

System Impact Study Report For PSCo OASIS Request Number 80074

Firm Point-to-Point Transmission Service for 100 MW or 150 MW From Finney to Midway or Boone for the Period of 1/1/2007 to 1/1/2017 as Requested by –<omitted text>

Xcel Energy Transmission Planning
October 2, 2003

Introduction

<omitted text> has submitted to PSCo under the Xcel Energy OATT a request for long-term firm point-to-point transmission service in the amount of 100 MW and an alternate amount of 150 MW. The term requested for each service is for 10 years starting on January 1, 2007 and ending January 1, 2017. The point of receipt will be the SPS Finney County 345 kV bus from the planned Sand Sage 600 MW unit at Sunflower Electric Cooperative's Holcomb Plant near Holcomb, Kansas and the point of delivery will be the PSCo Midway 115 kV bus with an alternate delivery at the PSCo Boone 115 kV bus

Although <omitted text> has submitted this request for transmission service from Finney to Midway or Boone, the PSCo OATT only covers transmission service from Lamar to Midway or Boone. Transmission service from Finney to Lamar will be covered under the SPP OATT. This request is considered to be from Lamar to Midway or Boone.

The PSCo system does not have any available transmission capacity (ATC) to support this request without system upgrades; therefore, as a result of the impact study, this report identifies system upgrades for the PSCo system to support the <omitted text> request. Other system upgrades to support this transaction will be required on the transmission systems of Aquila, Colorado Springs Utilities, and Tri-State.

Should this request be taken beyond this study, a joint area facility study with all area utilities will be required to identify the total system upgrades necessary to support this transaction, some of which are pre-existing problems. Appendix C contains the list of pre-existing system problems and equipment that need replacement to support this transaction.

System Impact Study Approach

PSCo adheres to the WECC Reliability Criteria for planning studies. For example, during system intact conditions, criteria are to maintain system bus voltages between 0.95 and 1.05 per unit. Operationally, PSCo tries to maintain a system voltage profile ranging from 1.02 at generators to 1.0 or higher at load buses. Following a single contingency, voltages must be within 0.90 and 1.10 per unit and facility loadings must remain within 100% of their nominal steady state ratings for system intact conditions.

Contingency analysis examined the existing system's weaknesses and determined the minimal required system reinforcements.

Figure 1 in Appendix A shows the existing expected 2007 Finney to Midway transmission system.

In order to determine if the PSCo transmission system from Lamar to Midway or Boone can accommodate the 100 or 150 MW transmission reservation as requested by <omitted text>, Xcel Energy Transmission Planning used a 2007 heavy summer power flow case that was modified to reflect an increased size of the Lamar HVDC Link from 210 MW to 310 MW with 310 MW of energy coming from the east (Finney).

Similarly, the alternate case of 150 MW increased injection at Lamar; the Lamar HVDC Link was set at 360 MW.

Two basic approaches were undertaken to examine delivery to the PSCo system in which one was a 345 kV option and the other was a 230 kV option.

Transmission Improvements

In order for PSCo to provide delivery to <omitted text> of 100 MW or 150 MW from Lamar to Midway or Boone, transmission system improvements must be made to the PSCo system. These improvements listed below are required for either the 100 MW or 150 MW deliveries. The estimates shown are indicative costs in 2003 dollars and are preliminary based on typical construction costs and previous estimates. These estimates should not be taken as detailed engineering estimates.

The cost differences shown below for each option is the cost to expand the Lamar HVDC link by 50 MW (100 MW vs. 150 MW). Costs to make improvements on other neighboring transmission systems have not been provided.

1. Improvements for 345 kV Deliveries at Midway –

**Cost - \$152 M for 100 MW Delivery
Or
\$153.9 M for 150 MW Delivery**

**Estimated Time Frame for Completion of Improvements:
58 Months**

- 1.1. 100 MW or 150 MW expansion of the Lamar HVDC Link injected at 345 kV
- 1.2. A new 142 mile 345 kV line from Lamar to Midway.
- 1.3. 345/230 kV, 560 MVA autotransformer at Midway and at Lamar.
- 1.4. Substation expansion at Lamar to include:
 - 345 kV East Yard ring bus to accommodate HVDC Link expansion
 - 230 kV Yard Breaker and a half to accommodate 345/230 kV auto transformer and new 230 kV line to Boone
 - New 345 kV West Yard to accommodate the 345/230 kV autotransformer, and HVDC link expansion
- 1.5. Substation expansion at Midway to include:
 - 230 kV yard expansion to accommodate the new 345/230 kV autotransformer
 - New 345 kV yard to accommodate new 345/230 kV autotransformer and new 345 kV line terminal

A one-line of the system improvements is shown in Appendix A, Figure 2.

