



Reliability Analysis Update

Transmission Expansion Advisory
Committee

December 13, 2018

- 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 RTEP Analysis Update

15 Year Analysis Results



15 Year Analysis Result for 2018 RTEP

2018 RTEP 15 Year Analysis - Single Result

| Fr Bus | Fr Name | To Bus | To Name | CKT | KVs | Areas | 100% Year | Comment |
|--------|---------------------|--------|--------------------------|-----|---------|----------|-----------|--------------------------|
| 219110 | GLOUCESTER | 219755 | CUTHBERT | 1 | 230/230 | PSEG | 2023 | Due to Suspended Gen |
| 224001 | BLUE PLAINS (23107) | 224004 | POTOMAC RIVER(station C) | 1 | 230/230 | PEPCO | 2024 | Glebe related |
| 314170 | COCHRAN MILL | 314006 | ASHBURN | 1 | 230/230 | DOMINION | 2028 | |
| 224000 | BLUE PLAINS (23106) | 224004 | POTOMAC RIVER(station C) | 1 | 230/230 | PEPCO | 2026 | Glebe related |
| 218343 | TOSCO | 218441 | VFT | 1 | 230/230 | PSEG | 2023 | Due to Hudson retirement |
| 219110 | GLOUCESTER | 219125 | CAMDEN | 1 | 230/230 | PSEG | 2032 | Due to Suspended Gen |
| 200064 | PEACH BOTTOM | 200004 | CONASTONE | 1 | 500/500 | PECO/BGE | 2030 | |



15 Year Analysis Result for 2018 RTEP

2018 RTEP 15 Year Analysis - Tower Result

| Fr Bus | Fr Name | To Bus | To Name | CKT | KVs | Areas | 100% Year | Comment |
|--------|----------------|--------|----------------|-----|---------|-----------|-----------|---------------|
| 206305 | RARITIAN RIVER | 218331 | KILMER 'I' | 1 | 230/230 | JCPL/PSEG | 2029 | |
| 228401 | MICKLETON | 228402 | MONROE | 1 | 230/230 | AE | 2029 | |
| 228401 | MICKLETON | 228402 | MONROE | 2 | 230/230 | AE | 2029 | |
| 206314 | RED OAK | 206305 | RARITIAN RIVER | 1 | 230/230 | JCPL/PSEG | 2030 | |
| 228313 | BRIDGEPORT | 228401 | MCKLTON | 1 | 230/230 | AE | 2030 | |
| 314041 | GLEBE | 314185 | RADNOR | 1 | 230/230 | DOMINION | 2029 | Glebe related |

- RTEP Analysis includes studies of known outages with a duration of at least 6 months
- All known outages (>6 mo.) expected to overlap are analyzed as a single event
- PJM studies all single contingency events in conjunction with known outage events
- Summer 2019, Summer 2023 and Winter 2023 cases studied

- Potential voltage issues identified in 2019 and 2023 Summer analysis
- PJM Planning presented these findings to PJM Operations, who will continue to evaluate scheduled outages to ensure reliability

- NERC Standard TPL-001-4 requires Extreme Event Analysis
- Assesses the impact of extreme events (N-2, Gas Pipeline, extreme weather, etc.)
- If analysis concludes there is cascading, PJM must evaluate possible actions to reduce likelihood of cascading
- Transmission Owners provide extreme event contingencies
- PJM Develops: Gas pipeline contingencies and N-2 pairs (every reasonable combination of PJM Single contingencies 345 kV and up)

- N-1 and N-2 analysis on 2023 RTEP Model
- Contingencies:
 - Over 155,000 N-2 pairs
 - Over 30 gas pipeline contingencies
 - Over 1000 TO Provided Extreme Events Contingencies based on TPL-001-4 Table 1
- No cascading events identified
- Results and report are provided to RFC and SERC as required



