Reliability Analysis Update

Transmission Expansion Advisory Committee

September 13, 2018

Proposal Window Exclusion Definitions

- The following definitions explain the basis for excluding flowgates and/or projects from the competitive planning process and designating projects to the incumbent Transmission Owner.
- Flowgates/projects excluded from competition will include the underlined language on the corresponding slide.
  - Immediate Need Exclusion: Due to the immediate need of the violation (3 years or less), the timing required for an RTEP proposal window is infeasible. As a result, the local Transmission Owner will be the Designated Entity. - Operating Agreement, Schedule 6 § 1.5.8(m)
  - Below 200kV: Due to the lower voltage level of the identified violation(s), the driver(s) for this project are excluded from the competitive proposal window process. As a result, the local Transmission Owner will be the Designated Entity - Operating Agreement, Schedule 6 § 1.5.8(n)
  - FERC 715 (TO Criteria): Due to the violation need of this project resulting solely from FERC 715 TO Reliability Criteria, the driver(s) for this project are excluded from the competitive proposal window process. As a result, the local Transmission Owner will be the Designated Entity - Operating Agreement, Schedule 6 § 1.5.8(o)
  - Substation Equipment: Due to identification of the limiting element(s) as substation equipment, the driver(s) for this project are excluded from the competitive proposal window process. As a result, the local Transmission Owner will be the Designated Entity - Operating Agreement, Schedule 6 § 1.5.8(p)

2018 Proposal Window Update

Analysis of 2023 – Reliability Criteria Violations

Overview of 2023 Results

Total of 160 flowgates identified

- 3 included in the window
  - 1 in West region
  - 2 in the South region
- 157 flowgates excluded
  - 126 due to Immediate Need (PJM OA 1.5.8(m)) (Includes Retired Generator related)
  - 26 Below 200kV (PJM OA 1.5.8(n))
  - 5 Substation Equipment (PJM OA 1.5.8(p))

2018 RTEP Proposal Window 1 - Statistics

- Timeline
  - Window Opened: July 2, 2018
  - Window Closed: August 31, 2018
    - Proposal definitions, simulation data and detailed cost data all due at this time
- 7 Proposals received from 2 entities addressing 2 target zones
  - All Transmission Owner Upgrade
  - No greenfield

2018 RTEP Proposal Window 1 - Proposals

Project ID	Upgrade/ Greenfield	Proposing Entity	Project Cost ($M)	Target Zone(s)	kV Level(s)	Analysis Type	FG#	Major Components/Project Description
1A	Upgrade	DEOK	$ 0.377	DEOK	138kV	Summer N-1 Load Drop	N1-SLD1	Add redundant relaying to Port Union 138kV Bus 2 to eliminate the contingency driving the reliablility criteria violation.
2A	Upgrade	Dominion	$ -	Dominion	69kV	Summer N-1 High Voltage	N1-SVH1, N1-SVH2	This is an operational solution that will remotely open Pentagon TX#1 breaker L122, immediately following the breaker-failure event (2036T2142) at Radnor Substation thus resolving the post contingency high voltage.
2B	Upgrade	Dominion	$ 0.481	Dominion	230/69kV	Summer N-1 High Voltage	N1-SVH1, N1-SVH2	Move the existing 230/69kV TX#4 to the vacant 230/69kV TX#2 spot at Pentagon Substation
2C	Upgrade	Dominion	$ 0.537	Dominion	230/69kV	Summer N-1 High Voltage	N1-SVH1, N1-SVH2	Move spare 230/69kV transformer from Jefferson Street Substation to the vacant Transformer #2 bay at Pentagon Substation
2D	Upgrade	Dominion	$ 13.493	Dominion	230kV	Summer N-1 High Voltage	N1-SVH1, N1-SVH2	Construct a 230kV four (4) breaker GIS ring bus in Pentagon Substation and terminate existing Line 2037 and Line 2121.
2E	Upgrade	Dominion	$ 3.161	Dominion	69kV	Summer N-1 High Voltage	N1-SVH1, N1-SVH2	Install a 50 MVAR fixed shunt reactor at Pentagon Substation on the 69kV bus
2F	Upgrade	Dominion	$ 12.732	Dominion	230kV	Summer N-1 High Voltage	N1-SVH1, N1-SVH2	A new substation called Cloverleaf with a 230kV variable shunt reactor with a new 230kV underground line roughly 300 ft extending from Cloverleaf Substation to Pentagon substation terminating at the 230kV bus

2018 RTEP Analysis Update

DEOK Transmission Zone: Baseline Project

PJM Criteria Violation – Load Loss limit (Summer), (N1-SLD1)

Problem Statement:

- Consequential Load Loss is greater than 300MW for the loss of the Port Union 138kV Bus #2 with relay failure.

Alternatives Considered:

- 2018_1-1A ($0.367M)

Preliminary Recommendation:

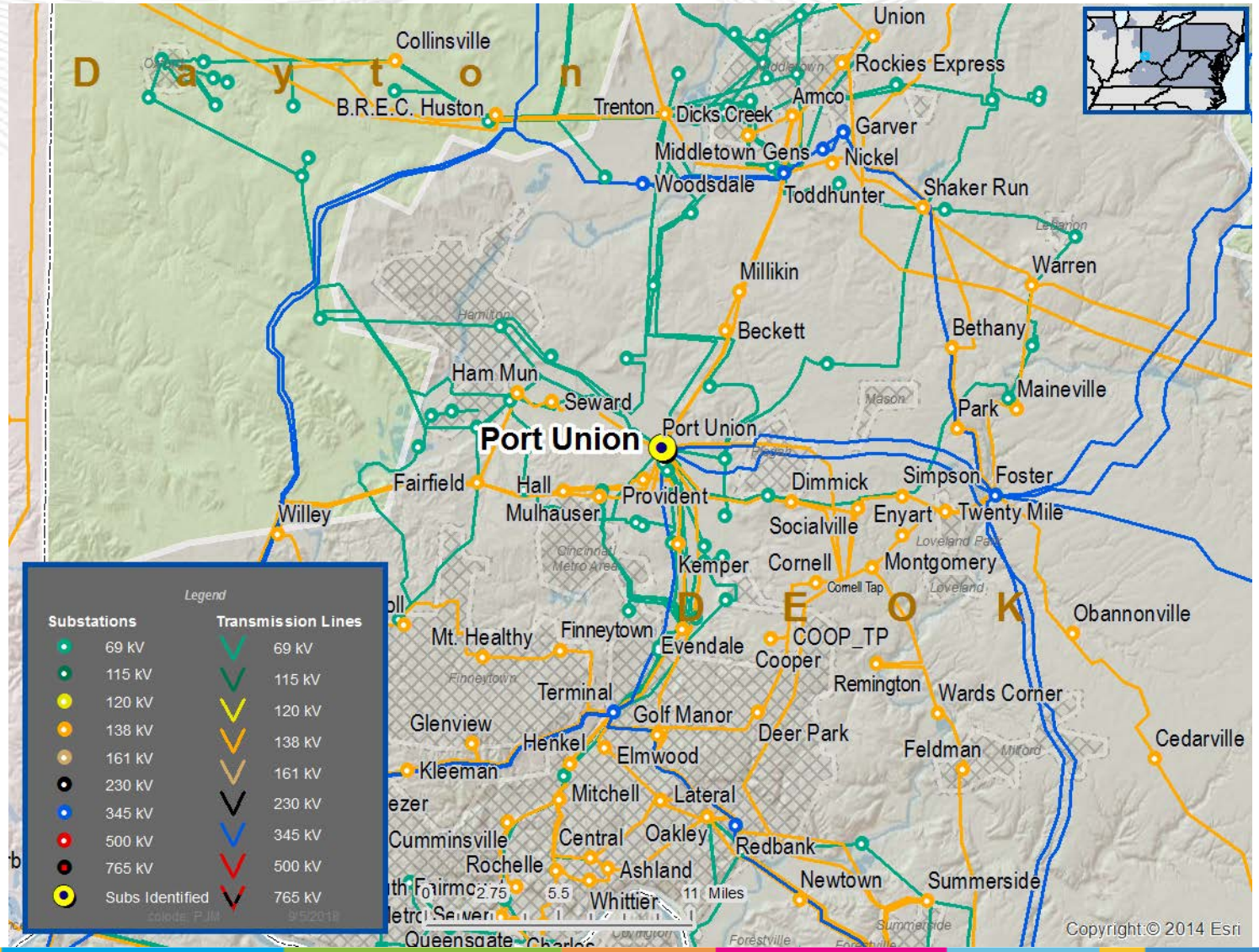
- Add redundant relay to Port Union 138kV Bus #2 (2018_1-1A)

