Reliability Analysis Update

Sub Regional RTEP Committee

PJM West

July 26, 2016

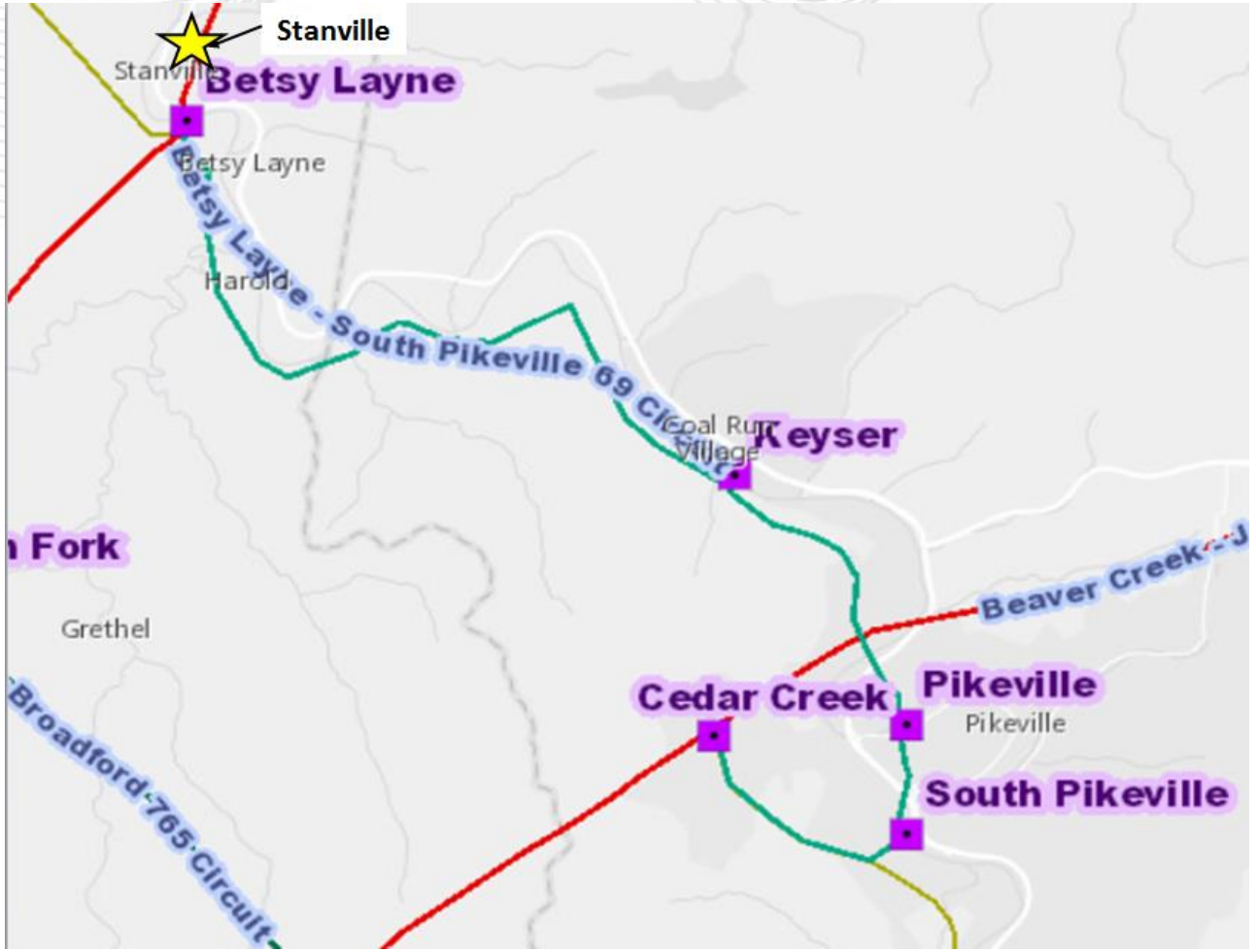
AEP Transmission Zone

- **AEP Criteria Violation**
- The Betsy Layne 138/69/46KV transformer is overloaded and voltage deviation violations occur at Pikeville and South Pikeville 69kV stations for the loss of the Cedar Creek 138/69kV transformer; Betsy Layne station is currently located in a flood plain and has severe access issues
- Retire Betsy Layne station and replace it with the greenfield Stanville station about a half mile north of the existing Betsy Layne station. (B2750.1)
- Relocate the capacitor bank to the 69 kV bus at Stanville and increasing the size (the current 9.6 MVAr capacitor at Betsy Layne is located on the 46 kV bus) to 14.4 MVAr. (B2750.2)
- **Immediate Need**
- Due to the timing of the need for the reinforcement an RTEP proposal window is infeasible
- **Alternatives Considered**
  - Upgrade the size of the 138/69/46 kV transformer at Betsy Layne. Install a 14.4 MVAR 69 kV capacitor bank.

  The current Betsy Layne station is confined from expansion. Access issues to the station (single lane railroad bridge) would make it physically improbable that a larger bank could be delivered to the existing station site. The station site is prone to flooding. Ability to deliver a mobile transformer to the site is doubtful (access issues) under outage scenarios.

  - Install a redundant 138/69 kV bank at Cedar Creek station.

  This solution would solve the violations for loss of the existing Cedar Creek transformer, but would not resolve the issues for a loss of the Cedar Creek – South Pikeville 69 kV line.
- **Construction Designation**
- Due to the immediate need, the local Transmission Owner will be the Designated Entity
- Estimated Project Cost: $14.0M
- Required IS Date: 12/1/2016



AEP Transmission Zone

- **Modification to existing approved baseline project (B2609.4)**

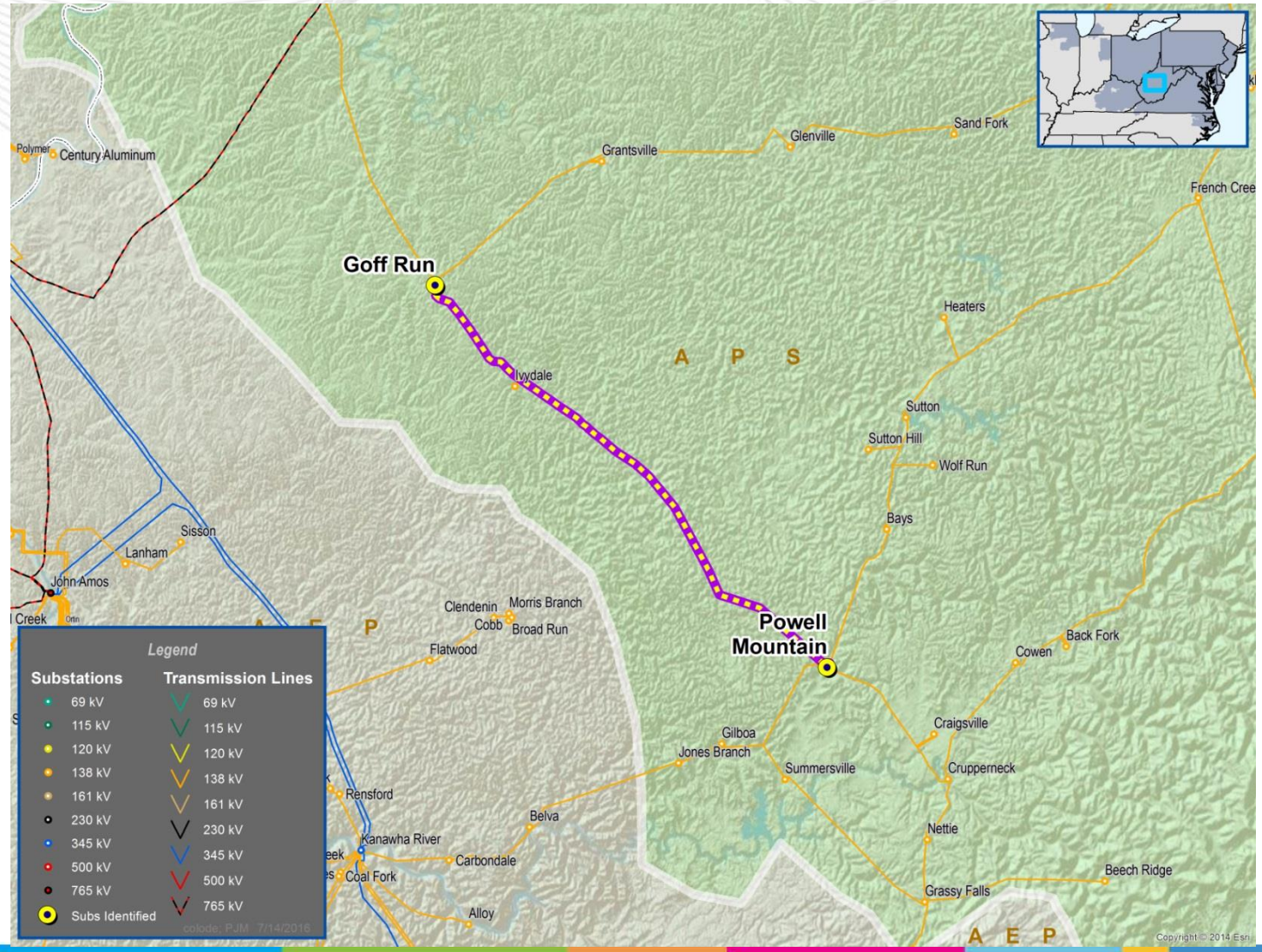
- **Old Scope:**
- Establish new 138 kV tap substation on Powell Mountain - Goff Run, construct 15 miles of new 138 kV line from Thorofare Creek to the new 138 kV tap substation, establish Chloe 138 kV substation

- **New Scope:**
- Establish the new Chloe 138 kV substation tapping the Powell Mountain - Goff Run 138 kV line, construct 25 miles of new 138 kV line from Thorofare Creek to the new Chloe 138 kV substation

- **Reason:**
  - It is subject to the approved CPCN and Joint Stipulation that modified that project component by adding 10 miles of new line to support the future enhancement of the reliability of the APCO distribution system, as ordered by the Public Service Commission of West Virginia.
  - (new line will be routed to accommodate the future Walton 138 kV substation (separate project to support future distribution substation) as ordered by the Public Service Commission of West Virginia).

- Old Estimated Project Cost: $59.5M
- New Estimated Project Cost: $72.0M

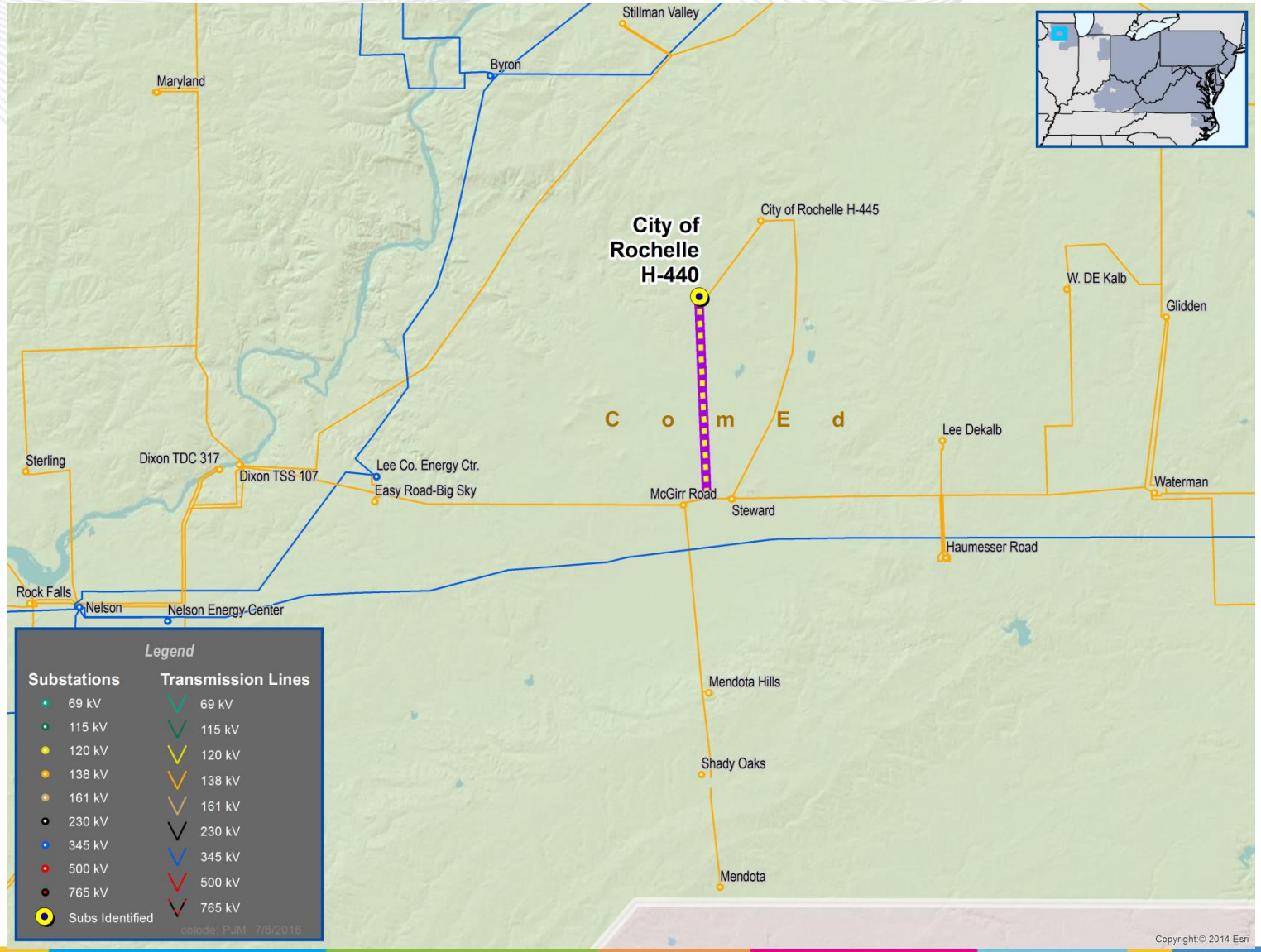
- Required IS Date: 6/1/2019



Rochelle Municipal (RMU) Transmission Zone

- **Generator Deliverability Violation**

- The H440 – H440 Tap 138KV Line is overloaded for the loss of the H440 tap – Steward 138kV line
- Rebuild/Resag the H440 – H440 Tap 138KV Line 16914-2 (Hays Road to SW 1403) (B2751)
- Reason: Line ratings update on the overloaded facility
- Immediate Need
  - Due to the timing of the need for the reinforcement an RTEP proposal window is infeasible
- Alternatives Considered
  - Due to the immediate need of the project no alternatives were considered
- Construction Designation
  - Due to the immediate need, the local Transmission Owner will be the Designated Entity
- Estimated Project Cost: $3.5M
- Required IS Date: 6/1/2016
- Projected IS Date: 6/28/2017



