Market Efficiency Update

Transmission Expansion Advisory Committee

July 11, 2019

Nick Dumitriu, Market Simulation

2018/19 Market Efficiency Window

2018/19 Market Efficiency Window Analysis Status

- Data validation for all projects (completed)
- Preliminary N-1 contingency analysis for all proposals (completed)
- PROMOD modeling of proposals (completed)
  - Completed PROMOD models for all proposals
  - Projects were modeled using the submitted assumptions
- PROMOD simulations for the proposals (completed)
  - Simulated years 2019, 2023, 2026, 2029
  - Both Base Case and FSA sensitivity
- Calculated preliminary PJM benefits and determined preliminary B/C ratios for all proposals
- Market Efficiency Analysis performed on a base case that includes all previously approved PJM RTEP enhancements and expansions

Preliminary Results for Hunterstown-Lincoln Proposals

Hunterstown-Lincoln Proposals Analysis

- Completed preliminary N-1 contingency analysis for Hunterstown-Lincoln proposals to determine flowgates to monitor
- Completed the PROMOD runs for the 22 proposals received from 7 entities
- Calculated preliminary benefits and determined preliminary B/C ratios
  - B/C ratios were computed using the submitted in-service cost of components
- Descriptions of submitted proposals included in Appendix A

Hunterstown-Lincoln Proposals Preliminary Results

Proposal ID	HL_469**	HL_622	HL_007
Proposal Description	Install SmartWire** power flow control 5% series reactance device in series with the Lincoln Tap-Hunterstown 115 kV line.	Rebuild the Hunterstown-Lincoln 115 kV line.	Build a 115 kV ring bus at the Lincoln tap.
Project Type	Greenfield**	Upgrade	Greenfield
B/C Ratio Metric	Lower Voltage	Lower Voltage	Lower Voltage
In-Service Cost ($MM)*	$4.65	$7.21	$7.58
Cost Containment	No	No	No
In-Service Year	2022	2023	2023
% Cong Driver Mitigated	100%	100%	86%
2023 Shifted Cong ($MM)	$2.03	1.78	$1.35
Base Case B/C Ratio*	110.51	76.22	53.53
FSA Sens. B/C Ratio*	12.75	8.84	7.85
Map	HL_469	HL_622	HL_007

* Costs under review by PJM

** PJM seeking clarity on installation details and project scope

Hunterstown-Lincoln Proposals Preliminary Results (cont.)

Proposal ID	BT_293	HL_960	HL_201	HL_413	HL_402
Proposal Description	Build Meade 115 kV substation.	Build new Hunterstown-Lincoln 115 kV line.	Install a 25 MW 2-hour battery at Lincoln 115 kV station.	Build new Hunterstown-Lincoln 115 kV line. Install a 10 MW 2-hour battery at Lincoln 115 kV substation.	Build new Hunterstown-Lincoln 115 kV line. Install a 25 MW 2-hour battery at Lincoln 115 kV substation.
Project Type	Greenfield	Greenfield	Greenfield	Greenfield	Greenfield
B/C Ratio Metric	Lower Voltage	Lower Voltage	Lower Voltage	Lower Voltage	Lower Voltage
In-Service Cost ($MM)*	$8.95	$10.13	$17.36	$19.22	$25.81
Cost Containment	No	Yes	Yes	Yes	Yes
In-Service Year	2023	2021	2021	2021	2021
% Cong Driver Mitigated	86%	100%	27%	100%	100%
2023 Shifted Cong ($MM)	$1.35	$1.89	$0.18	2.02	$2.01
Base Case B/C Ratio*	45.34	52.97	7.14	25.54	19.44
FSA Sens. B/C Ratio*	6.65	6.34	1.1	3.74	2.89
Map	HL_293	HL_960	HL_201	HL_413	HL_402

* Note: Costs under review by PJM

Hunterstown-Lincoln Proposals Preliminary Results (cont.)

Proposal ID	HL_453	HL_892	HL_830	HL_021	HL_647
Proposal Description	Install a 25 MW 4-hour battery at Lincoln 115 kV substation.	Install a 50 MW 2-hour battery at Lincoln 115 kV substation.	Build new Littlestown-Germantown 115 kV line.	Rebuild Hunterstown-Lincoln 115 kV. Build Peach Bottom-Graceton 230 kV circuit. Upgrade Face Rock 115/69 kV transformers.	Build a 115 kV ring bus at the Lincoln tap. Build Otter Creek 500/230 kV substation. Replace Face Rock 115/69 kV transformers. Reconductor Manor-Graceton 230 kV line.
Project Type	Greenfield	Greenfield	Greenfield	Upgrade	Greenfield
B/C Ratio Metric	Lower Voltage	Lower Voltage	Lower Voltage	Lower Voltage	Lower Voltage
In-Service Cost ($MM)*	$26.69	$28.98	$44.92	$54.75	$55.12
Cost Containment	Yes	Yes	No	No	No
In-Service Year	2021	2021	2024	2023	2023
% Cong Driver Mitigated	27%	25%	97%	100%	77%
2023 Shifted Cong ($MM)	$0.18	$0.35	$5.65	-	-
Base Case B/C Ratio*	4.64	7.69	13.05	11.42	6.80
FSA Sens. B/C Ratio*	0.71	4.86	1.57	3.03	1.54
Map	HL_453	HL_892	HL_830	HL_021	HL_647

* Note: Costs under review by PJM

Hunterstown-Lincoln Proposals Preliminary Results (cont.)

Proposal ID	HL_847	HL_357	HL_511	HL_868
Proposal Description	Build new Robinson Run-Graceton 230 kV line. Rebuild Cooper-Graceton 230 kV line. Reconductor Hunterstown-Lincoln 115 kV line.	Build new Robinson Run-Graceton 230 kV line. Rebuild Cooper-Graceton 230 kV line. Build Hunterstown-Green Valley 230 kV line.	Build a 115 kV ring bus at the Lincoln tap. Build Otter Creek 500/230 kV substation. Upgrade Otter Creek-Conastone 230 kV line. Replace Face Rock 115/69 kV transformers. Reconductor Manor-Graceton 230 kV.	Build new Delta Tap-Conastone 500 kV line. Build a 115 kV ring bus at the Lincoln tap. Replace Face Rock 115/69 kV transformers.
Project Type	Greenfield	Greenfield	Greenfield	Greenfield
B/C Ratio Metric	Lower Voltage	Lower Voltage	Lower Voltage	Regional
In-Service Cost ($MM)*	$56.00	$91.35	$95.47	$122.08
Cost Containment	Yes	Yes	No	No
In-Service Year	2023	2023	2023	2023
% Cong Driver Mitigated	100%	100%	74%	88%
2023 Shifted Cong ($MM)	$0.28	-	-	-
Base Case B/C Ratio*	10.79	6.28	4.07	2.02
FSA Sens. B/C Ratio*	3.81	2.58	1.18	0.88
Map	HL_847	HL_357	HL_511	HL_868

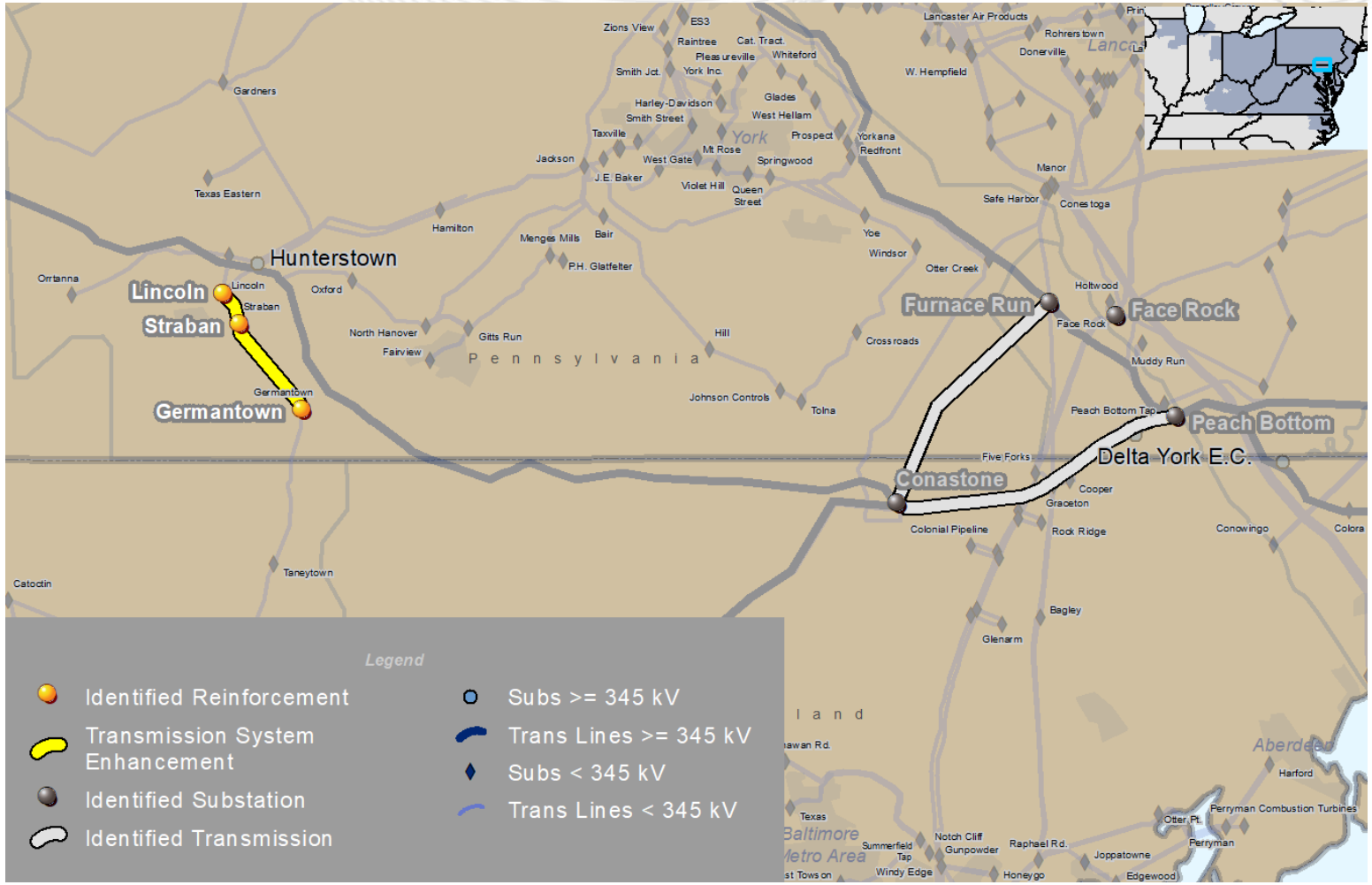
* Note: Costs under review by PJM

Hunterstown-Lincoln Proposals Preliminary Results (cont.)

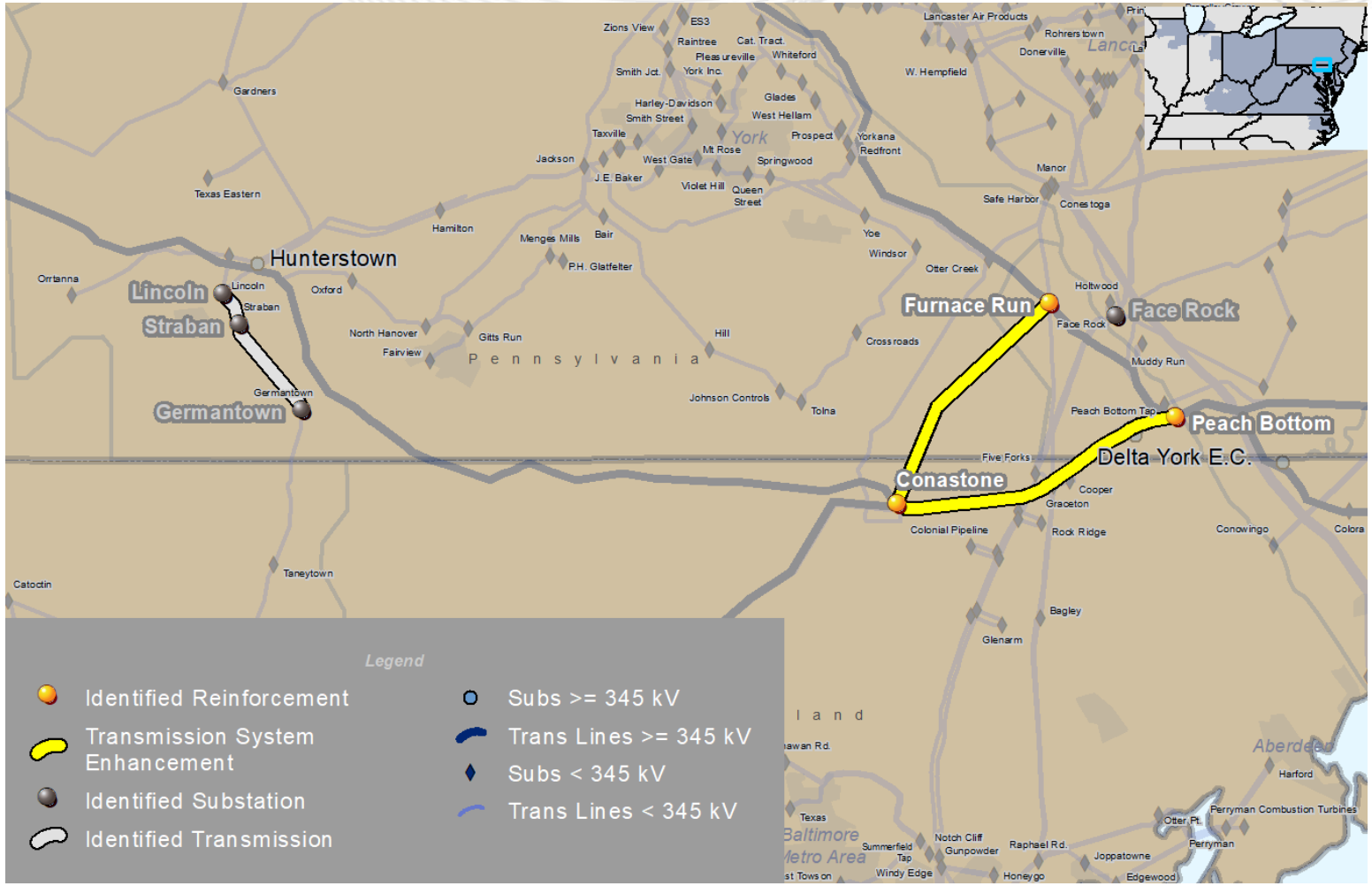
Proposal ID	HL_034	HL_389	HL_387	HL_593	HL_616
Proposal Description	Rebuild Hunterstown-Lincoln-Germantown 115 kV and Germantown-Carrol 138 kV corridors as a new Hunterstown Carroll 230 kV circuit.	Rebuild Hunterstown-Lincoln 115 kV line. Build Peach Bottom-Graceton 230 kV line.	Build new Wentz-Carroll 230 kV line. Increase ratings of Carroll-Mt. Airy 230 kV line.	Build new Littlestown-Germantown 115 kV line and new Peach Bottom-Graceton 230 kV line.	Build new Wentz-Carroll 230 kV line and Peach Bottom-Graceton 230 kV line. Increase ratings of Carroll-Mt. Airy 230 kV line.
Project Type	Upgrade	Greenfield	Greenfield	Greenfield	Greenfield
B/C Ratio Metric	Lower Voltage	Lower Voltage	Lower Voltage	Lower Voltage	Lower Voltage
In-Service Cost ($MM)*	$136.64	$147.64	$152.18	$183.69	$290.95
Cost Containment	No	No	No	No	No
In-Service Year	2023	2024	2024	2024	2024
% Cong Driver Mitigated	100%	100%	100%	98%	100%
2023 Shifted Cong ($MM)	$1.08	-	$1.65	$2.95	-
Base Case B/C Ratio*	4.03	4.83	3.84	3.71	2.36
FSA Sens. B/C Ratio*	0.84	1.68	0.84	1.42	0.99
Map	HL_034	HL_389	HL_387	HL_593	HL_616

