Sub Regional RTEP Committee
Mid-Atlantic

August 31, 2017

Baseline Reliability and Supplemental Projects
First Review

Generation Deliverability and N-1-1 Thermal (Summer):

Problem Statement:

- The BL England – Middle Tap 138 kV circuit is overloaded for multiple contingencies. (FG# GD-S569, N2-ST1 and N2-ST4):

Potential Solution:

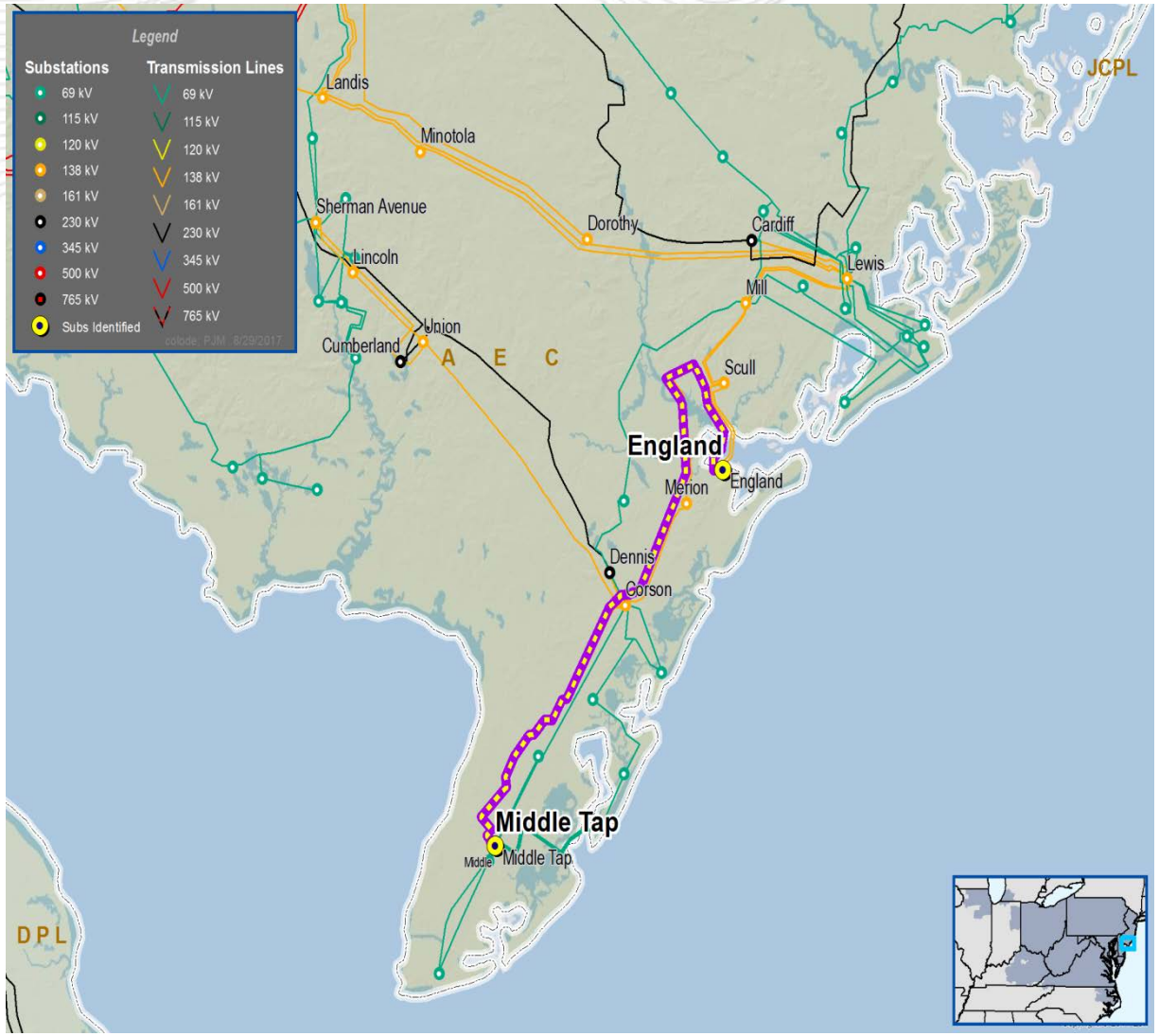
- The BL England – Middle Tap 138kV line is a 10.12 mile double circuited line with the BL England – Merion and Merion – Corson 138kV lines, constructed on lattice towers.
  - Rebuild the 138kV line to 2000A on double circuited steel poles and new foundations at a cost of $22,640,000
  - Re-conductor BL England – Merion 138kV (1.9miles) and Merion – Corson 138kV (8miles) lines at cost of $3,923,000 and $9,845,000 respectively as they share the same lattice towers.

Alternative Solution:

- Build a new 138kV line of approximately 16 miles originating at ACE's BL England substation located in Beesley's Point, New Jersey and ending at ACE's Lewis substation located in Pleasantville, New Jersey. Approximately 14 miles of existing rights-of-way would need to be expanded along the existing BL England – Lewis rights-of-way in order to build the new BL England – Lewis 138kV line. The new line would run parallel to the existing BL England – Scull – Mill – Lewis 138kV lines. The total cost of the new 16 miles of 138kV line including the new terminals at both BL England and Lewis is $54,675,400.

Required IS date: 6/1/2022

Project Status: Conceptual



Terrace Substation

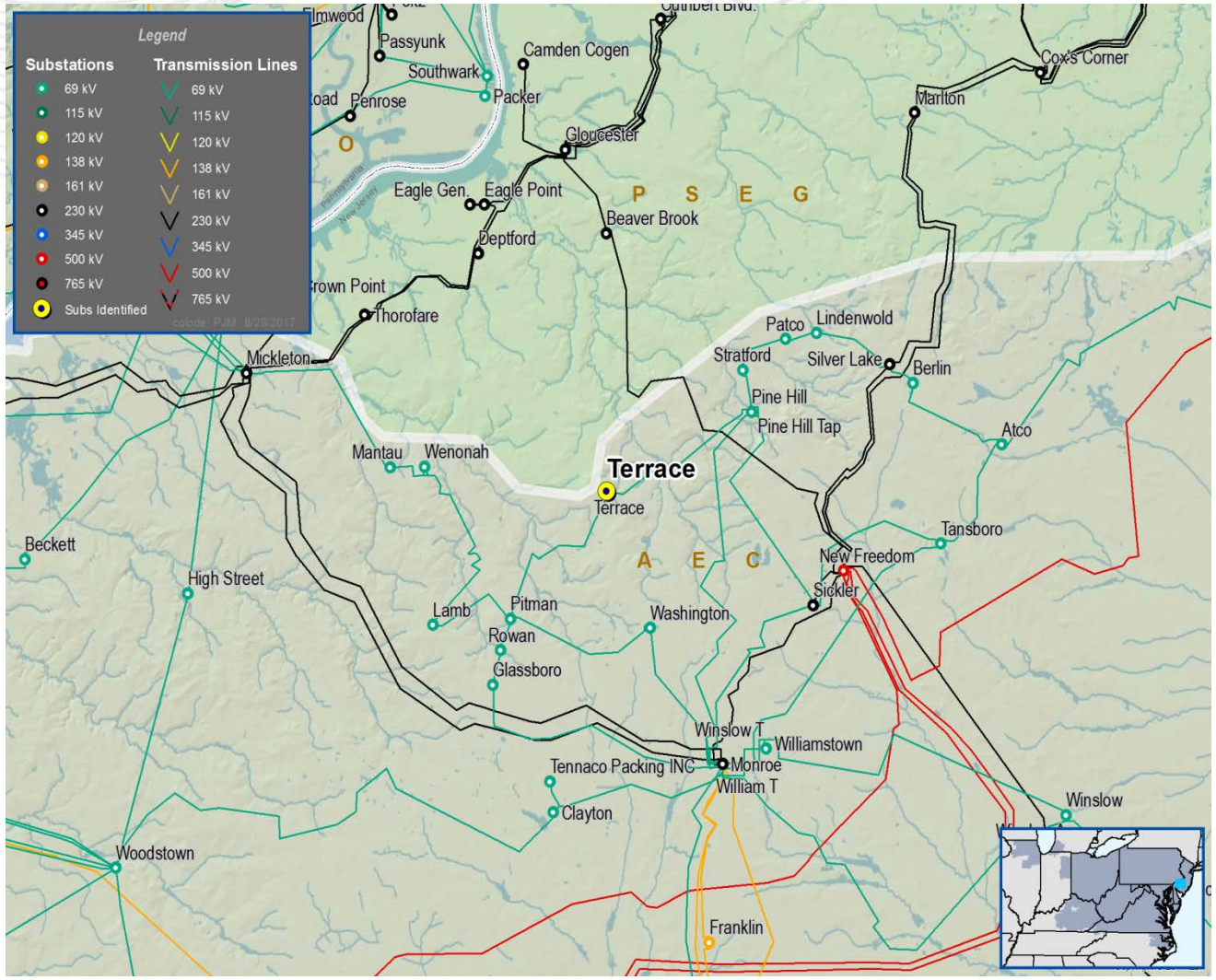
Problem Statement:

- The lack of line breakers at Terrace substation has resulted in the loss of the entire Terrace substation whenever there is a trip on the Pine Hill – Pitman 69kV line.

Alternatives:

- Ring bus – isolates substation from line faults that result in load loss and facilitates firm substation design and future expansion (Estimated cost: approximately $4.5M)
- Straight bus – isolates substation from line faults that result in load loss but does not facilitate firm substation design or future expansion (Estimated cost: approximately $4.0M)
- No upgrades – entire station exposed to faults on 69kV lines.

Project Status: Conceptual



Clayton – Woodstown 69kV

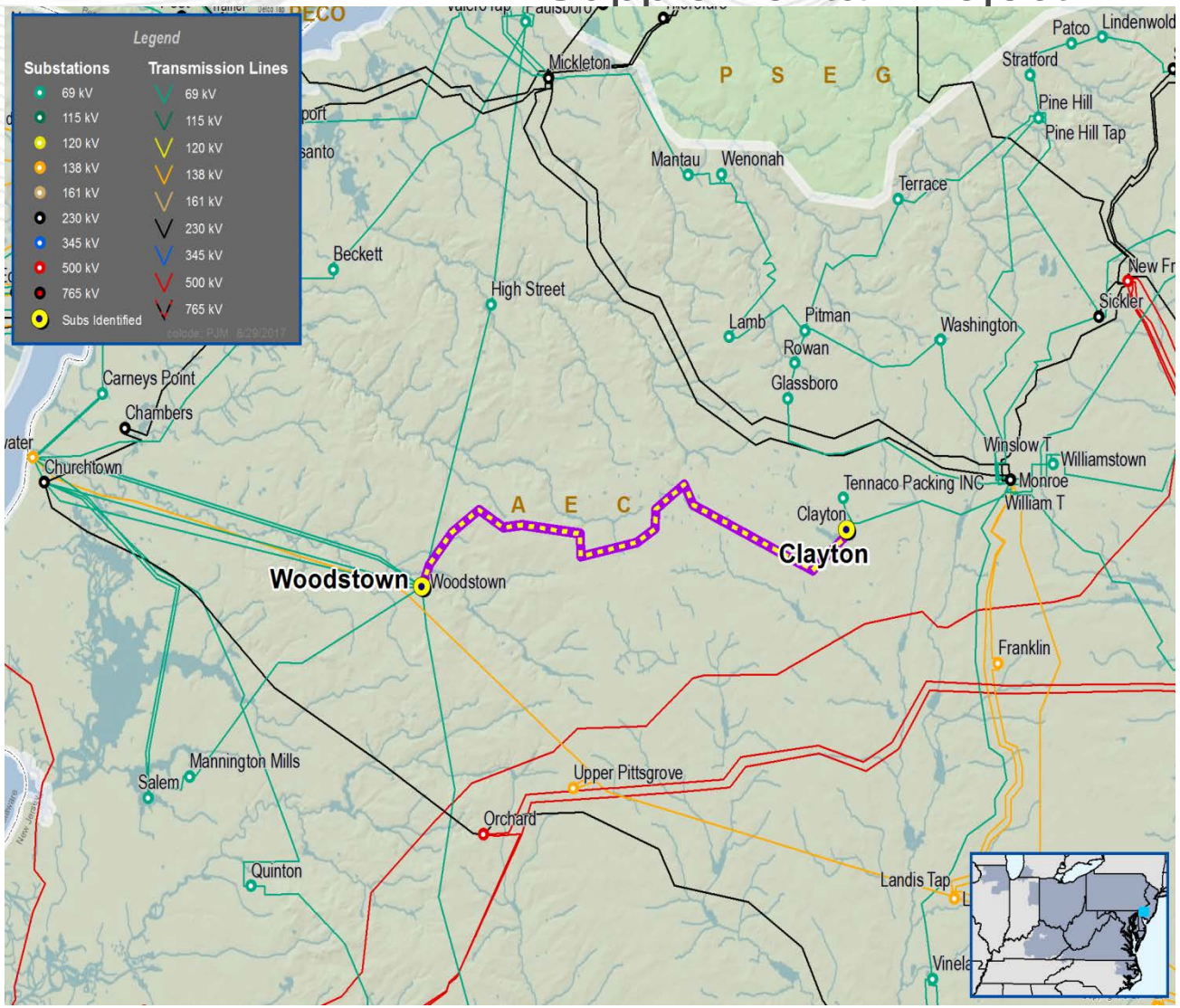
Problem Statement:

- This project is needed to mitigate performance risk associated with the current equipment material and condition. Specifically, based on inspection data, deteriorated, cracked, and weathered crossarms and deteriorated poles were identified, which places this line in the top quartile of the ACE age and condition ranking. This line was originally installed in 1955.