Estimated Project Cost : $0.367M

Required IS Date: 6/1/2023

Projected IS date: 11/30/2022

Status: Planning



AE Transmission Zone: Baseline Project

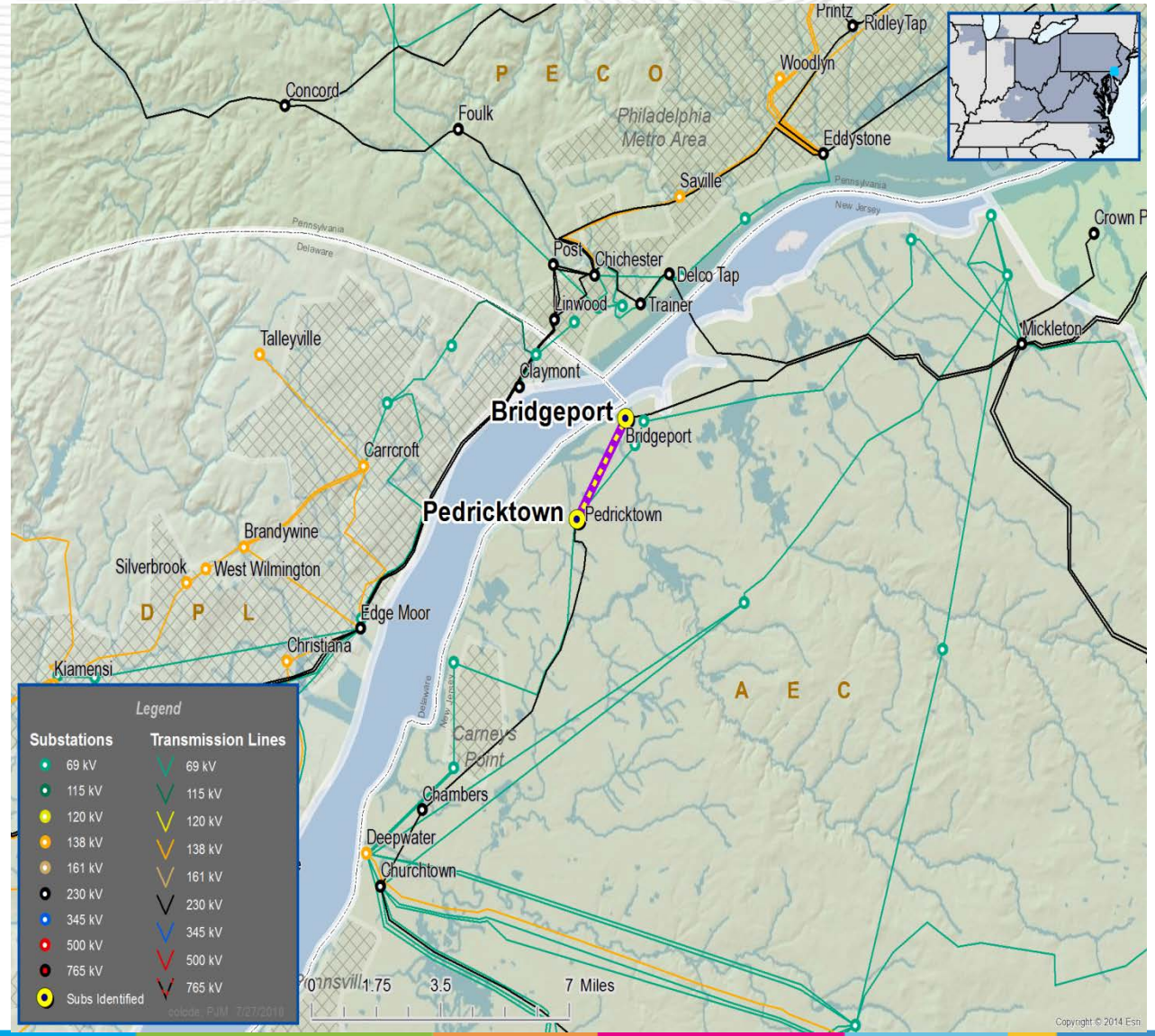
Generation Deliverability (Summer)

Substation Equipment

Problem Statement:

- The Bridgeport – Pedricktown 230 kV circuit is overloaded for a tower line outage loss of Churchtown – Orchard 230 kV and Churchtown – Upper Pittsgrove 138 kV circuits. (FG# GD-S470)

- The overload is no longer valid. There was an error with modeling the rating of the circuit. The correct rating is 650N/804E MVA



JCPL Transmission Zone: Baseline Project

Generation Deliverability (Summer)

Substation Equipment

Problem Statement:

- The Raritian River – Kilmer 230 kV circuit is overloaded for a tower line outage loss of Atlantic – R11 230 kV (P1030) and Freneau – Parlin 230 kV (K1025) circuits. (FG# GD-S466)

Proposed Solution:

- Replace substation conductor at Raritan River 230 kV substation on the Kilmer line terminal to achieve 709N/869E MVA summer rating.

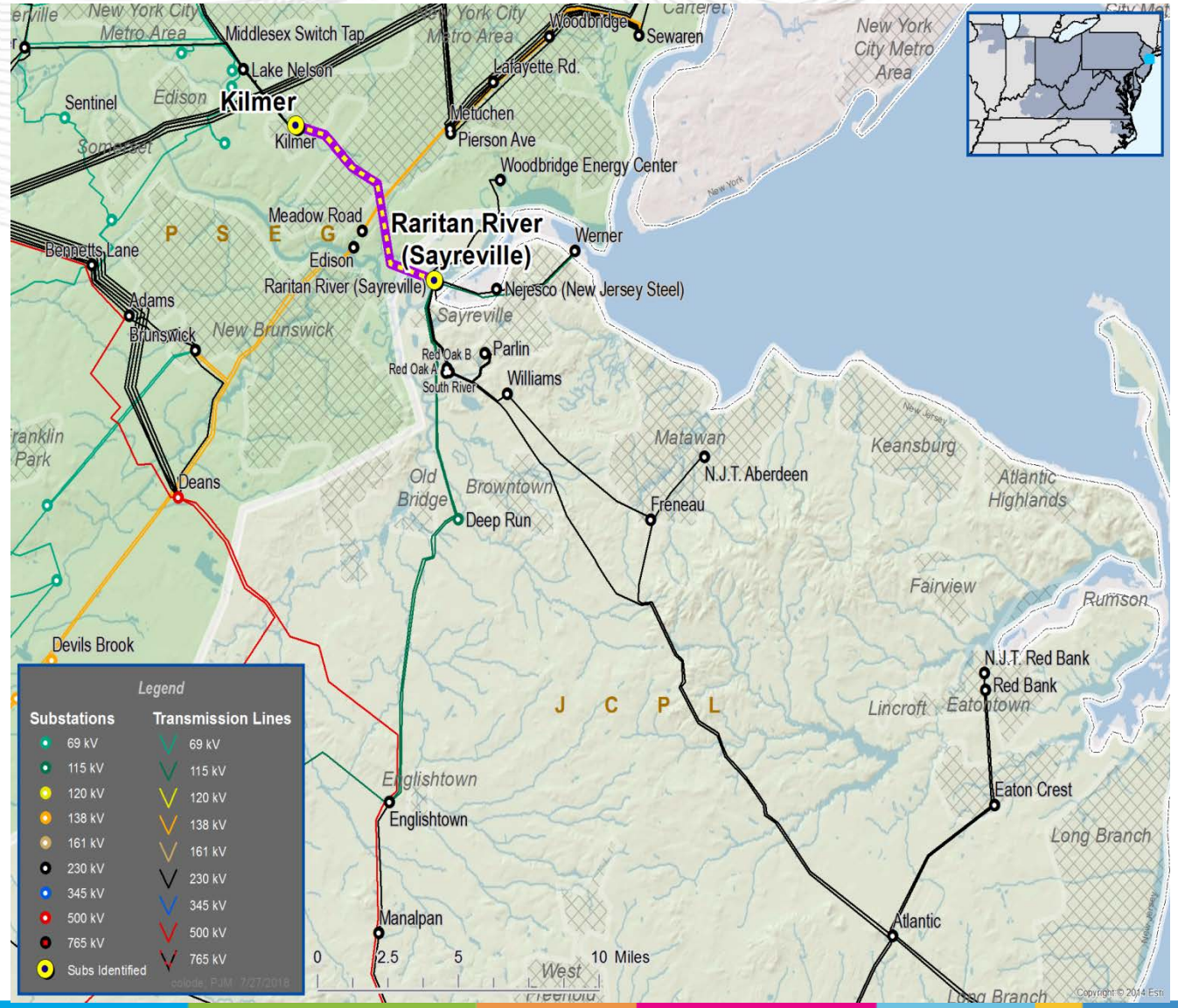
Alternatives Considered:

- None

Estimated Project Cost : $0.0535 M

Required IS Date: 6/1/2023

Status: Conceptual



PECO Transmission Zone: Baseline Project

Generation Deliverability (Summer and Winter)

Immediate Need

Problem Statement:

- The Peach Bottom – Furnace Run 500 kV circuit is overloaded for single line outage loss of the Peach Bottom – Conastone 500 kV circuit in both the summer and winter cases. (FG# GD-S42 and GD-W65)

Recommended Solution:

- Replace the following terminal equipment at Peach Bottom 500 kV substation: **(B3041)**
  - (5) disconnect switches, (2) circuit breakers, (1) line trap, (2) relays. (1) CT, (6) meters and (6) sections of station conductor

New Rating → Summer: 2826N/3525E MVA

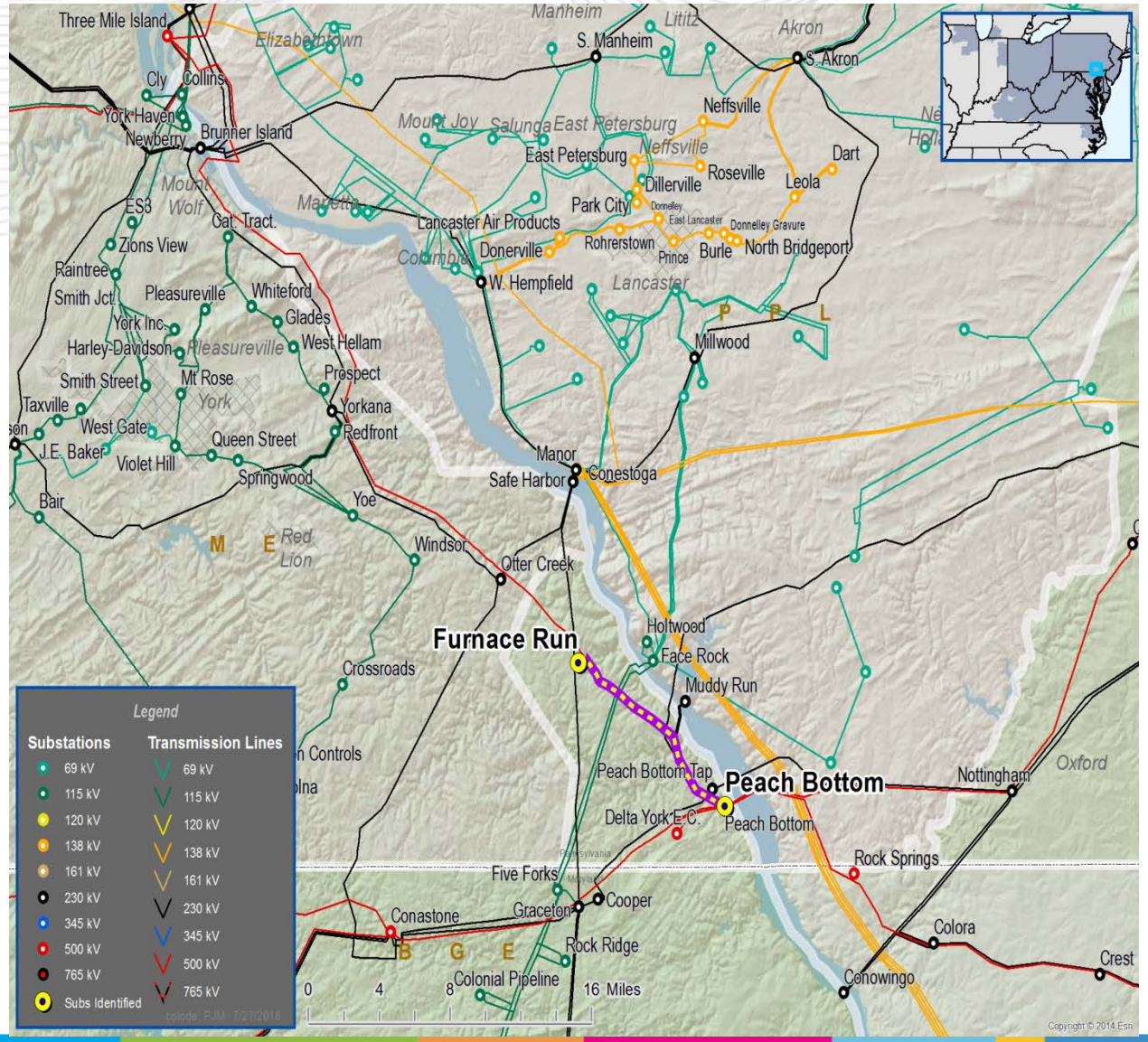
→ Winter: 3486N/4043E MVA

Estimated Project Cost : $3.5M

Required IS Date: 6/1/2021

Projected IS date: 6/1/2021

Status: Conceptual



TO Criteria Baseline Projects

Dominion End of Life Criteria

Dominion Transmission Zone: Baseline Line #2173 Loudoun to Elklick Rebuild

Baseline Reliability: TO Criteria Violation

Problem Statement: Dominion "End of Life Criteria"

