



Sub Regional RTEP Committee PJM West

May 21, 2018

Continue April 17, 2018 SRRTEP slides (#58- #88)

<http://www.pjm.com/-/media/committees-groups/committees/srrtep-w/20180417/20180417-reliability-analysis-update.ashx>

First Review

Baseline Reliability and Supplemental Projects

Common Mode Outage

Problem Statement:

The Schauff Road – Nelson Tap 138kV line is overloaded for the tower outage of the both Schauff Road – Rock Falls 138kV lines.

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.

Selected Solution:

Rebuild the 12.36 mile Schauff Road to Nelson tap 138kV line L15508. (B2999)

Alternatives:

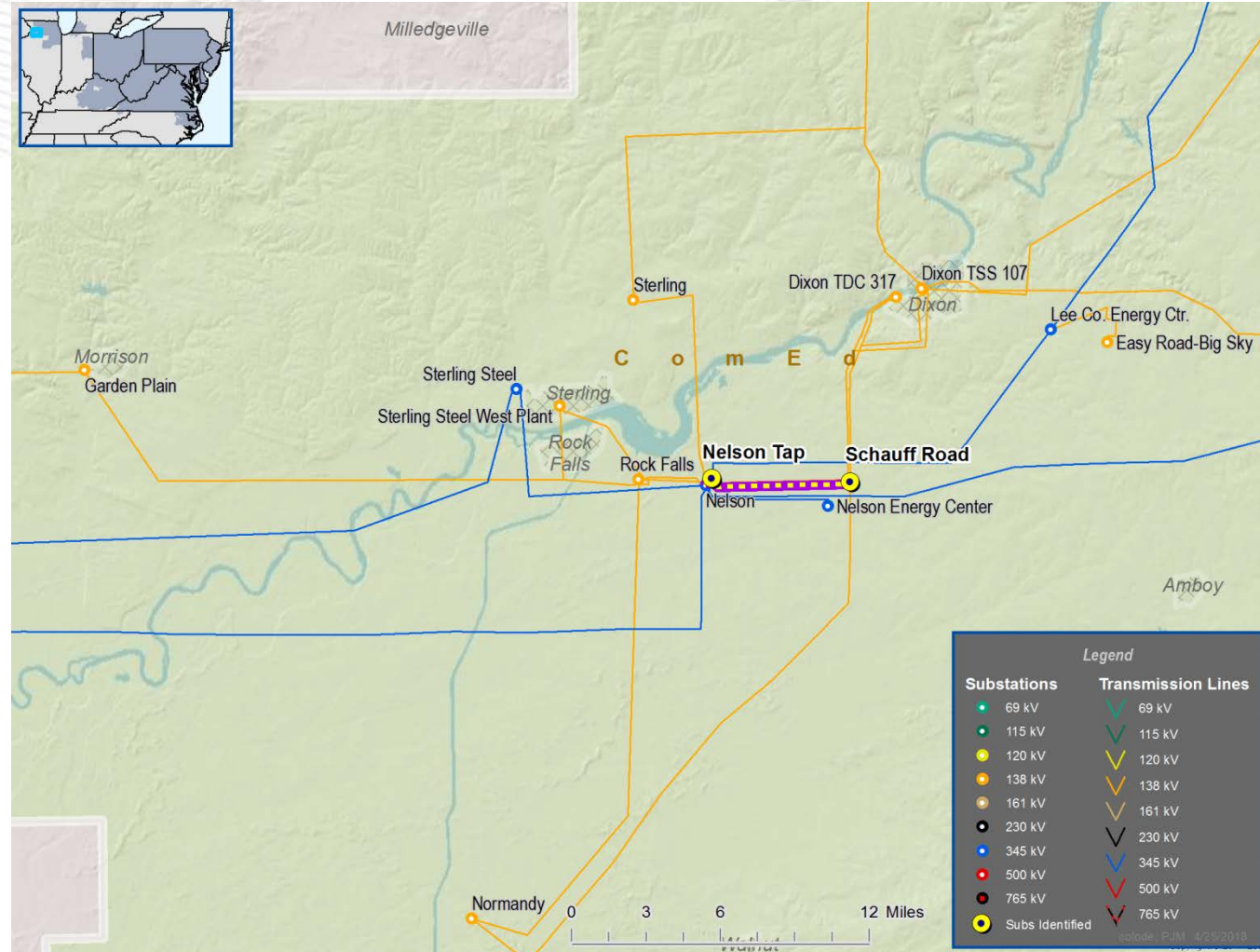
No feasible alternative is considered due to the immediate need.

Estimated Project Cost: \$16.5M

Required IS Date: 11/01/2019

Projected IS Date: 11/1/2021

Status: Engineering



Problem Statement:

Customer Service

- Provide 138 kV service to new customer
- Customer load 46 MWs

Potential Solution:

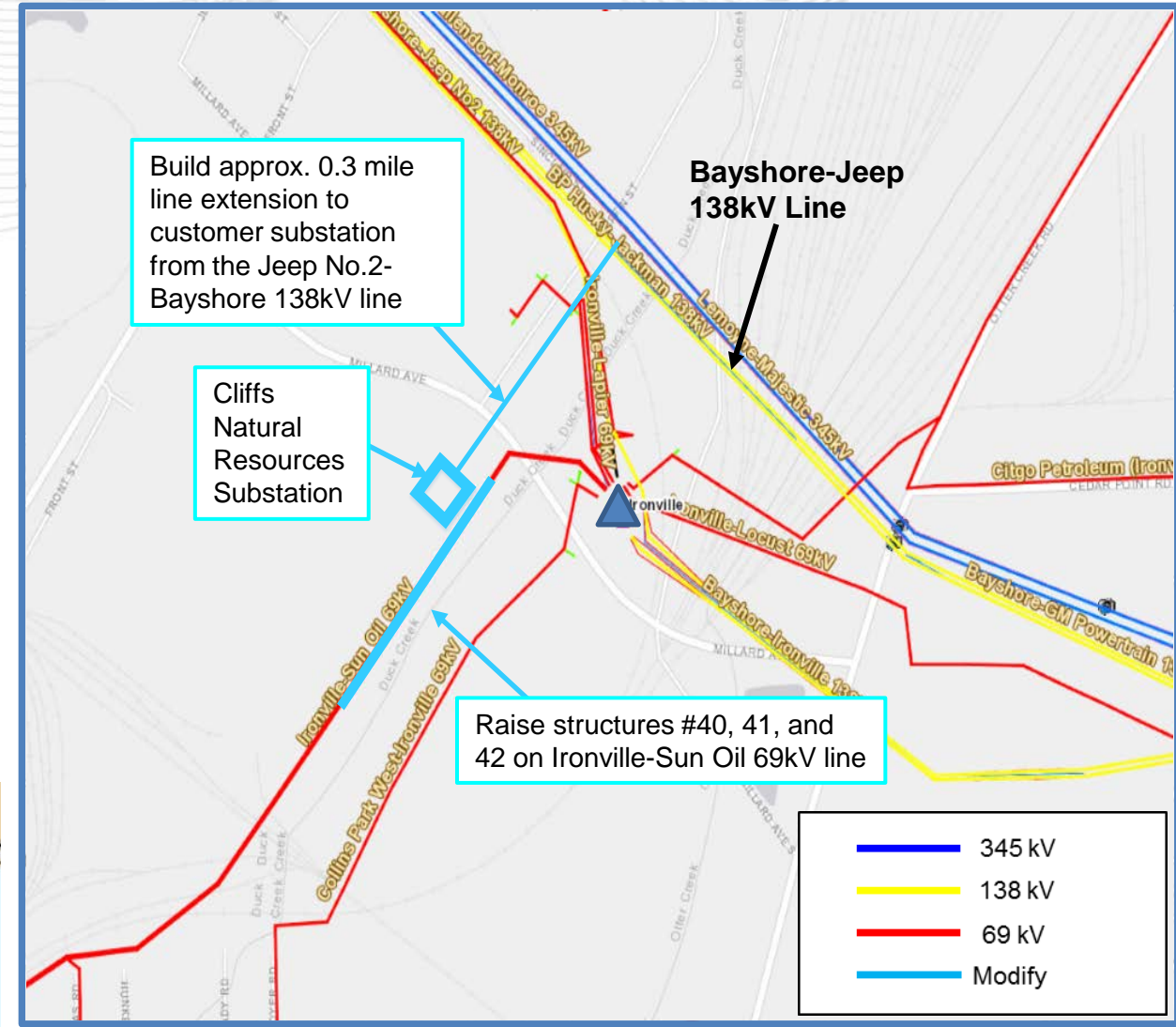
Cliffs Natural Resource Substation - Provide 138 kV Service

- Tap the existing Bayshore-Jeep #2 138kV circuit to the new Cliffs Natural Resource Substation (approx. 0.3 miles).
- Raise the line from tower #40 to tower #43 on the Ironville-Sun Oil 69kV line to increase clearances. (Reimbursable)
- Install SCADA Control at the in line switches of the tap connection. (Reimbursable)

Estimated Project Cost: \$0.7M

Projected IS Date: 8/01/2019

Status: Engineering



Problem Statement:

Customer Service

- Pennsylvania Corrective Action Plan (PA CAP) project for improved reliability
- Provides capacity relief for the area
- Customer load 3 MWs

Potential Solution:

Brush Creek 138 kV Substation – Provide 138kV Service

- Tap the existing Cranberry-Pine #1 138 kV Line to connect a new 138-12.47 kV distribution Mod Sub next to the existing transmission line.

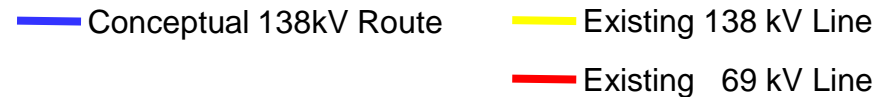
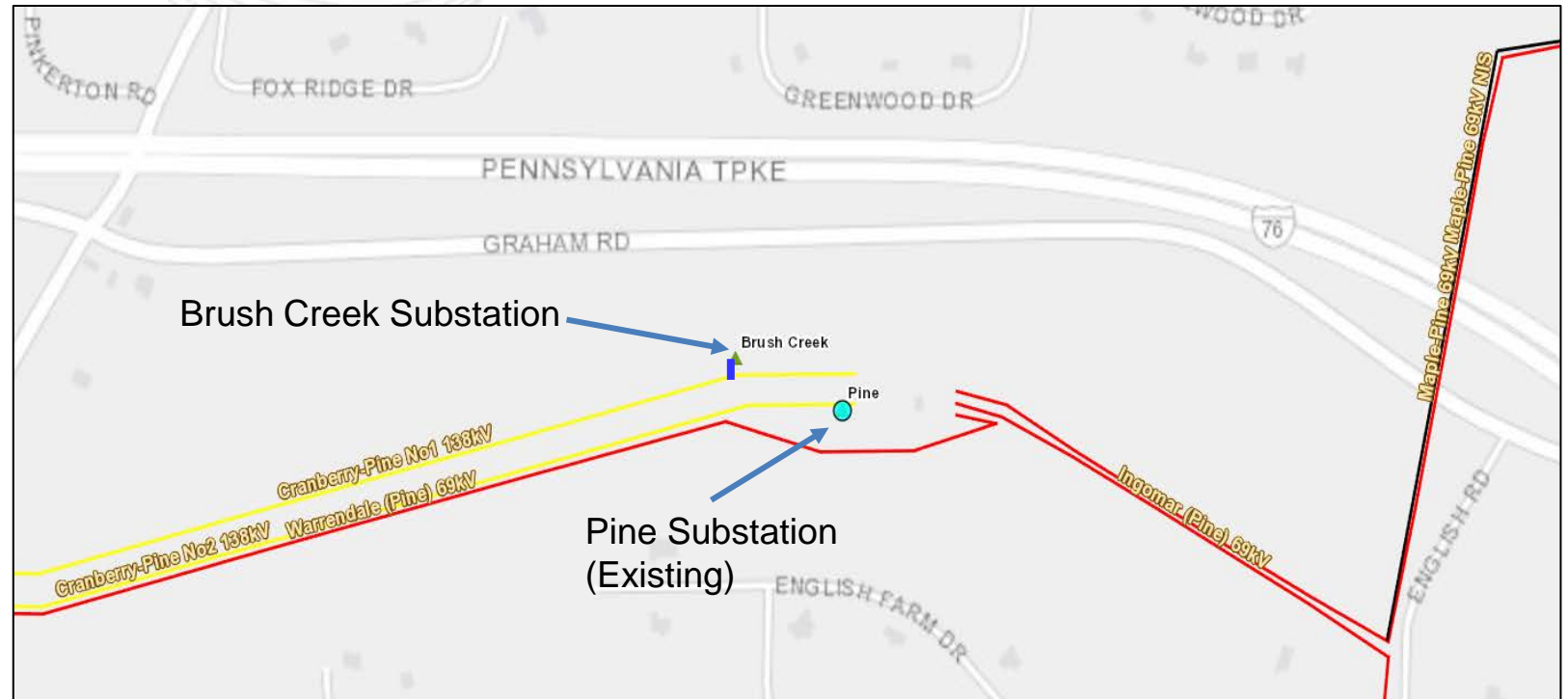
Alternatives Considered:

None

Estimated Project Cost: \$0.7M

Projected IS Date: 07/20/2018

Status: Engineering





Problem Statement:

Customer Service

- Provide 138 kV service to new customer
- Customer requested redundant feeds and ring for reliability (Reimbursable)
- Customer load 19 MWs

Potential Solution:

North Titus Substation - Provide 138 kV Service

- Build new 3-breaker 138kV ring bus (Reimbursable)
- Build new ~1 mile of 795 ACSR from northern tap location (Reimbursable)
- Build new ~0.5 miles of 795 ACSR from southern tap location
- Retire-In-Place 138kV line section between Northern and Southern tap locations.

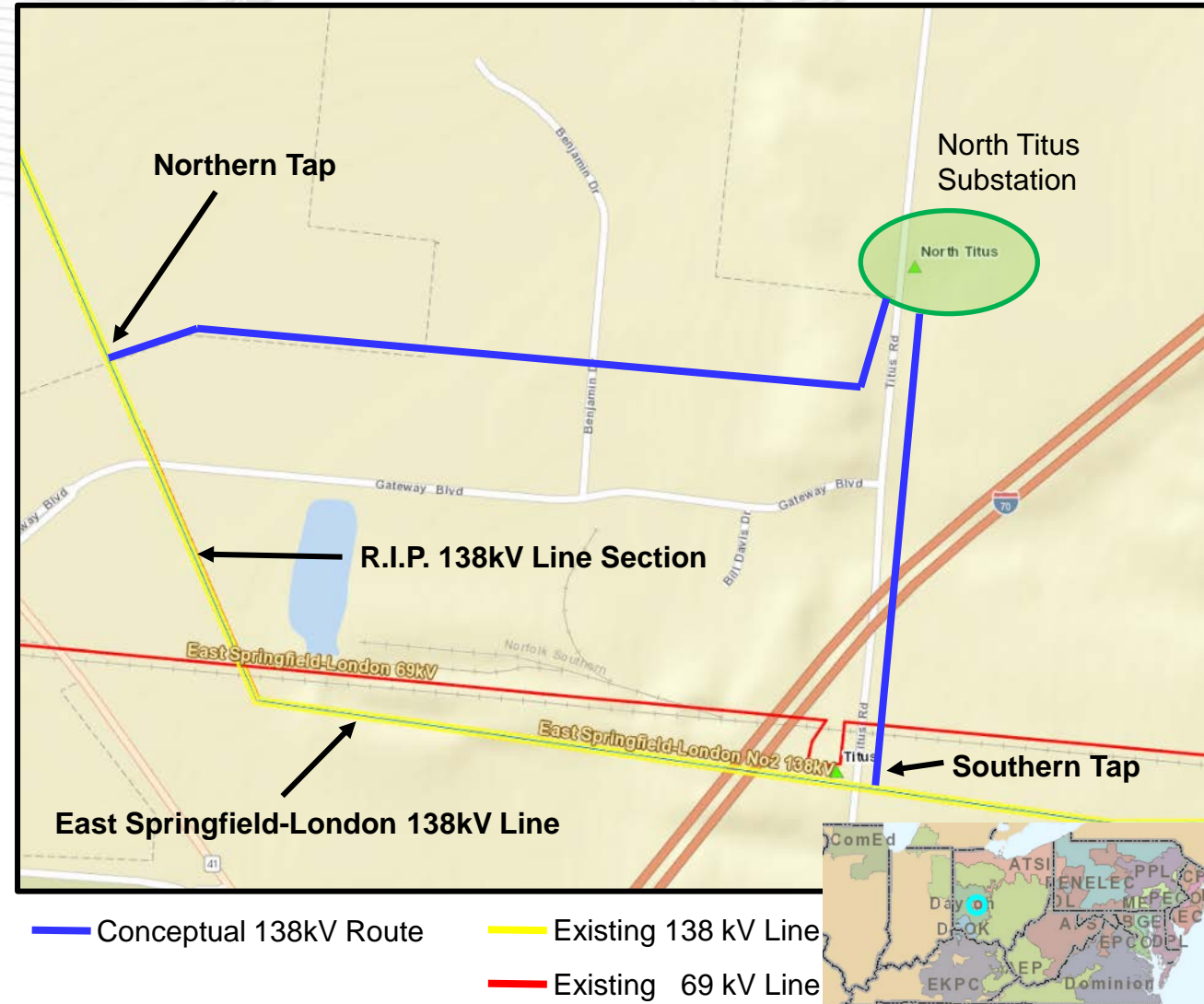
Alternatives Considered:

- Provide 69 kV service
- Provide service to customer through a single delivery point

Estimated Project Cost: \$2.0 M

Projected IS Date: 10/01/2018

Status: Engineering



Problem Statement:

Customer Service

- Provide 138 kV service to new customer
- Customer load 15 MWs

Potential Solution:

Ellwood Quality Steel #2 Substation - Provide 138 kV Service

- Tap the existing New Castle-Cedar Street 138 kV radial line extension.
- Build 2 spans of 336.4 ACSR 138 kV Line

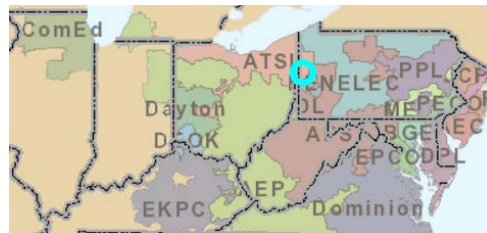
Alternatives Considered:

- Provide 69 kV service
- Provide service from existing service points

Estimated Project Cost: \$0.5 M

Projected IS Date: 9/1/2018

Status: Engineering



- Conceptual 138kV Route
- Existing 138 kV Line
- Existing 69 kV Line



Problem Statement:

Customer Service

- Provide 69 kV service to new customer
- Customer load 4 MWs

Potential Solution:

Envelope 1 Substation - Provide 69 kV Service

- Tap the existing Columbiana-Lisbon 69 kV radial line extension.
- Build 2 spans of 477 ACSR 69 kV Line

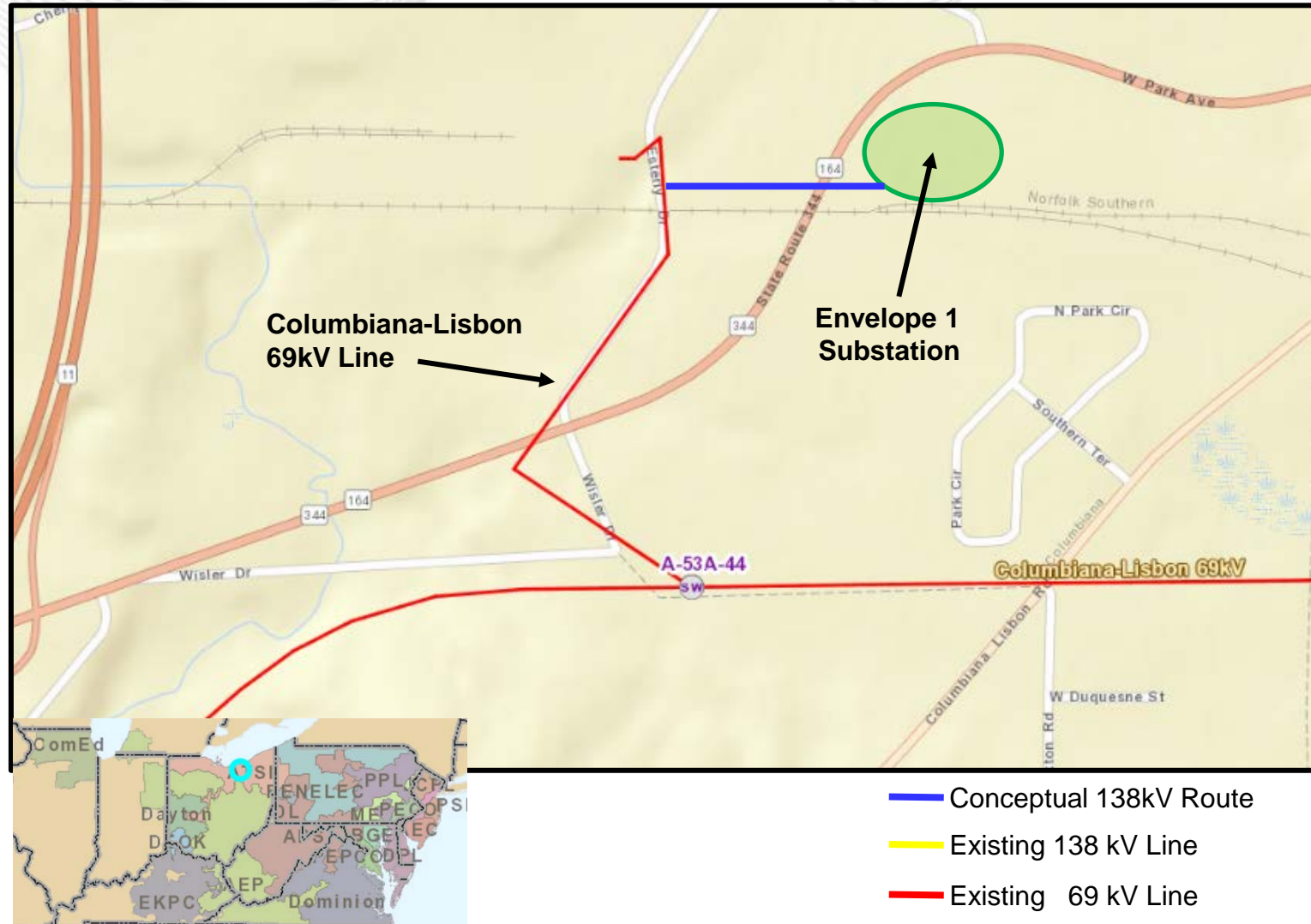
Alternatives Considered:

- Provide service at distribution level service

Estimated Project Cost: \$0.5 M

Projected IS Date: 9/1/2018

Status: Engineering



Supplemental Project (s1365) – Scope Change

Original Scope (Presented on 8/30/2017 Western SRTEAC): Duquesne Light's and the customer's equipment must be removed from the J&L Furnace, J&L Midland, and Beaver Valley substation. The Beaver Valley-J&L Midland (Z-33) 138kV and J&L Midland-Midland (Z-36) 138kV circuits will be jumpered together. Protection at each substation will be modified as needed.