Alternatives:

- Rebuild line 0714 between Clayton and Woodstown substations. All structures, conductor, and static wire will be replaced with new wood (in county ROW) and steel poles, conductor, and OPGW. (Estimated cost: approximately $22.3M)
- Obtain new ROW to install a new line

Project Status: Conceptual



Generation Deliverability (Winter):

Problem Statement:

- The Tanyard – Preston 69 kV circuit is overloaded for line fault stuck breaker contingency loss of the Milford to Steele and Steele to Vienna 230 kV circuits. (FG# GD-W499):

Potential Solution:

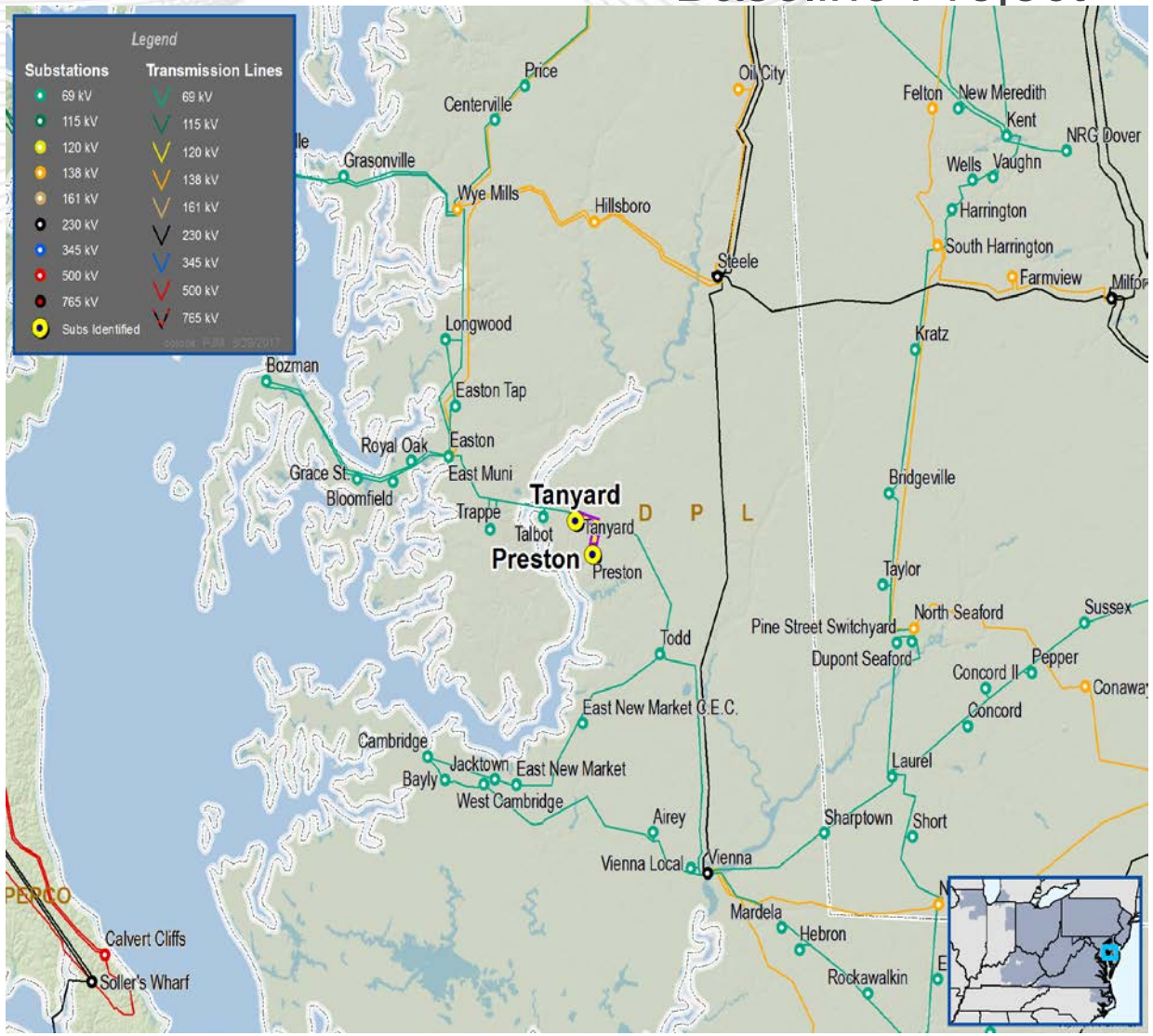
- Convert existing Preston 69 kV Substation to DPL's current design standard of a 3-breaker ring bus.
  - This solution resolves the overload, provides operation flexibility and the opportunity for future expansion at the Preston Substation**.**
  - The estimated Project Cost is $2.64 M

Alternative Solution:

- Convert existing Preston Substation to a 2-breaker line bus.
  - While this solution would adequately resolve the overload situation on the line, it would not provide the same flexibility or opportunity for future expansion that would be accomplished with the ring bus installation.
  - The estimated cost of this upgrade is $1.85M.

Required IS date: 6/1/2022

Project Status: Conceptual



Generation Deliverability (Summer):

Problem Statement:

- The Darley – Naamans 69 kV circuit is overloaded for tower line outage of the loss of the Edge Moor to Claymont and Edge Moor to Linwood 230 kV circuits. (FG# GD-SNew):

Potential Solution:

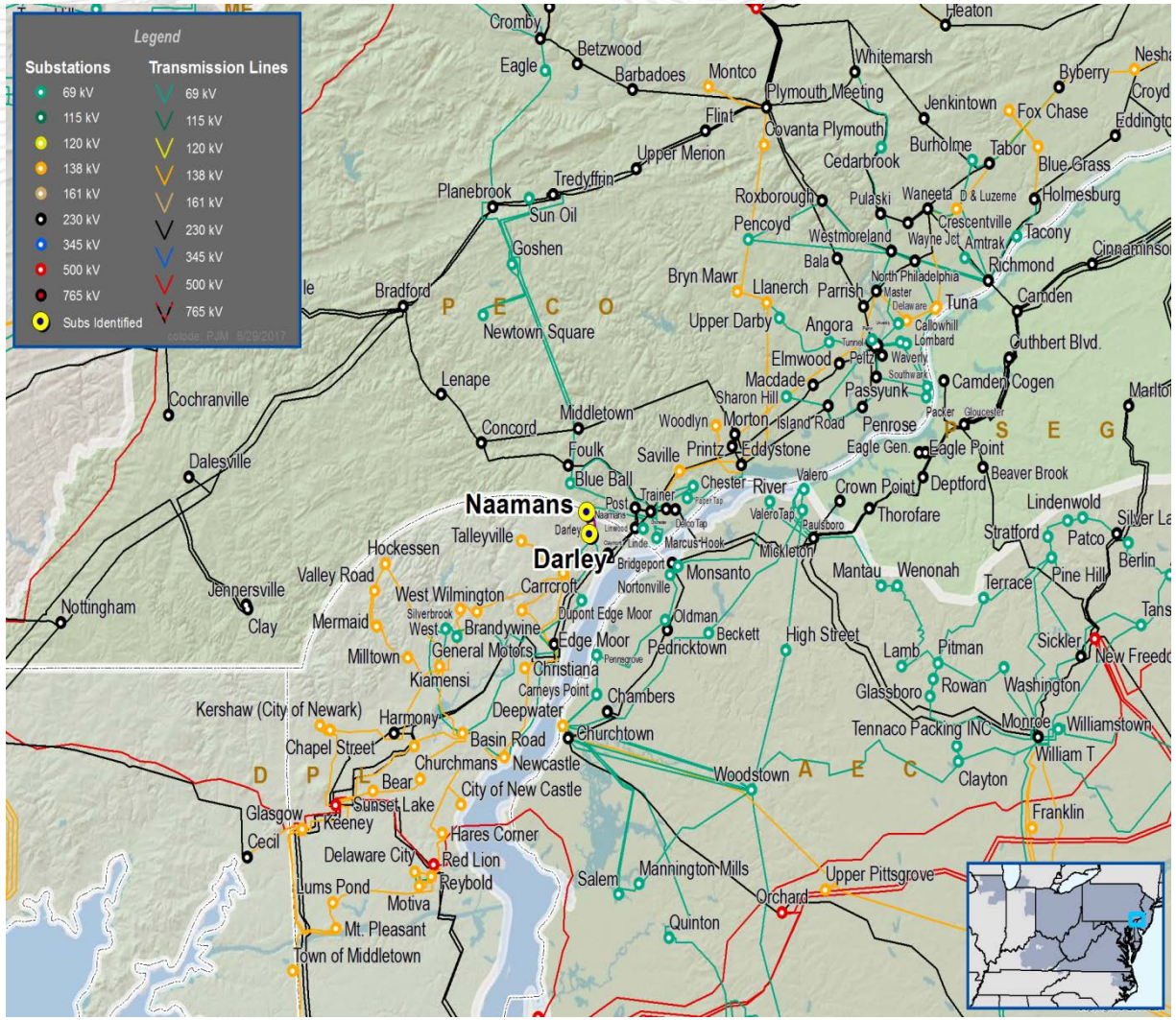
- Upgrade terminal equipment at DPL's Naamans Substation with an estimated cost of $151,200.
- Re-conductor 0.11 mile section of Darley-Naamans circuit with an estimated cost of $197,000.
  - This reconductor and terminal upgrade will eliminate the aforementioned overloads and is estimated to cost a total $348,200.

Alternative Solution:

- No alternatives were considered for this overload as this is the least cost solution and also meets DPL standards.

Required IS date: 6/1/2022

Project Status: Conceptual



Generation Deliverability (Summer):

Problem Statement:

- The Dupont Edge Moor –Silver R. 69 kV circuit is overloaded for tower line outage of the loss of the Edge Moor to Claymont and Edge Moor to Linwood 230 kV circuits. (FG# GD-S591):

Potential Solution:

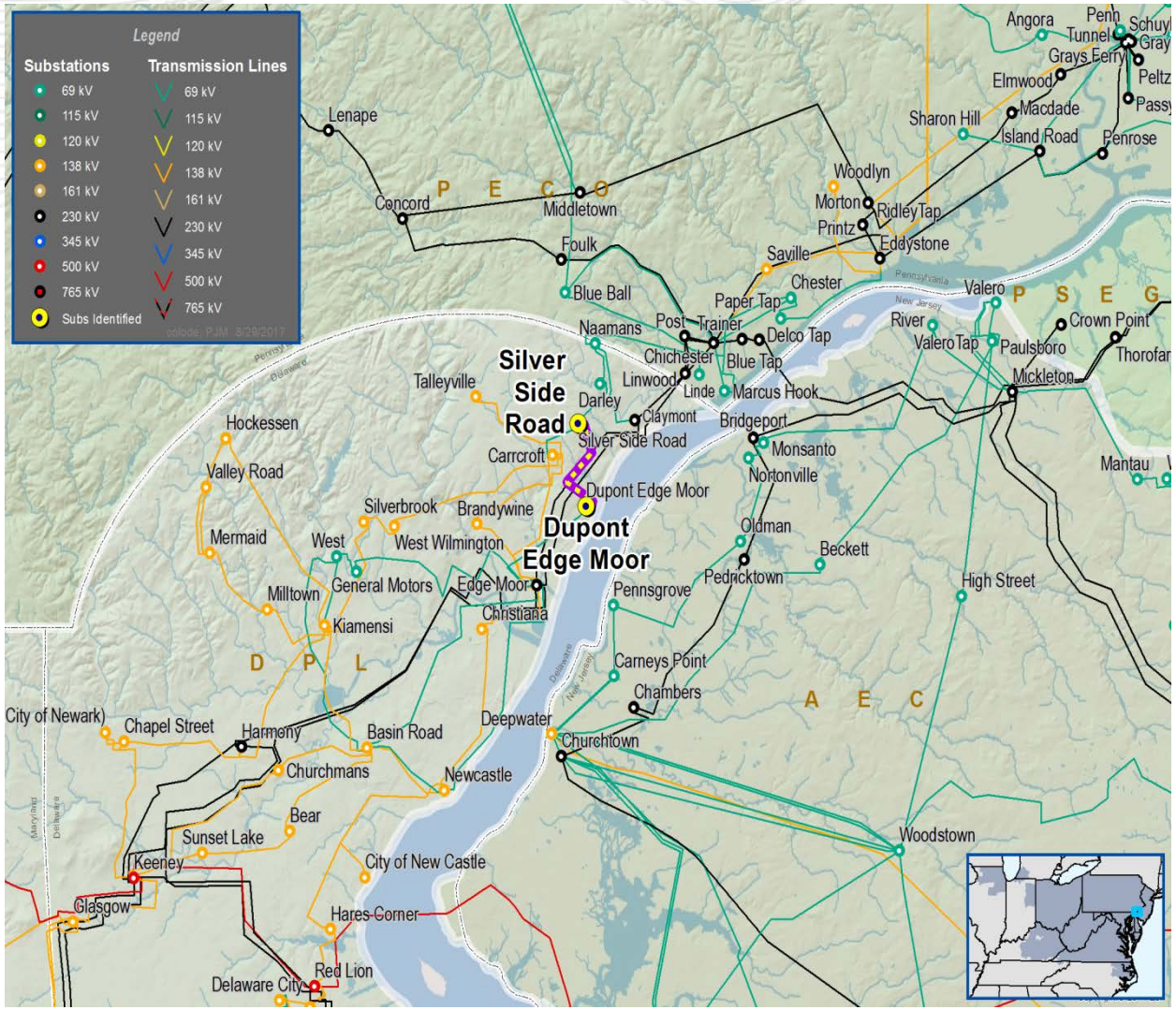
- Upgrade terminal equipment at DPL's Silverside Substation at a cost of $151,200.