- **NERC Reliability Violation**

- Moundsville Power IPP queues (Y3-068 and Z2-048) combined have a signed ISA with IPP responsibility of $24,561,400 including largely 69kV upgrades to eliminate violations with otherwise minimal system benefits. Backfeed date is March 1, 2018 and Commercial Operation Date is January 1, 2019.
- After the ISA's were signed, AEP identified that a George Washington bus conductor overloaded when the bus tie is open
- There are tight physical constraints, the nearby environmental issues and the age of the existing structure. To simply upgrade the existing bus work would require a very extensive (months at least) total outage of the 138kV bus at George Washington. This would be even less likely to happen after the IPP connects. It still would be left with a configuration that is not very flexible, expandable, or reliable

- New Plan:

  Cancel:
  - N4200:Install two (2) new 138 kV circuit breakers to connect the proposed generation. SCADA, 138 kV revenue metering, and associated equipment will also need to be installed.
  - N4205: Replace the George Washington 138/69 kV TR #2
  - N4201: Line protections and controls at the existing George Washington 138 kV station will need to be upgraded.
  - N4202: Replace the George Washington 138/69 kV TR #2
  - N4203: Replace "D" , "F", and "G" CBs at Geo Washington Substation
  - N4204: Replace "D" , "F", and "G" CBs at Geo Washington Substation
  - N4206: Rebuild the entire 5.83 mile section of DILLES - SHADYSID 69 kV line
  - N4207: Rebuild the entire 5.02 mile section of Glendale- Brues 69 kV

George Washington Station – Replace existing 138kV yard with GIS 138kV breaker and a half yard in existing station footprint. Install 138kV revenue metering for new IPP connection. (N5076.1/B2753.1) --AEP

Dilles Bottom Station – Replace Dilles Bottom 69/4kV Distribution station as breaker and a half 138kV yard design including AEP Distribution facilities but initial configuration will constitute a 3 breaker ring bus. (N5076.2/B2753.2) --AEP

Holloway Station – Connect two 138kV 6-wired ckts from "Point A" (currently de-energized and owned by First Energy) in ckt positions previously designated Burger #1 & Burger #2. Install interconnection settlement metering on both circuits exiting Holloway station. (N5076.3/B2753.3) --AEP

AEP/ATSI Transmission Zone

Holloway-"Point A" FE "Burger-Cloverdale No.2" 138kV Line – 6 wire "Burger-Cloverdale No. 2" 138kV Line for double capacity and connect at Holloway and "Point A" (N5076.4/B2753.4)--FE

Holloway-"Point A" FE "Burger-Longview" 138kV Line – 6 wire "Burger-Longview" 138kV Line for double capacity and connect at Holloway and "Point A" (N5076.5/B2753.5)--FE

Dilles Bottom-"Point A"138kV Line - Build dbl ckt 138kV line from Dilles Bottom to "Point A". Tie each new AEP ckt in with a 6 wired line at Point A. This will create a Dilles Bottom-Holloway 138kV ckt and a George Washington-Holloway circuit. (N5076.6/B2753.6) --AEP

Dilles Bottom-Bellaire and Moundsville-Dilles Bottom 69kV Lines - Retire line sections south of First Energy 138kV line corridor, near "Point A". Tie George Washington-Moundsville 69kV ckt to George Washington-West Bellaire 69kV ckt (N5076.7/B2753.7) --AEP

Washington-Dilles Bottom 69kV Line – Rebuild existing line as dbl ckt 138kV from George Washington to Dilles Bottom. One circuit will cut into Dilles Bottom initially and the other will go past with future plans to cut in. (N5076.8/B2753.8) --AEP

- Immediate Need
- Due to the timing of the need for the reinforcement an RTEP proposal window is infeasible

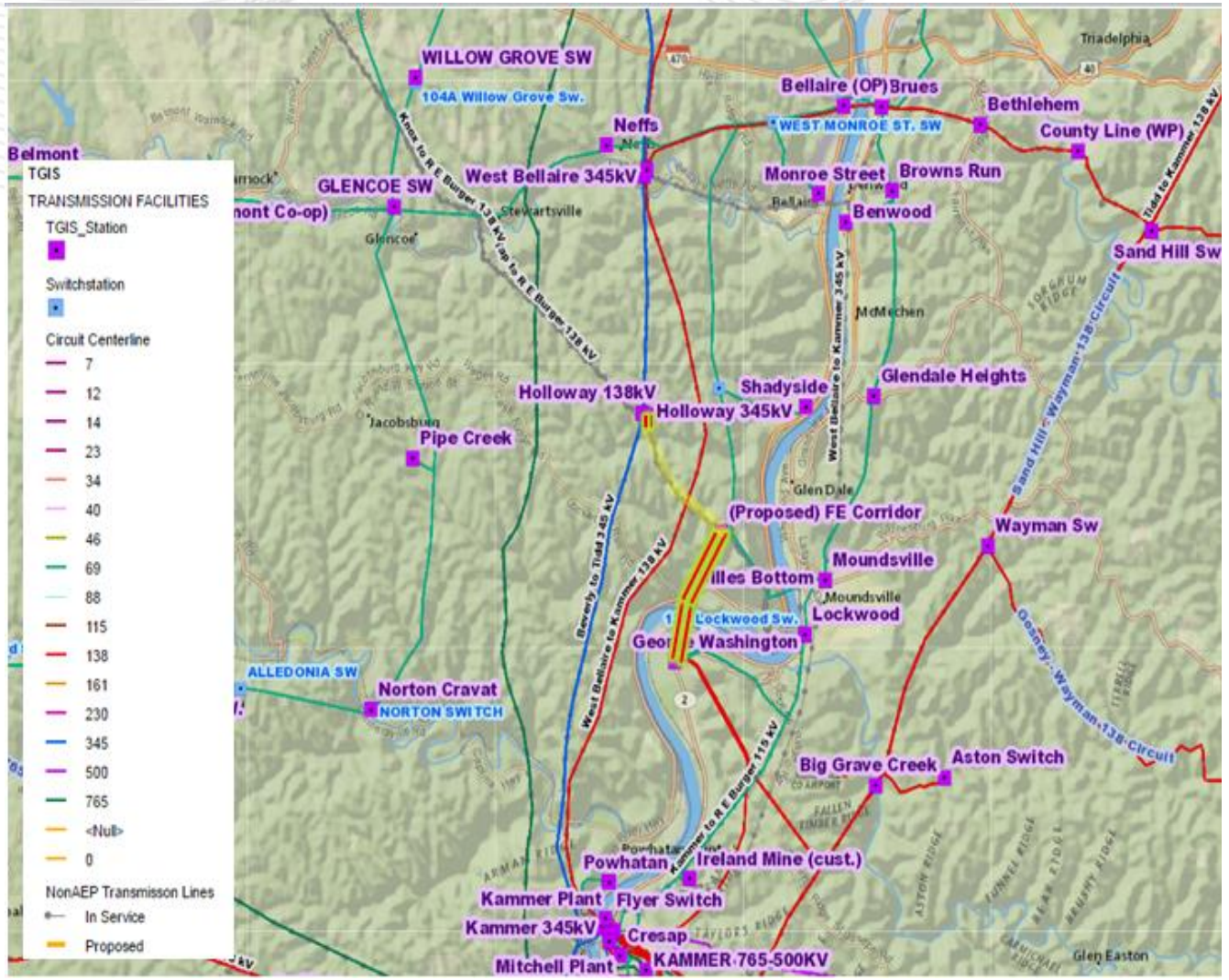
- Fixed Project Cost: $24.5614M (N5076.1-8)
- Estimated Project Cost: $25M (B2753.1-8)
  - B2753.1: $0M
  - B2753.2: $9M
  - B2753.3: $2M
  - B2753.4: $0.25M
  - B2753.5: $0.25M
  - B2753.6: $5M
  - B2753.7: $4.96M
  - B2753.8: $3.56M

AEP/ATSI Transmission Zone

- **Alternatives Considered**
  1. Upgrade / Rebuild George Washington bus work in place to alleviate overload. This would require outage of all 138kV facilities at George Washington for several months due to the existing interlaced bus configuration and the older facilities involved. Most likely the entire yard would need to be wrecked out and replaced and would make meeting the IPP milestones impossible. This is not acceptable.
  2. Expand the George Washington 138 kV yard to replace the existing yard. Any expansion would still need to tie in with existing bus work unless full replacement is done. The station is bounded by houses, mountains, and highway. No space is available and timing is not conducive to expanding and replacing the yard via conventional means. Given all constraints, this alternative is not feasible.
  3. Relocate the essentials of the George Washington 138kV yard to a new greenfield site. Surrounding the station are significant mountains, houses, and a highway. Across the highway is an EPA superfund site which would make any such endeavor prohibitively expensive and time consuming. Mountain top siting would also involve significant civil costs and timing issues making milestone dates for the IPP impractical and impossible. The Ohio River is also very nearby further reducing available sites for consideration. This is not acceptable.

- **Construction Designation**
- Due to the immediate need, the local Transmission Owner will be the Designated Entity

- **Required IS Date:** 1/1/2019



Short Circuit Updates

AEP Transmission Zone

Problem: Short Circuit

- The South Canton 138 kV 'K', 'J', 'J1', and 'J2' breakers (63kA) are overstressed

Immediate Need:

- Due to the immediate need, the timing required for an RTEP proposal window is infeasible. As a result, the local Transmission Owner will be the Designated Entity.

Alternatives Considered:

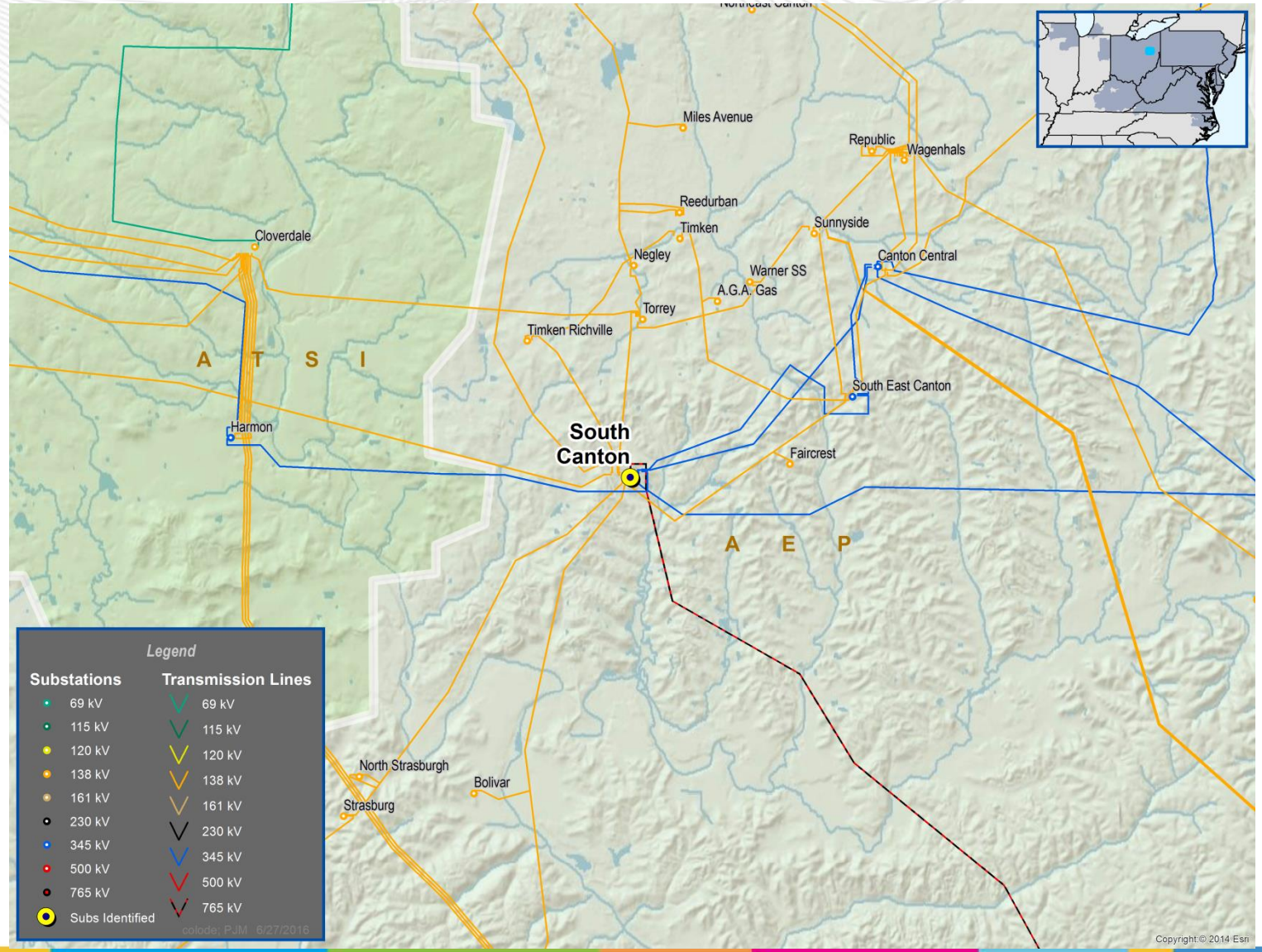
- Due to the immediate need of the project no alternatives were considered

Proposed Solution:

- Replace the South Canton 138 kV breakers 'K', 'J','J1', and 'J2' with 80 kA breakers (b2727)

Estimated Project Cost: $1.2M

Required IS Date: 6/1/2018



ATSI Transmission Zone

Problem: Short Circuit

- The Hoytdale 138 kV '83-B-26' and '83-B-30' breakers (40kA) are overstressed

Immediate Need:

- Due to the immediate need, the timing required for an RTEP proposal window is infeasible. As a result, the local Transmission Owner will be the Designated Entity.