New Scope: Duquesne Light's equipment must be removed from the J&L Furnace substation and equipment associated with the customer must be removed from the Beaver Valley substation.

Reason for Change:

Due to a customer request to continue operations at the plant connected to the J&L Midland substation, only the equipment at the J&L Furnace substation and equipment associated with the customer at the Beaver Valley substation will be removed.

Alternatives Considered:

No alternatives were reviewed as the customer requested to disconnect their service.

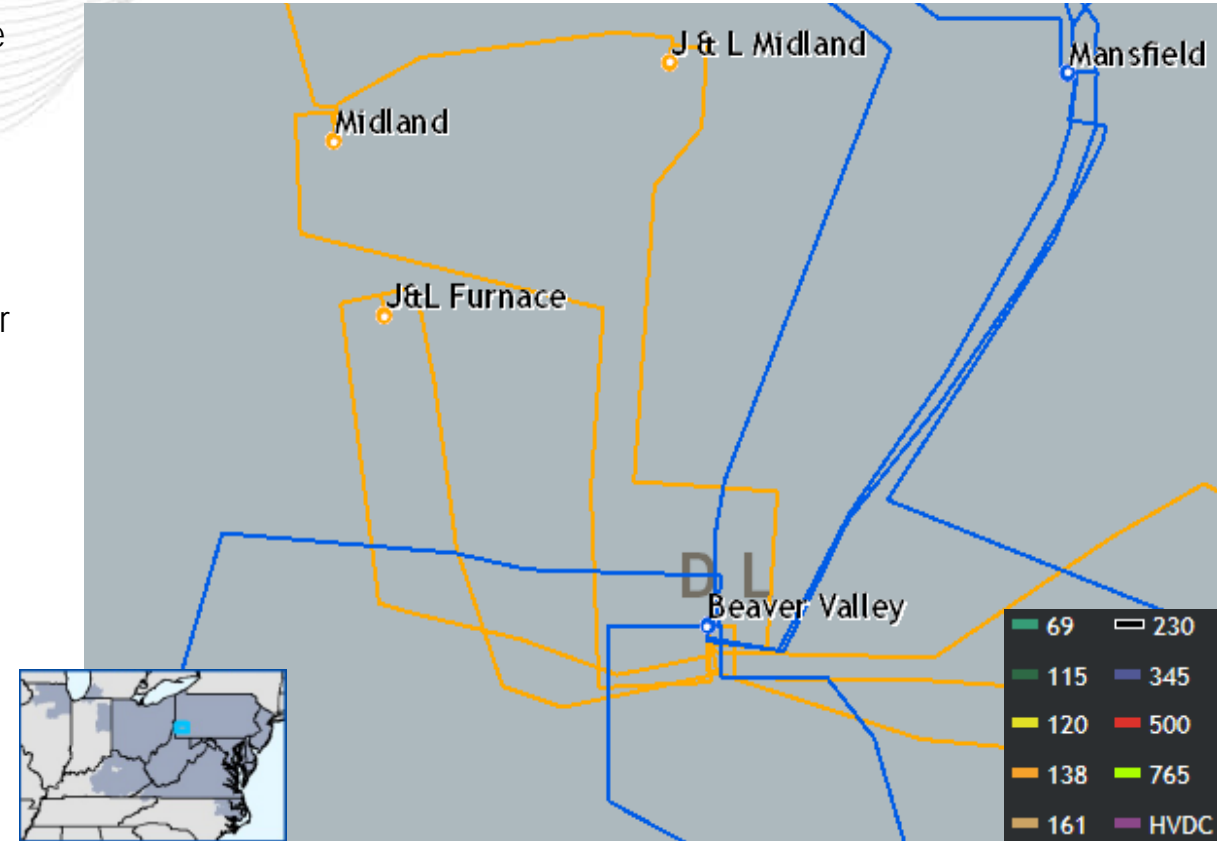
Original Estimated Project Cost: \$1.85M

New Estimated Project Cost: \$1.25M

Original Projected IS Date (Expected IS Date): 1/31/2018

New Projected IS Date (Expected IS Date): 6/1/2019

Status: Engineering



Problem Statement:

The 69 kV feeder between Symmes and Northgreen substations is aged and in deteriorating condition (1950's era).

Driver: Equipment Material Condition, Performance and Risk

Potential Solution:

Rebuild 10.5 miles of feeder between Symmes and Northgreen substations including the tap to Port Union with 298 new structures, hardware, and conductor. Capacity of the line will increase from 97 MVA to 150MVA.

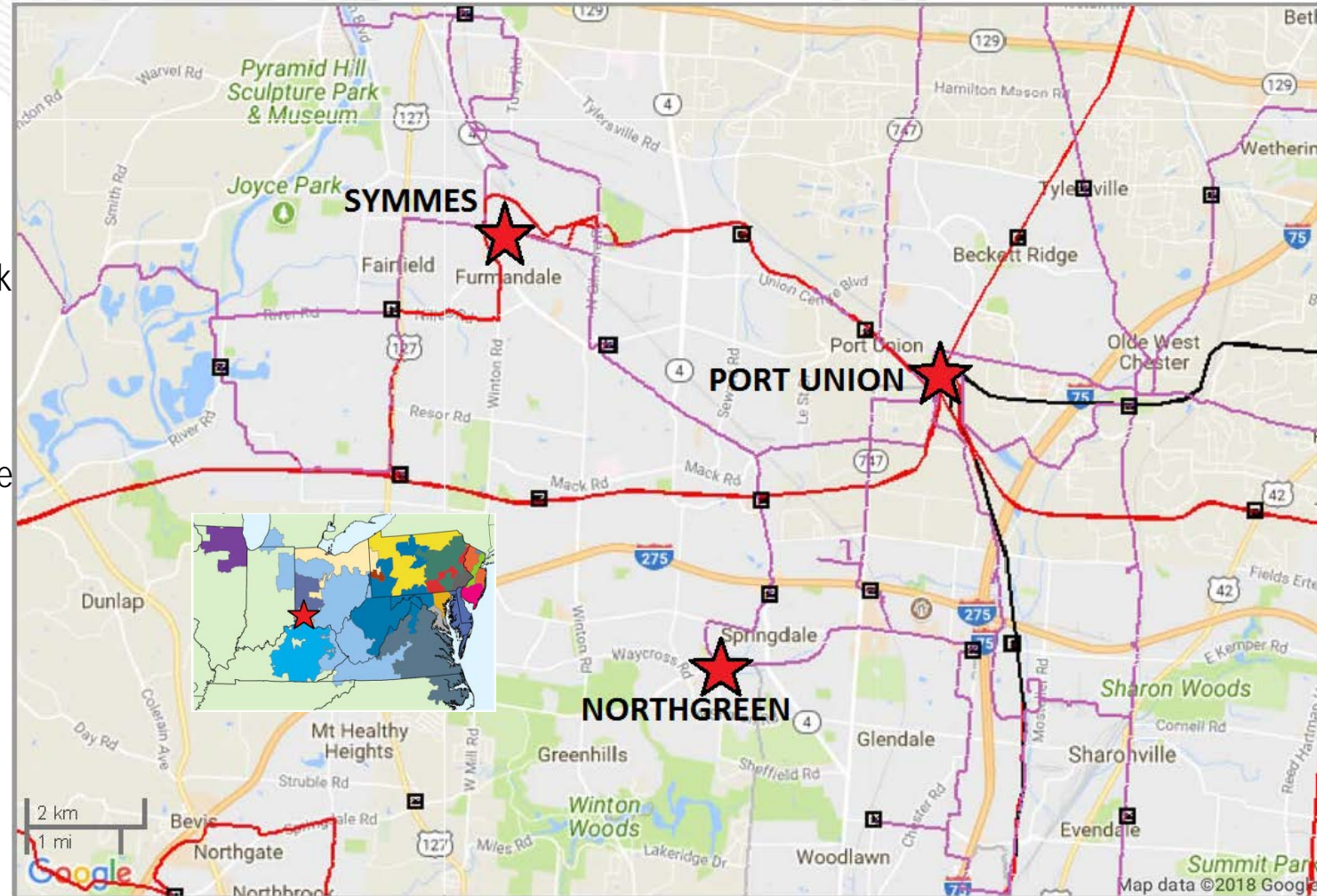
Estimated Cost: \$21.3 M

Alternatives:

None

Projected In-service: 12/31/2018

Project Status: Scoping



Problem Statement:

The 69 kV feeder between Princeton and Trenton substations is aged and in deteriorating condition (1950's era).

Driver: Equipment Material Condition, Performance and Risk

Potential Solution:

Rebuild 6.1 miles of feeder between Princeton and Trenton substations with 137 new structures, hardware, and conductor. Replace two 69 kV switches. Capacity of the line will increase from 97 MVA to 107 MVA (bus limited).

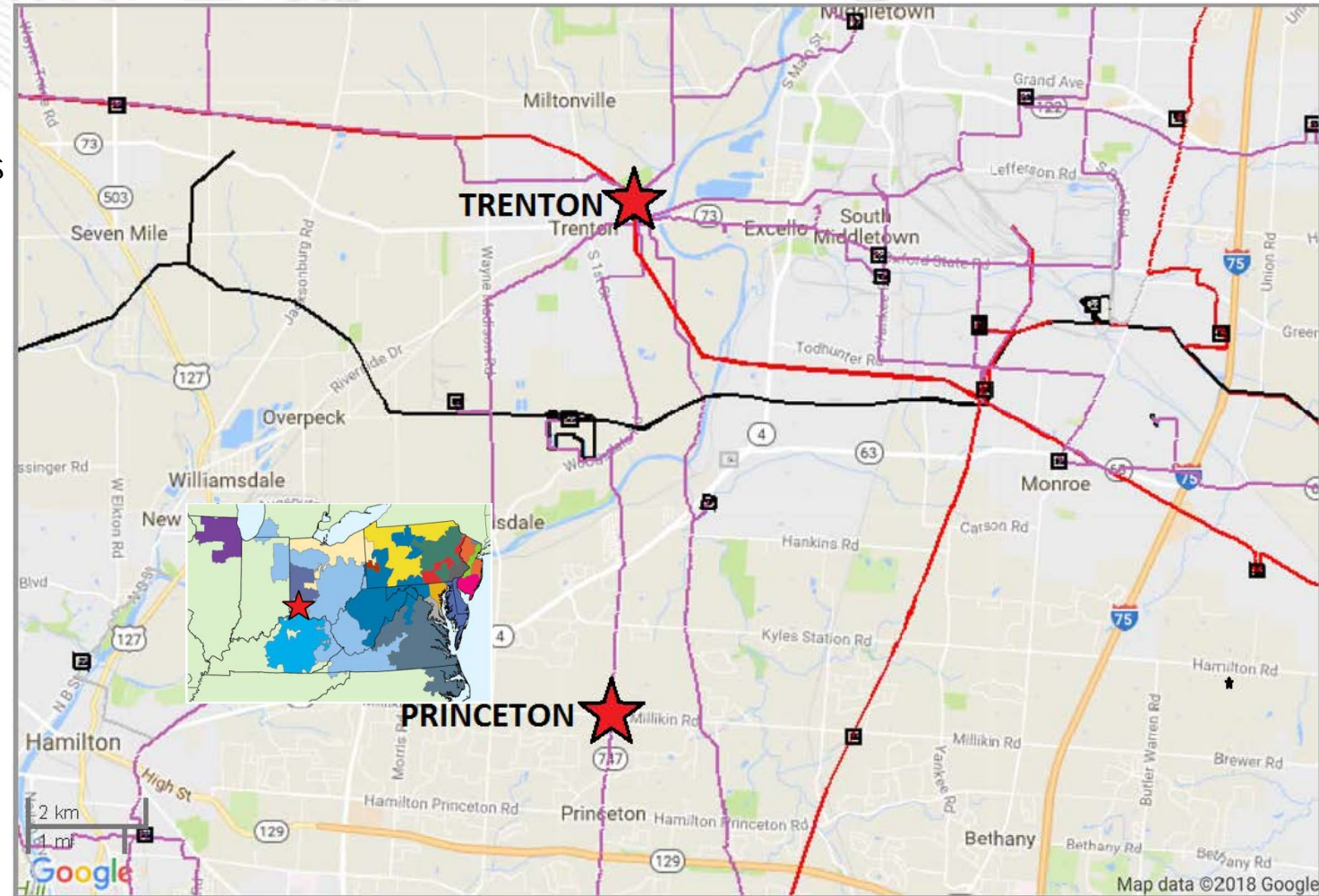
Estimated Cost: \$7.8 M

Alternatives:

None

Projected In-service: 12/31/2018

Project Status: Scoping



Problem Statement:

The 69 kV feeder between Oakley and Fairfax substations is aged and in deteriorating condition (1970's era).

Driver: Equipment Material Condition, Performance and Risk

Potential Solution:

Rebuild 2.3 miles of feeder between Oakley and Fairfax substations with 65 new structures, hardware, and conductor. Replace one switch. Access issues due to hills, creek and railroad. Capacity of the line will increase from 97 MVA to 150 MVA.

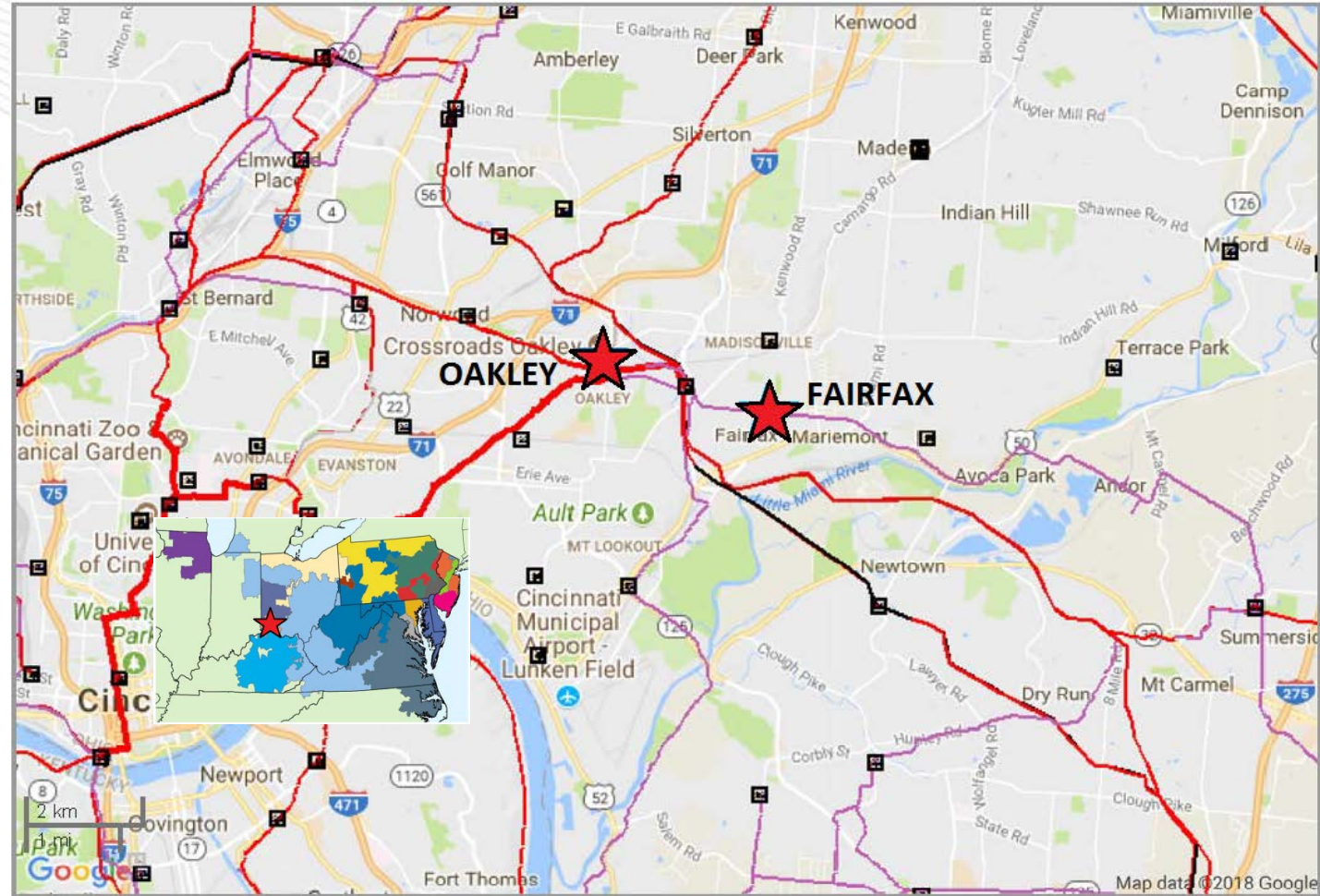
Estimated Cost: \$4.0 M

Alternatives:

None

Projected In-service: 12-31-2018

Project Status: Scoping



Second Review

Baseline Reliability and Supplemental Projects



AEP Transmission Zone: Supplemental Adams-Rarden 69kV Line Rebuild

Previously Presented: 4/17/2018 SRRTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

The Adams-Rarden line was constructed in 1962 using 4/0 ACSR (50 MVA). There are 193 category A Conditions (116 structures); a portion of those are on a radial tap (16 structures), serving Davon substation. Over the previous 3 years there were 547,876 customer minutes of interruption.

Operational Flexibility and Efficiency

The line cannot be taken out of service while it is being rebuilt. The FOI justifies the addition of MOABs.

Selected Solution

Rebuild the 69kV Adams-Rarden line. The new line will be rebuilt adjacent to the existing one leaving the old line in service until the work is completed **in the existing ROW as feasible. Supplemental ROW easements will be obtained where necessary.** The new 69kV line will be built with 795 ACSR (125 MVA). (S1612.1)

Estimated Cost: \$18.7M

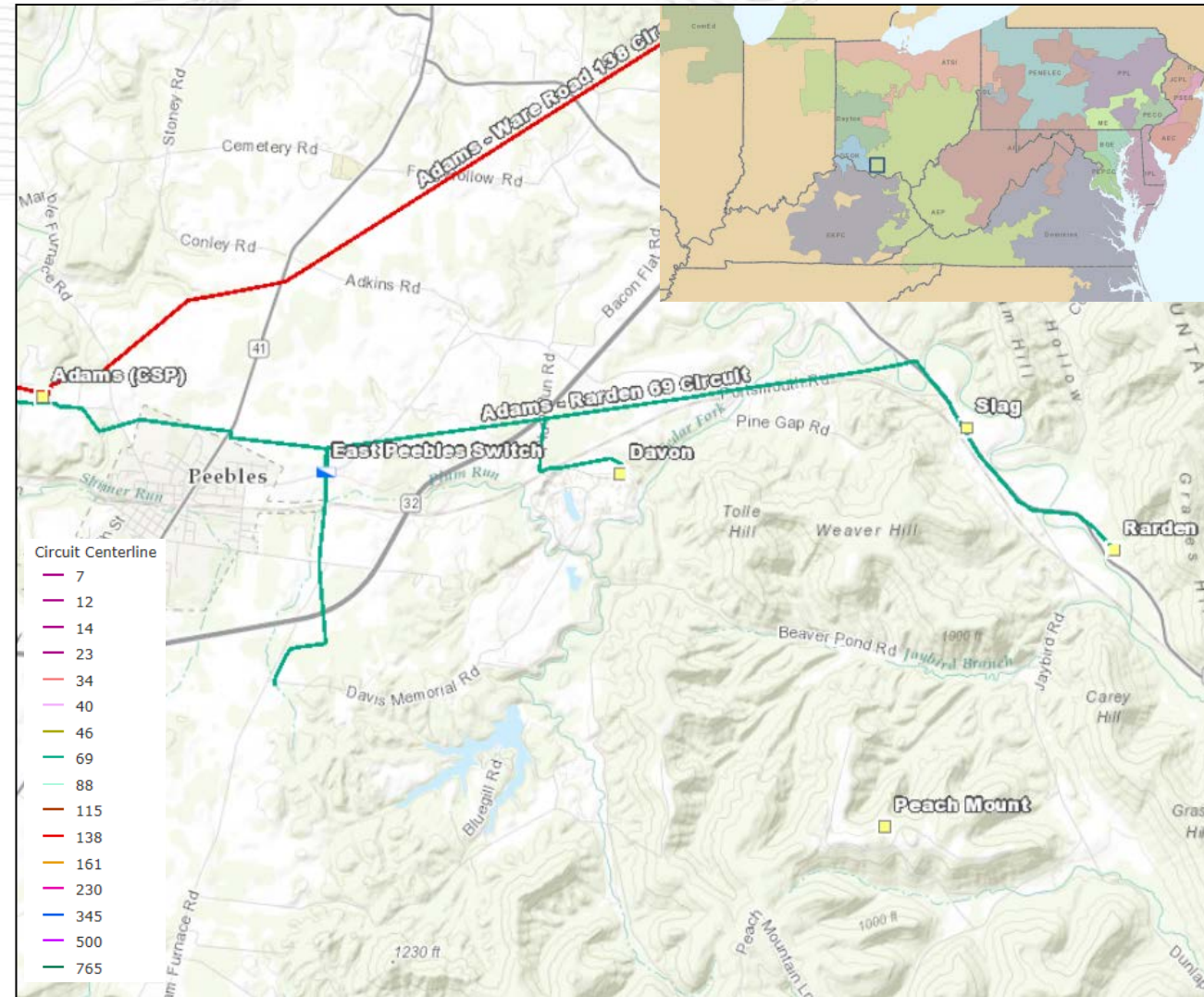
The switch at the Peebles Tap will be replaced with a 3- way SCADA-controlled MOAB switch. A new 3-way SCADA-controlled MOAB switch will be installed at the Davon Tap. (S1612.2)

Estimated Cost: \$1.6M

Total Estimated Transmission Cost: \$20.3M

Projected In-service: 6/1/2020

Project Status: Engineering



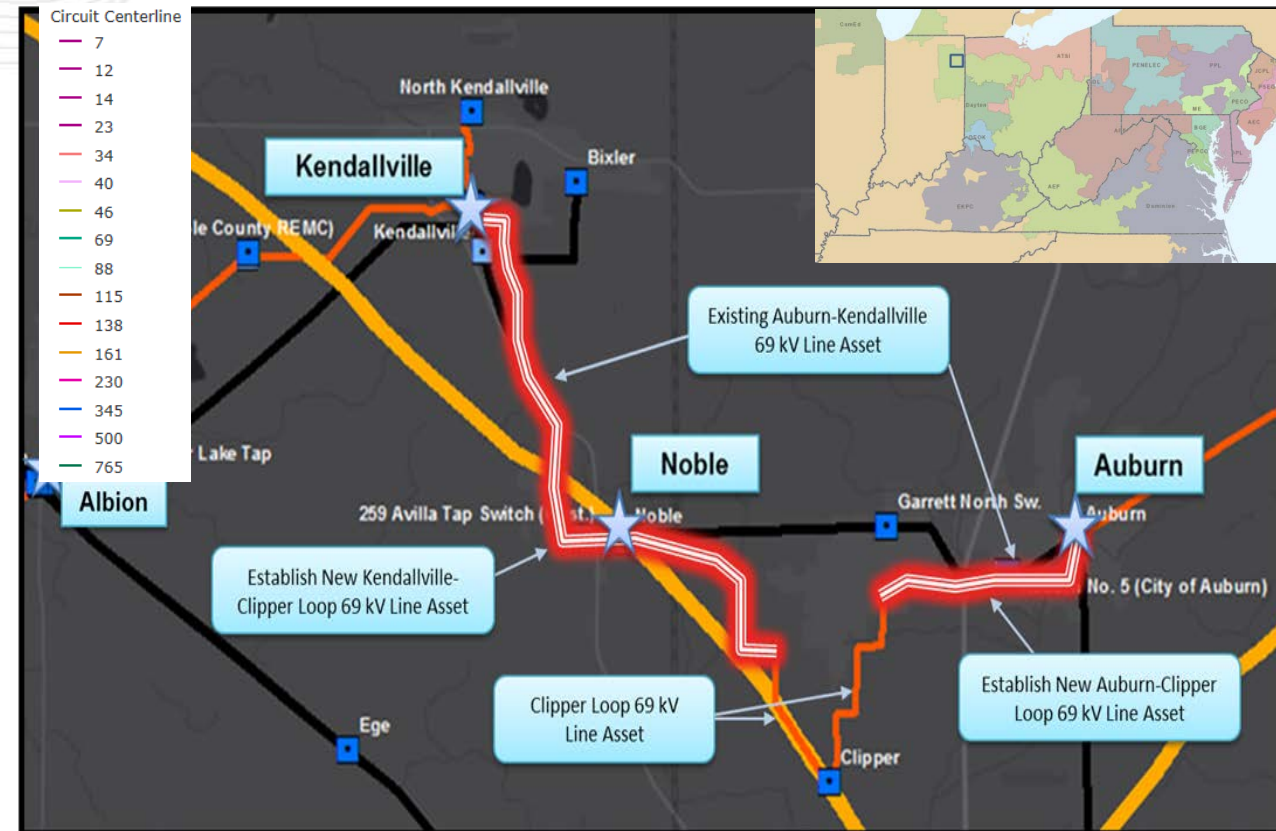
Previously Presented: 4/17/2018 SRRTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

The Auburn-Kendallville 69 kV line asset was constructed in 1954 using wood pole structures and 4/0 ACSR and 4/0 Cu overhead conductor types (50 MVA rating). Approximately 38% of the Auburn-Kendallville structures have open condition issues contributing to a 3 year CMI of 104,041 minutes of interruption affecting approximately 600 customers. Circuit breakers "A" (1952), "B" (1958) and "M" (1971) at Kendallville Station and the remote end breaker "A" (1952) at Albion Station are FK-type 1200A oil breakers that were identified for replacement. In general, these "FK" type oil breakers have become increasingly difficult to maintain due to the oil handling associated with them. Oil spills are frequent with failures and routine maintenance which is also an environmental hazard.