Studies of this option show that the majority of system overloads are eliminated during contingency conditions for the increase of the Lamar HVDC link. It also reduces the loading of the Aquila 115 kV system in and around Pueblo, Colorado. Some contingency overloads still occur, but these are pre-existing system problems on the neighboring utilities' (Tri-State, Aquila, and Colorado Springs Utilities) transmission systems. Appendix C has the list of these system problems.

However, this option will not allow for alternate deliveries to Boone. Studies indicate that deliveries to Boone cause a significant amount of contingency overloads on parts of the Aquila 115 kV system West of Boone.

2. Improvements for 230 kV Deliveries at Boone or Midway

**Cost: \$137.2 M for 100 MW Delivery
Or
\$139 M for 150 MW Delivery**

**Estimated Time Frame for Completion of Improvements:
62 Months**

- 2.1 100 MW or 150 MW expansion of the Lamar HVDC Link injected at 230 kV
- 2.2 A new 99 mile 230 kV line from Lamar to Midway built to 345 kV specifications, but operated at 230 kV
- 2.3 A new 43 mile 230 kV line from Boone to Midway built to 345 kV specifications, but operated at 230 kV
- 2.4 Substation expansion at Lamar to include
 - 230 kV Line termination for a new line to Boone
 - 230 kV termination for the HVDC Link expansion
- 2.5. Substation expansion at Boone to include:
 - 230 kV line termination for the new line to Lamar
 - 230 kV line termination for the new line to Boone
- 2.6 Substation expansion at Midway to a line termination for the new Boone to Midway 230 kV line.

A one-line of the system improvements is shown in Appendix A, Figure 3.

The primary advantage of this option is that it allows for deliveries at Boone or Midway. Studies show that with this system configuration loadings on the PSCo Comanche and Aquila 115 kV systems west of Boone are reduced; however, the 0.2 mile PSCo 115 kV line from Comanche to Reader continues to load to 99% of its 217 MVA rating and studies also show this line overloads more frequently for contingencies. PSCo and Aquila are currently evaluating system reinforcements to address this contingency overload. Some other contingency overloads still occur, but these are pre-existing system problems on the neighboring utilities' (Tri-State, Aquila, and Colorado Springs Utilities) transmission systems. Appendix C has the list of these pre-existing system problems.

