. It will be mandatory for this generation project to have a range of dynamic reactive capability that supports its operation from a 0.95 leading (absorbing vars) to 0.95 lagging (producing vars) power factor measured at the POI. Should the IC fail to provide dynamic reactive capability from the generation project for any reason once interconnected, the FE and/or PJM Dispatchers may need to take action to curtail both the energy and capacity portion of its output to prevent non-compliance with voltage criteria.

Revenue Metering and SCADA Requirements

PJM Requirements

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

JCPL Requirements

The Interconnection Customer will be required to comply with all FE Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "FirstEnergy Requirements for Transmission Connected Facilities" document located at the following links:

<http://www.firstenergycorp.com/feconnect>

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

Network Impacts

The Queue Project AA2-114 was evaluated as a 20.0 MW (Capacity 0.0 MW) injection/withdrawal at the Warren 34.5kV substation in the JCPL area. Project AA2-114 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AA2-114 was studied with a commercial probability of 100% using a Summer Peak 2019 case. Potential network impacts were as follows:

Generator Deliverability

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

None.

Light Load Analysis

Light Load Studies to be conducted during later study phases (applicable to wind, coal, nuclear, and pumped storage projects).

None.

Multiple Facility Contingency

(Double Circuit Tower Line contingencies were studied for the full energy output. The contingencies of Line with Failed Breaker and Bus Fault will be performed for the Impact Study.)

None.

Short Circuit

(Summary of impacted circuit breakers)

None.

First Energy Short Circuit Analysis

No short circuit analysis was performed by PJM based on the following; “no initial short circuit analysis needs to be performed by PJM since the project is an inverter based (solar, flywheel, battery etc.) project which will provide minimal fault current connected to or less than 69 kV (sub transmission) system.” Therefore, the FE Protection staff conducted a short circuit review of the project connection.

Section 14.2.6 of the FE “Requirements for Transmission Connected Facilities” document states that the winding configurations for the transformer connecting to a non-effectively grounded portion of the FE Transmission System shall be determined by FE on a case by case basis.

Evaluating the connection to the 34.5 kV system as an ungrounded connection for the AA2-114 generation project, there were no overdutied breakers identified.

The X/R ratio, and the fault currents on the Pequest River-Washington 34.5 kV line 300 feet from the existing Oxford Quarry tap are shown below.

	Three-Phase	Single-Line
X/R Ratio	9.6347	5.5845
Fault Current (Amps)	6,093	3,278

The Thevenin impedances at that location are shown below.

Positive Sequence Impedance:	0.80101 + j3.16904 ohms
Zero Sequence Impedance:	2.60315 + j11.3958 ohms

These values are for the current system configuration. Any system changes in the area could have a significant impact on these values. It will be the responsibility of the Interconnection Customer to make any protection upgrades required should this occur. The proposed interconnection facilities must be designed in accordance with the FE “Requirements for Transmission Connected Facilities.”

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.

Steady-State Voltage Requirements

(Summary of the VAR requirements based upon the results of the steady-state voltage studies)

None.

New System Reinforcements

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

The results of the FE analysis of the underlying (less than 100 kV) transmission system show that thermal violations occur while the AA2-114 Generation Project battery installation absorbs energy from the JCP&L transmission system. Therefore the Interconnection Customer will have an allocated cost responsibility for the transmission network upgrades required to mitigate the violations. See Attachment 4 for First Energy’s Contingency Analysis Results.

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost	AA2-114 Allocation
1	Pequest-Hazen Switch Point 34.5 kV line	In order to mitigate the overloads of facilities above, the following reinforcements are required: <ul style="list-style-type: none"> Reconductor Pequest River - Hazel Switch Point 34.5 kV line. C705 34.5 kV reconductor, Pequest River - Hazel Switch Point approximately 1.37 miles 556 ACSR conduction. Pequest River 34.5 kV SS. Adjust Remote Relay Settings at Pequest River 34.5 kV substation. 	n4962	\$ 893,100	\$ 905,100
			n4963	\$ 12,000	
Total New Network Upgrades					\$ 905,000

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.

