Sub Regional RTEP Committee
Mid-Atlantic

January 5, 2017

Reliability Analysis Update

JCPL Transmission Zone

N-1 First Energy Planning Criteria (FERC Form 715):

- The Traynor - Whippany 34.5 kV (N14) circuit is overloaded for the loss of the Madison – Traynor 34.5 kV (R96) circuit .
- The facility is overloaded due to revised load forecast and modeling

Immediate Need:

- Due to the time – sensitive nature and current issue this problem presents, JCPL (Local TO) will be the Designated Entity

Alternatives Considered:

- Do to the immediate need of the project, no alternative solution was considered.

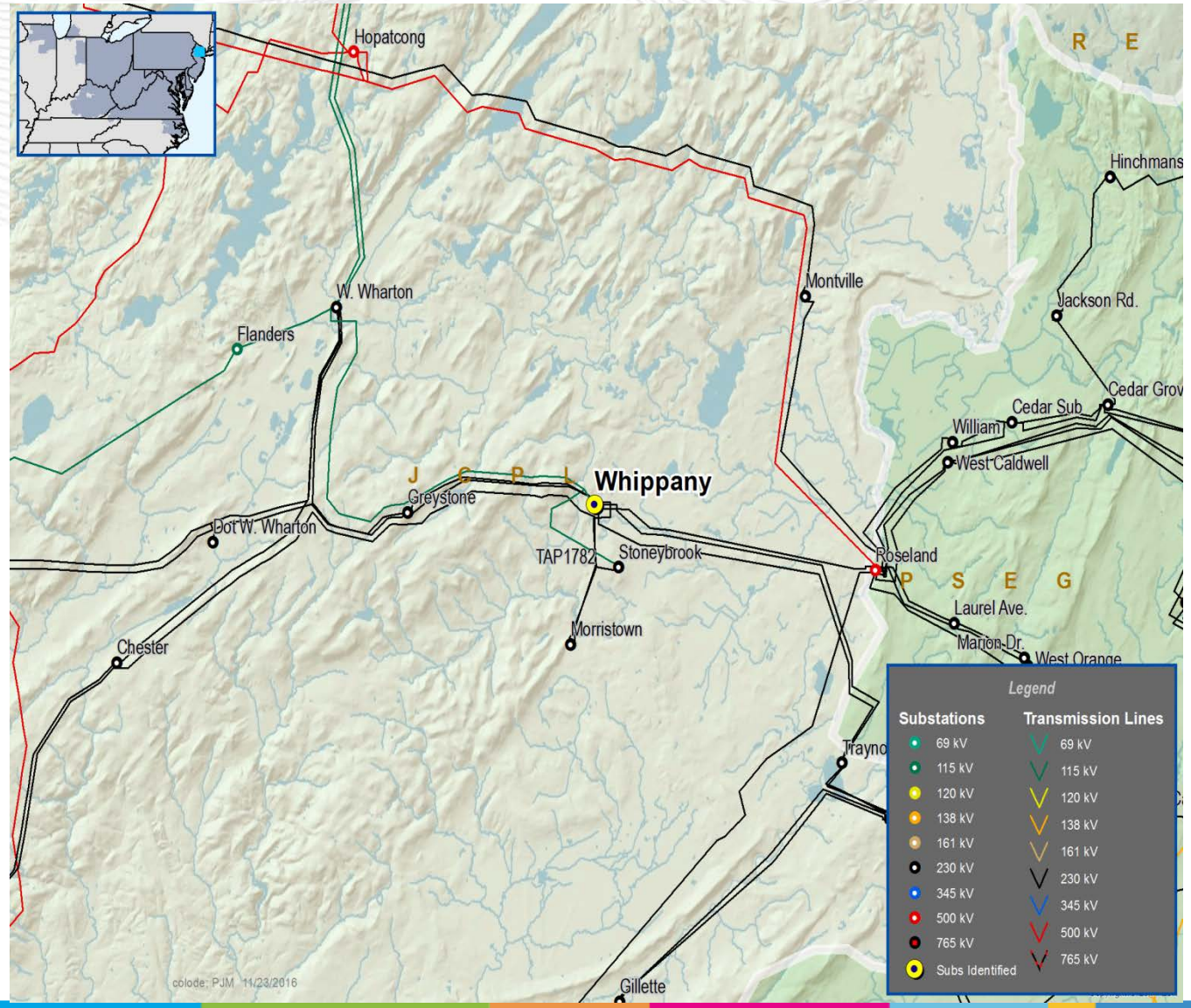
Proposed Solution:

- Install a bypass switch at Mount Pleasant 34.5 kV substation to allow the Mount Pleasant substation load to be removed from the N14 line and transfer to O769 line. (B2809)

Estimated Project Cost: $ 0.01 M

Required IS Date: 6/1/2017

Expected IS Date: 6/1/2018



MetEd Transmission Zone

N-1 First Energy Planning Criteria (FERC Form 715):

- An existing customer in MetEd will be increasing their load incrementally starting from 2018 -2023. The load is radially served from Lyons 230/69 kV substation. In 2019 the Lyons 230/69 kV transformer #3 is overloaded for the loss of the #5 transformer.

Immediate Need:

- Due to the time – sensitive nature and current issue this problem presents, Met-Ed (Local TO) will be the Designated Entity

Alternatives Considered:

- Do to the immediate need of the project, no alternative solution was considered.

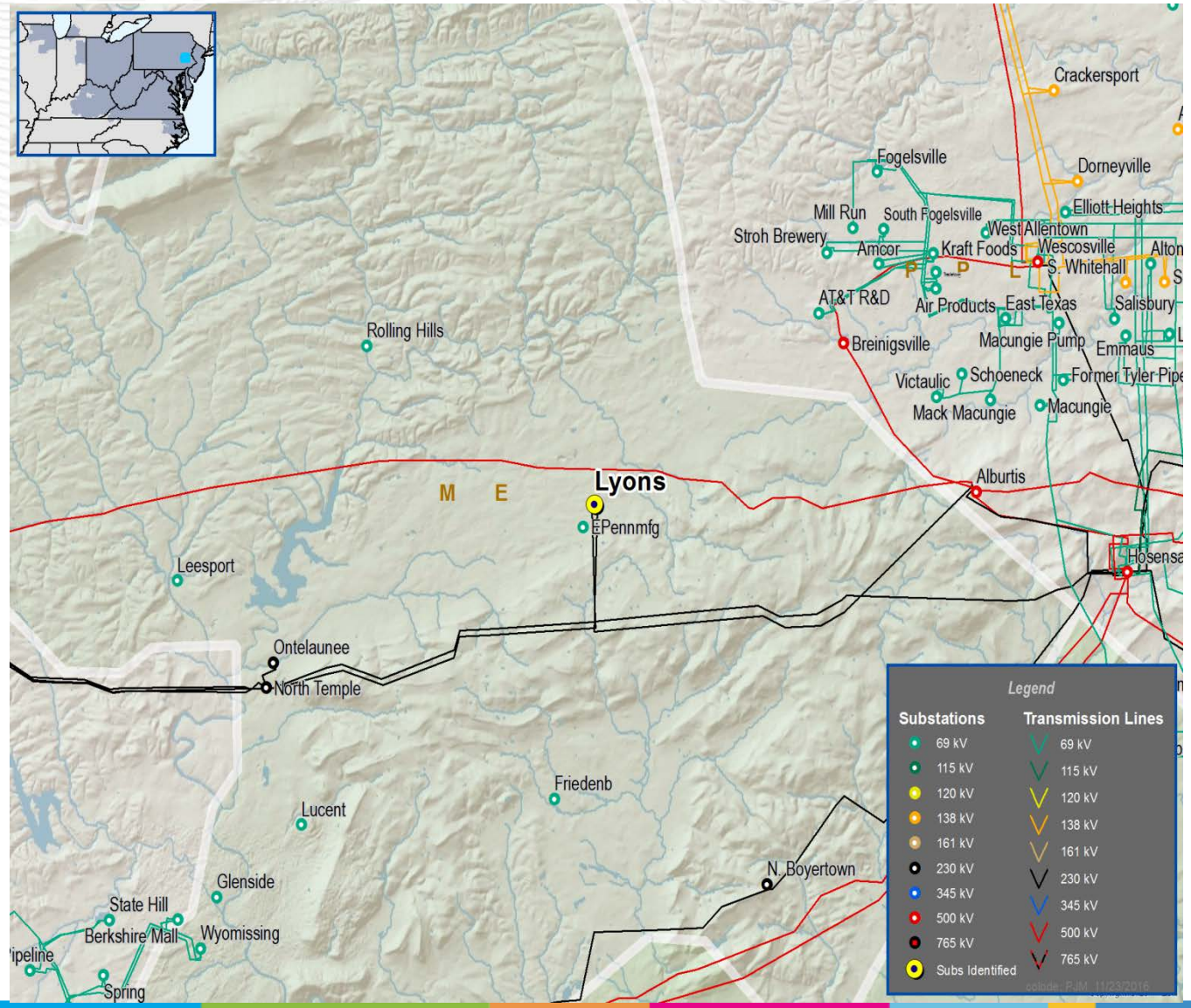
Proposed Solution:

- Install a 3rd 230/69 kV 224 MVA Transformer at Lyons and install new terminal equipment for existing Lyons - East Penn(865) 69 kV Line. (B2814)

Estimated Project Cost: $ 5.5 M

Required IS Date: 6/1/2019

Expected IS Date: 6/1/2019



MetEd Transmission Area

Cost Change for B2588 Upgrade

Problem:

- Voltage drop and voltage magnitude violations at the Glendon 115 kV station for the N-1-1 contingency loss of the Northwood – Quarry 230 kV circuit, Northwood 230/115 kV transformer, and Portland – North Bangor 115 kV circuit.

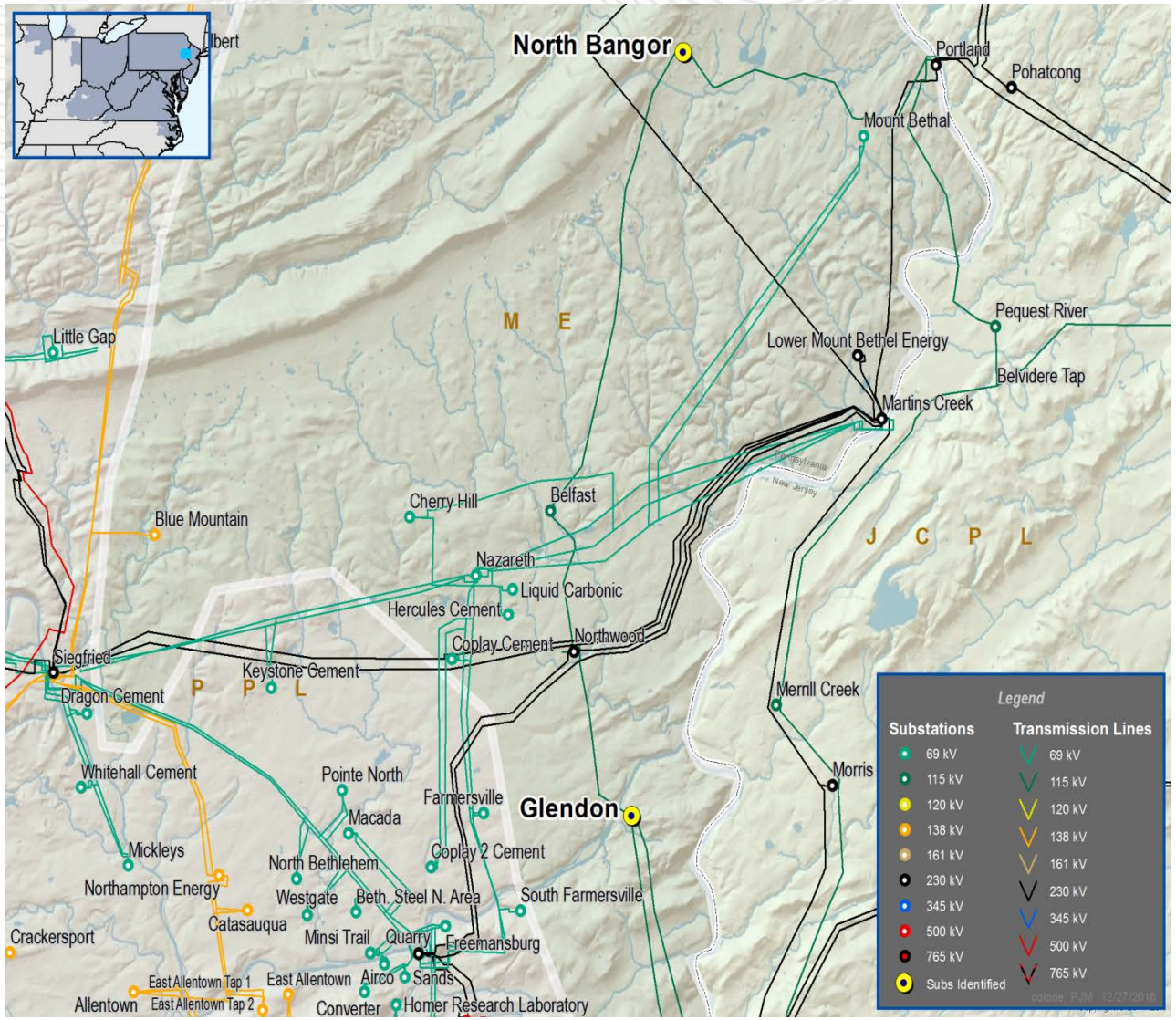
Proposed Solution:

- Install a 36.6 MVAR 115 kV capacitor at the North Bangor substation
- Installing the capacitor requires reconfiguring the North Bangor 115 substation to ring bus configuration, the original cost didn't take the substation work into consideration.

Old Estimated Project Cost: $0.98 M

New Estimated Project Cost: $6.5 M

Required IS Date:
6/1/2019



PenElec Transmission Zone

N-1 First Energy Planning Criteria (FERC Form 715):

- The Bethlehem to Leretto 46 kV circuit is overloaded for a single contingency loss of the Summit 115/46 kV transformer and the Summit – Claysburg, Summit – C. Slope 115 kV circuits.
- The facility is overloaded due to revised load forecast and modeling

Immediate Need:

- Due to the time – sensitive nature and current issue this problem presents, PenElec (Local TO) will be the Designated Entity

Alternatives Considered:

- Do to the immediate need of the project, no alternative solution was considered.

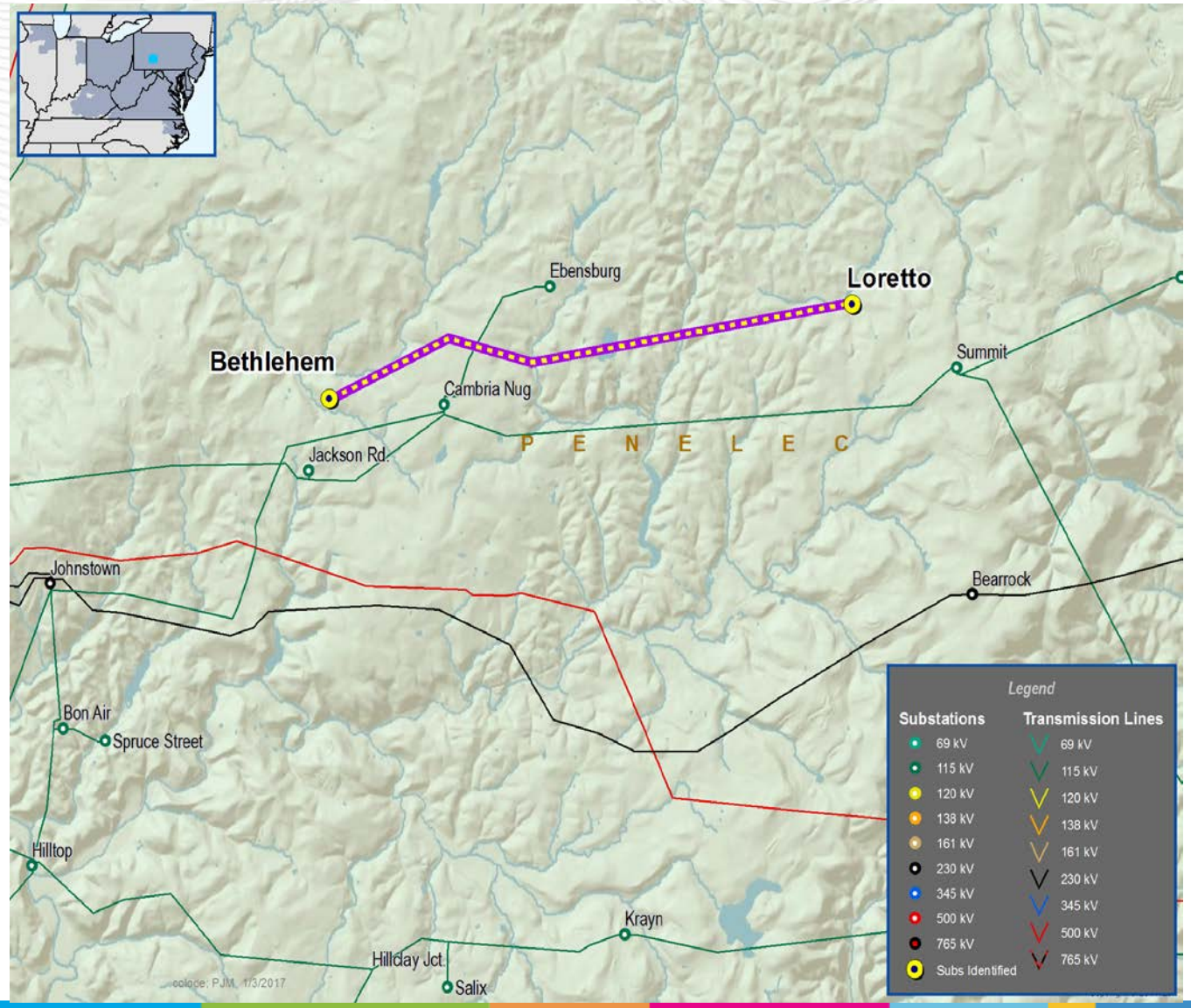
Proposed Solution:

- Reconductor 3.7 miles of the Bethlehem to Leretto 46 kV circuit and replace terminal equipment at Summit 46 kV. (B2803)

Estimated Project Cost: $ 4.0 M

Required IS Date: 6/1/2017

Expected IS Date: 12/1/2017



PenElec Transmission Zone

N-1 First Energy Planning Criteria (FERC Form 715):

- The Huntingdon to C Tap 46 kV circuit is overloaded for single contingency loss of the Huntingdon – Raystown 46 kV circuit.
- The facility is overloaded due to revised load forecast and modeling

Immediate Need:

- Due to the time – sensitive nature and current issue this problem presents, PenElec (Local TO) will be the Designated Entity

Alternatives Considered:

- Do to the immediate need of the project, no alternative solution was considered.

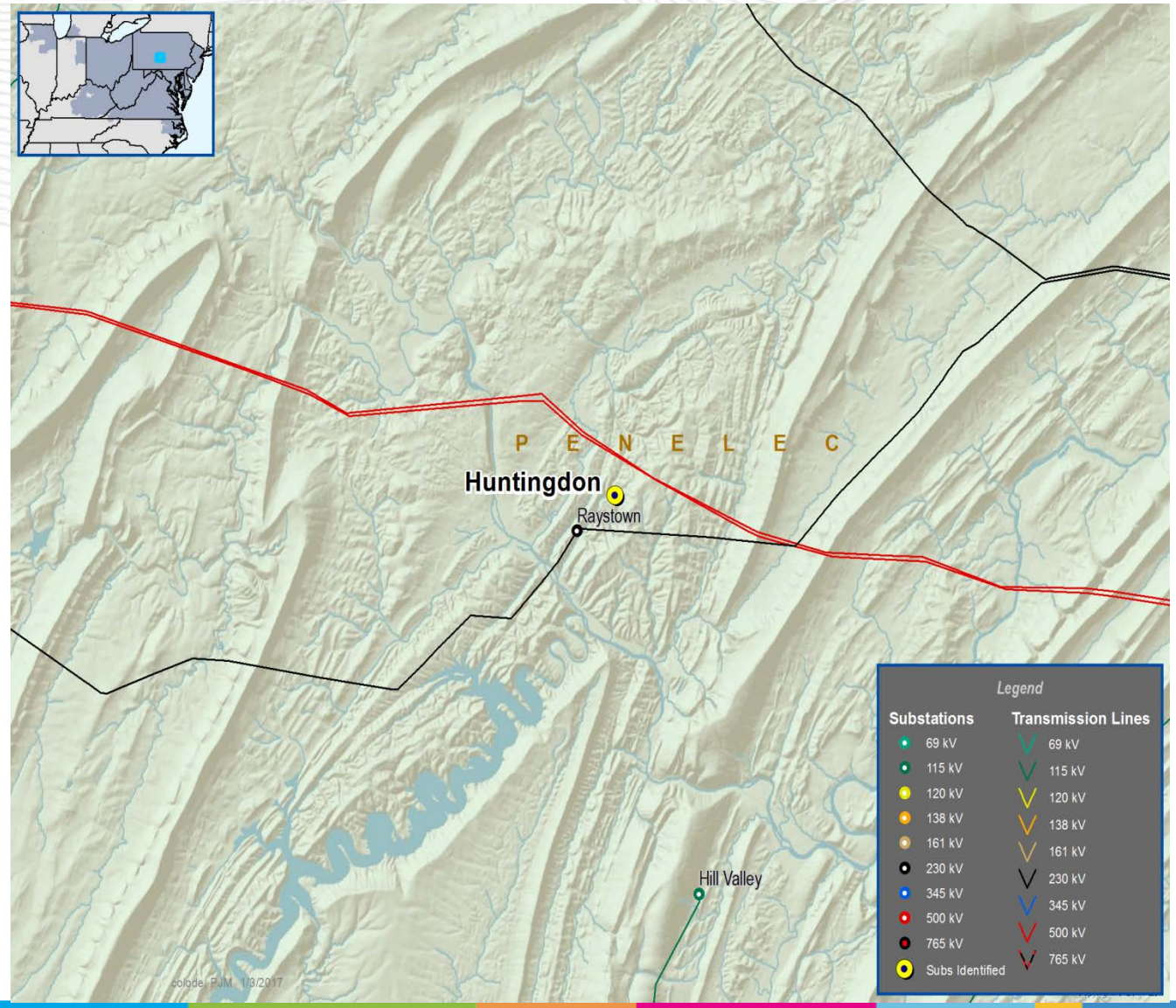
Proposed Solution:

- Install a new relay and replace 4/0 CU bus conductor at Huntingdon 46 kV station: on the Huntingdon - C tap 46 kV circuit . (B2804)

Estimated Project Cost: $ 0.5 M

Required IS Date: 6/1/2017

Expected IS Date: 12/1/2017



PenElec Transmission Zone

N-1 First Energy Planning Criteria (FERC Form 715):

- The Hollidaysburg - HCR Tap 46 kV circuit is overloaded for single contingency loss of the Bear Rock – Johnstown 230 kV circuit.
- The facility is overloaded due to revised load forecast and modeling

Immediate Need:

- Due to the time – sensitive nature and current issue this problem presents, PenElec (Local TO) will be the Designated Entity

Alternatives Considered:

- Do to the immediate need of the project, no alternative solution was considered.