APPENDIX A ONE-LINES AND SYSTEM DIAGRAMS

Figure 1: Single line diagram of the Finney to Midway Transmission System

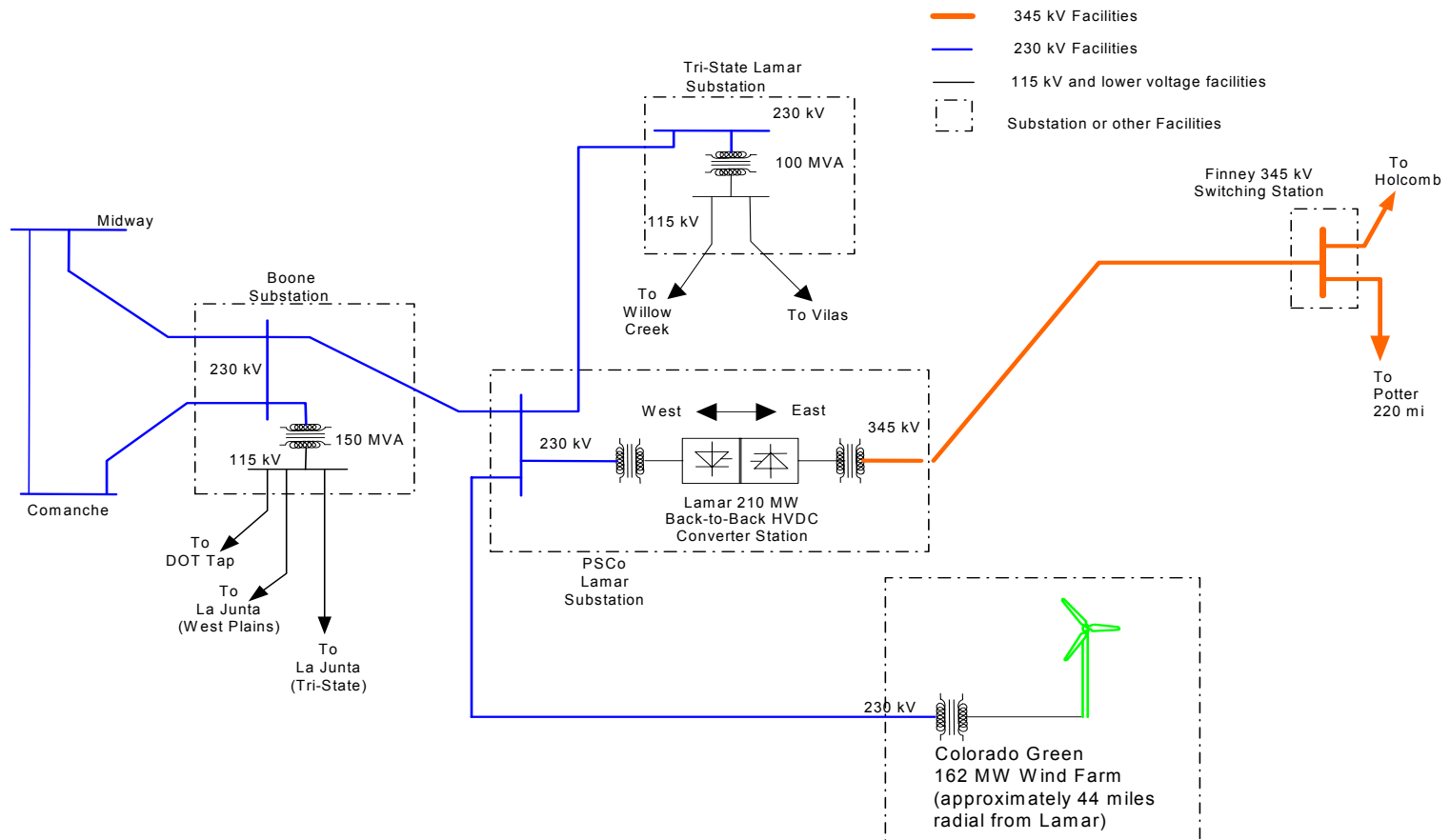


Figure 2: Single Line Diagram of the Finney to Midway Transmission System with 345 kV Improvements for Deliveries to Midway