* Note: Costs under review by PJM

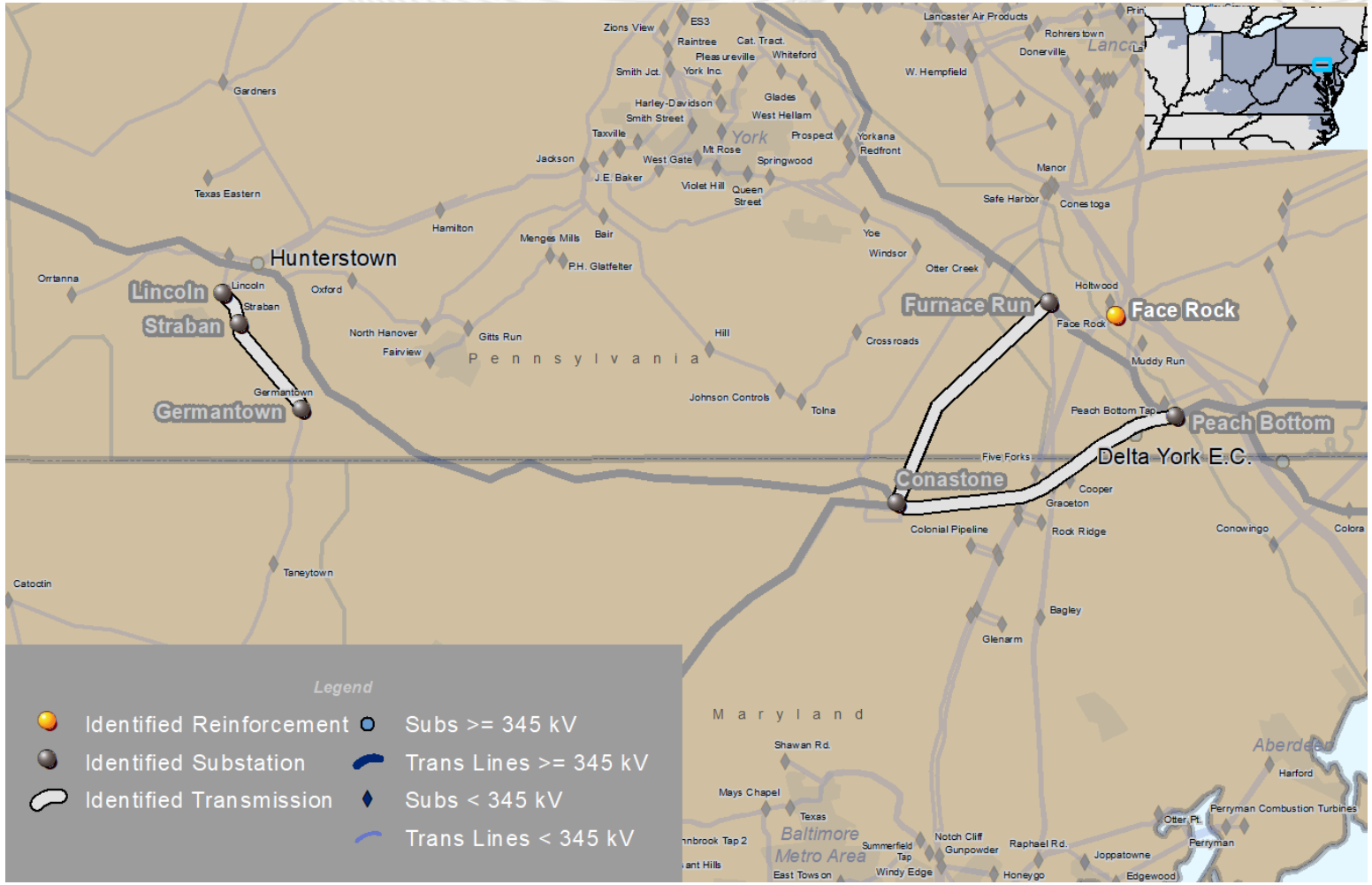
Shifted Congestion – Area Near Lincoln



Shifted Congestion – Area Near Peach Bottom



Shifted Congestion – Area Near Face Rock



Proposals by Component Congestion Area

Project ID	Cost	Area Near Lincoln	Area Near Peach Bottom	Area Near Face Rock
HL_469	$4.65	✓		
HL_622	$7.21	✓		
HL_007	$7.58	✓		
HL_293	$8.95	✓		
HL_960	$10.13	✓		
HL_201	$17.36	✓		
HL_413	$19.22	✓		
HL_402	$25.81	✓		
HL_453	$26.69	✓		
HL_892	$28.98	✓		
HL_830	$44.92	✓		
HL_034	$136.64	✓		
HL_387	$152.18	✓		

Proposals by Component Congestion Area (cont.)

Project ID	Cost	Area Near Lincoln	Area Near Peach Bottom	Area Near Face Rock
HL_847	$56.00	✓	✓	
HL_357	$91.35	✓	✓	
HL_593	$183.69	✓	✓	
HL_616	$290.95	✓	✓	
HL_389	$147.64	✓	✓	
HL_021	$54.75	✓	✓	✓
HL_647	$55.12	✓	✓	✓
HL_511	$95.47	✓	✓	✓
HL_868	$122.08	✓	✓	✓

Next Steps

- Interregional Proposals
  - Correction of LNG-Maple modeling for Bosserman – Trail-Creek projects
  - Coordination with MISO on interregional proposal B/C ratios
    - Preliminary B/C ratios including both PJM and MISO benefits will be presented at the next IPSAC meeting
  - RPM Check for Bosserman – Trail-Creek projects
- Hunterstown – Lincoln Proposals
  - Shifted Congestion Analysis
- Run Load and Gas Price sensitivities for all proposals
- Complete Reliability Analysis for all proposals
- Cost Constructability Analysis for all proposals

Appendix A
2018/19 Long Term Window
Hunterstown-Lincoln Proposal Descriptions

HL_007

Project ID: 201819_HL_007

Proposed Solution:
Install a new 115 kV ring bus at the Orrtanna tap point of the METED Hunterstown-Orrtanna-Lincoln 115 kV 963 line.

kV Level: 115 kV

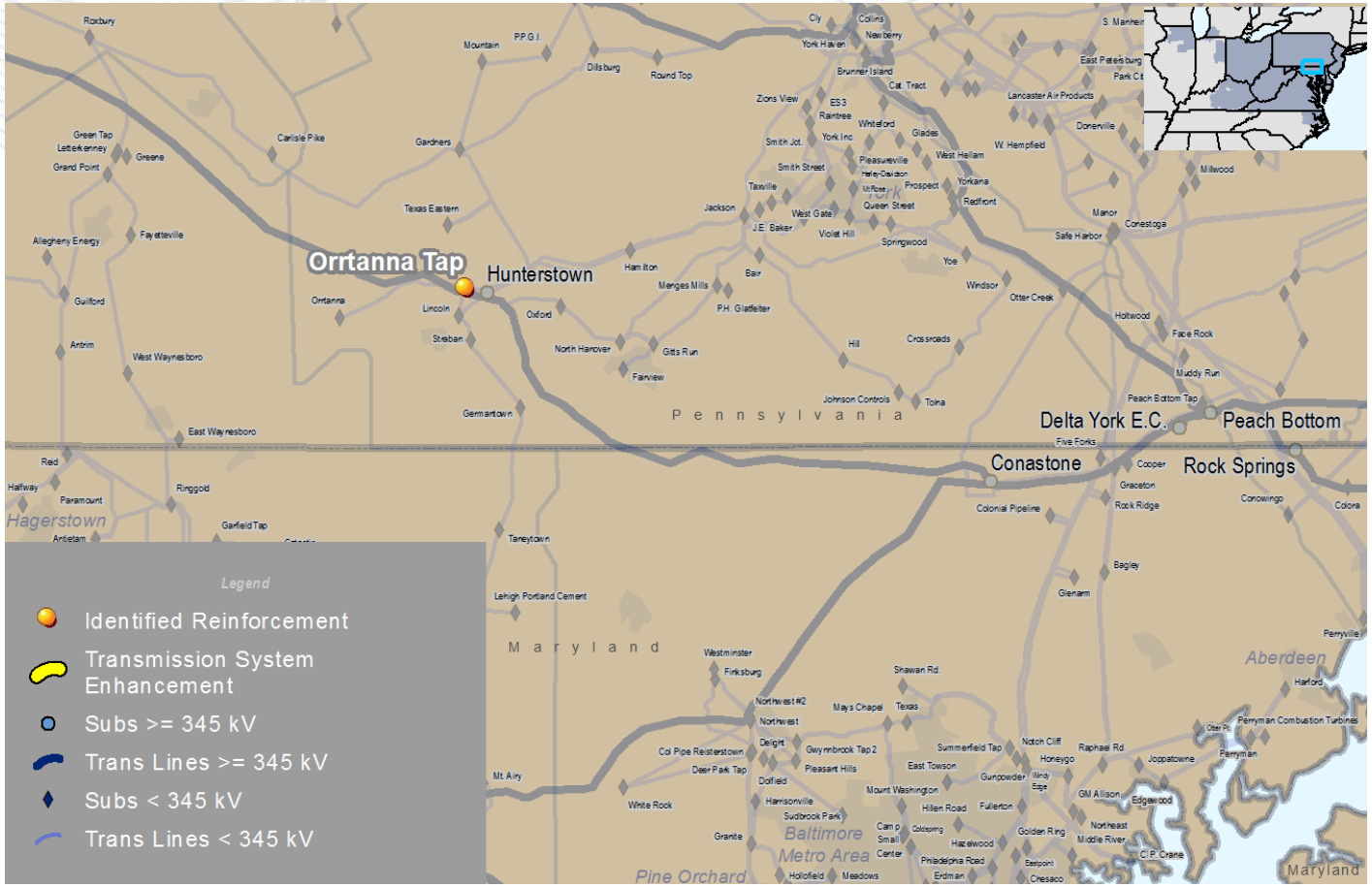
In-Service Cost ($M): $7.58

In-Service Year: 2023

Target Zone: METED

ME Constraints:
Huntertown - Lincoln 115 kV

Notes:



HL_021

Project ID: 201819_HL_021

Proposed Solution:
Rebuild the Hunterstown-Lincoln 115 kV line. Create a new Peach Bottom-Graceton 230 kV circuit, with a series reactor at Graceton. Upgrade/Replace the existing Face Rock 115/69 kV transformers. Upgrade Rice and Ringgold 230 kV stations.