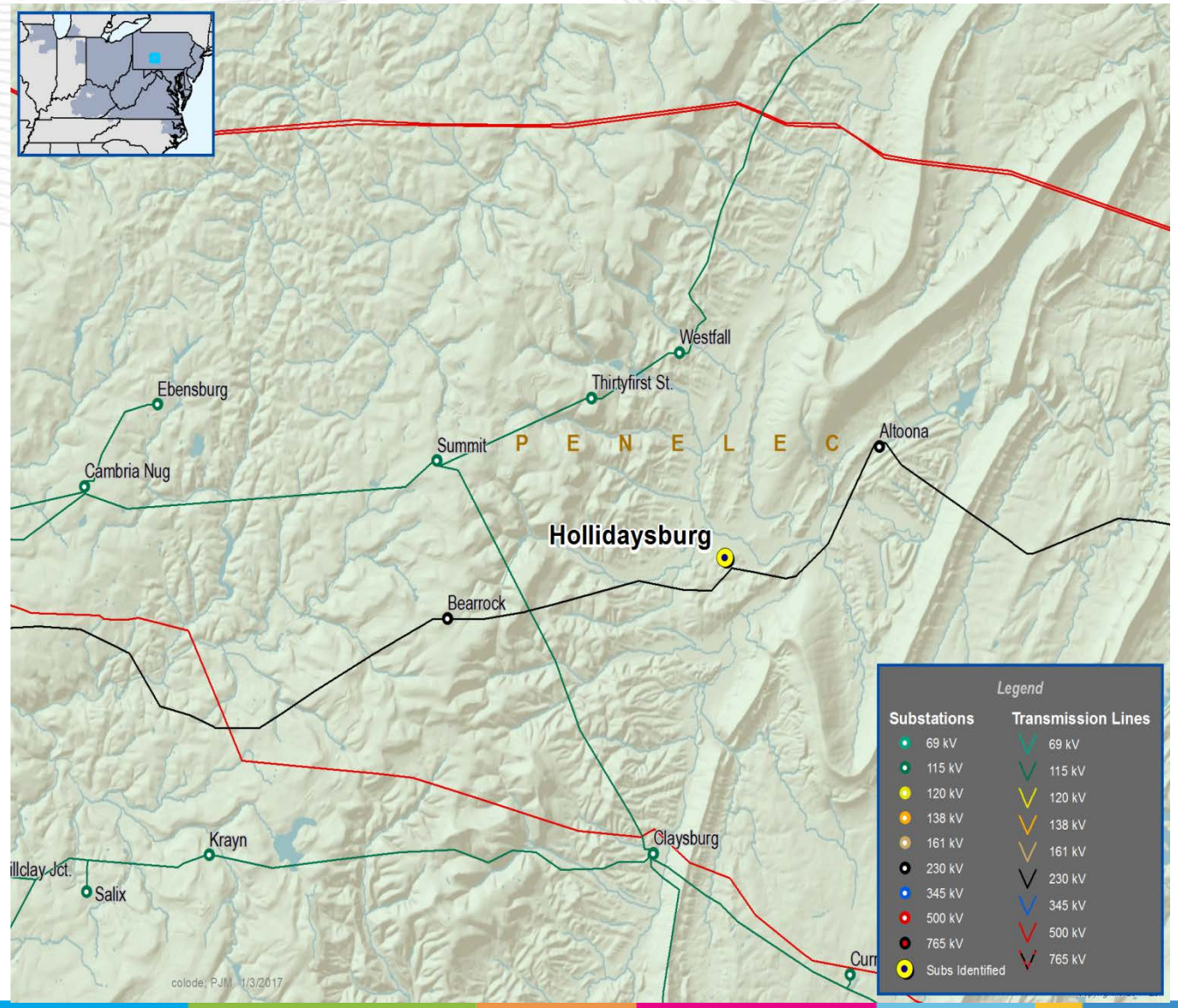
Proposed Solution:

- Install a new relay and replace 4/0 CU & 250 CU substation conductor at Hollidaysburg 46 kV station: on the Hollidaysburg - HCR Tap 46 kV circuit. (B2805)

Estimated Project Cost: $ 0.5 M

Required IS Date: 6/1/2017

Expected IS Date: 12/1/2017



PenElec Transmission Zone

N-1 First Energy Planning Criteria (FERC Form 715):

- The Raystown - Smithfield 46 kV circuit is overloaded for single contingency loss of the Huntingdon – Raystown 46 kV circuit.
- The facility is overloaded due to revised load forecast and modeling

Immediate Need:

- Due to the time – sensitive nature and current issue this problem presents, PenElec (Local TO) will be the Designated Entity

Alternatives Considered:

- Do to the immediate need of the project, no alternative solution was considered.

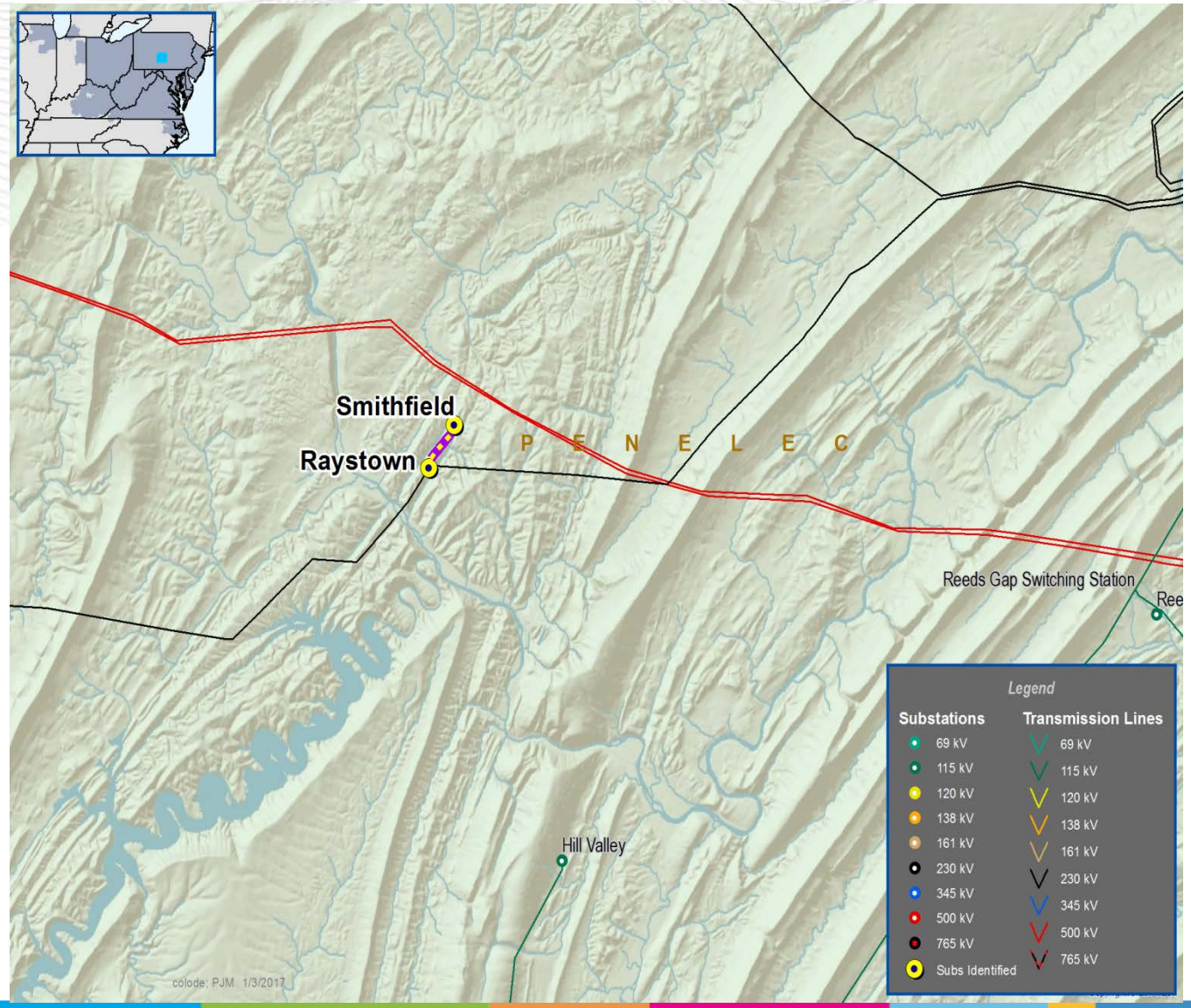
Proposed Solution:

- Install a new relay and replace meter at the Raystown 46 kV substation: on the Raystown - Smithfield 46 kV circuit. (B2806)

Estimated Project Cost: $ 0.5 M

Required IS Date: 6/1/2017

Expected IS Date: 12/1/2017



PenElec Transmission Zone

N-1 First Energy Planning Criteria (FERC Form 715):

- The Eldorado - Gallitzin 46 kV circuit. is overloaded for single contingency loss of the Bear Rock – Johnstown 230 kV circuit.
- The facility is overloaded due to revised load forecast and modeling

Immediate Need:

- Due to the time – sensitive nature and current issue this problem presents, PenElec (Local TO) will be the Designated Entity

Alternatives Considered:

- Do to the immediate need of the project, no alternative solution was considered.

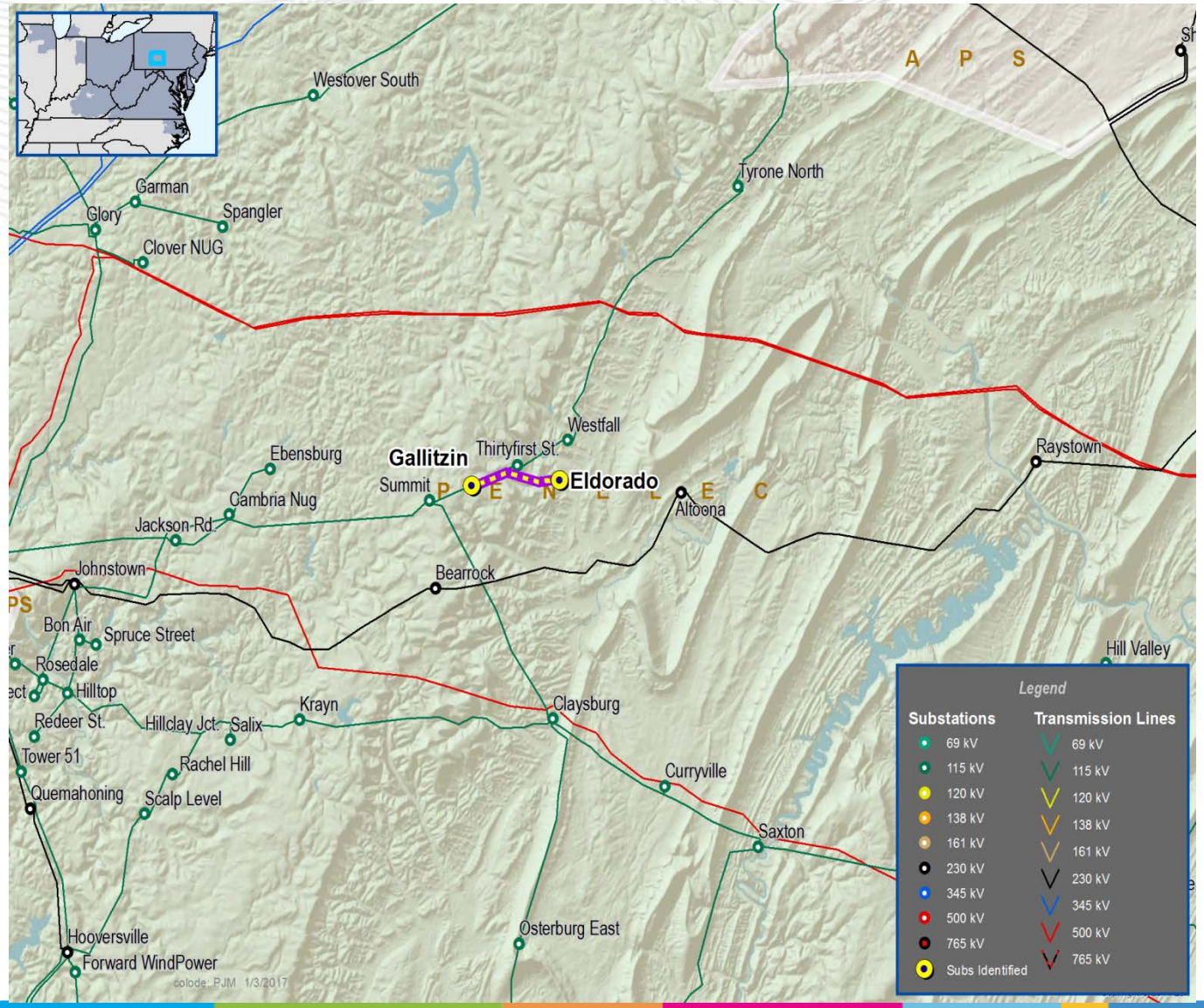
Proposed Solution:

- Replace the CHPV and CRS relay, and adjust the IAC overcurrent relay trip setting; or replace the relay at Eldorado 46 kV substation: on the Eldorado - Gallitzin 46 kV circuit. (B2807)

Estimated Project Cost: $ 0.3 M

Required IS Date: 6/1/2017

Expected IS Date: 12/1/2017



PenElec Transmission Zone

N-1 First Energy Planning Criteria (FERC Form 715):

- The Raystown - Huntingdon 46 kV circuit is overloaded for single contingency loss of the Hill Valley - Huntingdon - Raystown 46kV circuit.
- The facility is overloaded due to revised load forecast and modeling

Immediate Need:

- Due to the time – sensitive nature and current issue this problem presents, PenElec (Local TO) will be the Designated Entity

Alternatives Considered:

- Do to the immediate need of the project, no alternative solution was considered.

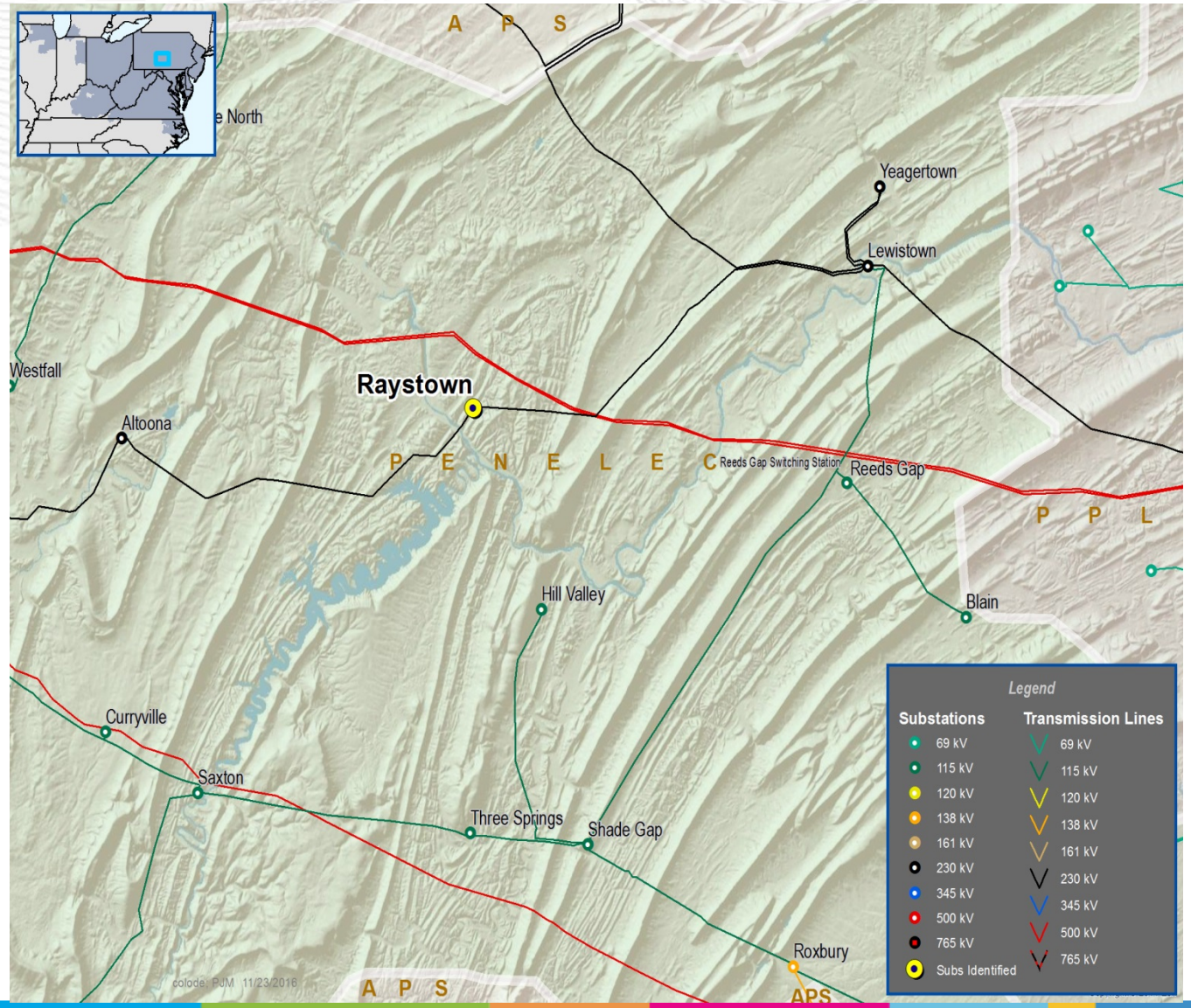
Proposed Solution:

- Adjust the JBC overcurrent relay trip setting at Raystown, and replace relay and 4/0 CU bus conductor at Huntingdon 46 kV substations: on the Raystown - Huntingdon 46 kV circuit. (B2808)

Estimated Project Cost: $ 0.3 M

Required IS Date: 6/1/2017

Expected IS Date: 12/1/2017



PPL Transmission Zone

PPL Planning Criteria (FERC Form 715):

- A stuck 69 kV bus section Circuit Breaker in the Lycoming 69 kV yard or a bus section failure in the Lycoming 69kV yard leads to more than acceptable (5 %) voltage drop and creates less than acceptable minimum voltage (0.90 pu).
- PPL TO Criteria for 69 kV System- No more than 5% voltage drop and not less than 0.90 pu voltage for P2-2 (bus section fault) or P4-6 contingency (stuck bus section Circuit Breaker).
- The above PPL criteria was filed with FERC on April 2016.

Immediate Need:

- Due to the time – sensitive nature and current issue this problem presents, PPL (Local TO) will be the Designated Entity

Alternatives Considered:

- Building a new 230-69 kV regional substation and more than 50 miles of double circuit 230 kV line is the other possible alternatives to resolve this problem. However this alternative is not considered due to higher cost ($188 M).

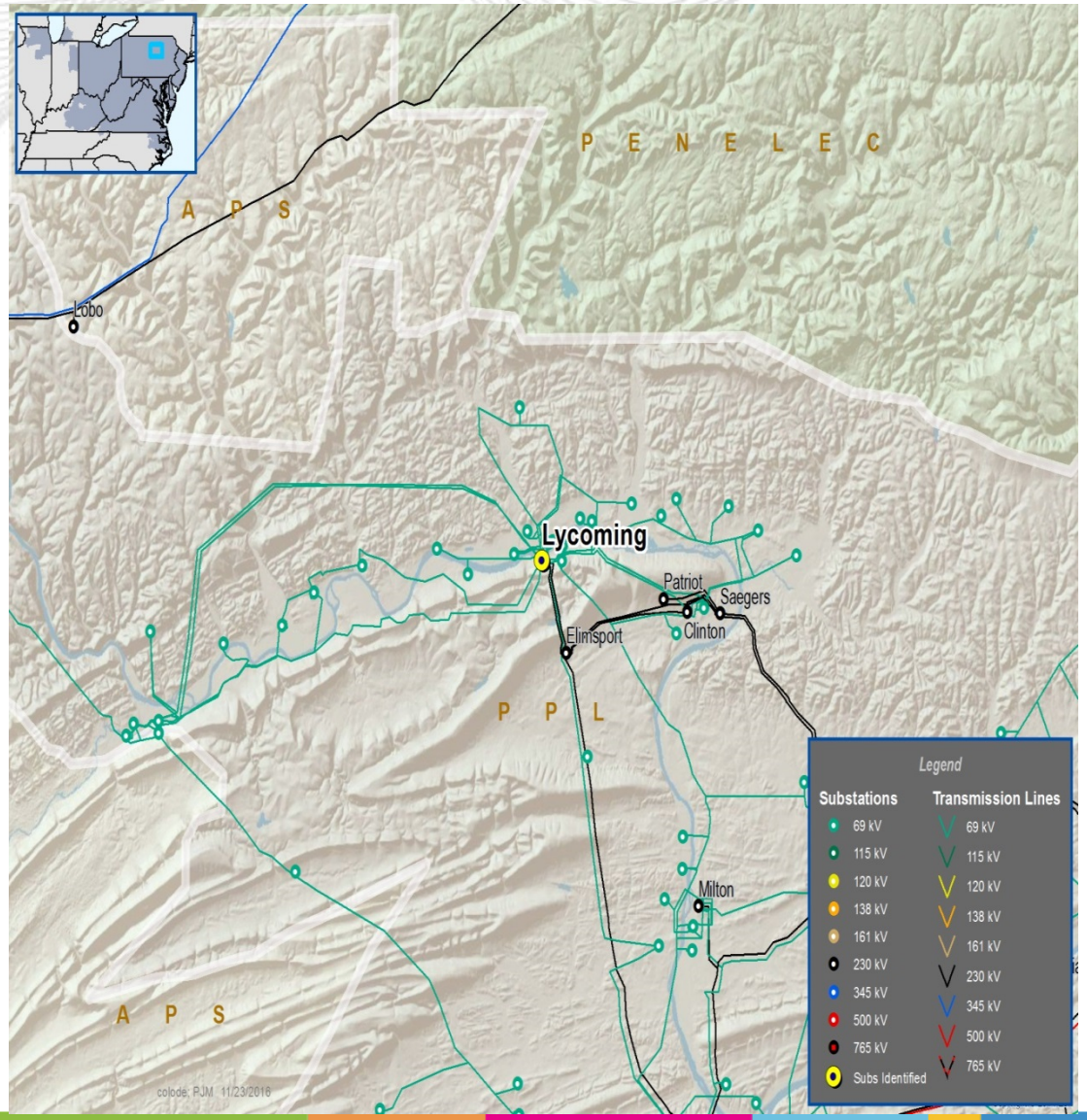
Proposed Solution:

- Expand existing Lycoming 69kV yard to double bus double breaker arrangement. This will convert the substation from single operating bus to double bus configuration and will eliminate the risk of losing Lycoming source under a Stuck Circuit Breaker Contingency**. (B2813**)

Estimated Project Cost: $ 22 M

Required IS Date: 6/1/2018

Expected IS Date: 11/30/2019



PSEG Transmission Zone

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

- Great Notch currently has two 69kV circuits as its supply.
- During an N-1-1 contingency event, Great Notch 69kV substation loses its electric supply, which is a violation of PSEG's FERC 715 Planning Criteria.