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Selected Solution

Rebuild the existing Auburn-Kendallville 69 kV line asset using 556 ACSR 26/7 “Dove” overhead conductor (~15 miles, 102 MVA rating) **(S1613.1) Estimated Cost: \$14.9M**

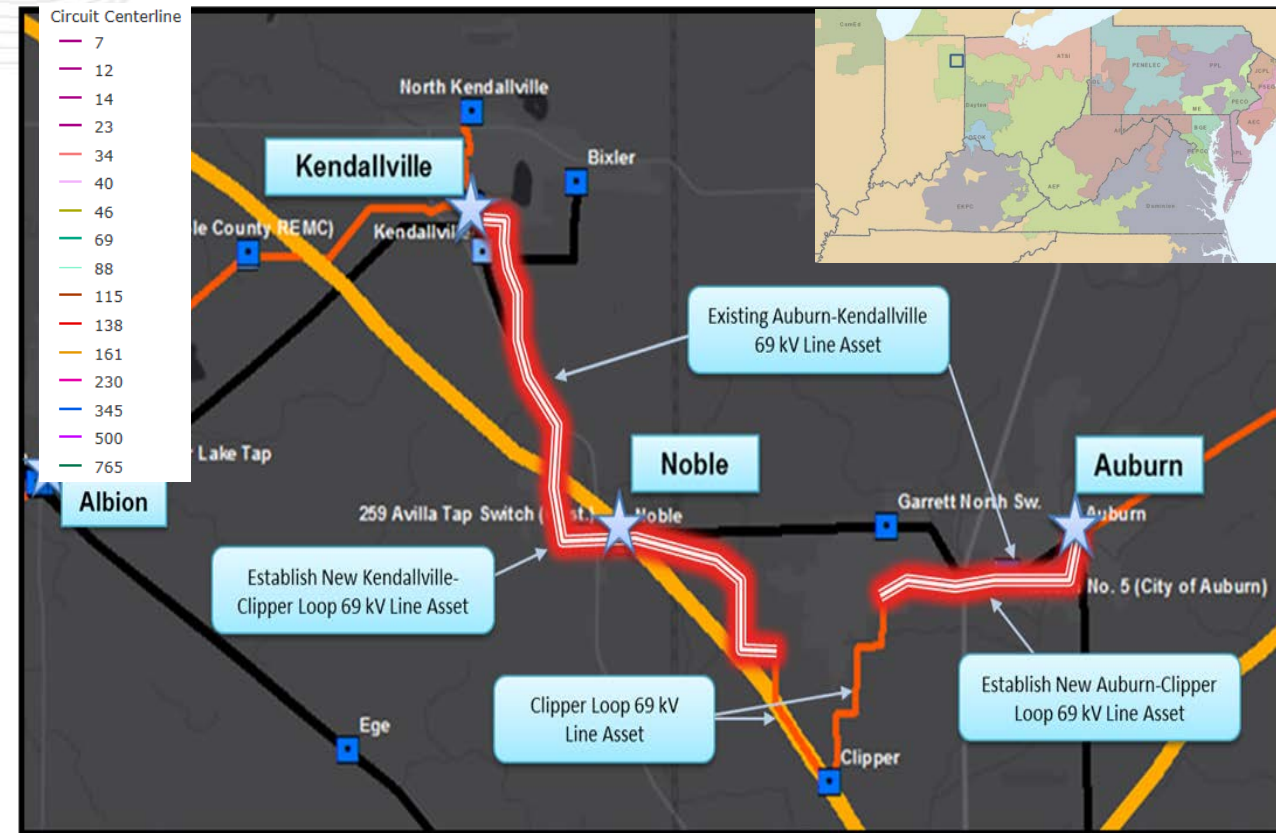
At Kendallville Station, replace 69 kV circuit breakers A, B and M and associated equipment with 69 kV, 40 kA, 3000 A circuit breakers. **(S1613.2) Estimated Cost: \$1.7M**

At Albion Station, replace 69 kV circuit breaker A and associated equipment with 69 kV, 40 kA, 3000 A circuit breaker. **(S1613.3) Estimated Cost: \$0.3M**

Total Estimated Transmission Cost: \$16.9M

Projected In-service: 06/30/2019

Project Status: Scoping



Previously Presented: 4/17/2018 SR RTEP

Problem Statement:

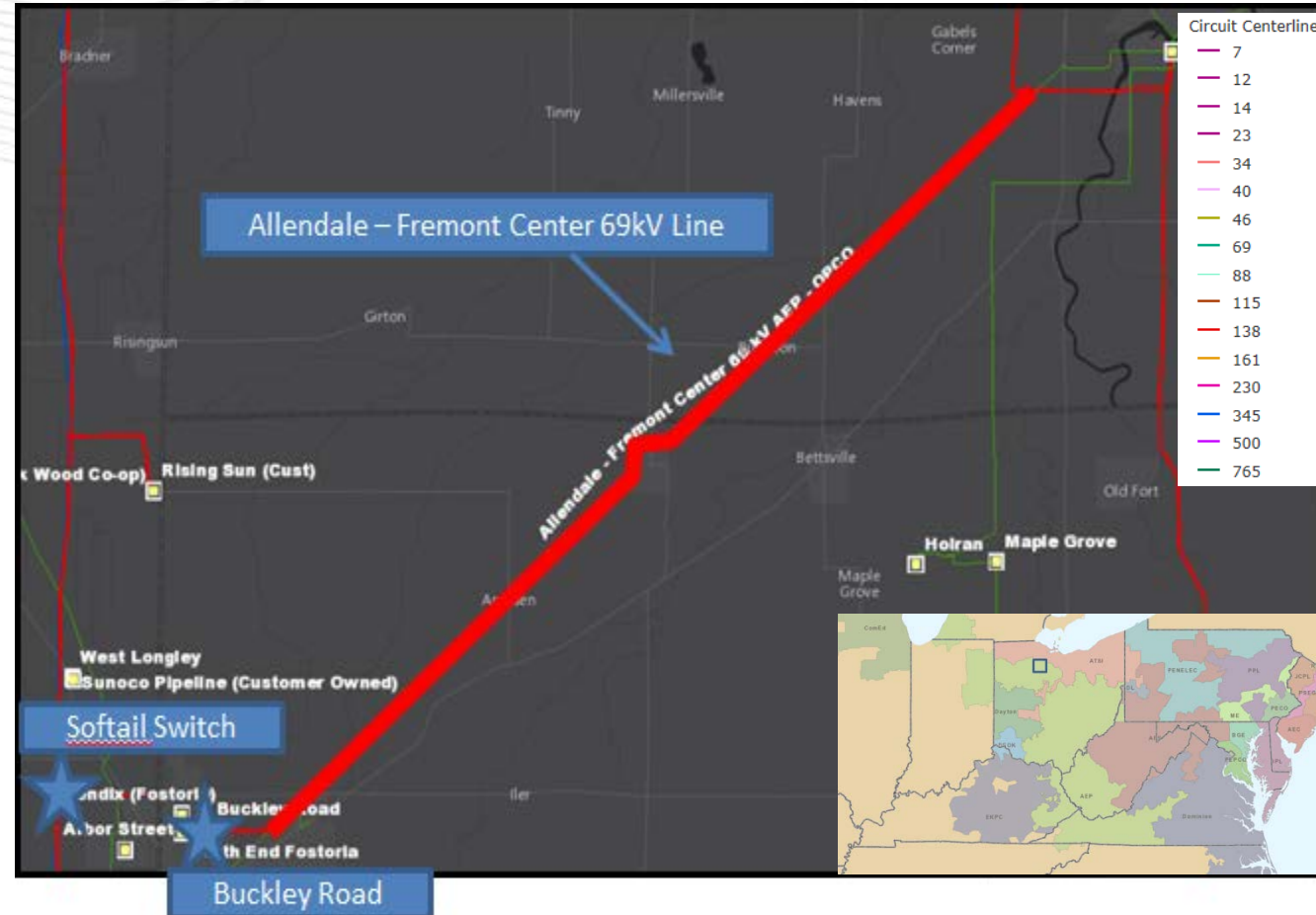
Equipment Material/Condition/Performance/Risk:

Breakers 'A' and 'C' at Buckley Road station are vintage 1975, 1800 A, 27 kA oil medium models with fault counts of 7 and 82 respectively. Oil breaker maintenance has become more difficult due to the oil handling required to maintain them. Oil spills are frequent with breaker failures and routine maintenance and can become an environmental hazard. The drivers for replacement of these breakers are age, number of fault operations, a lack of available repair parts and potential PCB content.

Breaker 'D' will be added at Buckley Road to improve high side transformer protection by eliminating the existing ground switch and MOAB scheme. This will improve reliability by more effectively isolating faults on either side of the breaker so that the 69kV lines are not affected by a 138kV line fault and vice versa or faults in the transformer.

The Allendale – Fremont Center 69kV line is predominately 1917 era construction and is made up of the Amsden – Fremont Center 69kV and Buckley Road – East End Fostoria 69kV Circuits. The significant age of the structures, conductor, and shield wire has prompted the need for a line rebuild. There are 11 category A conditions and 29 category B conditions along on this line.

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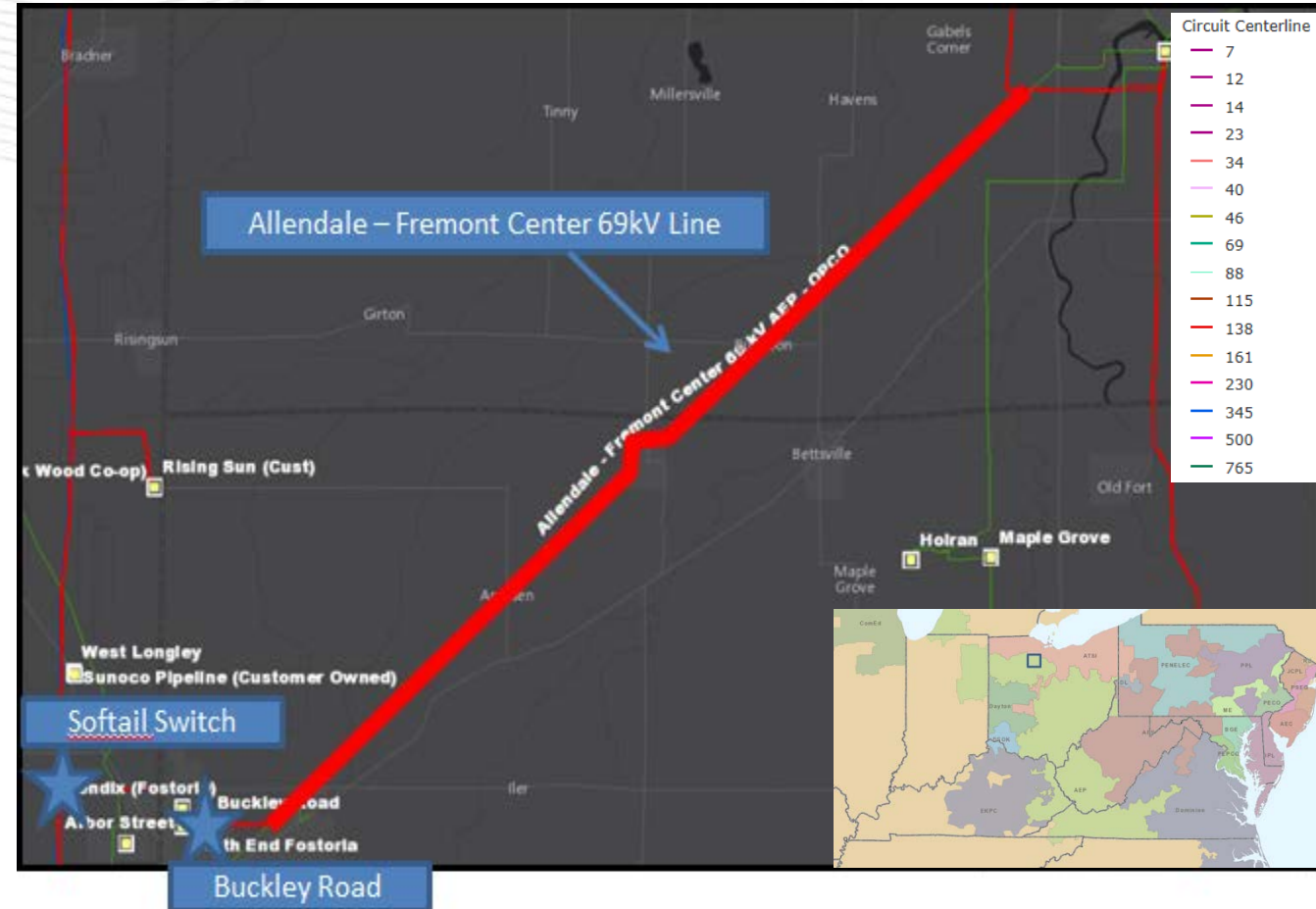
Operational Flexibility and Efficiency

Rebuilding the Allendale – Fremont Center 69kV line to 138kV standards will provide operational flexibility and efficiency benefits when a conversion to 138kV operation is conducted in the future. The conversion to 138kV will create a direct path between Buckley Road and Fremont Center stations; the 69kV path is currently kept normally open at Amsden Switch due to the low-rated conductor section that exists on the Allendale – Fremont Center 69kV line. Future conversion will also allow Buckley Road to have 138kV looped service; currently the station is radially fed from Fostoria Central station.

Customer Service:

Softtail Switch is being installed as requested by Buckeye Power on behalf of NCEC, to improve reliability and operational flexibility for their Rising Sun delivery point. The new three-way GOAB switch replaces the existing hard tap allowing Rising Sun to be switched back into service during an outage at Buckley Road station. The Buckley Road – Fostoria Central 138kV circuit information has been provided in the appendix for reference.

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Selected Solution

At Buckley Road Station, replace 69kV breaker 'A' and 'C' with 3000A 40kA breakers and associated equipment. Add 3000A 40kA 138kV circuit breaker 'D' for high side protection of transformer #1. This will replace the existing ground switching protection currently at the station. **(S1614.1)**

Estimated Cost: \$2.6M

At Softail Switch, replace the hard tap for the Rising Sun delivery point, on the Buckley Road – Fostoria Central 138kV Line, with a 2000A three-way phase-over-phase switch. **(S1614.2)**

Estimated Cost: \$1.06M

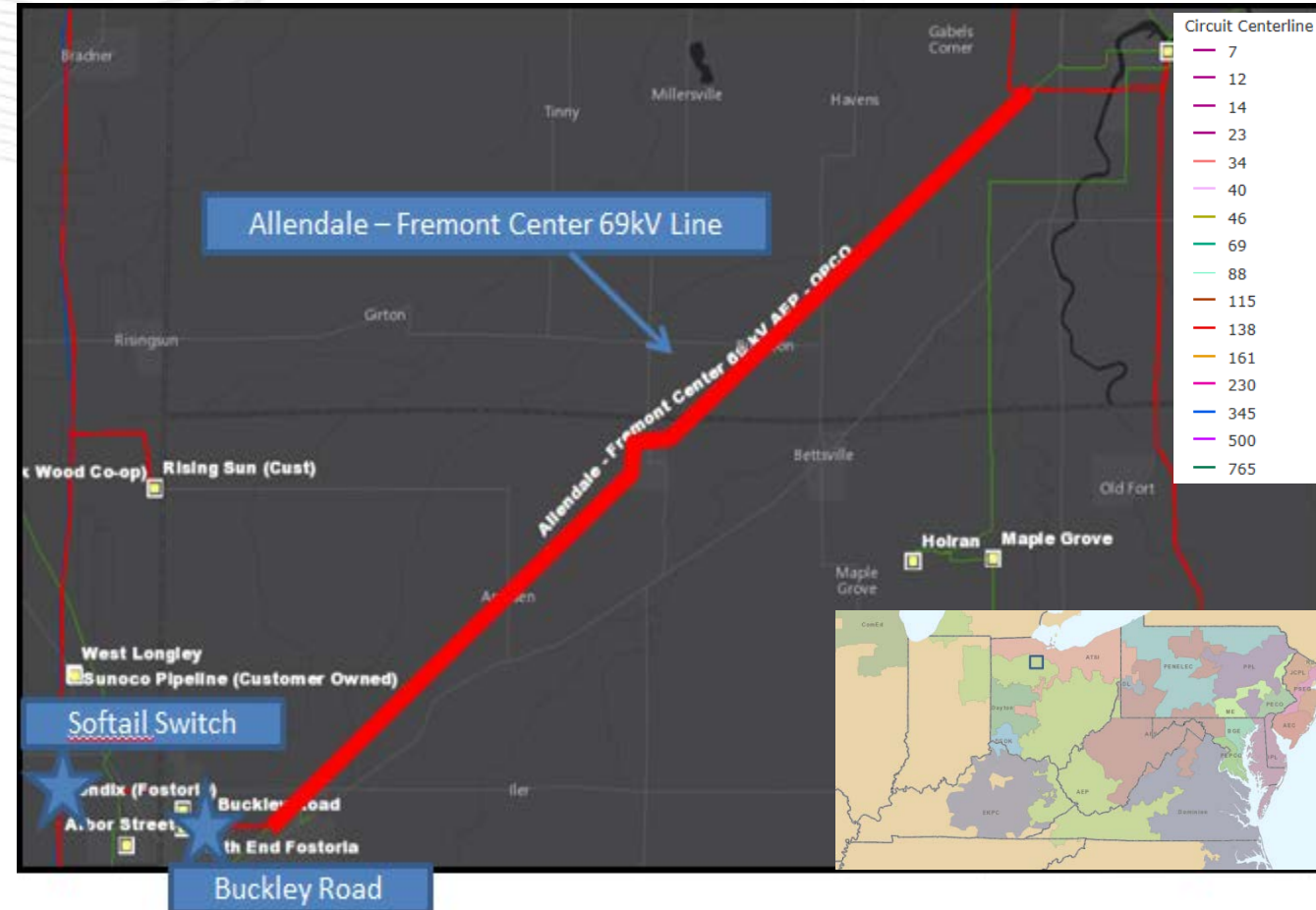
Rebuild approximately 15.2 miles of the Allendale – Fremont Center 69kV Line with 138kV line construction operated at 69kV. The new line will be double circuit 138kV construction for 0.6 miles at the Allendale end so that the customer served at Weaver Switch can remain served at 69kV even after a future 138kV conversion of the rebuilt line. The remaining 14.6 miles of line rebuild will be single circuit 138kV construction. **(S1614.3)**

Estimated Cost: \$22.2M

Total Estimated Transmission Cost: \$25.9M

Projected In-service: 12/31/2020

Project Status: Engineering



Previously Presented: 4/17/2018 SRRTEP

Problem Statement:

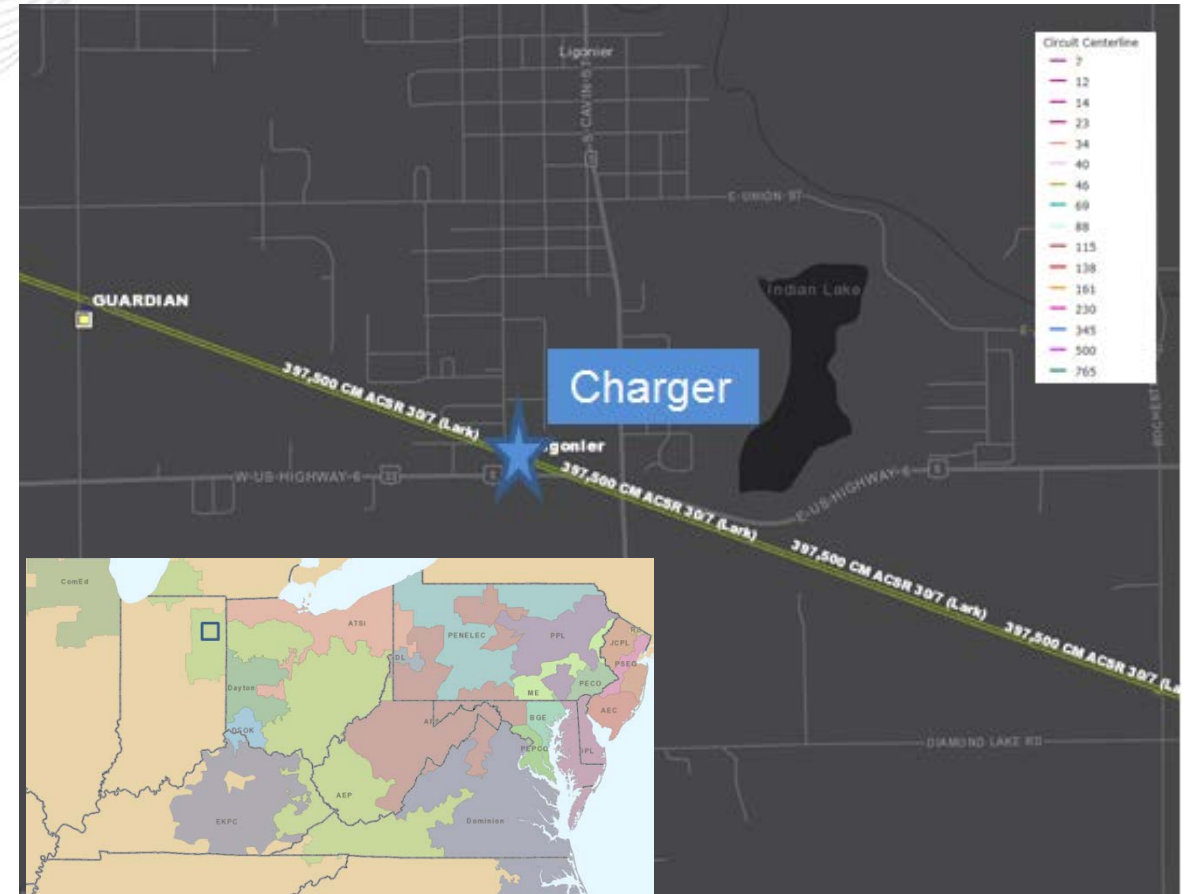
Operational Flexibility and Efficiency

The current 138 kV transmission line configuration entering Ligonier Station consists of two “hard taps” which are non-standard and contribute to customer interruptions. The existing line-tie looprupter is unable to split the loop flow when needing to split the circuit tie after it has been closed for planned work or customer load recovery reasons. To safely open the looprupter switch the customers must be interrupted by drop-and-pick switching. Reconstructing the station to a standard configuration will modernize the station, reduce customer interruptions, enhance operational flexibility, and eliminate a legacy transmission system configuration deficiency.