Alternative Solution:

- No alternatives were considered for this overload as this is the least cost solution and also meets DPL standards.

Required IS date: 6/1/2022

Project Status: Conceptual



Load Deliverability DPL South (Summer):

Problem Statement:

- Low voltage violation at the Five Point 69 kV plus the Robinson and Rehoboth 138 kV stations during the Delmarva South LDA load deliverability analysis. (FG# LD-SVL1, LD-SVL,2 and LD-SVL3)

Potential Solution:

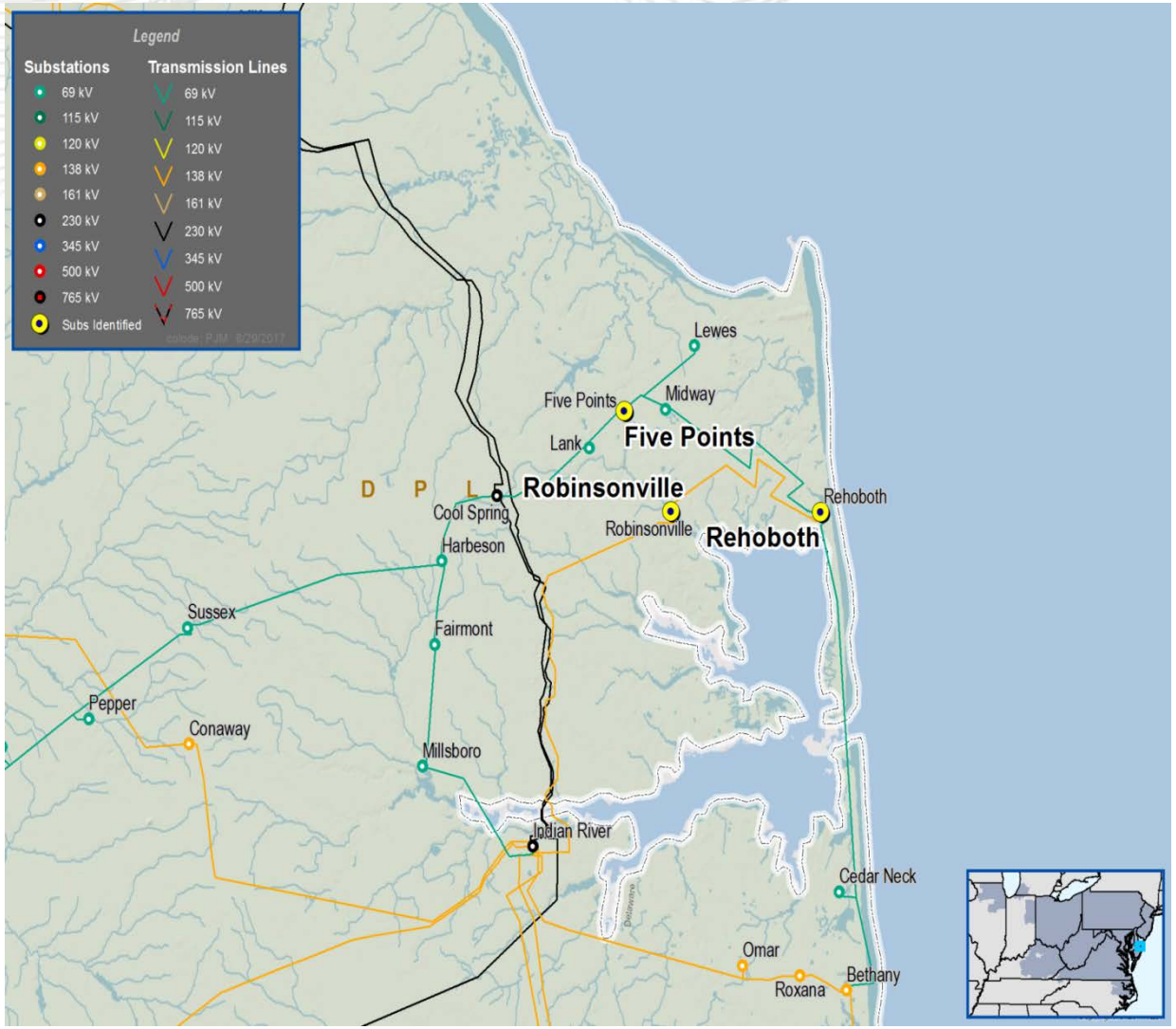
- Install additional 30 MVAR capacitor bank at DPL's Rehoboth 138 kV Substation.
  - The capacitor bank would be installed in two separate 15 MVAR stages allowing DPL operational flexibility. At this stage, there are ongoing discussions with Substation Engineering to assess the viability of this option from a constructability standpoint, and the estimate is being created accordingly. This solution will resolve all of the voltage issues identified above.

Alternative Solution:

- Replace existing 30 MVAR capacitor bank at DPL's Rehoboth 138 kV Substation with a +50/-25 MVAR Static VAR Compensator (SVC).
  - At this stage, there are ongoing discussions with Substation Engineering to assess the viability of this option from a constructability standpoint, and the estimate is being created accordingly. This solution will resolve all of the voltage issues identified above

Required IS date: 6/1/2022

Project Status: Conceptual



Generation Deliverability (Summer):

Problem Statement:

- The Northwood 115 kV bus is overloaded for Single contingency loss of the Hosensack to Steel City 500 kV circuit. (FG# GD-S180):

Potential Solution:

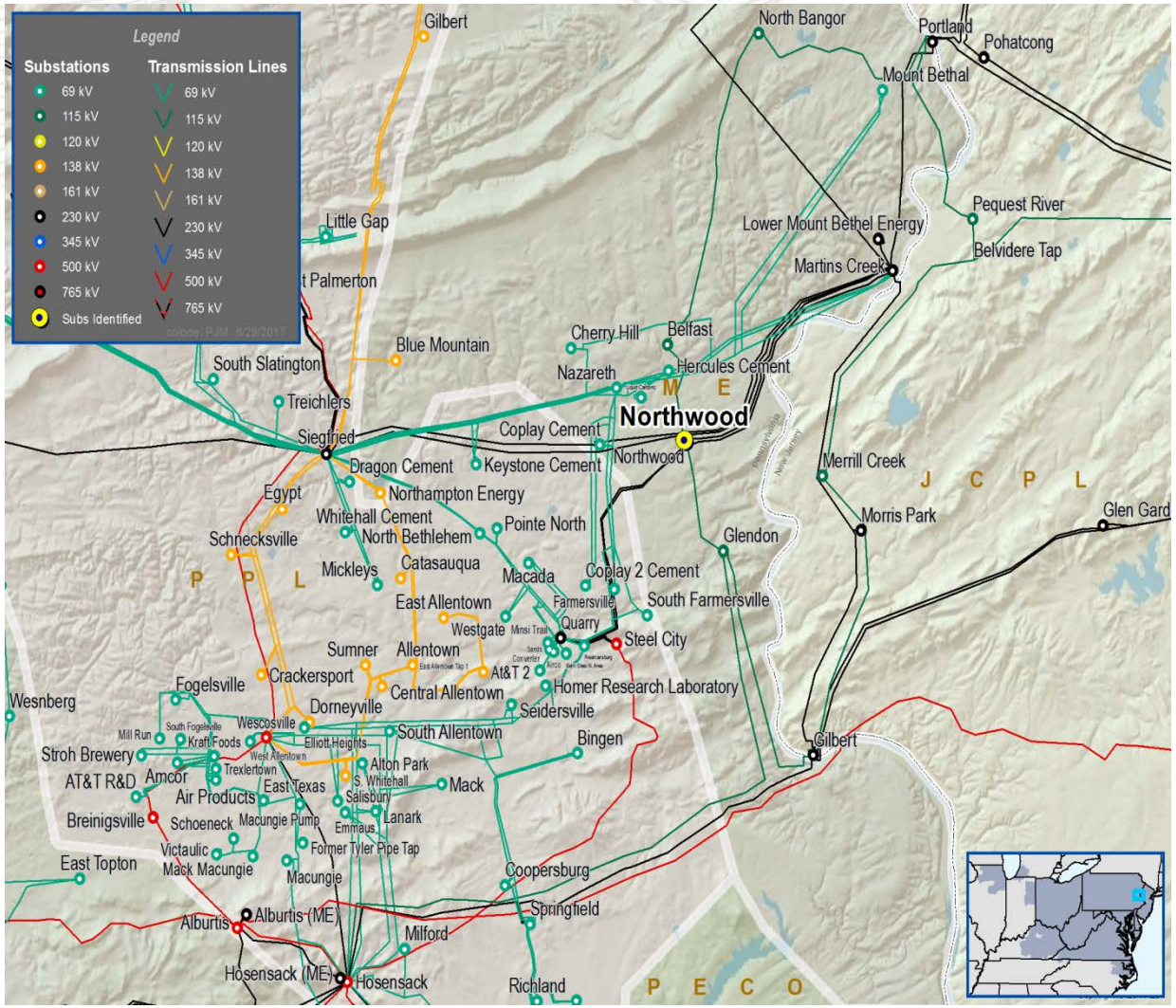
- Upgrade limiting 115 kV switches on the 115 kV side of the 230/115 kV Northwood substation and adjust setting on limiting ZR relay at estimated cost of $ 97,400

Alternative Solution:

- No alternative considered

Required IS date: 6/1/2022

Project Status: Conceptual



Generation Deliverability (Summer):

Problem Statement:

- The Seward – Florence 115 kV circuit is overloaded for multiple line fault stuck breaker contingencies. (FG# GD-S792 and GD-S793):

Potential Solution:

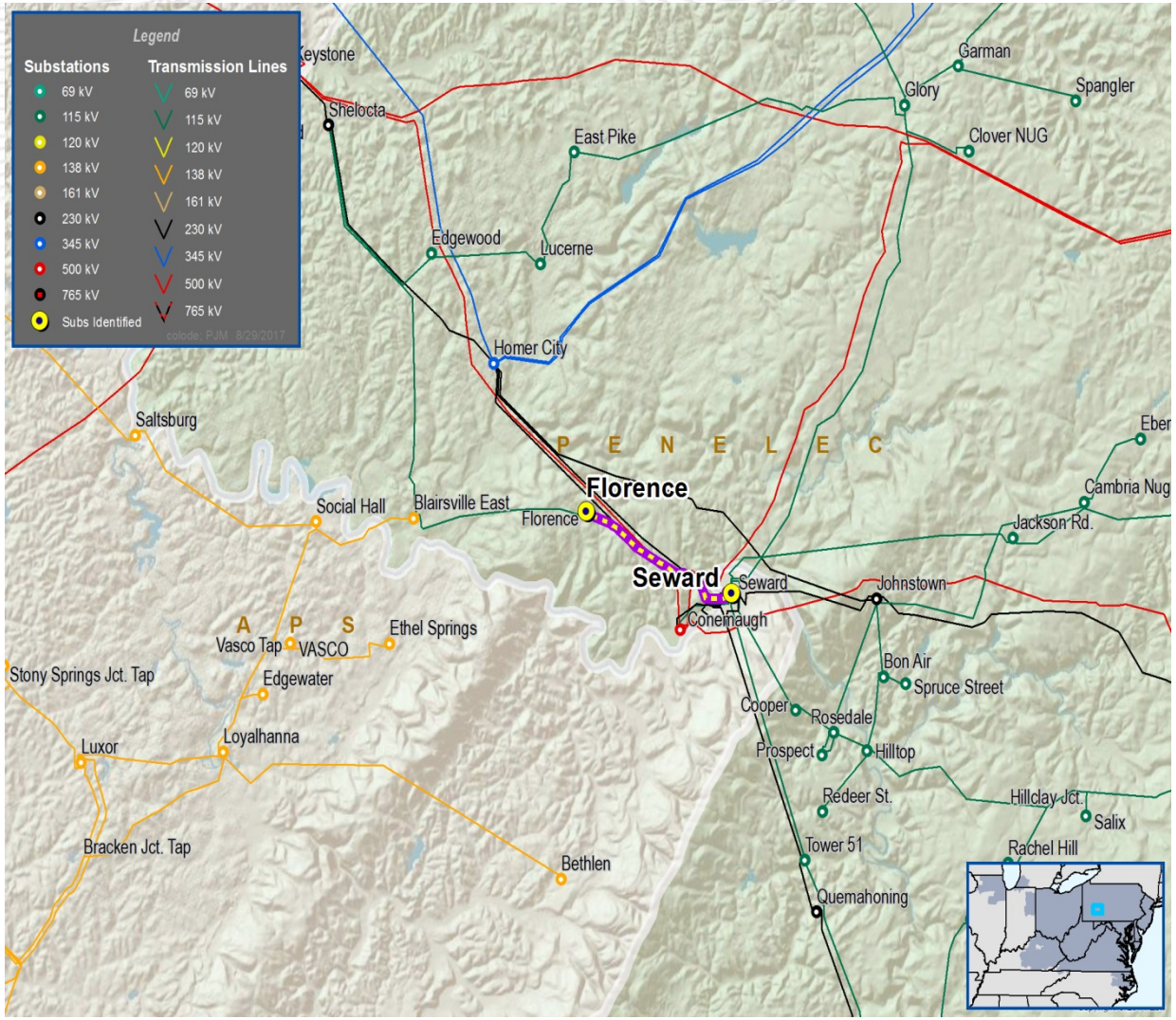
- Upgrade Florence 115kV line terminal equipment at Seward SS.
- Replace Blairsville East/Seward 115kV line tuner, coax, line relaying and carrier set at Shelocta SS.
- Replace Seward/Shelocta 115kV line CVT, tuner, coax, and line relaying at Blairsville East SS
  - Estimated Upgrade Cost: $1.49 M