Alternatives Considered:

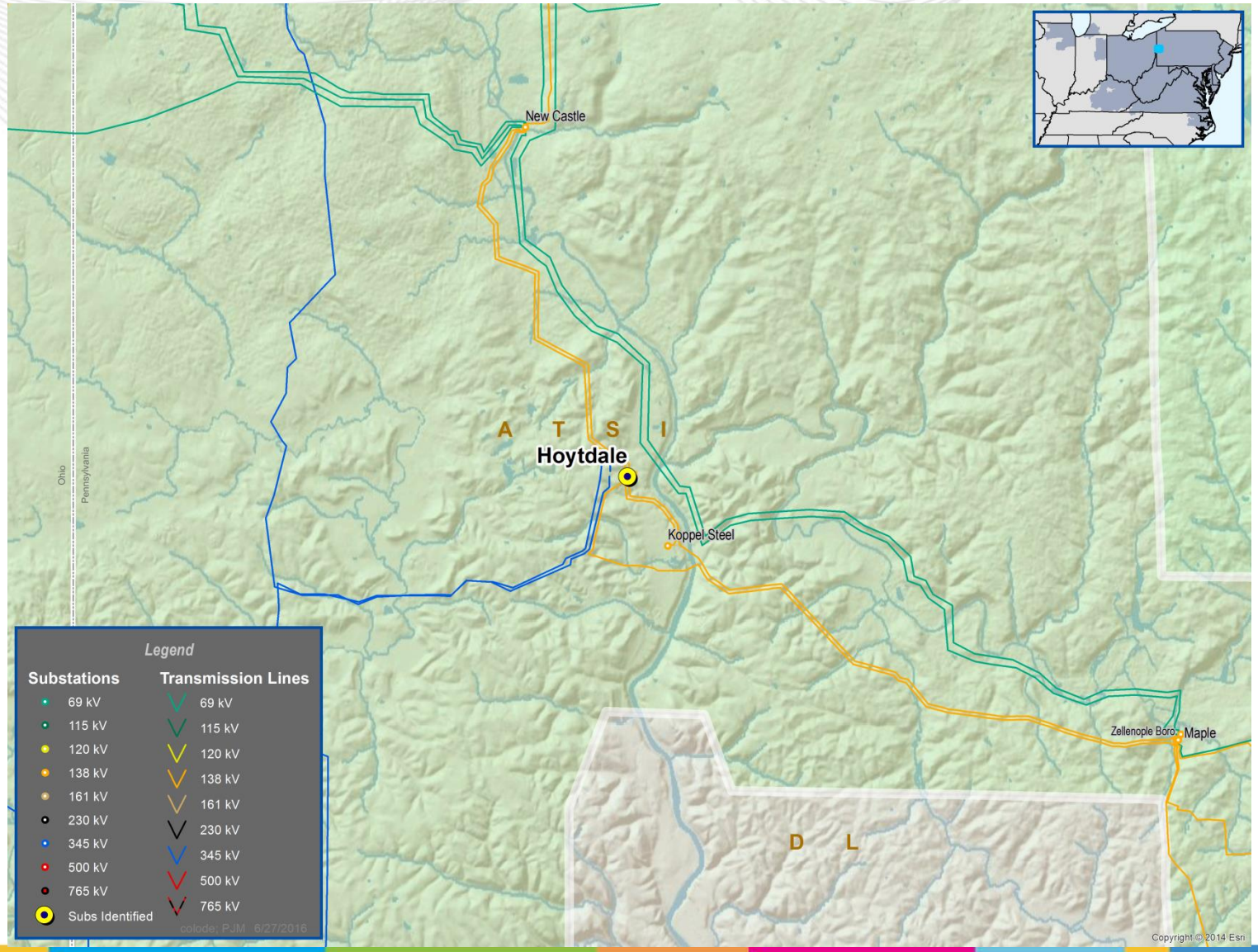
- Due to the immediate need of the project no alternatives were considered

Proposed Solution:

- Replace the Hoytdale 138 kV '83-B-26' and '83-B-30' breakers with 63 kA breakers (b2742)

Estimated Project Cost: $410K

Required IS Date: 6/1/2017



Supplemental Projects

AEP Transmission Zone

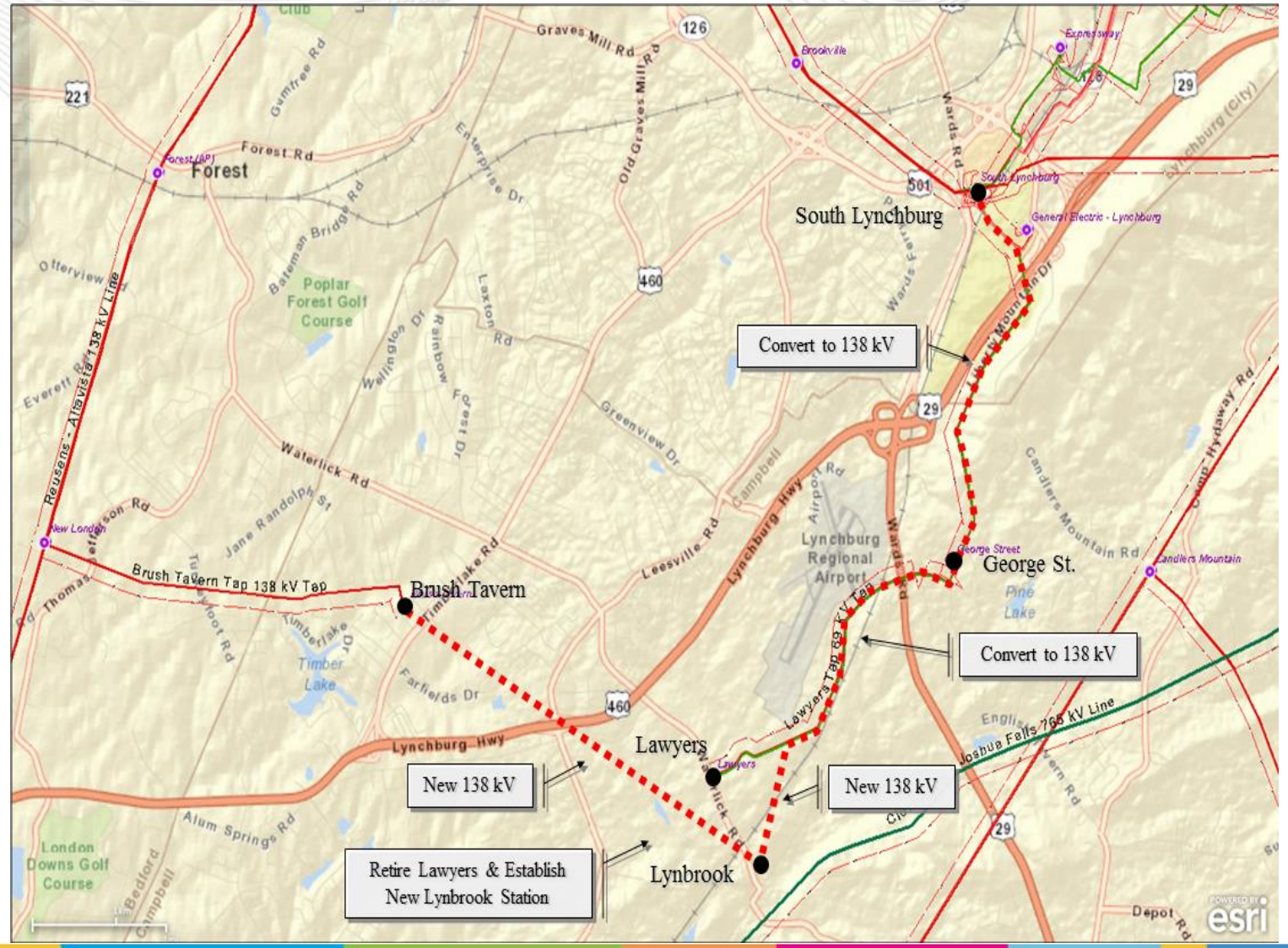
- **Supplemental Project**

- Convert the existing 69 kV Lawyers Tap to 138 kV and construct a new 138 kV line from Brush Tavern to a new Lynbrook Station (retiring Lawyers Station) in order to provide two-way service to Brush Tavern, Lynbrook and George Street. (S1157)

- Provide two-way transmission service to customers in the South Lynchburg area that are currently served radially, representing a current load of approximately 65 MVA that is projected to increase to over 80 MVA by 2017/2018 winter peak. AEP's guideline is to provide two-way service to radial loads greater than 30 MVA.

- Estimated Project Cost: $35M

- Projected IS Date: 6/1/2017



AEP Transmission Zone

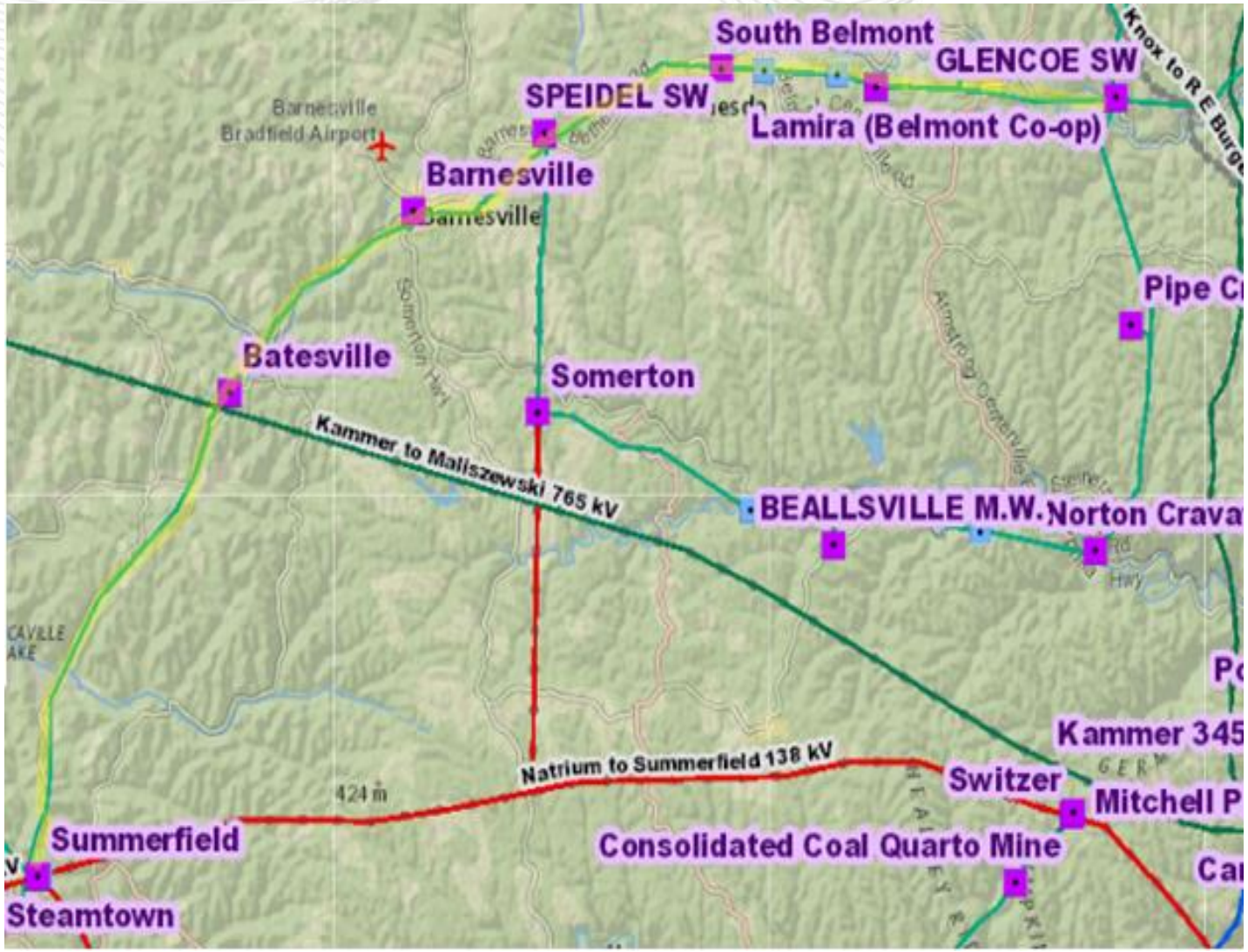
- **Supplemental Project**

- Rebuild and upgrade approx. 32 miles of 69kV line from Summerfield station to Glencoe station. (S1158)

- Reason: Age & deterioration: The 69kV lines between Summerfield, Speidel, and Glencoe range in vintage from 1913 to 1943. The structures and conductors are weak and deteriorated and threaten area reliability. As part of the line rebuild, both conductors and poles will be replaced and upgraded. The majority of the lines will be designed for 138kV with the exception of the route through the city of Barnesville where doing so is not feasible due to ROW constraints.

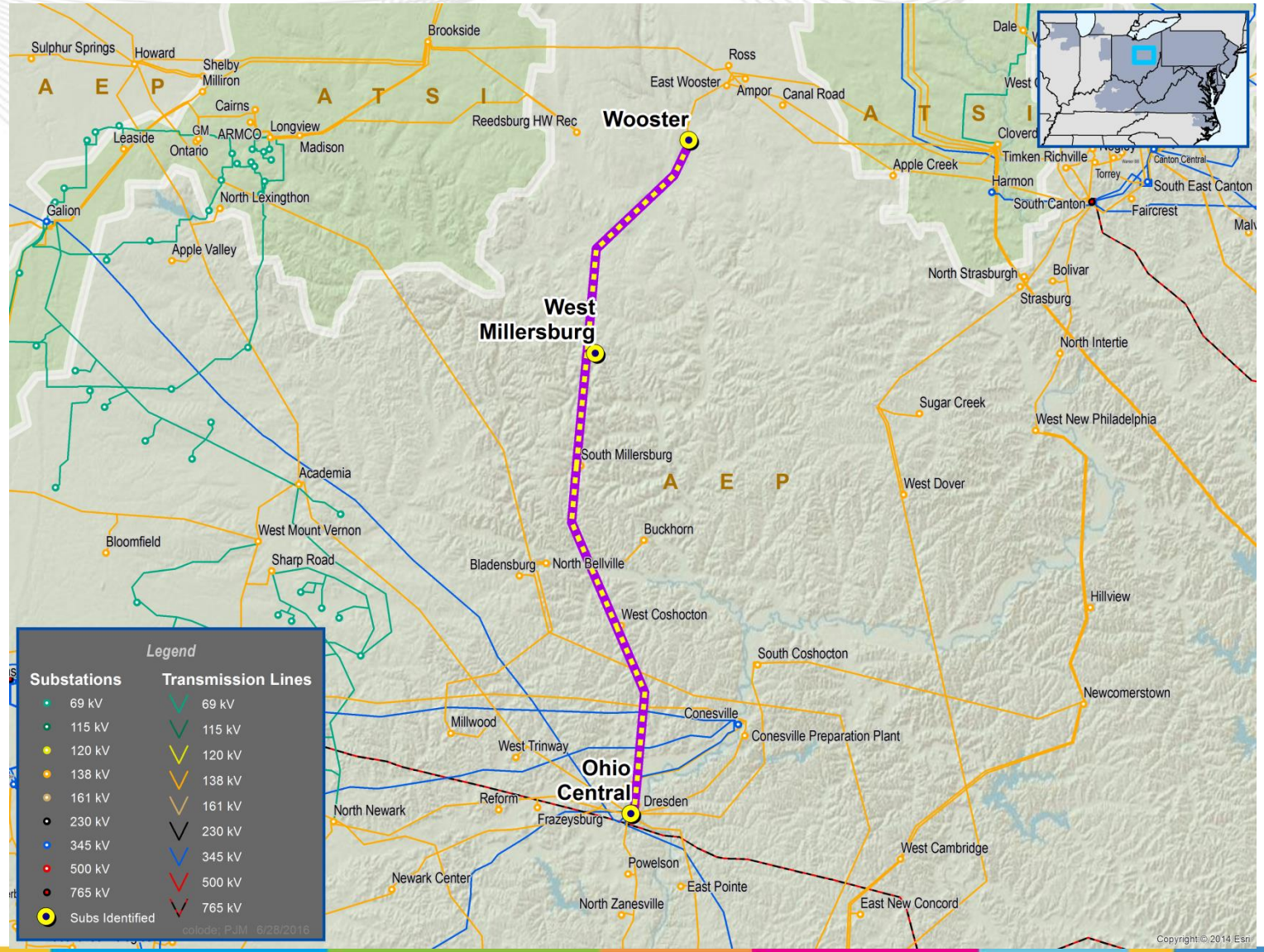
- Estimated Project Cost: $37.2M

- Projected IS Date: 6/1/2019



AEP Transmission Zone

- **Supplemental Project**
- Perform a sag study utilizing LIDAR data to resolve any clearance issues on the Ohio Central-West Millersburg & West Millersburg-Wooster 138kV circuits. (S1159)
- Reliability Improvement
- Estimated Project Cost: $2.1M
- Projected IS Date: 6/1/2017