Customer Service:

The associated line rebuild of the Robison Park-Twin Branch 138 kV line (s1336), which serves the existing Ligonier station, will require a re-route to eliminate several encroachments caused by construction of business underneath the line. By adjusting the ROW route slightly, this avoided the need to purchase several local businesses directly underneath the line, which was appreciated by the local community and Mayor. The re-route of this line to the south of the existing station site provided an opportunity to establish a new station with sufficient property size to accommodate the layout of the 3 breaker ring bus, improving the reliability and performance of the customers served from this station.

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Selected Solution

Construct a new 138 kV tie line from the new Charger 138 kV Switching Station to the existing Ligonier Station using 795 ACSR conductor. **(\$1615.1)**

Estimated Cost: \$0.6M

Construct new 3-breaker ring bus 138 kV switching station across the road from the existing I&M 138/12 kV Ligonier Station, allowing a 138 kV transmission line reroute through an area with multiple underlying commercial building encroachments. Equipment consists of 138 kV, 40 kA, 3000 A circuit breakers and 3000 A disconnect switches. **(\$1615.2)**

Estimated Cost: \$6.5M

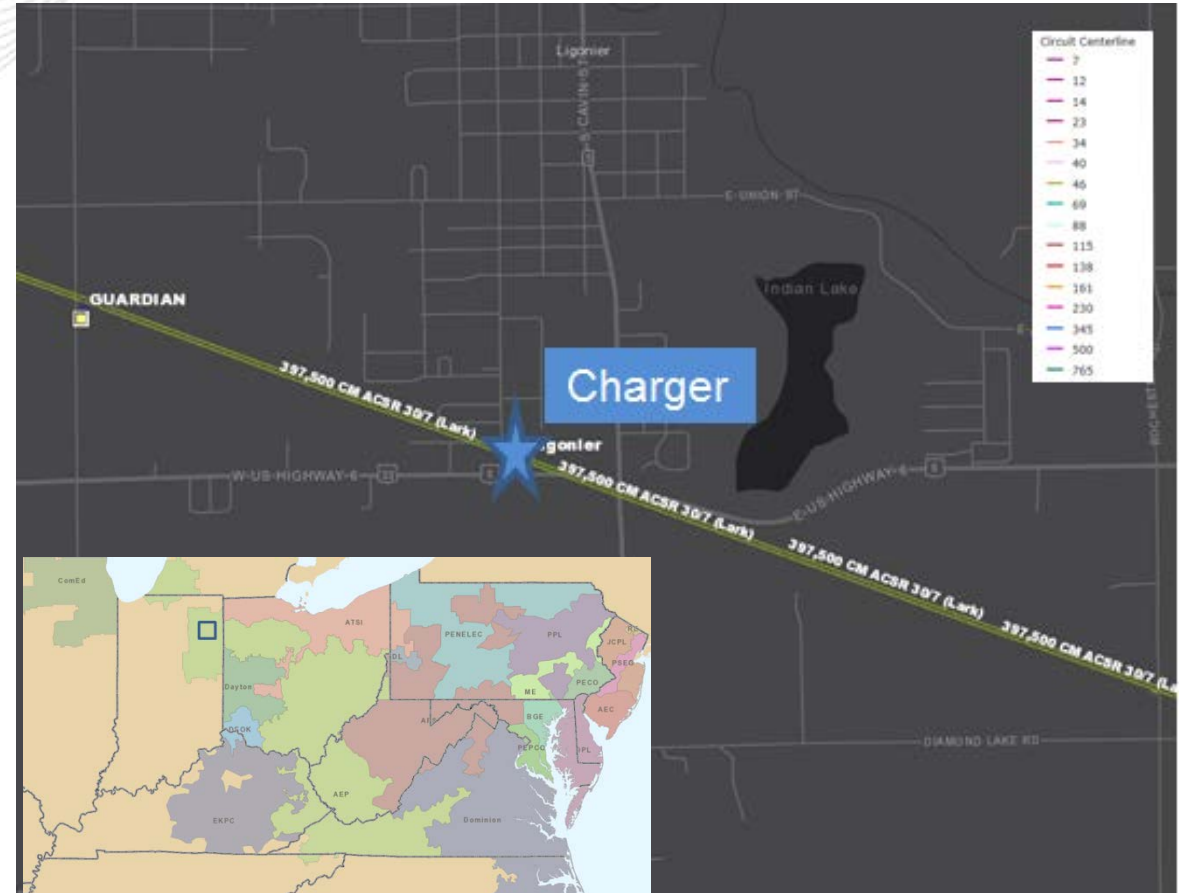
Expand existing Ligonier Station. **(\$1615.3)**

Estimated Cost: \$0.1M

Total Estimated Transmission Cost: \$7.2M

Projected In-service: 12/31/2018

Project Status: Scoping



Previously Presented: 4/17/2018 SRRTEP

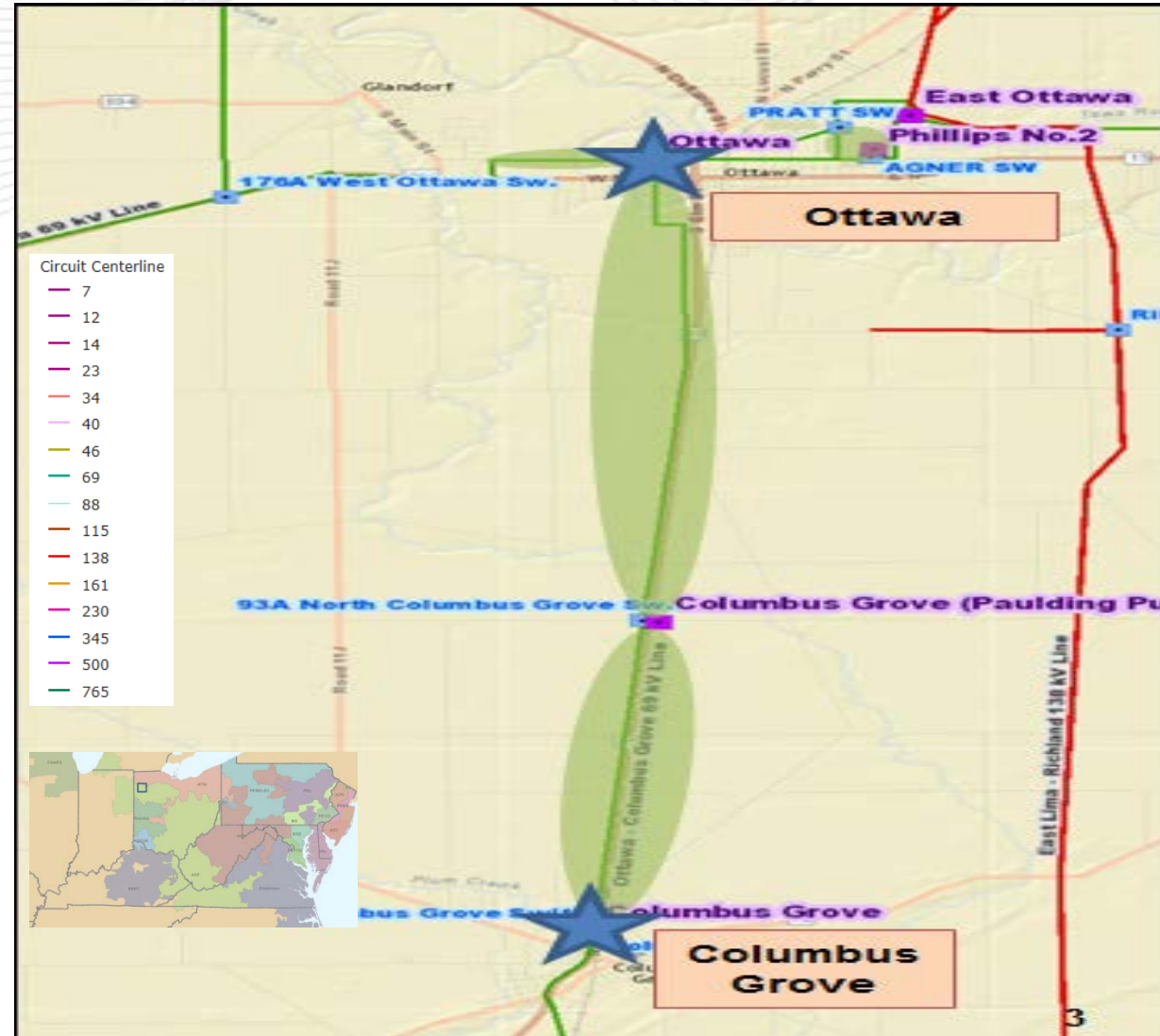
Problem Statement:

Equipment Material/Condition/Performance/Risk:

The Ottawa-Columbus Grove 69kV line is mostly wood pole construction with the oldest structures dated at 66 years old (vintage 1951) and the vast majority of the line at or above 50 years old with 3/0 ACSR 6/1 Pigeon conductor (44 MVA) . Also, the East Lima-East Ottawa 69kV circuit has CMI of more than 251,509. There are a variety of conditions including rotting poles, splitting and rotting cross arms, burnt insulators, and insect damage. Newer steel poles on this line were replacements required due to a derecho in recent years where the older wood poles were broken. The newer steel poles are not targeted for replacement except as is necessary to complete the targeted work. North Columbus Grove Switch has experienced alignment problems on a wood pole and needs to be replaced.

East Ottawa station currently utilizes 3 transmission oil CB's, requiring rehab driven replacement based on age and condition. The 69 kV CB's L, N, and K have experienced 16, 55, and 42 fault interruptions respectively and were manufactured in 1966. Additionally, the 69kV cap switcher is a Mark V model and has had a number of operations that has led to issues with the interrupters. Mark V cap switchers have a track record of mechanical problems and have been recommended for replacement due to these issues in addition to the fact that they don't integrate well into modern relaying packages. Spare parts for Mark V cap switchers are also becoming more difficult to find.

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Operational Flexibility and Efficiency

69/12kV Ottawa station is currently radially served from two short radial hard taps into station MOABs, one of which is operated N.O. The line between Kalida and the new Glandorf site includes 13 miles of exposure (including a 5.3 mile radial to Miller City) through a wind prone area of primarily farm land. The line between East Ottawa and the new Glandorf site includes 2.3 miles of exposure that crosses the flood prone Blanchard river and includes a few short stretches of forested area and several residential properties with nearby trees. Adding CB's on each side of Glandorf station will provide automated protection from potential failures on the Kalida-East Ottawa and will provide remote operational flexibility to recover from complications in the area such as flooding conditions.

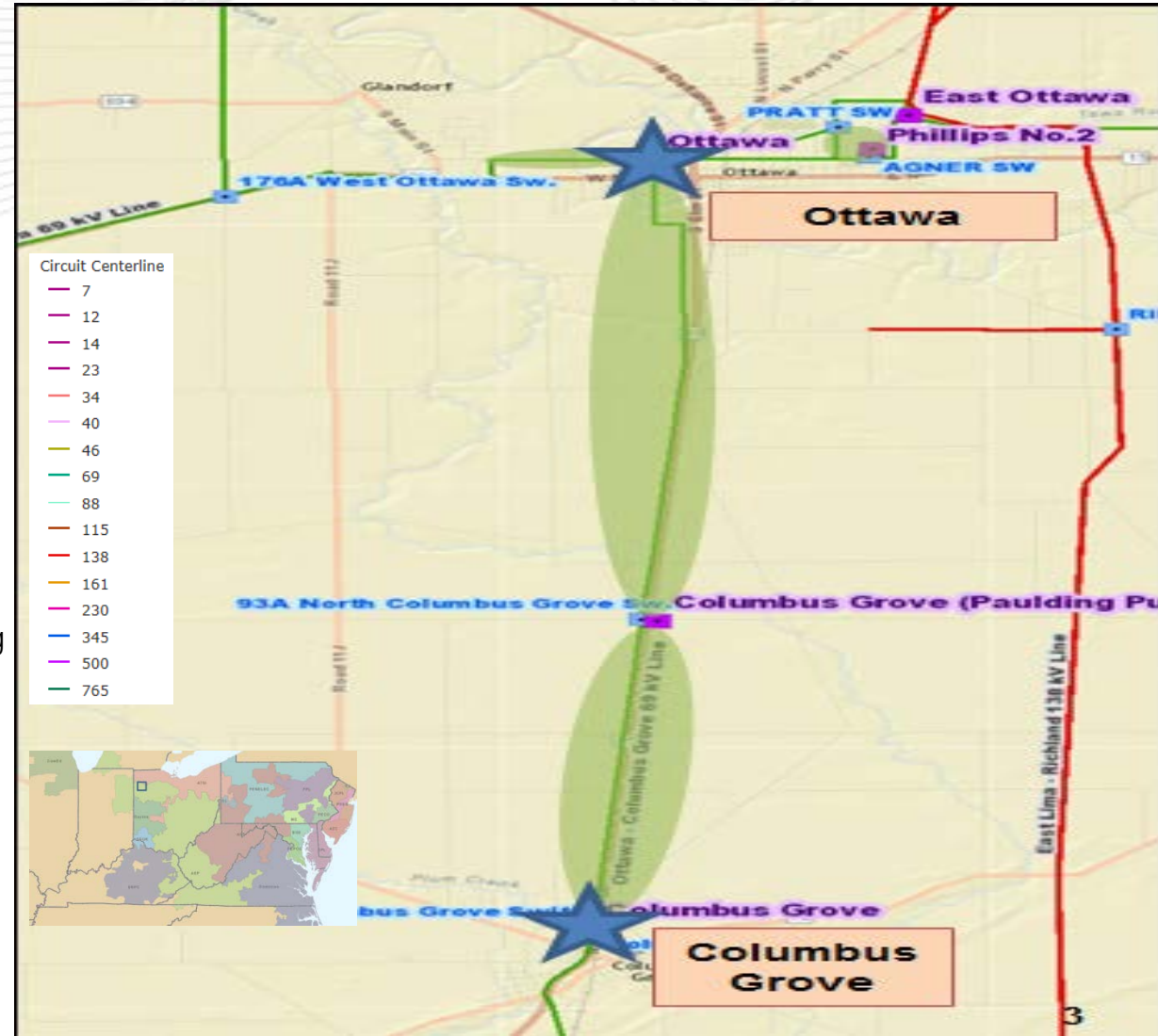
With the reconfiguration of Agner switch, a N.O. switch and a line in the bus zone of protection will be eliminated. This switch and connected load will be relocated to the East Lima-East Ottawa 69kV circuit. The location of this load makes further sectionalizing of the line desirable. Given the need to replace the switches at North Columbus Grove Switch and the relative exposure involved, North Columbus Grove Switch was selected as the best location for motorizing a switch.

East Ottawa Station has experienced 2,965,627 of CMI. Extended outages were experienced during the 2012 derecho when several structures had to be replaced to restore service to all customers. East Ottawa Station is surrounded on three sides by the Blanchard River which has severely flooded the station at least twice in the past, rendering the station unusable until flood waters receded.

Customer Service:

A new station at a different location is needed to avoid the flooding problem in the future. AEP-Ohio has elected to retire Ottawa station and replace it with Glandorf station, largely to address this flooding issue. **The majority of equipment in the station is in need of replacement, and the Distribution company has requested to move the station due to flooding at the site.**

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Selected Solution

Rebuild 6.91 miles on Ottawa - Columbus Grove 69kV line with 795 ACSR (128 MVA rating) in existing ROW. Remove taps to Ottawa station. Build 69kV line extensions to serve Glandorf station using 795 ACSR. Retire Pratt Extension 69kV Line. Reconfigure 69kV connections at Agner Switch. Remove line sections and de-energized conductor that will no longer be needed. (S1616.1)

Estimated Cost: \$13.0M

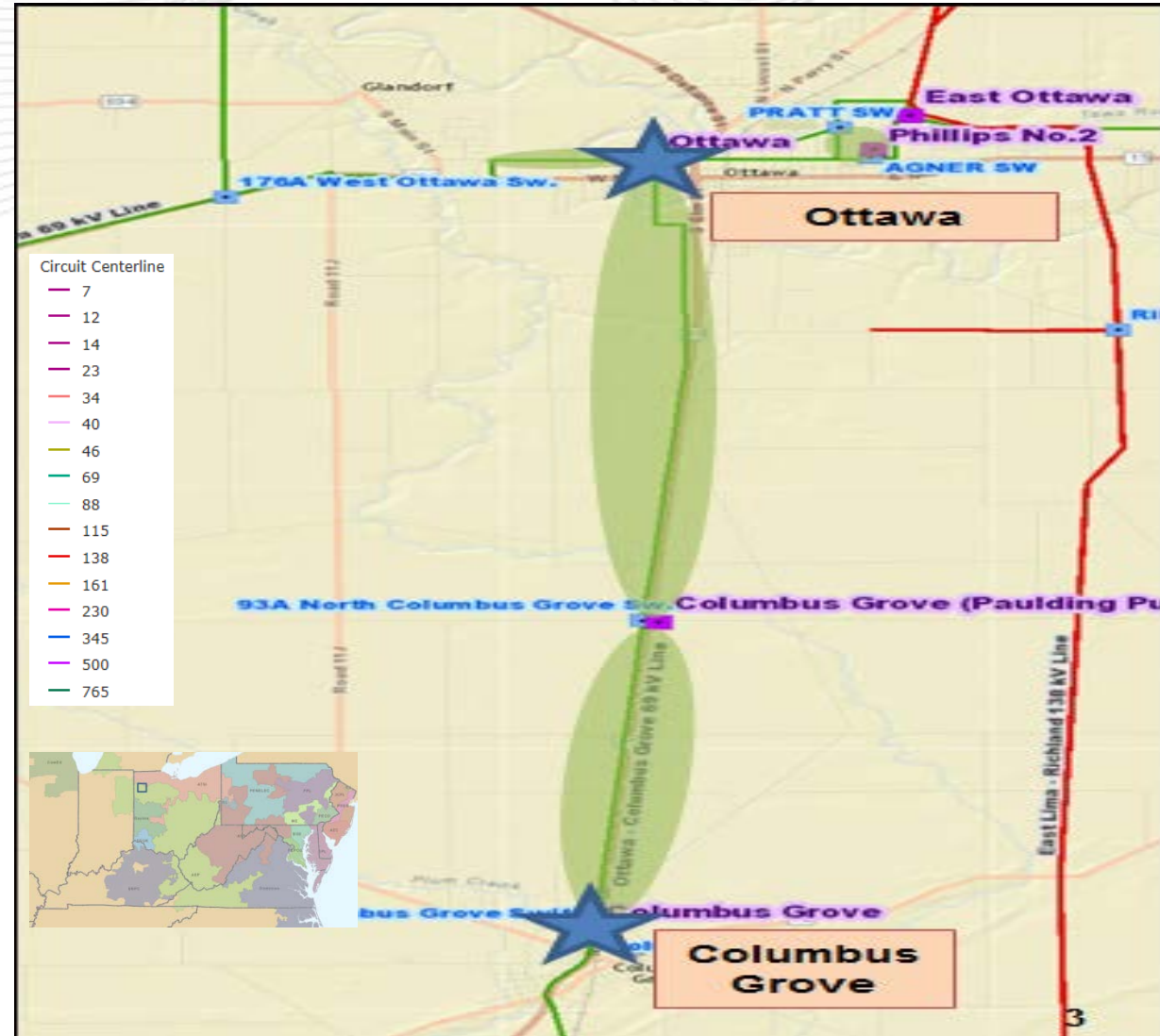
Replace 69/12kV Ottawa station with 69/12kV Glandorf station at a new station site. Upgrade existing 3 way switch at North Columbus Grove to 3 way switch with 1 MOAB. Replace 3-69kV CB's and 1-69kV cap switcher at East Ottawa. (S1616.2)