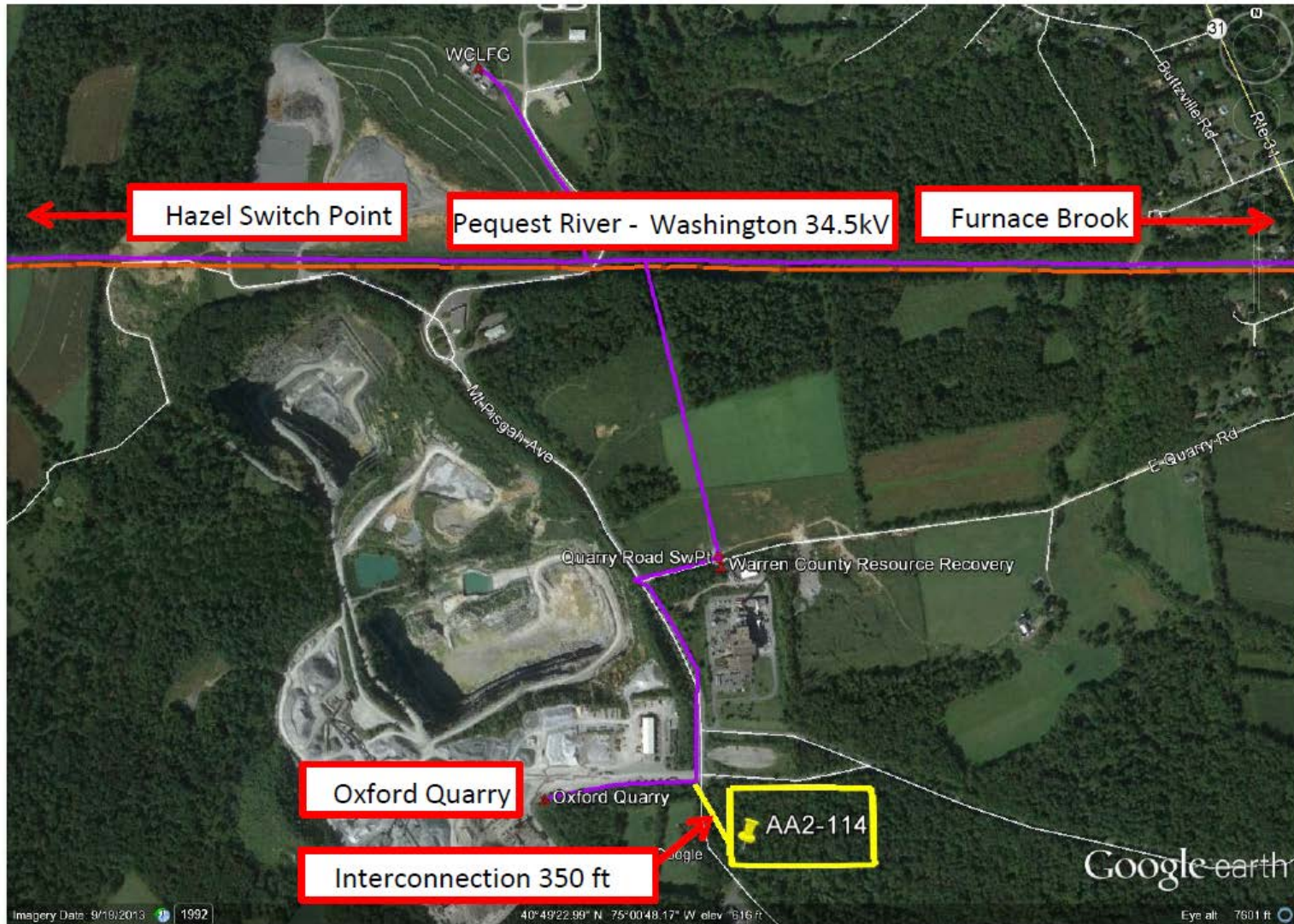
Potential Congestion due to Local Energy Deliverability

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

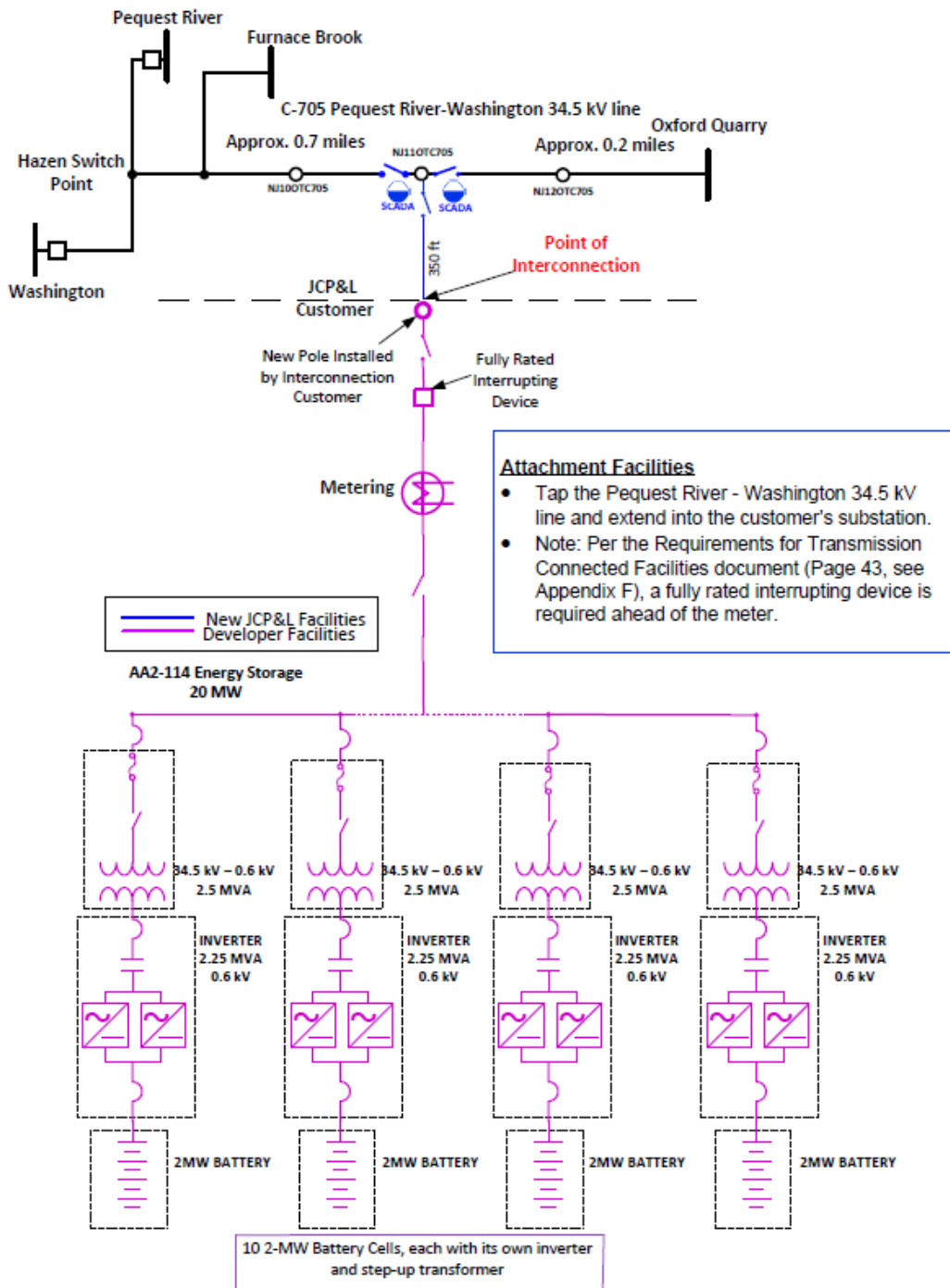
Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which shall study all overload conditions associated with the overloaded element(s) identified