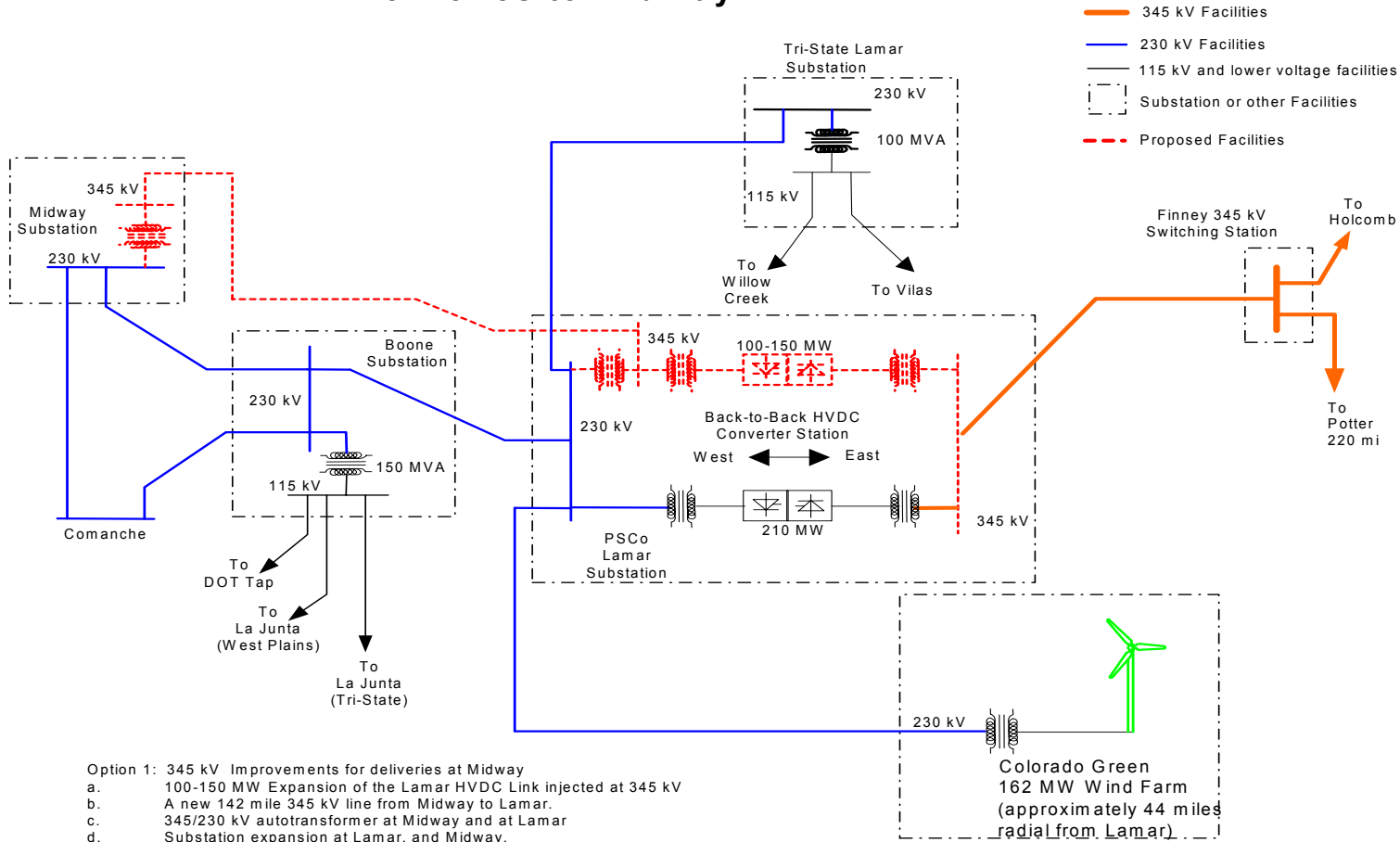


Figure 3: Single Line Diagram of the Finney to Midway Transmission System with 230 kV Improvements for Deliveries to Boone or Midway