Estimated Cost: \$6.1M

Total Estimated Transmission Cost: \$19.1M

Projected In-service: 12/01/2019

Project Status: Scoping



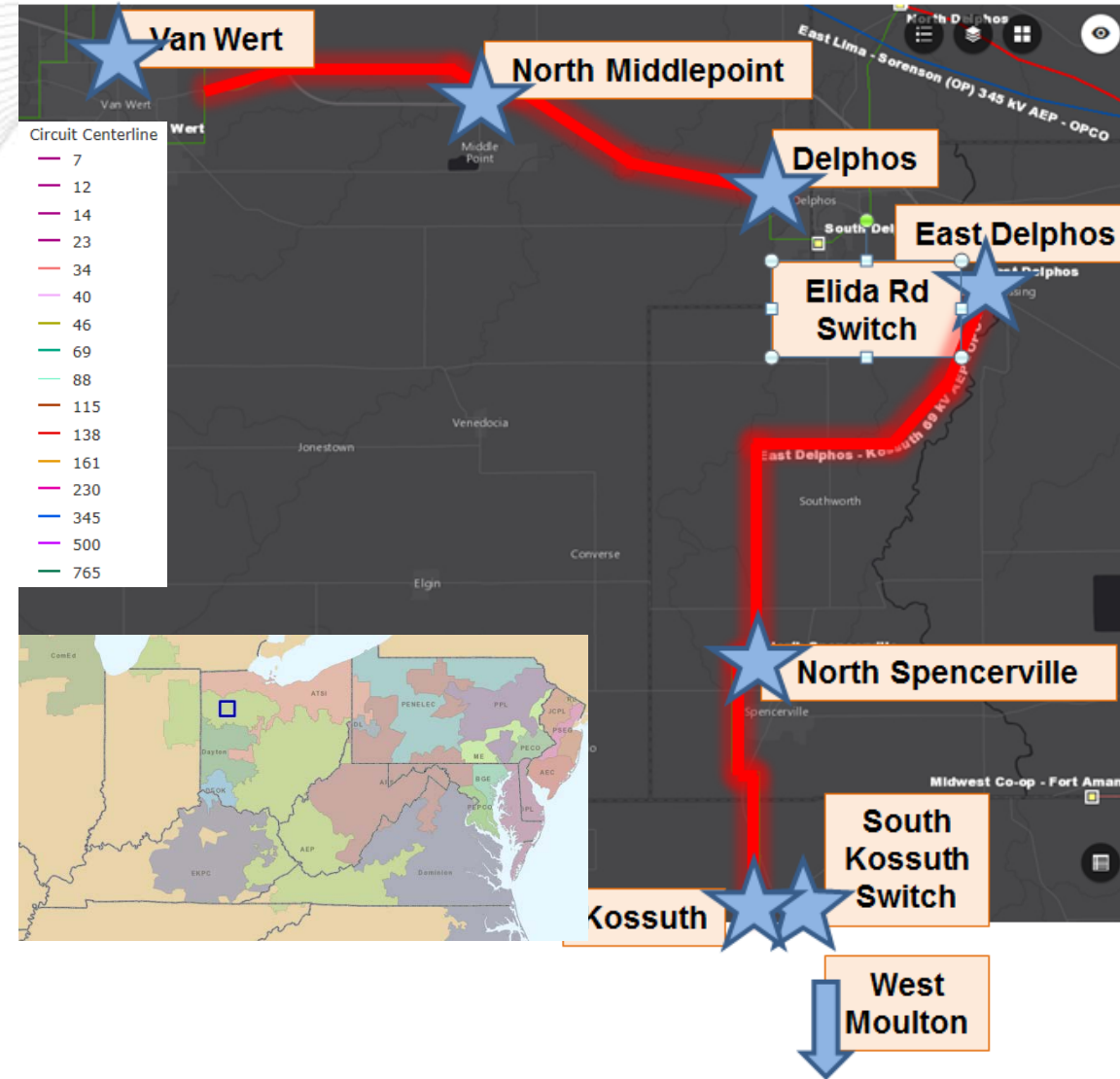
Previously Presented: 4/17/2018 SR RTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

There are 284 open conditions on the North Delphos – Van Wert circuit, which was originally constructed in 1926 with 2/0 Copper conductor (40 MVA rating). There are 727 open conditions on the North Delphos – West Moulton section, constructed in 1927 with 2/0 Copper. Existing lines between Delphos and Van Wert and between East Delphos and North Spencerville are almost entirely cross arm construction with vertical post insulators, which is not a current AEP standard. Along the East Delphos-Kossuth circuit, many vertical post insulators have burn marks, showing signs of in-service failures. Many insulators on both lines are tie-top type, and some existing wood pole structures have bay-o-nets supporting the shield wire, which are prone to failure. Existing line between North Spencerville and Kossuth is mostly burnt-colored horizontal post insulators with many leaning poles and bay-o-nets. The ability to repair breakdowns of the obsolete conductor size and type on both lines is becoming increasingly difficult due to limited availability of materials. Existing shield wire conductor types are obsolete for use as shield wires on the AEP system, and some are even unavailable as a like-kind breakdown replacement. Both lines have distribution underbuild, which mechanically consumes pole strength. Legacy underlying easement rights for a line of this vintage are inadequate by present day AEP Transmission standards.

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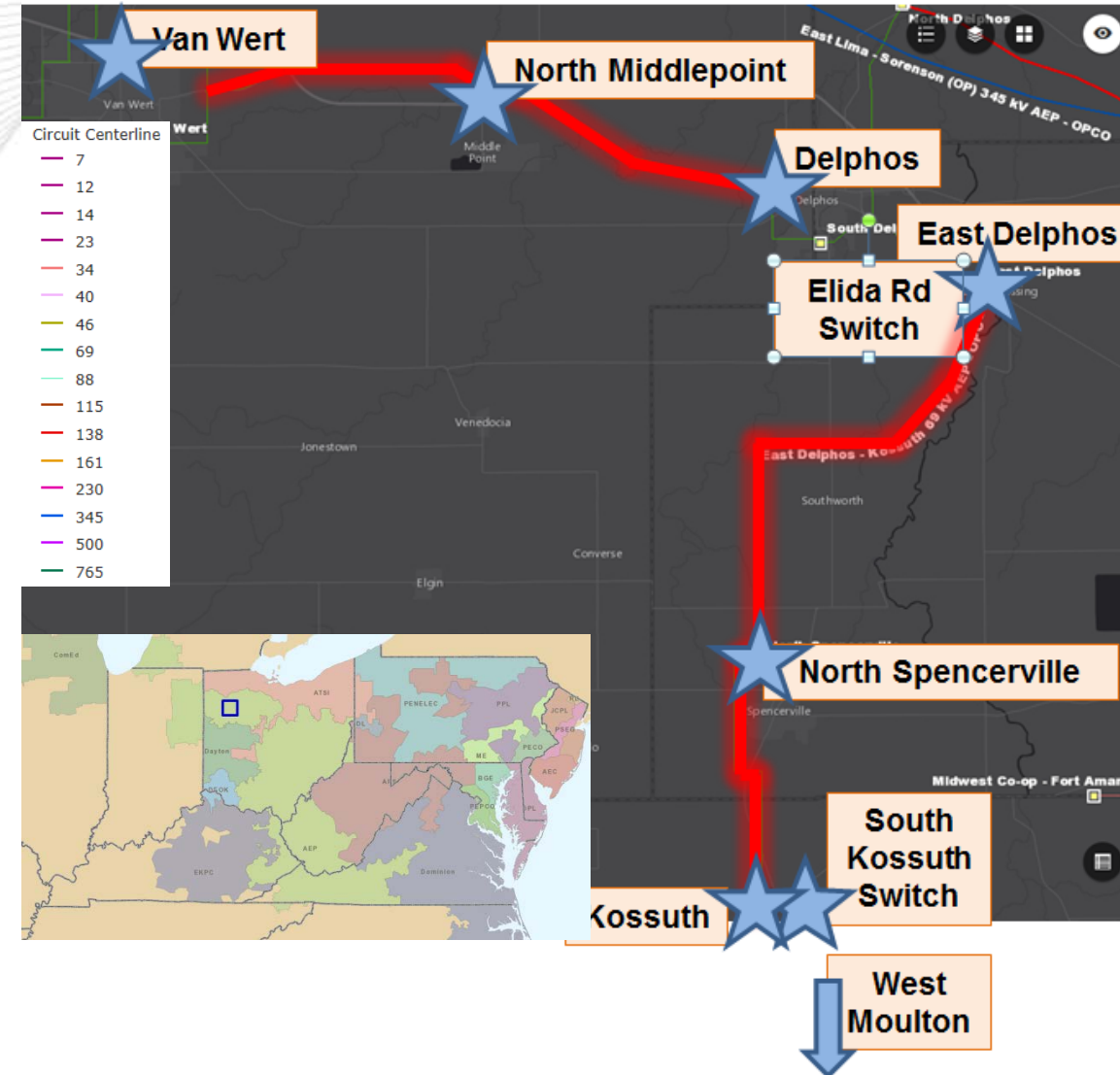
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Operational Flexibility and Efficiency

North Spencerville station will be rebuilt to include new bus work and two new Transmission CBs. The new CBs at North Spencerville will break up the North Delphos-West Moulton circuit. This will greatly improve the circuit's reliability because the stations will no longer be exposed to 29 miles of line, and this will eliminate the ground switch MOAB scheme at North Spencerville. There are currently 2466 customers on this line with approximately 18.6 MVA of load. There have been 25 total sustained or momentary outages on this line from 2013 to present. By placing breakers at North Spencerville, customers will no longer be interrupted by line faults. Current CMI for this circuit is 161,901.

At North Middlepoint station, there will be one new MOAB looking toward station Vanwert and another motor mech operated switch looking toward Delphos. This will improve the circuit reliability thus improving the SAIFI numbers because the minutes of interruption will be decreased. Also there will be new circuit switcher at the high side of the transformer which will allow any temporary fault on the bus to restore and will not allow faults on the distribution to effect the transmission.

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Selected Solution

Rebuild North Spencerville station. Install two 69 kV CBs. (S1617.1)

Estimated Cost: \$1.2M

At North Middlepoint station, construct new high side switching facilities. Install one MOAB, Switch and Circuit Switcher. (S1617.2)

Estimated Cost: \$0.3M

At South Kossuth station, install a new 1-way switch toward North Spencerville, retire the existing 1-way switch and build a section of line in the clear on the north side of the highway. (S1617.3)

Estimated Cost: \$0.2M

Rebuild existing Delphos – Van Wert 69 kV line (~11.4 miles) with 795 ACSR (128 MVA rating), including partial line reroute. (S1617.4)

Estimated Cost: \$12.3M

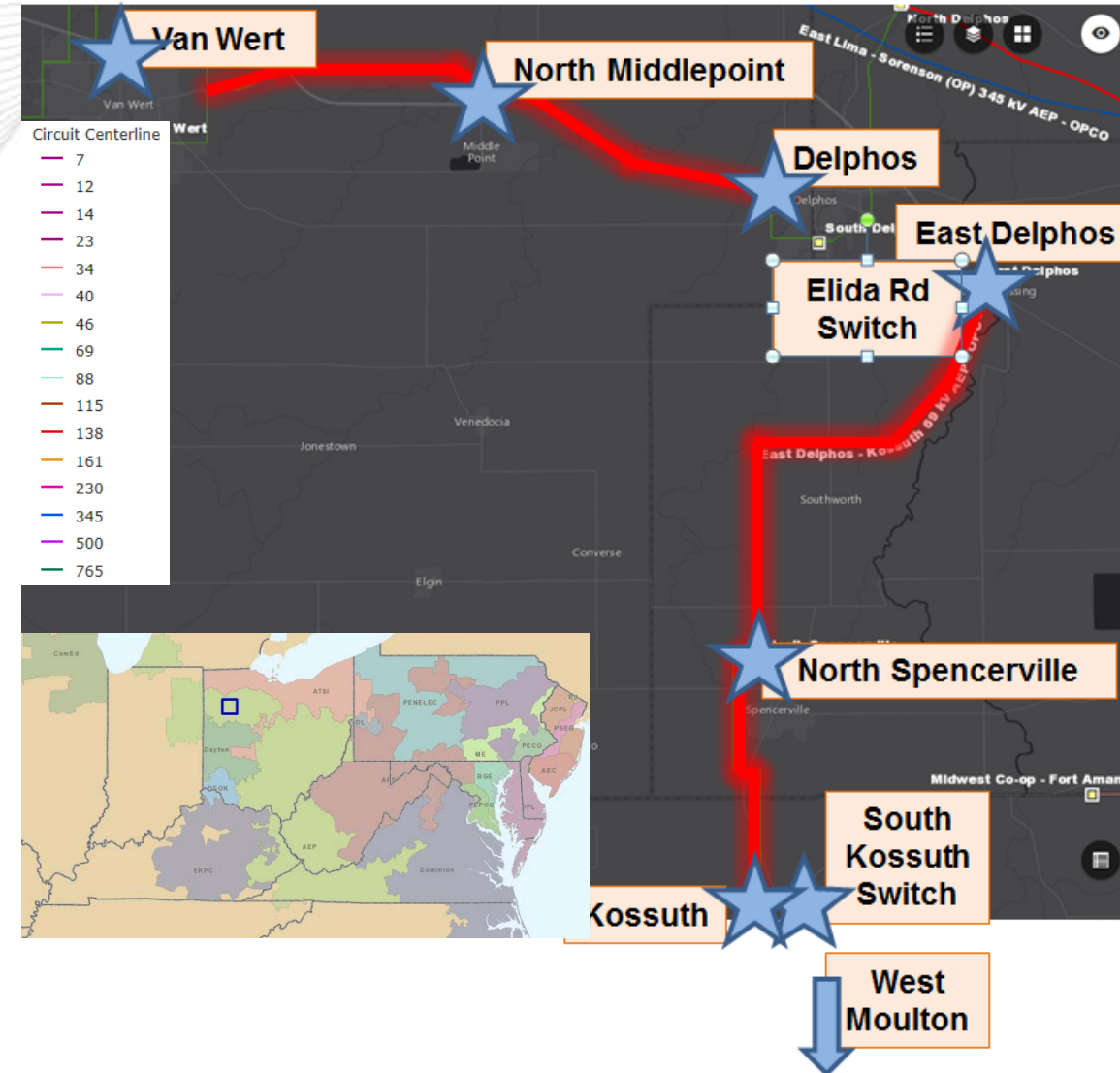
Rebuild existing East Delphos – Kossuth 69 kV line (~15.5 miles) with 795 ACSR, including partial reroute. (S1617.5)

Estimated Cost: \$16.1M

Total Estimated Transmission Cost: \$30.1M

Projected In-service: 12/31/2020

Project Status: Engineering



Previously Presented: 4/17/2018 SRRTEP

Problem Statement:

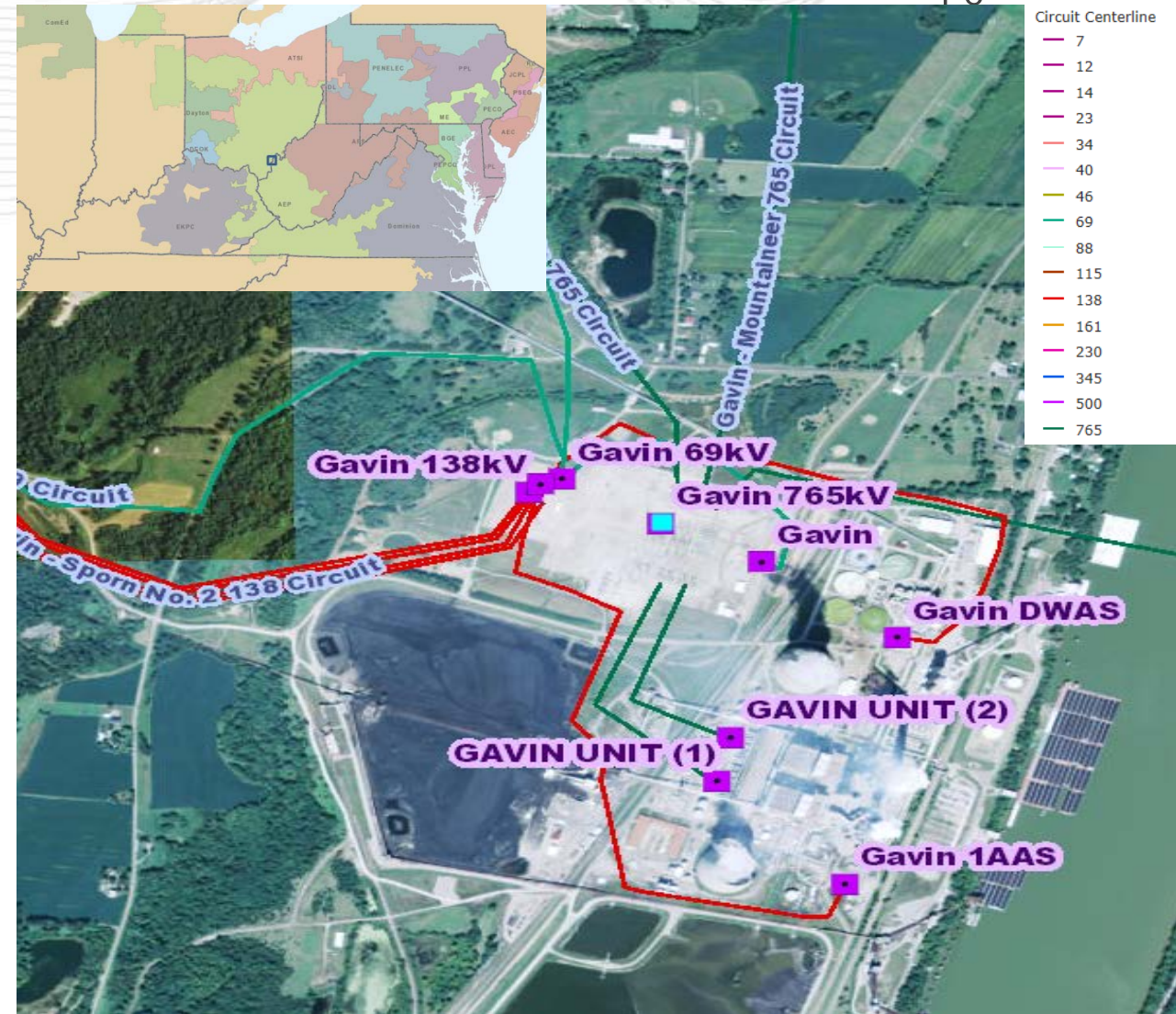
Equipment Material/Condition/Performance/Risk:

The 69kV CB's BJ, BK, and BH at Gavin are all oil breakers without oil containment. Oil breaker maintenance has become more difficult due to the oil handling required to maintain them. Oil spills are frequent with breaker failures and routine maintenance, and can become an environmental hazard. These breakers are also models that are worthy of replacement due to their reliability, and lack of spare part availability. Meigs CB-BJ is 1 of 33 remaining CG-48-72.5-20-1200 circuit breakers remaining on AEP's system, and CB-BK/CB-BH are 2 of 45 remaining FK-72.5-27000-10 circuit breakers remaining on the system. Breaker BJ and BH both have exceeded their manufacturers recommended fault operations (28 and 18 respectively).

Customer Service:

Gavin is the largest coal power plant in Ohio, with 2.64 GW Nameplate capacity. The two units' sources of operating power for start up and coal handling are the 138-69 kV Gavin Transformers. The loss of either of the 138-69kV transformers will prevent continuous operation of one of the 1.3GW units.

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Selected Solution

Rebuild the existing 69kV yard as a 6-CB ring bus station, using 2000A, 40kA breakers. The Plant's existing auxiliary power source, the 138-69 kV transformer #2, will terminate into the ring along with the local service 138-69kV transformer #1. Add 1 new CB (138 kV) at the high side of the transformer #1. The station's auxiliary power will then be supplied from the ring. Associated PCE upgrades (\$1618.1)

Estimated Cost: \$9.2M

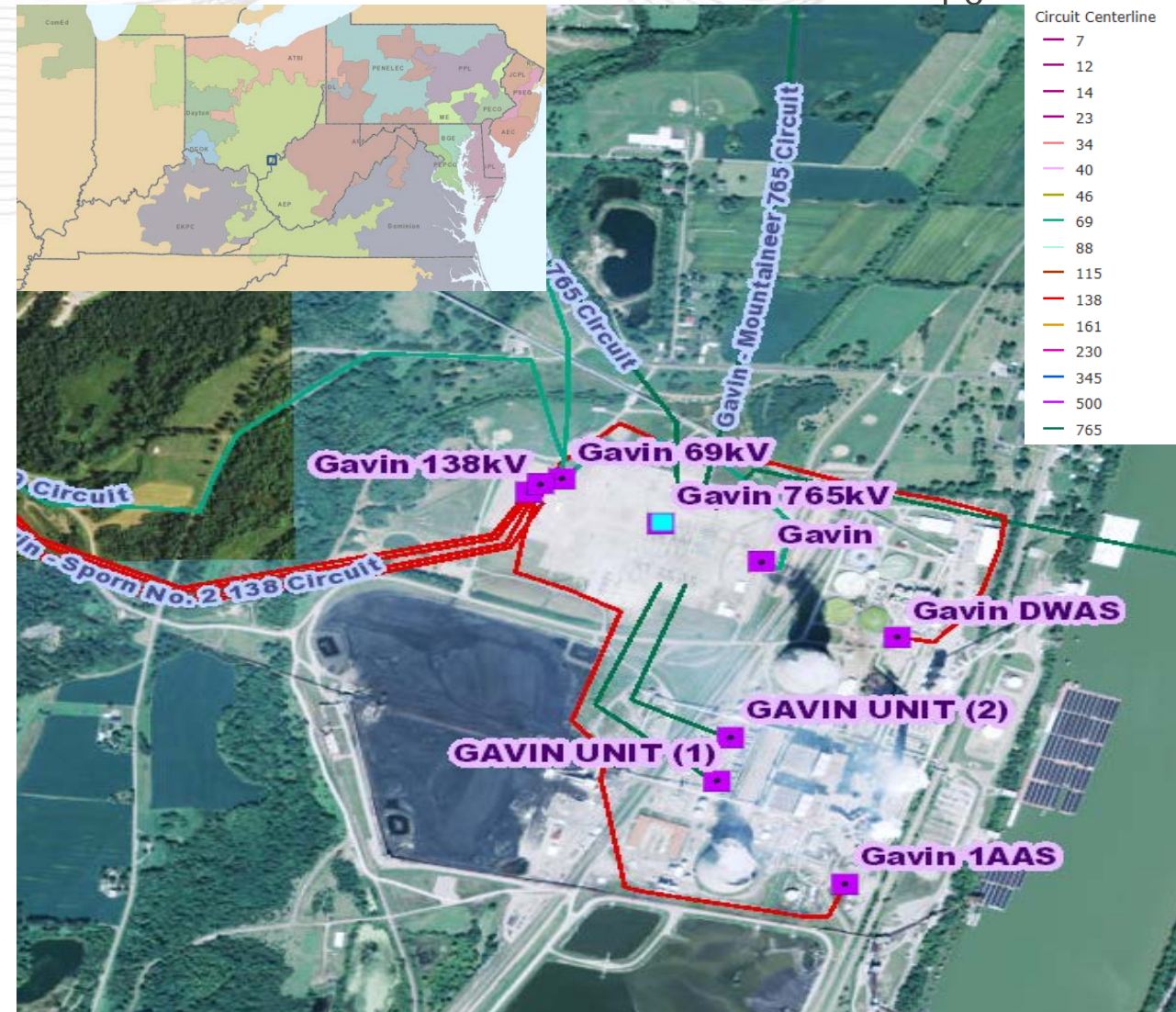
Modify existing line exits out of Gavin station. (\$1618.2)