PJM CIL (Capacity Import Limit) Study 2018

- Compliance:
 - NERC Standard MOD-004-1, Requirement 6:
 - Requires the Transmission Planner to establish a CBM value for each Available Transfer Capability (ATC) Path or Flowgate to be used in planning during each of the full calendar years two through ten following the current year.
- Purpose:
 - The purpose of this study is to confirm that the PJM and surrounding transmission systems will be robust enough to enable PJM to import the amount of emergency assistance (CBM) assumed available in the 2018 PJM Reserve Requirement Study (RRS) and PJM RAA (R6.1).
 - The amount of CBM used in the PJM Reserve Requirement Study (RRS) is **3,500 MW**.
 - Attachment C.7 of Manual M-14B requires that CBM be preserved in generator deliverability studies
- Methodology:
 - Attachment G.11 “PJM Capacity Import Limit (CIL) Calculation Procedure”

| <u>Supply Zone</u> | <u>2018 RTEP CBM Allocation (MW)</u> | <u>2019 RTEP CBM Allocation (MW)</u> |
|--------------------|--------------------------------------|--------------------------------------|
| North | 0 | 412 |
| West 1 | 1,251 | 1,104 |
| West 2 | 819 | 926 |
| South 1 | 852 | 176 |
| South 2 | 578 | 881 |
| TOTAL | 3,500 | 3,500 |

- The 2018 PJM CIL Study verifies that PJM meets its requirement for CBM in accordance with NERC standard MOD-004-1 Requirement 4.
- The primary drivers for the CBM allocation changes from the previous study are
 - Integration of OVEC
 - Reactor installed on the Trimble County – Clifty Creek 345 kV tie line.
 - Elimination of LTF transmission service that is not confirmed by an external Balancing Authority.

Dominion End of Life Criteria



Dominion Transmission Zone: Baseline Line #224 Lanexa to Northern Neck Rebuild

Baseline Reliability: TO Criteria Violation

Problem Statement: Dominion “End of Life Criteria”

The 41 mile long Line #224 between Lanexa and Northern Neck was constructed in 1969 on predominately wood H-frames along with 32 weathering steel lattice towers. The existing summer emergency rating is 386 MVA.

Industry guidelines indicate equipment life for wood structures is 35-55 years, steel structures is 40 to 60 years, conductor and connectors is 40-60 years, and porcelain insulators is 50 years.

The 224 Line provides network transmission service to Dunnsville Substation which serves over 7500 customers including over 4650 Co-op customers at Howerton DP (REC).

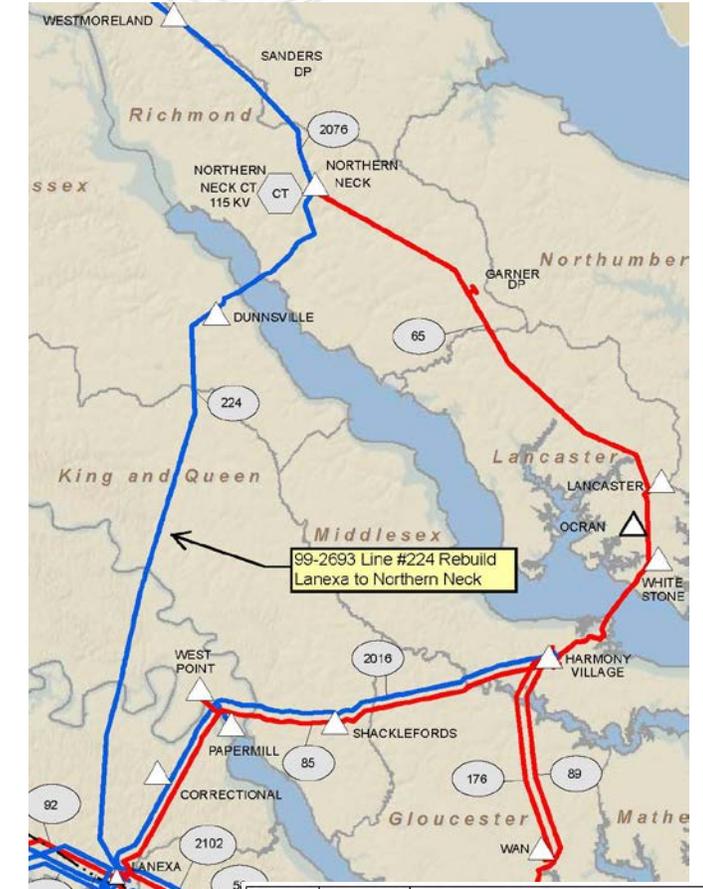
Permanent removal of the 224 Line results in over 300MW load loss for a N-1-1 condition (loss of the 65 Line and the 2083 Line (Fredericksburg to Birchwood)).