Immediate Need:

- Due to the time – sensitive nature and current issue this problem presents, PSEG (Local TO) will be the Designated Entity

Alternatives:

- Connect Great Notch to Jackson Rd. 69kV station. This route is much longer and will require major highway and river crossings. Estimated Project Cost: >$48M

Proposed Solution:

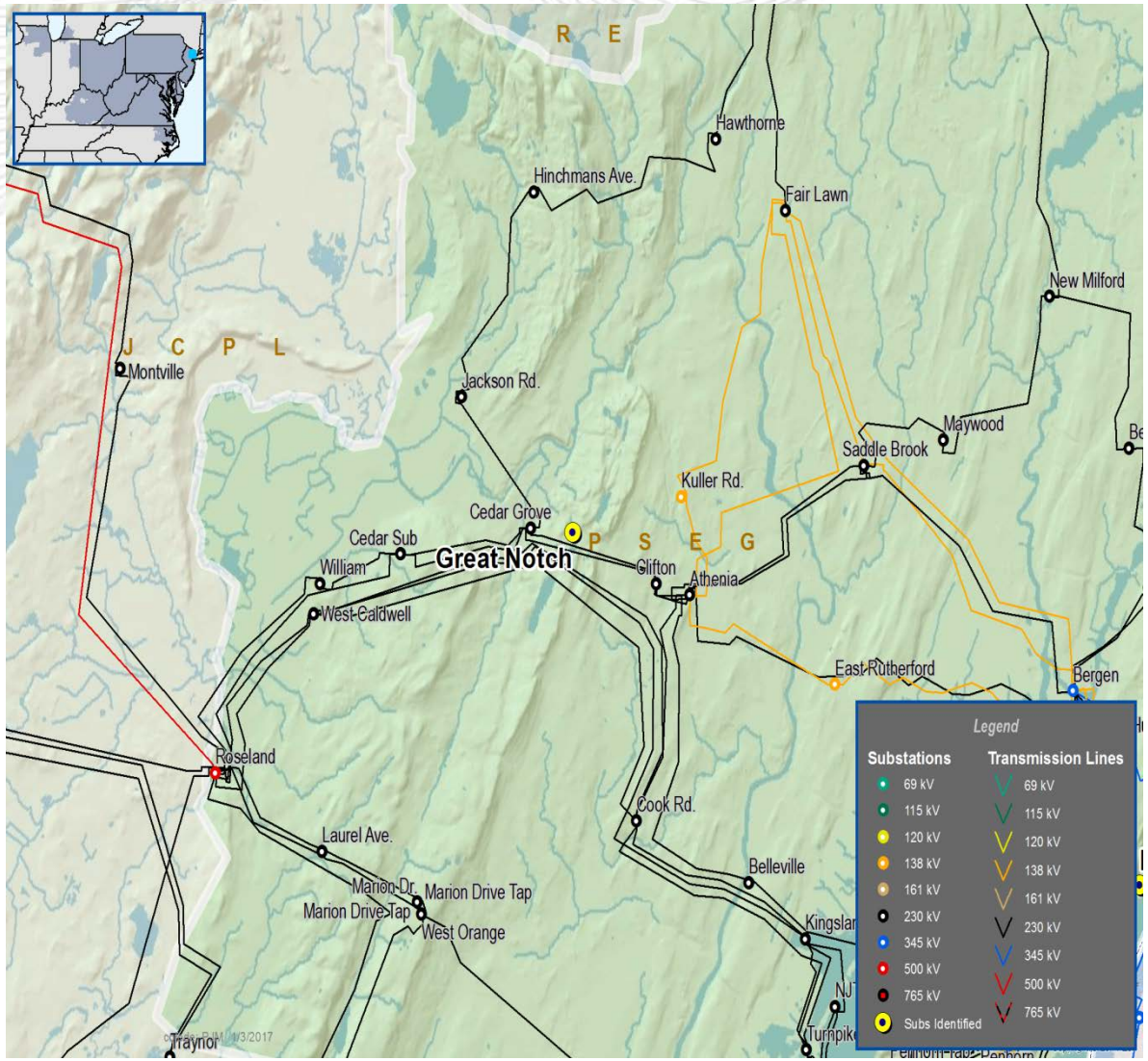
- Install second 230/69kV Transformer at Cedar Grove. (B2810.1)
- Build a new line between Cedar Grove 69kV and Great Notch 69kV. (B2810.2)

Estimated Project Cost: $44M

Required IS Date: 6/1/2019

Expected IS Date: 4/1/2019

Project Status: Study Stage



PSEG Transmission Zone

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

- Tonnelle Avenue and River Road currently have two 69kV circuits as its supply.
- During an N-1-1 contingency event, Tonnelle Avenue and River Road 69kV substations lose their electric supply, which is a violation of PSEG's FERC 715 Planning Criteria.

Immediate Need:

- Due to the time – sensitive nature and current issue this problem presents, PSEG (Local TO) will be the Designated Entity

Alternatives:

- Connect River Rd. to Union City 69 kV station. This route will be double the distance and will be all underground construction.
- This alternative would also include a second circuit to be added from Bergen SW to Tonnelle Ave. The GIS at Bergen SW would have to be expanded. Estimated Project Cost: >$40M

Proposed Solution:

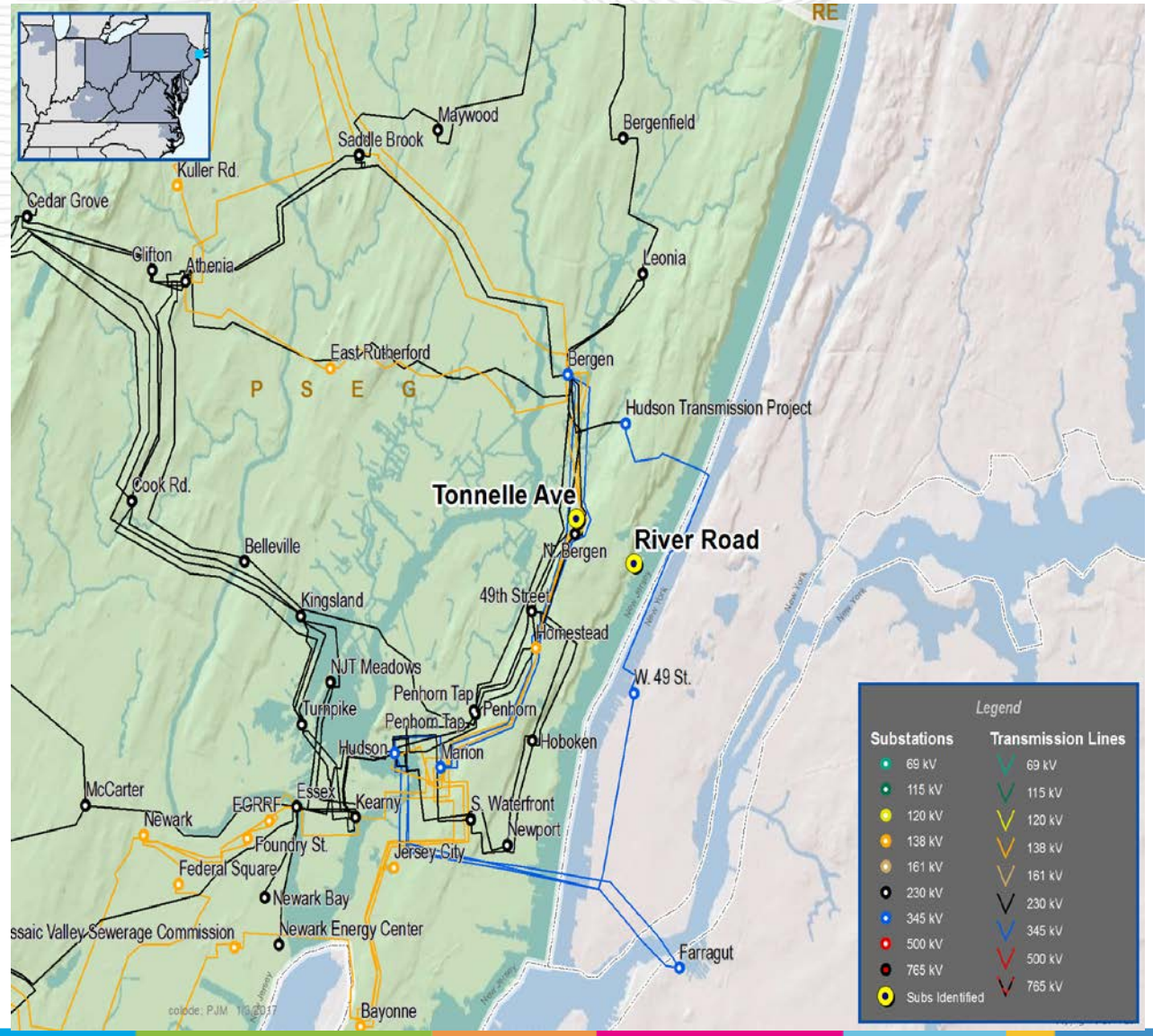
- Build a new line between Tonnelle Avenue and River Road . (B2812)

Estimated Project Cost: $31M

Required IS Date: 6/1/2017

Scheduled IS Date: 4/1/2019

Project Status: Study Stage



PSEG Transmission Zone

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

- Delair and Locust Street currently have two 69kV circuits as its supply.
- Locust street is the main supply for load growth occurring in the Camden area.
- During an N-1-1 contingency event, Delair and Locust Street 69kV substations lose their electric supply, which is a violation of PSEG's FERC 715 Planning Criteria.

Immediate Need:

- Due to the time – sensitive nature and current issue this problem presents, PSEG (Local TO) will be the Designated Entity

Alternatives:

- Connect Locust to East Riverton 69kV station. This route is approximately 60% longer. Estimated Project Cost: >$20 M

Proposed Solution:

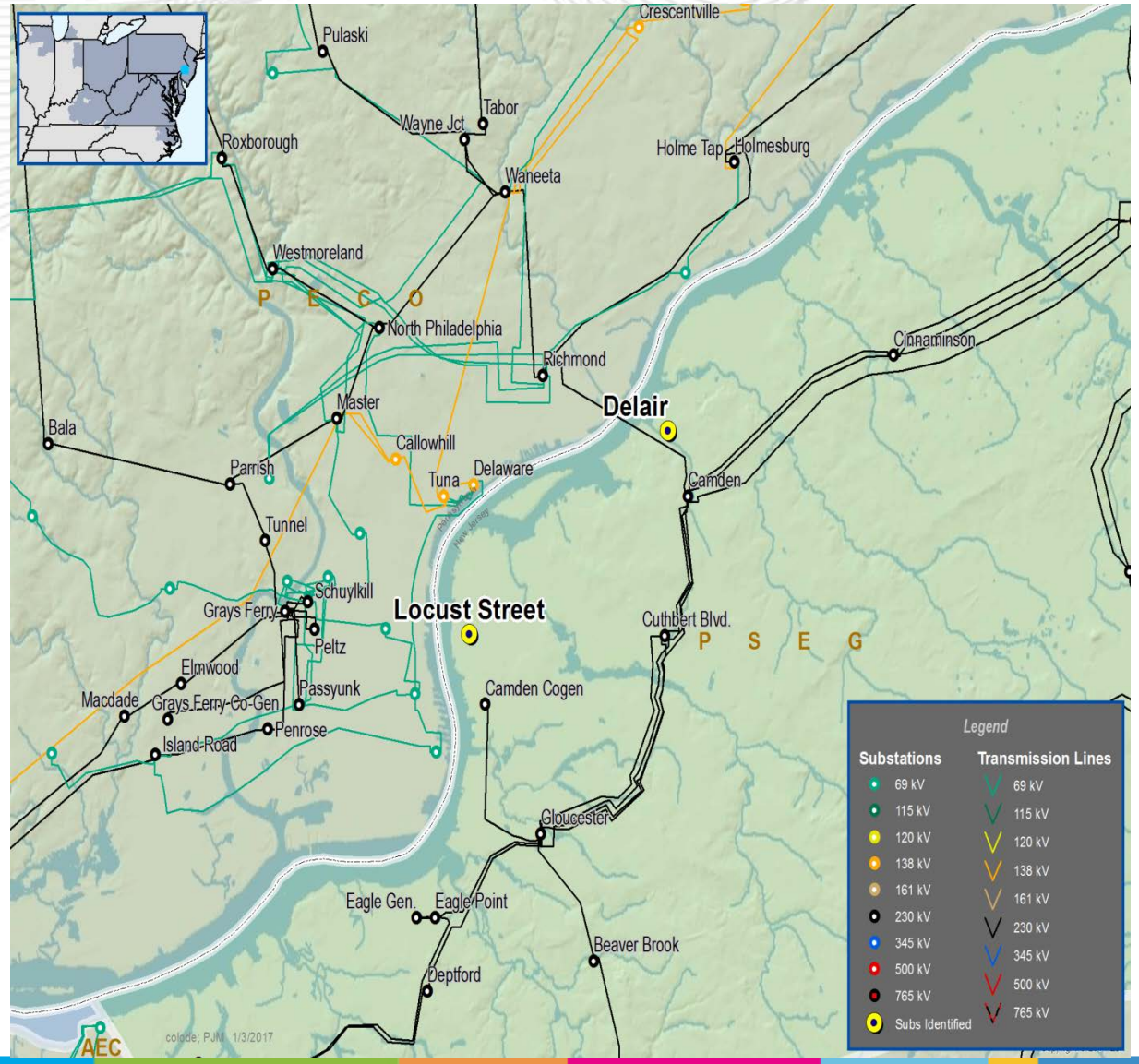
- Build a new line between Delair and Locust Street. (B2811)

Estimated Project Cost: $13.5 M

Required IS Date: 61/2017

Scheduled IS Date: 6/1/2018

Project Status: Study Stage



Supplemental Projects

AEC Transmission Zone

Supplemental Upgrade:

Distribution Overloads and Aging Infrastructure in Beckett Area

Problem Statement:

- Distribution overload issues have been identified at Beckett substation. Upgrades are needed to relieve local area distribution overloading, address aging equipment concerns at Mullica Hill substation, and convert to a more standard operating voltage.

Proposed Project:

- **High Street Substation**
  18.7 mile rebuild and upgrade of the existing Woodstown-Paulsboro 34.5 kV distribution line to create two (2) 69 kV sources to a new High Street Substation. The Paulsboro-High Street 69 kV line would be approximately 9.1 miles long. The Woodstown-High Street 69 kV line would be approximately 9.6 miles long. The new High Street substation configuration includes a six breaker 69 kV ring bus and one 69/12 kV 42 MVA distribution transformer with a position available for a future second 69/12 kV transformer. The project includes a new 69 kV terminal at Woodstown substation and a new 69 kV terminal at Paulsboro substation. Retire Mullica Hill substation after load is transferred to the new High Street.

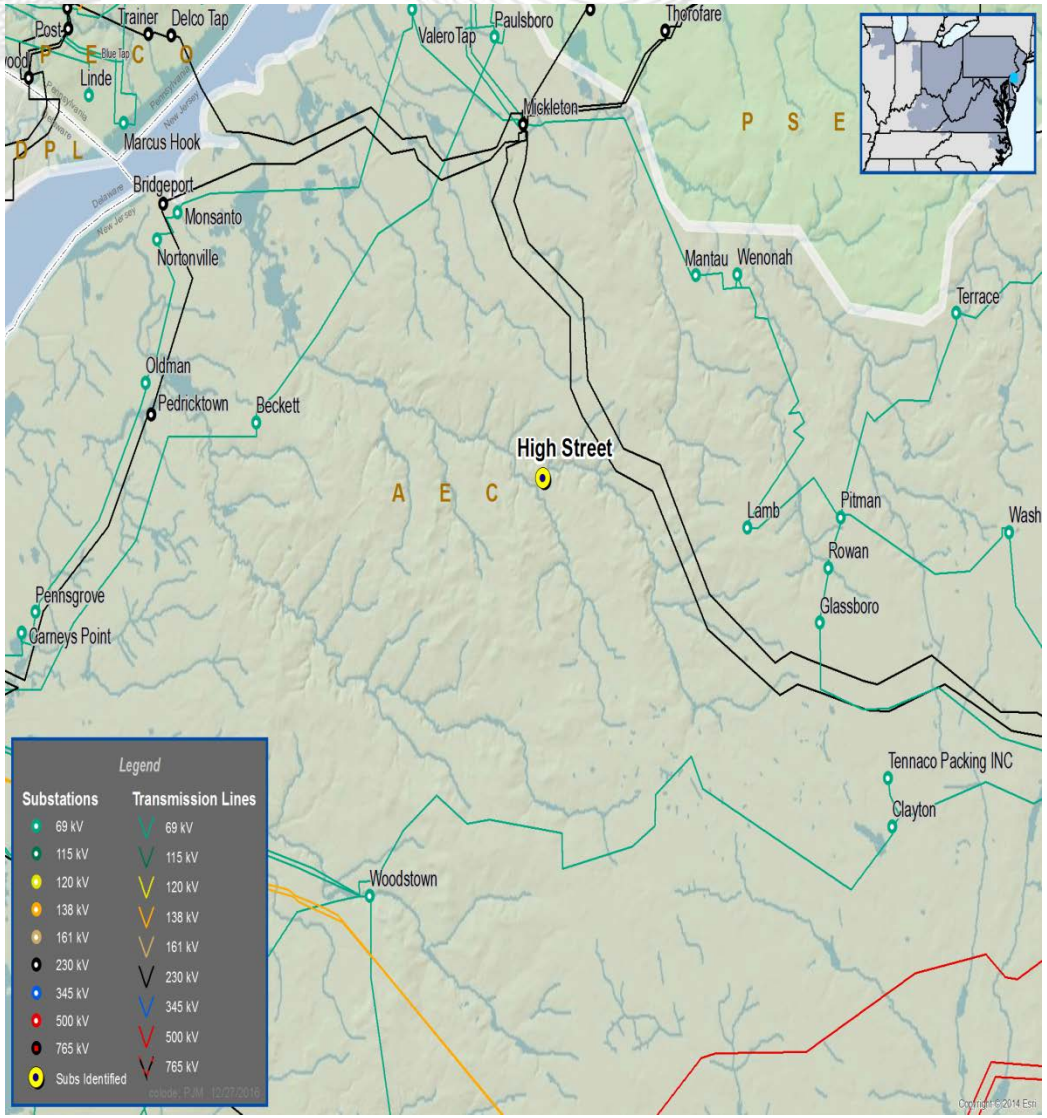
Alternatives:

- Replace both Mullica Hill substation transformers. Rebuilding Mullica Hill substation with a new 40 MVA transformer within the existing fence line is not feasible. Purchasing adjacent land is not possible because Mullica Hill is bordered by a road and backed by wetlands.
- Transfer all Mullica Hill substation load to tie substations. Not possible with current configuration. Neighboring substations would eventually be overloaded.
- Expand nearby Beckett substation. Expansion of Beckett substation along with the required distribution feeders would result in degraded reliability, limited operational flexibility, and would not allow for long term area load growth associated with retail business expansion. Additional land would also be required around Beckett substation, which is surrounded by wetlands, making permitting complicated and expensive.

Estimated Cost: $38.2 M

Scheduled In Service Date: 5/31/2018

Project Status: Design & Engineering



AEC Transmission Zone

Supplemental Upgrade:

Line Overload Conditions During Churchtown Transformer Outage

Problem Statement:

- Anticipated line overload conditions exist during an outage of the Churchtown 230/69 kV transformer with the Carlls Corner #2 CT offline.

Proposed Project:

- **Beckett–Paulsboro 69 kV Reconductor**
  Reconductor 0.27 mile section 'J' of the Beckett-Paulsboro 69 kV line with 1200 amp minimum conductor.

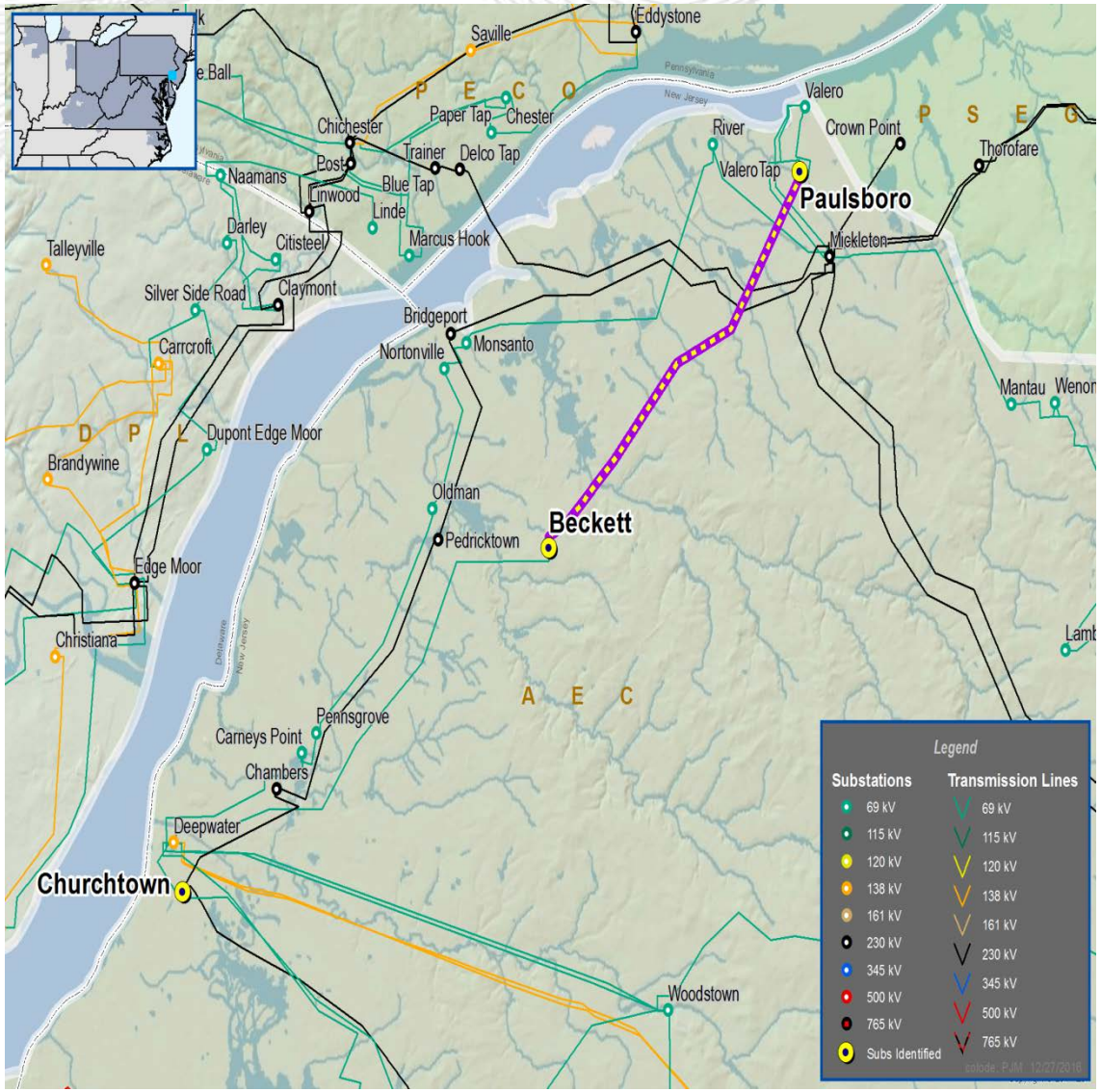
Alternatives:

- Do nothing – allow overload (not acceptable)

Estimated Cost: $2.2 M (Transmission)

Scheduled In Service Date: 5/31/2017

Project Status: Design & Engineering



Supplemental Upgrade:

Tansboro Transformer Overload Forecast

Problem Statement:

- Tansboro Substation 12 kV load is forecasted to be over the existing transformer T2 normal rating capacity by 2020.