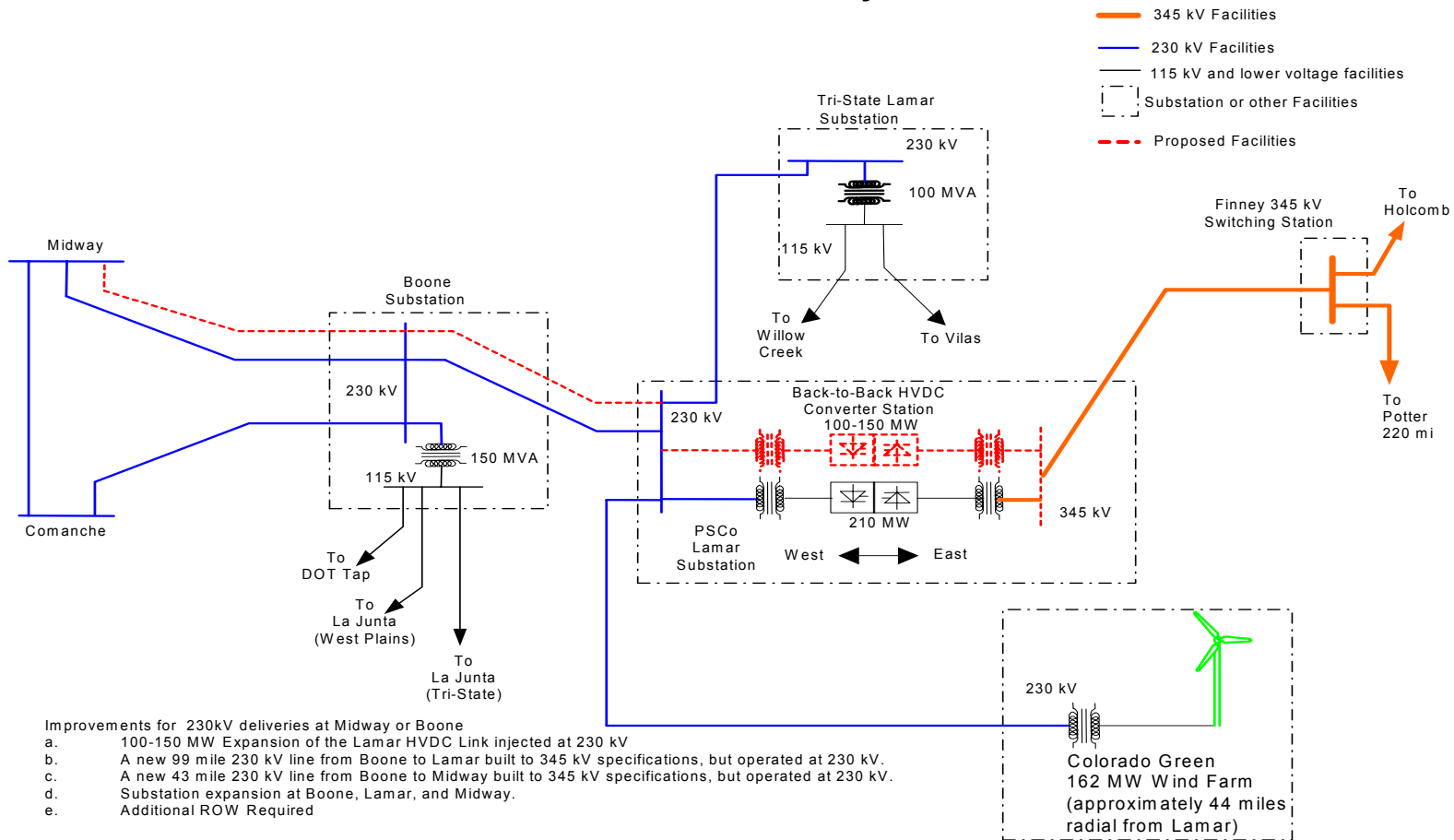
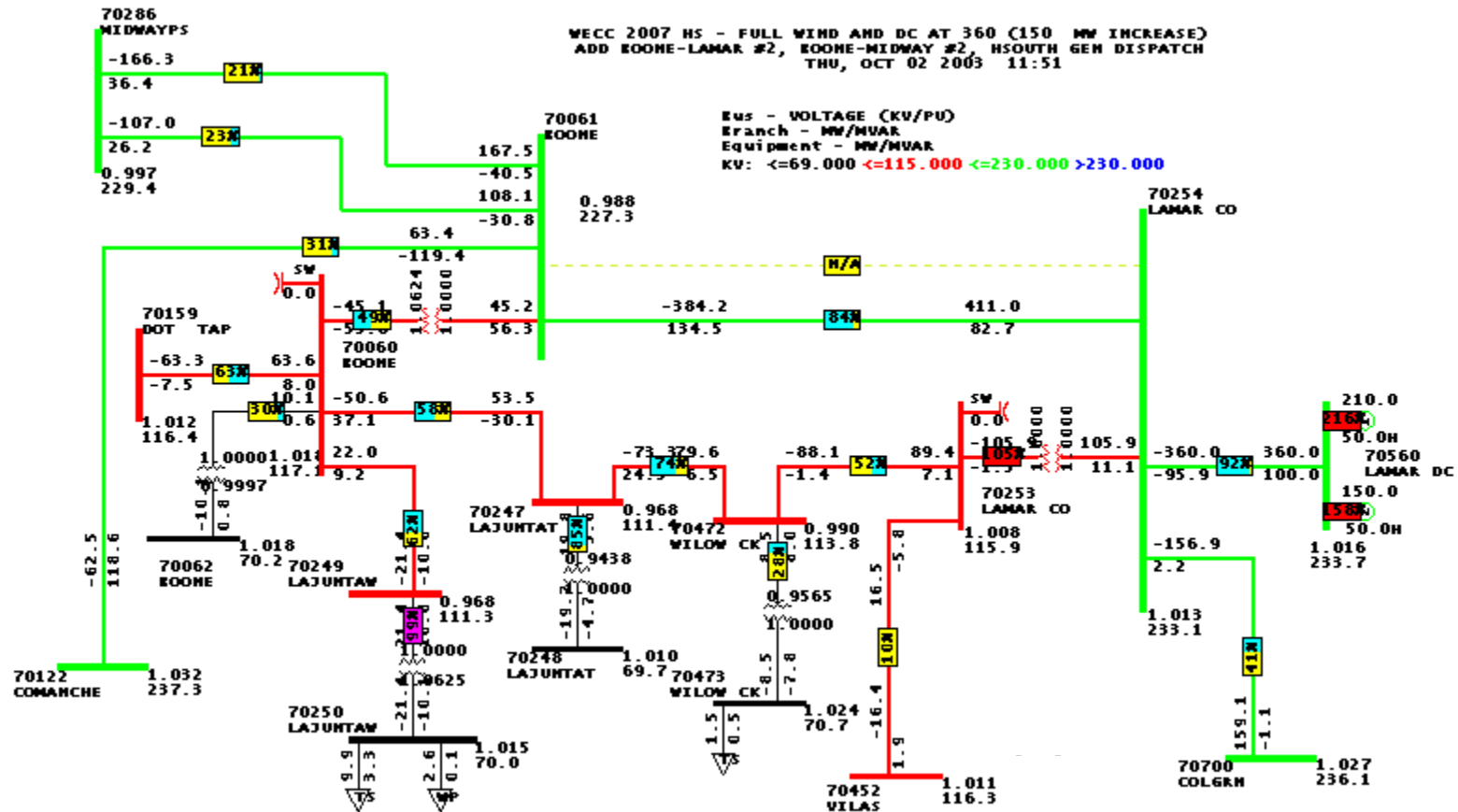