Recommended Solution:

Rebuild Line #224 between Lanexa and Northern Neck utilizing double circuit structures to current 230kV standards. Only one circuit is to be installed on the structures with this project with a minimum summer emergency rating of 1047 MVA. **(b3089)**

Rebuilding Line #224 with double circuit structures will prepare for a future project to resolve a N-1-1 300 MW load loss issue for the loss of the two 230kV sources into Northern Neck. Presently the 65 Line will be opened at Northern Neck between events to resolve thermal and voltage issues that occur when attempting to feed the 230kV from this 115kV line after the second event. VDOT maintenance on the White Stone Bridge across the Rappahannock River continues to require outages on the segment of the attached 65 Line due to delays to the project to remove it from the bridge attachments (b2505). These VDOT maintenance outages hamper the ability to resolve the N-1-1 issues and results in over 300MW load loss beginning in 2019 without the 65 Line river crossing in service. Even with the river crossing in service the load served from the 230kV lines is expected to exceed 300MW within the life expectancy of the rebuilt 224 Line.

Continued on next slide...



| COLOR | VOLTAGE | TRANSMISSION LINE NUMBER |
|--------|---------|-------------------------------|
| Green | 500 KV. | 500 thru 599 |
| Blue | 230 KV. | 200 thru 299 & 2000 thru 2099 |
| Red | 115 KV. | 1 thru 199 |
| Orange | 138 KV. | AS NOTED |
| Cyan | 69 KV. | AS NOTED |



Dominion Transmission Zone: Baseline Line #224 Lanexa to Northern Neck Rebuild

Continued from previous slide...

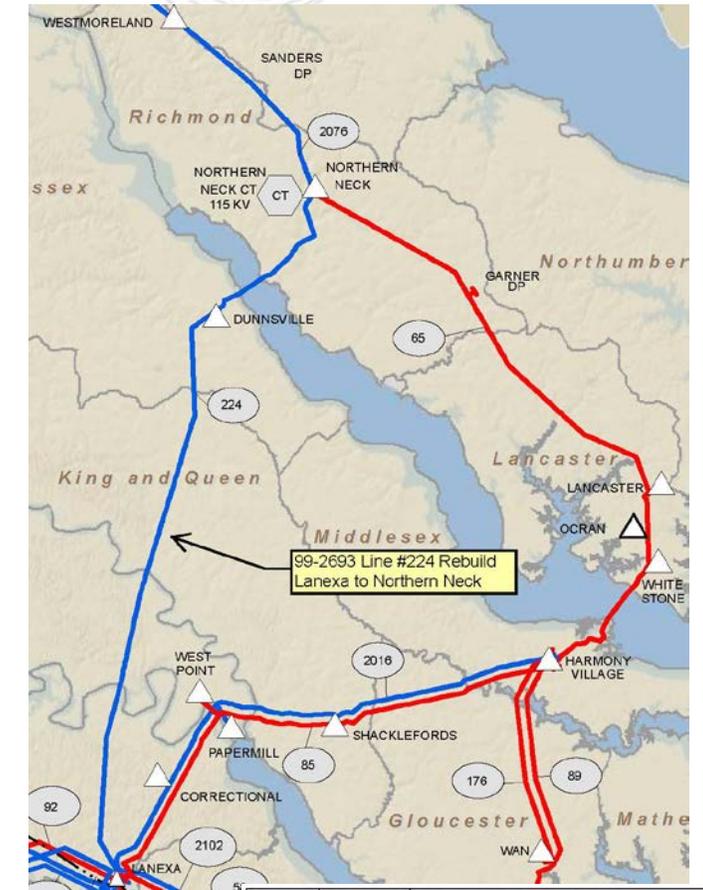
Alternative: Rebuild Line #224 utilizing 230kV single circuit structures - \$56.5M.

Estimated Project Cost: \$86 M

Required In-service Date: Immediate Need

Projected In-service Date: 12/31/2023

Project Status: Conceptual



| COLOR | VOLTAGE | TRANSMISSION LINE NUMBER |
|--------|---------|-------------------------------|
| Green | 500 KV. | 500 thru 599 |
| Blue | 230 KV. | 200 thru 299 & 2000 thru 2099 |
| Red | 115 KV. | 1 thru 199 |
| Orange | 138 KV. | AS NOTED |
| Cyan | 69 KV. | AS NOTED |