Proposed Project:

- **Upgrade Tansboro 69kV Bus to Ring Bus**
  Upgrade 69 kV bus to a ring bus (current line bus configuration has no sectionalizing breakers). Replace T1 with a new 69/12 kV 40 MVA transformer and transfer loading from T2.

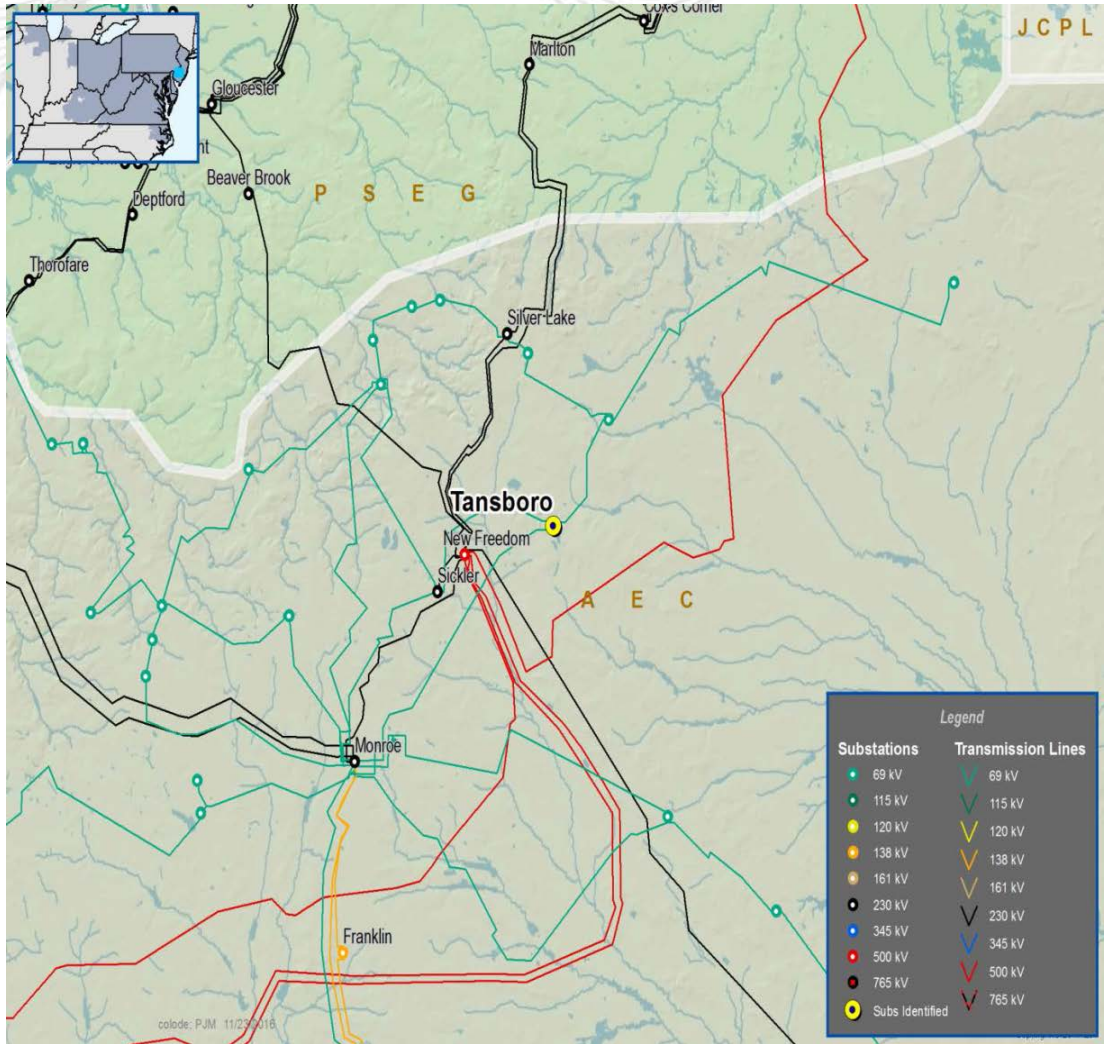
Alternatives:

- Temporary solution would be to install a new 12 kV 1200A circuit breaker in the open position between CB-H and CB-J, and transfer Cedarbrook 12 kV feeder on the new circuit breaker. A bus sectionalizing switch would be placed between CB-H and the new CB. This temporary solution would cost $375,000, but it would not tackle the load growth concerns

Estimated Cost: $5.74 M

Scheduled In Service Date: 12/31/2019

Project Status: Design & Engineering



Supplemental Upgrade:

Cape May Substation Reliability Improvements

Problem Statement:

- For any outage to the only existing 37 MVA transformer, 20 MVA of the carried substation load cannot be restored via external feeder ties (35 MVA is the peak). A 40 MVA mobile transformer must be transported to the substation to serve customers if the transformer cannot be immediately restored. For a forced outage this may cost approximately $100k and a mobile transformer takes 36-48 hours to place in service in addition to permitting. Cape May substation has no existing 69 kV circuit breakers and the existing switches have maintenance issues.

Proposed Project:

- **Cape May Sub – Establish 69 kV Ring Bus**
  Installation of an in-line four position 69 kV ring bus, two 69 kV lines and two transformer terminals (utilizing one new 40 MVA transformer and one existing). Installation of four 69 kV circuit breakers and associated disconnect switches, two motor operated disconnects for #1 and #2 Rio Grande 69 kV lines. Primary and backup line relaying for both 69 kV lines will be required.

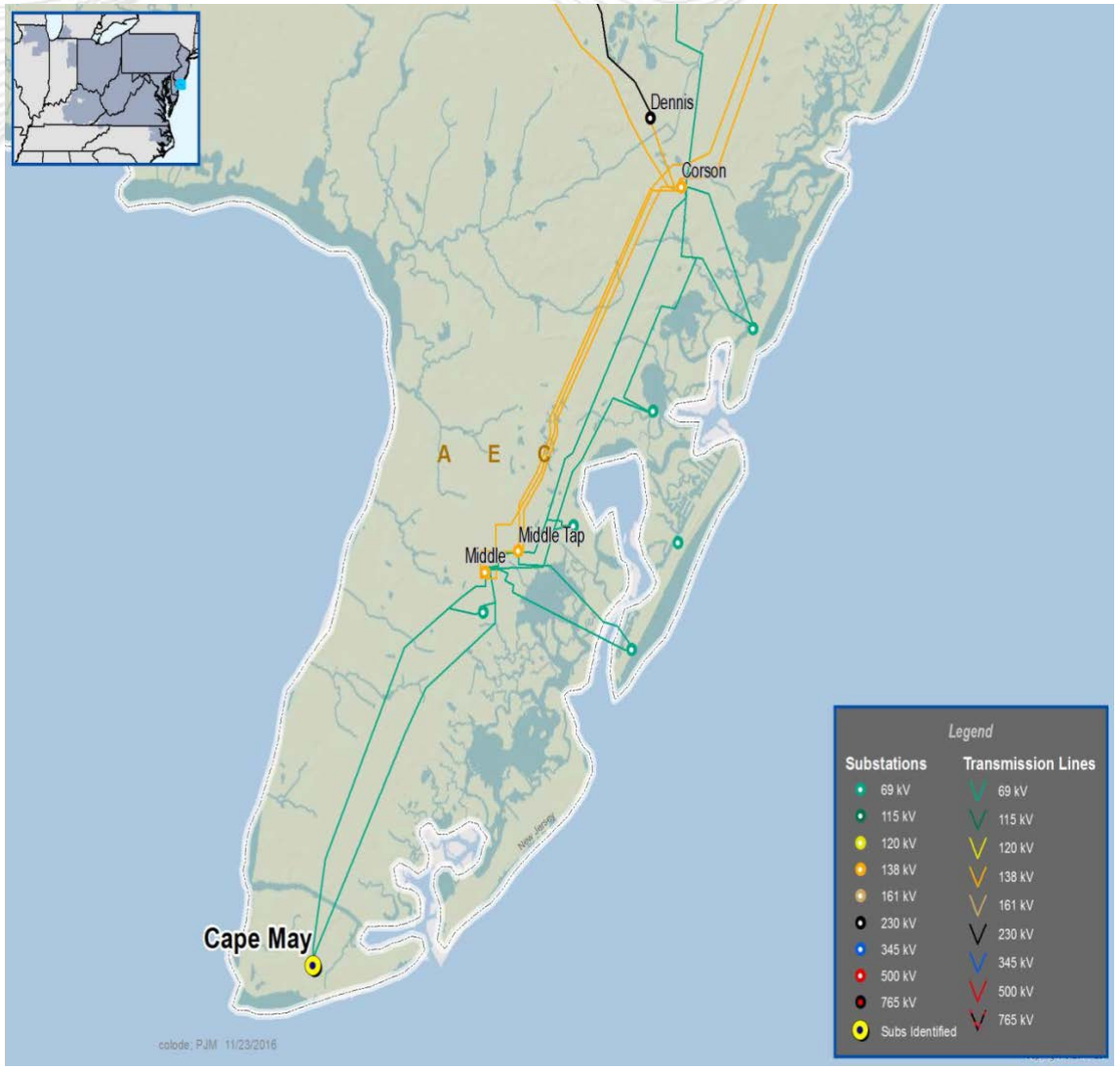
Alternatives:

- Alternative 1 - Load Transfer to Adjacent Substations (not feasible because it would overload neighboring substations)
- Alternative 2 - Two Mobile Units for back-up (this alternative is not feasible due to limited space in the substation)

Estimated Cost: $4.7 M

Scheduled In Service Date: 5/31/2020

Project Status: Design & Engineering



Supplemental Upgrade:

Stratford Substation Reliability Improvements

Problem Statement:

- There are no existing 69 kV breakers at Stratford Substation to isolate 69 kV line faults. Stratford Substation serves approximately 8500 customers, including a hospital.

Proposed Project:

- **Stratford Sub: Install 69 kV Line Bus**
  At Stratford Sub, install three 69 kV circuit breakers in a line bus configuration. Install associated breaker controls/relays and bus differential relays. Install new control house.

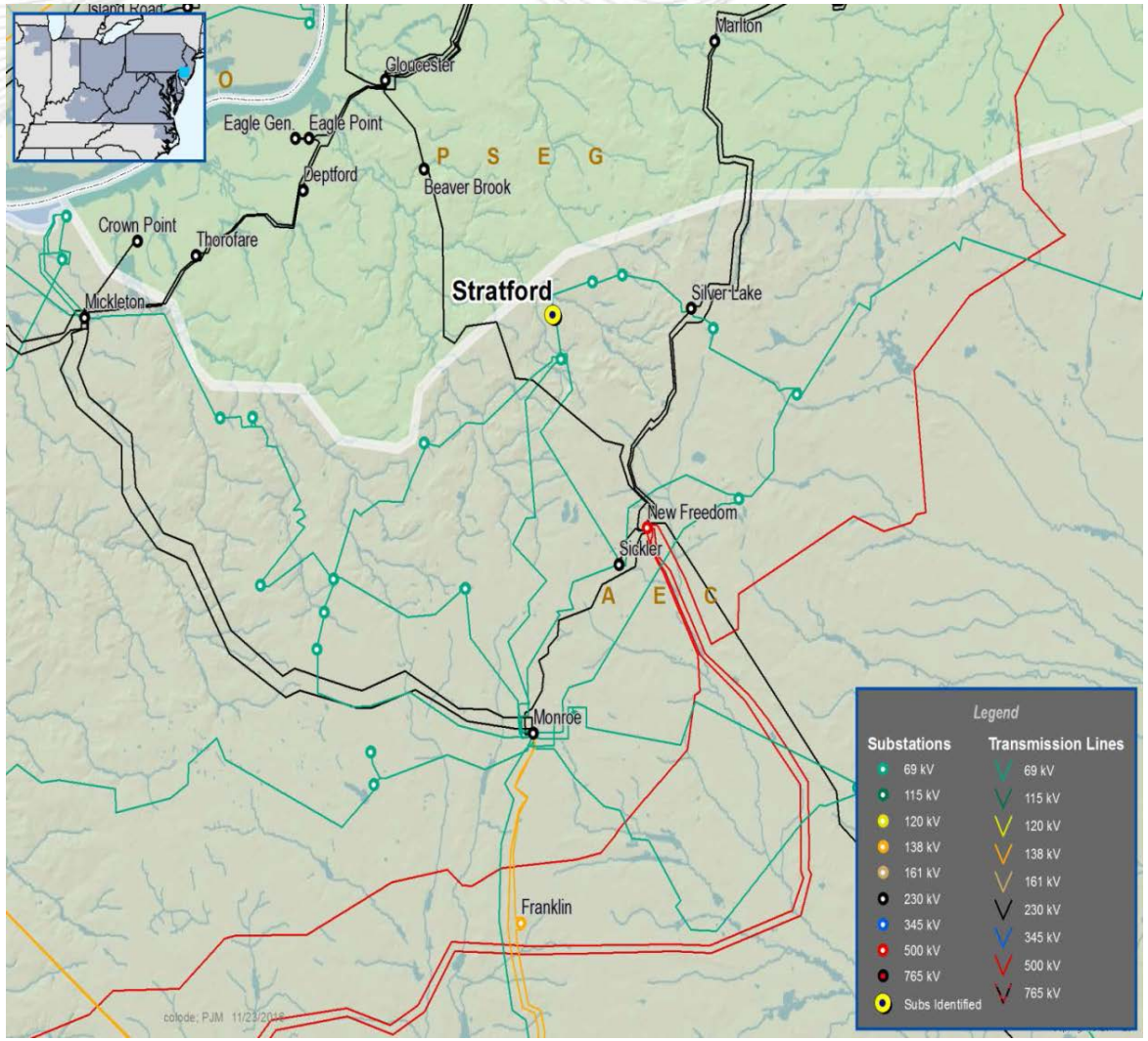
Alternatives:

- Install a 69 kV ring bus (space is too limited).

Estimated Cost: $2.8 M

Scheduled In Service Date: 5/31/2024

Project Status: Conceptual



Supplemental Upgrade:

Mickleton Substation Reliability Improvements

Problem Statement:

- Critical industrial and distribution customers in the area are served from the 69/12 kV transformers at this site. Existing transformers are in poor condition and are beyond the end of their useful life. Upgrades are needed to address aging equipment concerns at Gibbstown substation and convert to a more standard operating voltage.

Proposed Project:

- **Mickleton Substation: 69kV Ring Bus**
  Replace existing Mickleton substation 69 kV line bus with a 69 kV ring bus. A ring bus will improve reliability and allow for operational flexibility in the area. Retire Gibbstown substation after load is transferred to Mickleton.

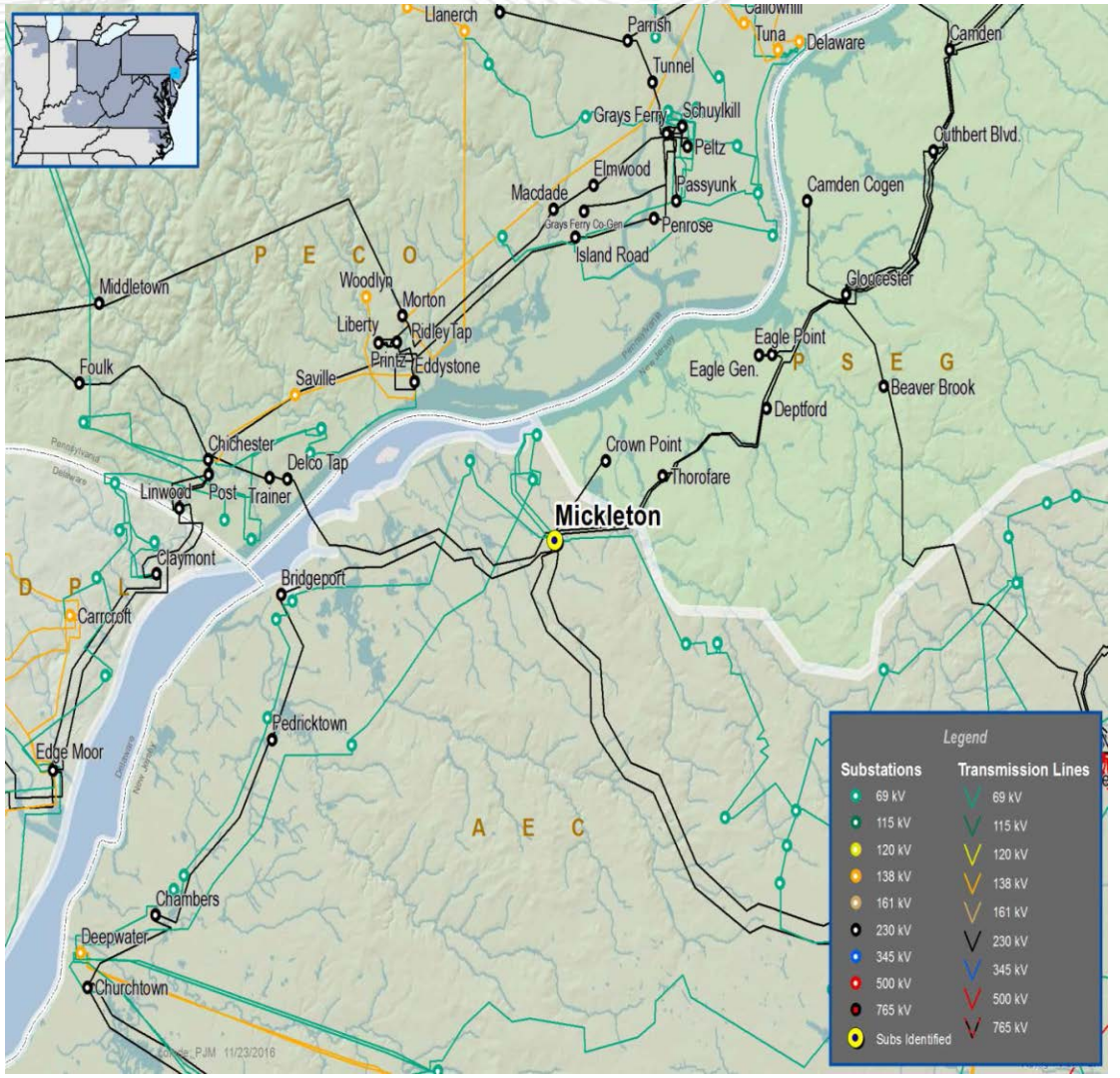
Alternatives:

- Rebuild the deteriorated Gibbstown substation, which has reached its end of life. This alternative is not a long-term solution since additional capacity in the area will eventually be needed.
- Replace existing Paulsboro T5 (69/4 kV) with a 40 MVA 69/12 kV transformer. Estimate is approximately $4.4 million. This will leave Gibbstown substation (4 kV) with no alternatives to transfer load.
- Leave the existing line bus in place (does not address reliability concerns).
- Upgrade the line bus (does not address reliability concerns).
- Breaker and a half 69 kV configuration (space constraints).

Estimated Cost: $12.3 M

Scheduled In Service Date: 12/31/2020

Project Status: Design & Engineering



BGE Transmission Zone

Supplemental Upgrade:

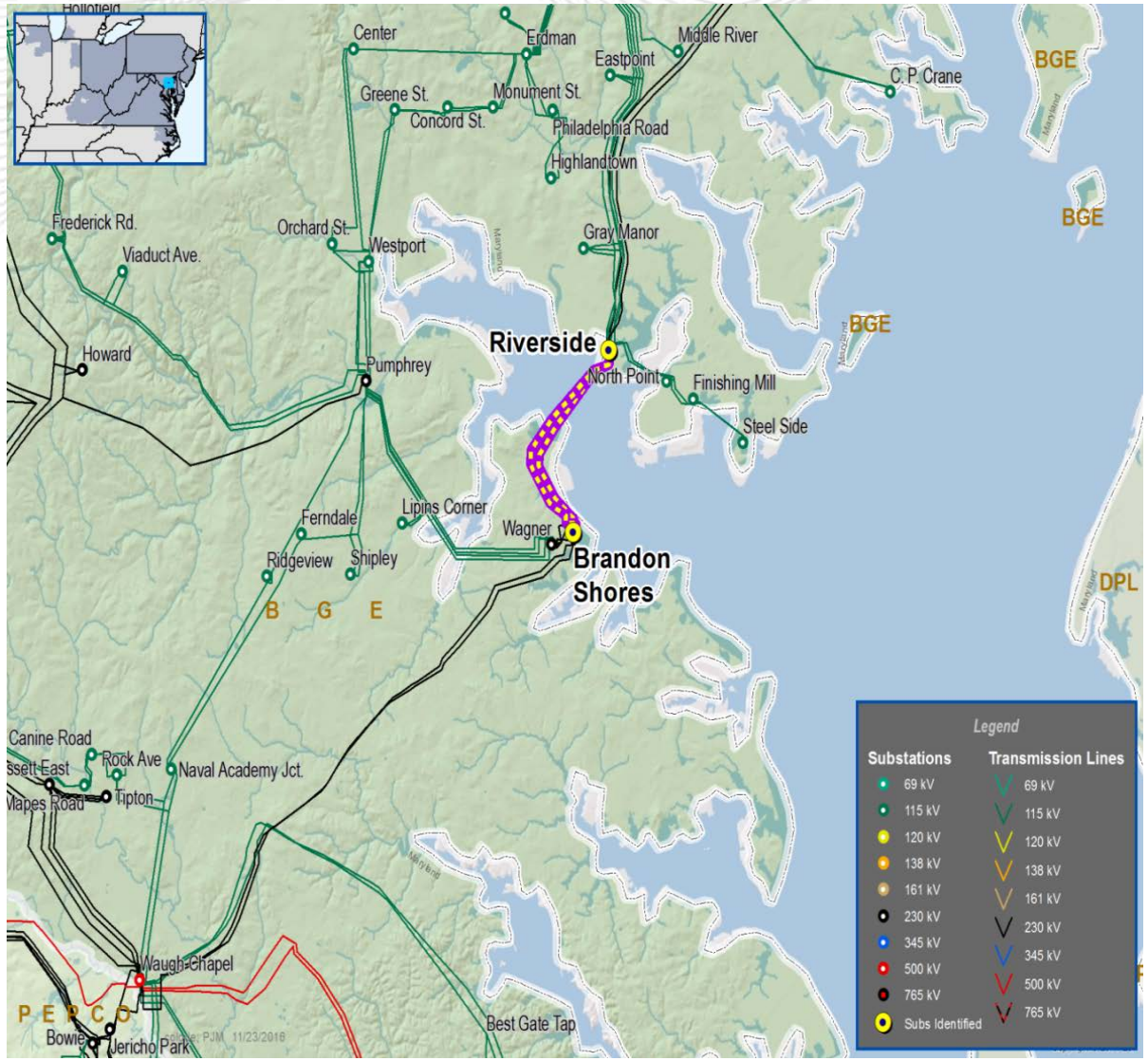
230 KV Harbor Cables Replacement

Problem Statement:

- BGE circuits #2344 and #2345 connect Brandon Shores to Riverside substations and are an important part of the 230 kV transmission ring enabling power transfer from southern generation (Brandon Shores, Wagner) to the northern portion of the BGE zone.
- A third of these circuits is under the Patapsco River near the Francis Scott Key bridge (~2 ¼ mile section of the total ~6 mile circuit length).
- This section is comprised of five identical 230kV oil filled pipe type transmission cables, two per circuit and an in service spare.
- Hawkins Point and Sollers Point Terminal Stations connect the cables to overhead lines.
- The oil filled pipe type transmission cables are nearing end of life and have an increased risk of failure as indicated by elevated levels of dissolved gasses within oil (2 to 3 times the action level for acetylene and hydrogen gases).
- All cables show the same symptoms. The gas levels continue to grow.
- Terminations have already been replaced. The cable oil has been degassed and gas generation continues.
- Pipe integrity is unknown. Pipe failure could result in contamination of remaining cables

Proposed Project:

- Replace underground submarine cables with overhead conductors on towers. Install a double circuit single tower line from the existing OH transmission structures at Hawkins Point to the existing OH transmission structures at Sollers Point.
- The proposed OH conductors will tie into the existing OH portion of the circuits at or near the location of the existing terminal stations.
- Foundations and structures will be located in the Chesapeake Bay and will require protective collision prevention features or structures.