Estimated Cost: \$0.3M

Total Estimated Transmission Cost: \$9.5M

Projected In-service: 06/01/2019

Project Status: Scoping



Previously Presented: 4/17/2018 SRRTEP

Problem Statement:

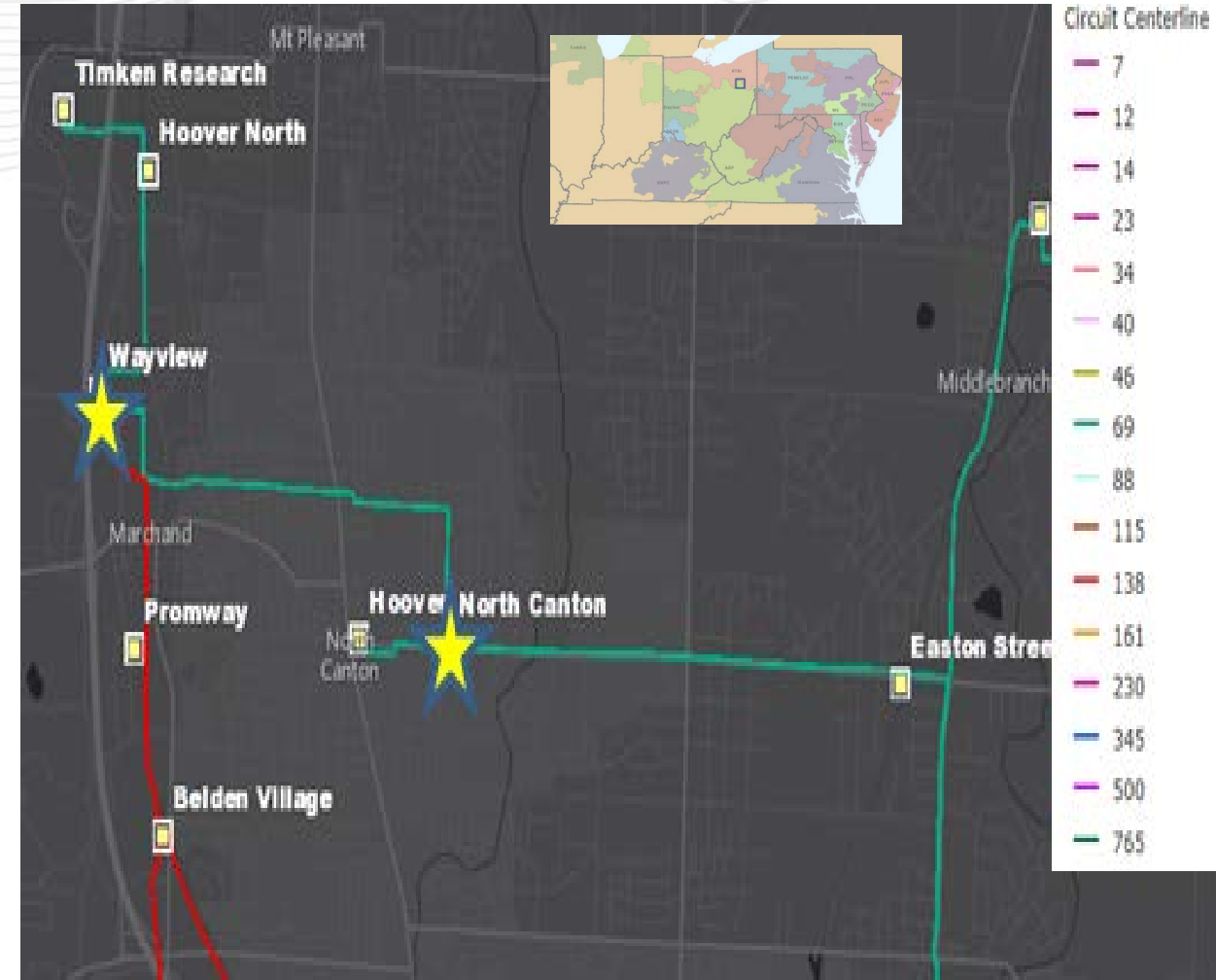
Equipment Material/Condition/Performance/Risk:

The North Canton 69-12kV distribution transformer failed. 69kV breakers E & G are oil-filled breakers made in 1963 (CF-48 model). The 69kV CB's E and G at North Canton are oil breakers without oil containment. Oil breaker maintenance has become more difficult due to the oil handling required to maintain them. Oil spills are frequent with breaker failures and routine maintenance, and can become an environmental hazard. These breakers are also models that are worthy of replacement due to their past reliability, and lack of spare part availability. These breakers have exceeded the designed number of full fault operations (10) with 12 and 26 fault operations respectively.

The distribution XFMR was made in 1968 and failed in 2017 (since that time load has been transferred to adjacent distribution stations where possible, or by using a mobile sub during peak periods).

The 69kV circuit protection uses electromechanical relays and pilot wire, which is more prone to misoperations and has issues in finding repair parts. The 69kV protection will be upgraded to microprocessor relays and fiber-optic communications. The 69kV bus protection currently utilizes an older IAC electromechanical scheme, which needs upgraded to modern bus-differential protection. The RTU is also of an obsolete vintage and needs to be replaced.

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Operational Flexibility and Efficiency

Currently the North Canton-Hoover 69kV circuit is tapped directly to the North Canton 69kV bus, without a fault-interrupting device. As a result, a fault on the 69kV T-Line, or at the high-side of the Hoover customer's station would take out the entire North Canton station, including the substantial amount of distribution load (21 MVA peak, 5200 customers). In addition, the failed distribution transformer at North Canton only had a high-side MOAB switch, which required tripping the entire 69kV bus to remove XFMR faults, plus outaged the Hoover customer. A 69kV circuit switcher will be installed to protect the XFMR and properly isolate faults.

Currently, there are 3 separate zones of protection lumped together: Hoover 69kV circuit, N. Canton 69-12kV XFMR, N. Canton 69kV bus. Adding the 3rd 69kV breaker, plus the XFMR circuit switcher will greatly improve reliability for customers in the area.

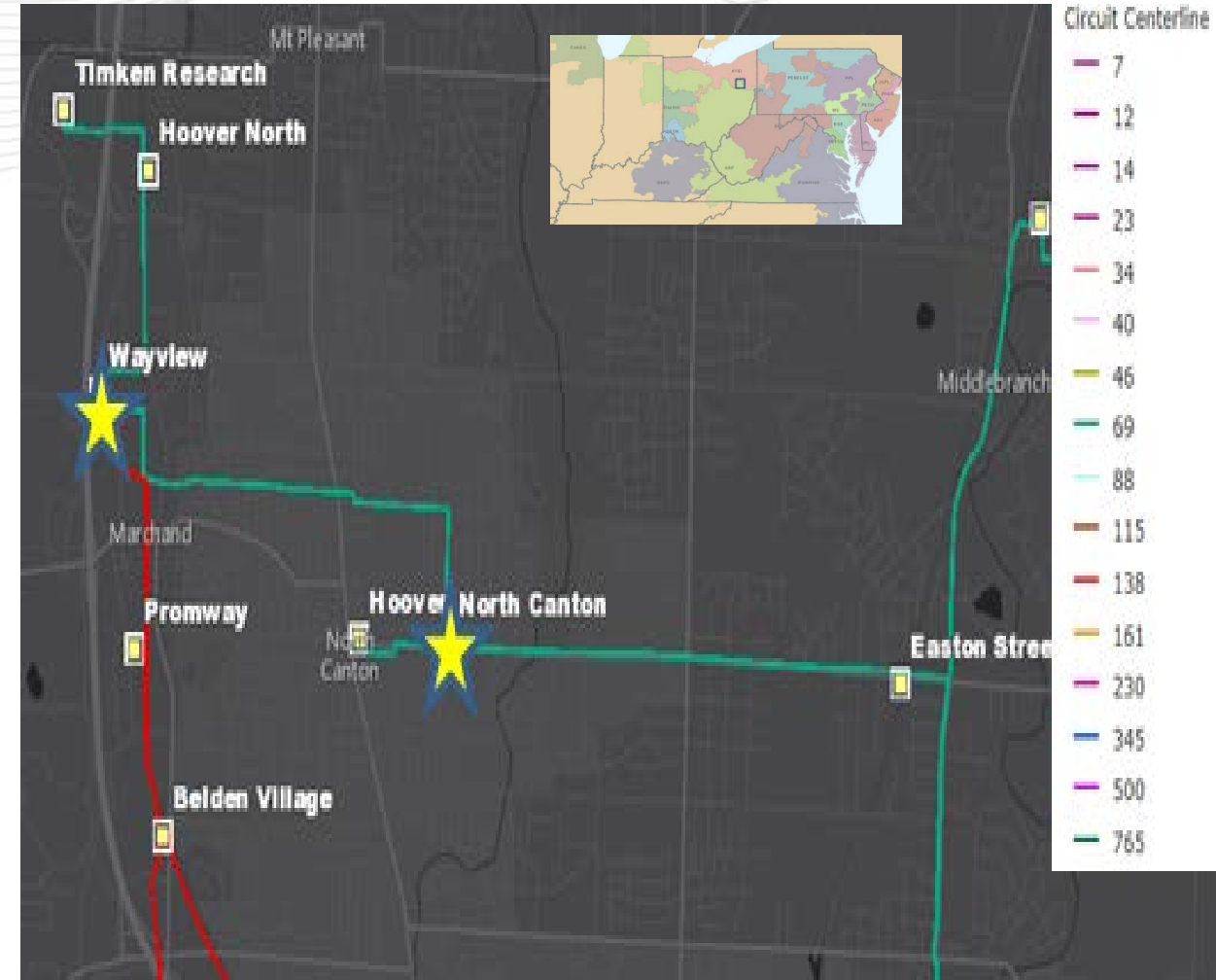
To facilitate the 69kV & 12kV improvements at the small urban station, the 69kV cap bank needs to be removed. This system change was studied in conjunction with AEP Operations, and no adverse effects were found.

The pilot wire communications scheme between North Canton and Wayview 69kV will be replaced with a modern fiber-optic communications channel, increasing the resiliency of the sub-transmission grid.

Customer Service:

By installing the 3rd 69kV breaker and 69kV circuit switcher, reliability will be improved for the Hoover 69kV customer and North Canton AEP Ohio distribution customers. Today, a fault for either customer will interrupt the other. This risk will be eliminated due to this project.

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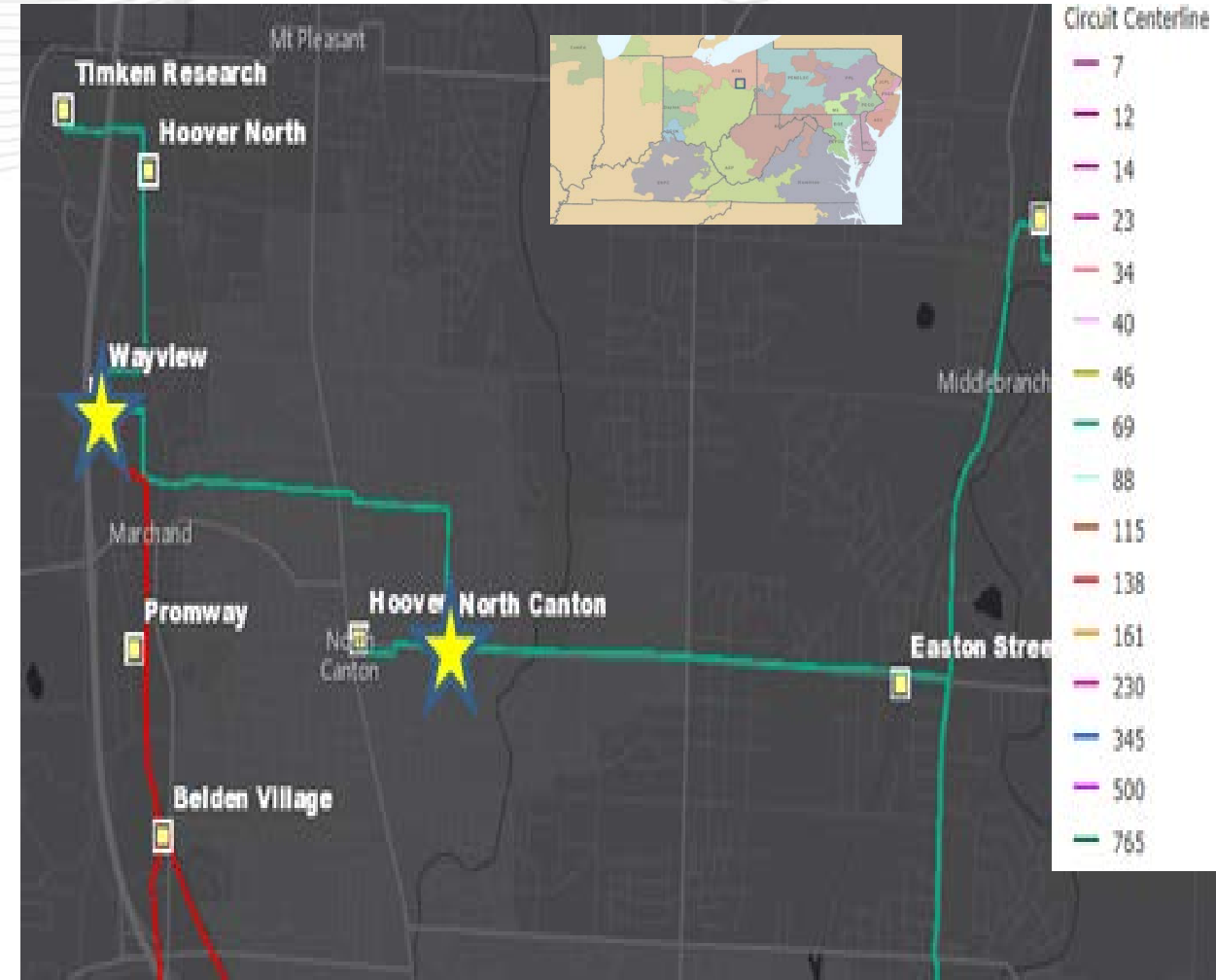
Selected Solution

At North Canton station, rebuild 69kV bay, install 3- 69kV gas breakers, remove 69kV cap bank. Replace failed 69-12kV distribution transformer and other associated distribution work. Upgrade the Wayview 69kV remote-end circuit protection to coordinate with North Canton. (\$1619)

Total Estimated Transmission Cost : \$3.2M

Projected In-service: 12/01/2018

Project Status: Engineering



Previously Presented: 4/17/2018 SR RTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

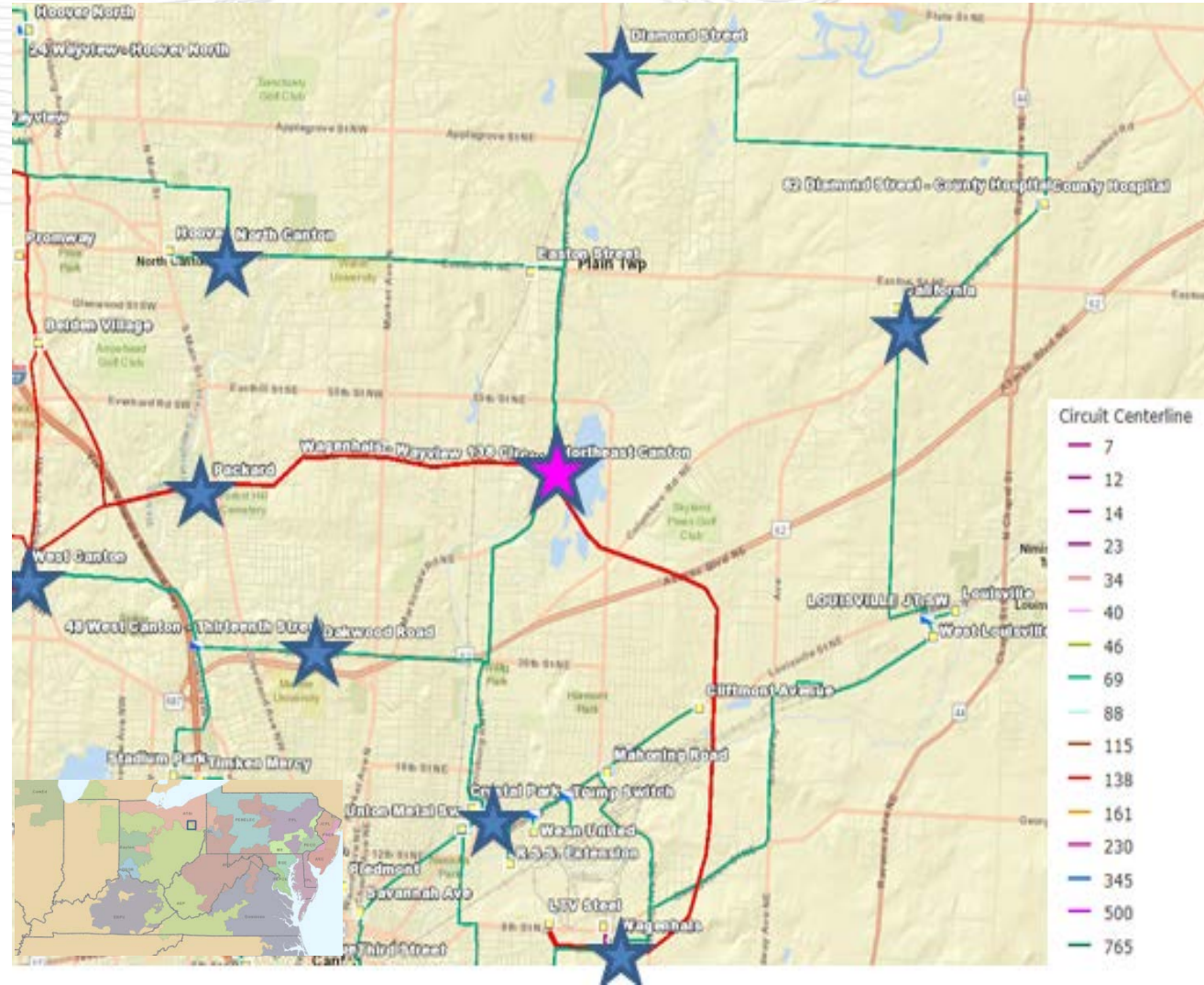
The four 69kV breakers at NE Canton station are oil-filled units between 43-57 years old **with between 16 and 38 fault operations on them**. The transformer is a 3-winding model (138-69-12kV), with distribution load served off of the tertiary. The XFMR is 55 years old and is in poor condition. NE Canton has wood station support structures on the 138kV & 69kV, which are deteriorating. The control house consists of 70 electromechanical relays, 4 static relays, and zero modern microprocessor relays. Electromechanical and static relays are more prone to failure and a challenge to find replacement parts.

West Canton 138kV breaker C is 31 years old and a rare model, making repairs & maintenance difficult.

Oakwood 69kV breaker is oil-filled (55 years old) and in poor condition, and relays are electromechanical.

Diamond Street 69kV breaker is oil-filled (55 years old) and in poor condition and relays are obsolete. A leased-line pilot wire communications scheme is used for area system protection, which is obsolete and prone to service interruptions in the coming years.

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Operational Flexibility and Efficiency

The Wagenhals-NE Canton-West Canton 138kV circuit is a 3-terminal line, due to the 138-69kV source at NE Canton; this is a protection challenge and places customer load at risk. The NE Canton XFMR doesn't have a high-side breaker (only motor-operated switch and remote-end tripping scheme); this places the XFMR at a higher risk of fault damage, and unnecessarily outages customers at NE Canton & Packard stations. The NE Canton XFMR has distribution load served off of the 12kV tertiary winding, with no isolation device, which is a reliability risk to the transmission system. The 138kV line switches at Packard will be converted to motor-operated switch with auto-sectionalizing, due to the large load center served there, and meeting AEP's MPOI calculation threshold. The 69kV breaker and MOAB switch installations adhere to AEP's MPOI/FOI guidelines.

Operational Flexibility:

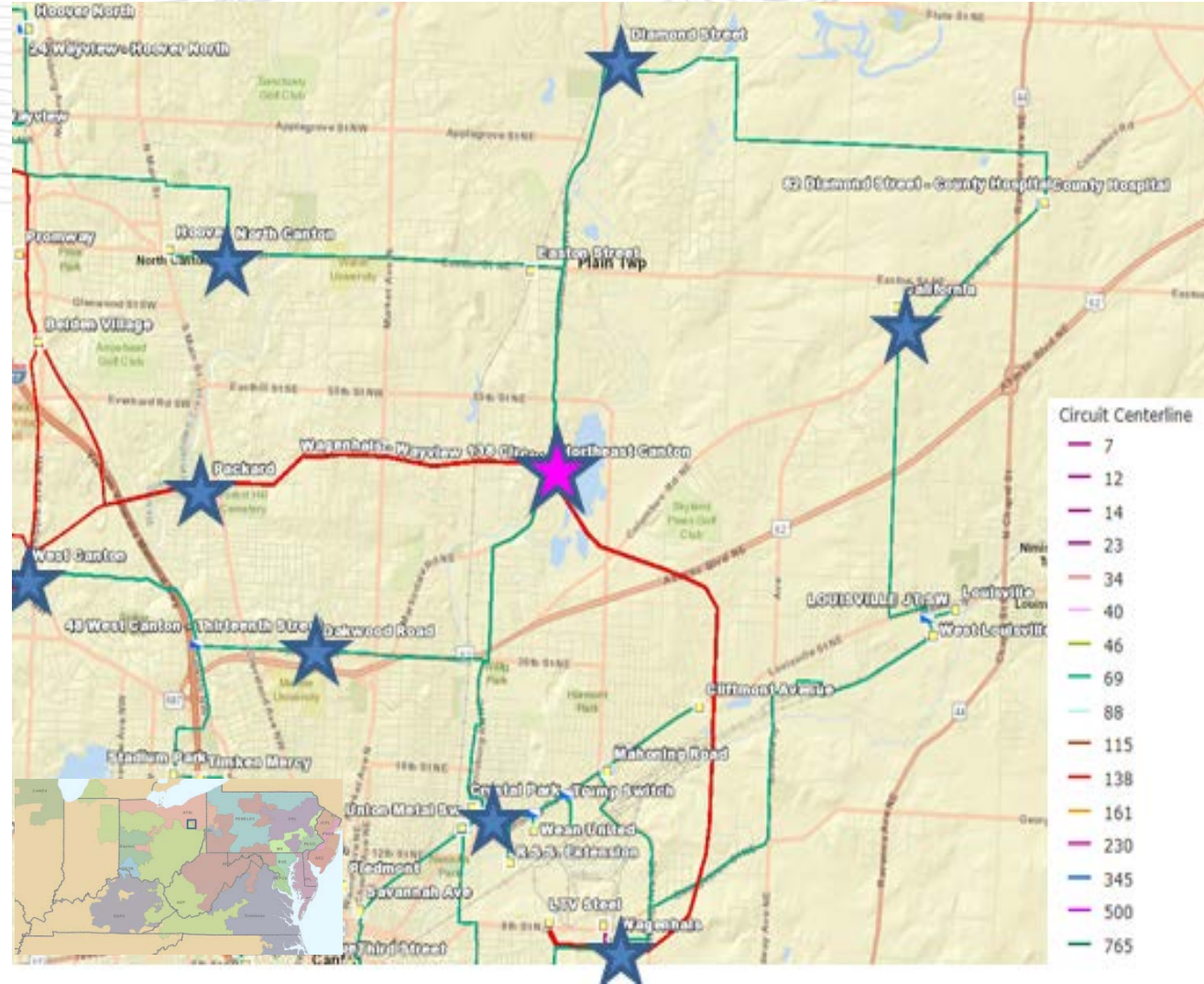
The Telecom fiber network will be connected by the hub at NE Canton station; this will upgrade the communications network utilized by EMS/SCADA and protective relaying. The outdated pilot wire system will be retired. In addition, today NE Canton has very little SCADA functionality, which is inadequate for such a critical station.