Figure 4 – Example Load Flow as the Result of Losing a Recommended Alternative



APPENDIX B

ALTERNATIVES EXAMINED

Alternate 1 – Alternate Improvements for 230 kV deliveries at Midway or Boone

**Cost - \$146.9 M for 100 MW Delivery
Or
\$148.7 M for 150 MW Delivery**

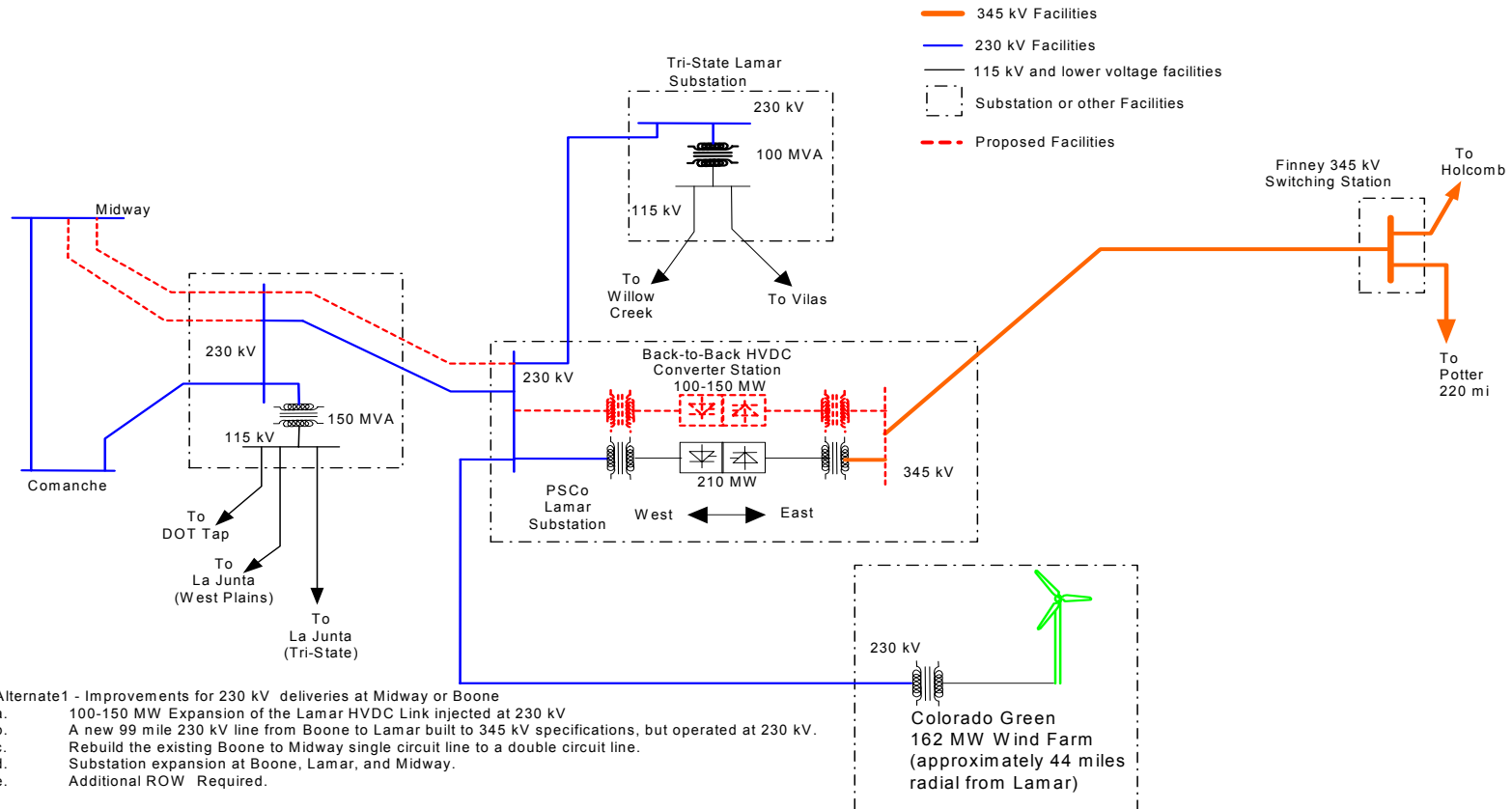
**Estimated Time Frame for Completion of Improvements:
58 Months**