Alternative Solution:

- No alternative considered

Required IS date: 6/1/2022

Project Status: Conceptual



Generation Deliverability (Winter):

Problem Statement:

- The North Meshoppen 230/115 kV transformer #3 along with the 115 kV series reactor are overloaded for single contingency loss of the North Meshoppen – Canyon – E. Towanda 230 kV circuit and the North Meshoppen 230/115 kV transformer #4 . (FG# GD-W35 and GD-W75):

Potential Solution:

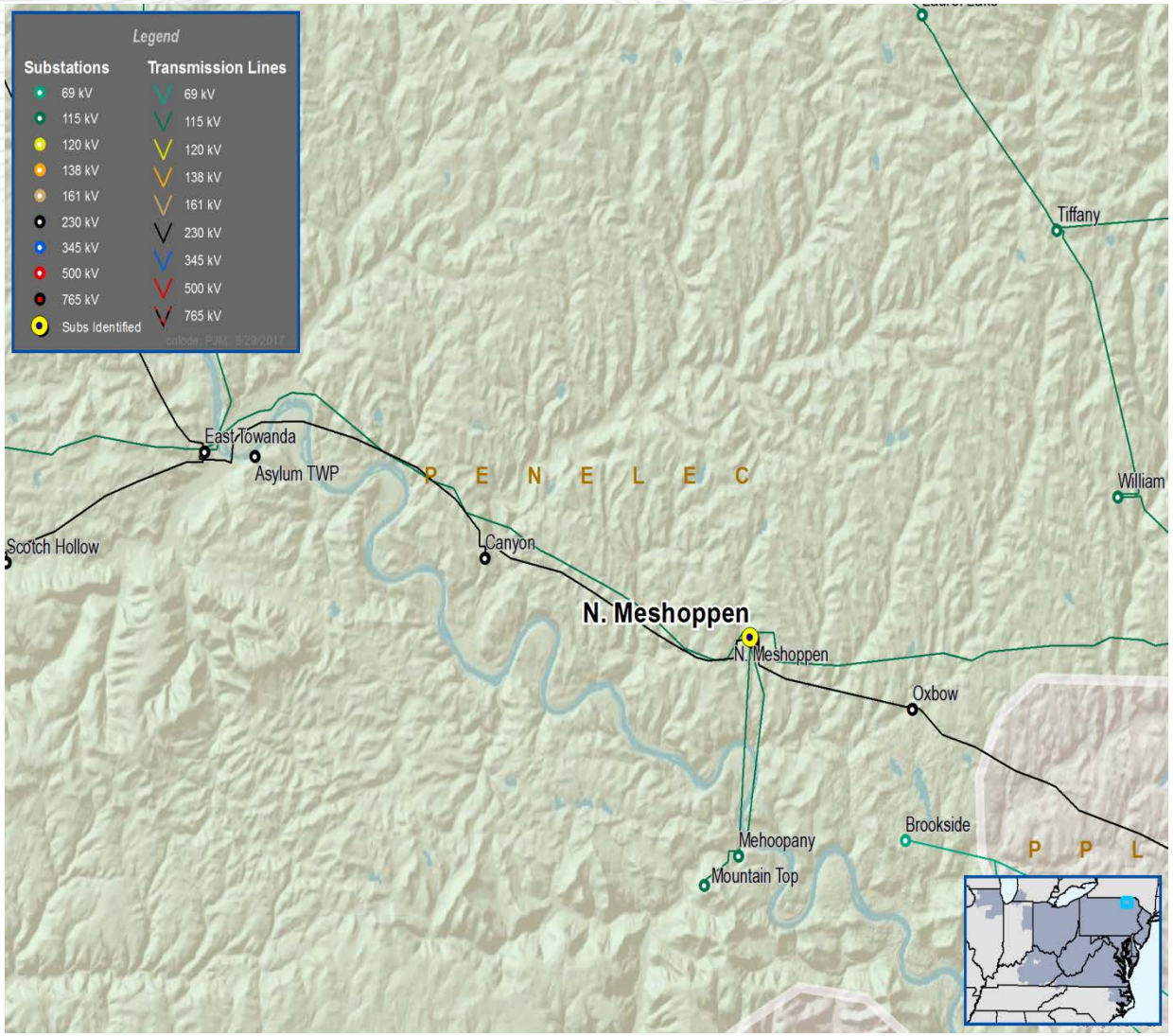
- Replace the North Meshoppen #3 230/115kV transformer eliminating the old reactor and installing two breakers to complete a 230kV ring bus at North Meshoppen.
  - Estimated Project Cost: $6.802 M

Alternative Solution:

- No alternative considered

Required IS date: 6/1/2022

Project Status: Conceptual



Additional Supply to the Newport 13 kV station

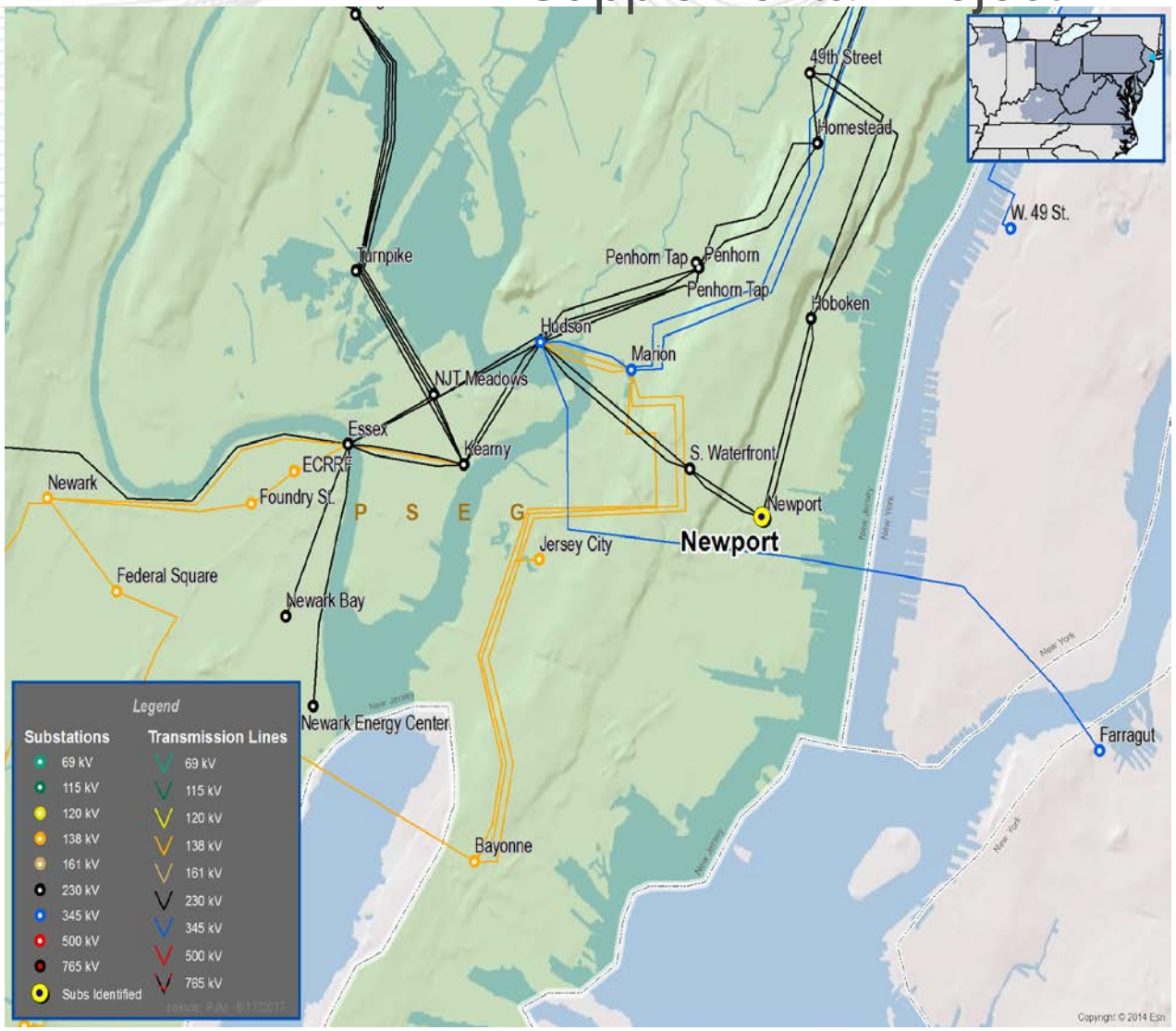
Problem Statement:

- The Newport station is islanded (no connection to other substations). Potential station shutdown in an event of N-1-1 (the loss of the two Newport 230/13 kV transformers).
- Load Growth: Currently Newport Class H supplies network customers (>7,300 customers) in the Jersey City area. The load supplied exceeded 72 MVA during summer 2017 and is expected to grow. For an n-1 event, there will be ~16% overload.

Alternatives:

1. Install a new 230 kV bay at Newport 230 kV
   - Build a second half class H. The second half class H will support the future load growth in the area..
   - **Estimated Project Cost:** $42M
2. Build a new class H in the Jersey City area.
   - Locate and purchase new property
   - Run a 230kV line
   - **Estimated Project Cost:** $85M
3. Do Nothing Alternative
   - Consequences of No Action – loss of load

Project Status: Conceptual



Voltage drop for a NERC N-1 single contingency in Franklin 69kV area

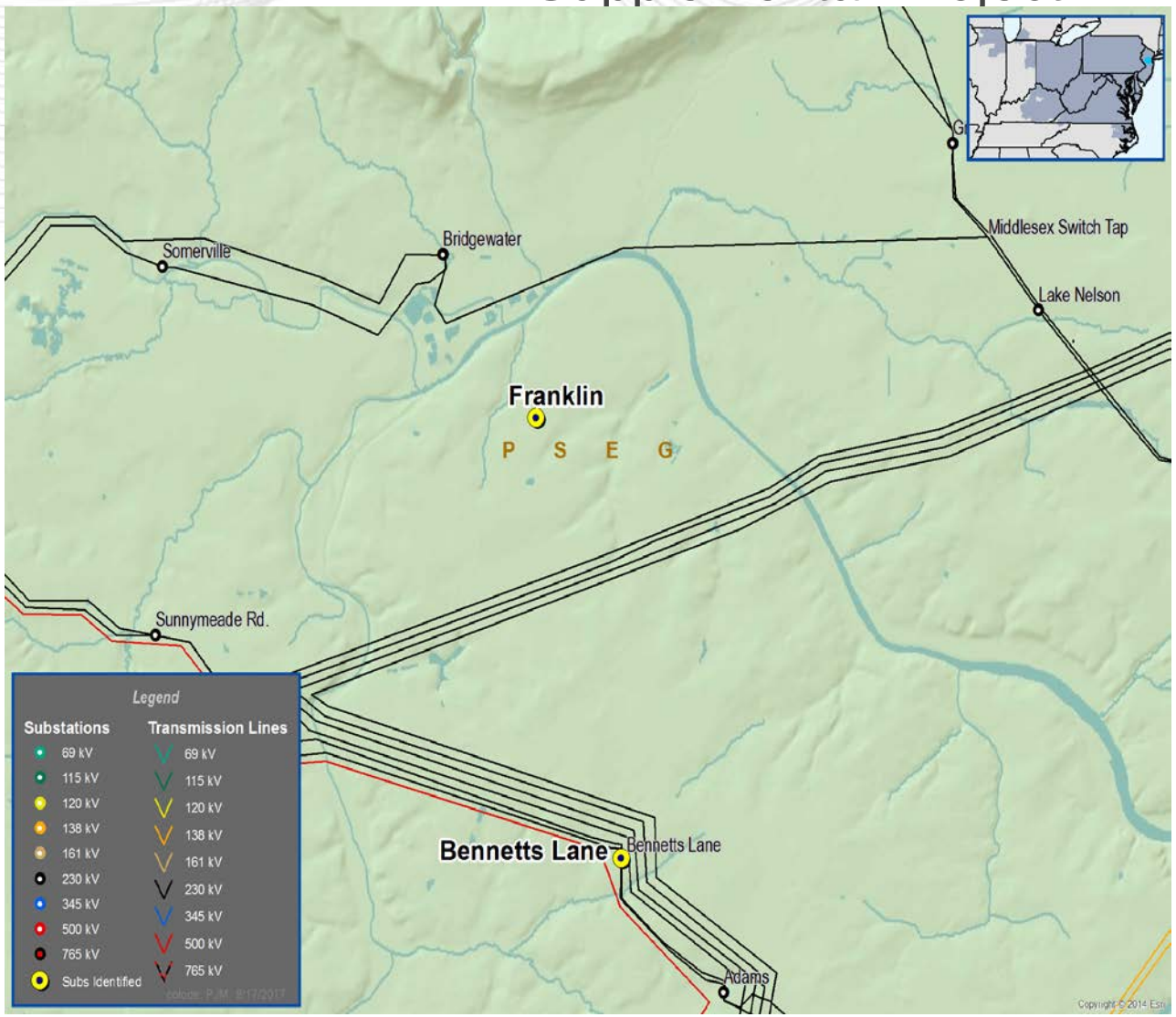
Problem Statement:

Franklin 69 kV station is connected to the Bridgewater and Bennett's Lane 69 kV stations and during an N-1 contingency event, there are voltage violations that occur in the area. This project will mitigate the voltage violations in the area.