Dominion/PEPCO

B2443 – Glebe to Station C Project Update



Dominion Transmission Zone: Baseline Glebe – Station C Project

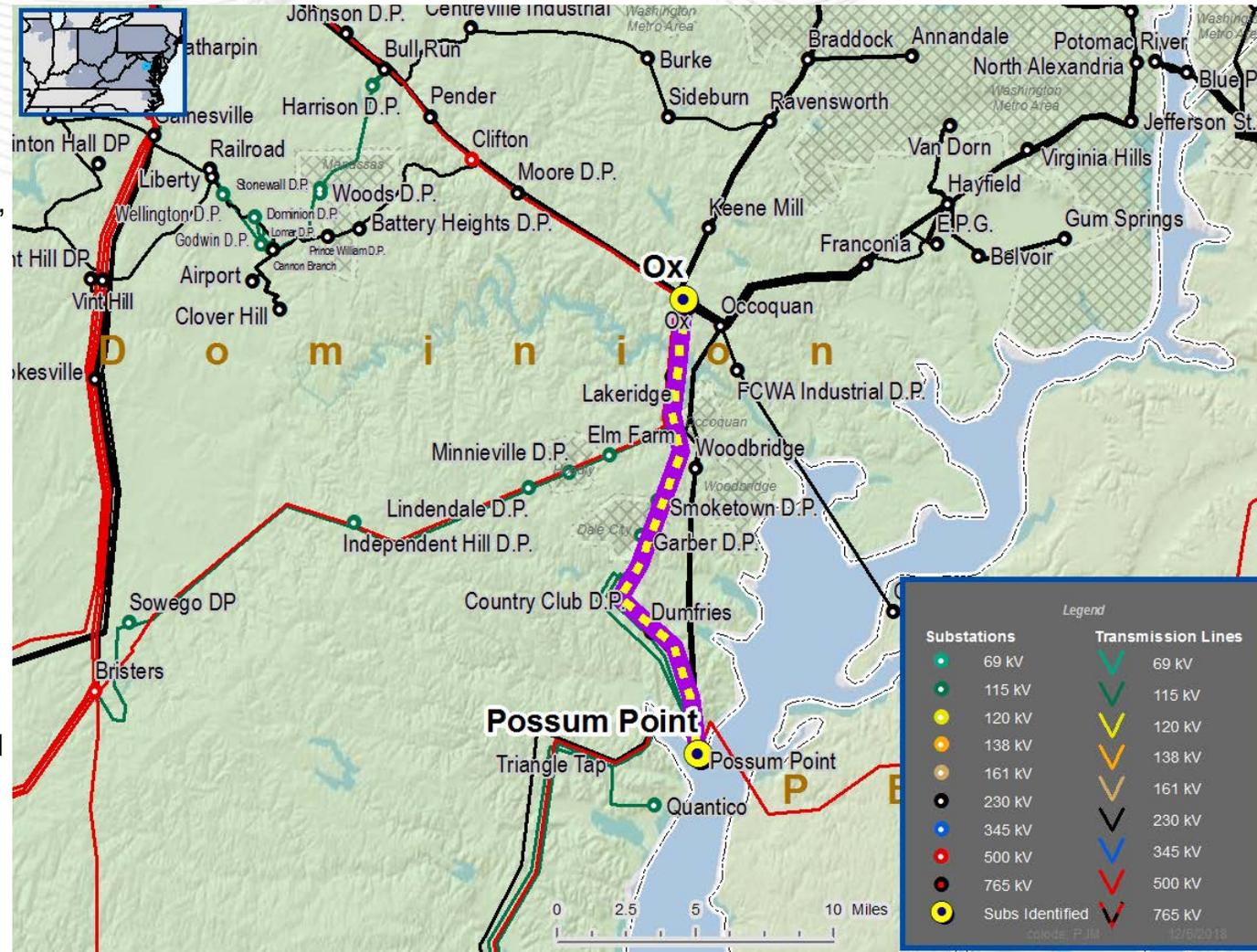
Existing Baseline b2443

Date Project Last Presented: 12/11/2013, 01/09/2014, 11/11/2014 & 06/08/2017

Problem Statement: Updated NERC Reliability Drivers

- Original criteria violations included overloads of Ox 500/230 kV Tx #1 & #2, 230 kV Line #248 (UG section between Carlyle South – North Potomac Yard) and the Franconia – Van Dorn Section of 230 kV Line #243.
- Updated criteria violation – Based on recent generation retirements (Possum Point Units #3 & #4) and the PJM 2018 Load Forecast updates indicates that for a NERC Category P1 – single contingency that Possum Point 500/230 kV Tx #1 overloads for a loss of the Possum Point – Ox 500 kV Line #571 under Dominion’s critical stress case criteria.
- Other previously identified deficiencies in Dominion and PEPCO are no longer present.
- The Glebe – Station C Project (b2443) will be cancelled and replaced with a new baseline to resolve the NERC reliability deficiencies.
 - The previously approved cost for the Glebe – Station C Project: **\$299 M**
 - The new baseline will be discussed on the next slide.