AEP Transmission Zone

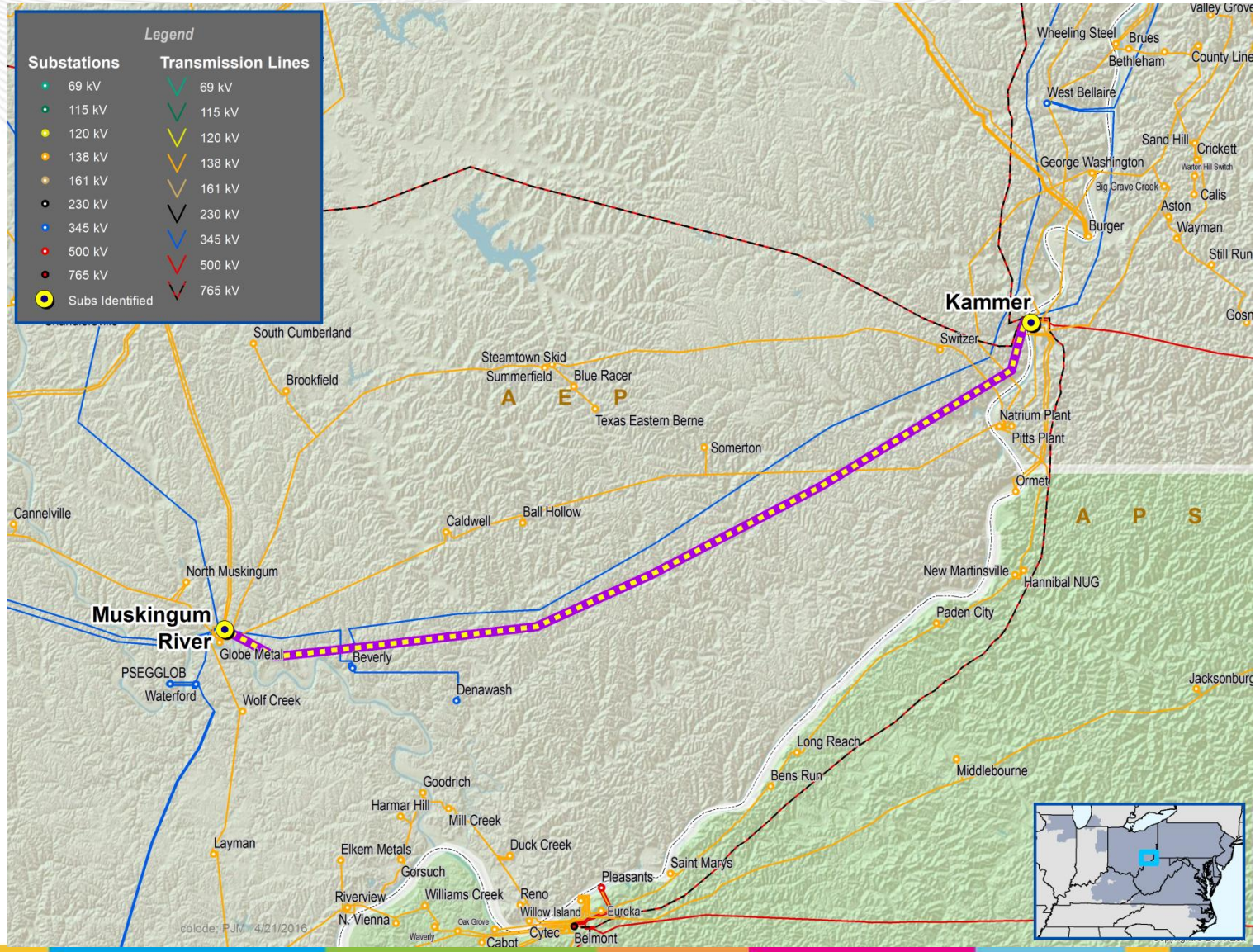
- **Supplemental Project**

- Construct a new 345-138kV substation “Lamping”, connected to AEP’s Kammer-Muskingum 345kV circuit. Build a new 24 mile 138kV circuit from Lamping to Devola substation, serving the R.E.C. customer stations along the way. (S1160)

- This will provide new transmission service to several Buckeye Power co-op delivery points, which have suffered from poor reliability for a number of years on the outdated 23kV distribution system. It is necessary to build to Devola (Mill Creek) station to provide networked service to these customers. In addition, this will provide another 138kV source to AEP’s Devola station, improving reliability and operational flexibility.

- Estimated Project Cost: $68M

- Projected IS Date: 6/1/2022

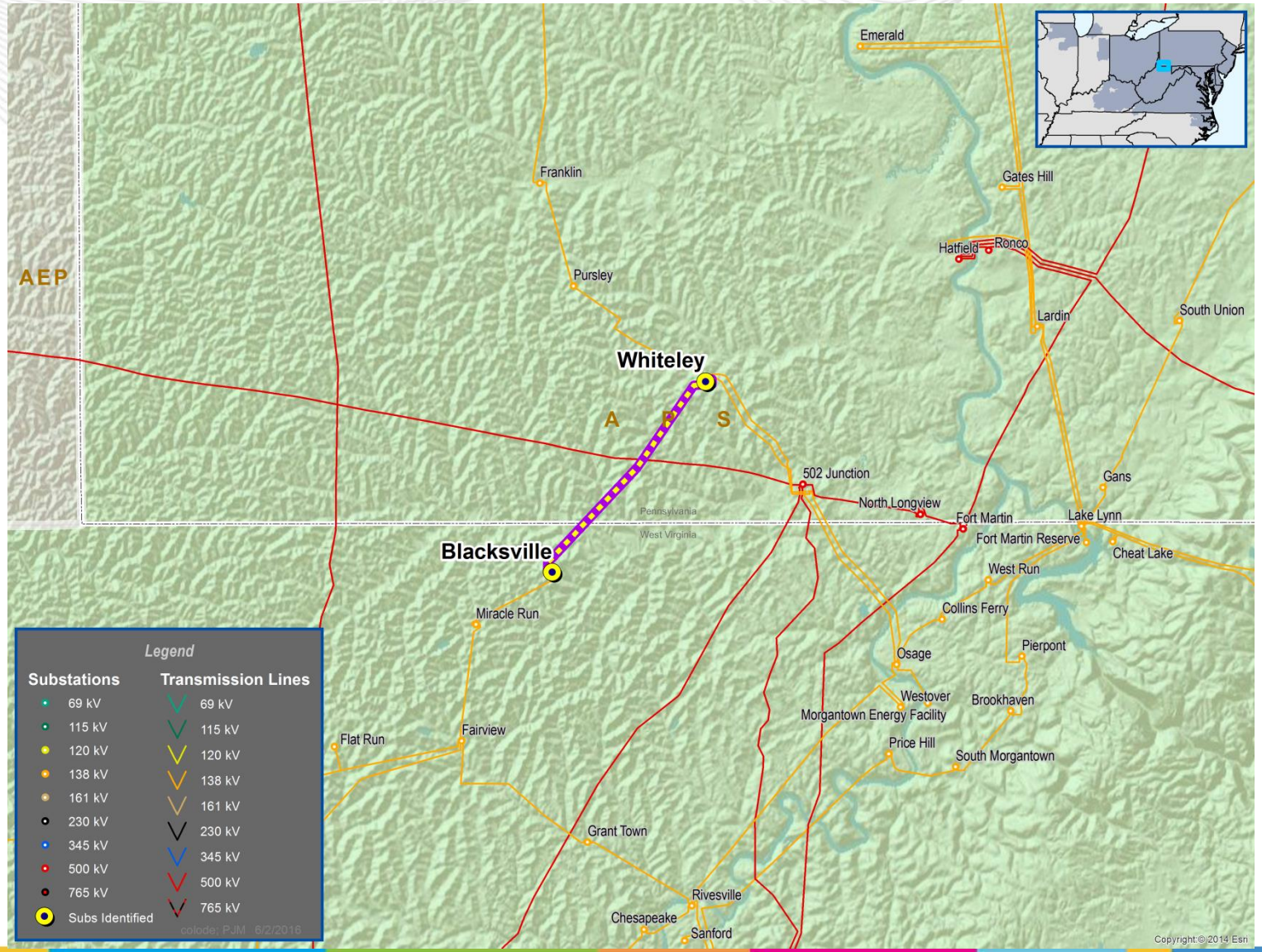


APS Transmission Zone

- **Supplemental Project**

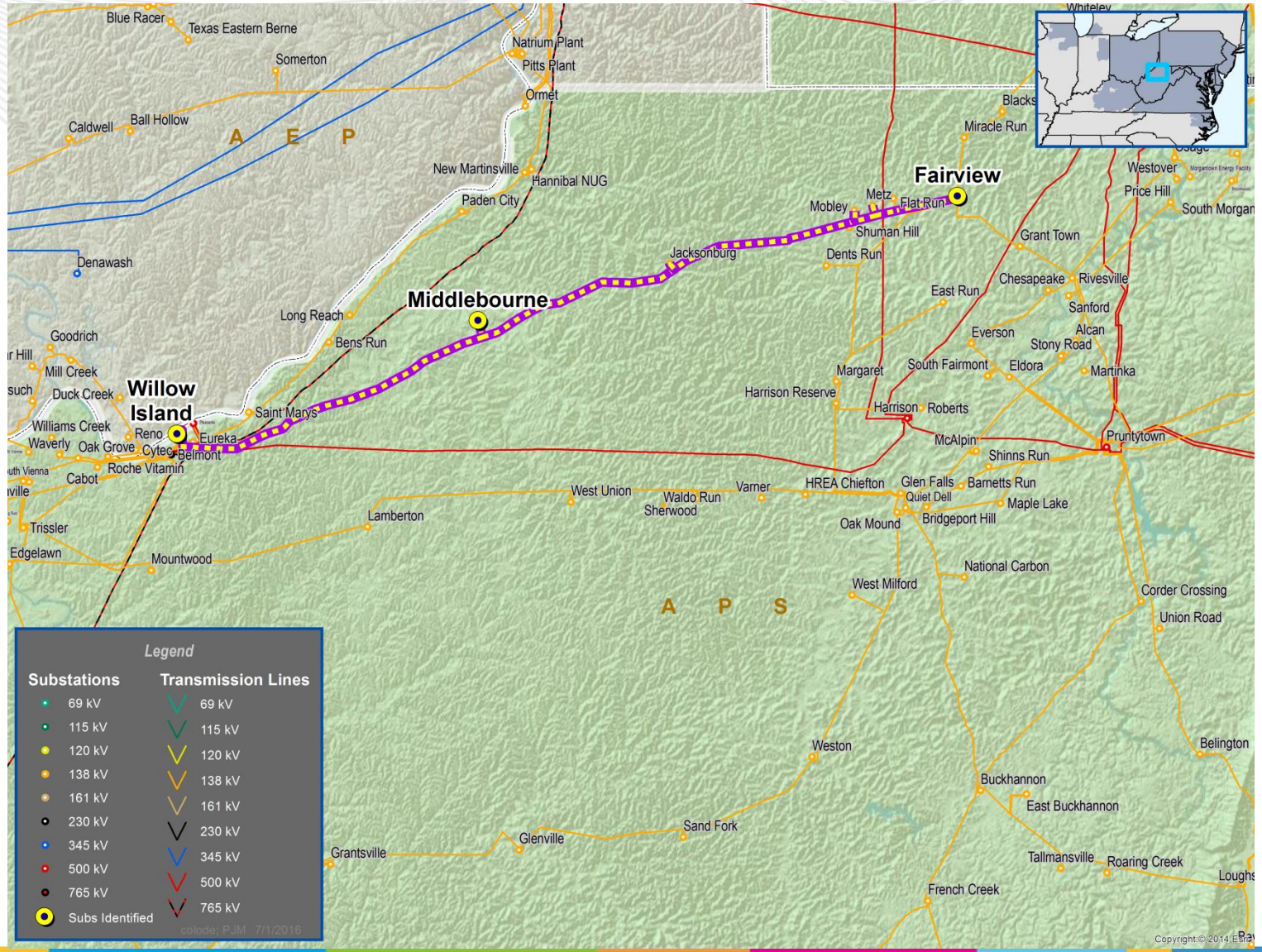
- Tap the Whitleley - Blacksville 138 kV line and install all required equipments to provide service to a new customer (MEPCO Shannon Run load service) (S1176.1)
- Whiteley - Install breaker failure receiver on Fairview 138 kV terminal (S1176.2)
- Fairview - Install breaker failure receiver on Whiteley 138 kV terminal (S1176.3)

- New Load Service (10MVA)
- Estimated Project Cost: $0.2M
- Projected IS Date: 7/1/2017



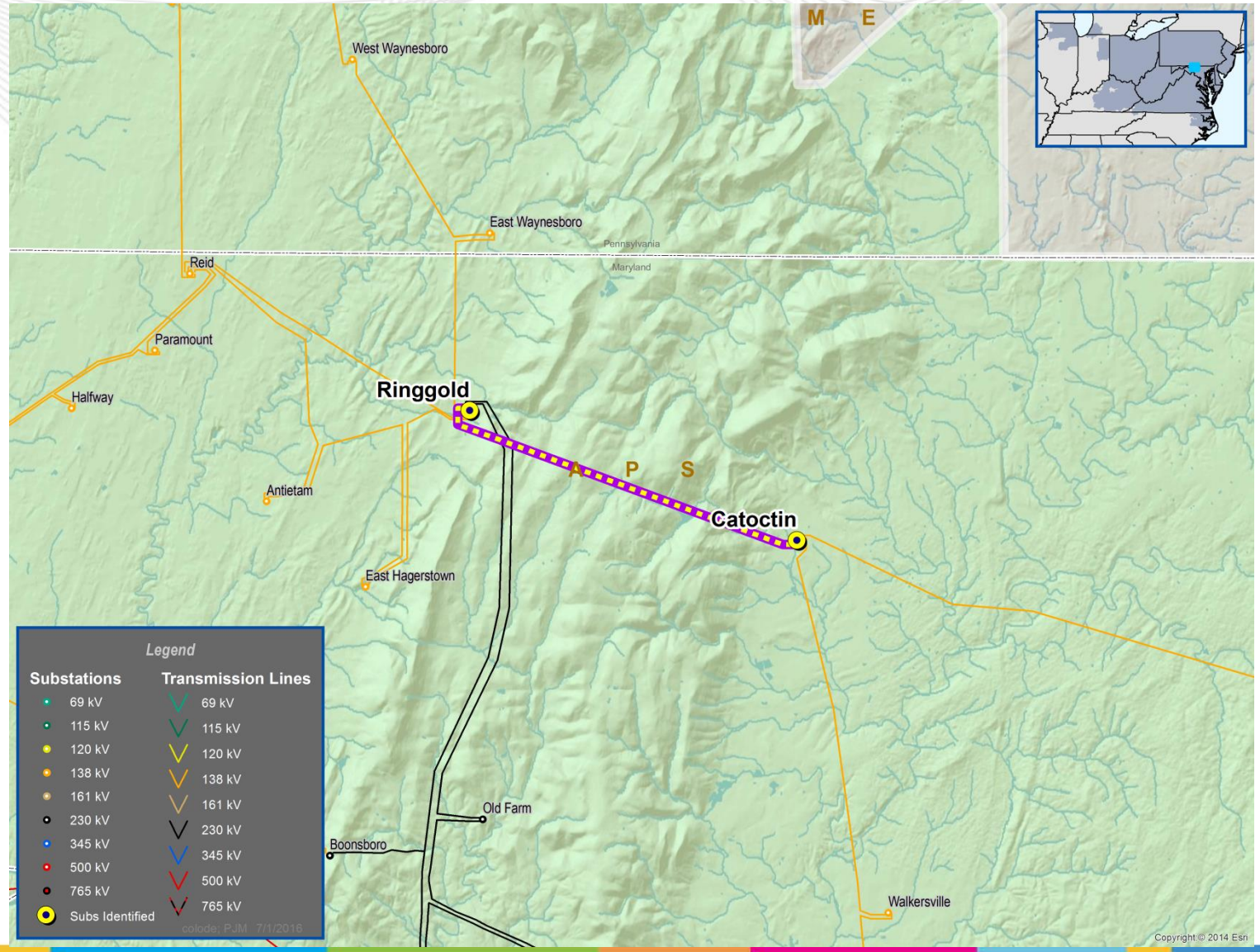
APS Transmission Zone

- **Supplemental Project**
- Provide 138 kV metering point on the Willow Island-Fairview 138 kV line near Middlebourne substation. (S1161)
- New Customer
- Estimated Project Cost: $0.2M
- Projected IS Date: 6/1/2018