- a. 100 MW or 150 MW expansion of the Lamar HVDC Link injected at 230 kV
- b. A new 99 mile 230 kV line from Boone to Lamar built to 345 kV specifications, but operated at 230 kV
- c. Rebuild the existing 43 mile Boone to Midway single circuit 230 kV line to a double circuit 345 kV line, but operated at 230 kV
- d. Substation expansion at Lamar:
 - 230 kV Line terminal for a new line to Boone
 - 230 kV terminal for the HVDC Link expansion
- e. Substation expansion at Boone:
 - 230 kV Line terminal for a new line to Lamar
 - 230 kV Line terminal for a new line to Midway
- f. Substation expansion at Midway to include a new 230 kV line terminal to Midway

Alternative 1 provides similar results as the 230 kV option; however, it is estimated that this alternative will cost an additional \$10M. The difference is that this option will utilize the existing right-of-way between Boone and Midway. If this option is chosen, a more detailed analysis will be required of the existing permits and ROW to allow for a possible 345 kV line in the future.

Figure B1 is a one-line with Alternative 1 system improvements.

Figure B1: Single line diagram of the Finney to Midway Transmission System Alternate 1 - 230 kV Deliveries to Midway or Boone



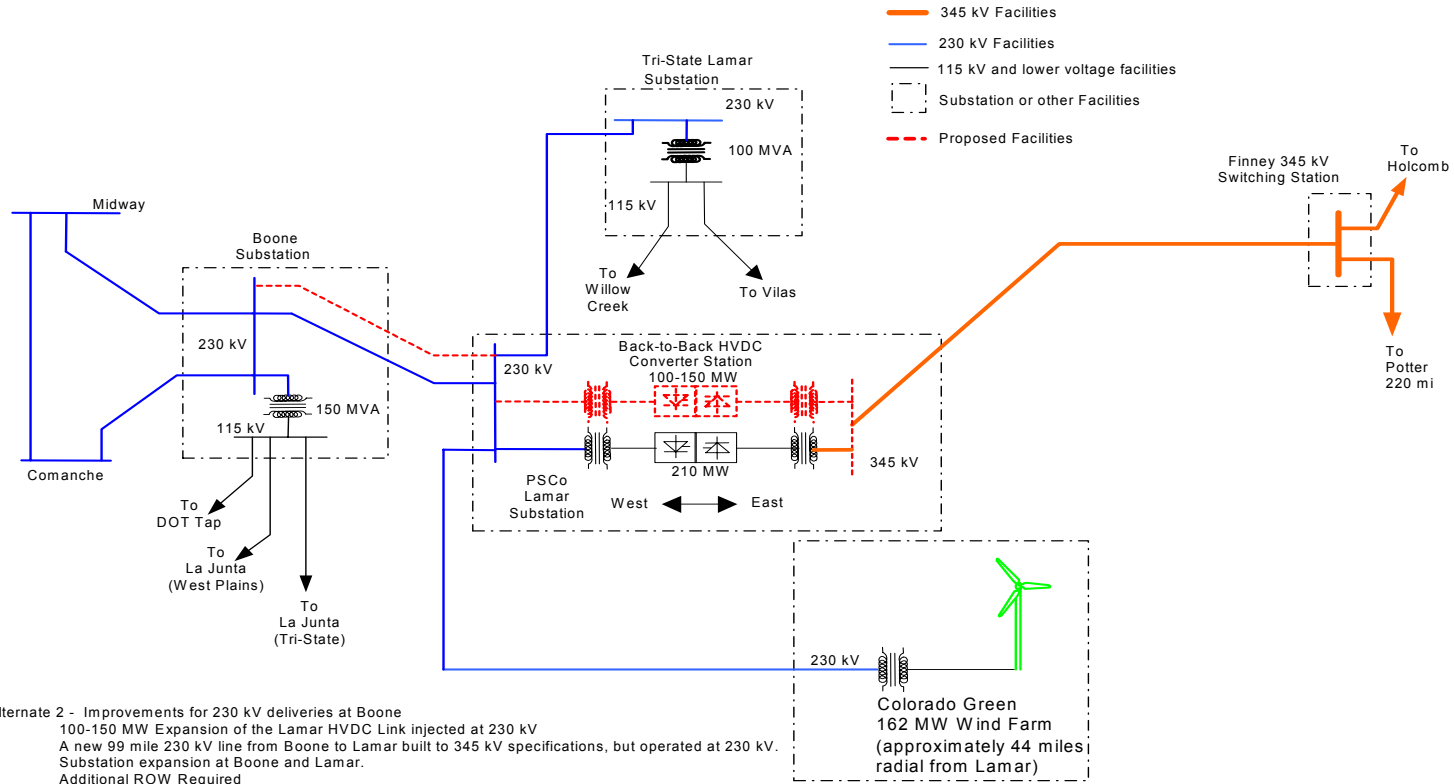
Alternate 2 – Alternate Improvements for 230 kV Deliveries at Boone**Cost - \$109 M for 100 MW Delivery****Or****\$110.8 M for 150 MW Delivery****Estimated Time Frame for Completion of Improvements:
42 Months**