BGE Transmission Zone

Supplemental Upgrade: Continue from previous page

230 KV Harbor Cables Replacement

Alternatives:

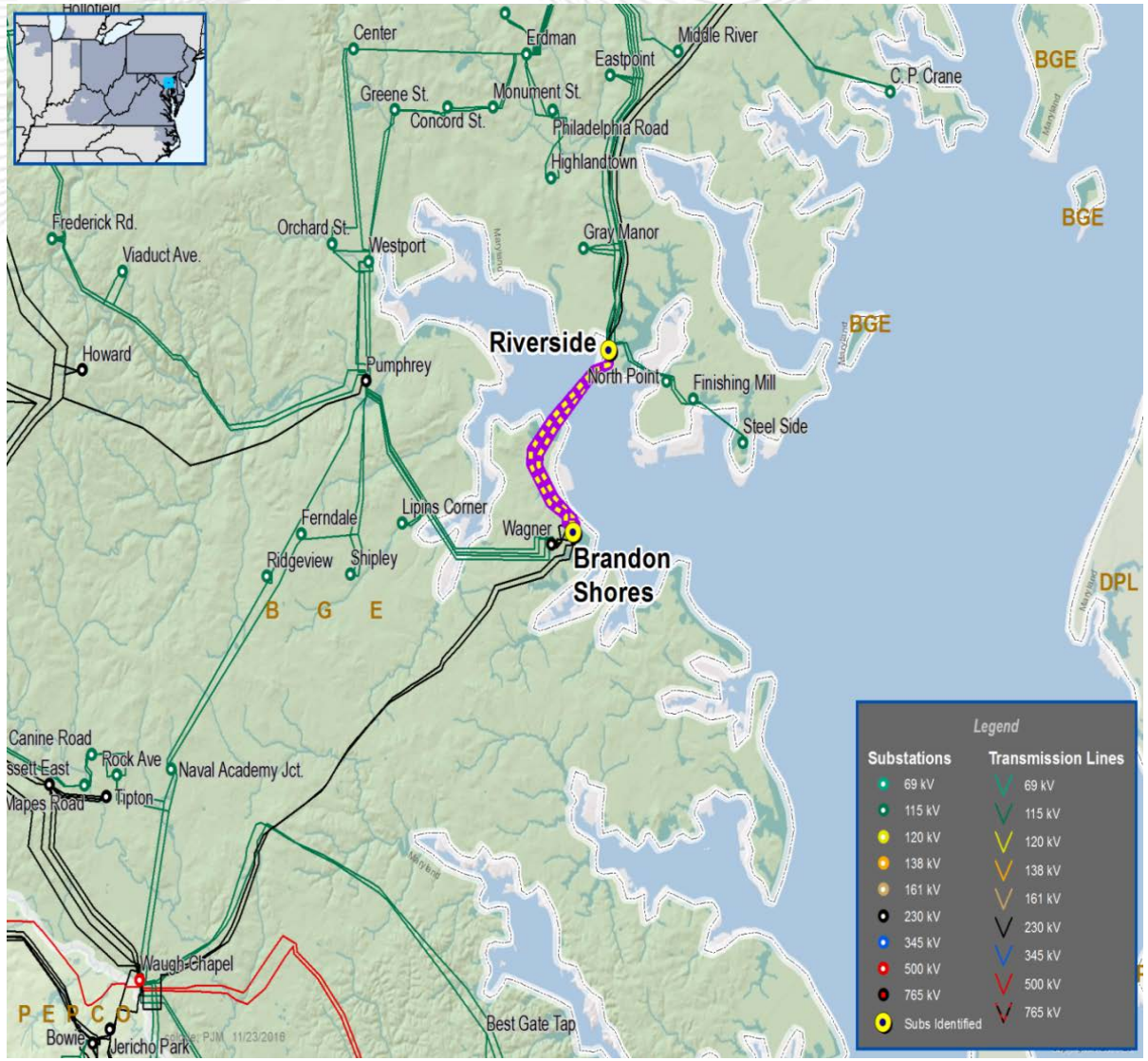
- Replace existing underground submarine cables with new solid dielectric transmission submarine cables from Hawkins Point to Sollers Point.
  - Two to three times more costly than OH option ($320M to $420M).
  - Longer to construct and slower to repair than OH.
  - Greater environmental risk on Chesapeake Bay during UG Cable installation than OH tower construction
  - Does not provide ability to increase capacity in the future if necessary.
- Run to Failure and Repair: Repair times could be in excess of 12 months (3-5 years depending on the extent of the failure) due to submarine nature of the cables. Permitting and Regulatory requirements will take significant amount of time to complete. Cables are experiencing systematic issue as opposed to single component failure. Single component repairs are costly and do not mitigate failure risk on cable system.

Estimated Cost: $183M - $203M (OH solution)

$100M for tower and foundation construction
$78M for islands and collision protection
$5M for environmental costs

Scheduled IS Date: 12/31/2022

Project Status: Engineering Procurement



BGE Transmission Zone

Supplemental Upgrade:

Transmission Relay Replacement

Problem Statement:

- Relay configurations/schemes require replacement due to reasons such as inability to support system event recording, technologies prone to mis-operations, obsolete equipment or equipment for which spares are difficult to procure, enhanced ability to comply with NERC PRC-005, etc.

Proposed Projects

- Replacing the following relay configurations/schemes in 2017 (will result in an increase in the facility ratings).
  - Erdman to Windy Edge 110507 115kV Circuit
  - Erdman to Windy Edge 110508 115kV Circuit

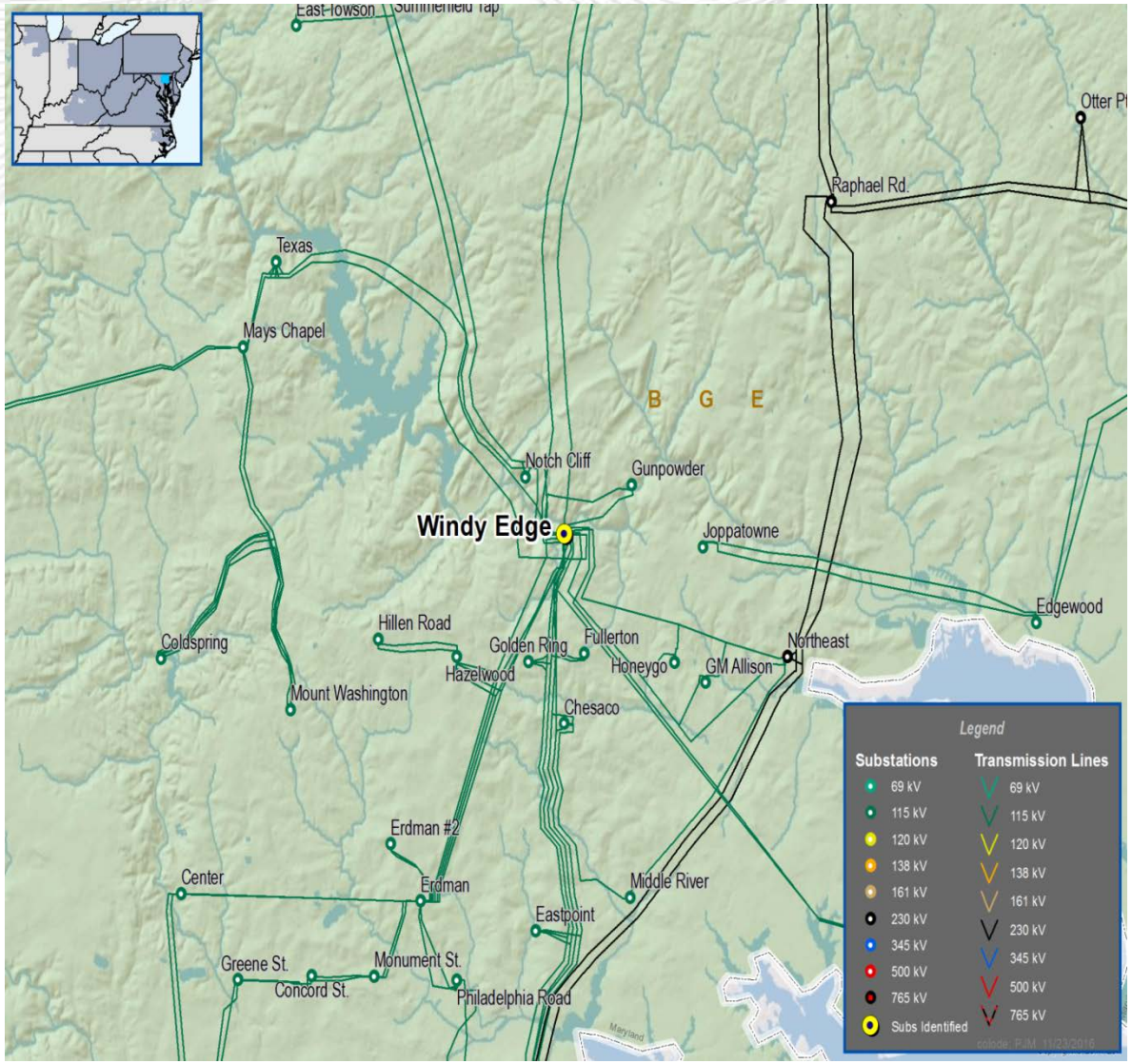
Alternatives:

- Do not address issues proactively and perform the upgrade, run to failure, repair/upgrade infrastructure when failures occur, live with existing relaying capability.

Estimated Cost: Typically around $90k per circuit

Scheduled IS Date: 12/31/2017

Project Status: Engineering Procurement



BGE Transmission Zone

Supplemental Upgrade:

Conastone to Otter Creek #2302 230 kV Line Rebuild and Protection and Communications Upgrade

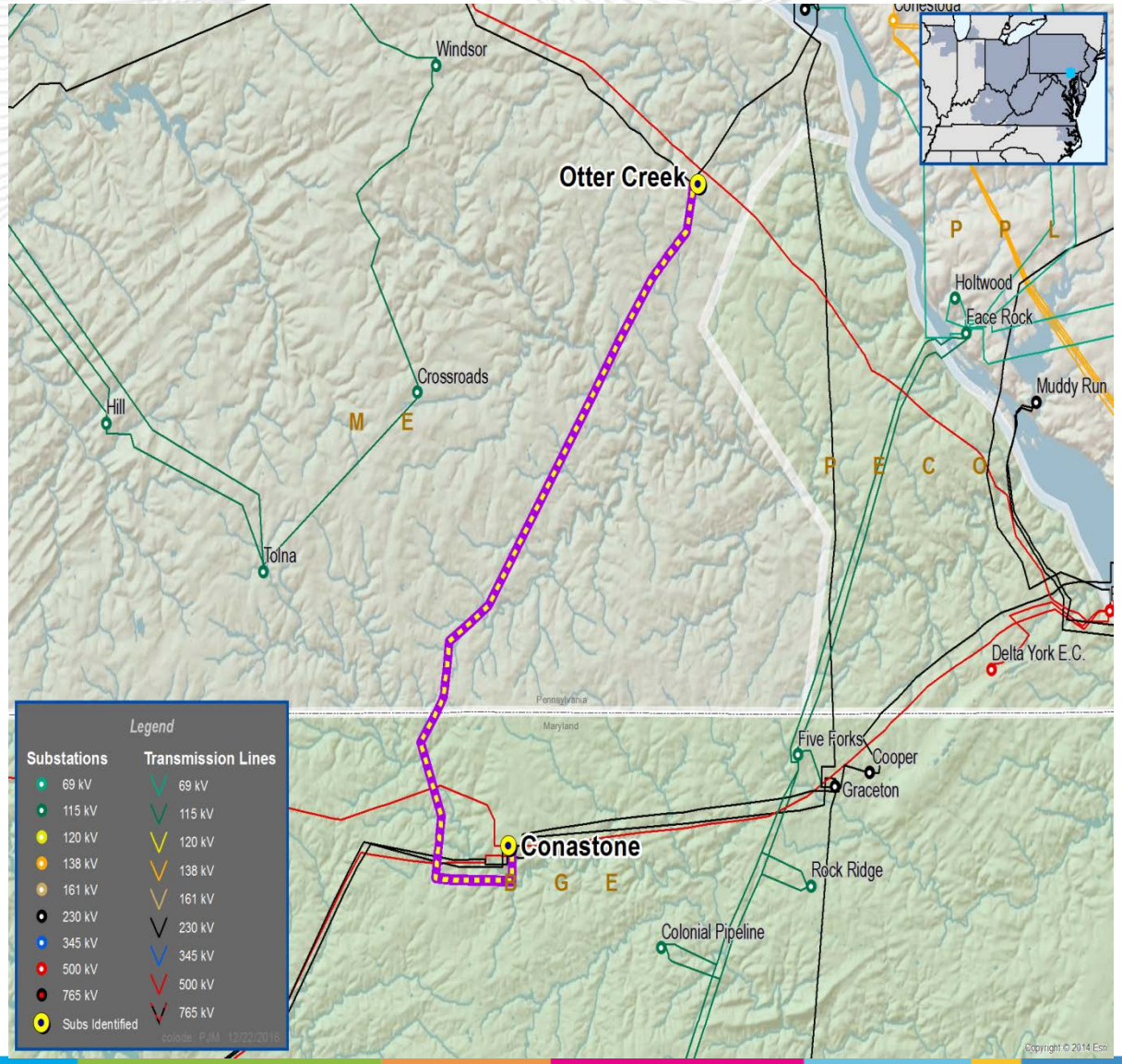
Problem Statement:

- Line #2302 is a 230 kV tie line between the BGE Conastone substation and the PPL Otter Creek Substation. The line uses a power line carrier blocking relay scheme that is currently not reliable and a frequent contributor to mis-operation(s). BGE standards call for dual pilot channels on 230 kV circuits. BGE has retired all internal PLC blocking schemes within the BGE zone and on all BGE tie lines with PEPCO in an effort to modernize the communication and protection systems.
- PPL identified this line to be rebuilt as part of supplemental project S0233 due to significant aging infrastructure concerns in their zone. To resolve this, PPL is rebuilding 12 miles of its portion of the line to 1590 ACSR, installing OPGW and upgrading relaying as part of PPL supplemental project S0233. This supplemental project is in construction and is scheduled to be completed in February 2017.
- BGE needs to address its portion of the tie line.

Potential Solutions:

- Rebuild 1.6 miles of the #2302 transmission circuit with 1590 ACSR, remove existing wave trap , replace static wire with OPGW, and install new communications and upgrade protective relaying equipment.
- Do not address issues proactively and perform the upgrade, run to failure, repair infrastructure when failures occur, retain existing relaying.

Project Status: Pending



BGE Transmission Zone

Supplemental Upgrade:

Transmission Relay Replacement (2018)

Problem Statement:

–Relay configurations/schemes require replacement due to reasons such as inability to support system event recording, technologies prone to mis-operations, obsolete equipment or equipment for which spares are difficult to procure, enhanced ability to comply with NERC PRC-005, etc.

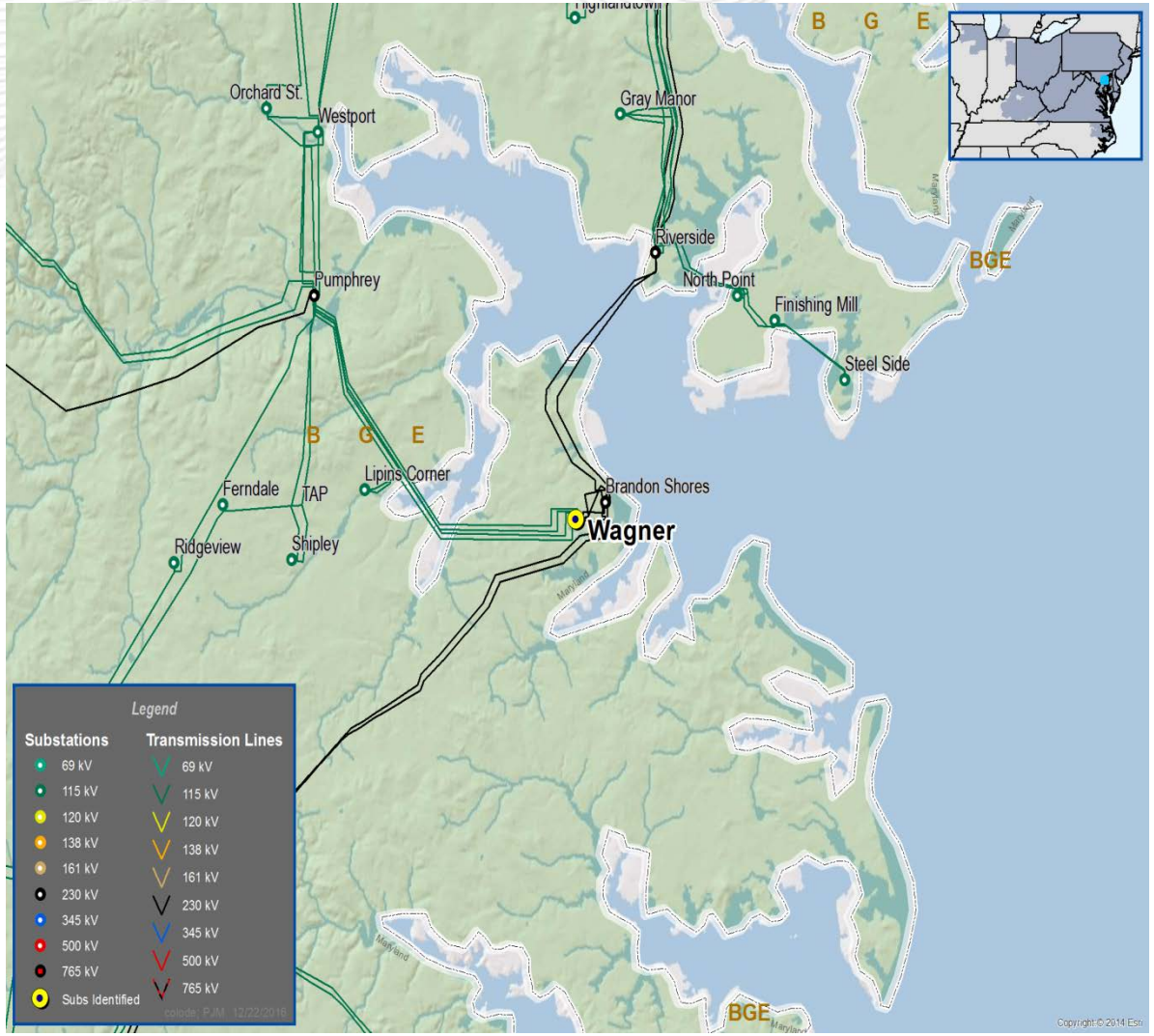
Potential Solutions

–Replacing the following relay configurations/schemes in 2018 (will result in an increase in the facility ratings).

- Wagner 230-1 Transformer
- Wagner 230-2 Transformer

–Do not address issues proactively and perform the upgrade, run to failure, repair/upgrade infrastructure when failures occur, live with existing relaying capability.

Project Status: Pending



DPL Transmission Zone

Supplemental Upgrade:

Centreville Area Reliability Improvements

Problem Statement:

- MD PSC reliability requirements for improved COMAR SAIFI and SAIDI performance in the Centreville area.

Proposed Project:

- **New Carville Substation (138/25 kV)**
  Construct a new 138/25 kV Carville Substation with one new 138/25 kV 37.6 MVA transformer and room for an additional 138/25 kV transformer in the future. Install a four position 138 kV ring bus at the new 25 kV substation with room for ultimate six (6) position 138 kV ring bus configuration in the future for capacitor bank installation. New substation would be on circuit 13723, approximately 1.4 miles north of Centreville substation.