Continued on next slide...



Continued from previous Glebe – Station C Project slide...

Potential Solution:

- Install a second 500/230 kV transformer at Possum Point substation and replace 19 - 63 kA 230 kV breakers with 19 – 80 kA 230 kV breakers and replace bus work and associated equipment as needed.
 - 230kV Possum Point breakers: H892, H8T2078, H992, H9T237, 23792, G6BTGT, GT92, 202292, 252T2022, 21592, G5T215, 25292, G492, G592, G6A92, G6B92, G4T2001, 200192, 207892

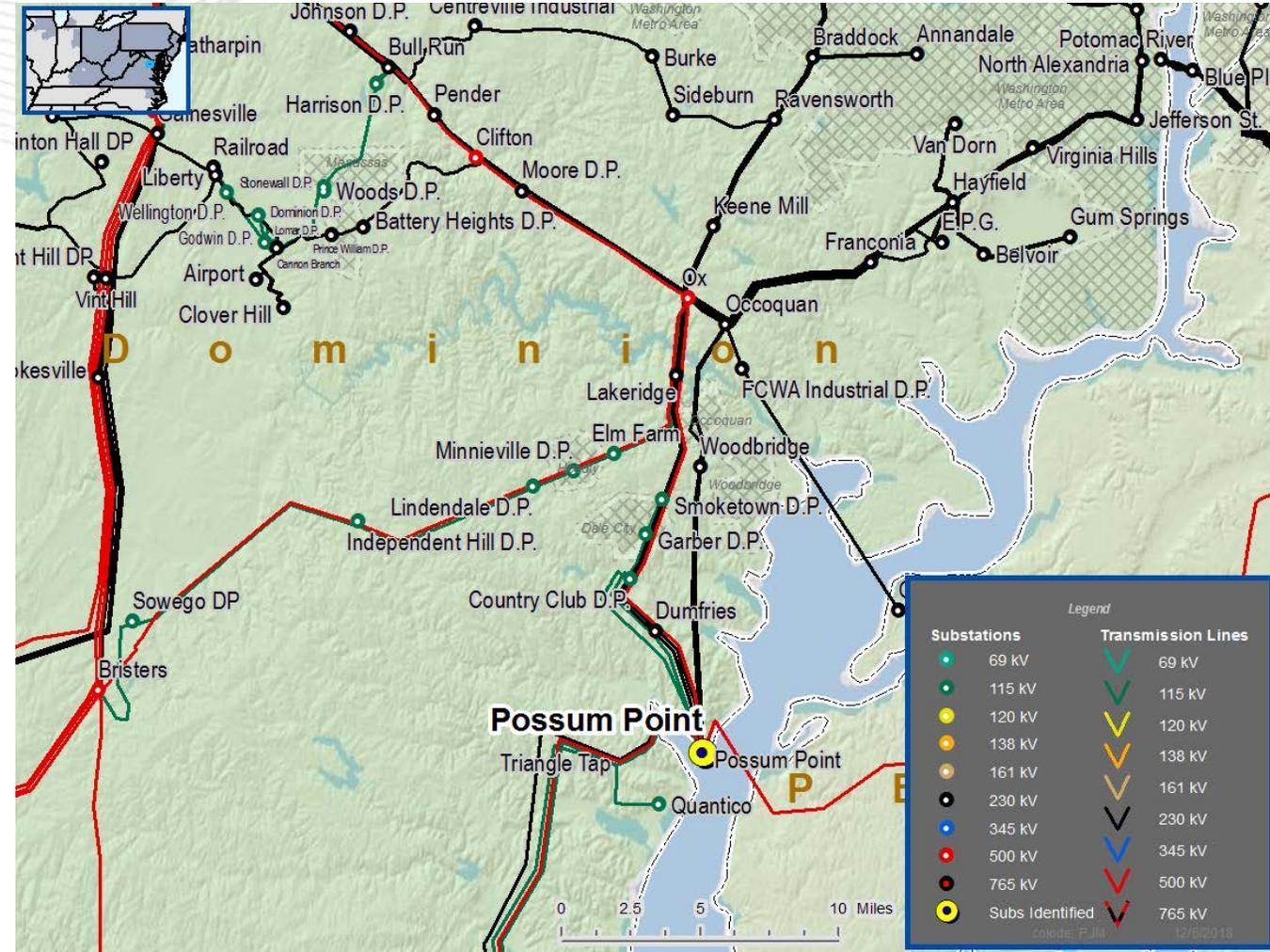
Estimated Project Cost:

| | |
|-----------------------------------|---------------|
| 500/230 kV transformer bank, | |
| bus work & associated equipment : | \$21 M |
| 19 – 230kV 80kA breakers: | \$19 M |
| Total: | \$40 M |

Required IS Date: 06/01/2023

Projected IS Date: 06/01/2023

Project Status: Conceptual



Dominion Operational Performance



Dominion Transmission Zone: Baseline Potomac Yards North SUP Expiration

Baseline Reliability: Operational Performance

Problem Statement: Expiration of Special Use Permit

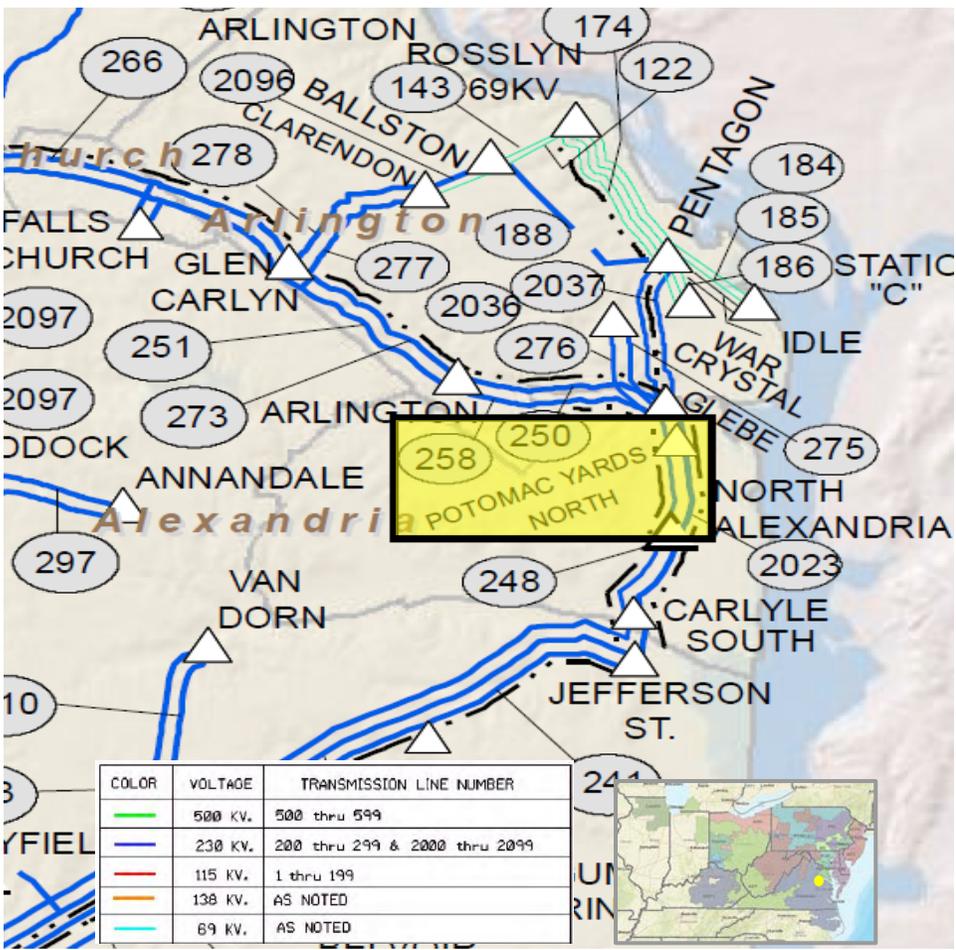
The special use permit (SUP), issued by the City of Alexandria, for Potomac Yards North substation expires on 01/01/2021. The City of Alexandria has indicated they will not extend, nor renew, the permit further.

Reliability Studies indicate that the removal of 230 kV Lines #248 & #2023 which currently are located at Potomac Yards North terminal station, result in numerous NERC criteria violations. Specifically, Category P1, P4 & P7 criteria violations and significant load loss scenarios in the Arlington – Alexandria area.