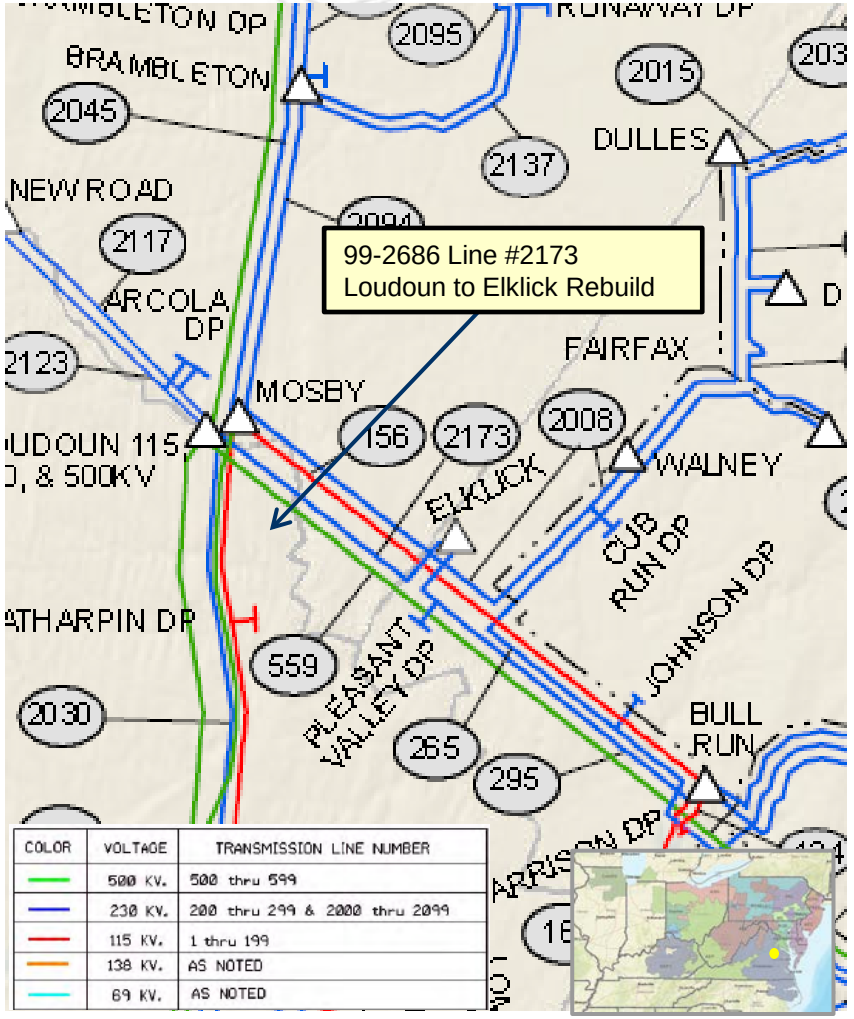
The 230kV Line #2173 from Loudoun to Elklick is roughly 4.18 miles long and was constructed on Cor-ten lattice-type double circuit towers. These towers have been shown to have inherent corrosion problems that continuously deteriorate the steel members. This line has been identified to be rebuilt as part of Dominion's End of Life criteria. This line has a current summer emergency rating of 812 MVA.

Line #2173 is part of the network feed to Elklick substation feeding over 100 MW of load that is required to meet Dominion's Transmission Planning Criteria. Additionally, removing Line #2173 from service permanently creates numerous N-1-1 thermal violations on the transmission system.

Potential Solution:
Rebuild Line #2173 (Loudoun - Elklick) with double circuit steel structures with a single circuit conductor at current 230kV northern Virginia standards with a minimum rating of 1200 MVA.

Alternative:
No feasible alternatives.

Estimated Project Cost: $13.5 M
Possible In-service Date: 12/31/2022
Project Status: Conceptual



Dominion Transmission Zone: Baseline Line #295 and Partial Line #265 Rebuild

Baseline Reliability: TO Criteria Violation

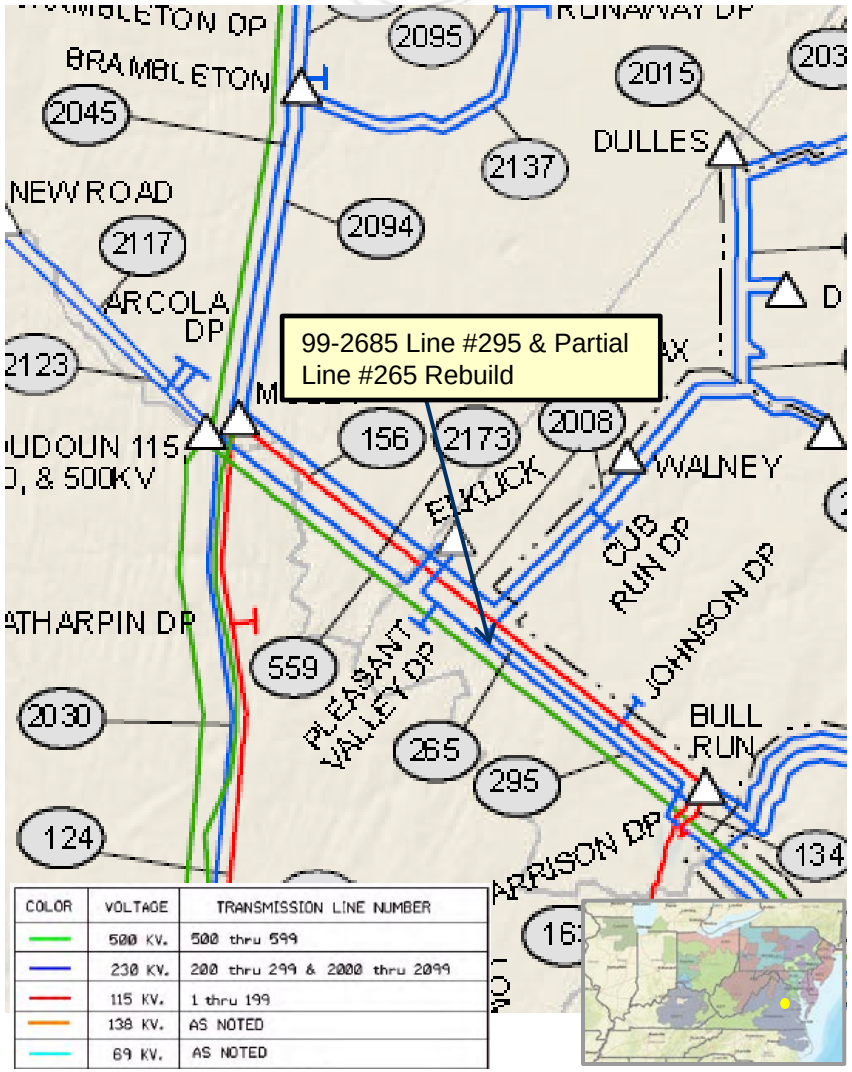
Problem Statement: Dominion "End of Life Criteria"

The 230kV Line #295 from Elklick to Bull Run is roughly 4.64 miles long and was constructed on Cor-ten lattice-type double circuit towers. A 3.85 mile long section of 230kV Line #265 between Clifton to Walney is on the same structures as Line #295. These towers have been shown to have inherent corrosion problems that continuously deteriorate the steel members. These lines have been identified to be rebuilt as part of Dominion's End of Life criteria.

Line #295 is part of the network feed to Elklick substation feeding over 100 MW of load that is required to meet Dominion's Transmission Planning Criteria. This line has a current summer emergency rating of 812 MVA.

Line #265 is part of the network feed to Sully substation feeding over 100 MW of load that is required to meet Dominion's Transmission Planning Criteria. It also has tapped load at Johnson D.P. and Walney substation totaling 98 MW. This line has a current summer emergency rating of 715 MVA.

Additionally, removing Line #295 and partial Line #265 from service permanently creates numerous N-1-1 thermal and voltage violations on the transmission system.