Customer Service:

This project will improve service reliability for many AEP Ohio distribution customers in the area, as well as the transmission customer served from Diamond Street station.

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AEP Transmission Zone: Supplemental Northeast Canton Upgrades





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Selected Solution:

Rebuild the NE Canton 138/69/12kV station on the existing property. Install a 138kV 4-breaker ring bus, 138-12kV distribution transformer, 138-69kV, 90 MVA transformer, 69kV 6-breaker ring bus, 69kV cap bank (14 MVAR). **(S1620.1)**

Estimated Transmission Cost: \$9.4M

At West Canton 138kV station, replace 138kV breaker, disconnects & relays.

Estimated Transmission Cost: \$0.7M **(S1620.2)**

At Wagenhals 138kV station, change relay settings to coordinate with NE Canton. **Estimated Transmission Cost:** \$0M **(S1620.3)**

At Packard 138kV station, convert manual line switches (2) to auto-sectionalizing MOAB's. **Estimated Transmission Cost:** \$0.2M **(S1620.4)**

At Stanley Court 69, upgrade relays to coordinate with NE Canton (fiber-based). **Estimated Transmission Cost:** \$0.2M **(S1620.5)**

At Oakwood Rd 69kV station, replace 69kV breaker & relays. **Estimated Transmission Cost:** \$0.4M **(S1620.6)**

At Diamond St 69kV station, remove 69kV breakers (2) and replace with sectionalizing MOAB's (This change is due to lack of space and poor condition of existing control house, which doesn't permit 2 new gas breakers and modern relays to be installed). **Estimated Transmission Cost:** \$0.3M **(S1620.7)**

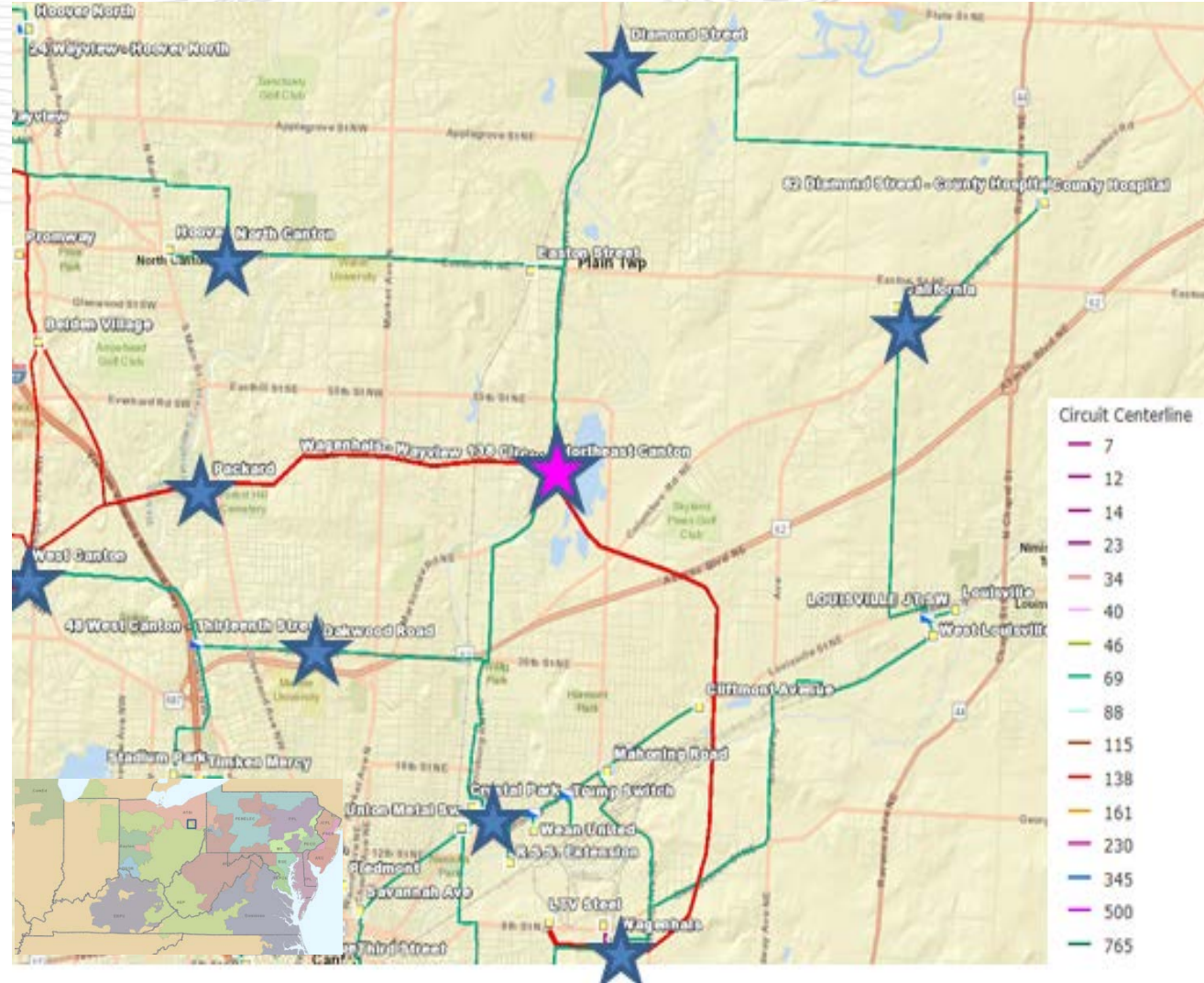
At California 69kV station, relocate the breakers from Diamond St (2) and install new relays. **Estimated Transmission Cost:** \$0.7M **(S1620.8)**

Total Estimated Transmission Cost: \$11.9M

Projected In-service: 12/01/2020

Project Status: Scoping

AEP Transmission Zone: Supplemental Northeast Canton Upgrades



Previously Presented: 4/17/2018 SRRTEP

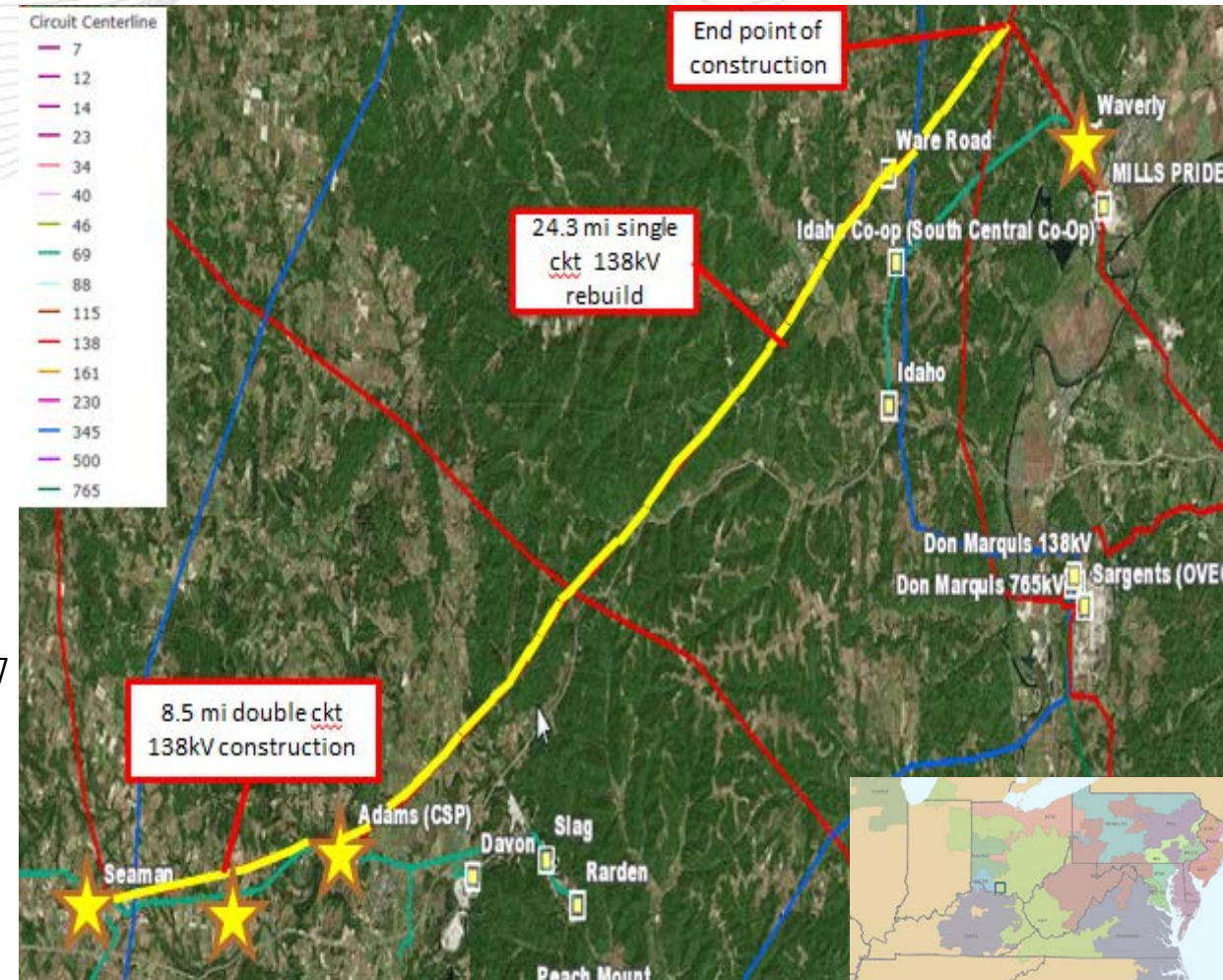
Problem Statement:

Equipment Material/Condition/Performance/Risk:

The 32.8 mile Waverly-Adams-Seaman 138 kV line was built in 1954 with 336 ACSR conductor (150 MVA rating). On the 244 structures on this line, there are 153 open conditions. There have been over 1 Million customer minutes of interruption in a 3-year period. The conditions include: rotten cross-arms, burnt/broken insulators, and loose/broken conductor hardware. The average duration of sustained outage is 2.8 hours.

The majority of the Adams-Seaman 69kV line was built in 1939 with 336 ACSR (75 MVA rating). The line extends 11.9 miles radially from Seaman to serve Sardinia. On the line's 440 structures, there are 401 open conditions. Of the 401 conditions between Adams and Sardinia, approximately 88 conditions are in the Adams-Seaman section (97 structures). There have been 8 momentary and 5 sustained outages on this circuit over the last 3 years. The 69kV line is needed to serve Adams Coop's 69-12kV Lawshe load, and to provide a back up source for Seaman and Adams.

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Selected Solution

Rebuild the 138kV line from Waverly to Adams utilizing 1033.5 ACSR (296 MVA). The rebuild will begin at structure 22 west of Waverly where the line changes to the Waverly-Ross line and continue 24.3 miles to Adams Substation. The remaining 3.1-mile section from structure 22 to Waverly is newer double ckt construction and was not identified for renewal at this time. Remove old line after rebuild complete. (S1621.1)

Estimated Cost: \$42.0M

Rebuild two independent lines, less than 1/2 mile apart between Seaman and Adams, one 138kV and one 69kV, as a double circuit for approximately 8.5 miles using 1033.5 ACSR. Remove old lines after rebuild complete. There will also need to be a short single ckt tap for Lawshe 69kV. (S1621.2)

Estimated Cost: \$23.0M

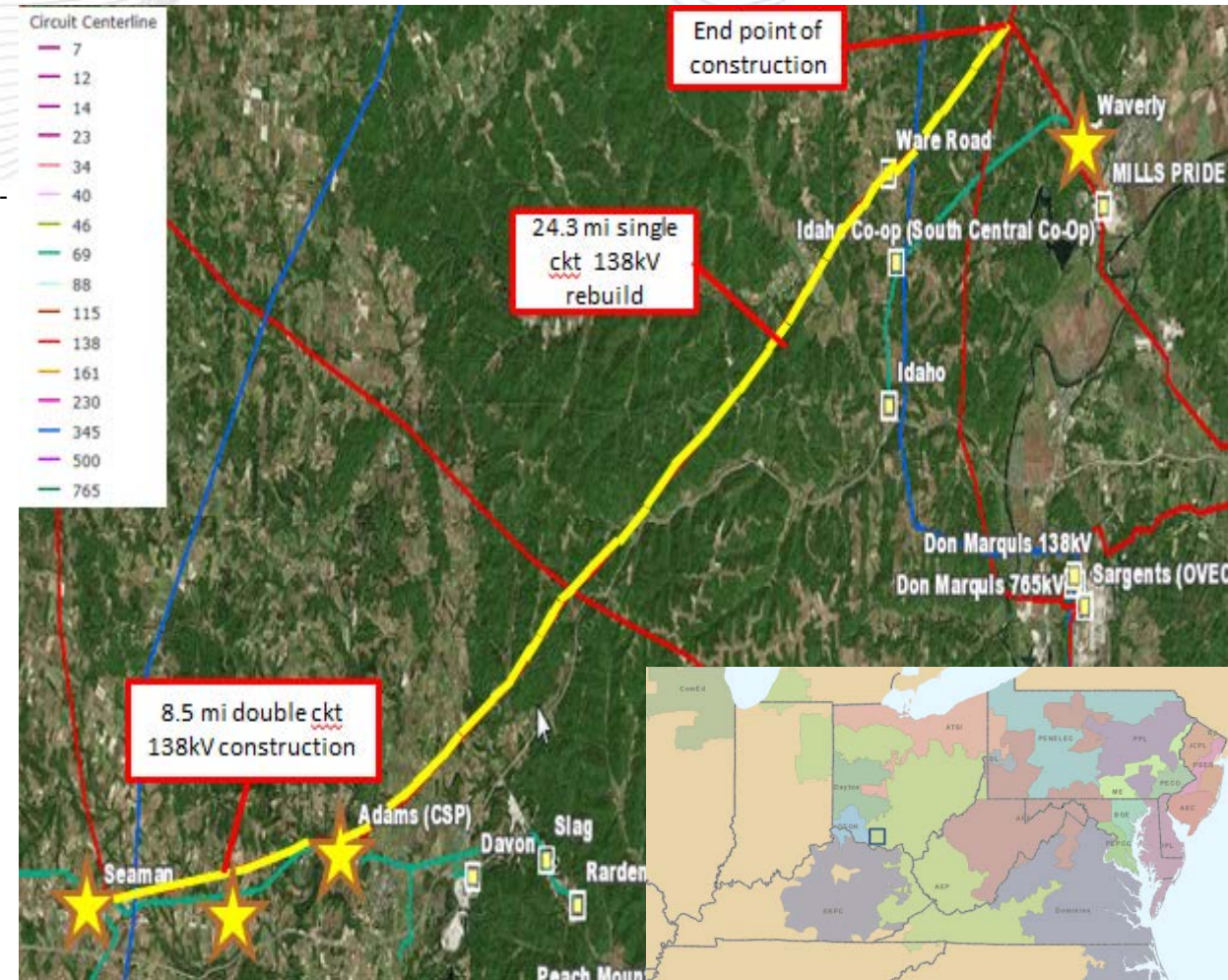
A three-way POP switch structure will be constructed outside Lawshe 69kV substation. (S1621.3)

Estimated Cost: \$1.0M

Total Estimated Transmission Cost: \$66.0M

Projected In-service: 06/01/2021

Project Status: Engineering





Previously Presented: 4/17/2018 SRRETP

Problem Statement:

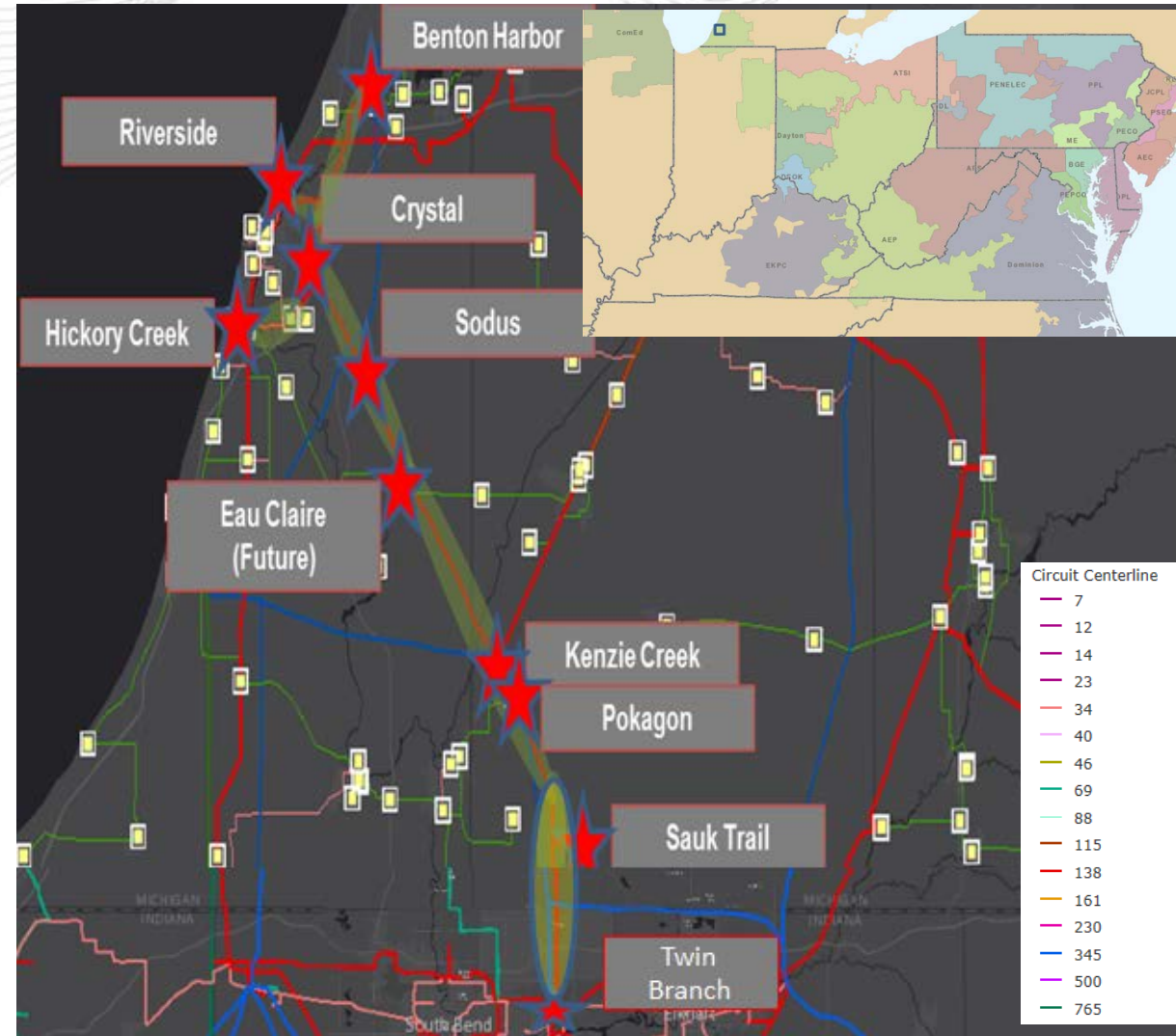
Equipment Material/Condition/Performance/Risk:

The Twin Branch-Benton Harbor 138kV line asset is split up in two assets (IN & MI) and consists of different circuit sections: Benton Harbor-Riverside, Riverside-Kenzie Creek, Hickory Creek-Kenzie Creek, Kenzie Creek-Sauk Trail and Sauk Trail-Twin Branch. The original Twin Branch-Benton Harbor line assets were placed in service in 1929. The line assets combined have a total of 489 structures of which 65% are still from 1929. In addition, roughly 77% of the 397 ACSR conductor is still from 1929. The line assets' obsolete design included installation of armor grip suspension assemblies that were installed to extend the life of the conductors originally. Over the life of the line, through maintenance and remediation work, crews have found broken conductor strands under the armor grip suspensions due to long term exposure to Aeolian vibration. Crews have also found spots where the steel core of the conductor has been significantly corroded at the low point of sag. There are numerous issues with insulators along the line as evidenced by the 97 reported conditions associated with insulators and insulator suspensions. Many of these insulators have lost their outer glaze, allowing contaminant buildup, compromised electrical integrity and growing risk of electrical failure. Also, original easement language does not include ability to control building encroachments. The Hickory Creek-Kenzie Creek has experienced 3 sustained outages over the last three years, resulting in 775,945 Customer Minutes of Interruption.

The Benton Harbor extension is 1969 vintage and is currently subject to 64 open conditions across its 34 structures including broken conductor strands; burnt insulator; and burnt, chipped and contaminated insulator suspension.