None.

Attachment 1. Project Location

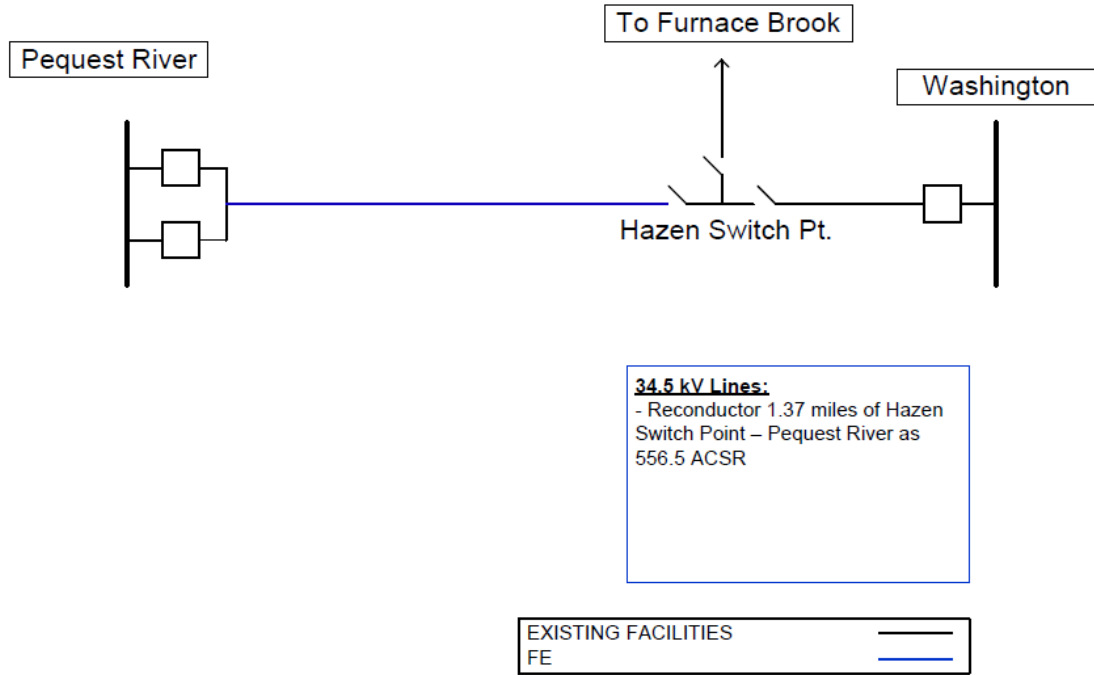


Attachment 2. Single Line Diagram



Attachment 3. Transmission Owner Network Upgrades

Hazen Switch Point – Pequest River Reconductor



Attachment 4. Transmission Owner Network Upgrades Contingency Analysis Results

Single (N-1) Contingency Results

Overloaded Element	Contingency Description	Rating (MVA)	AC% Loading	Reinforcement
Pequest-Hazen Switch Point	Kittatinny-Pohatcong	48	105.6	Reconductor the Pequest River-Hazen Switch Point 34.5 kV line