- a. 100 MW or 150 MW expansion of the Lamar HVDC Link injected at 230 kV
- b. A new 99 mile 230 kV line from Boone to Lamar built to 345 kV specifications, but operated at 230 kV
- c. Substation expansion at Lamar:
 - 230 kV Line terminal for a new line to Boone
 - 230 kV terminal for the HVDC Link expansion
- d. Substation expansion at Boone to include a new 230 kV line termination to Lamar

Alternative 2 will provide deliveries to Boone. Studies show that this alternative stresses the Aquila 115 kV system immediately west of Boone and places heavy flow on the Boone to Comanche 230 kV line. Also, the 115 kV system west of Comanche is heavily loaded during contingencies. Furthermore, loadings on the underlying PSCo system increase significantly for the 100 MW and 150 MW deliveries.

Figure B2 is a one-line with Alternative 2 system improvements.

Figure B2: Single line diagram of the Finney to Midway Transmission System Alternate 2- Deliveries to Boone



APPENDIX C

LIST OF PRE-EXISTING AREA PROBLEMS

Studies revealed the following problems on neighboring systems:

Utility	Element	Cause
Aquila	Reader 115/69 Xfmr 1 or 2 Overloads	Outage of Reader Xfmr 1 or 2
	Boone to La Junta 69 kV Line Overloads	Outage of Boone to La Junta 115 kV Line Or Outage of La Junta 115/69 kV
	Various 69 kV Aquila Lines	Loss of Various 69 kV Aquila Lines
Various	Voltage on various buses below 0.9 pu	Loss of the PSCo 230/115 kV at Boone
PSCo	Comanche to Reader 115 kV Line Overloads	Loss of Tri-State Comanche-Walsenburg 230 kV line
Tri-State	West Station to Walsenburg 115 kV Line Overloads	Loss of Tri-State Comanche-Walsenburg 230 kV line
	La Junta 115/69 kV Autotransformer Overloads	Loss of City of La Junta 69/13.8 kV Transformer
	Lamar 230/115 kV Autotransformer Overloads	Loss of Boone to Lamar 230 kV line
Colorado Springs Utilities (CSU)	Birdsall East 115/34.5 kV Transformer Overloads	Loss of Birdsall Generation
	Cottonwood North to Kettle Creek 115 kV line Overloads	Loss of Cottonwood North to Briargate 115 kV Line
Mountain View REA	Falcon 115/69 kV Transformer Overloads	Loss of CSU Cottonwood North 230/115 kV Autotransformer
ARPA	Willow Creek to Lamar 69 kV line Overloads	Loss of City of Lamar 25/14 kV Transformer
City of Lamar	Lamar 69/25 kV Transformer #2 Overloads	Loss of Lamar 69/25 kV Transformer #1