Alternatives:

1. Construct a new 69kV line from Bennett's Lane to Franklin.
   - Replace Franklin with a GIS ring.
   - Install one (1) new line position at Bennett's Lane.
   - **Estimated Project Cost:** $89M
2. Construct a new 69kV line from Bridgewater to Franklin.
   - Replace Franklin with a GIS ring.
   - Install one (1) new line position and Bridgewater.
   - **Estimated Project Cost:** $120M
3. Do Nothing Alternative
   Consequences of No Action - there is a reliability risk created by not acting to address

Project Status: Conceptual



Mercer Generation Deactivation

Problem Statement:

- Mercer Generating station retired on June 1, 2017. As part of the retirement and decommissioning activities PSEG Power will be de-energizing and isolating all the interconnections to the Mercer Switching Station. Following decommissioning, the generating station will not have any AC or DC power to support any interconnection protection / control / indication schemes at Mercer Switch.

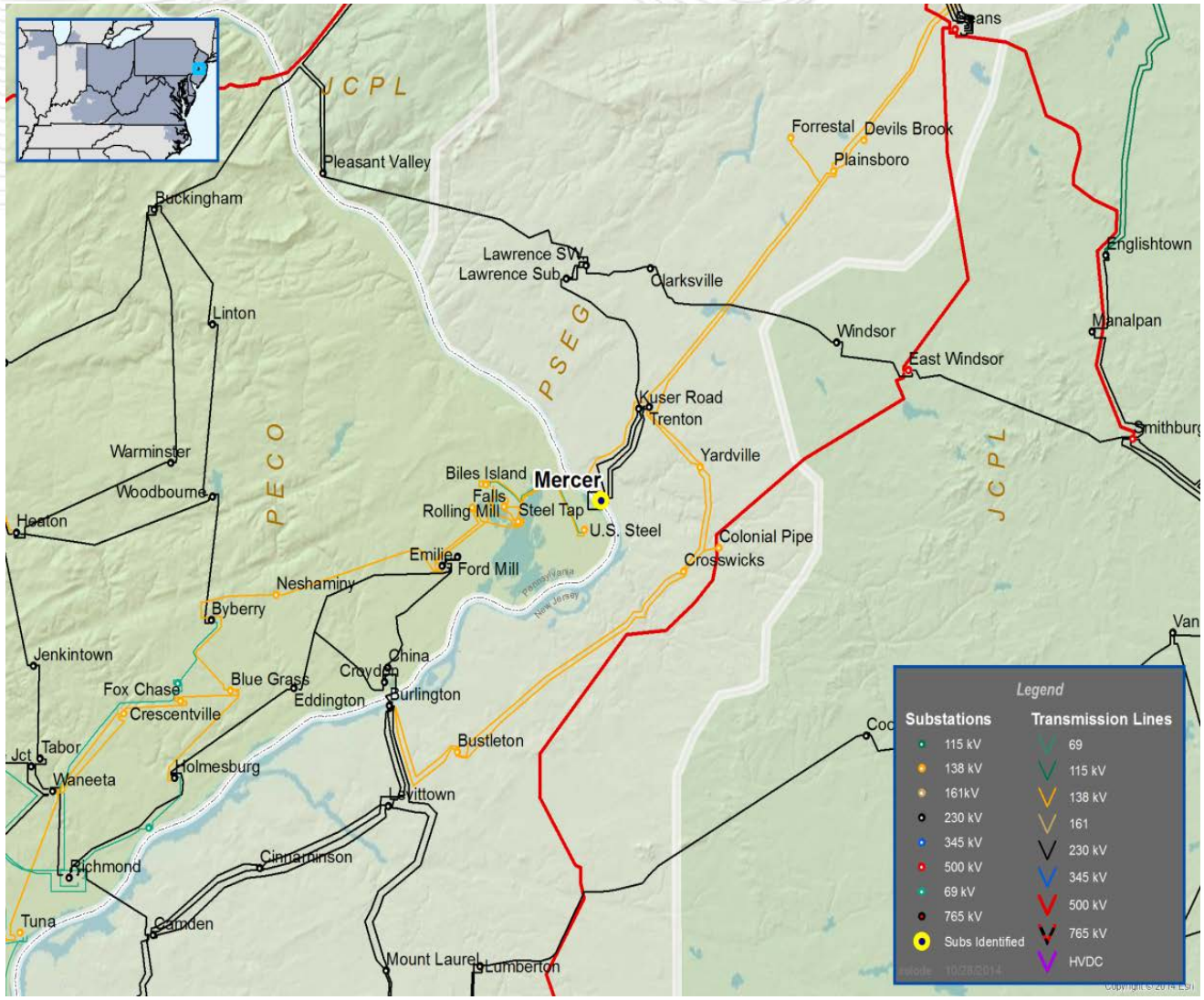
Alternatives:

1. At Mercer Switch, physical isolation of all protective relay, control and indication circuits (both AC and DC) at 230kV to/from Generation station equipment
   - Eliminate the existing SL&P (Station Light and Power) #1 and #2 Transformers
   - Place existing Live tank breakers from SL&P #1 and #2 in inventory
   - Supply power to relays using SL&P #4 and #5
   - Install Relays in New Control House

   Estimated Project Cost: $4.2M

2. Do Nothing Alternative
   - Consequences of No Action - there is a reliability risk due to lack of relay protection created by not acting to address.

Project Status: Conceptual



PSEG Transmission Zone Supplemental Project

Hudson Generation Deactivation

Problem Statement:

- Hudson Generating station unit 2 retired on June 1, 2017. As part of retirement and decommissioning activities PSEG Power will be de-energizing and isolating all the interconnections to the Marion 345kV switchyard, 26 kV system for Aux Power, and the 138kV system for BET 1 & 2. After decommissioning, the generating stations will not have any AC or DC power to support any interconnection protection / control / indication schemes that are needed to operate Marion Switch.

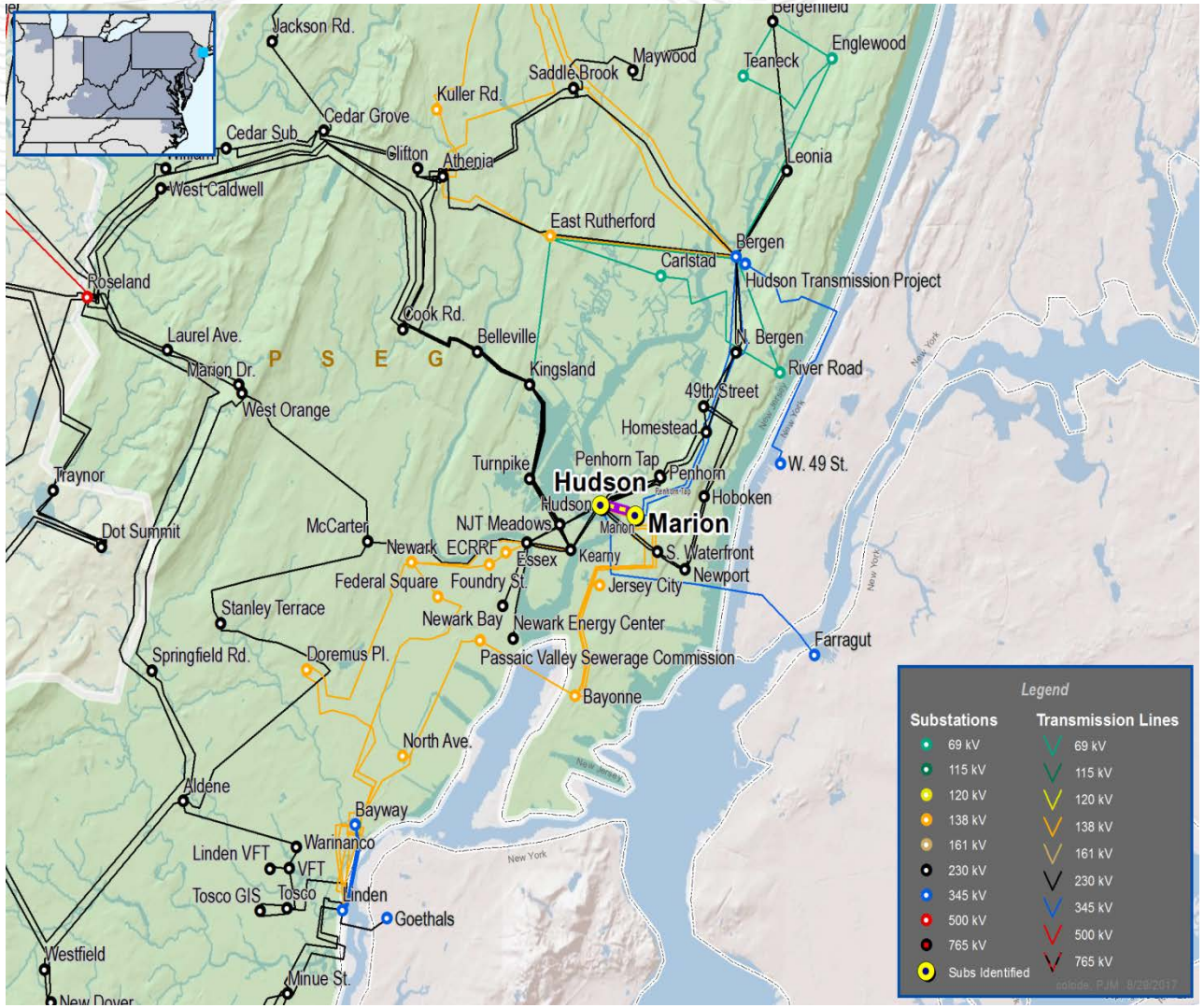
Alternatives:

1. At Hudson, Physical isolation of
   - HV interconnection for Unit 2 main step up transformer at Marion 345kV.
   - HV interconnection for Hudson Gen station power transformers 1 & 2, and Coal Handling 2B transformer at Marion 26kV.
   - BET transformers that are currently fed from Marion 138kV
   - Installation of relays in Hudson switchyard Control House

Estimated Project Cost: $2.6 M

2. Do Nothing Alternative
   - Consequences of No Action - there is a reliability risk due to lack of relay protection created by not acting to address.

Project Status: Conceptual



Sewaren Generation Deactivation

Problem Statement:

- PSEG Power plans to retire Sewaren Generating Units 1-4 in June 2018. Following commissioning of the new generating units at Sewaren, the existing generating station associated with Units 1-4 will be removed from service. The entire 138 kV yard will be retired from service , including the autotransformer to the 230k yard and 26kv yards.

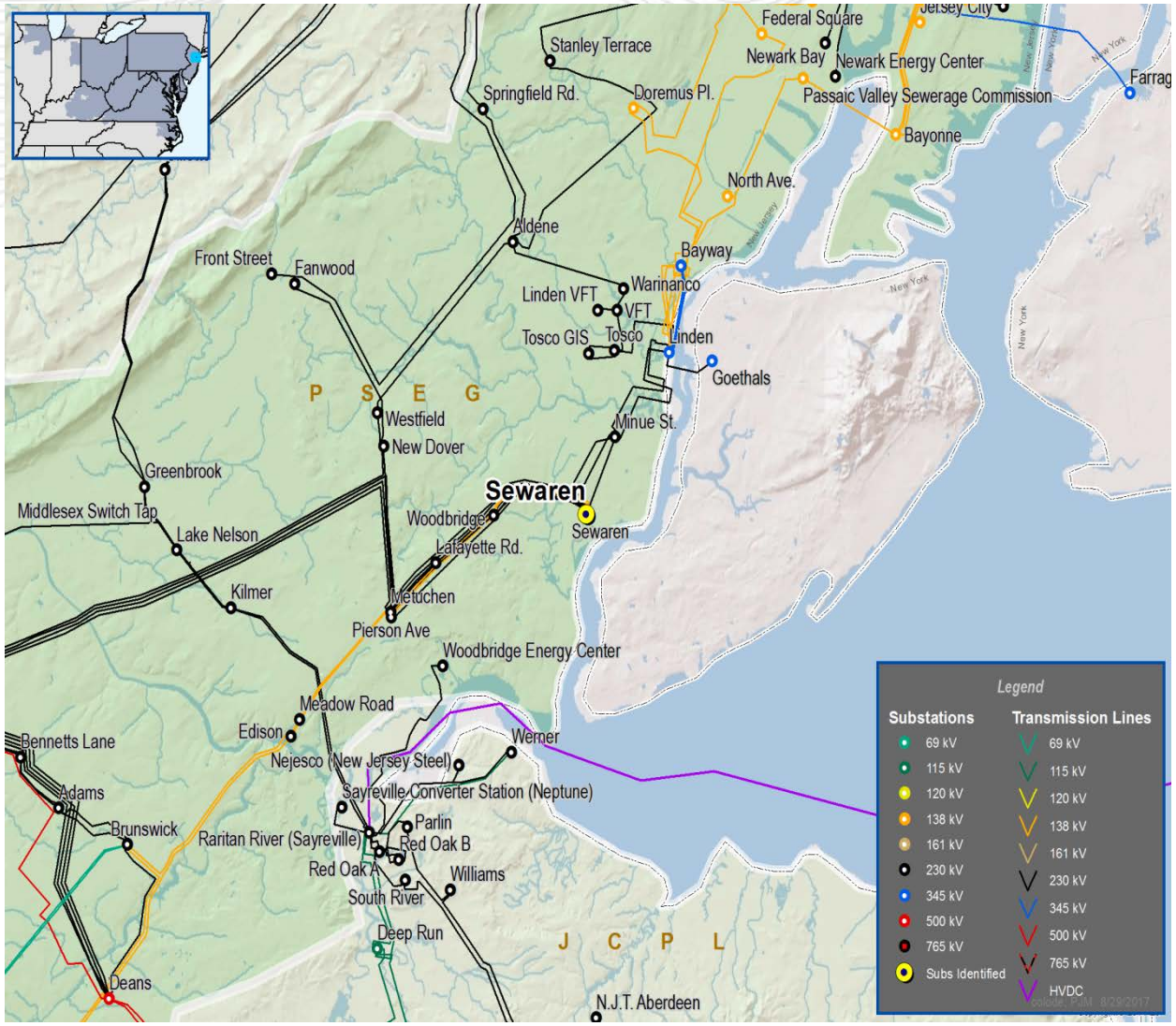
Alternatives:

1. Physical isolation of all protective relay, control and indication circuits (both AC and DC) at 230kV to/from Gen station equipment
   - Cut clear control cables to the Generation station.
   - Retire and remove 220-1 transformer, and entire 138kV A-frame and associated bus, circuit breakers, and relay protection / control / indication schemes.
   - Remove and scrap 138kV transformers: 132-2, 132-3, and 132-7. Remove the associated wood pole line for 132-7
   - Physical isolation and removal of 26kV circuits LP1F6, LP3F3, LP2F6. Remove 26kV towers and wires from Sewaren Gen to the sheltered aisle switchgear.
   - Remove and scrap 26kV transformers 26-2 and 26-3.