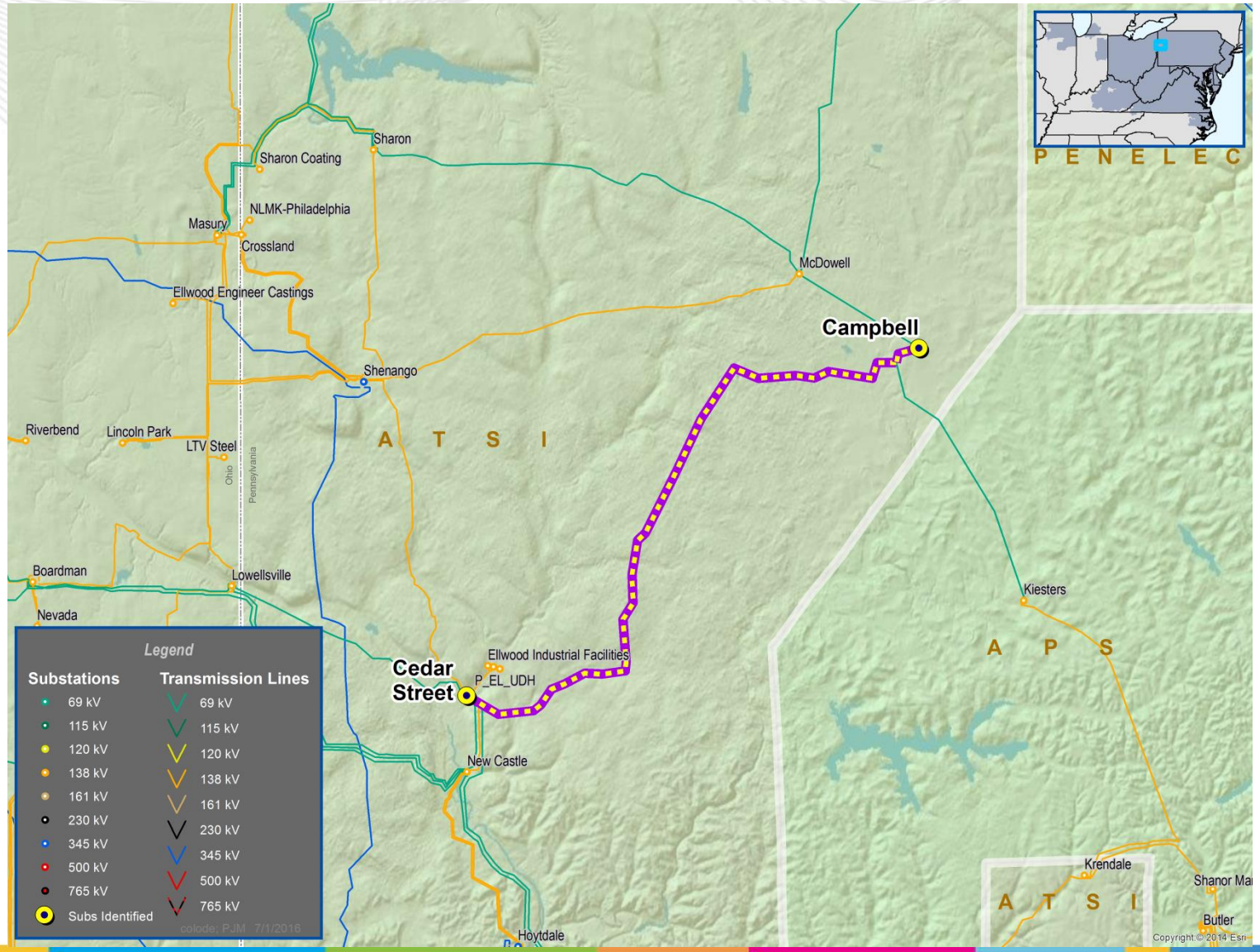
APS Transmission Zone

- **Supplemental Project**
- Tap the Catoctin-Ringgold 138 kV line and construct a 138-12 kV substation (Wolfsville). (S1162)
- New Customer
- Estimated Project Cost: $0.8M
- Projected IS Date: 11/1/2017



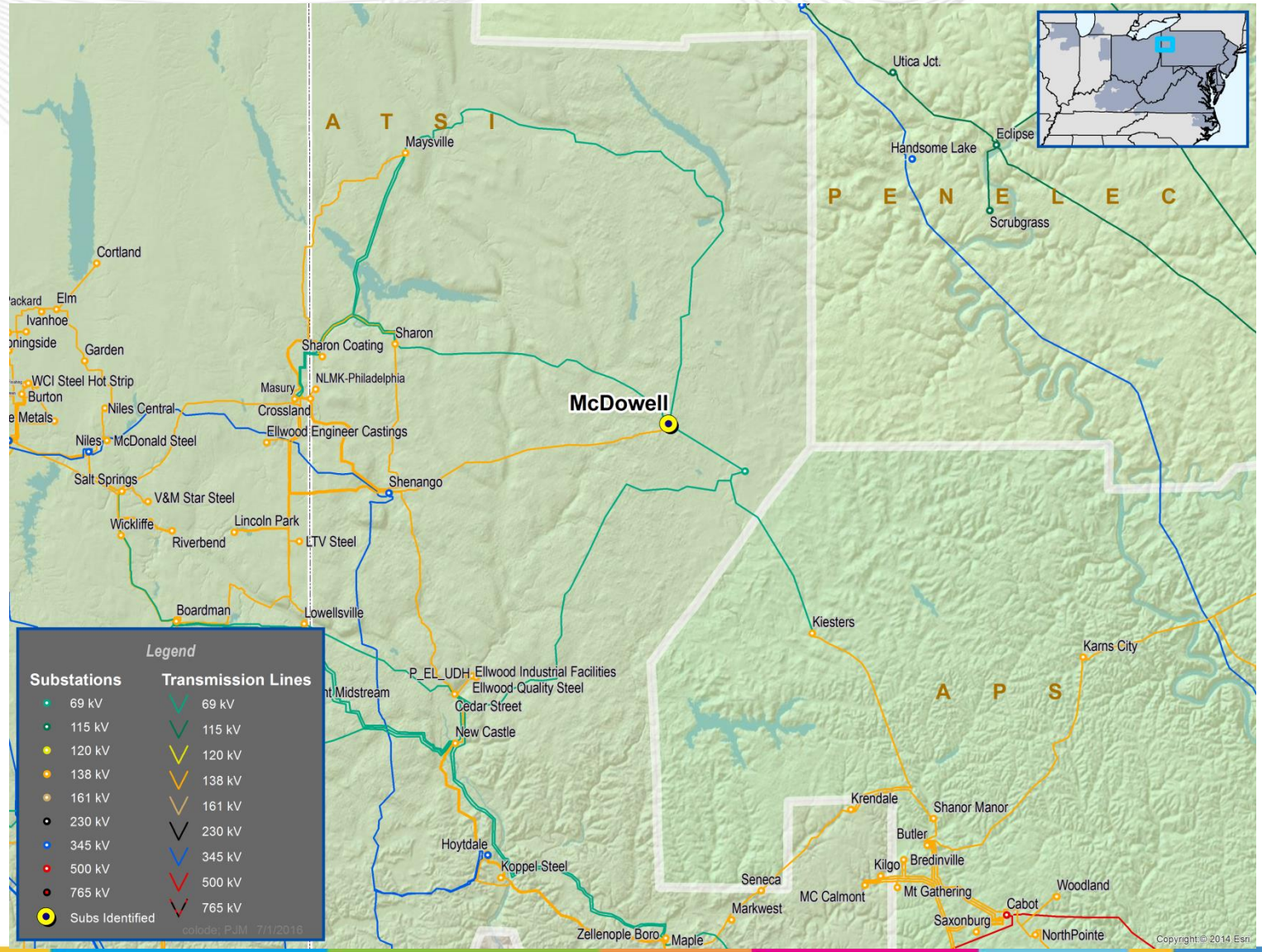
ATSI Transmission Zone

- **Supplemental Project**
- Connect a new 69 kV substation (Frew Mill) on the Campbell-Cedar Street Y-10 69kV Line (S1173)
- New Customer
- Estimated Project Cost: $0.6M
- Projected IS Date: 11/1/2017



ATSI Transmission Zone

- **Supplemental Project**
- Connect a new 69/12.47 kV substation (Henderson) on the Greenville-McDowell 69kV Line (S1174)
- New Customer
- Estimated Project Cost: $0.6M
- Projected IS Date: 11/1/2017



ATSI Transmission Zone

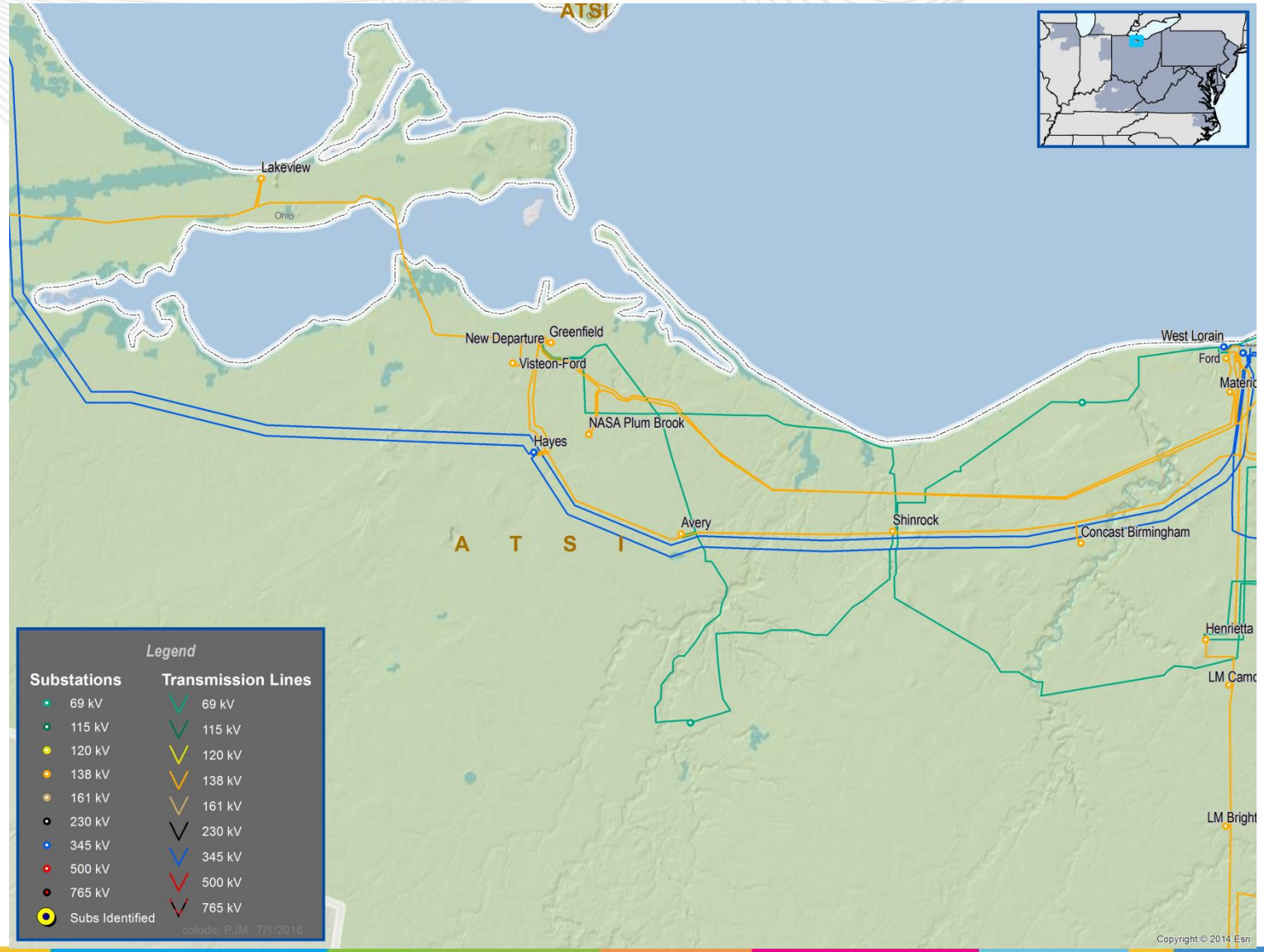
- **Supplemental Project**

- Rebuild 0.2 mile 69kV tap and line extension from the Bellevue-Flatrock 69kV line to a new (Amcor Ridge) Substation. (S1175)

- New Customer (Customer Upgrade)