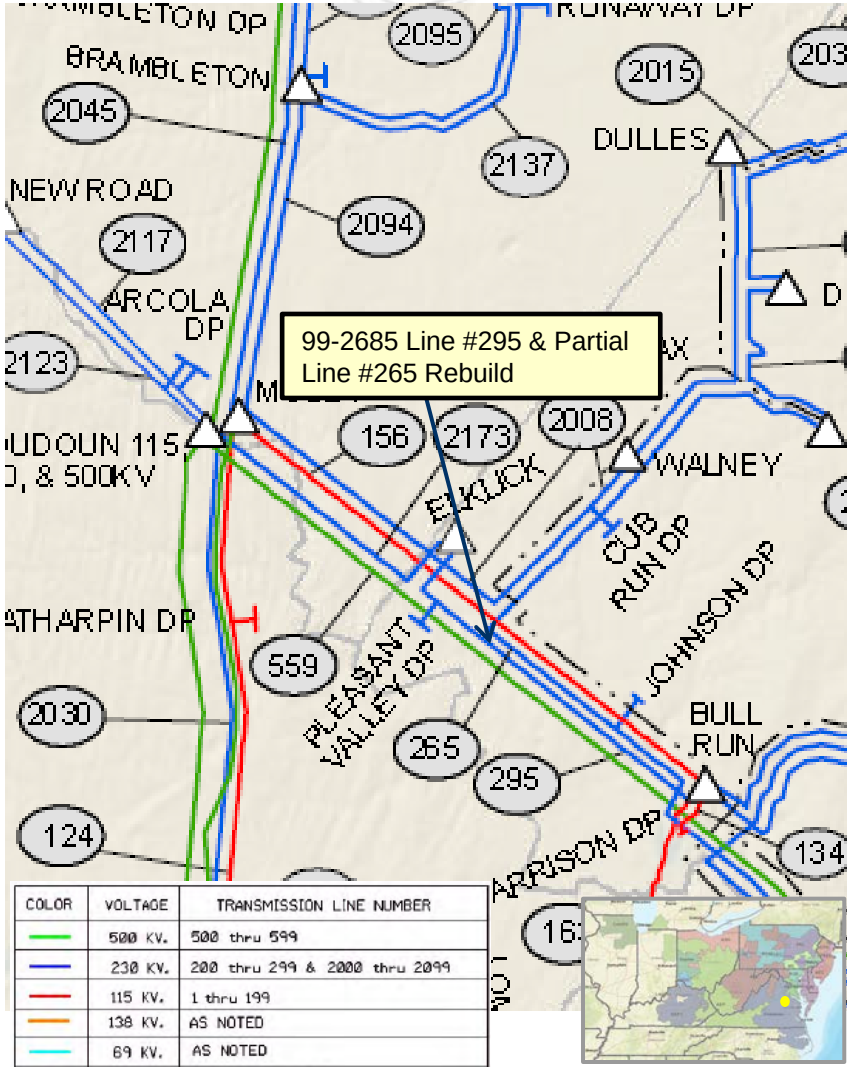


Dominion Transmission Zone: Baseline Line #295 and Partial Line #265 Rebuild

Potential Solution:
Rebuild Line #295 and partial Line #265 with double circuit steel structures using double circuit conductor at current 230kV northern Virginia standards with a minimum rating of 1200 MVA.

Alternative:
No feasible alternatives.

Estimated Project Cost: $15.5 M
Possible In-service Date: 12/31/2022
Project Status: Conceptual



Re-evaluation of the B1690 (MCRP) project

Re-evaluation of the B1690 (MCRP) project:

- The B1690 (Build a new third 230 kV line into the to Red Bank 230 kV substation) was initially proposed in 2011 to resolve a voltage violations identified in the Red Bank area.
- PJM and First Energy performed retool analysis without the B1690, due to recent proceedings, and confirmed the violations still exist.
- The analysis was performed on the 2021 and 2023 cases; and the violation exists on both cases, and therefore an upgrade will be needed immediately.
- PJM and First Energy are working on the solution and will provide update in the future.

Re-evaluation of the B1690 (MCRP) project Cont…

- Severe voltage drop violation on the Red Bank bus for towerline outage loss of Atlantic – Red Bank 230 kV (T2020 & S1033) circuits.
- Severe voltage drop violation on the Red Bank bus for N-1-1 contingency loss of Atlantic – Red Bank 230 kV (T2020 & S1033) circuits.
- Several JCPL 34.5 kV lines severely overloaded for the towerline outage loss of Atlantic – Red Bank 230 kV (T2020 & S1033) circuits requiring dynamic cascade analysis.
    - First Energy performed dynamic cascade analysis
    - The dynamic cascade analysis resulted in tripping significant number of 34.5 kV lines and loss of >520 MW load due to voltage collapse.

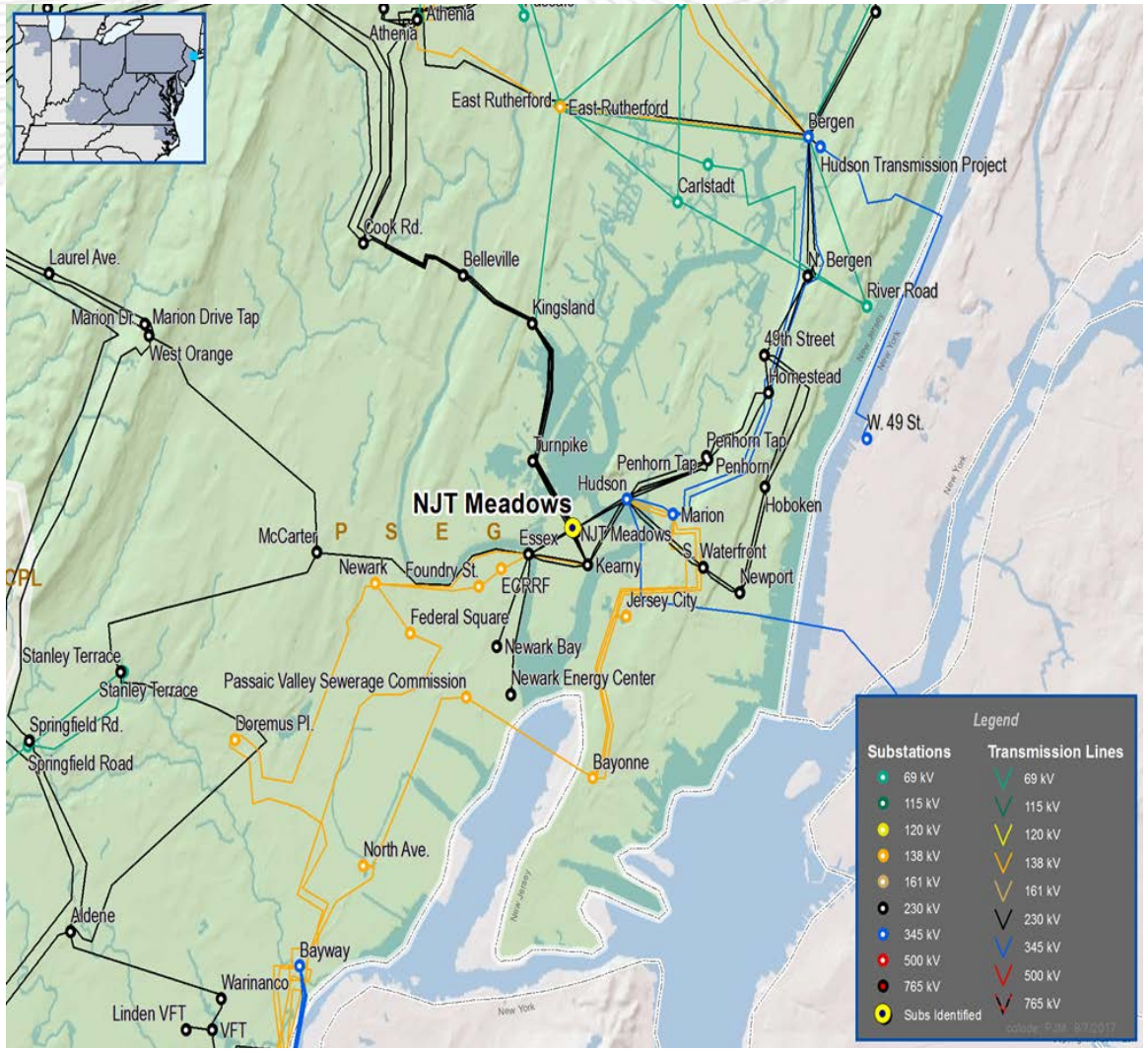
NJ Transit Mason Station Rebuild Supplemental Project

PSEG Transmission Zone: Supplemental Project
NJT Meadow Substation

Previously Presented : 09/14/2017

Background:

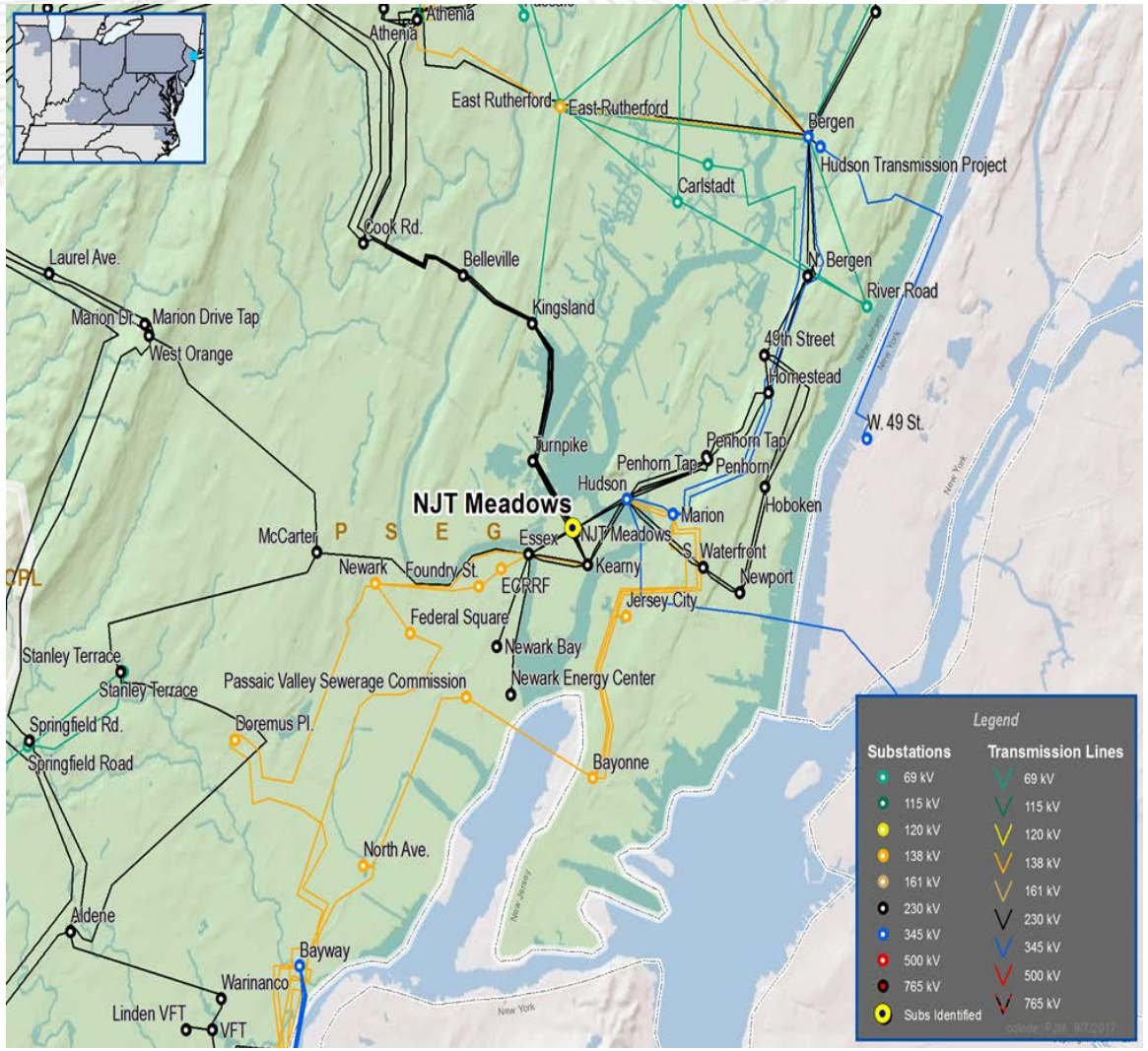
- The Mason Substation (also known as NJT Meadows) consists of two parallel 230kV feeds that provide power to critical NJ Transit rail facilities in Northern New Jersey, including power for train tunnels connecting New York City and New Jersey.
- The Mason Substation is a "pass-through" substation for the PSE&G 230kV Northern New Jersey Athenia - Essex transmission line. The majority of the power flowing through the Mason Substation is not consumed by NJ Transit.
- The Mason Substation is owned by NJ Transit and was severely damaged due to Superstorm Sandy flooding. The Substation needs to be rebuilt.



PSEG Transmission Zone: Supplemental Project
NJT Meadow Substation

Background Cont…

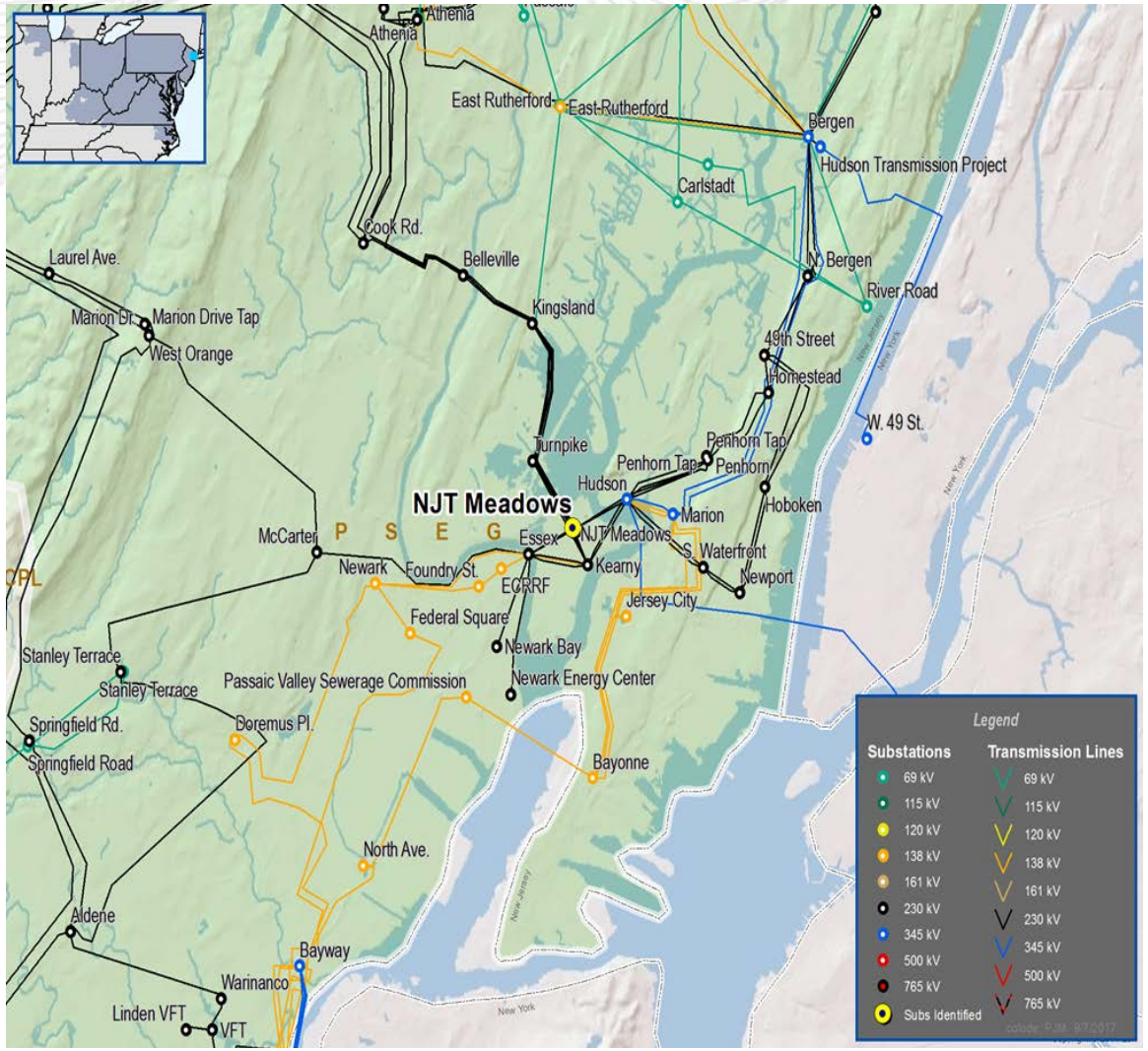
- The operation of the substation impacts PSE&G's ability to deliver power to customers throughout its Northern New Jersey service area, by agreement, PSE&G has the right to operate, test, and adjust certain elements of the Existing Substation.
- The existing equipment configuration and current operational constraints preclude outages necessary to accomplish routine maintenance and repairs.
- The current arrangement has proven to limit PSE&G's ability to promptly access the Existing Substation to expeditiously perform necessary repairs



PSEG Transmission Zone: Supplemental Project
NJT Meadow Substation

Selected Solution: (S1749)

- Two existing 230kV high voltage transmission circuits will be connected to a 230kV breaker-and-a-half design gas-insulated switchgear (GIS) switching station in place of the existing 230kV straight bus design.
- The GIS facility will be comprised of four (4) bays including three (3) breakers and two (2) line positions each, totaling 12 breakers and 8 line positions of GIS equipment as well as a protective GIS hall building, control room, station light and power transformers, and a backup generator.
- The entire 230kV yard will be raised to required 500 year flood elevations to mitigate damage from future storms.
- The Substation will have line capacity of 735 MVA summer normal rating (estimated peak load of NJ Transit at the Substation will be approximately 30 MVA).