   Estimated Project Cost: $11 M

2. Do Nothing Alternative
   - Consequences of No Action - there is a reliability risk due to lack of relay protection created by not acting to address.

Project Status: Conceptual



Baseline Reliability and Supplemental Projects
Second Review

Previously presented at June 9, 2017 SRRTEP - MAAC

N-1-1 PSEG Planning Criteria (FERC Form 715):

Third Source for Springfield Rd. and Stanley Terrace Stations

Previously presented: 6/09/2017

Problem Statement:

FERC Form 715: Springfield Substation is supplied by two 230kV underground lines. Springfield supplies more than 10,000 customers with load in excess of 80MVA. An N-1-1 event would result in a complete loss of electric supply to the station for more than 24 hrs.

FERC Form 715 : Stanley Terrace is supplied by two 230kV underground lines. Stanley Terrace will supply more than 5,000 customers with an anticipated load in excess of 37MVA. An N-1-1 event would result in a complete loss of electric supply to the station.

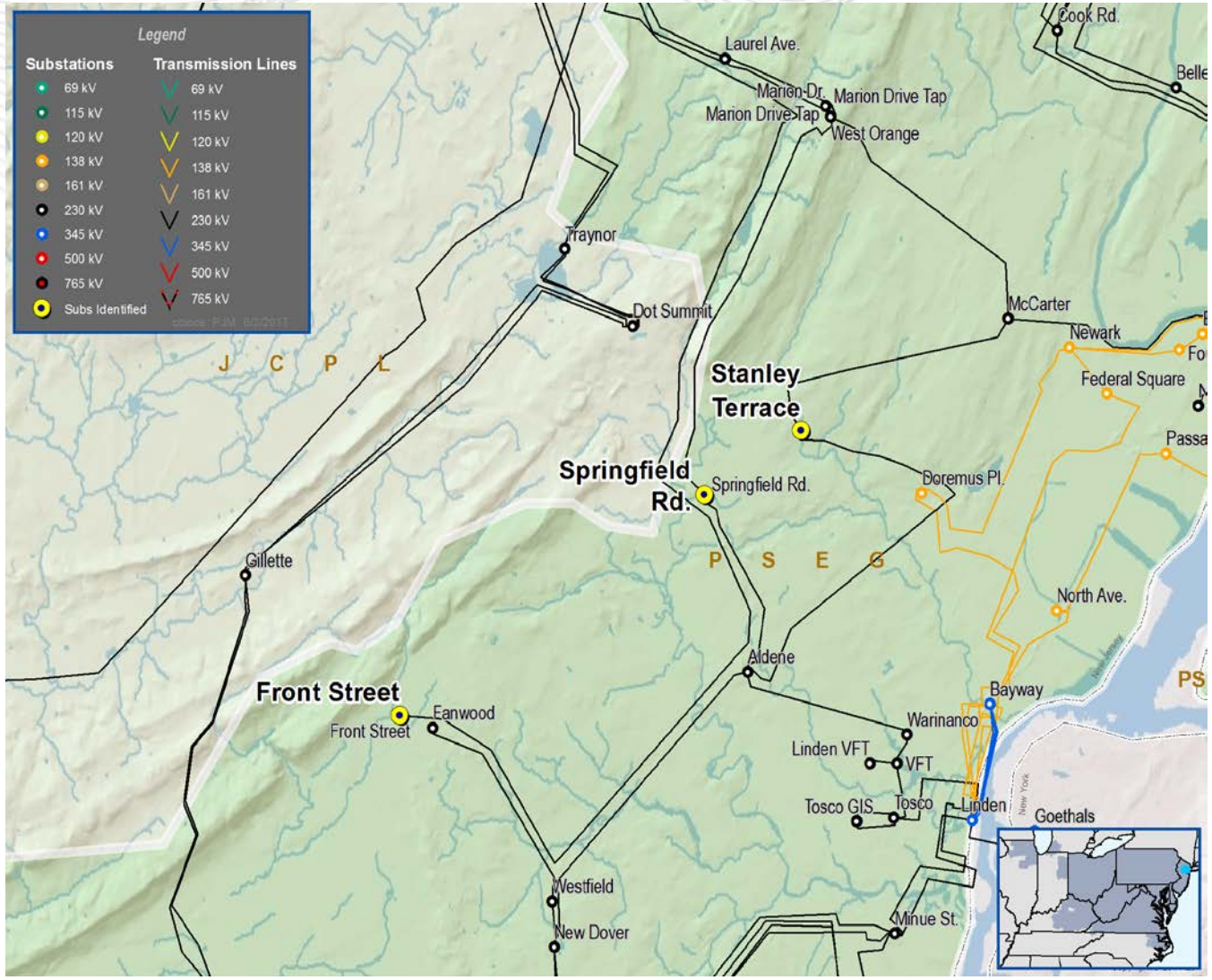
Recommended Solution:

- Construct a 230/69 kV station at Springfield. (B2933.1)
- Construct a 230/69 kV station at Stanley Terrace. (B2933.2)
- Construct a 69 kV network between Front Street, Springfield and Stanley Terrace. (B2933.3)

Estimated Project Cost: $197M

Required IS Date: 6/1/2018

Project Status: Engineering



PSEG Transmission Zone Baseline Reliability

N-1-1 PSEG Planning Criteria (FERC Form 715):

Third Source at Carlstadt and Hasbrouck Heights Stations

Previously presented: 6/09/2017

Problem Statement:

FERC Form 715: The Carlstadt 69kV Substation is supplied by two partially underground 69kV circuits. Carlstadt supplies more than 1,400 customers with load in excess of 30 MVA. An N-1-1 event would result in a complete loss of electric supply to the station for more than 24 hrs.

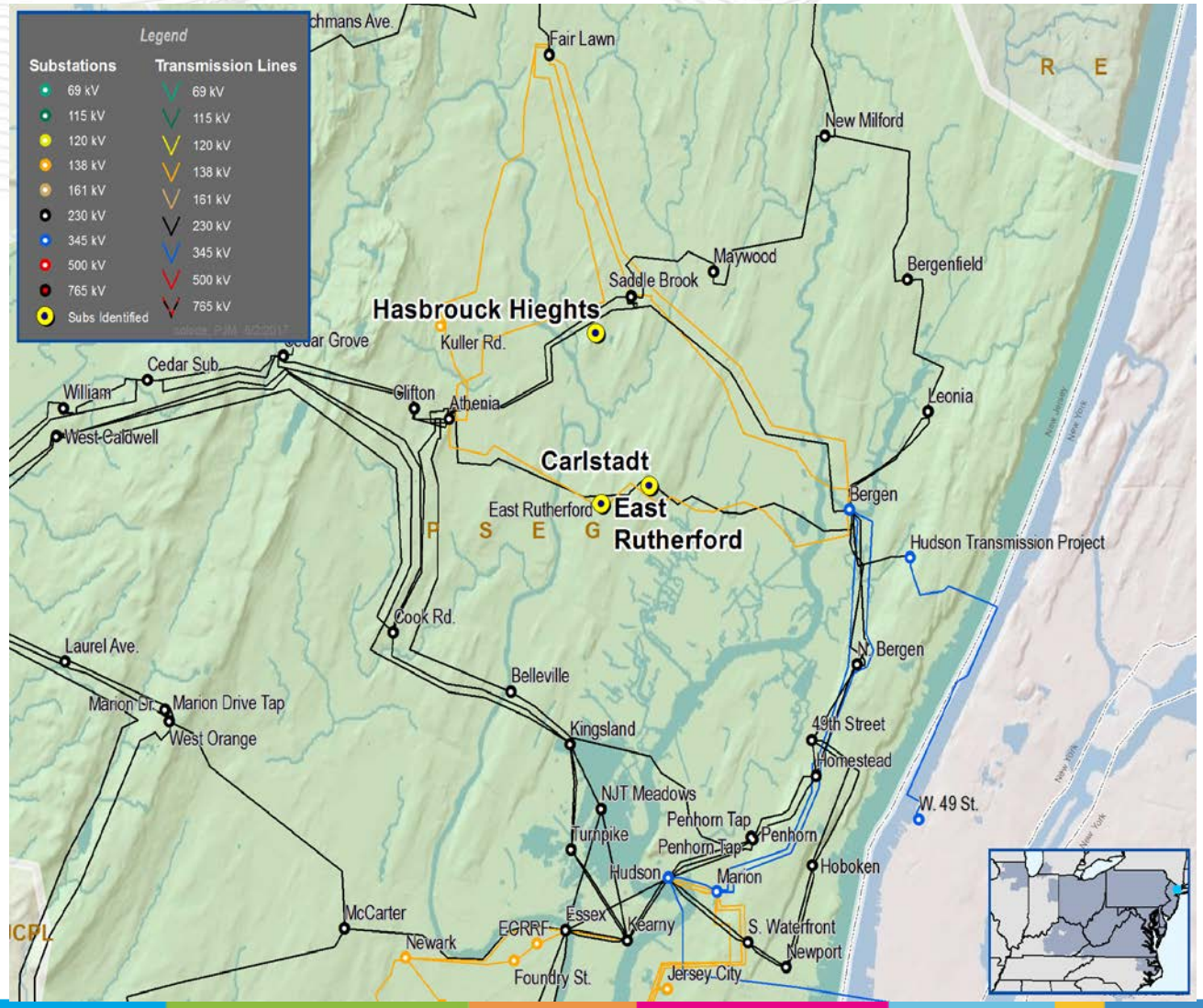
Recommended Solution:

- Build a new 69kV line between Hasbrouck Heights and Carlstadt. (B2934))

Estimated Project Cost: $21M

Required IS Date: 6/1/2018

Project Status: Engineering



N-1-1 PSEG Planning Criteria (FERC Form 715):

Third Supply for Runnemede 69kV and Woodbury 69kV

Additional Transmission Supply for Camden-Gloucester Load Pocket

Previously presented: 6/09/2017

Problem Statement:

FERC Form 715: Runnemede 69kV Substation is supplied by only two 69kV lines; load exceeds 46MW. One of the lines has portions of the circuit fed by underground cable that would take longer than 24 hours to restore during an outage. In addition, a breaker failure on the Runnemede 69kV bus would result in the loss of both 69kV supply lines and a complete substation shutdown, interrupting more than 11,000 customers. As a result, there is a need to enhance the station design and provide a 3rd source to Runnemede 69kV station. The Woodbury station, after conversion to 69kV, will be supplied by two 69kV lines from Gloucester 69kV station with no other 69kV source in the near vicinity to supply the 3rd source, leaving a need to provide a 3rd supply to satisfy FERC Form 715 requirements.

Network Availability: The cost effective solution for the southern area is to convert stations to 69kV. Long term it will be cost effective to supply all PSE&G stations in Gloucester and Camden County from 69kV because there is less infrastructure required and the system benefits from being planned to and operating at higher voltages.