kV Level: 230 kV

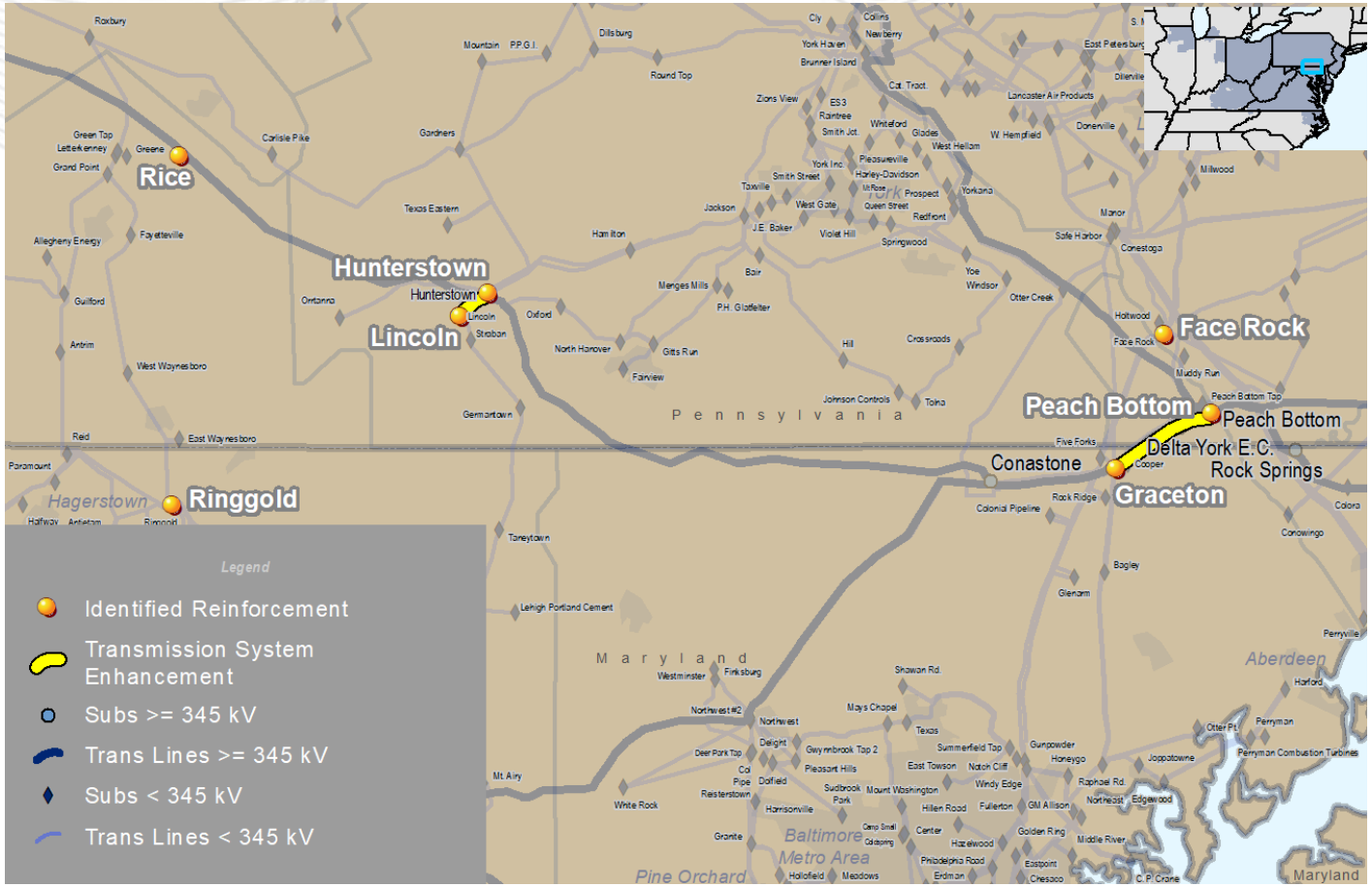
In-Service Cost ($M): $54.75

In-Service Year: 2023

Target Zone: METED

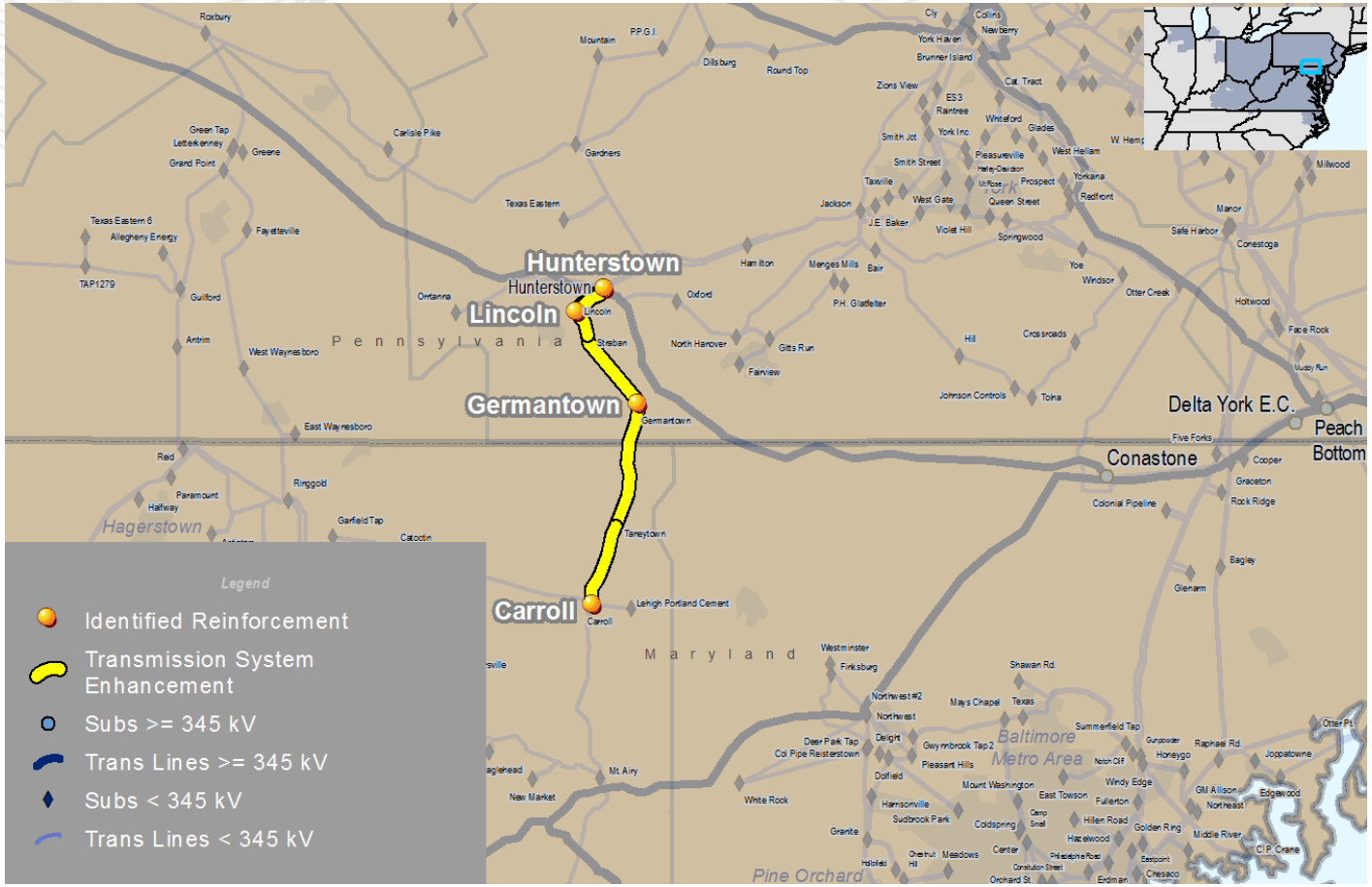
ME Constraints:
Huntertown - Lincoln 115 kV

Notes:



HL_034

Project ID: 201819_HL_034
Proposed Solution: Rebuild the Hunterstown-Lincoln-Germantown 115 kV and Germantown-Carroll 138 kV corridor using double circuit 230 kV construction. Construct a new 230 kV ring bus at Carroll substation and add a new 230 kV breaker at Hunterstown substation.
kV Level: 230 kV
In-Service Cost ($M): $136.64
In-Service Year: 2023
Target Zone: METED
ME Constraints: Huntertown - Lincoln 115 kV
Notes:



HL_201

Project ID: 201819_HL_201

Proposed Solution:
Build a 25 MW 2-hour battery to be connected to Lincoln 115 kV station. Upgrade Lincoln 115 kV station.

kV Level: 115 kV

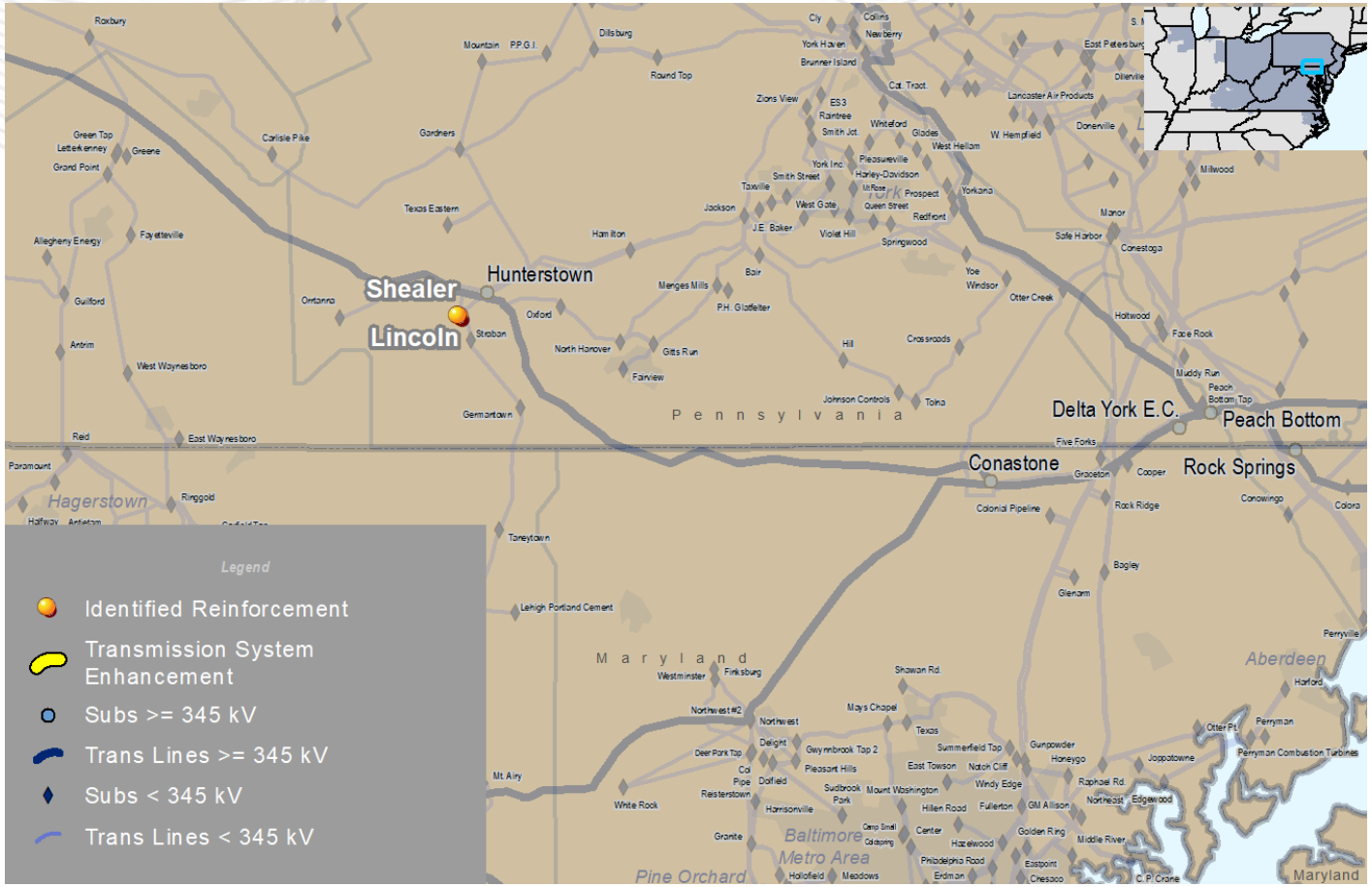
In-Service Cost ($M): $17.36

In-Service Year: 2021

Target Zone: METED

ME Constraints:
Huntertown - Lincoln 115 kV

Notes:



HL_293

Project ID: 201819_HL_293

Proposed Solution:
Construct a new 115 kV Meade ring bus at Lincoln Tap substation, including outgoing lines to Orrtanna, Hunterstown, and Lincoln substations.