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AEP Transmission Zone: Supplemental Twin Branch – Benton Harbor 138kV Line Rebuild



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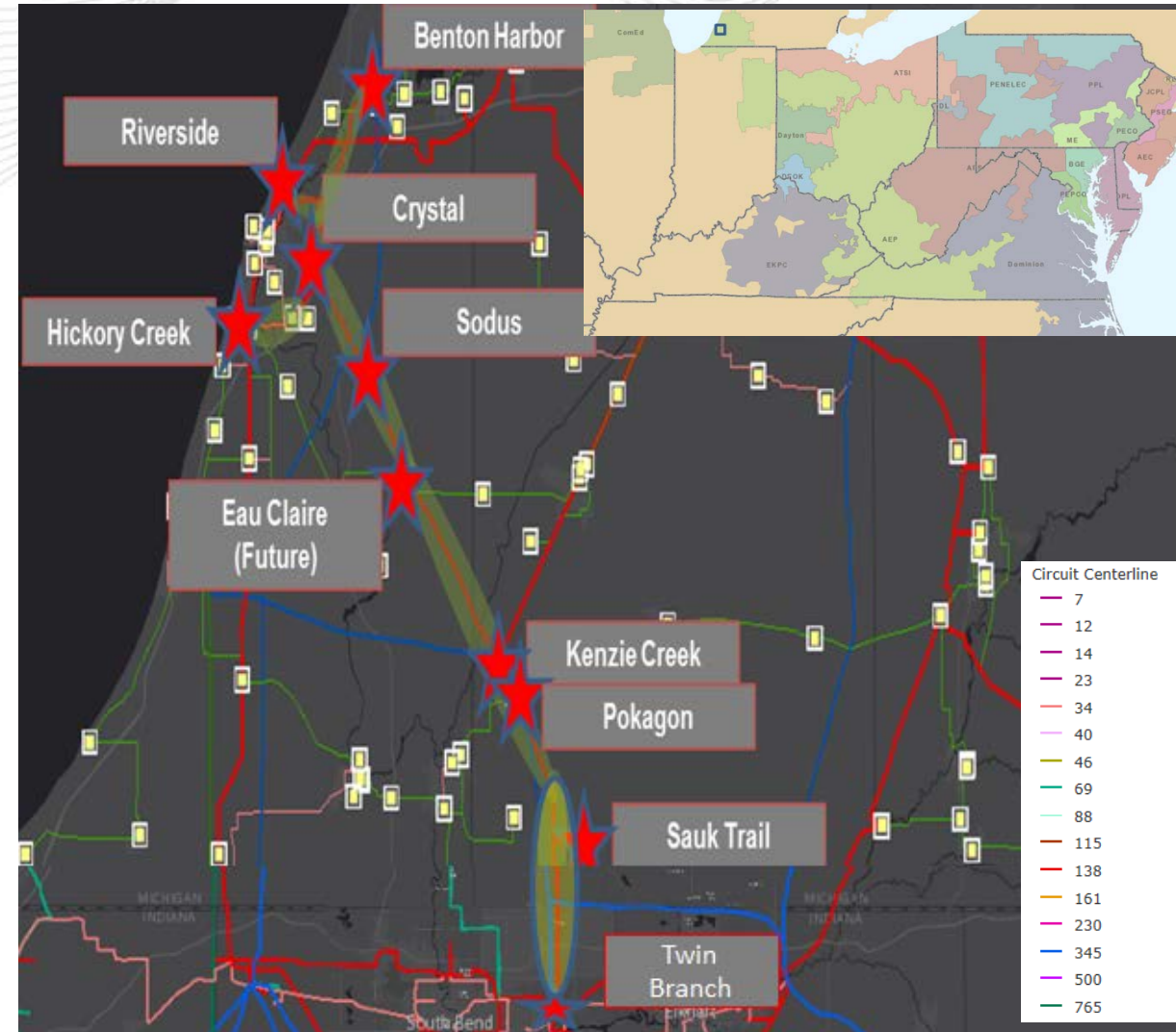
The Hickory Creek extension is 1951 vintage and is currently subject to 10 open conditions across its 27 structures including burnt insulator; and chipped and broken insulator suspension. In addition to this, the Hickory Creek extension currently has 3 river crossings and has a location where the line is in danger of being washed away by the St Joseph River.

The Twin Branch – Benton Harbor is 1929 vintage and is currently subject to 106 open A conditions across its 218 structures including broken conductor; burnt insulator; broken insulator suspension and loose shield wire hardware.

Operational Flexibility and Efficiency:

The Twin Branch-Benton Harbor double circuit 138 kV line is one of three critical 138 kV sources into Michigan. The existing conductor is currently the most limiting element in this corridor and moving to a higher capacity conductor will match the capability of other area facilities and provide the necessary system strength and prepare the grid for future load or generation changes.

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Selected Solution

Rebuild the roughly 43 miles from the Twin Branch to Riverside station with double circuit 138kV 1033.5 ACSR (296 MVA rating). (S1622.1)

Estimated Cost: \$94.3M

Rebuild the 6 mile double circuit Benton Harbor 138kV extension with double circuit 138kV 1033.5 ACSR. (S1622.2)

Estimated Cost: \$16.9M

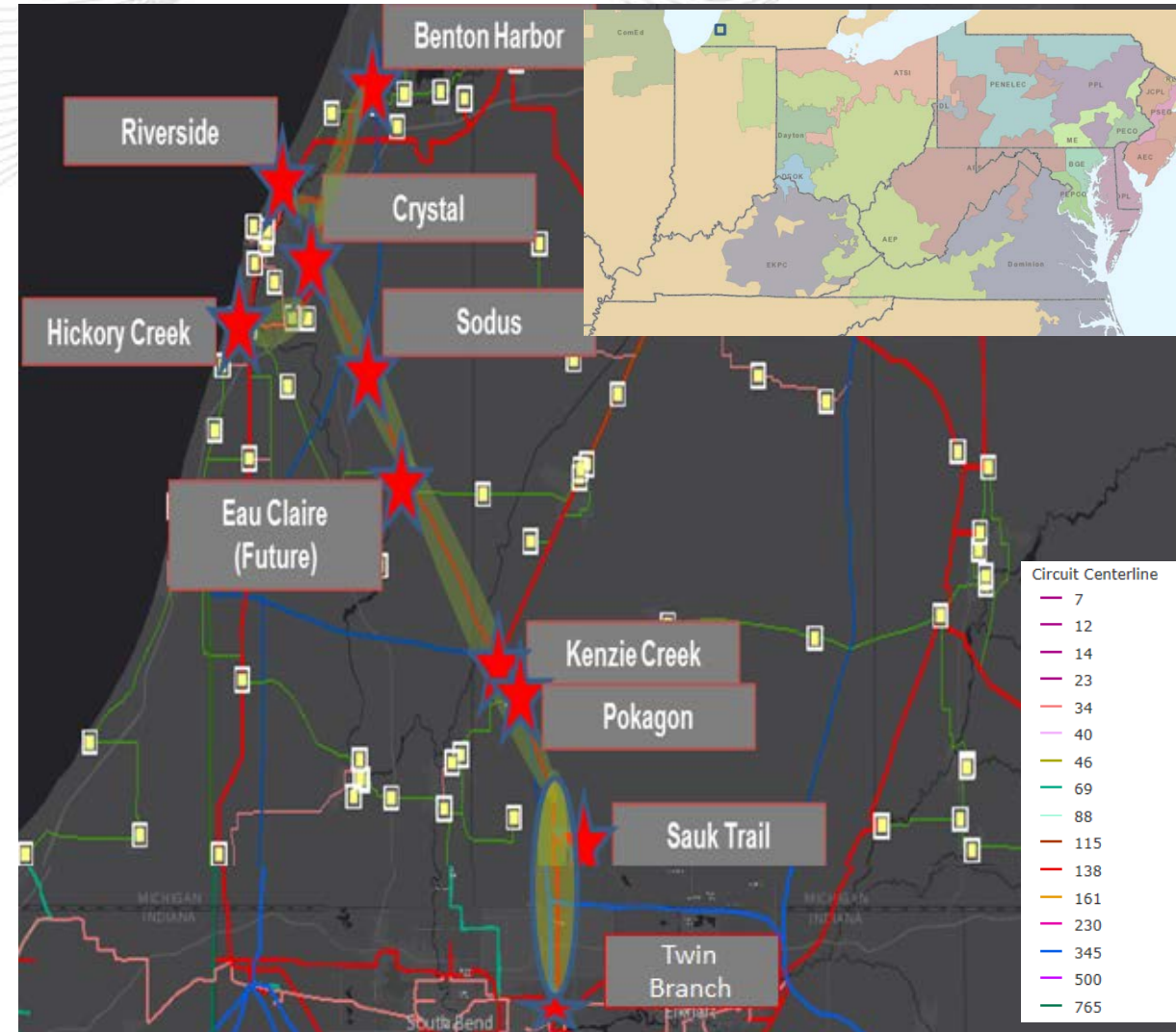
Rebuild the 5 mile double circuit Hickory Creek 138kV Extension with double circuit 138kV 1033.5 ACSR. (S1622.3)

Estimated Cost: \$16.5M

Total Estimated Transmission Cost: \$127.7M

Projected In-service: 12/01/2021

Project Status: Scoping



Previously Presented: 4/17/2018 SRRTEP

Problem Statement:

Equipment Material/Condition/Performance/Risk:

The 20-mile 69kV Moundsville-West Bellaire circuit has a 3-year CMI total of 6.76 million minutes of customer interruption. Very lengthy outages have resulted from degraded T-Line structures, inoperable sectionalizing equipment, and rugged terrain. 91% of the outage duration and 75% of the outage frequency was due to T-Line equipment problems.

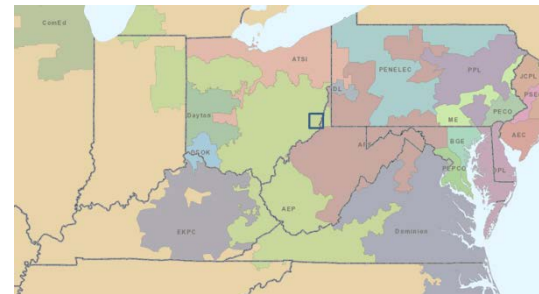
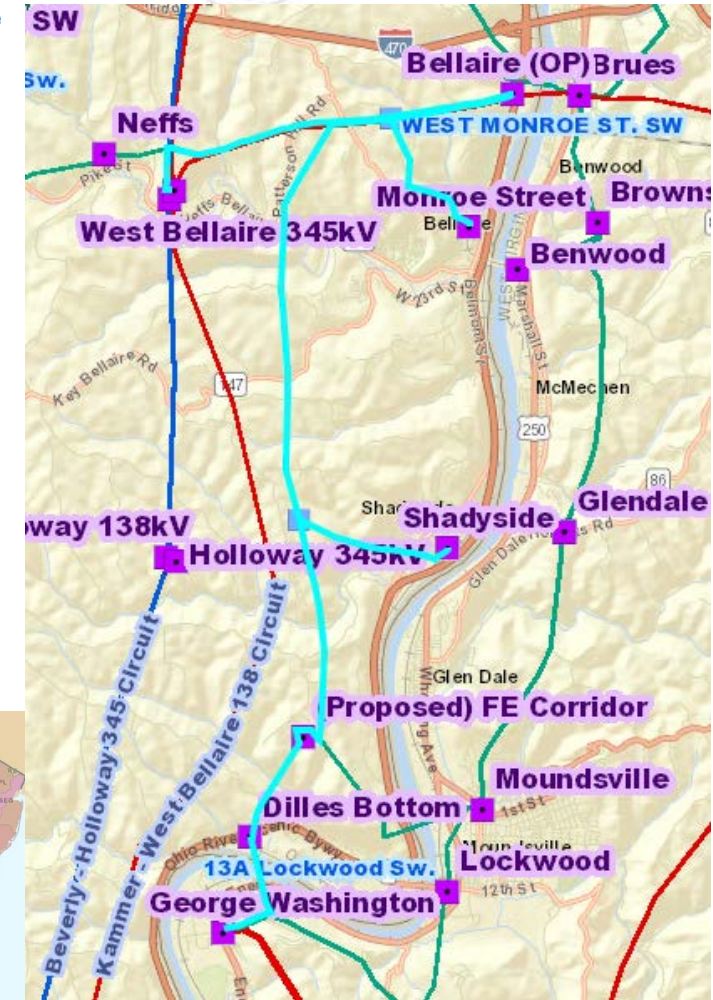
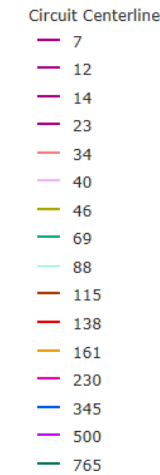
The line has 141 open conditions. Examples include broken poles, hazard trees, woodpecker damage, pole rot, and broken insulators.

The majority of circuit (9 miles) was built in 1943 with 3/0 & 4/0 copper conductor and copperweld ground wire (runs north-south, 46 MVA rating). The Glencoe-Bellaire 69kV line (4.4 miles) was built in 1913, but reconducted in 1970 with 556 ACSR conductor (runs east-west between West Bellaire and Bellaire, 100 MVA rating). The Shadyside and Monroe Street 69kV radial T-Line taps were built in 1944 & 1960, with 4/0 or 2/0 ACSR conductor (40 MVA rating) and are in very poor condition.

Operational Flexibility and Efficiency

West Monroe Street Switch (MOAB) and West Shadyside Switch are inoperable (since 2010), so are now hard taps. Monroe Street and Shadyside distribution stations are served off long radial taps through rugged terrain; their distribution load is non-recoverable (cannot be picked up by other stations). Per AEP's MPOI/FOI calculations, the data exceeds the guideline for installing MOAB switches. However, due to the number of taps and existing MOAB at Bellaire station, more than 3 MOAB's cannot be installed in series (due to protection/timing complications); therefore two breakers will be installed at Monroe Street to sectionalize this 20-mile circuit.

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The 69kV MOAB/ground-switch transformer protection scheme at Monroe Street will be replaced with a circuit switcher & relays. Note that at the Shadyside distribution station there is not sufficient space to install a 69kV circuit switcher, and the transformer is too large to permit fusing.

Customer Service:

The circuit has suffered from poor reliability historically, which will be improved through the T-Line rebuild and station upgrades. The circuit currently serves 6,100 AEP Ohio distribution customers, and 24 MW of peak load.

Selected Solution

Rebuild the West Bellaire-Moundsville 69kV circuit; utilize 795 ACSR conductor (128 MVA rating). *Note that the section from West Bellaire east to structure #31 will not be rebuilt, due to adequate condition (2.4 miles). The extension into Monroe Street will be rebuilt as a double-circuit loop. The extension into Shadyside will be mostly rebuilt as a double-circuit loop (except for final 0.5 mile, due to route constraints). (S1623.1)

Estimated Cost: \$39.7M

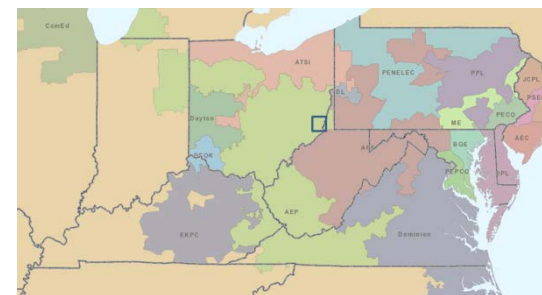
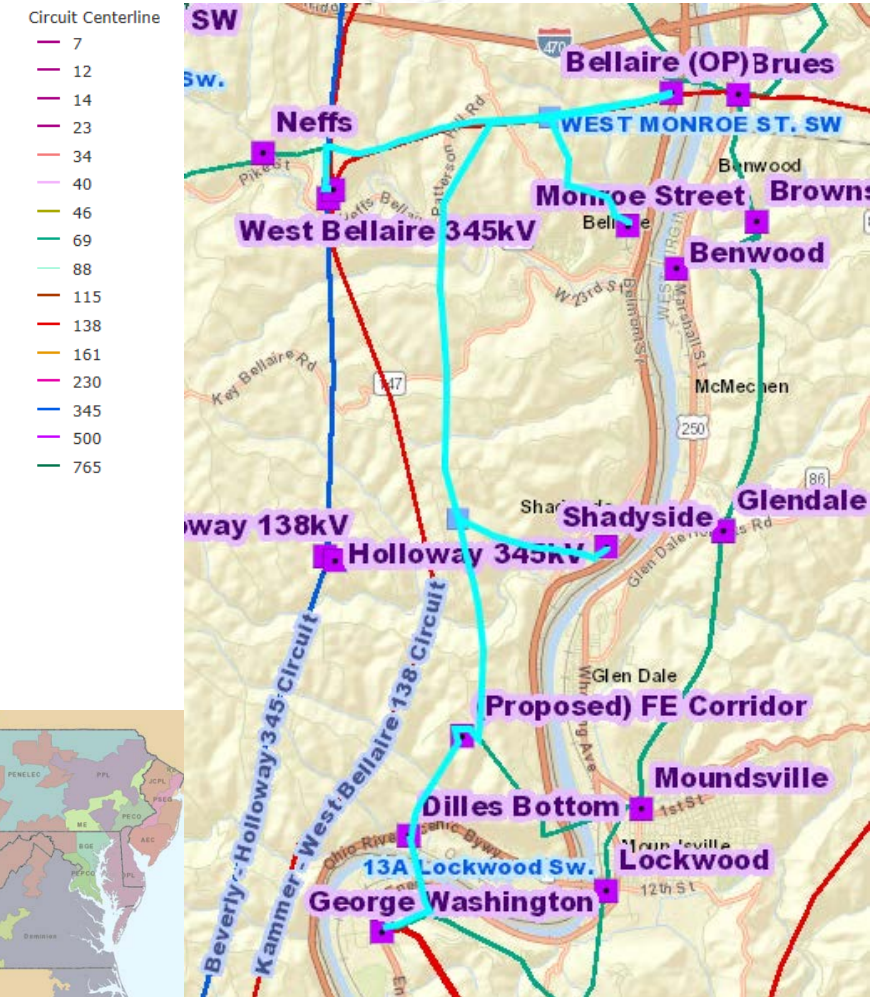
Convert Monroe Street to in-and-out with 2- 69kV breakers; replace 12kV breakers & regulators; install 69kV circuit switcher. Remove inoperable line switches at West Monroe Street and West Shadyside. Install new 3-way MOAB switch with sectionalizing and SCADA at Shadyside. (S1623.2)

Estimated Cost: \$2.6M

Total Estimated Transmission Cost: \$42.3M

Projected In-service: 12/01/2022

Project Status: Scoping





AEP Transmission Zone: Supplemental Whitaker 69/34.5/12kV Station Rebuild

Previously Presented: 4/17/2018 SR RTEP

Problem Statement:

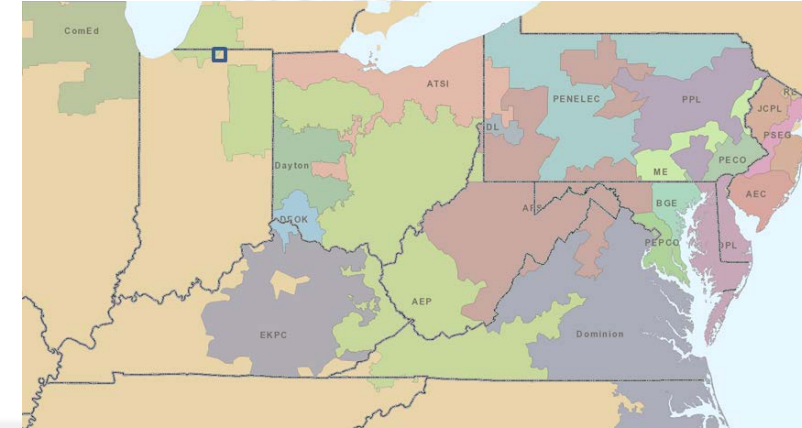
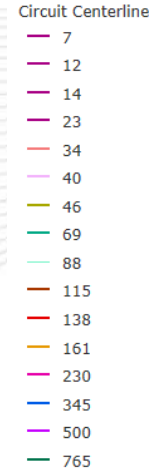
Equipment Material/Condition/Performance/Risk:

The 34.5/12kV Transformer #2 at Whitaker Station, manufactured in 1973, is showing signs of deterioration. The unit has extremely high values of combustible gasses and carbon dioxide. The unit has experienced overheating temperature faults. Also, the interfacial tension is extremely low proving that the oil is in poor condition. The LTC DGA values are high for Ethylene and the LTC compartment shows visible leaks. Drivers for replacement of the transformer include breakdown in dielectric strength (insulation system), short circuit strength (winding short circuit strength breakdown due to magnitude of short circuit fault events), oil quality issues and accessory problems (bushings, pumps etc.).

The 12kV Circuit Breakers A and B manufactured in 1968 are oil filled breakers without oil containments. Oil filled breaker maintenance has become more difficult due to the oil handling required to maintain them. Oil spills are frequent with breaker failures and routine maintenance and can become an environmental hazard. Breaker A has had 221 fault operations and breaker B has had 84 fault operations. The manufacturer recommendation is 10 for this type of breaker. The Breakers have numerous issues related to age, wear, PCB content, maintenance issues and no repair part availability.

Adding the Bus Tie Circuit breaker will keep the distribution customer energized when we lose one of the two lines serving this station.

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Selected Solution

At Whitaker Station, install one 69kV, 40 kA, 3000A Bus Tie Circuit Breaker along with associated distribution work to rebuild the station. (S1624.1)

Estimated Cost: \$1.2M

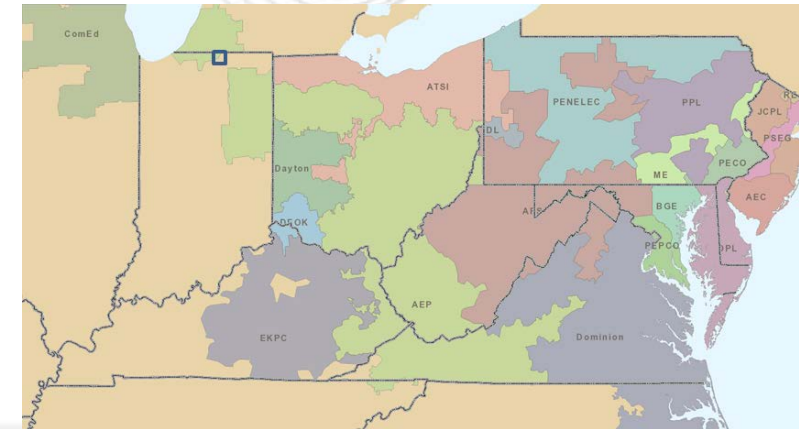
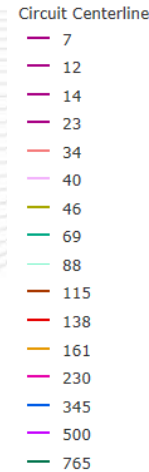
Rebuild Whitaker - Kline 34.5kV for Distribution under-build. (S1624.2)

Estimated Cost: \$0.5M

Total Estimated Transmission Cost: \$1.6M

Projected In-service: 12/01/2018

Project Status: Scoping



Next Steps

Upcoming Western SRRTEP Dates

West	Start	End
5/30/2018	12:00	4:00
7/27/2018	12:00	4:00
9/28/2018	12:00	4:00
11/29/2018	12:00	4:00



- PJM will retire the RTEP@pjm.com email address as of September 1, 2018. Stakeholders with questions about planning updates or planning windows should use the [Planning Community](#).
- PJM is enhancing the way we communicate to follow industry standards and maintain its standing as an industry leader.
- The [Planning Community](#) is a vital avenue for PJM members and staff to collaborate on planning updates, including RTEP windows, and get their questions answered.

Revision History

5/15/2018 – V1 – Original version posted to pjm.com

5/18/2018 – V2 – Slides #5- #10 – Add locator maps

- Corrected reference to 4/17/2018 slide deck

6/26/2018 – V3 – Slide #16: Add statement about ROW.

- Slide #25: Add statement about equipment condition and flooding concern

- Slide #35: Add number of fault operations