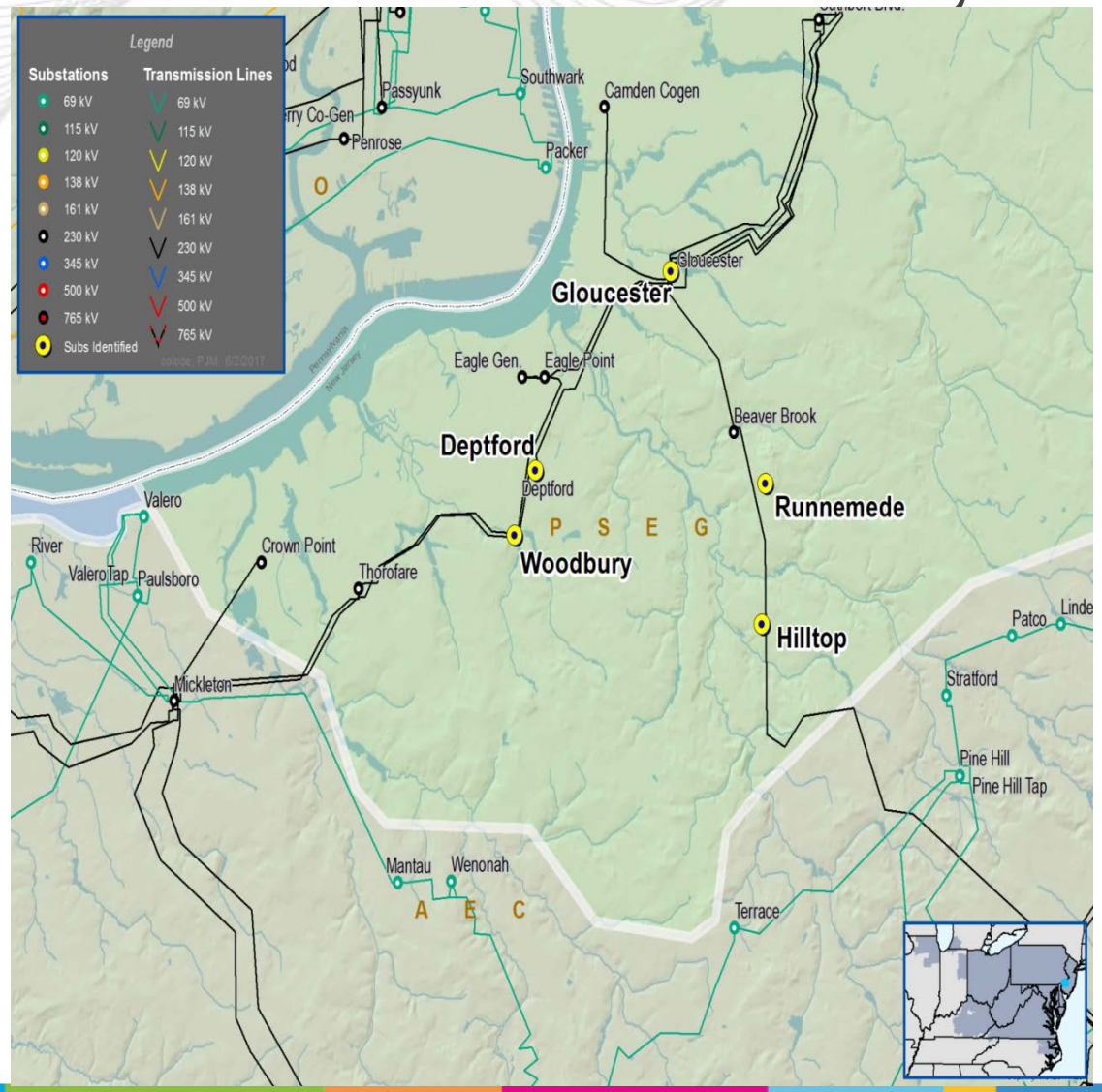
Recommended Solution:

- Build a new 230/69 kV switching substation at Hilltop utilizing the PSE&G property and the K-2237 230 kV line.
- Build a new line between Hilltop and Woodbury 69 kV providing the 3rd supply (FERC Form 715).
- Convert Runnemede's straight bus to a ring bus (eliminating the bus fault violation) and construct a 69 kV line from Hilltop to Runnemede 69 kV. (B2935.1, B2935.2 and B2935.3)

Estimated Project Cost: $98M

Required IS Date: 6/1/2018

Project Status: Engineering



Paterson Area Asset Condition and Reliability

Previously presented: 6/09/2017

Problem Statement:

Equipment Material Condition, Performance and Risk; Operational Flexibility and Efficiency:

Paterson and Passaic 26kV Substations went into service in the 1930s supplying the cities of Paterson and Passaic. The area has experienced an increase in supply outages, with over 70 interruptions on the Paterson and Passaic 26kV circuits in the last five years.

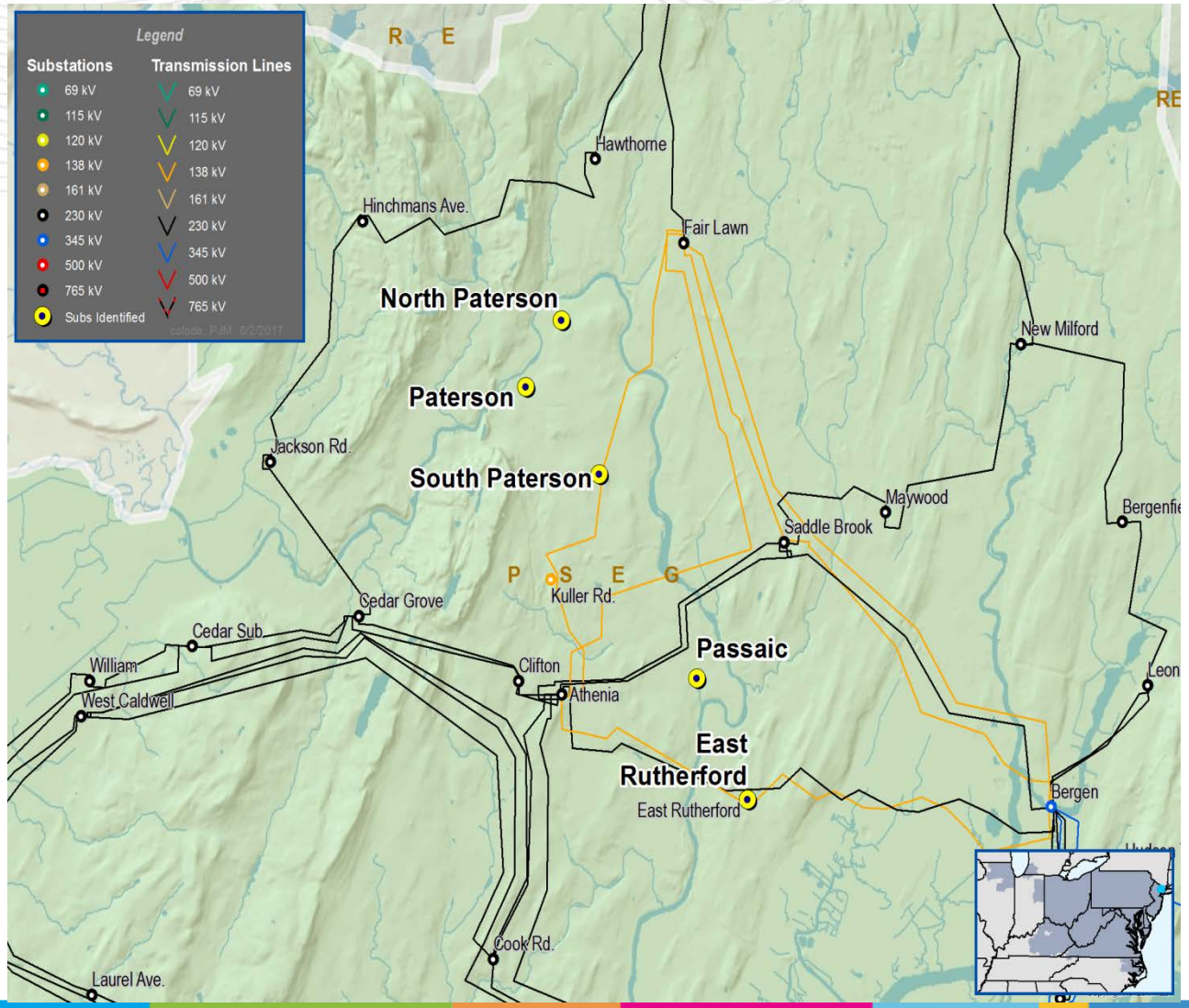
Selected Solution:

- Convert Paterson 26 kV to 69 kV station. (s1366.1)
- Convert Passaic 26 kV to 69 kV station. (s1366.2)
- Build a 69 kV network between South Paterson, Paterson, North Paterson, Passaic and East Rutherford. (s1366.3)

Estimated Project Cost: $169M

Expected IS Date: 3/1/2021

Project Status: Engineering



Station Reliability and Area Load Growth near Camden 69kV

Previously presented: 6/09/2017

Problem Statement:

Operational Flexibility and Efficiency, Customer Service:

PSE&G must address voltage issues caused by a normally open bus. PSE&G also needs to increase capacity by providing more 69kv supply lines due to load growth in the area.

- Bus faults at Camden 69kV station result in losing two 69kV lines on either side of the Camden 69kV bus breaker and a 230/69kV transformer. As a result, there are multiple voltage issues at neighboring 69kV buses.
- If the breakers are replaced and the normally open bus breaker is closed and a breaker failure occurs, the voltage would drop to near 67% of nominal voltage. In addition, there are severe voltage drop conditions at Locust Street 69kV and Maple Shade 69kV stations.

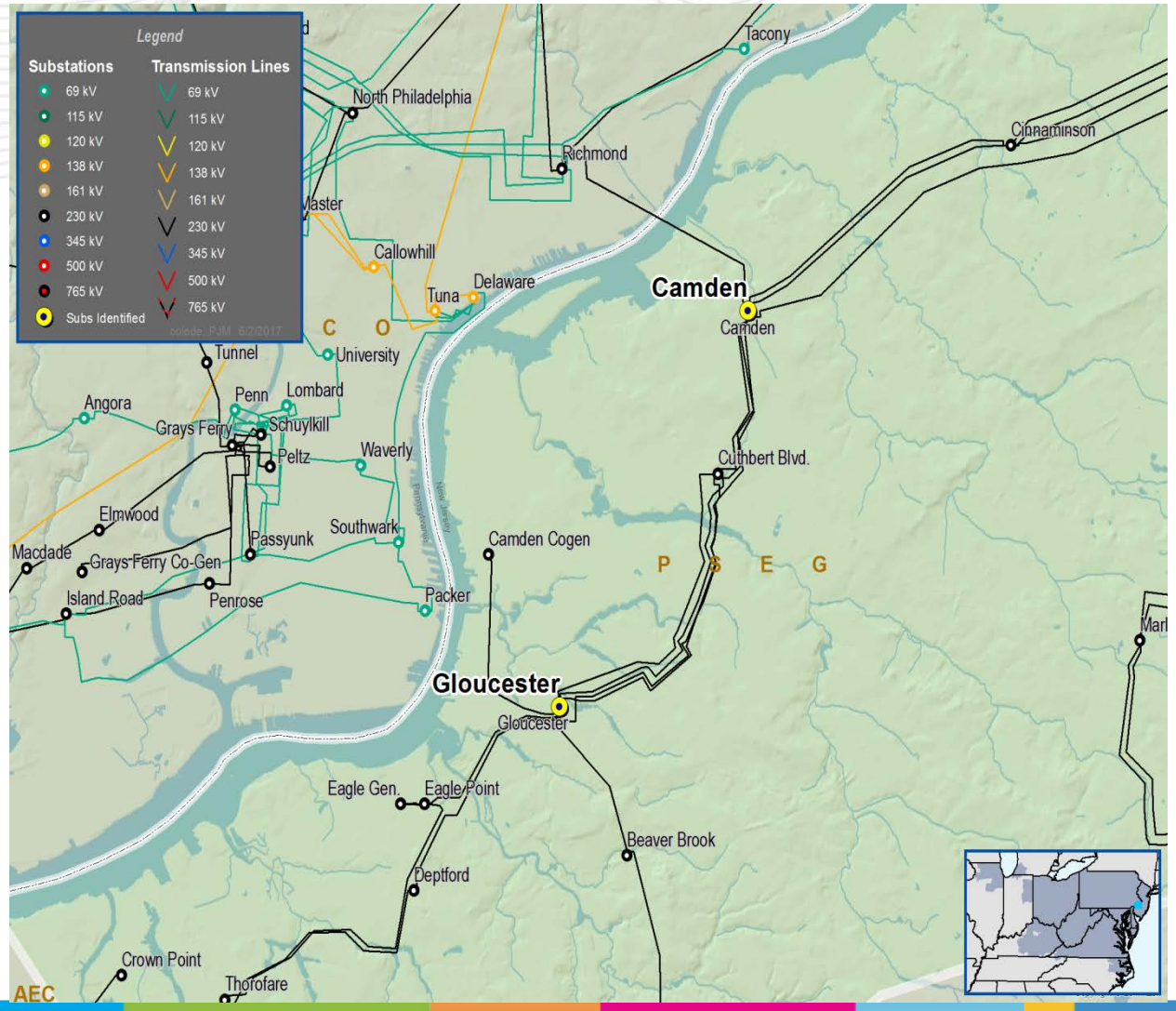
Selected Solution:

- Replace the 69kV AIS bus at Camden with a GIS breaker-and-a-half design. (S1367)

Estimated Project Cost: $84M

Expected IS Date: 12/31/2020

Project Status: Engineering



Station Reliability and Customer Load Growth at Penns Neck 69kV

Previously presented: 6/09/2017

Problem Statement:

Operational Flexibility and Efficiency, Customer Service:

- PSE&G must address voltage issues caused by a normally open bus. PSE&G also needs to increase capacity by providing more 69kv supply lines due to load growth in the area.
  - During a breaker failure on the Penns Neck 69kV bus, the voltage at Penns Neck 69kV substation will collapse