- Estimated Project Cost: $0.0 M

- Projected IS Date: 10/16/2016



ComEd Transmission Zone

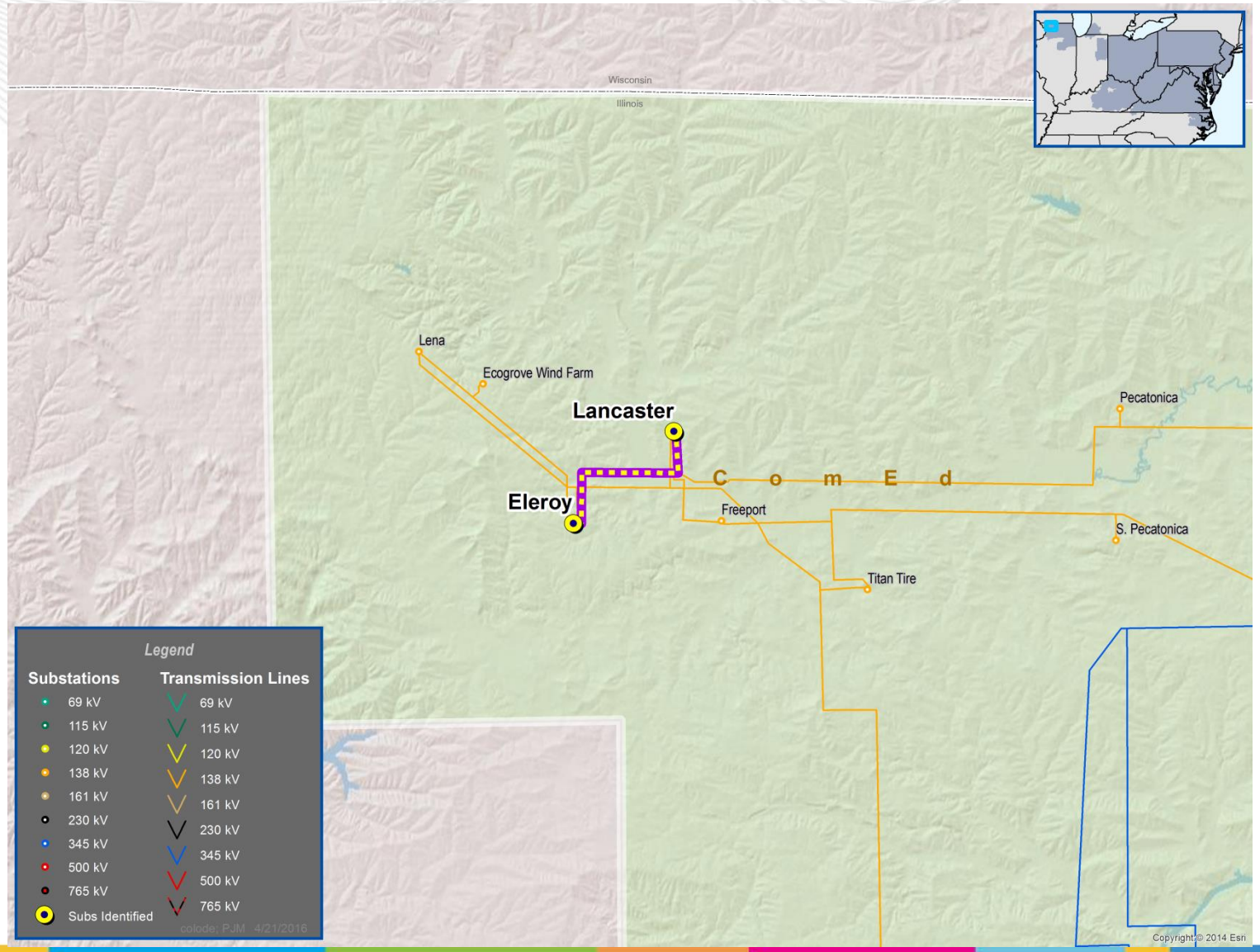
- **Supplemental Project**

- Reconfigure 138KV lines 11904 (Lancaster – Eleroy Tap) and 19414 (ESS B-427 – Freeport) in the far western part of our system, and add breakers at Lancaster. (S1168)

- Improve reliability at Freeport, Lancaster, and other area distribution substations and to bring Lancaster up to existing standards : Freeport station was built in 1930 (86 years old); The station is configured as a 4 CB ring bus with 2 lines and 4 distribution transformers. 3 of the circuit breakers date to the 1940s. Freeport sits in a flood plain; The ultimate plans for the area call for Freeport to be retired and load transferred to Lancaster which is 1.3 miles away; This project will enable this future work; The lines near Freeport will be reconfigured to provide 2 radial feeds to Freeport, removing the station from the bulk power path; Current line 11901 is 1.3 miles long from Lancaster to Freeport and is connected to a straight bus with no line CB at Lancaster (when the line trips it also trips adjacent line 11902). After the project this line becomes part of longer line 19414, so a line CB will be installed at Lancaster.

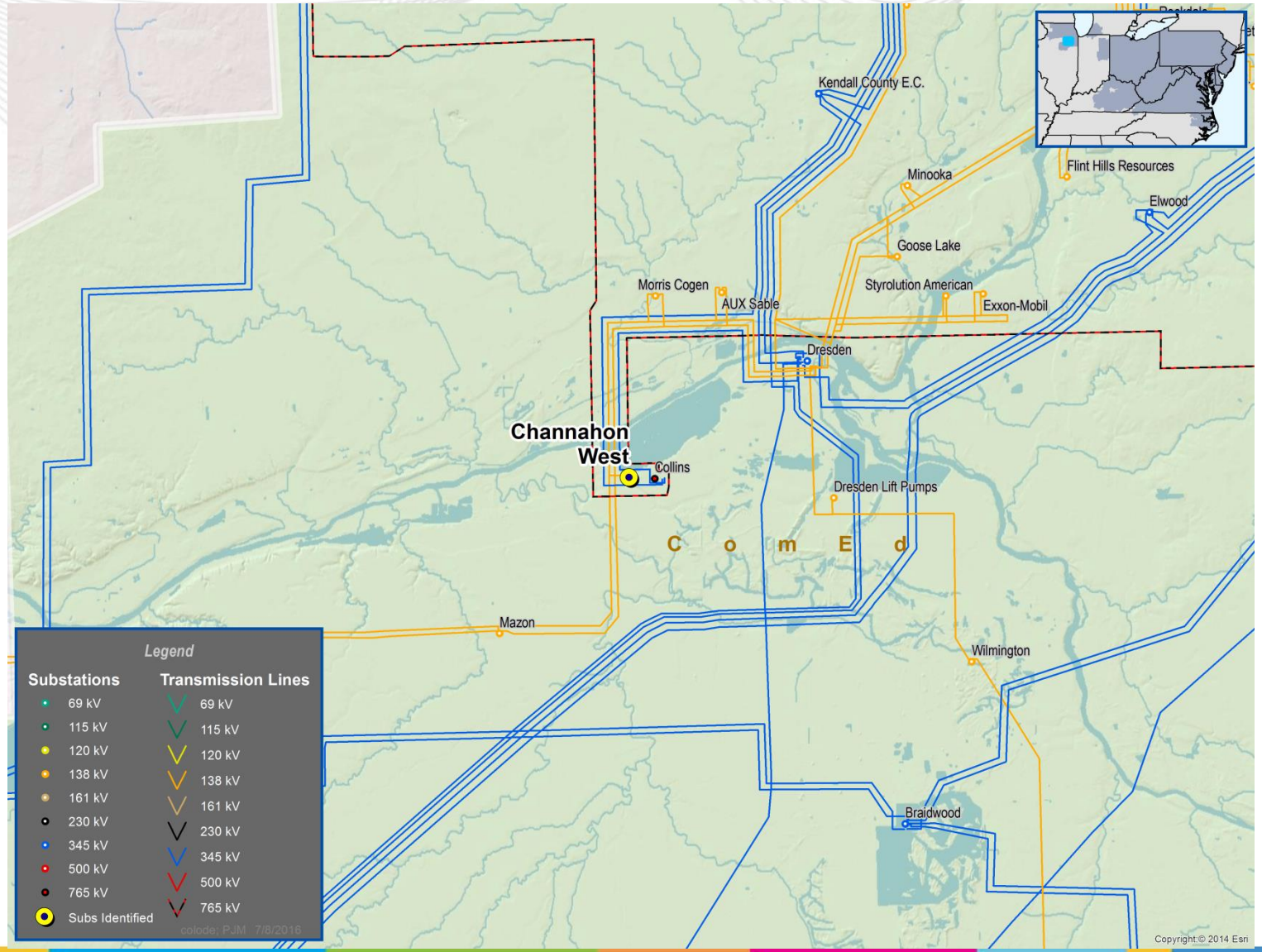
- Estimated Project Cost: $8.6M

- Projected IS Date: 6/1/2017



ComEd Transmission Zone

- **Supplemental Project**
- Expand 138 kV Channahon West substation with five 138 kV CBs and a new 138/34 kV TR (S1169)
- New customer load : The existing station consists of a tap off a 138 kV transmission line feeding directly into a 138/12 kV transformer, which serves two 12 kV feeders; A new 10 MW customer facility needs 34 kV service in the area; The area is zoned for industrial development and is expected to grow; In order to serve the additional load and expected future growth, a new 138/34 kV transformer needs to be connected at this site; The transmission portion of the project consists of building a 138 kV bus with 3 circuit breakers, and cutting the transmission line to create two feeds to the station. (transmission cost $8.5M)
- Estimated Project Cost: $22M
- Projected IS Date: 6/1/2017



ComEd Transmission Zone

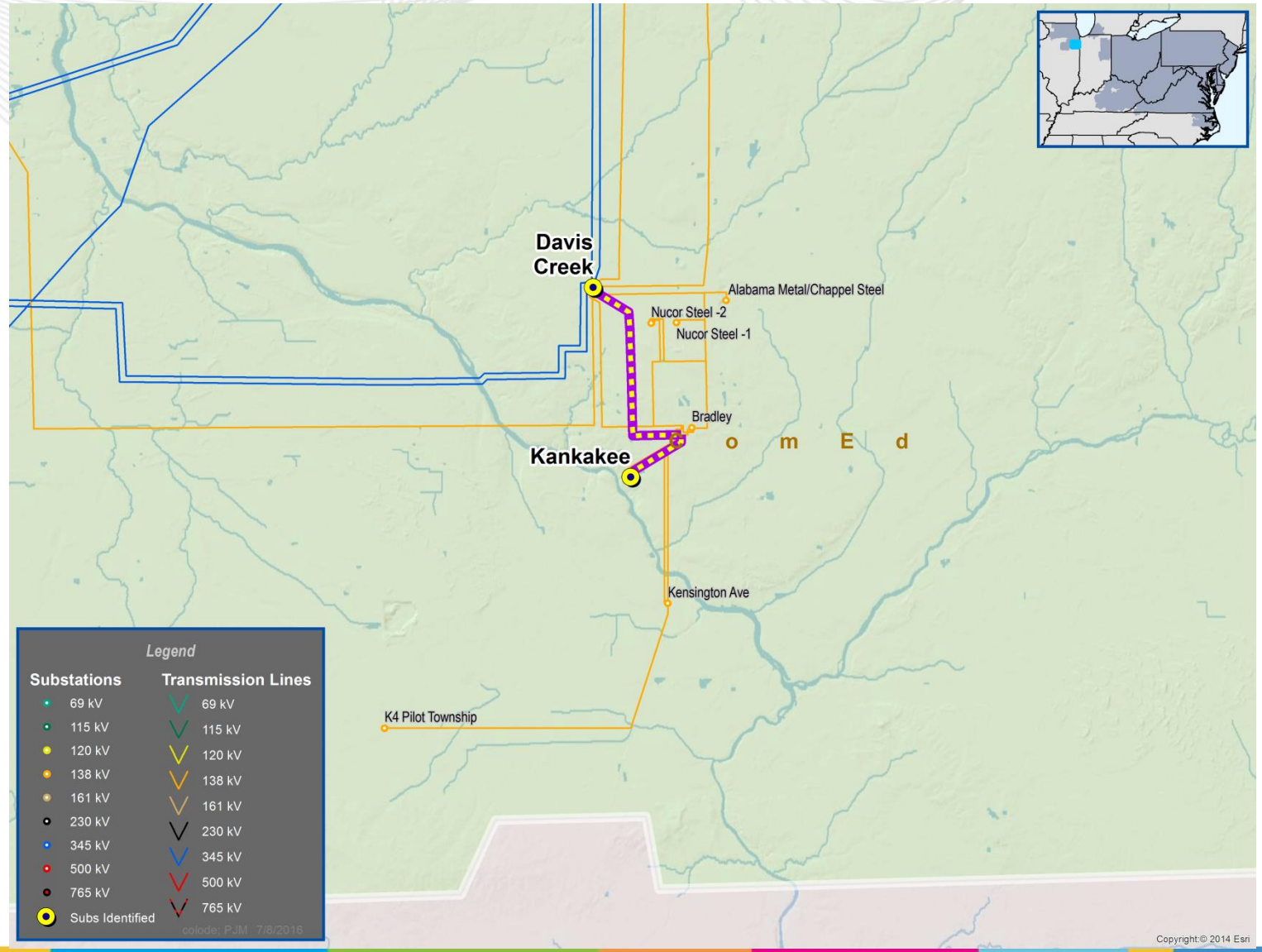
- **Supplemental Project**

- Replace 138KV line 8603 (Davis creek - Kankakee) circuit switcher at Bradley (S1170)

- Material condition (43 years old): Bradley station is being hardened due to reliability issues/concerns; Hardening includes reconfiguration of lines just outside of Bradley to minimize line crossings; Existing circuit switcher is 43 years old and sits on a wood structure just outside of Bradley; Wood structures are no longer installed on ComEd's transmission system; the circuit switcher will be replaced along with the wood structure during this hardening/reconfiguration work

- Estimated Project Cost: $0.4M

- Projected IS Date: 12/31/2016



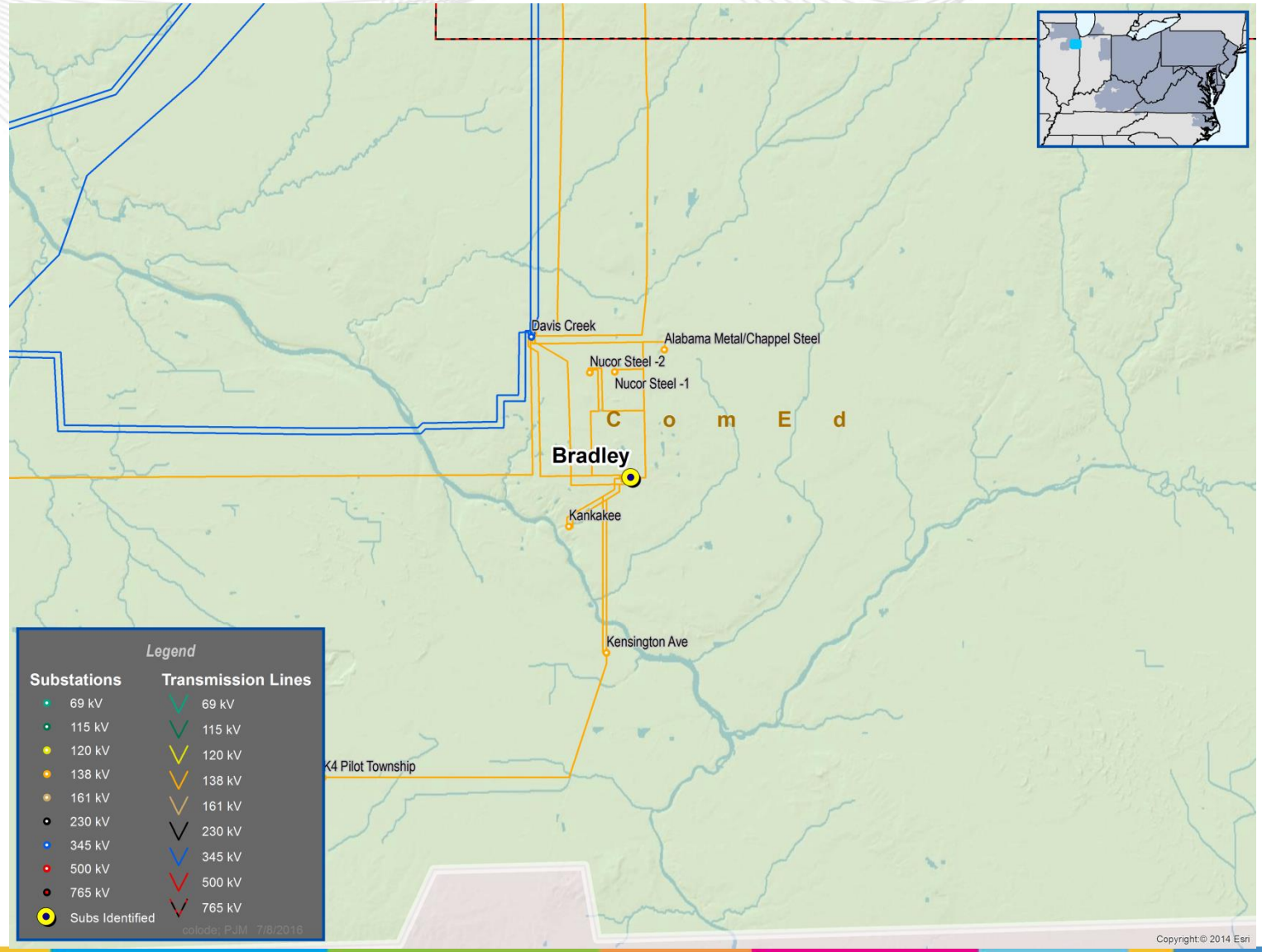
ComEd Transmission Zone

- **Supplemental Project**

- Reconfigure Bradley 138KV substation to add 138 kV bus ties 1-2 & 3-4 and relocate lines (S1171)