PSEG Transmission Zone: Supplemental Project
NJT Meadow Substation

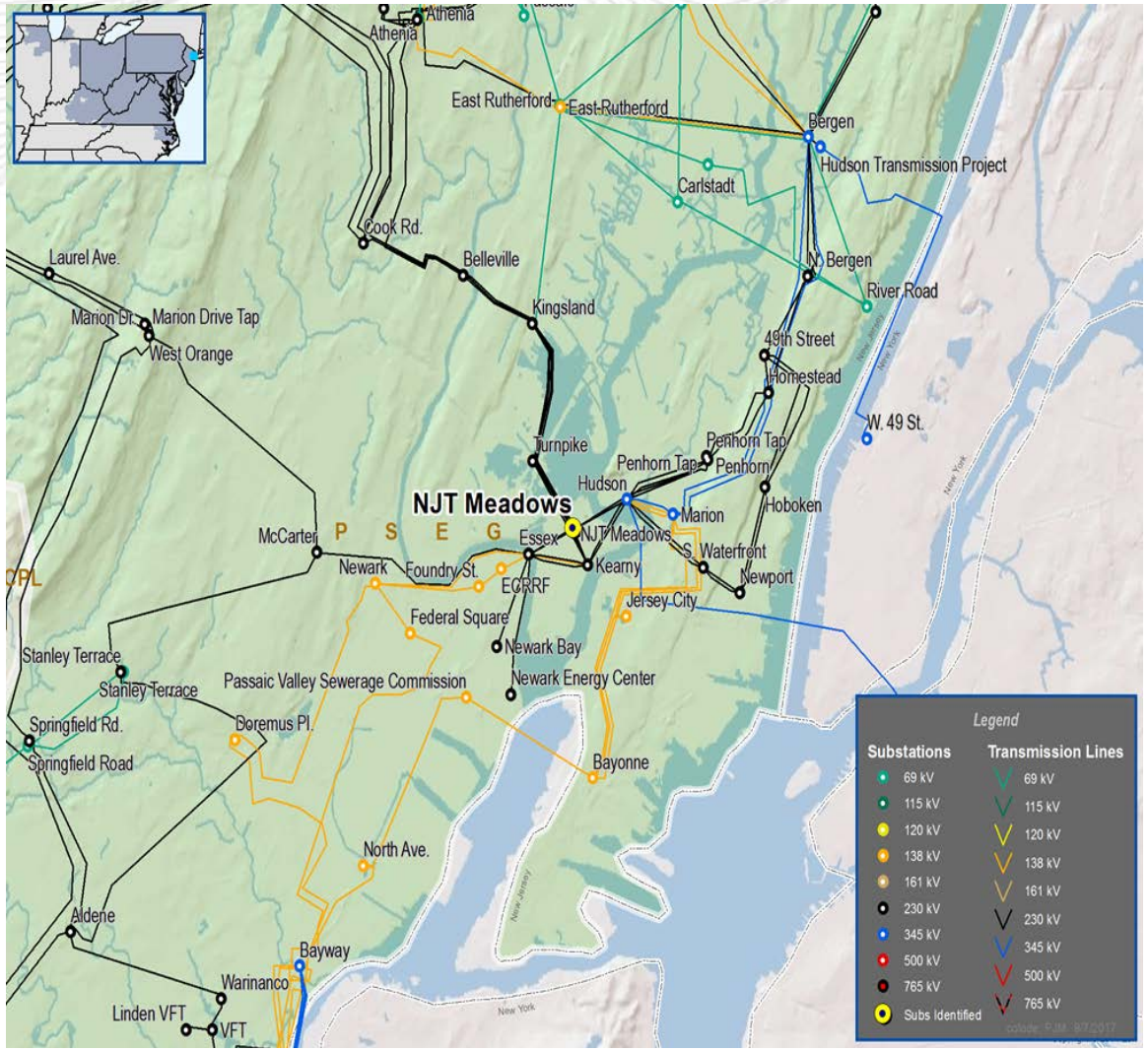
Selected Solution cont…

- On November 21, 2017, the New Jersey BPU issued an order approving a stipulation of agreement between the NJ BPU staff, NJ Rate Counsel, PSE&G and NJ Transit in which the parties agreed that PSE&G own, construct and operate the Substation
- Costs for the project will not be recovered through transmission rates. The costs for the transmission project will be recovered from NJ Transit.

Estimated Project Cost : $127M

Expected IS date: 12/31/2021

Status: Engineering



Operational Benefits of proposed New Substation & future PSE&G Ownership

- PSE&G's ownership of the Substation will ensure that PSE&G has control of the station to properly effectuate maintenance and repairs that will greatly reduce the likelihood of outages and the duration of outages.
- Reconstruction of the station will also improve reliability of two adjacent substations in Kearny serving the PSE&G system, and serving NJ Transit.
- The current 230kV bus configuration provides limited system reliability due to the existence of a single point of failure. Modification of the Substation from a straight-bus design to a breaker-and-a-half design will result in increased system reliability benefits to PSE&G customers.

Supplemental Projects

AEP Transmission Zone: Supplemental Jacksons Ferry 765 kV PK Breakers

Supplemental Project
Previously Reviewed 8/9/2018

Problem Statement:

Equipment Material/Condition/Performance/Risk:
At Jacksons Ferry station, 765 kV circuit breakers “A”, “A1”, “A2”, “B1” & “B2” are PK Air blast breakers, which currently require hearing protection be used for personnel within the substation. Air blast breakers are being replaced across the AEP system due to reliability concerns, intensive maintenance, and their tendency to catastrophically fail. During failures, sharps pieces of porcelain from their bushings are typically expelled, which, can be a potential safety hazard to field personnel. In addition, the ability to get spare parts for these breakers is becoming increasingly difficult. CB “A” has experienced 8 operations, “A1” has experienced 11 operations, “A2” has experienced 17 operations, “B1” has experienced 17 operations and “B2” has experienced 30 operations