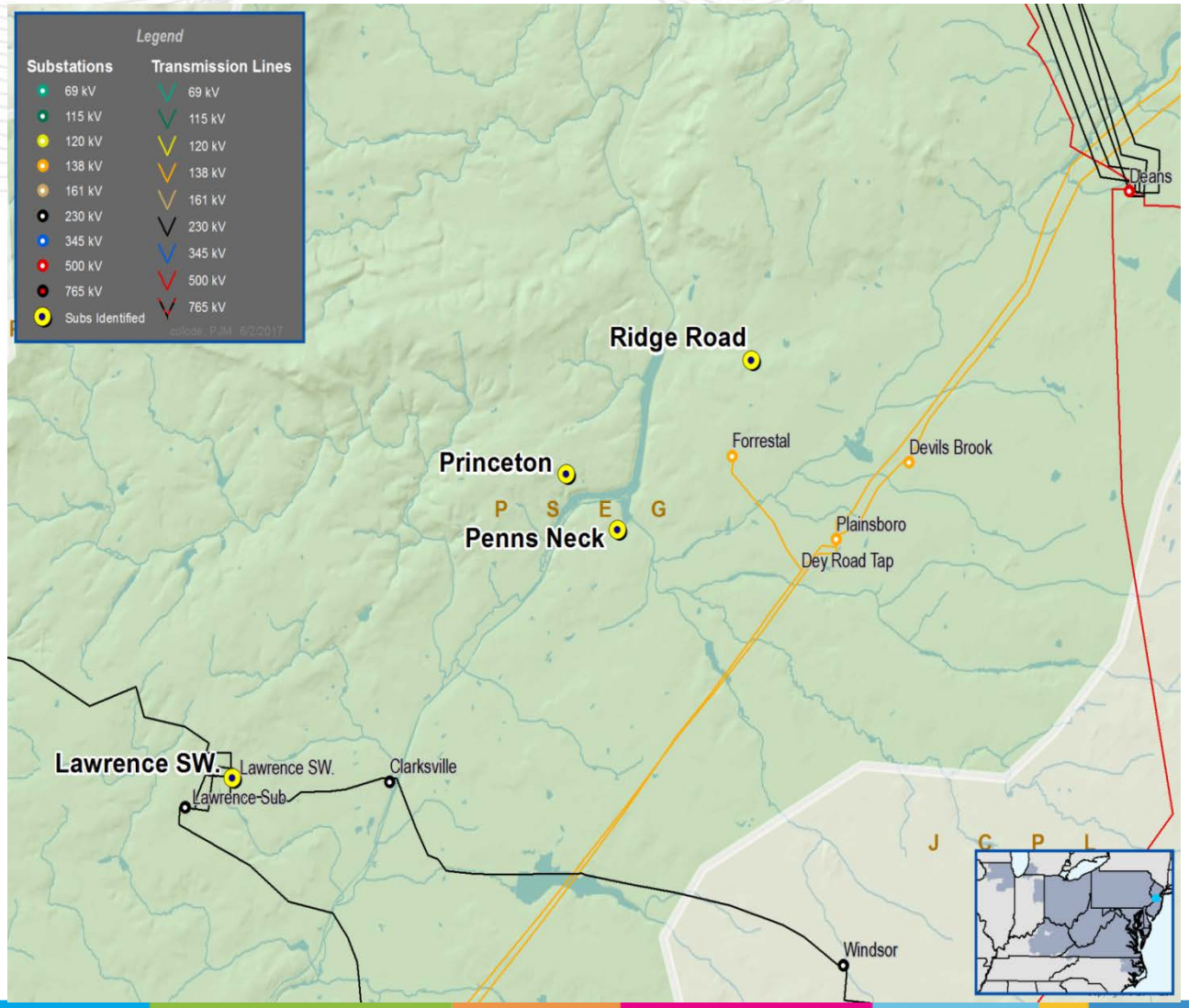
Selected Solution:

- Replace the 69kV AIS straight bus at Penns Neck with an AIS breaker-and-a-half design. (S1368.1)
- Install a 69 kV line between Penns Neck and Ridge Rd. S1368.2)
- Install 18 MVAR capacitor banks at Ridge Rd. 69 kV station. S1368.3)

Estimated Project Cost: $84M

Expected IS Date: 12/1/2020

Project Status: Engineering



Station Reliability and Area Load Growth near Gloucester 69kV

Previously presented: 6/09/2017

Problem Statement:

Operational Flexibility and Efficiency, Customer Service: PSE&G must address voltage issues caused by a normally open bus. PSE&G also needs to increase capacity by providing more 69kv supply lines due to load growth in the area.

- Loss of bus section three leaves Runnemede with one source. This creates a large voltage drop not recoverable with capacitors.
- Loss of bus section four causes two large customers to hang off Locust Street Substation with long lines from Camden, causing low voltage at these customers.
- If the breakers are replaced and the normally open bus breaker is closed and a bus fault occurs, voltage collapse would occur for a stuck breaker.

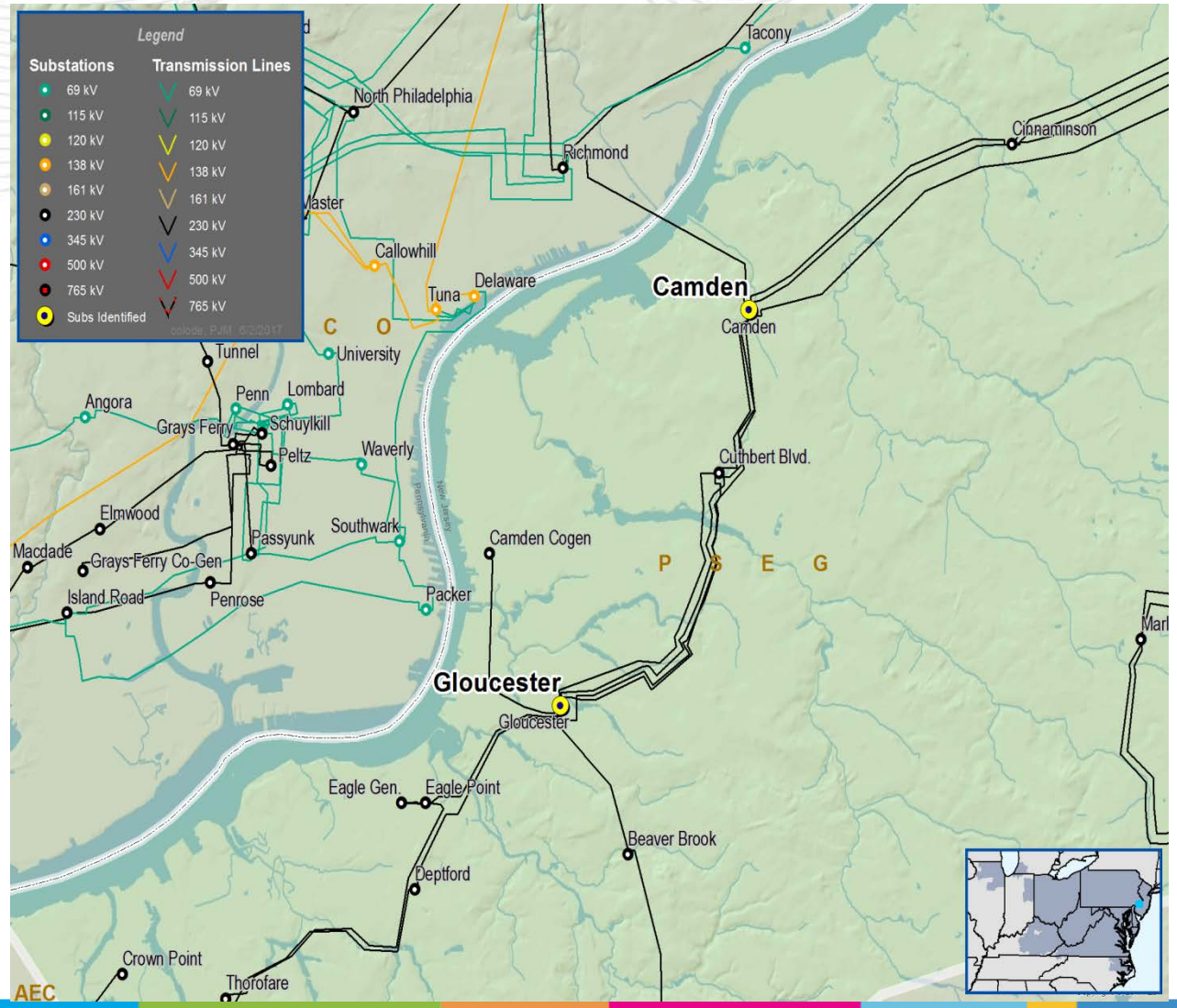
Selected Solution:

- Replace the 69kV AIS straight bus at Gloucester with a GIS breaker-and-a-half design. (S1369)

Estimated Project Cost: $84M

Expected IS Date: 12/1/2020

Project Status: Engineering



Station and Supply Circuit Condition at Woodbury 26kV

Previously presented: 6/09/2017

Problem Statement:

Equipment Material Condition, Performance and Risk; Operational Flexibility and Efficiency**:** The overall performance of the 26kV Woodbury Substation and the supply circuits has begun to deteriorate. Additionally, the Gloucester-Camden area has experienced load growth. This network feeds Woodbury Station and six large industrial customers scattered around the lower Gloucester county area. By converting this station, PSE&G can improve service to the industrial customer load base in the area while providing additional capacity to the general area at-large.

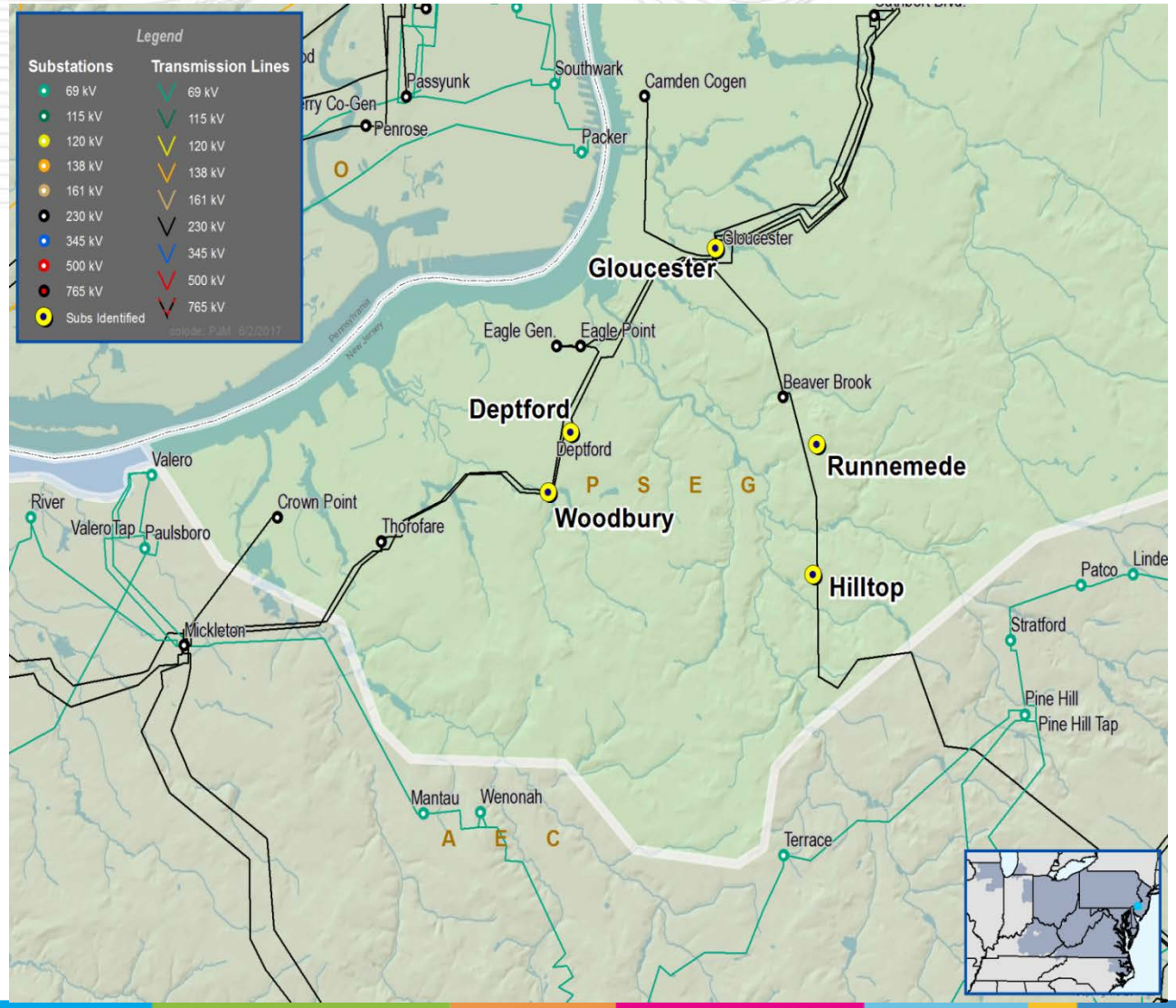
Selected Solution:

- Convert Woodbury 26 kV to a 69 kV substation. (S1370.1)
- Build two new lines between Gloucester and Woodbury 69 kV. (S1370.2)

Estimated Project Cost: $114M

Expected IS Date: 12/31/2020

Project Status: Engineering



Questions?

Email: RTEP@pjm.com

- Revision History
  - V0 - 8/28/2017 – Original version posted to PJM.com
  - V1 - 8/29/2017
    - Updated diagrams for several slides
    - Updated information on slide #13