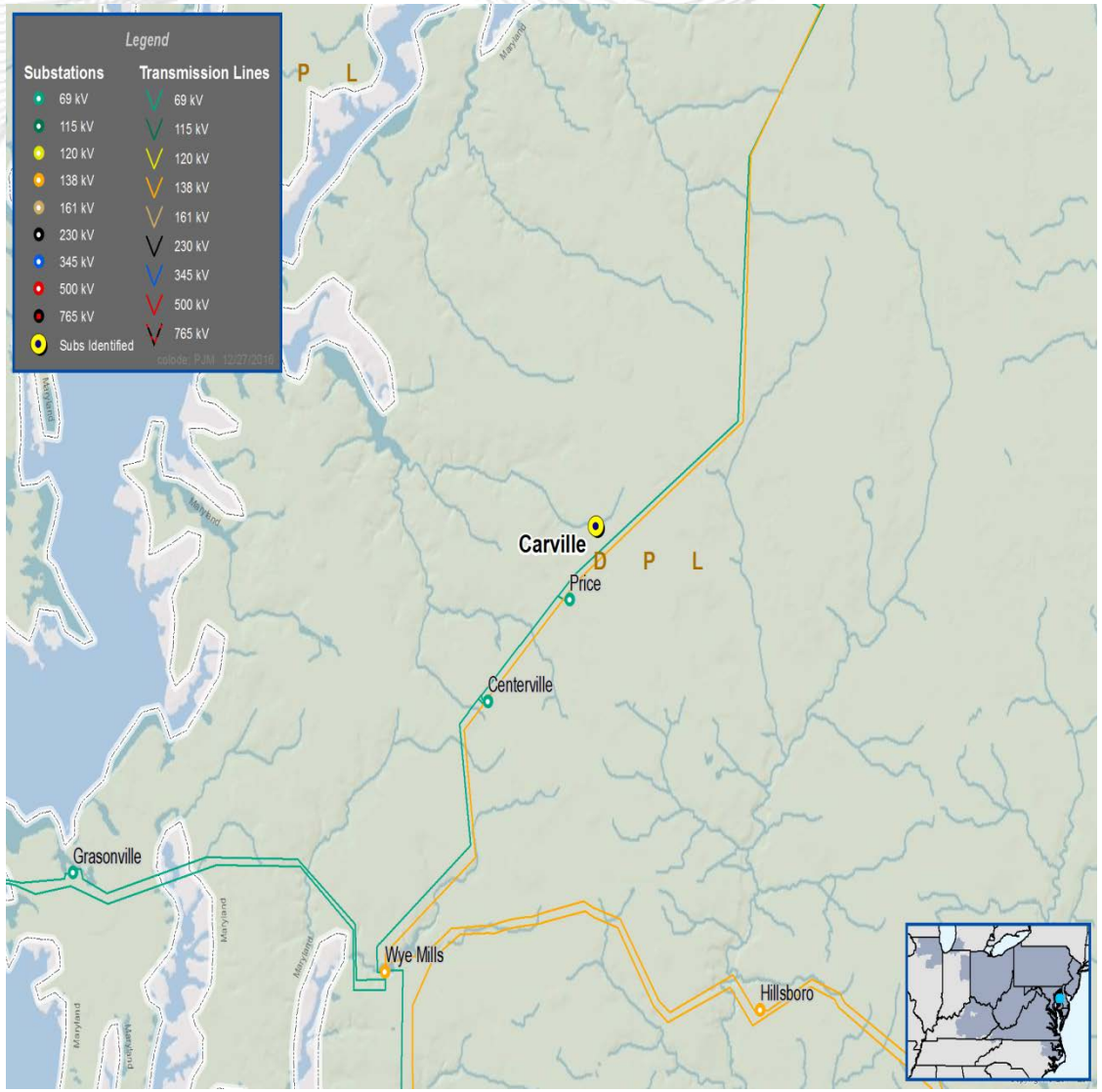
Alternatives:

- Continue to conduct reactive reliability improvements on the system, basing the work locations on past outages.
- Underground the entire backbone of local feeders (would result in more expensive project).

Estimated Cost: $5.4 M

Scheduled In Service Date: 12/31/2018

Project Status: Design & Engineering



DPL Transmission Zone

Supplemental Upgrade:

Salisbury Area Reliability Improvements

Problem Statement:

- MD PSC reliability requirements for COMAR SAIFI and SAIDI performance in the Salisbury area.

Proposed Project:

- Combined solution:
- **Hebron Substation 69 kV Upgrade**
  - Rebuild the Hebron Substation as a 69/25 kV substation that can accommodate one new 69/25 kV 28 MVA transformer and two new 69 kV high-side breakers, with ultimate three breaker configuration. Hebron substation is on circuit 6708.
- **Beaglin 69/25 kV New Substation**
  - New substation tied into circuit 6726 (North Salisbury – Mt. Hermon)
- **Fruitland Substation Transformer Replacement**
  - Replace a 1969 vintage 38MVA 69/25 kV transformer with a 56MVA transformer due to age and poor condition.

Alternatives:

- Continue to conduct reactive reliability improvements on the system, basing the work locations on past outages.
- Underground the entire backbone of local feeders (would exceed the available budget).

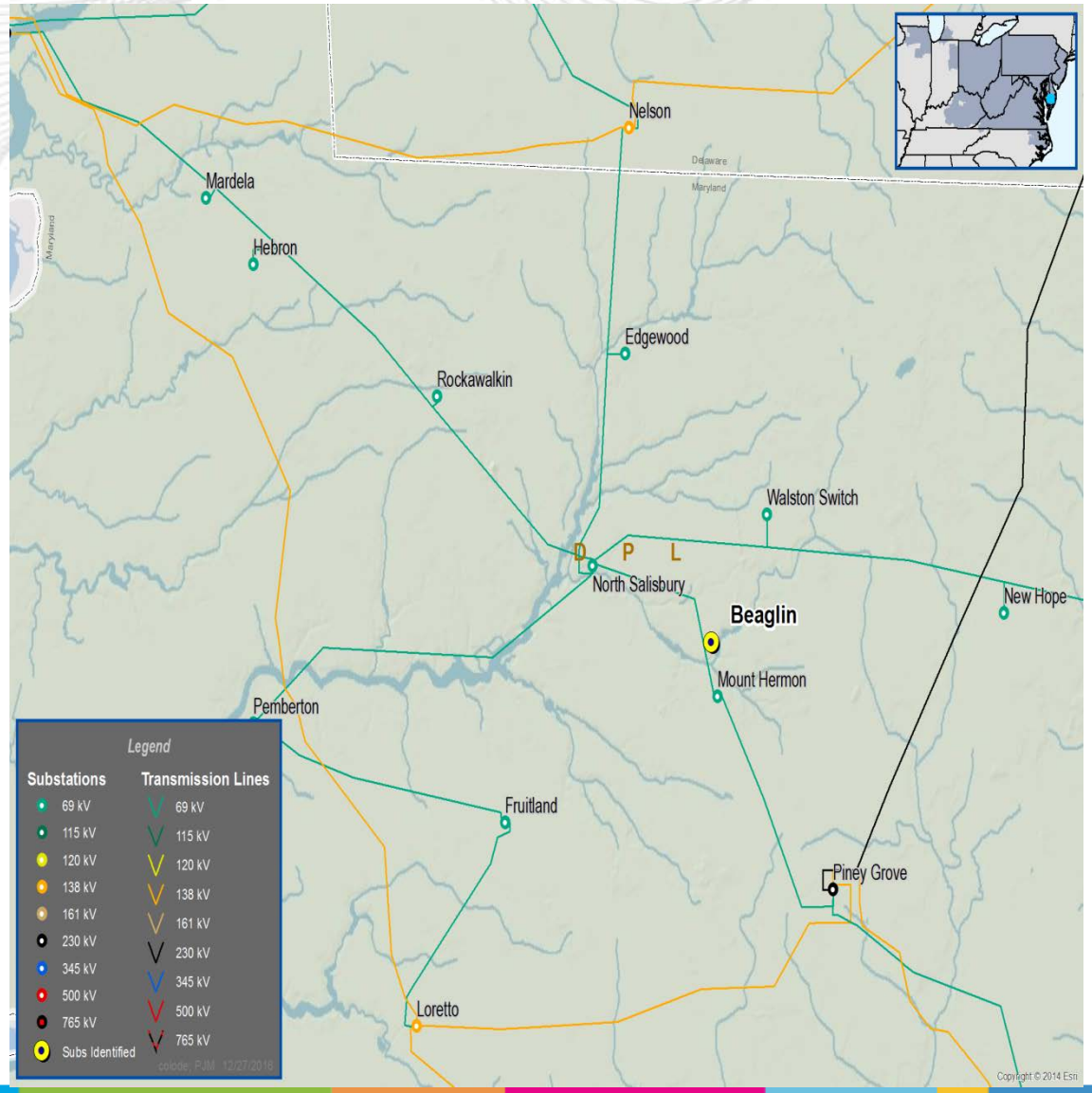
Estimated Costs:

- Hebron: $3.3 M
- Beaglin: $11.5 M
- Fruitland: $2.15 M

Scheduled In Service Dates:

- Hebron: 5/31/2019
- Beaglin: 5/31/2020
- Fruitland: 5/31/2020

Project Status: Design & Engineering



Supplemental Upgrade:

Midway Substation Reliability Improvements

Problem Statement:

- Currently, Midway substation is tapped off of Line 6751, and any fault on the line will result in the loss of the station. Recurring extended outages have occurred in recent years. Additionally, anticipated future feeder overloads exist on the distribution system (2018 Summer OL of 3% on Midway DE0510).

Proposed Project:

- **Midway Substation: 69 kV Line Bus Upgrade**
  Add a second transformer, which requires a new line position and line bus configuration. Reconfigure the present 69 kV tap at Midway Substation to be a three-breaker line bus. Split the 6751 transmission line into two lines: from Rehoboth to Midway and from Midway to Five Points.

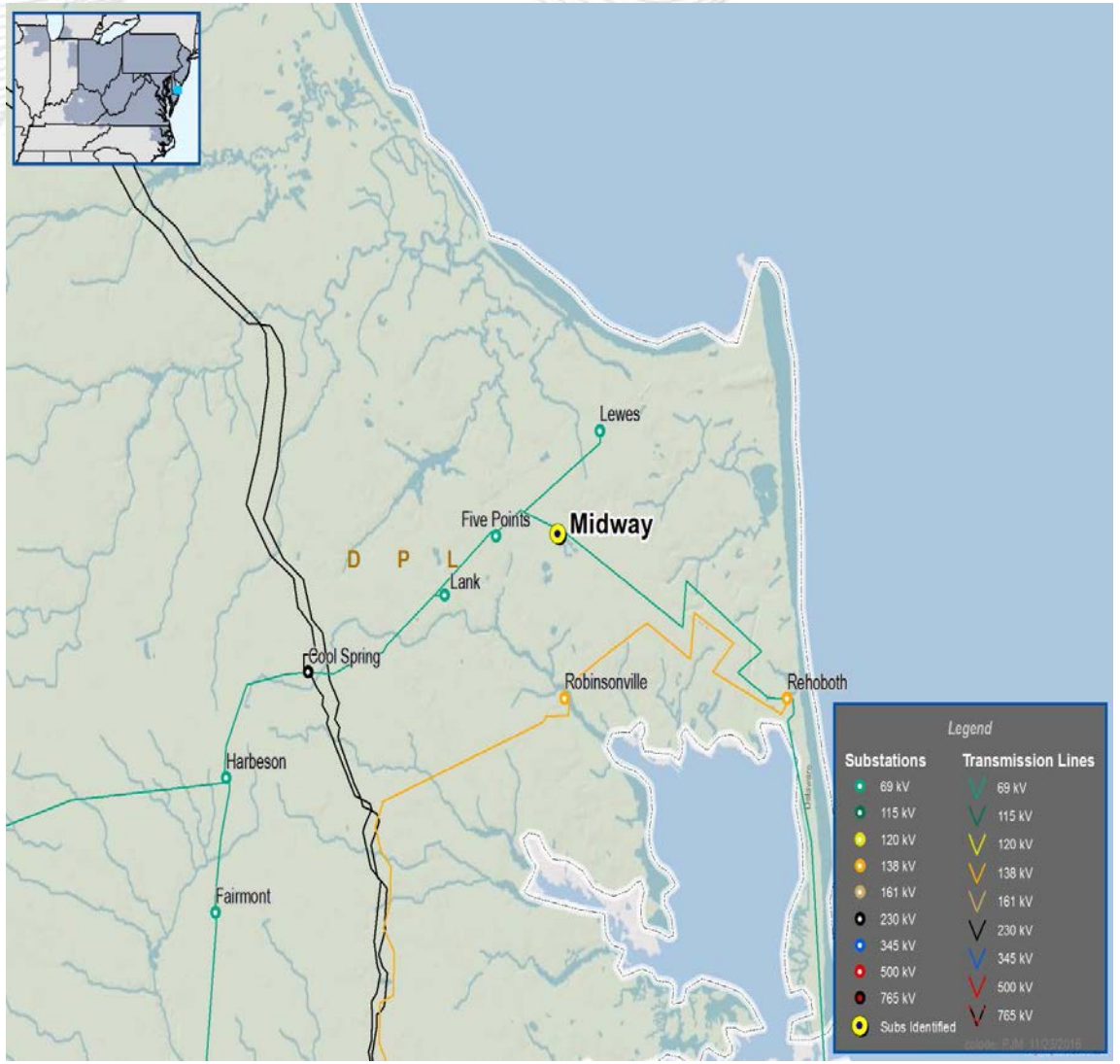
Alternatives:

- Leave the substation as a tap off of Line 6751, which would not improve the reliability and service to Midway Substation. A forced outage on Line 6751 would result in a loss of both transformers at Midway substation with no ability to sectionalize and restore service without restoring all of Circuit 6751.
- A ring bus would further improve the sectionalizing capability along the existing Line 6751 (not enough space available).

Estimated Cost: $2.7 M

Scheduled In Service Date: 5/31/2018

Project Status: Design & Engineering



PECO Transmission Zone

Supplemental Upgrade:

Add 3rd 230-13 kV Transformer at Post Substation

(Distribution System Project)

Problem Statement:

- Maintenance of Eddystone 138 kV bus section #2 followed by outage of Chichester 230-138 kV #9A/B transformer overloads Eddystone 138-69 kV transformer and Eddystone-Paper Tap 69 kV line
- Blueball 69-13 kV distribution substation will need major repair/maintenance work in near future

Proposed Project:

- Install 3rd 230-13 kV transformer at Post Substation, move load from Blueball substation to Post substation and retire Blueball substation

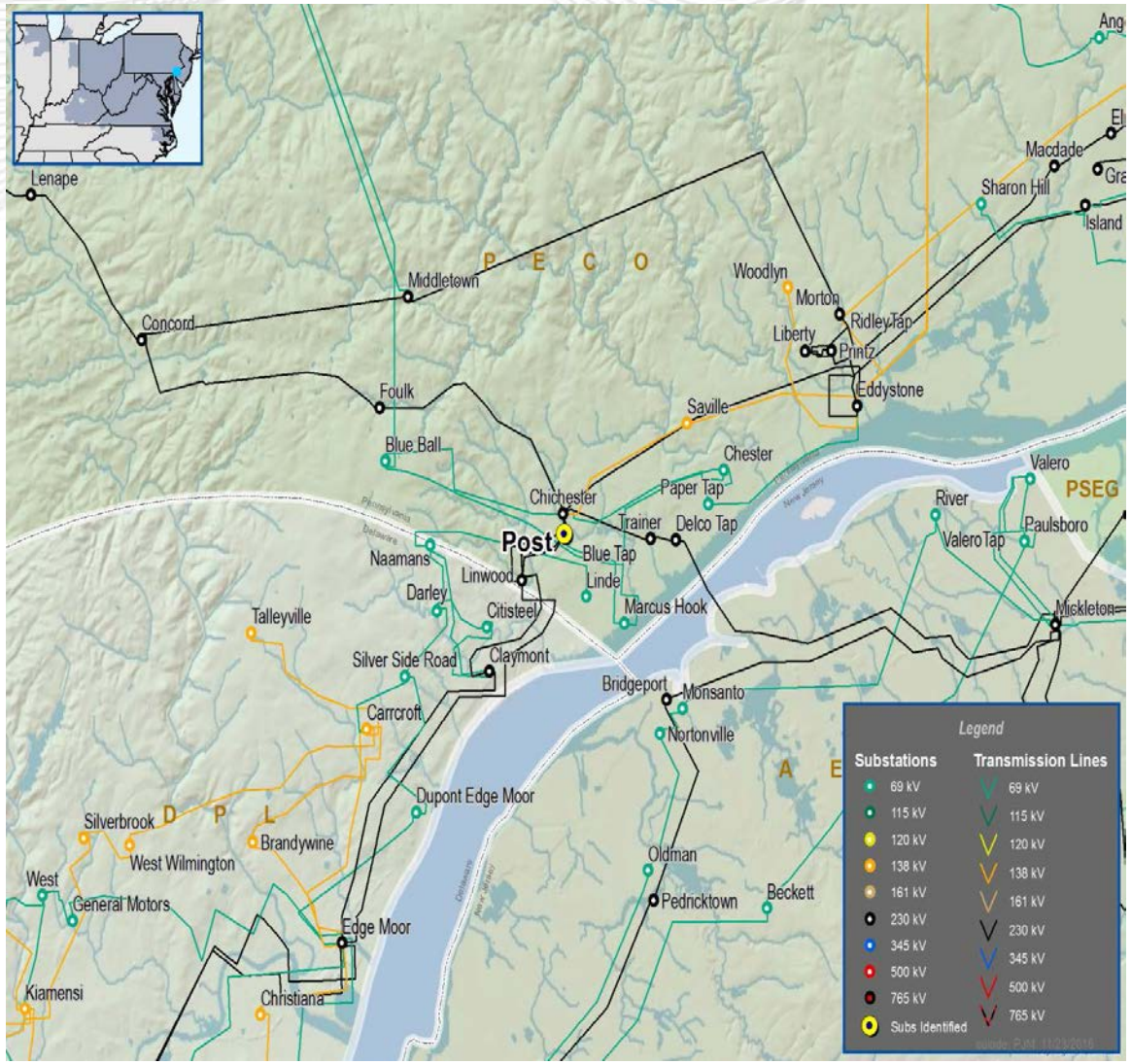
Alternative:

- Replace the Eddystone 138-69 kV transformer, replace aerial and underground portions of the Eddystone-Paper Tap 69 kV line, and upgrade Blueball 69-13 kV distribution substation

Estimated Cost of Proposed Solution: $8M (90% distribution)

Scheduled In-Service Date: 6/1/2019

Project Status: Conceptual



PenElec Transmission Zone

Supplemental Upgrade:

- Construct Trade City 115 kV Ring Bus

Problem Statement:

- **Reliability:** Reduce customer exposure and load loss due to outages (more than 25 MW load at risk); To provide continuity of supply by eliminating simultaneous outages to two or more network elements.
- **Operational Performance:** Improve operational switching capabilities. There have been 23 outage over the last three years.

Proposed Solution:

- Trade City 115 kV Substation: Construct a 115 kV ring bus.

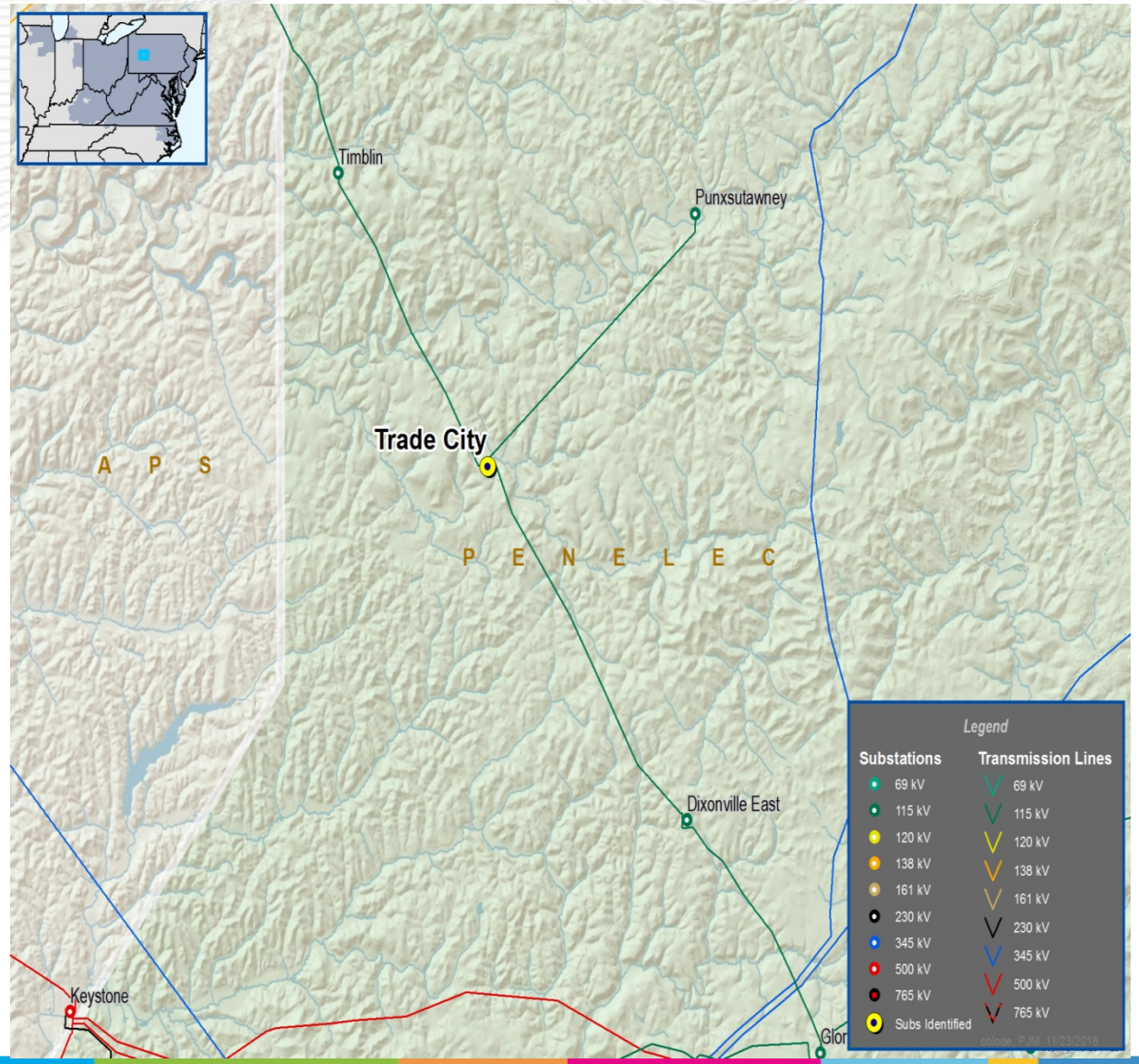
Alternatives:

- Construct 8 miles of new 115 kV line to Punxsutawney – ($22 M)

Estimated Project Cost: $ 7 M

Projectedl IS Date: 12/31/2017

Project Status: Engineering and Planning



PPL Transmission Zone

Supplemental Upgrade:

- Rebuild Hauto-Frackville #3 69kV line to double circuit

Problem Statement:

- To address asset health issue due to 80+years old lattice towers and 60+years old wood poles that are well beyond intended service life.
- To improve resiliency for the area by providing two line supply
- To address lacking of backbone fiber path between Siegfried Substation and Frackville Substation
- To provide better flow balance for Type B distribution substation

Proposed Solution:

- Rebuild 26.3 miles of Hauto-Frackville #3 69kV line, including most of main line and tap lines. Install 5.1 miles of fiber on the section of Hauto-Frackville #3 Line that is not scheduled for rebuild.
- Retire 0.9 mile of Hauto-Frackville #1 69kV Line that is aged and becomes functionally obsolete.
- Replace existing switches with MOLBABs, install new MOLBABs to enhance sectionalizing capability