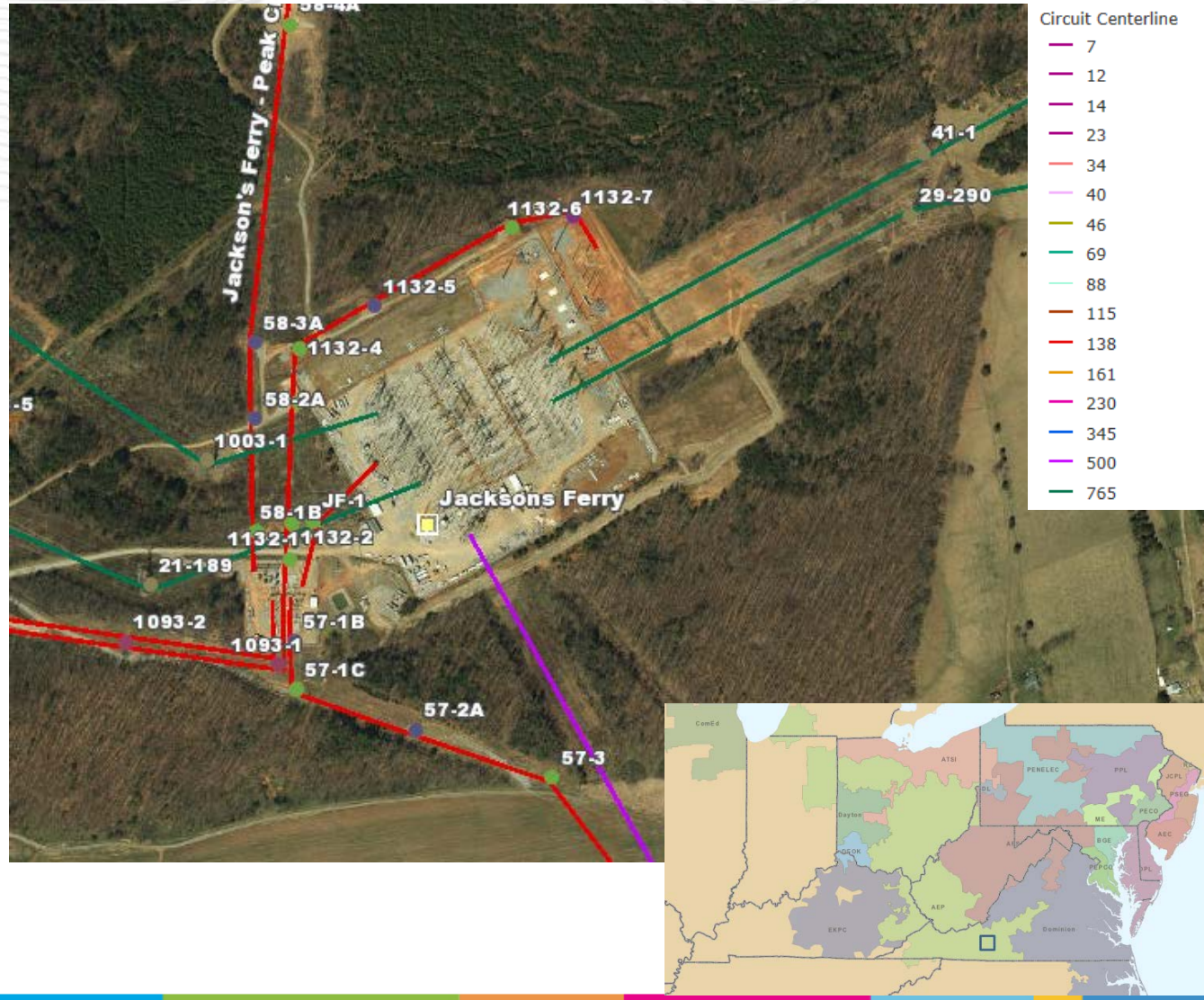
Selected Solution:

Replace existing 3000 A 50 kA 765 kV PK CB’s “A”, “A1”, “A2”, “B1” & “B2” with new 4000 A 63 kA CB. (S1684)

Total Estimated Transmission Cost: $25.4M

Projected In-service: 11/2019

Project Status: Engineering



Highland 500/138/69 kV Substation (S0856) Cancelation

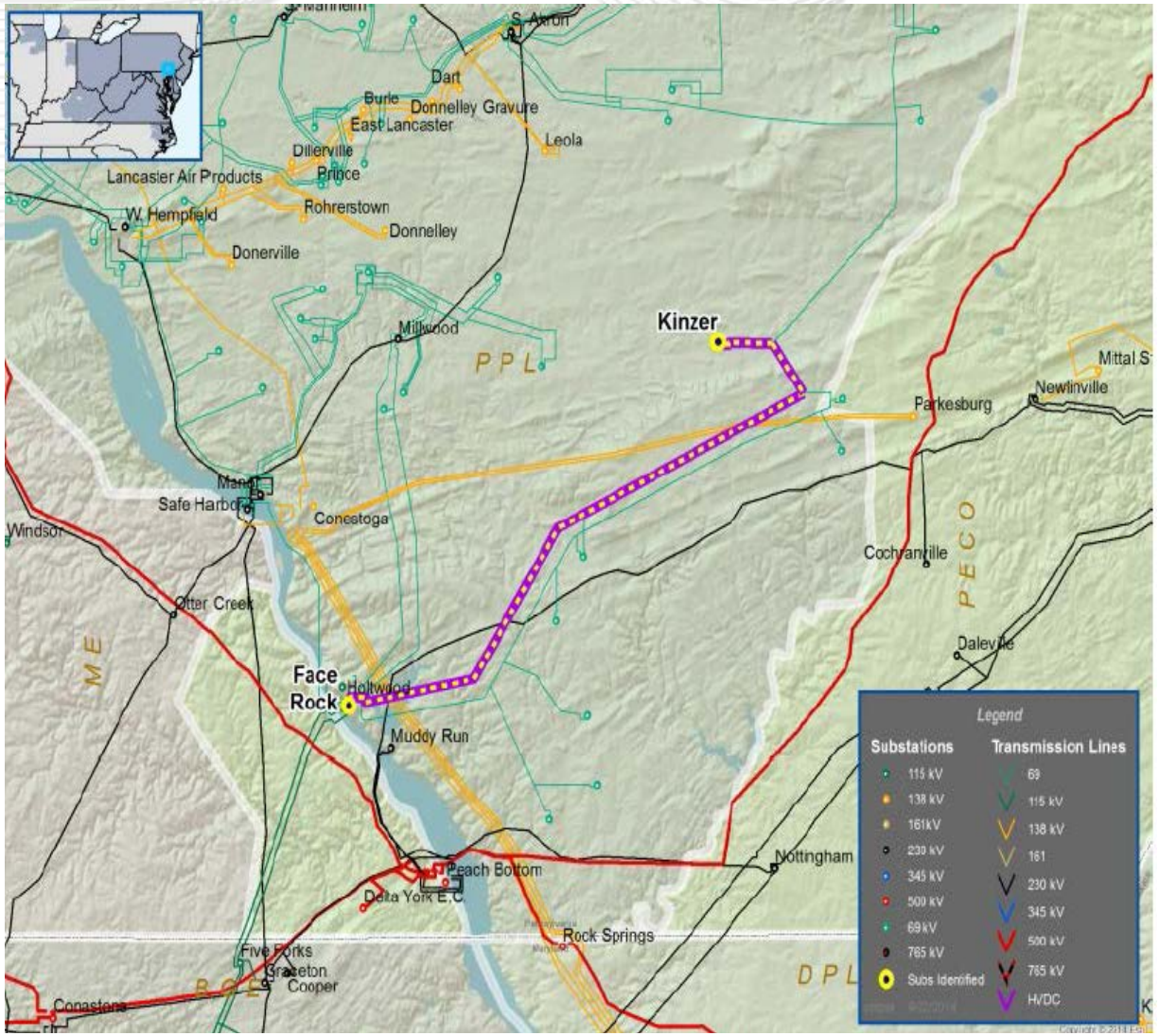
Project (s0856): Build new 500/138/69KV near Quarryville and terminate Face Rock – Kinzer 13 & 14 69 kV lines.

- The project was proposed to address load growth in Quarryville area.

Project Update: The project has been cancelled.

- Load growth in the Quarryville area did not increase as expected.

Estimated Cost: $56.45M



2018 RTEP Next Steps

2018 RTEP Next Steps

- Continue review of required baseline reinforcements
- Potential scenario study analysis
- Extreme contingency analysis

RTEP@pjm.com to Be Retired

- PJM will retire the RTEP@pjm.com email address as of September 1, 2018. Stakeholders with questions about planning updates or planning windows should use the Planning Community.
- PJM is enhancing the way we communicate to follow industry standards and maintain its standing as an industry leader.
- The Planning Community is a vital avenue for PJM members and staff to collaborate on planning updates, including RTEP windows, and get their questions answered.

Upcoming TEAC Meetings

2018

- TEAC meetings are the following Thursdays in 2018
- 1/11, 2/8, 3/8, 4/5, 5/3, 6/7, 7/12, 8/9, 9/13, **10/11, 11/8, 12/13**

Revision History

- V1 – 9/7/2018 – Original Slides Posted
- V2 – 9/13/2018
  - Slides 14-16 added inset maps and a voltage level tables.
  - Slide 6: Corrected spelling and costs.