kV Level: 115 kV

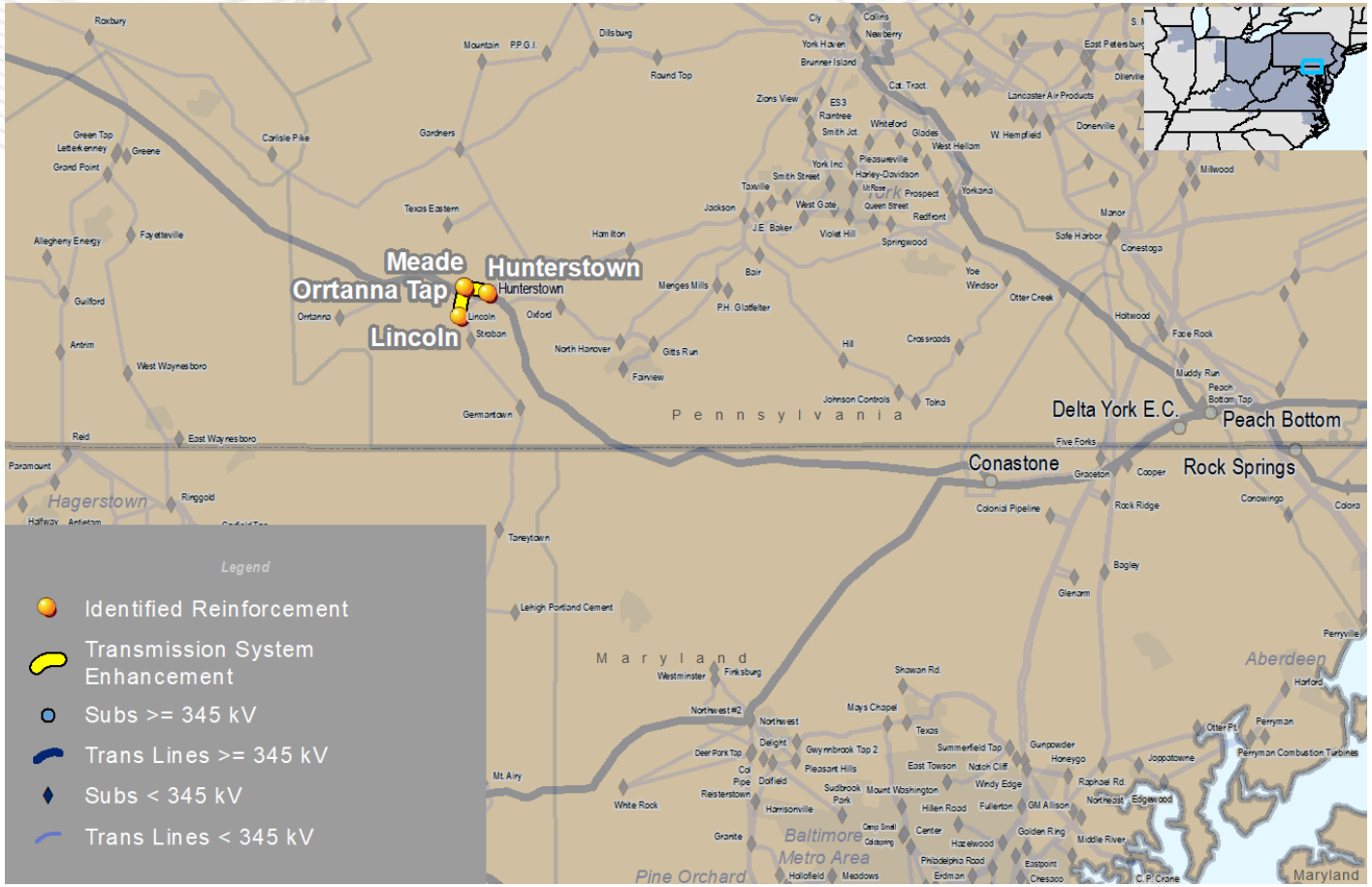
In-Service Cost ($M): $8.95

In-Service Year: 2023

Target Zone: METED

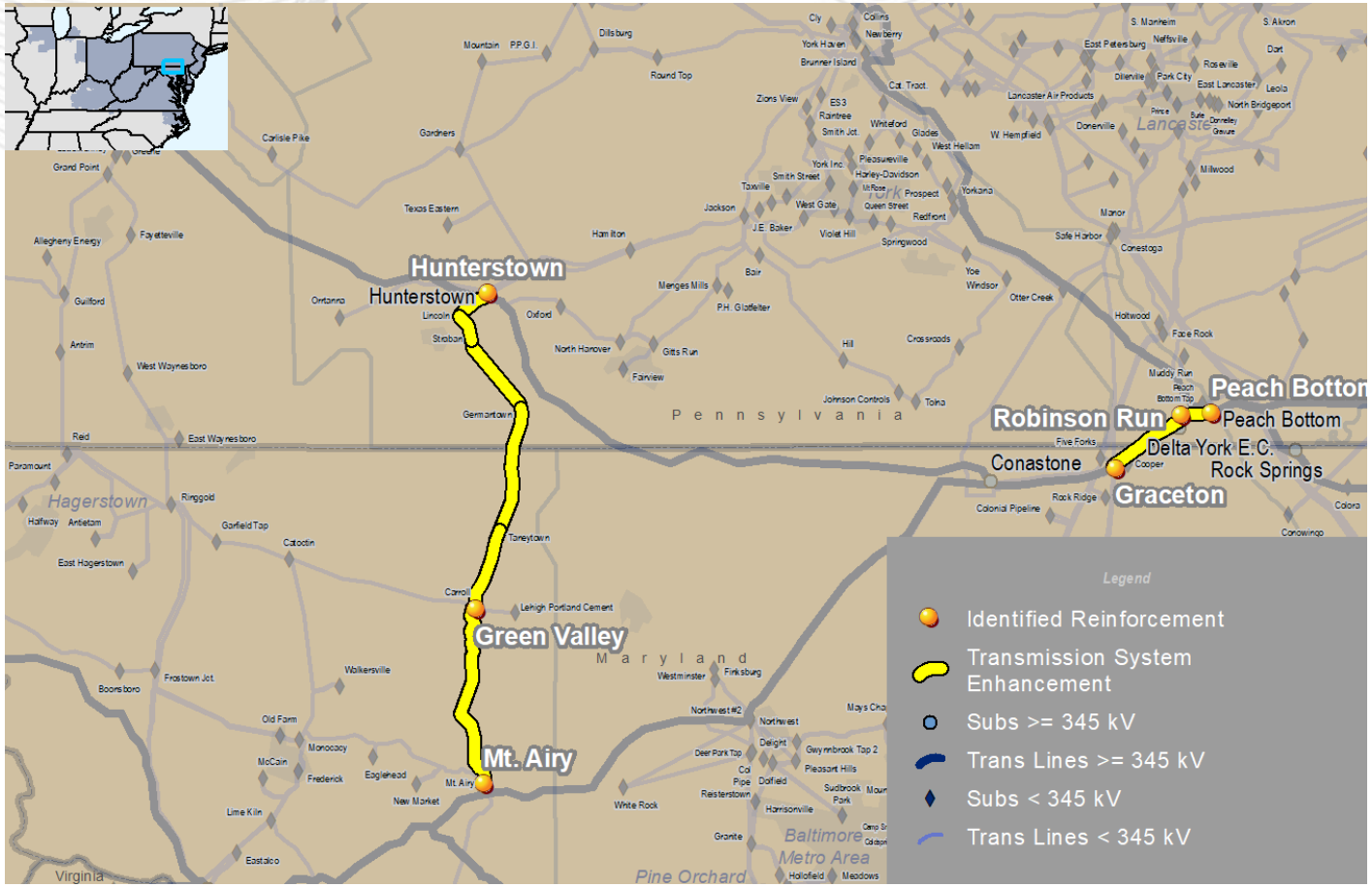
ME Constraints:
Huntertown - Lincoln 115 kV

Notes:



HL_357

Project ID: 201819_HL_357
Proposed Solution: Build a new Robinson Run 500/230 kV substation interconnecting Delta-Peach Bottom 500 kV line. Build Robinson Run-Graceton 230 kV line. Rebuild Cooper-Graceton 230 kV line. Build a new Green Valley 230 kV switching station interconnecting Carroll-Mt. Airy 230 kV line. Construct Hunterstown-Green Valley 230 kV line.
kV Level: 230 kV
In-Service Cost ($M): $91.35
In-Service Year: 2023
Target Zone: METED
ME Constraints: Huntertown - Lincoln 115 kV
Notes:



HL_387

Project ID: 201819_HL_387

Proposed Solution:
Add a new Wentz 500 kV substation on Hunterstown-Conastone 500 kV line and a 500/230 kV transformer at Wentz substation. Add a new Wentz-Carroll 230 kV line. Increase ratings of Carroll-Mt. Airy 230 kV line.

kV Level: 500 kV

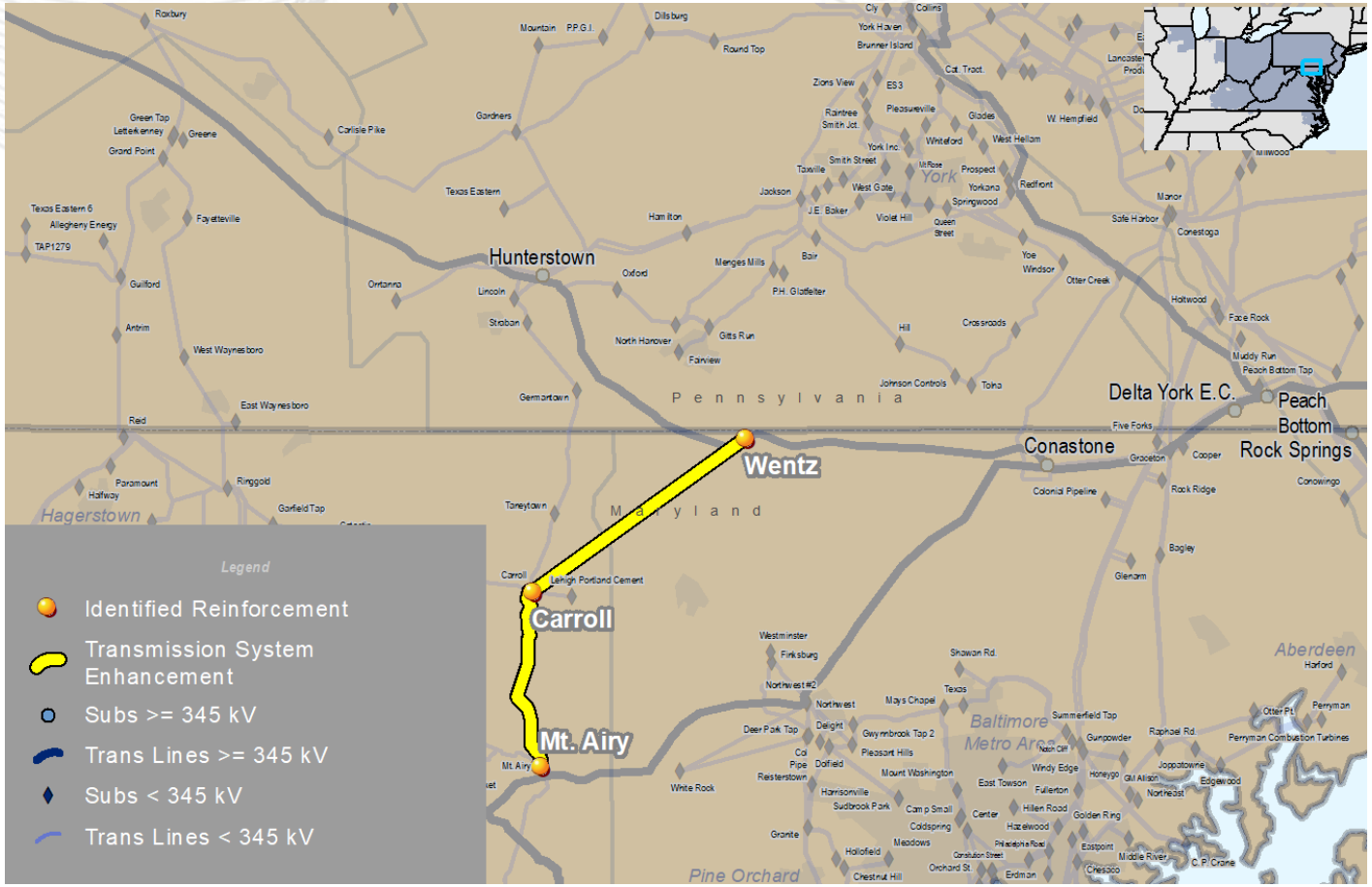
In-Service Cost ($M): $152.18

In-Service Year: 2024

Target Zone: METED

ME Constraints:
Huntertown - Lincoln 115 kV

Notes:



HL_389

Project ID: 201819_HL_389

Proposed Solution:
Rebuild Hunterstown-Lincoln 115 kV line. Add a Peach Bottom 500/230 kV transformer. Add a Peach Bottom-Graceton 230 kV line and reconfigure the 230 kV connections at Peach Bottom into a new switching station.

kV Level: 500 kV

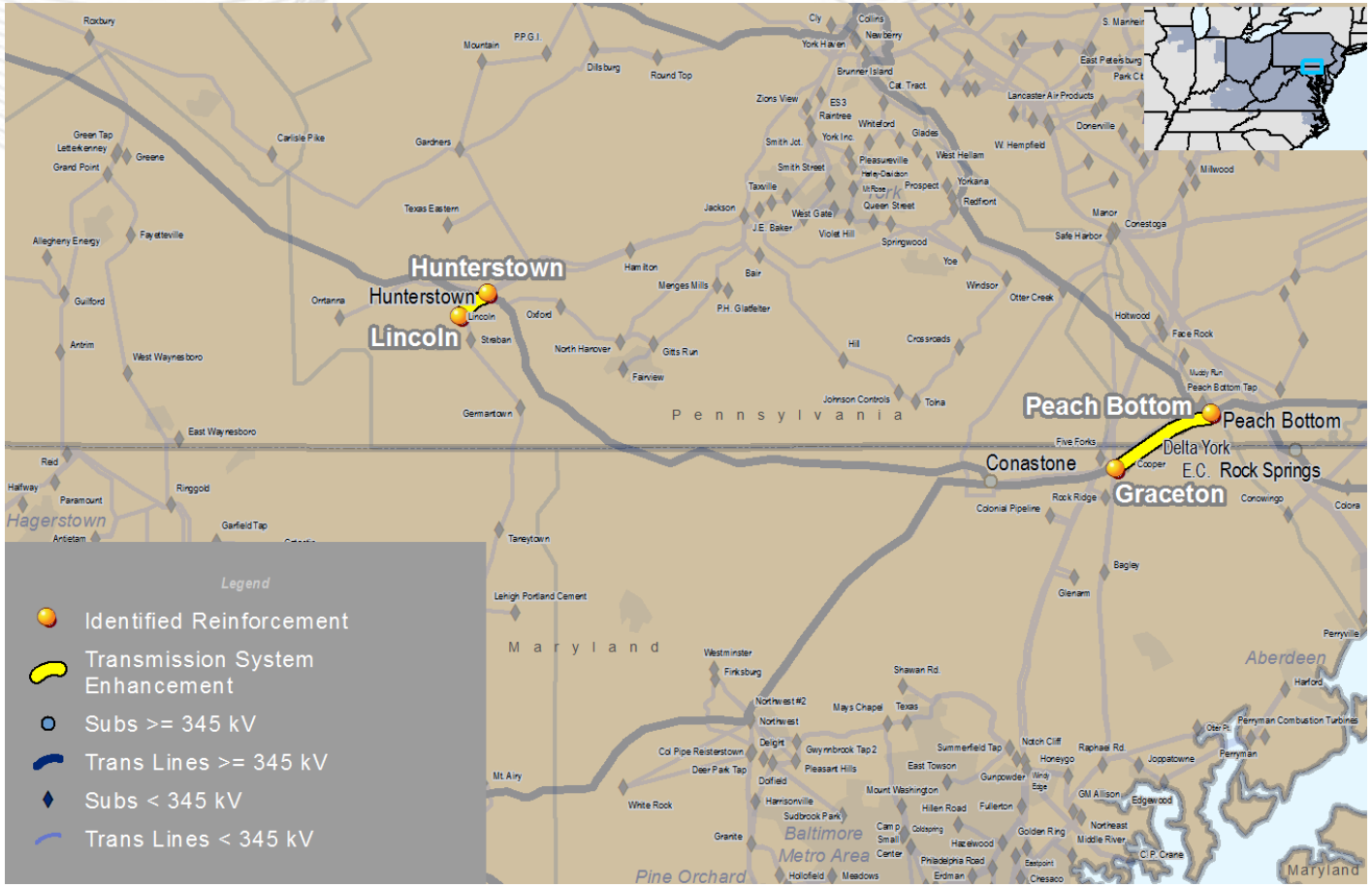
In-Service Cost ($M): $147.64

In-Service Year: 2024

Target Zone: METED

ME Constraints:
Huntertown - Lincoln 115 kV

Notes:



HL_402

Project ID: 201819_HL_402

Proposed Solution:
Build a new Hunterstown-Lincoln 115 kV line. Construct a 25 MW 2-hour battery storage facility to be connected to Lincoln 115 kV station. Upgrade Lincoln 115 kV and Hunterstown 115 kV substations.

kV Level: 115 kV

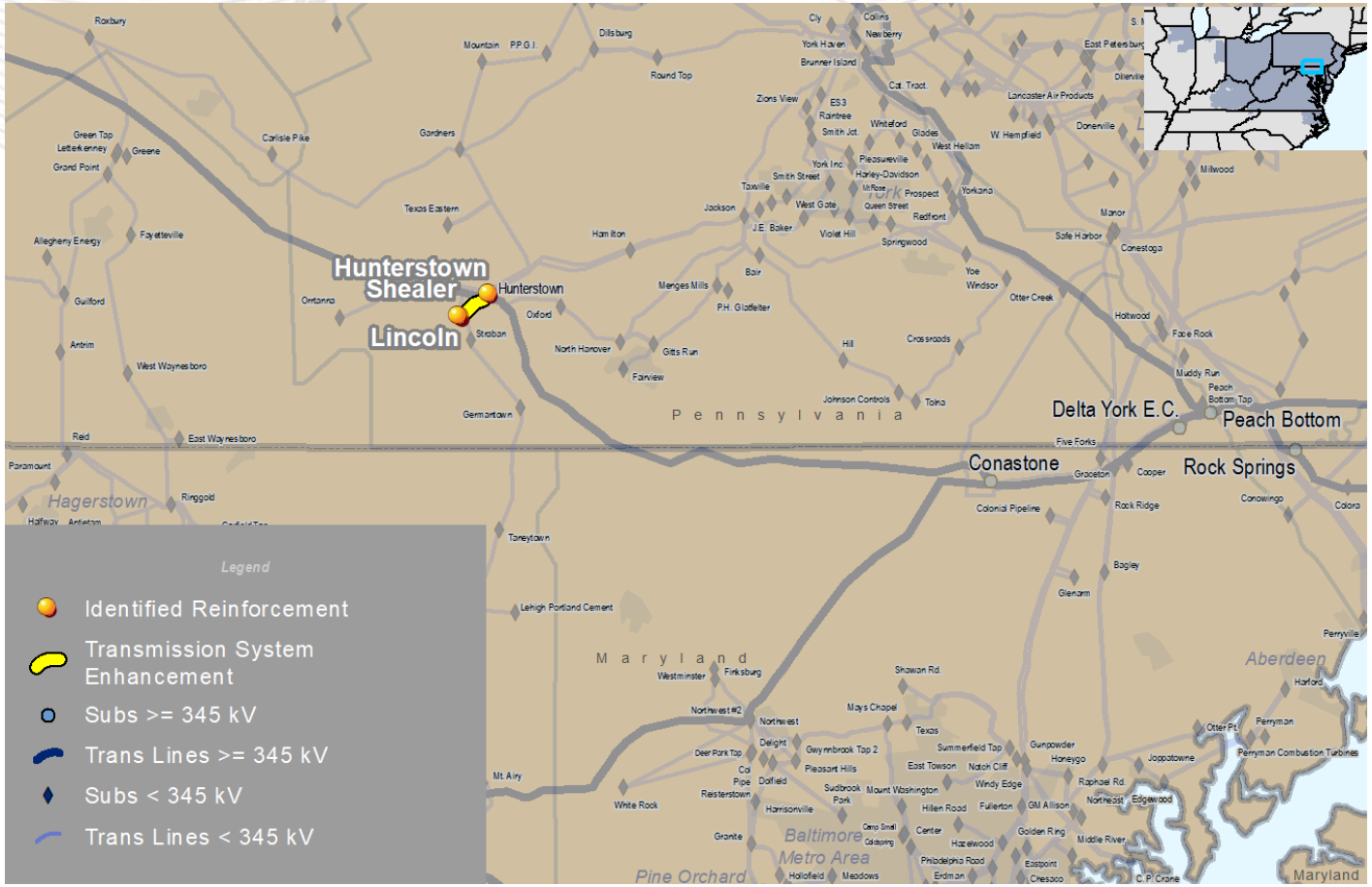
In-Service Cost ($M): $25.81

In-Service Year: 2021

Target Zone: METED

ME Constraints:
Huntertown - Lincoln 115 kV

Notes:



HL_413

Project ID: 201819_HL_413

Proposed Solution:
Build a new Hunterstown-Lincoln 115 kV line. Construct a 10 MW 2-hour battery storage facility to be connected to Lincoln 115 kV station. Upgrade Lincoln 115 kV and Hunterstown 115 kV substations.

kV Level: 115 kV

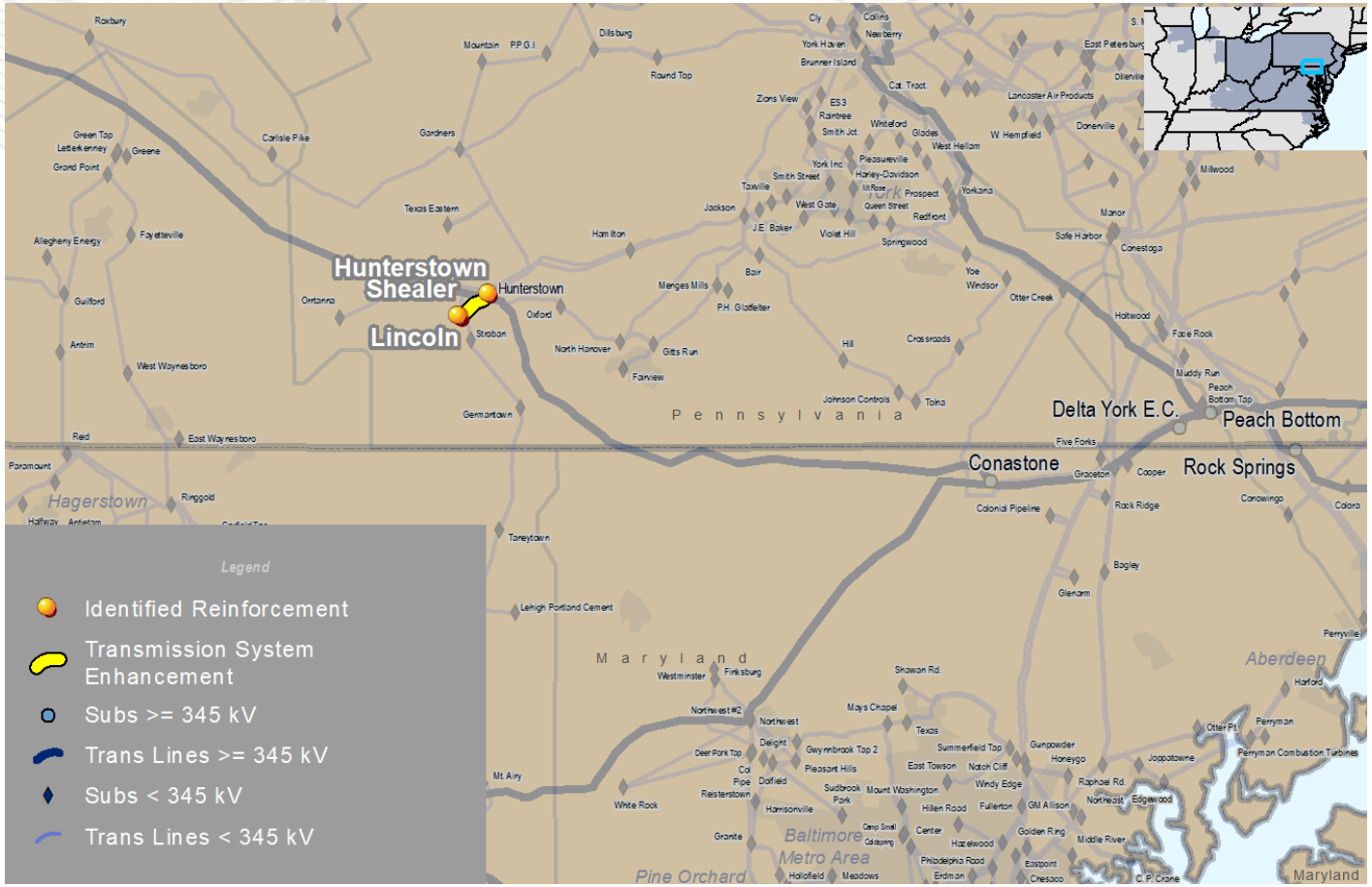
In-Service Cost ($M): $19.22

In-Service Year: 2021

Target Zone: METED

ME Constraints:
Huntertown - Lincoln 115 kV

Notes:



HL_453

Project ID: 201819_HL_453

Proposed Solution:
Build a 25 MW 4-hour battery to be connected to Lincoln 115 kV station. Upgrade Lincoln 115 kV substation.

kV Level: 115 kV

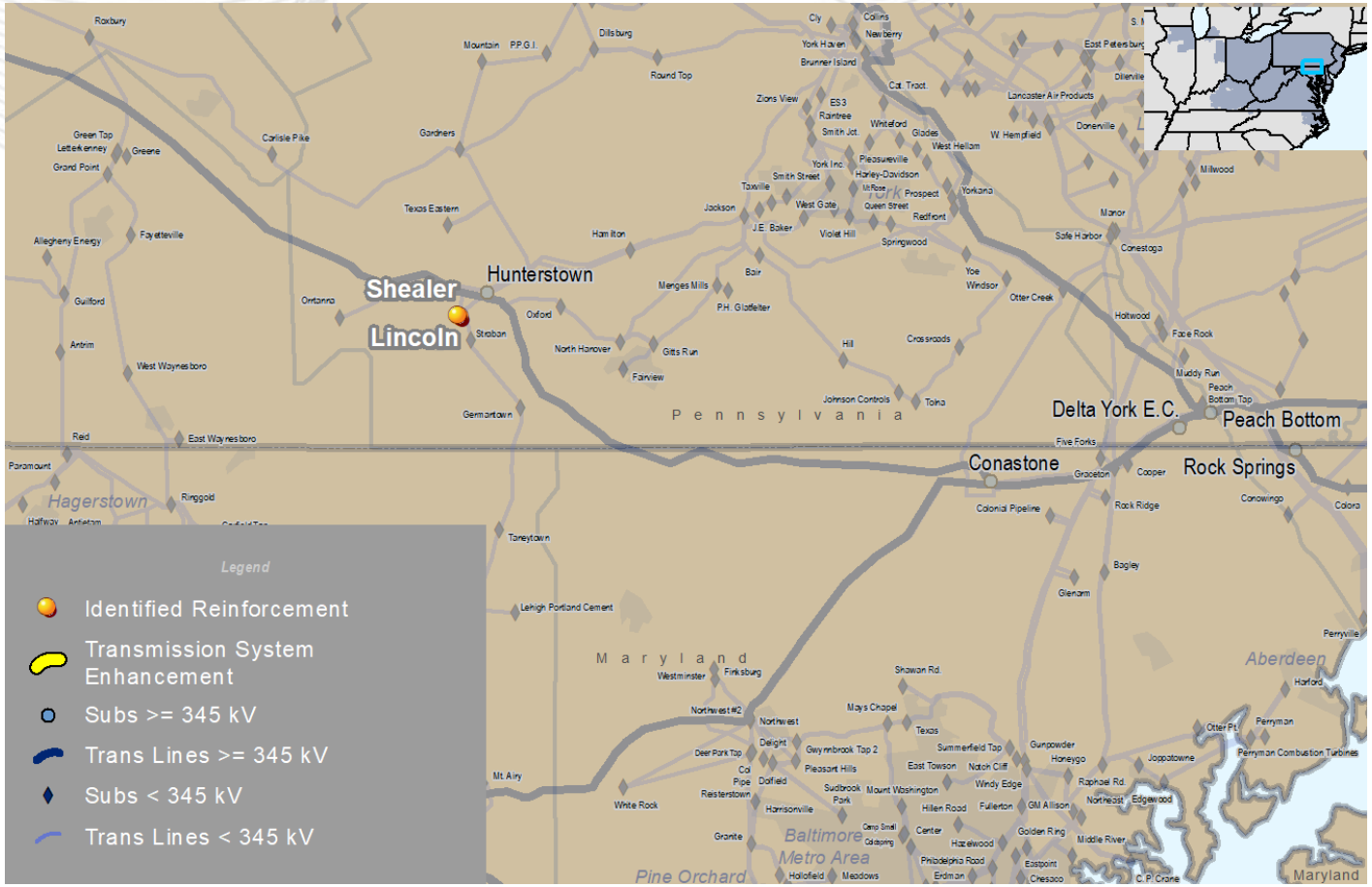
In-Service Cost ($M): $26.69

In-Service Year: 2021

Target Zone: METED

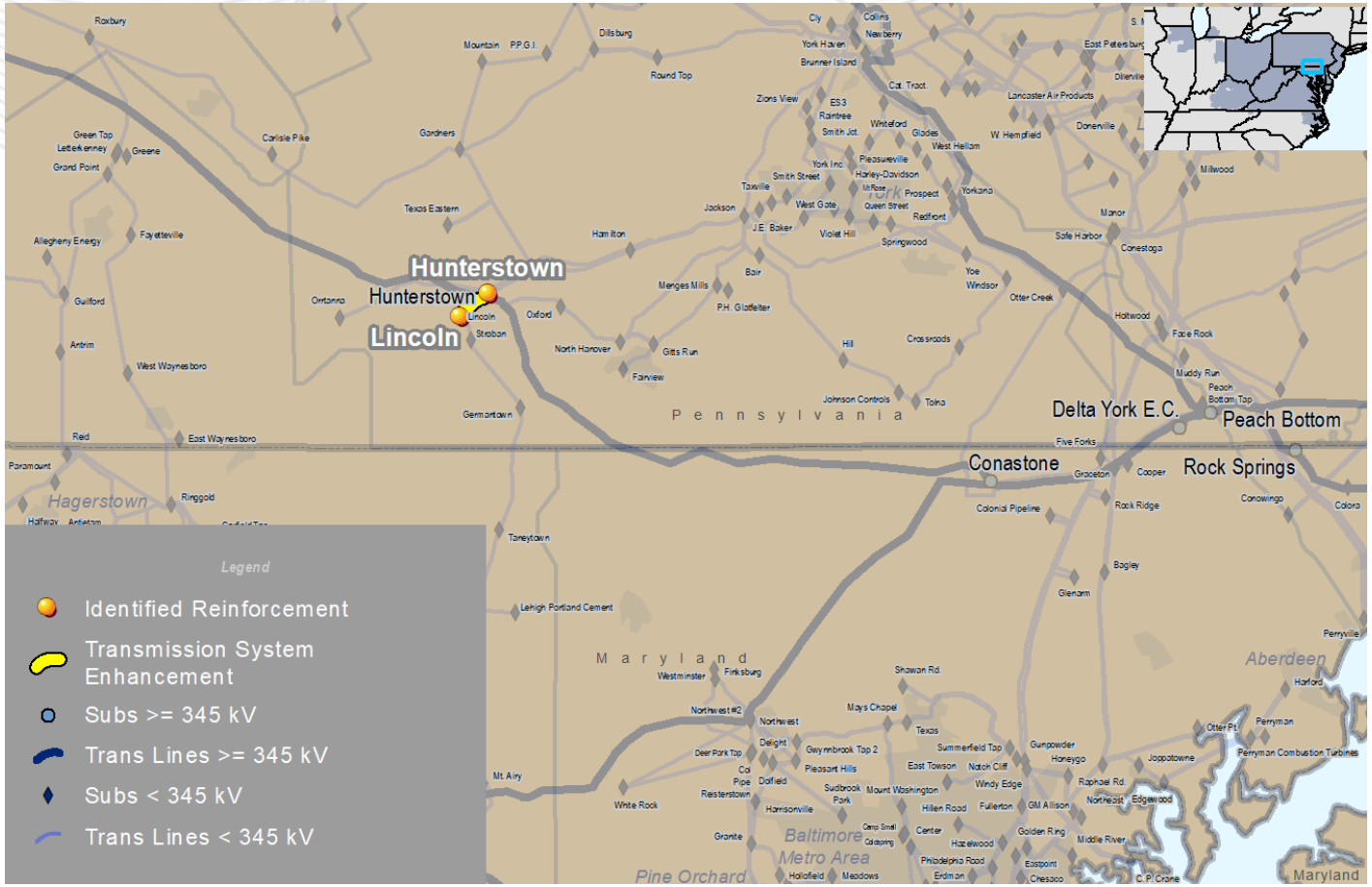
ME Constraints:
Huntertown - Lincoln 115 kV

Notes:



HL_469

Project ID: 201819_HL_469
Proposed Solution: Smart Wire with 5% of series reactance along the Lincoln Tap-Hunterstown 115 kV line.
kV Level: 115 kV
In-Service Cost ($M): $4.65
In-Service Year: 2022
Target Zone: METED
ME Constraints: Huntertown - Lincoln 115 kV
Notes:



HL_511

Project ID: 201819_HL_511

Proposed Solution:
Install a new 115 kV ring bus at the Orrtanna tap point of Hunterstown-Orrtanna-Lincoln 115 kV 963 line and tap into Hunterstown-Lincoln 115 kV 963 line. Construct a new Otter Creek 500/230 kV substation and tap into TMIS-Furnace Run 500 kV line. Connect the new Otter Creek 500/230 kV substation to the existing Otter Creek 230 kV station. Upgrade the existing Otter Creek 230 kV switchyard and Otter Creek - Conastone 230 kV line. Replace Face Rock 115/69 kV T1 and T2 transformers. Reconduct/rebuild 1.3 miles of Manor-Graceton 230 kV line. Upgrade Peach Bottom North station.

kV Level: 500 kV

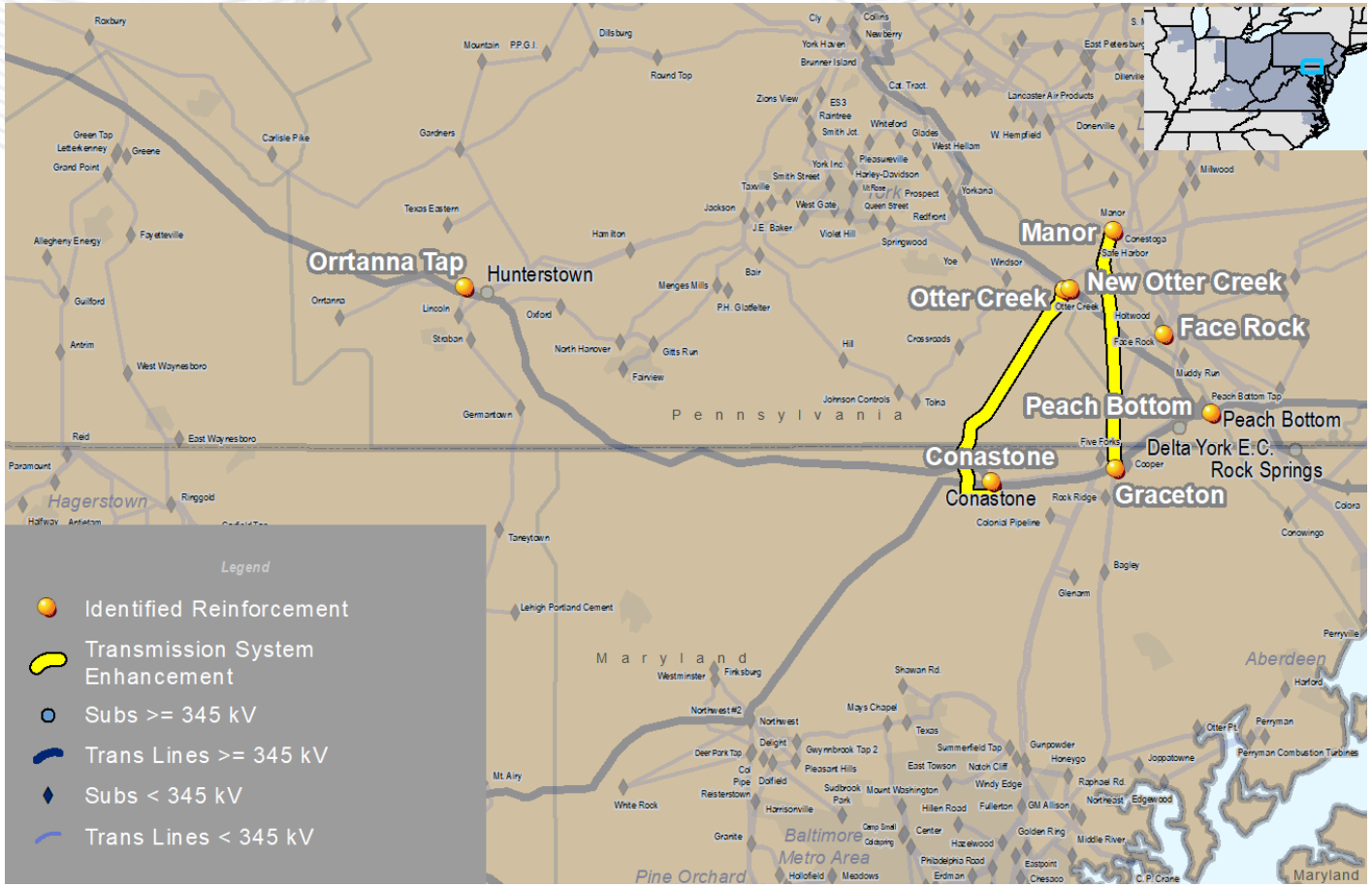
In-Service Cost ($M): $95.47

In-Service Year: 2023

Target Zone: METED

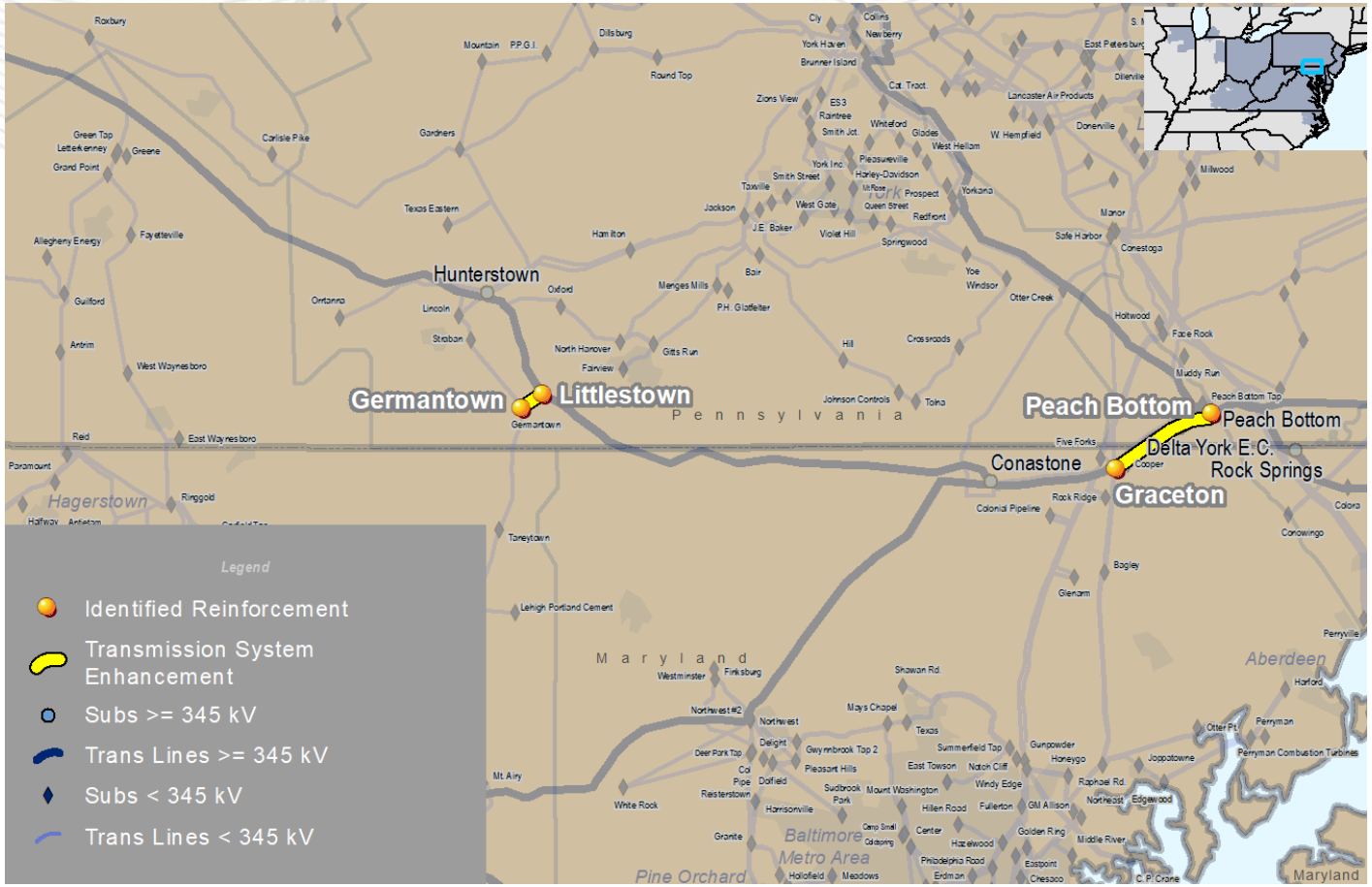
ME Constraints:
Huntertown - Lincoln 115 kV

Notes:



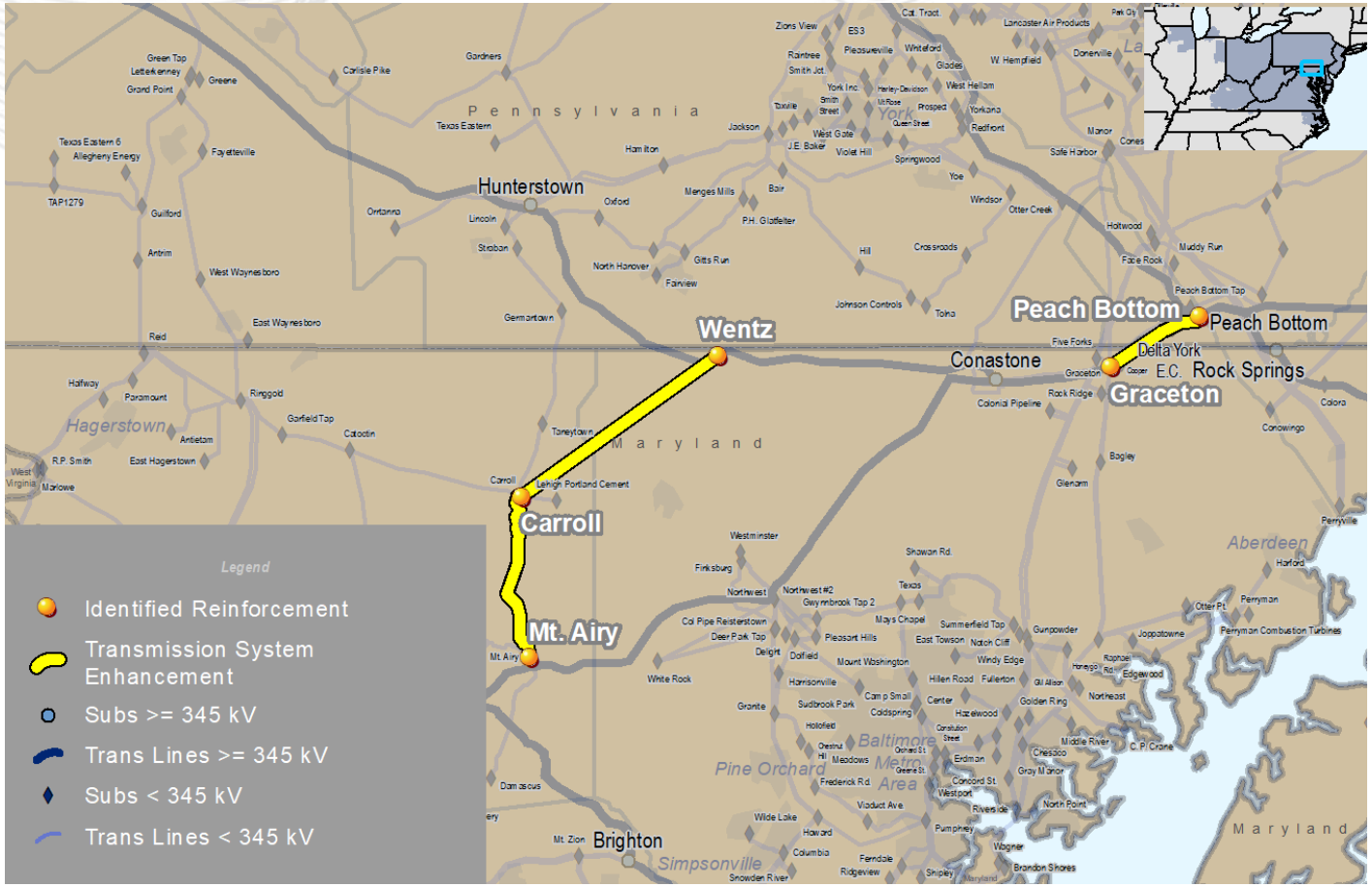
HL_593

Project ID: 201819_HL_593
Proposed Solution: Add a new Littlestown 500 kV substation on Hunterstown-Conastone 500 kV line and a 500/115 kV transformer at Littlestown substation. Add a new Littlestown-Germantown 115 kV line. Add a Peach Bottom 500/230 kV transformer, add a Peach Bottom-Graceton 230 kV line and reconfigure the 230 kV connections at Peach Bottom into a new switching station.
kV Level: 500 kV
In-Service Cost ($M): $183.69
In-Service Year: 2024
Target Zone: METED
ME Constraints: Huntertown - Lincoln 115 kV
Notes:



HL_616

Project ID: 201819_HL_616
Proposed Solution: Add a new Wentz 500 kV substation on Hunterstown-Conastone 500 kV line and a 500/230 kV transformer at Wentz substation. Add a new Wentz-Carroll 230 kV line. Add a Peach Bottom 500/230 kV transformer, add a Peach Bottom-Graceton 230 kV line and add 230 kV switching station at Peach Bottom. Increase ratings of Carroll-Mt. Airy 230 kV line.
kV Level: 500 kV
In-Service Cost ($M): $290.95
In-Service Year: 2024
Target Zone: METED
ME Constraints: Huntertown - Lincoln 115 kV
Notes:



HL_622

Project ID: 201819_HL_622

Proposed Solution:
Rebuild the Hunterstown-Lincoln 115 kV 962 line. Upgrade limiting terminal equipment at Hunterstown 115 kV and Lincoln 115 kV substations.