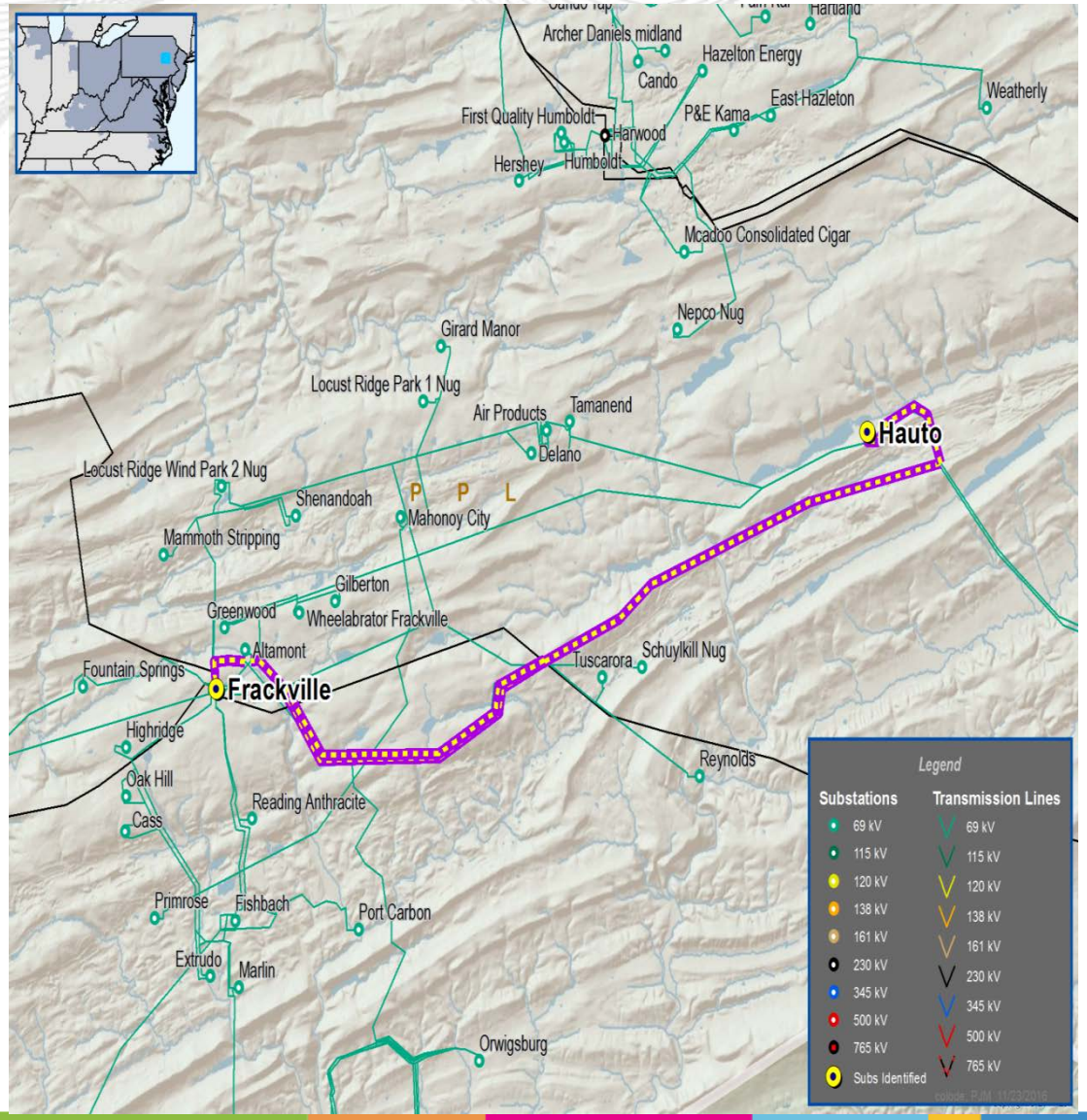
Alternatives:

Rebuild a 4.8 miles section of Frackville-Shenandoah 69kV Line in lieu of a 3.2 miles section of Hauto-Frackville #3 Line. This alternative provides better flow balance for Type B distribution substation, but requires rebuilding line that was newly rebuilt in 2011 and longer in length. Estimated Cost → $67.4 M

Estimated Project Cost: *$57.8 M*

Projected IS Date: 12/31/2020

Project Status: Planning



PSEG Transmission Zone

Supplemental Upgrade:

- Replace Brunswick 220-4 Transformer (S1096)

Problem Statement:

- The 230kV expansion project requires the existing 220-4 transformer
- position must be relocated.

Proposed Solution:

- Replace Brunswick 220-4 , 230/69 kV transformer . (S1096)
- The new transformer will have a life cycle of 40 years.
- The existing transformer meets standards from the 90's and will be kept for use as a capital spare for all older 230/69kv banks of this type for which we currently have 6 in service.

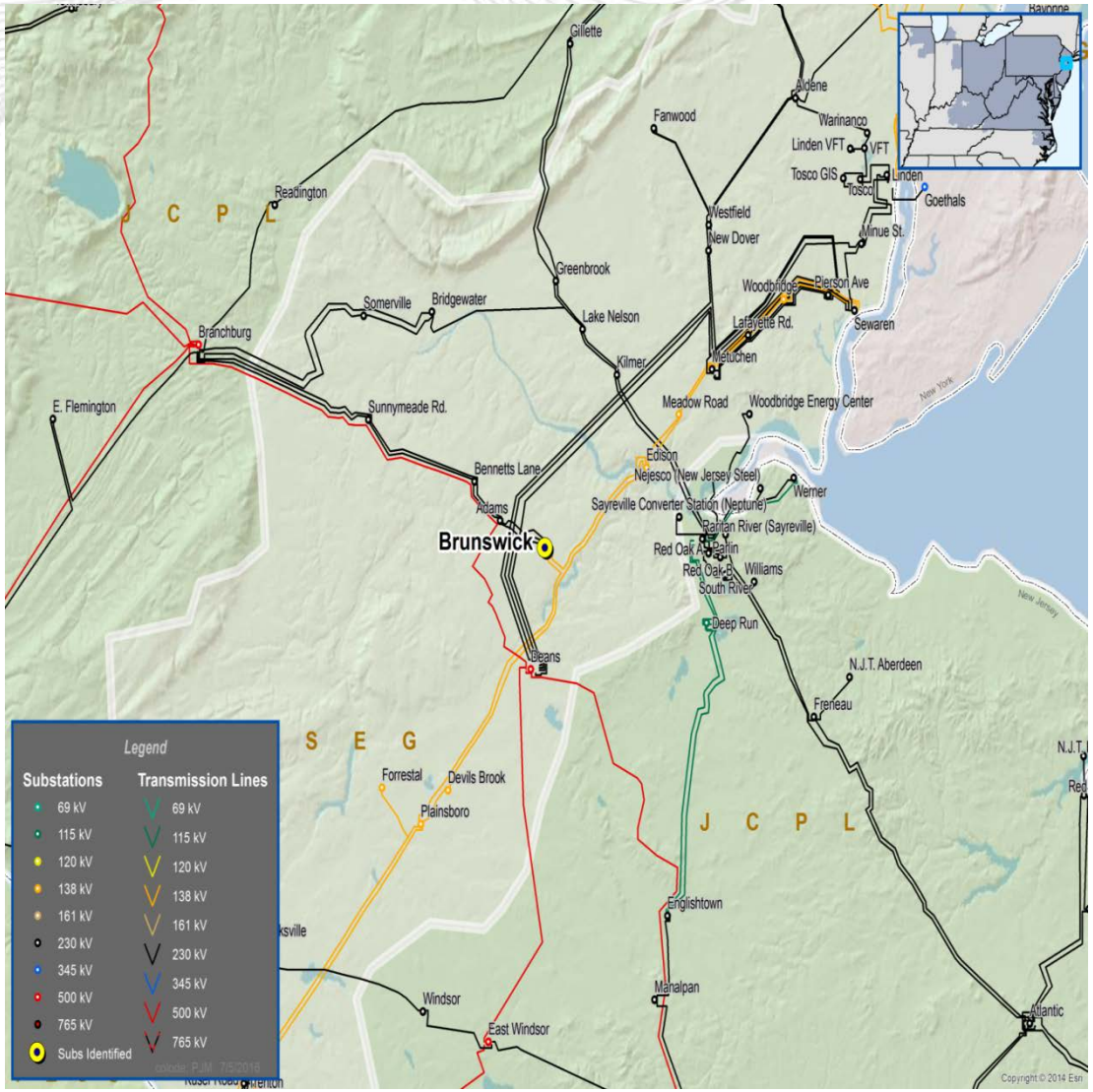
Alternatives:

- Relocate the 26 year old transformer
  - Use of the existing transformer will provide only 14 years of life to the 220-4 position. Provide spare for similarly sized transformer (system requirement) . Estimated Project Cost: $7.4M

Estimated Project Cost: $8 M

Projected IS Date: 6/15/2018

Project Status: Study Stage



PSEG Transmission Zone

Supplemental Upgrade:

- Replace Bustleton 230-13 kV transformers (S1178)

Problem Statement:

- Bustleton T1 and T2 transformers are approaching the end of life based on our Condition Assessment and our transformer Life Cycle Strategy. In addition a review of industry data in our risk model indicates probability of failure is increased based on manufacturer.
- These transformers have a history of nitrogen leaks, frequent tap changer operations and a bushing failure.

Proposed Solution:

- Replace Bustleton T1 and T2 with transformers recently removed from service leveraging existing assets. Replaced transformers have higher MVA ratings. (S1178)

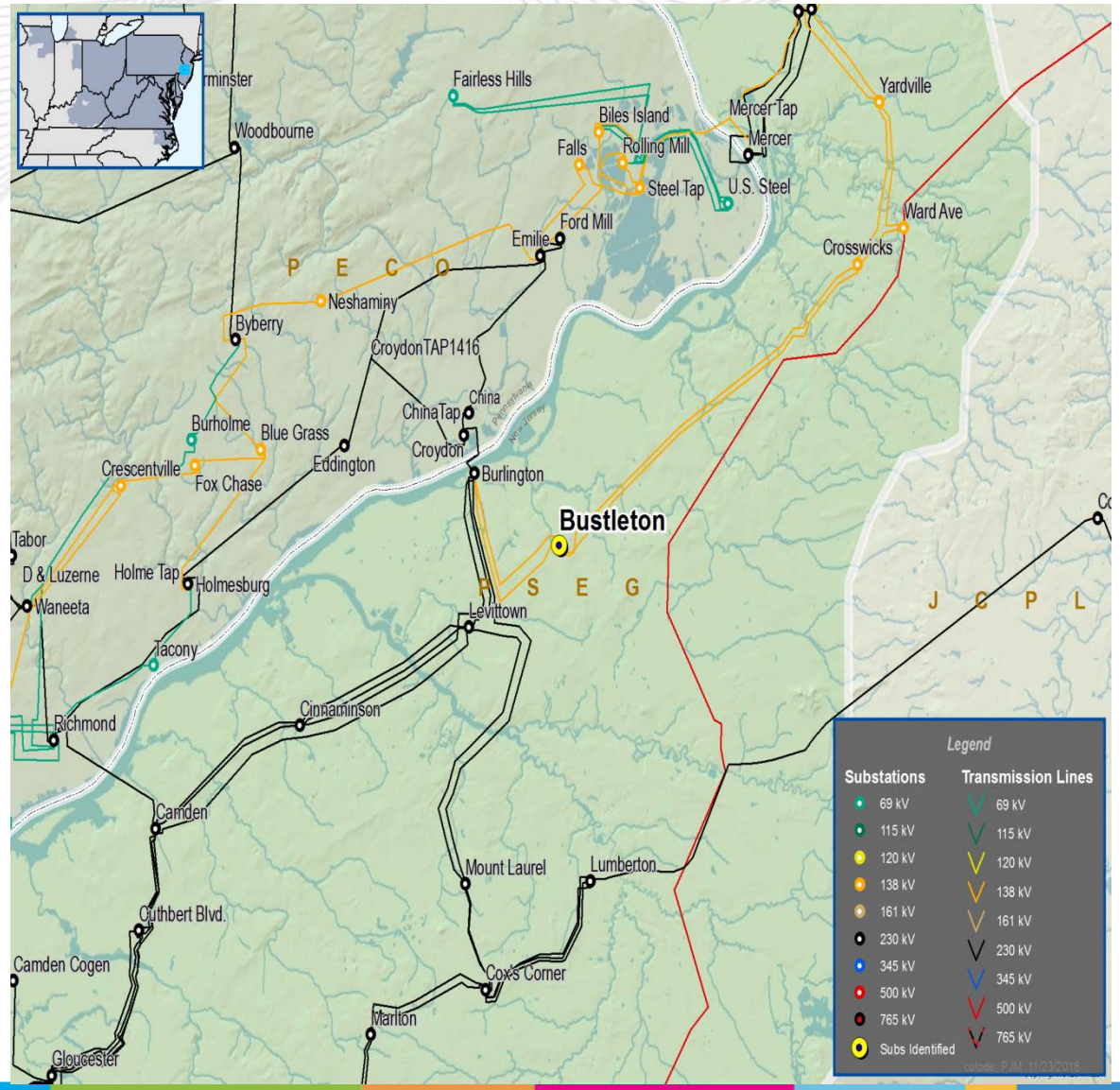
Alternatives:

- Purchase New Transformers providing 40 years of service. Estimated Project Cost: $9.8M.
- Life extension was considered. While this addresses the cooling system and dielectric condition of the oil, it does not address the electrical dielectric integrity and thermal performance of the transformer which progressively worsens. Estimated Project Cost: $3 to 5M

Estimated Project Cost: $ 7.8 M

Projected IS Date: 12/31/2019

Project Status: Study Stage



PSEG Transmission Zone

Supplemental Upgrade:

- Replace Trenton 138-26-11 kV , 132-1, 2 and 3 transformers (S1179)

Problem Statement:

- Trenton Transformer 132-1, Transformer 132-2 and Transformer 132-3 are approaching the end of life based on our Condition Assessment and our transformer Life Cycle Strategy.
- These transformers have a history of high Doble winding PF, high water content, and high combustible gas content.

Proposed Solution:

- Replace Trenton 138/26/11 kV 132-1, 132-2 and 132-3 transformers in accordance with PSE&G's Transmission Life Cycle standards. (S1179)

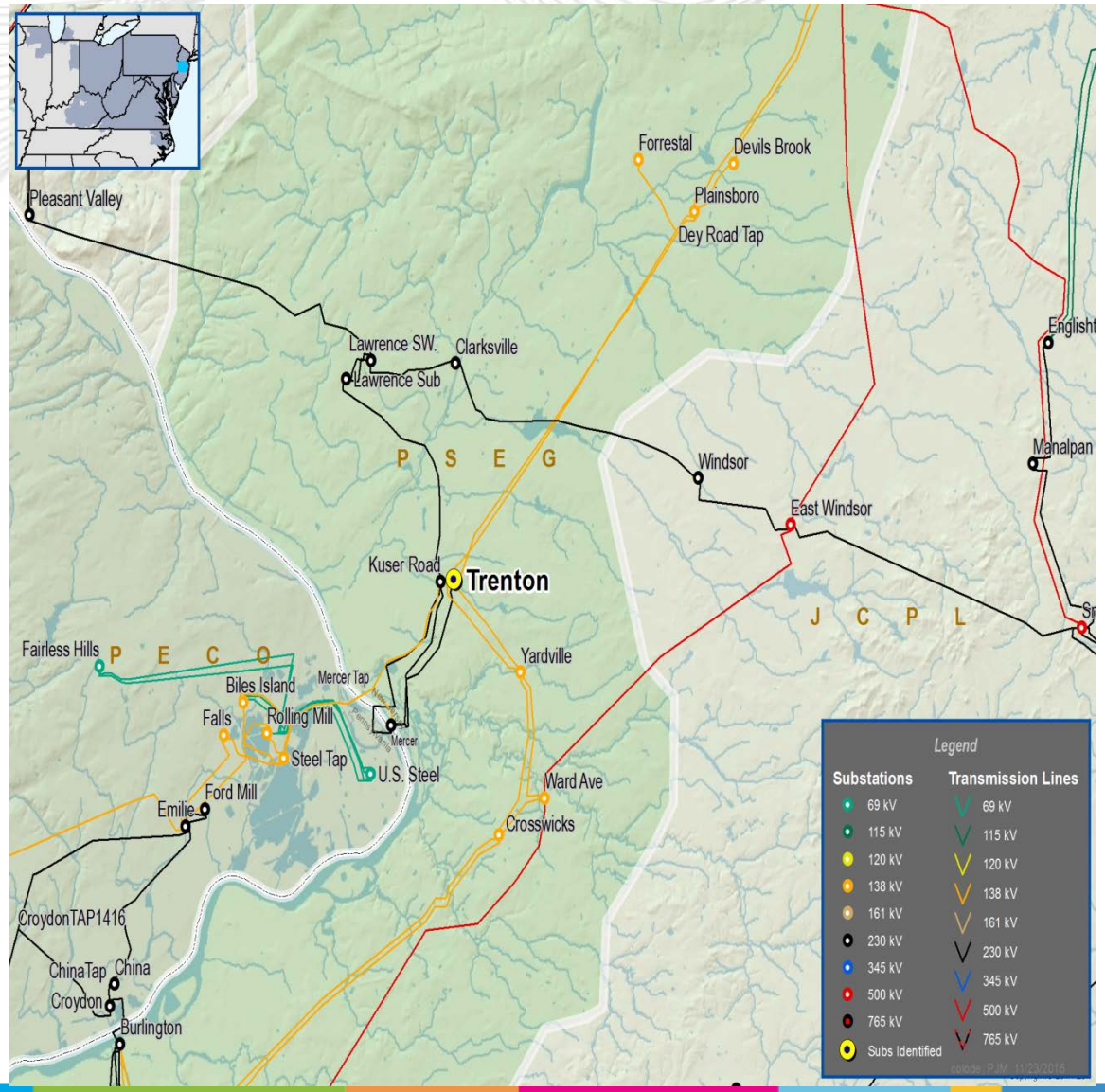
Alternatives:

- Life extension was considered. While this addresses the cooling system and dielectric condition of the oil, it does not address the electrical dielectric integrity and thermal performance of the transformer which progressively worsens.

Estimated Project Cost: $ 36 M

Projected IS Date: 12/31/2020

Project Status: Study Stage



PSEG Transmission Zone

Supplemental Upgrade:

- Replace Trenton 230-138 kV , 220-2 transformer (S1183)

Problem Statement:

– The transformer is approaching the end of life based on our Condition Assessment and our transformer Life Cycle Strategy.

Proposed Solution:

– Replace Trenton 230/138 kV , 220-2 transformer in accordance with PSE&G's Transmission Life Cycle standards. (S1183)

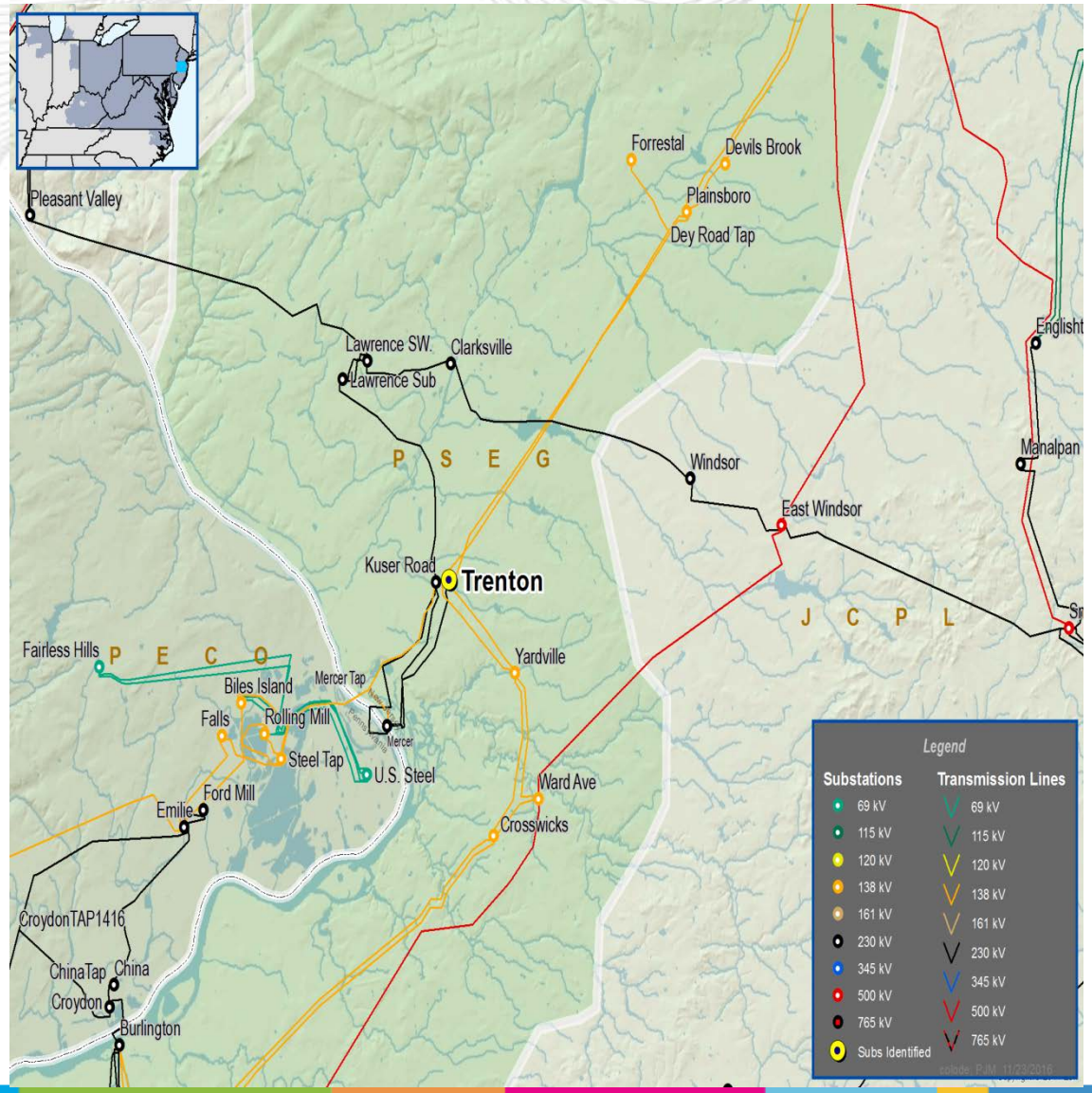
Alternatives:

– Life extension was considered. While this addresses the cooling system and dielectric condition of the oil, it does not address the electrical dielectric integrity and thermal performance of the transformer which progressively worsens.

Estimated Project Cost: $ 12 M

Projected IS Date: 12/31/2019

Project Status: Study Stage



PSEG Transmission Zone

Supplemental Upgrade:

- Purchase Spare 138-69kV Transformer

Problem Statement:

– Absence of a spare for this transformer. The minimum requirement is to maintain one (1) spare in stock as the in-service population.