- New customer connection & reliability improvement: Bradley was built in 1947 (69 years old). The station is feed by 3 transmission lines and feeds 7 distribution transformers; Numerous outages have been experienced due to distribution equipment issues at Bradley; A hardening project is being completed to address the distribution issues (cost not included in this cost estimate); A new customer connection requires installation of a new 138/12 kV distribution transformer; The current design is 2 straight buses connected by a bus tie. Loss of the bus tie would result in a complete outage at the station; The lines feeding the station all cross at a point outside the station. Loss of the top circuit would result in a complete outage at the station; To improve reliability of the transmission supply to Bradley, 2 bus tie circuit breakers will be installed to create 4 busses instead of 2. These circuit breakers are part of the planned expansion of the station; The transmission lines will be rerouted to avoid crossing. (transmission cost: $9M)

- Estimated Project Cost: $9M
- Projected IS Date: 12/31/2017



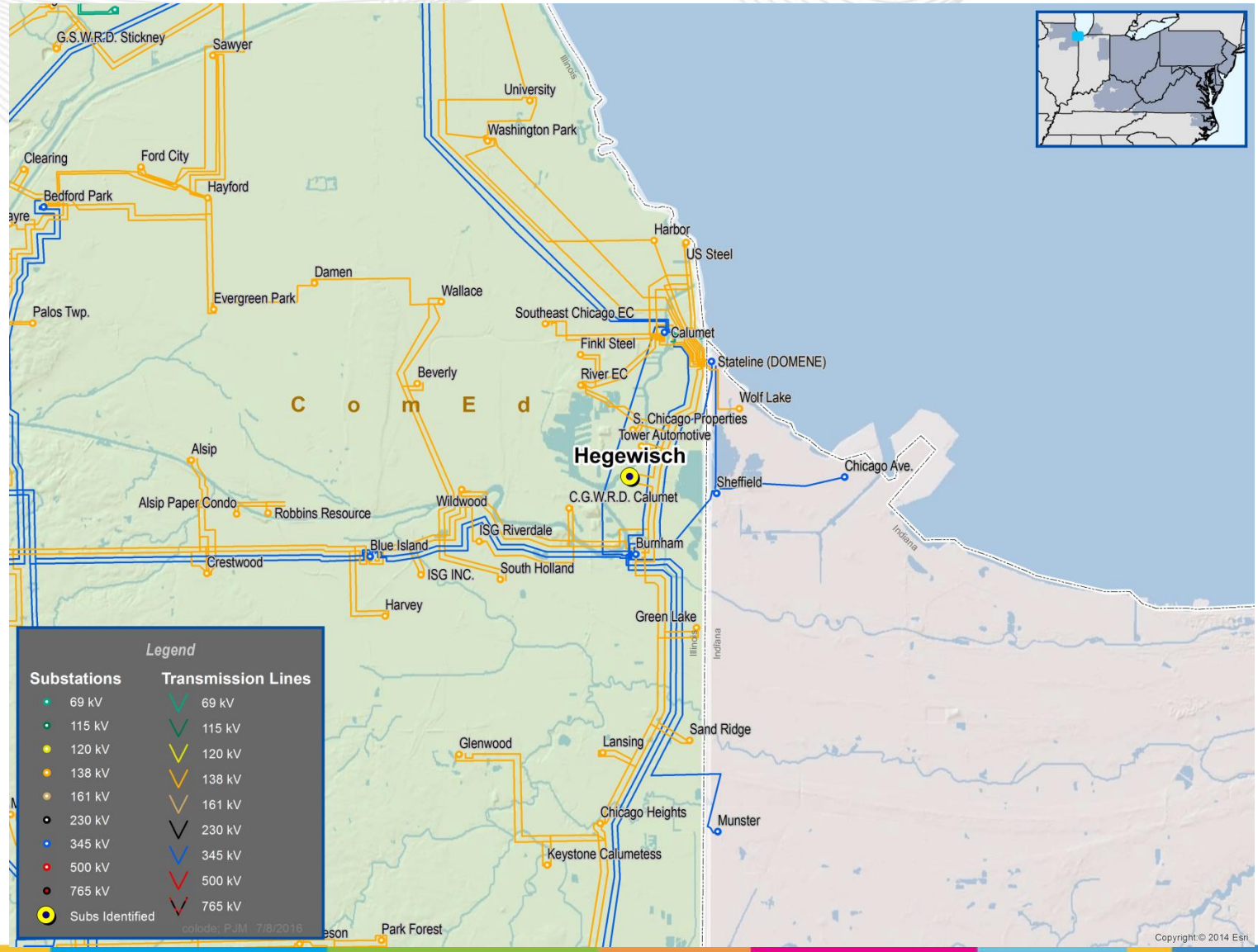
ComEd Transmission Zone

- **Supplemental Project**

- Refurbish & reconfigure Hegewisch 138KV substation into a breaker-and-a-half configuration (S1172)

- Reliability improvement :The station was built in 1957 (59 years old) and has had reliability issues. Due to reliability issues and material condition the station was selected for distribution reliability improvement (already completed); The existing transmission configuration has design issues. It is a single line-tie CB with 2 transformers tapped off either side of the CB. Loss of either line trips 2 transformers. A breaker failure takes out the whole station; Due to the existing configuration at the station and outage constraints due to sensitive customers that require short outage windows, maintenance at the site is difficult. The new design will allow breaker maintenance at any time without a transmission outage; The site is large enough to accommodate a modern breaker-and-a-half design;The breaker-and-a-half design will accommodate expected future expansion of 4 additional transformers and two additional lines. (Transmission cost: $38M)

- Estimated Project Cost: $38M
- Projected IS Date: 12/31/2017



- **Prioritization**

- List of sample locations
- Date Collected
  - Kinectrics reports
  - Number of outages
  - Number of customers
  - Length
  - Age
  - Service Center input

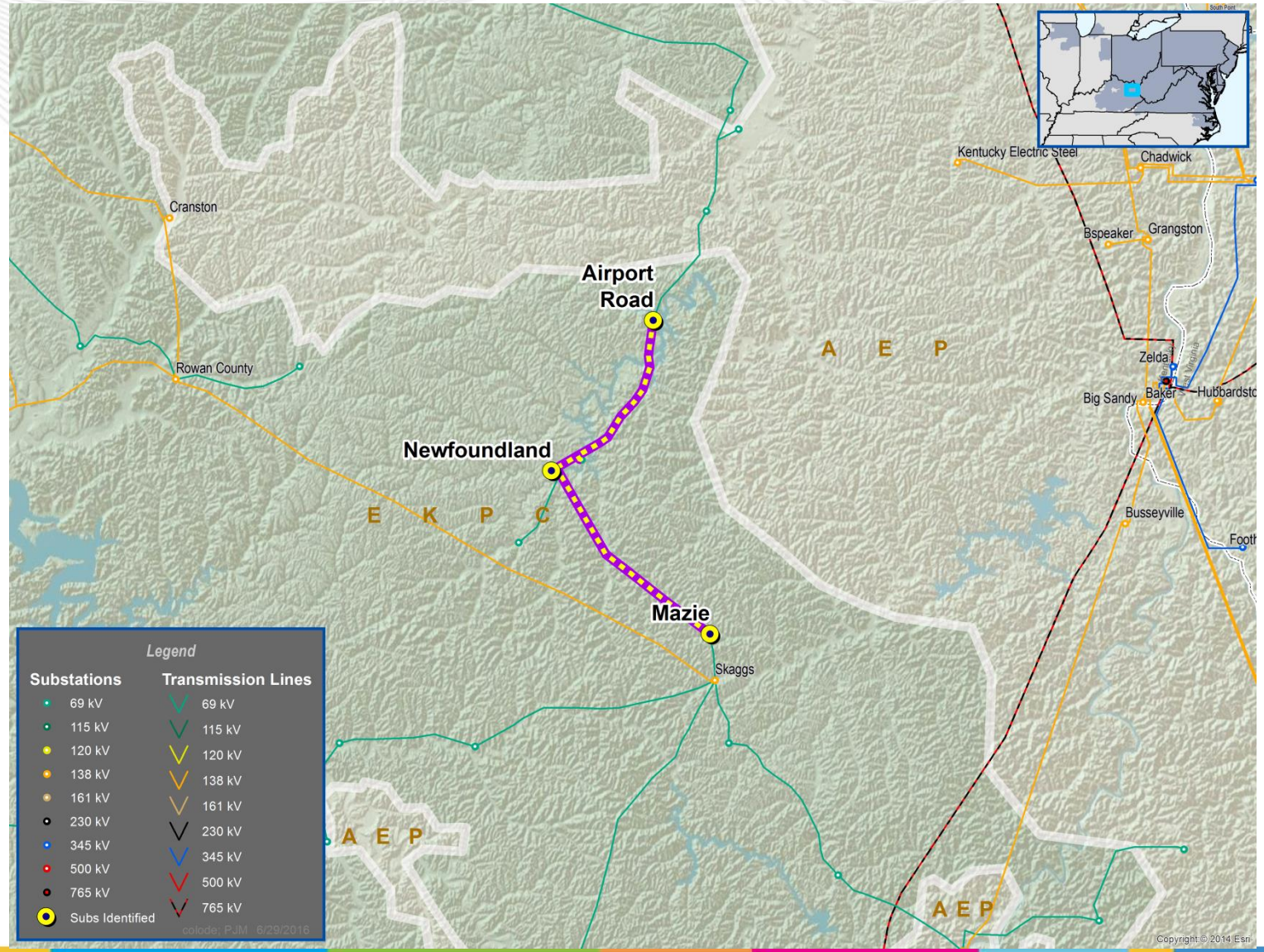
Date Weights

Parameter	Static Weight	Phase Conductor Weight
Kinectrics report	50%	45%
No. of outages	0% [1]	25%
No. of customers	25%	20%
Length	10%	5%
Age	5%	5%
Service Center input	10%	

[1] No outages due to failed static

EKPC Transmission Zone

- **Supplemental Project**
- Rebuild the existing 3/0 ACSR Airport Rd - Newfoundland - Mazie 69 kV, line section using 556.5 MCM ACSR/TW conductor. (S1163)
- Aging facility
  - 50/51 years old
  - 14.3/10.1 miles
  - 4769 customers
  - 5 substations: Airport Raod, Elliott County Prison, Newfoundland, Sandy Hook, Mazie
  - Conductor failure outages: 0 phase conductor
  - Leon-Newfoundland ranking
    - #11 Phase (3/0)
    - #3 Static (3/8)
  - Newfoundland-Mazie ranking
    - #7 Phase (266)
    - #7 Static (3/8)
- Estimated Project Cost: $6.68M
- Projected IS Date: 6/1/2021



EKPC Transmission Zone

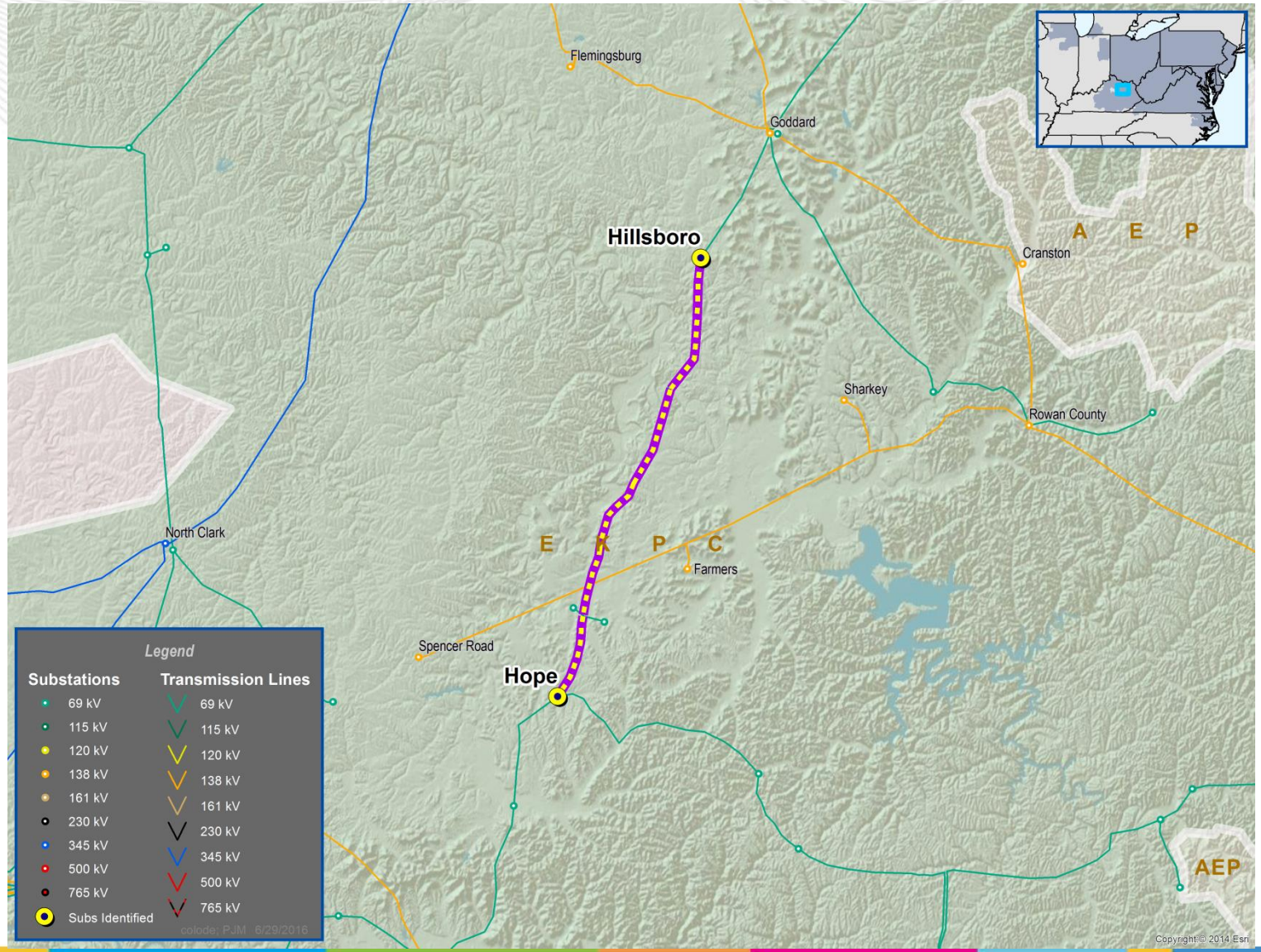
- **Supplemental Project**

- Rebuild the existing 4/0 ACSR Hope - Hillsboro 69 kV, line section using 556.5 MCM ACSR/TW conductor. (S1164)