Recommended Solution:

Convert the OH portion (approx. 1500 Feet) of 230 kV Lines #248 & #2023 to underground to maintain the current configuration of the 230 kV system in this load area. There is not adequate space at the existing Glebe substation to terminate the 230 kV underground circuits and expansion of the existing footprint is not practical. Therefore, Glebe substation will be converted to GIS to accommodate the additional space requirements of the two underground cable terminations and be converted from its existing configuration into a breaker and a half scheme. **(b3090)**

Continued on next slide...



Continued from previous slide...

Alternative:

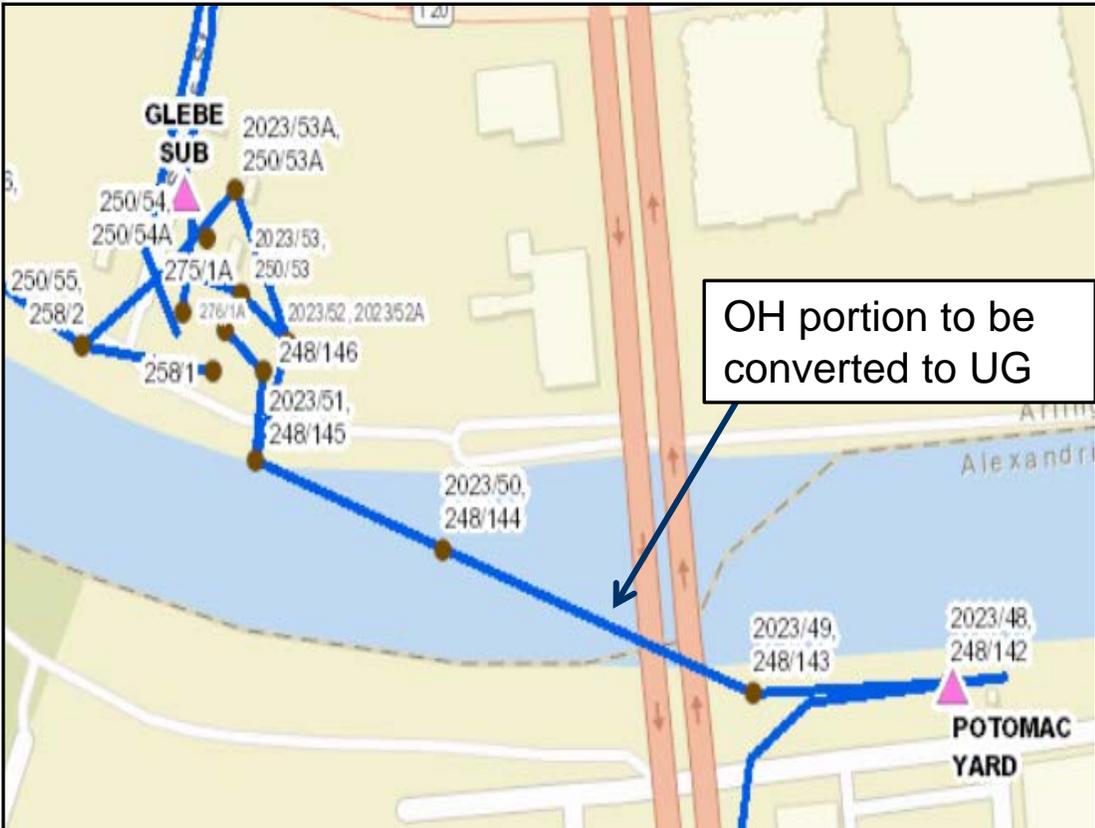
No feasible alternatives are available.

Estimated Project Cost: \$120 M

Required In-service Date: Immediate Need

Projected In-service Date: May 1, 2022

Project Status: Conceptual



Short Circuit Projects



Dominion Transmission Zone: Baseline Project

Problem: Short Circuit

- The Morrisville 500kV breakers "H1T594" and "H2T545" are overdutied

Significant Driver:

- B3019: Rebuild 500kV Line #552 Bristers to Chancellor – 21.6 miles long

Recommended Solution:

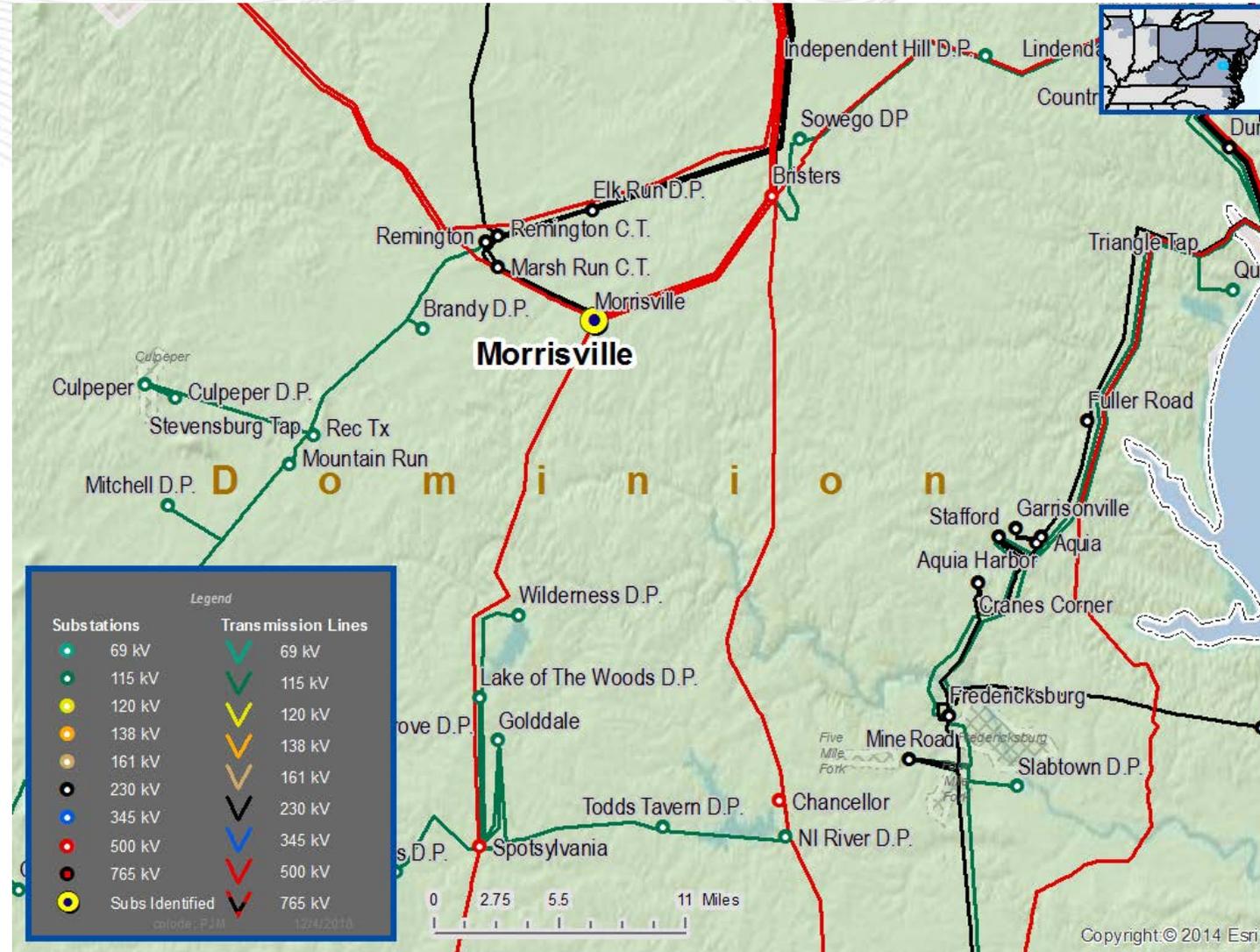
- Update the nameplate for Morrisville 500kV breaker "H1T594" to be 50kA breaker (B3019.1)
- Update the nameplate for Morrisville 500kV breaker "H2T545" to be 50kA breaker (B3019.2)

Estimated Project Cost:

New nameplate ratings (\$2 K per breaker) : \$4 K

Required IS Date: June 1, 2018

Projected IS Date: December 31, 2023



2018 RTEP Next Steps

- Retirement Sensitivities
- Finalize stability studies

Questions?



2019

- TEAC meetings are the following Thursdays in 2019
- **1/10, 2/7, 3/7, 4/11, 5/16, 6/13, 7/11, 8/8, 9/12, 10/17, 11/14, 12/12.**

- V1 – 12/07/2018 – Original Slides Posted