Proposed Solution:

– Purchase 250MVA, 138-69kV spare transformer . The transformer can also serve as a spare at 3 other locations. (S1181)

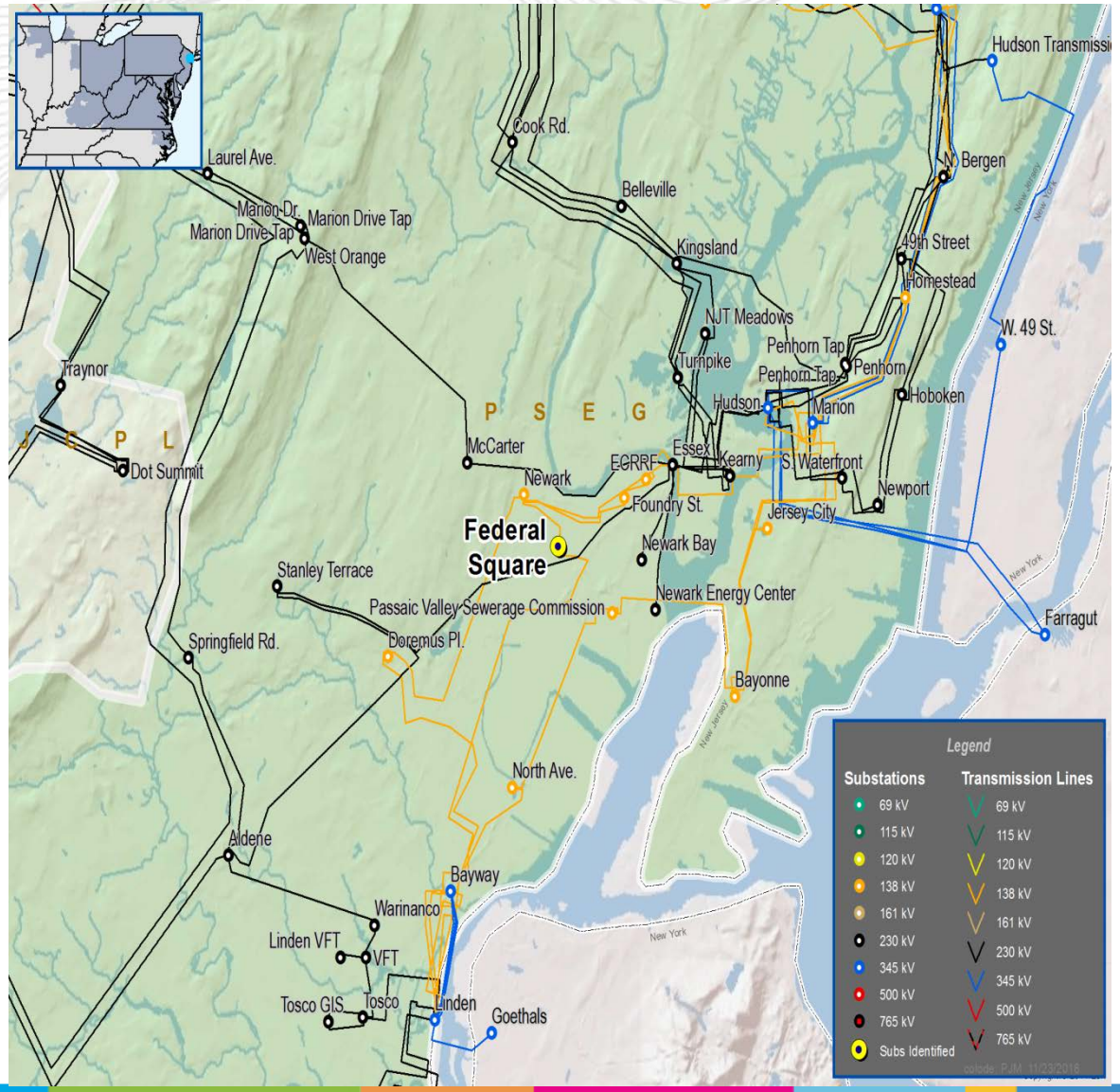
Alternatives:

– Accept the risk associated with operating with limited replacement options that potentially compromises PSE&G's reliability and ability to adhere to prevailing requirements and industry standards. Lead times associated with securing and replacing a similar unit in the event of a failure is or could be extensive.

Estimated Cost: $ 3.3 M

Projected IS Date: 3/31/2018

Project Status: Study Stage



PSEG Transmission Zone

Supplemental Upgrade:

- **Purchase Spare Power 230-26kV Transformer**

Problem Statement:

– There is presently only one (1) system spare. The minimum requirement is to maintain two (2) spare in stock as the in-service population.

Proposed Solution:

– Purchase 72/96/120MVA, 230/26 kV Spare Power Transformer for spare inventory to support the forty-two (42) In-Service 230-26kV transformers in the system. (S1182)

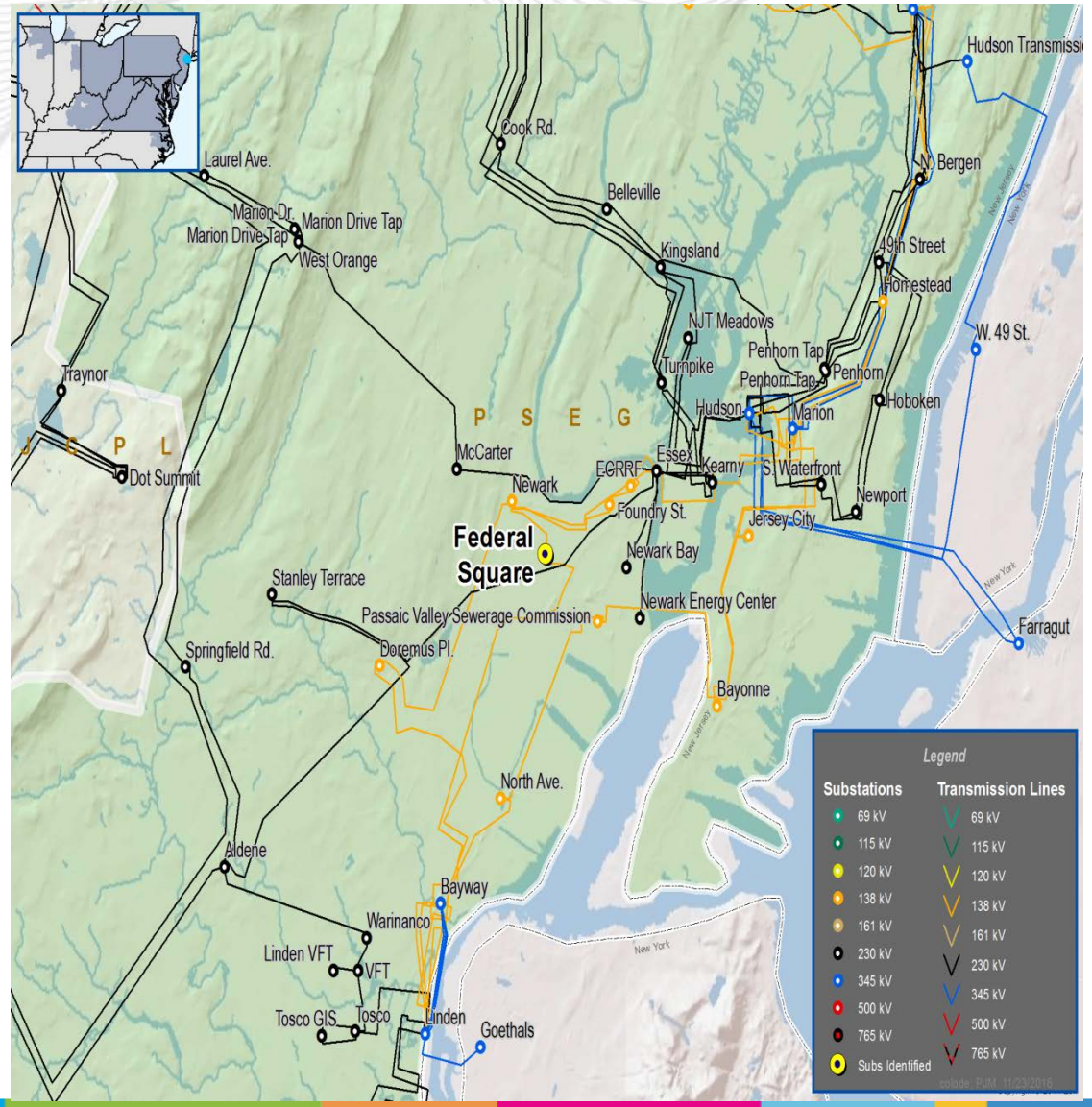
Alternatives:

– Accept the risk associated with operating with limited replacement options that potentially compromises PSE&G's reliability and ability to adhere to prevailing requirements and industry standards. Lead times associated with securing and replacing a similar unit in the event of a failure is or could be extensive.

Estimated Cost: $ 2.6 M

Projected IS Date: 4/30/2018

Project Status:



PSEG Transmission Zone

Supplemental Upgrade:

- **Linden Overstressed 138kv breakers**

Problem Statement:

- In response to recent natural disasters like Sandy, PSE&G is implementing several resilient initiatives (s0644) including Linden 138 kV switchyard, as a result the existing Linden 138 kV breakers 1APA and 2BPB are overstressed..

Proposed Solution:

- Re-route, Re-conductor and bundle with two conductors, to provide rated power flow of 600 MVA, and enter via one line U-1347 into the switchyard via one uprated 80 kA breaker 2BPB to avoid stuck breaker scenario.
- PSEG Power design includes series reactor near generators.

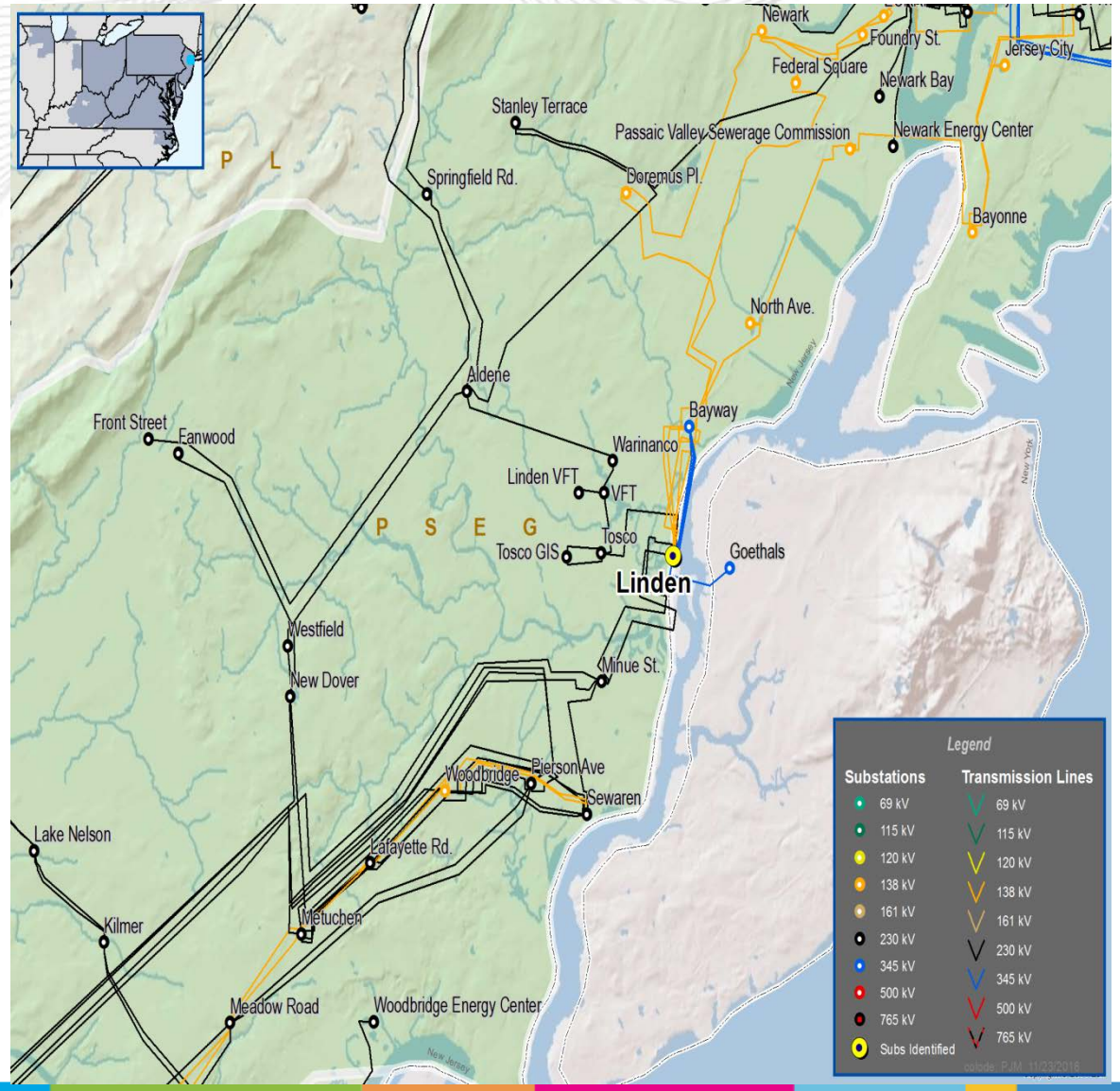
Alternatives:

- An alternative is to replace three generator-side breakers, along with two overstressed breakers 1APA and 2BPB. Estimated Project Cost: $15M

Estimated Cost: $ 10.9 M (Cost Responsibility of PSEG Power)

Projected IS Date: 12/31/2018

Project Status: Study Stage



PSEG Transmission Zone

Supplemental Upgrade:

- Build 13 kV Stanley Terrace Class H substation with two 230/13kV Transformers (S1241)

Problem Statement:

– Metalclad switchgear approaching 70 years old has cause station performance metrics to drop below acceptable standards. Vauxhall and Hillside have been in service for 70 plus years, the metal enclosure are decaying to the point where water is able to get into energized bus during heavy rain storms and extreme temperature inversion. These stations are 4kv distribution islands and with loads under 15MVA. It is more cost effective to covert these customer to 13kv self-healing loops

Proposed Solution:

– Building Stanley Terrace class H substation station will enable conversion of the . Vauxhall and Hillside stations and of station in the area with similar aging characteristic. Initially we will establish this new station and create interstation tie points and self-healing loop schemes. These loops will tie Doremus Place Substation to Stanley Terrace station using two circuit from each location. These circuits will convert customer to a 13kv supply and provide automatic reclosing schemes. Improving customer performance. (S1241)

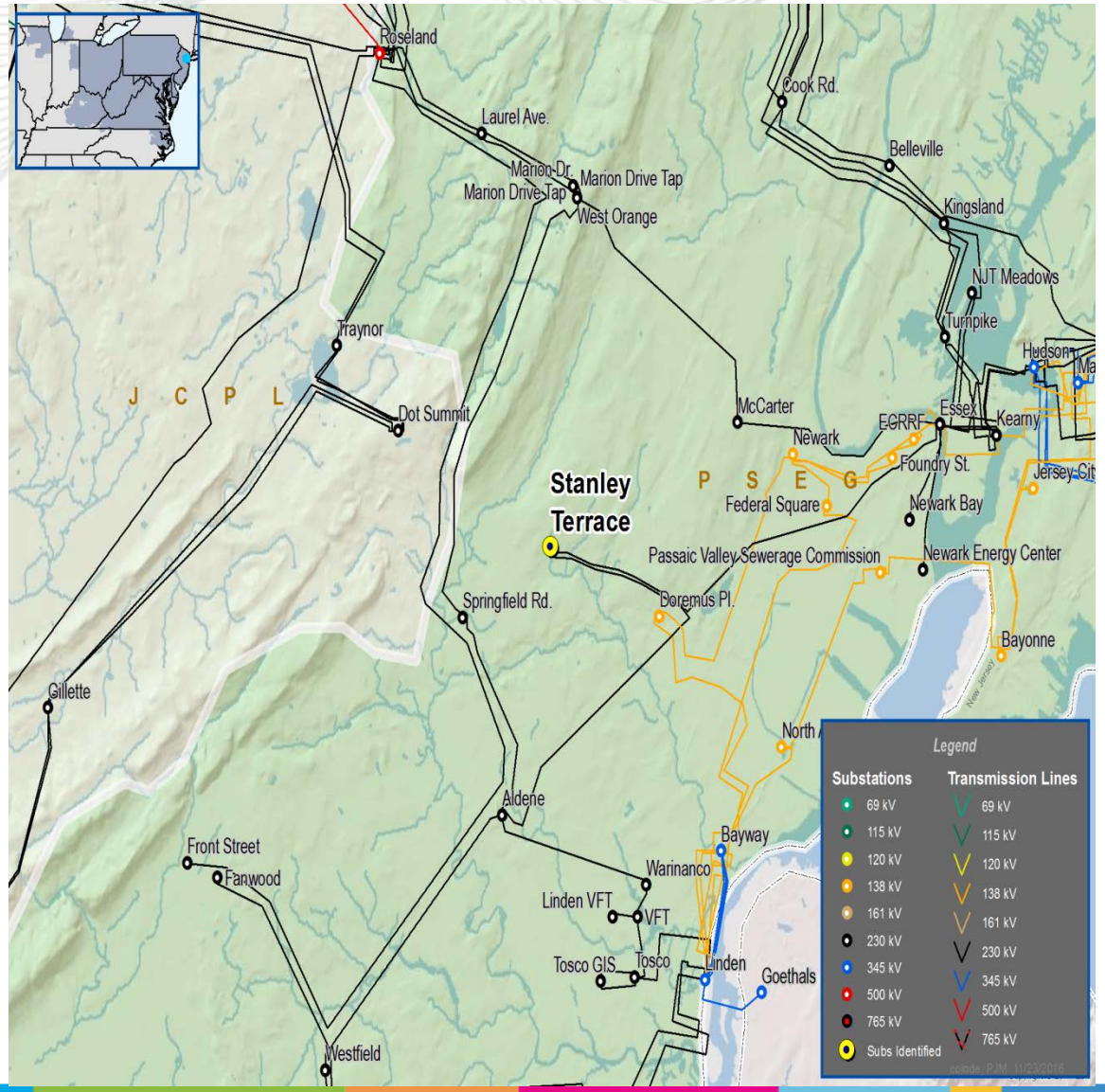
Alternatives:

– Continue to operate the stations as-is with incremental upgrades. Rebuild the 4kV metal clad equipment and modernize 26kv breakers. Estimated Project Cost: >$35M each

Estimated Cost: $20.7M

Projected IS Date: 5/1/2018

Project Status: Study Stage



UGI Transmission Zone

Supplemental Upgrade:

- Huntsville 66/13.8kV Substation Expansion

Problem Statement:

– Need to accommodate a second 66/13.8kV distribution transformer planned to support load growth, enhance 13.8kV tie-line/sectionalizing options and to guard against single transformer outages.

Proposed Solution:

– Install two additional 66kV breakers (1- line terminal breaker and 1-bus tie breaker) and rearrange the current 66kV configuration to accommodate the addition/connection of the new transformer.

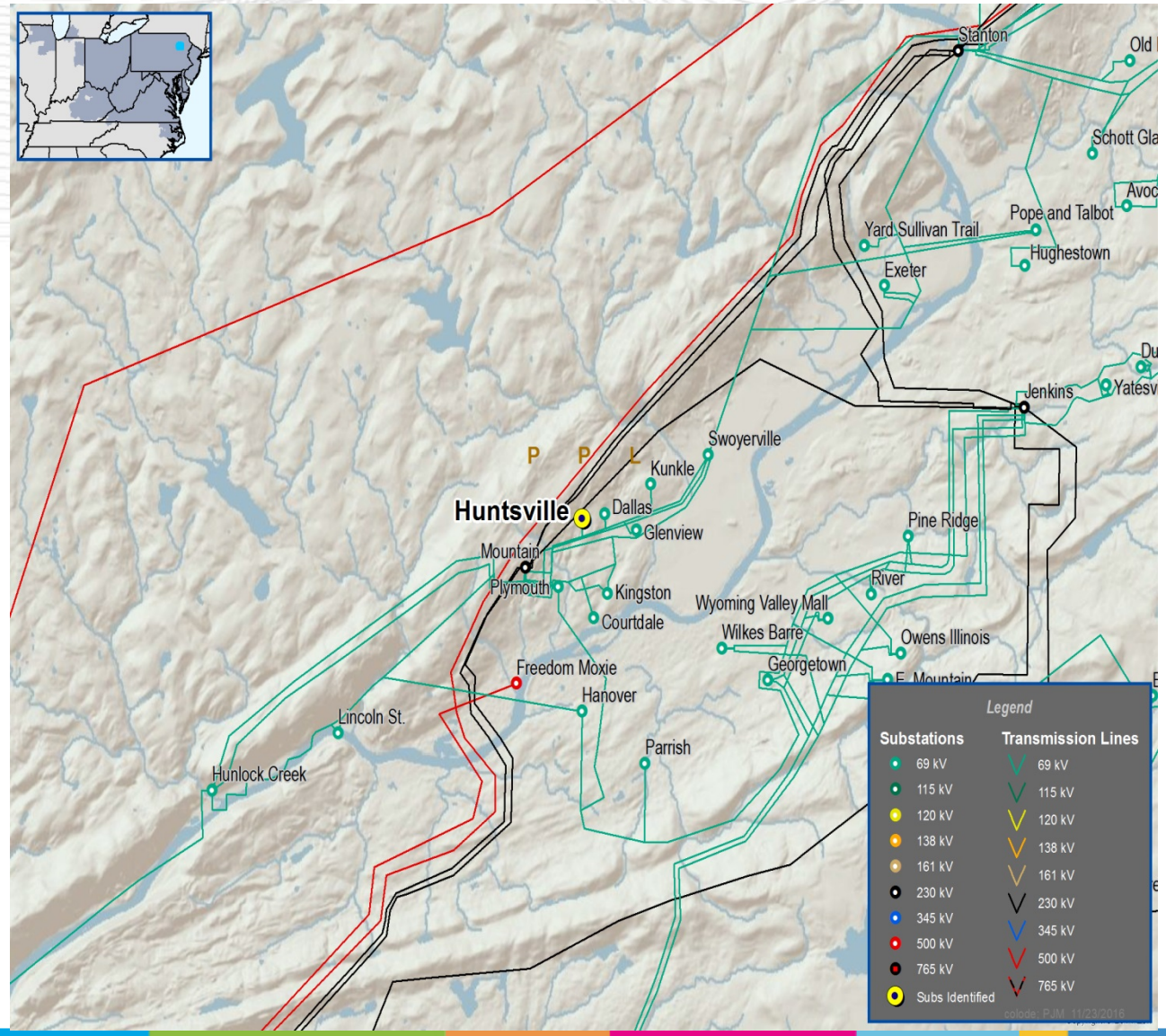
Alternatives:

– Tap transformer off existing line without breaker additions.

Estimated Cost: $0.20M

Projected IS Date: 06/01/2017

Project Status: Under Construction



Questions?

Email: RTEP@pjm.com

Revision History

12/30/2016 – Original version posted to PJM.com

01/03/2017 – V1 – removed PSEG slide #34, modified PSEG supplemental slides (35, 36, 37, 38, 39, 40, 41, 42, 43 and made minor changes to some slides. Replaced several maps.