- Aging facility
  - 61 years old
  - 20.63 miles
  - 4915 customers
  - 4 substations: Hillsboro, Peasticks, Preston, Blevins Valley
  - Conductor failure outages: 1 phase conductor
  - Ranking
    - #6 Phase (4/0)
    - #2 Static (3/8)

- Estimated Project Cost: $8.32M

- Projected IS Date: 12/1/2020



EKPC Transmission Zone

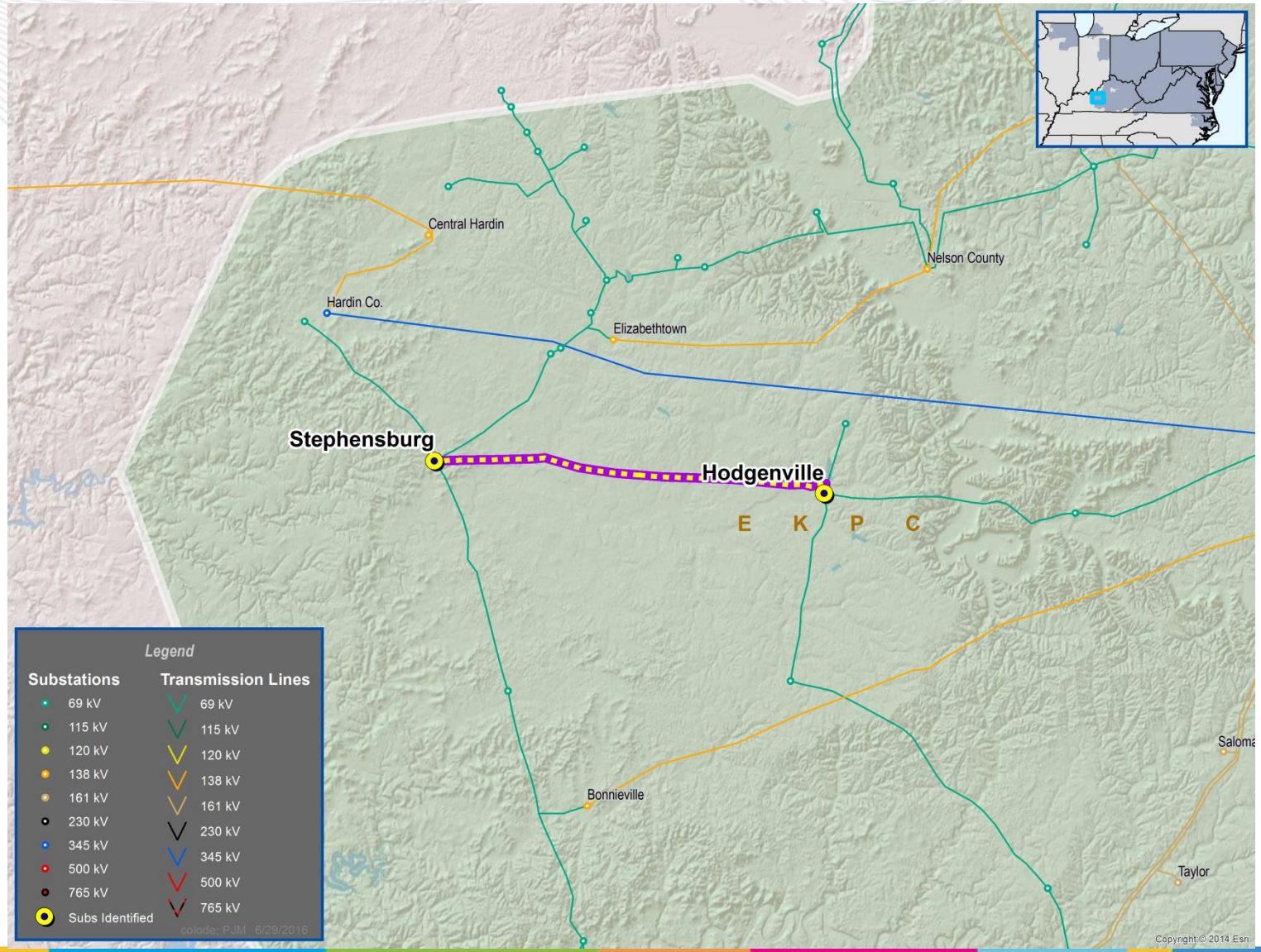
- **Supplemental Project**

- Rebuild the existing 1/0 ACSR Stephensburg - Hodgenville 69 kV, line section using 556.5 MCM ACSR/TW conductor. (S1165)

- Aging facility
  - 62 years old
  - 17.6 miles
  - 1715 customers
  - 1 substations: Glendale
  - Conductor failure outages: 2 phase conductor
  - Ranking
    - #2 Phase (1/0)
    - #1 Static (3/8)

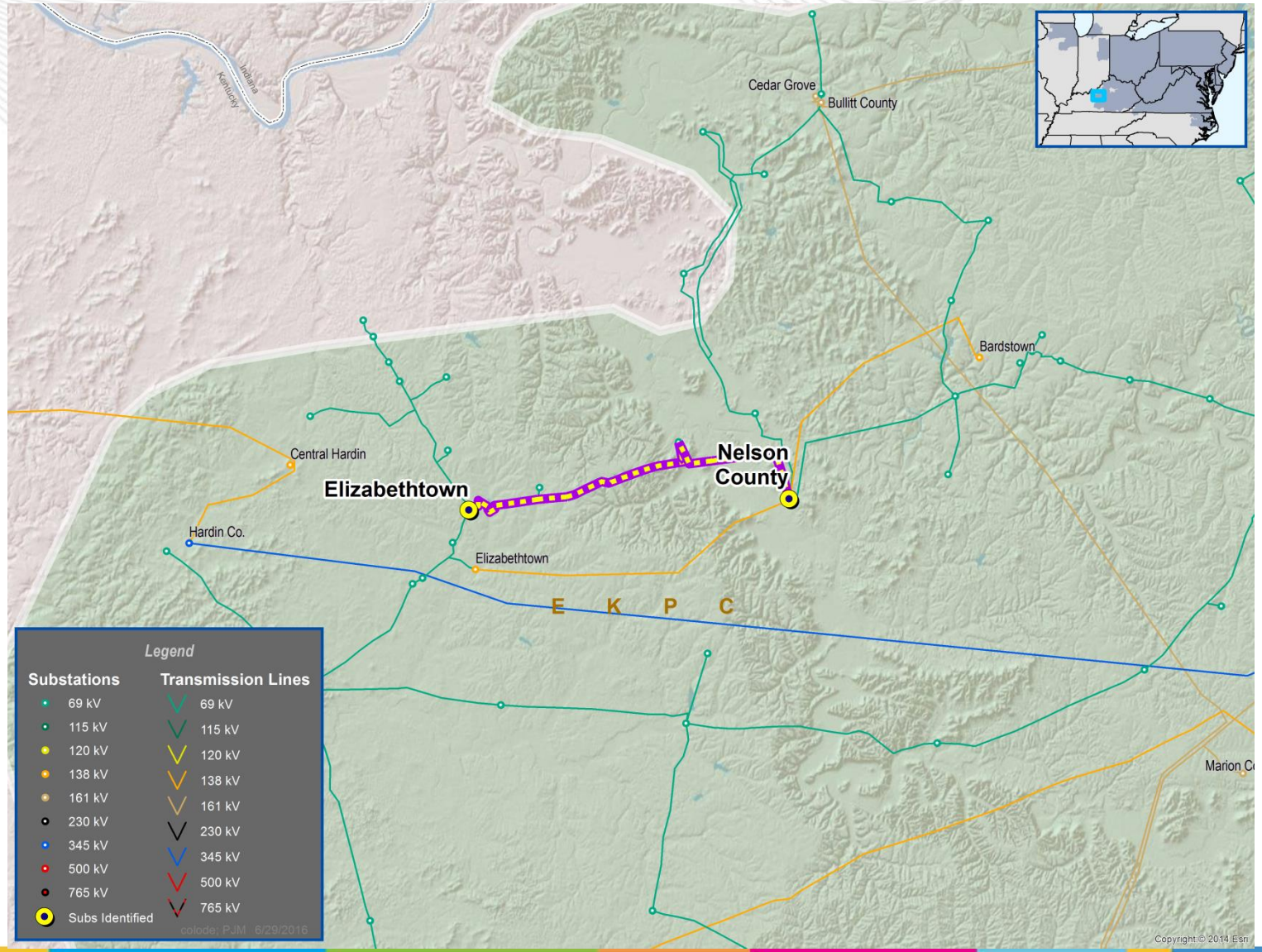
- Estimated Project Cost: $5.88M

- Projected IS Date: 12/1/2020



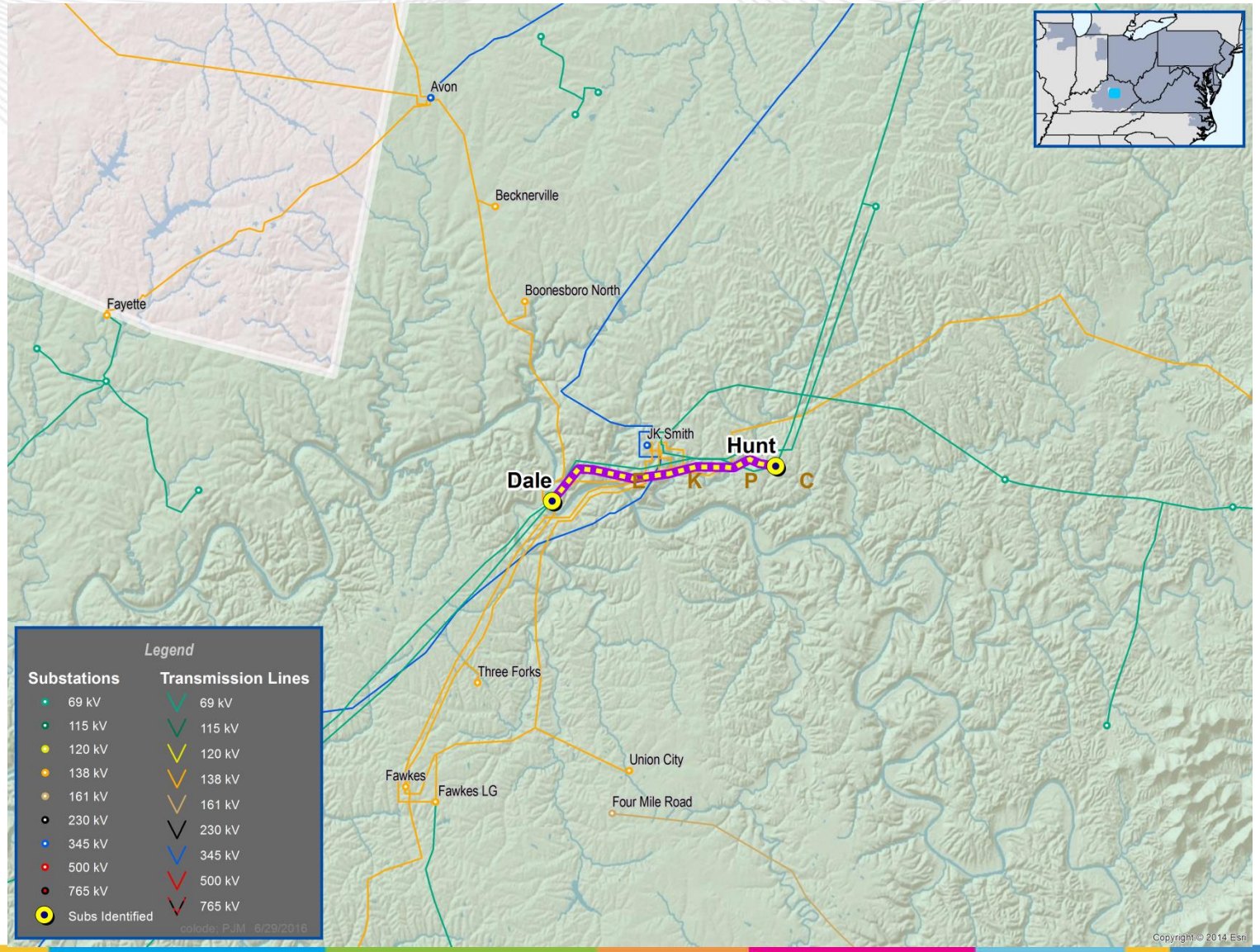
EKPC Transmission Zone

- **Supplemental Project**
- Rebuild the existing 2/0 ACSR Nelson County - Elizabethtown 69 kV, line section using 556.5 MCM ACSR/TW conductor. (S1166)
- Aging facility
  - 63 years old
  - 14.5 miles
  - 6432 customers
  - 4 substations: Tunnel Hill 1&2, Lyman B. Williams, Colesburg
  - Conductor failure outages: 1 phase conductor
  - Ranking
    - #1 Phase (2/0)
    - #8 Static (3/8)
- Estimated Project Cost: $4.85M
- Projected IS Date: 6/1/2019



EKPC Transmission Zone

- **Supplemental Project**
- Rebuild the existing 266.8 MCM ACSR Dale-Hunt 69 kV, line section using 556.5 MCM ACSR/TW conductor.(S1167)
- Aging facility
  - 63 years old
  - 6.4 miles
  - 6345 customers
  - 6 substations: Hunt, Miller Hunt, N. Clark Station Service, Reid Village, Mt. Sterling, Sideview
  - Conductor failure outages: 1 phase conductor
  - Ranking
    - #5 Phase (266)
    - #5 Static (3/8)
- Estimated Project Cost: $3.84M
- Projected IS Date: 12/1/2018



Questions?

Email: RTEP@pjm.com

Revision History

1. Add slides 5-7 on 7/22/2016
2. Slide #6 typo: change (N5076.1-9) to (N5076.1-8) on 7/22/2016
3. Slide#9&10: add current kA ratings for the breakers on 8/9/2016
4. Slide #13: details for the current line condition added on 8/9/2016
5. Add Slide #27: a general guideline for EPKC facility prioritization when being supplemental projects on 8/9/2016
6. Slides #28- #32: Detailed ranking information added per the request during SRTEAC on 8/9/2016
7. Slides #22-#26: Detailed information including transmission cost added per the request during SRTEAC on 8/9/2016
8. Slides #3: B2609.5 is changed to B2609.4 on 8/18/2016
9. Slides #3: B2609.4 Required IS date is changed to 6/1/2016 on 3/9/2017