kV Level: 115 kV

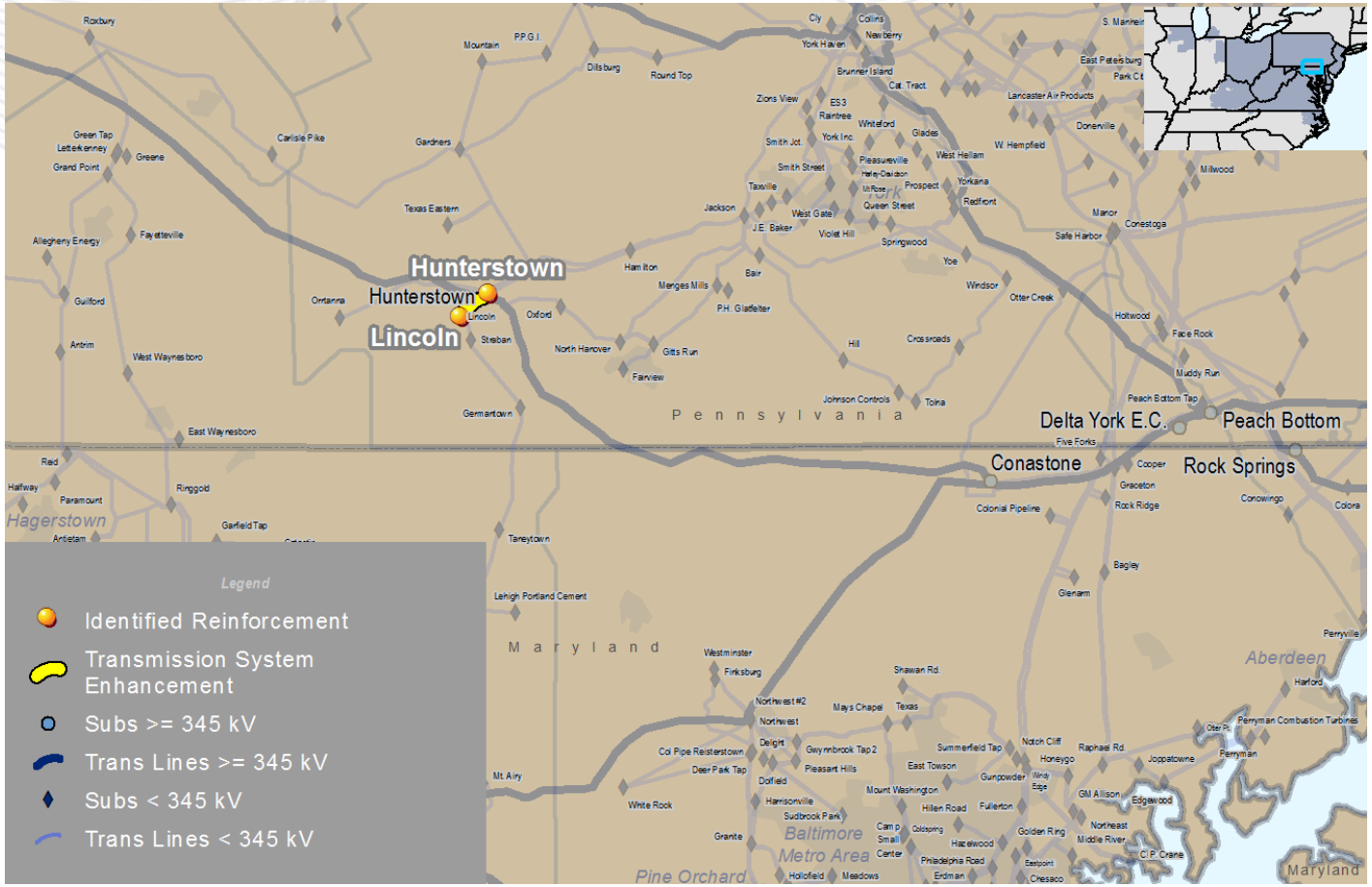
In-Service Cost ($M): $7.21

In-Service Year: 2023

Target Zone: METED

ME Constraints:
Huntertown - Lincoln 115 kV

Notes:



HL_647

Project ID: 201819_HL_647

Proposed Solution:
Install a new 115 kV ring bus at the Orrtanna tap point of Hunterstown-Orrtanna-Lincoln 115 kV 963 line and tap into Hunterstown-Lincoln 115 kV 963 line. Construct a new Otter Creek 500/230 kV substation and tap into TMIS-Furnace Run 500 kV line. Connect the new Otter Creek 500/230 kV substation to the existing Otter Creek 230 kV station.
Upgrade the existing Otter Creek 230 kV switchyard. Replace Face Rock 115/69 kV T1 and T2 transformers.
Reconduct/rebuild 1.3 miles of Manor-Graceton 230 kV line.
Upgrade Peach Bottom North station.

kV Level: 500 kV

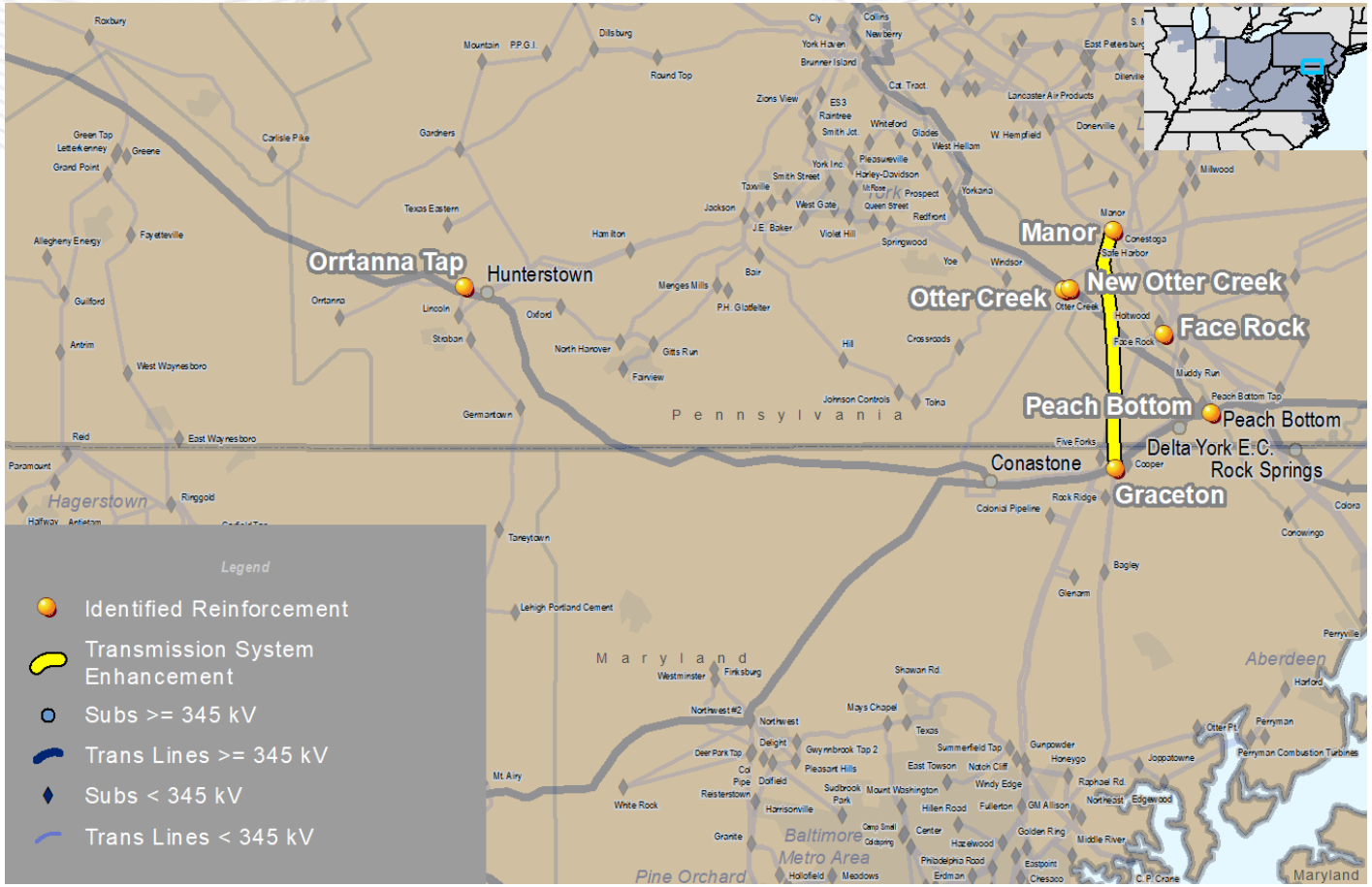
In-Service Cost ($M): $55.12

In-Service Year: 2023

Target Zone: METED

ME Constraints:
Huntertown - Lincoln 115 kV

Notes:



HL_830

Project ID: 201819_HL_830

Proposed Solution:
Add a new Littlestown 500 kV substation on Hunterstown-Conastone 500 kV line and a 500/115 kV transformer at Littlestown substation. Add a new Littlestown-Germantown 115 kV line.

kV Level: 500 kV

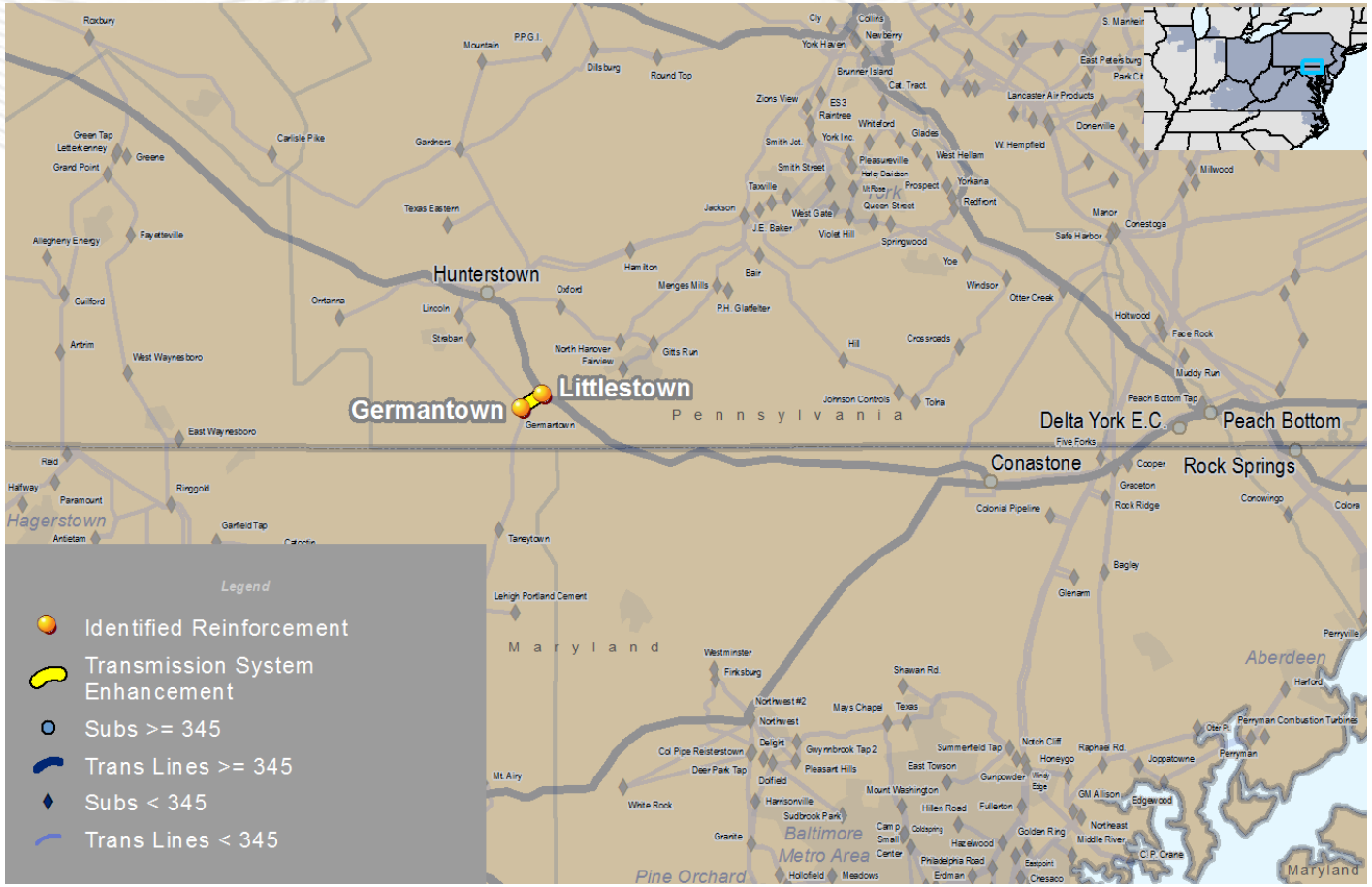
In-Service Cost ($M): $44.92

In-Service Year: 2024

Target Zone: METED

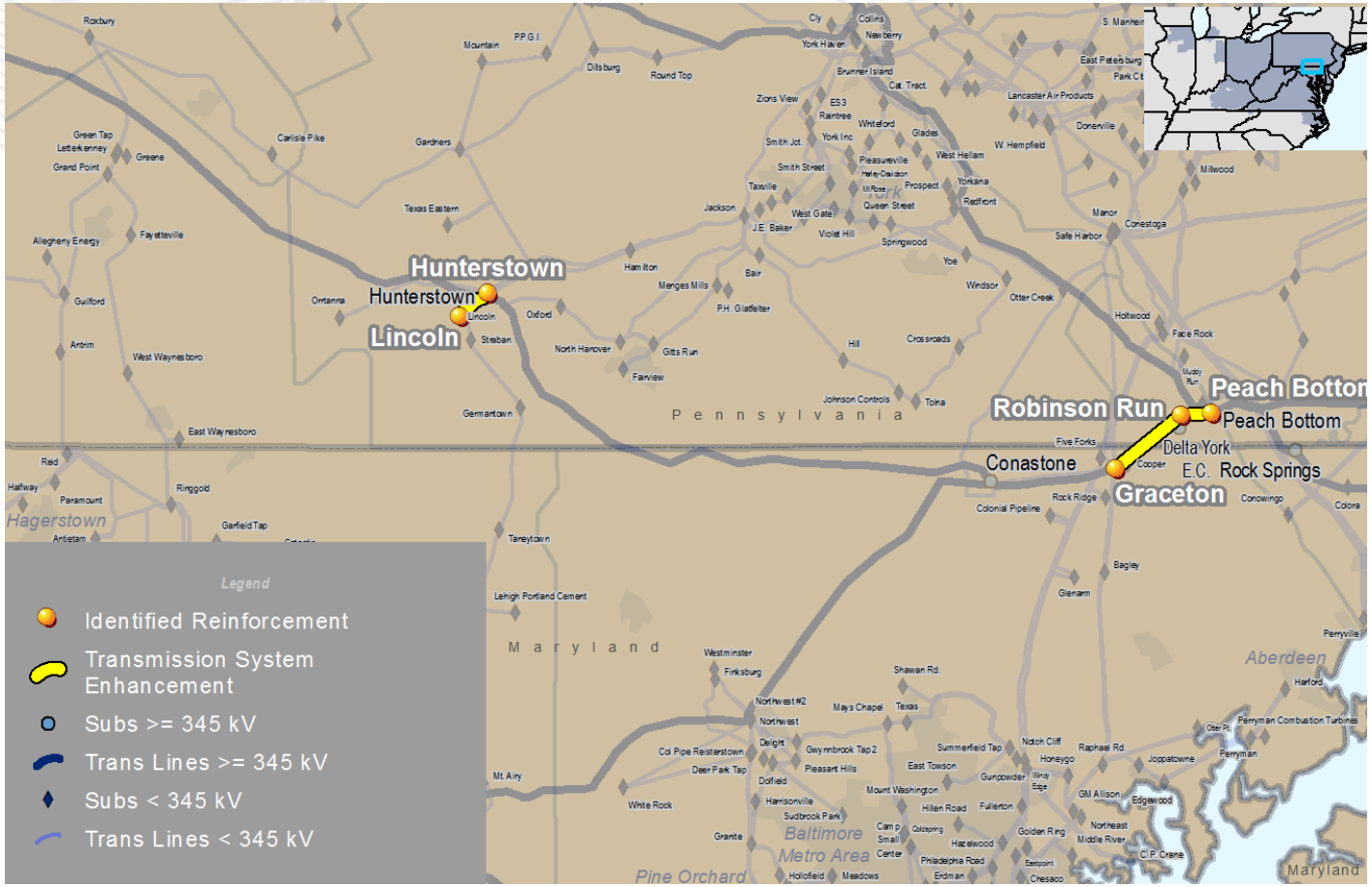
ME Constraints:
Huntertown - Lincoln 115 kV

Notes:



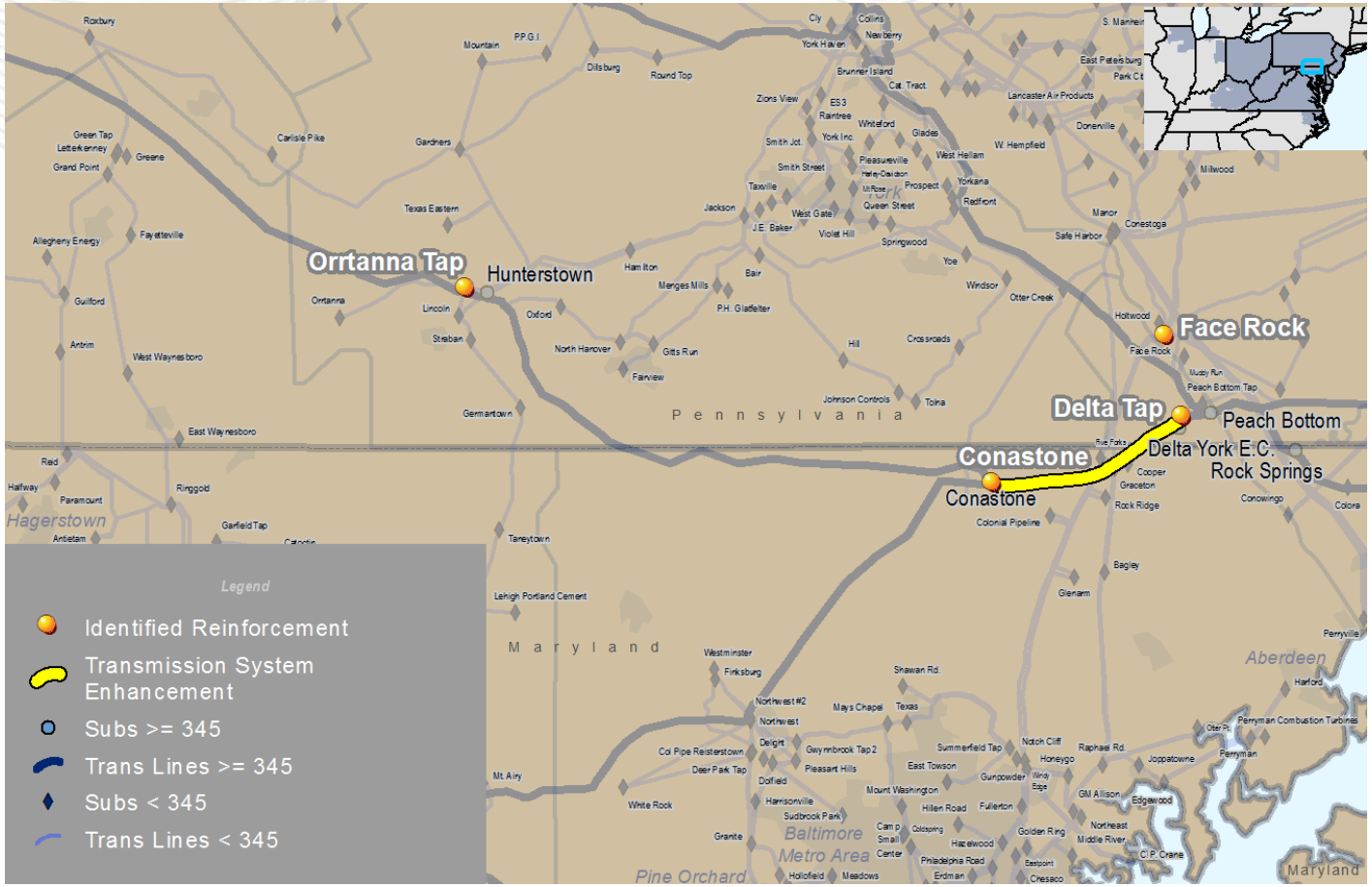
HL_847

Project ID: 201819_HL_847
Proposed Solution: Build a new Robinson Run 500/230 kV substation interconnecting Delta-Peach Bottom 500 kV line. Build Robinson Run-Graceton 230 kV line. Rebuild Cooper-Graceton 230 kV line. Reconductor Hunterstown-Lincoln 115kV line.
kV Level: 230 kV
In-Service Cost ($M): $56.00
In-Service Year: 2023
Target Zone: METED
ME Constraints: Huntertown - Lincoln 115 kV
Notes:



HL_868

Project ID: 201819_HL_868
Proposed Solution: Build a new Delta 500 kV switchyard and tap into Peach Bottom-Delta 500 kV (5034) line. Construct a new Delta Tap Switchyard-Conastone 500 kV line. Install a new 115 kV ring bus at the Orrtanna tap point of Hunterstown-Orrtanna-Lincoln 115 kV 963 line. Replace Face Rock 115/69 kV T1 and T2 transformers.
kV Level: 500 kV
In-Service Cost ($M): $122.08
In-Service Year: 2023
Target Zone: METED
ME Constraints: Huntertown - Lincoln 115 kV
Notes:



HL_892

Project ID: 201819_HL_892

Proposed Solution:
Build a 50 MW 2-hour battery to be connected to Lincoln 115 kV station. Upgrade Lincoln 115 kV substation.

kV Level: 115 kV

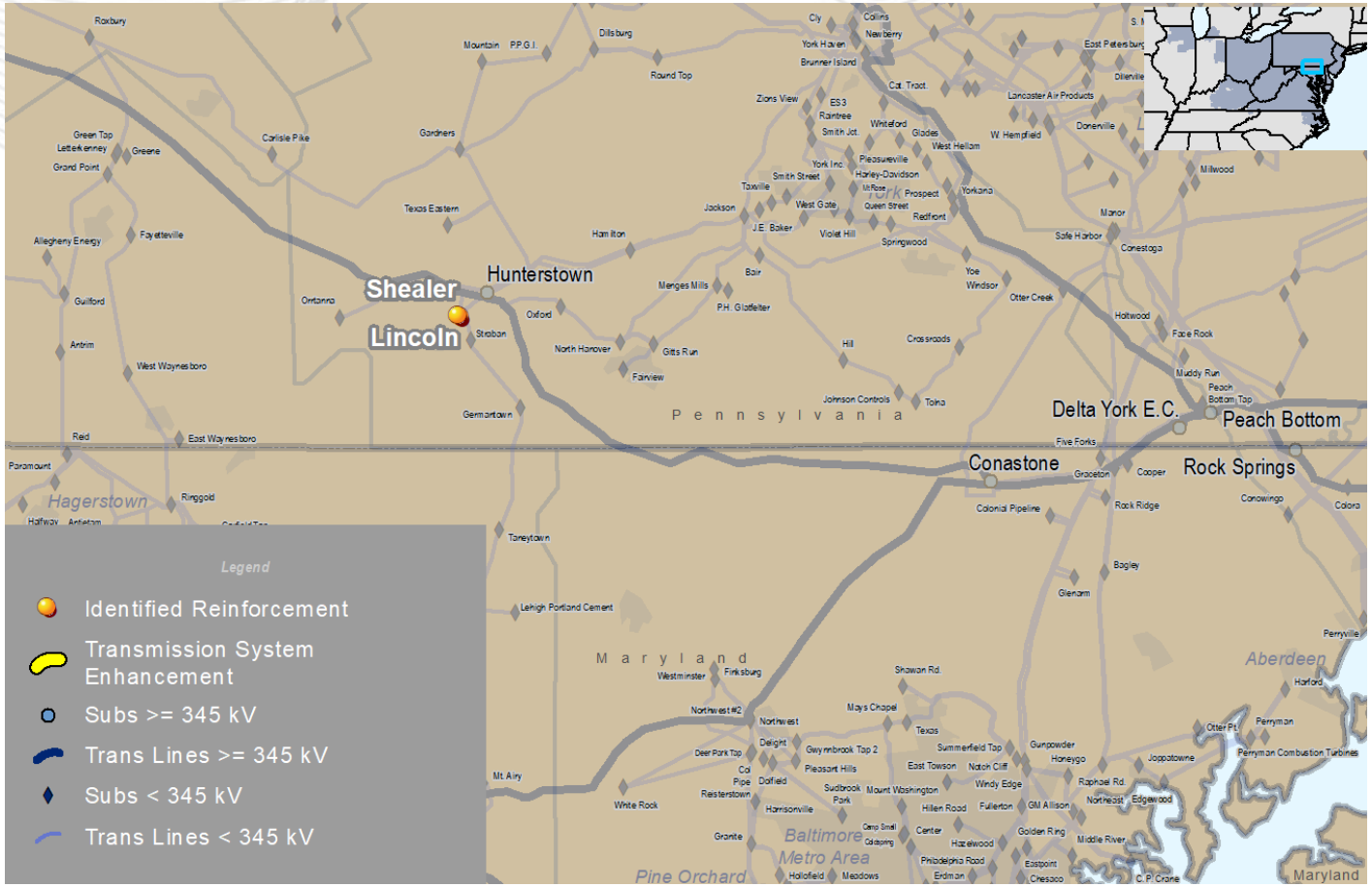
In-Service Cost ($M): $28.98

In-Service Year: 2021

Target Zone: METED

ME Constraints:
Huntertown - Lincoln 115 kV

Notes:



HL_960

Project ID: 201819_HL_960

Proposed Solution:
Construct a new Hunterstown-Lincoln 115 kV line. Upgrade Hunterstown 115 kV and Lincoln 115 kV substations.

kV Level: 115 kV

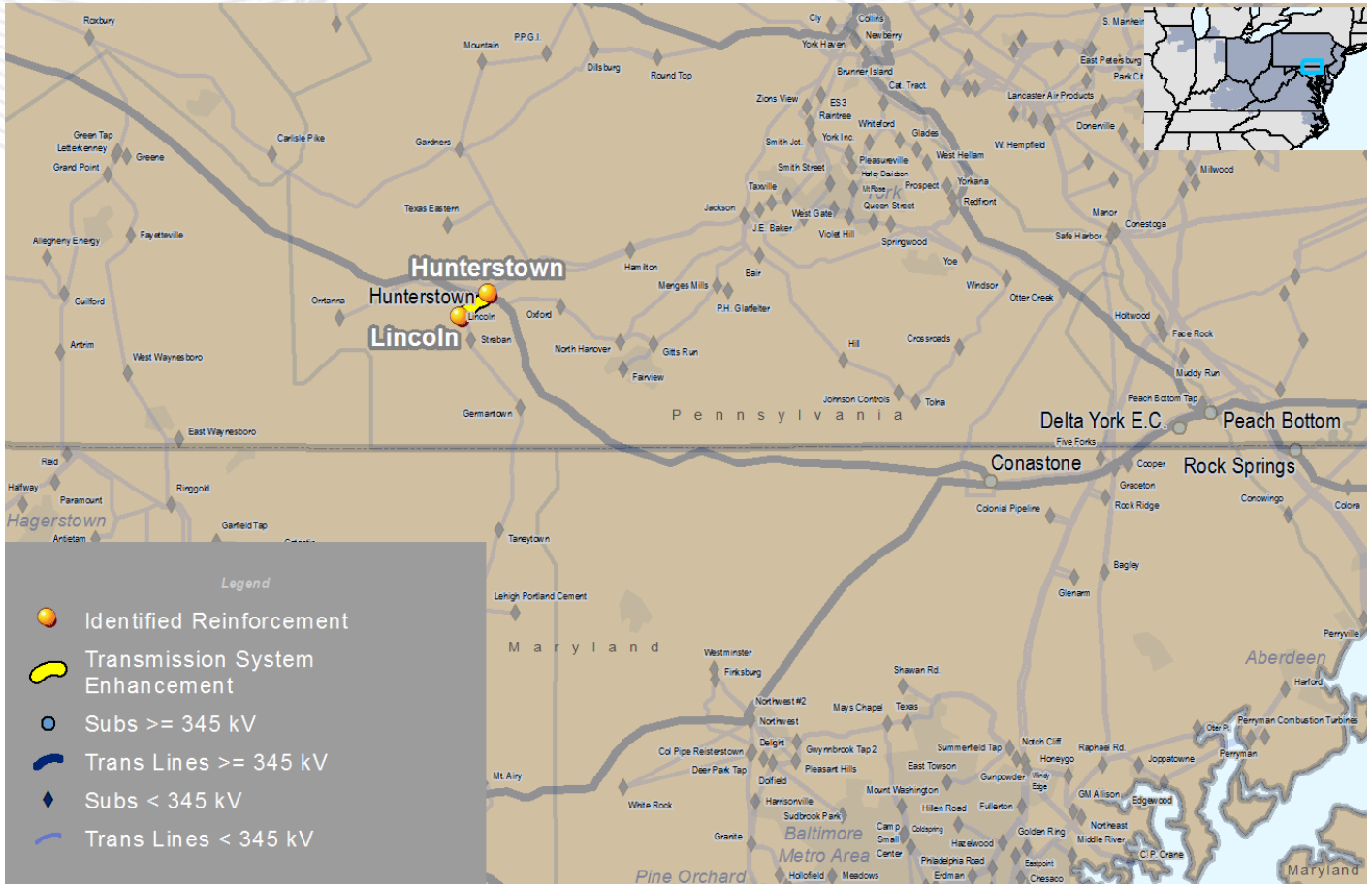
In-Service Cost ($M): $10.13

In-Service Year: 2021

Target Zone: METED

ME Constraints:
Huntertown - Lincoln 115 kV

Notes:



Revision History

7/8/2019 – V1 – Original version posted to pjm.com

7/9/2019 – V2 – Corrections are listed below

- Slide 3 – added note about base case topology
- Slide 6 – added note about SmartWire scope
- Slides 7-10 – clarified which lines are new
- Slide 16 – added Shifted Congestion Analysis task