Alternatives to the San Luis Valley-Calumet Portion of the San Luis Valley-Calumet-Comanche Transmission Project

Transmission Study Report

Exhibit JRD-1

Prepared on behalf of

Blanca Ranch Holdings, LLC and
Trinchera Ranch Holdings, LLC

October 28, 2009

Project 9184

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JRD-1
PART 1

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I. Executive Summary

Background

In Public Utilities Commission of the State of Colorado ("CPUC" or "Commission") Docket Nos. 09A-324E and 09A-325E ("CPCN Dockets"), Tri-State Generation and Transmission Association, Inc. ("Tri-State") and Public Service Company of Colorado ("Public Service") have requested a Certificate of Public Convenience and Necessity ("CPCN") for their proposed San Luis Valley-Calumet-Comanche Transmission Project ("Proposed Project" or "Alternative 1"). The Proposed Project involves: (i) building a new double-circuit 230 kV transmission line from the San Luis Valley substation near Alamosa, Colorado to a new substation called Calumet to be located approximately six miles north of Walsenburg, Colorado; (ii) building a new double-circuit 345 kV transmission line from the new Calumet substation to Comanche substation located in Pueblo, Colorado; (iii) rebuilding an existing 115 kV transmission line between the new Calumet substation and the existing Walsenburg substation to operate at 230 kV; and (iv) various other upgrades related to the aforementioned proposed new and rebuilt transmission lines, including, but not limited to, two new 345/230 kV transformers at the proposed Calumet substation.

Tri-State and Public Service (collectively the "Companies") assert the Proposed Project addresses a voltage collapse-related reliability problem in the San Luis Valley area, reduces the likelihood of automatic load shedding in northern New Mexico and potentially provides the opportunity for the development of up to approximately 1,500 MW of additional generation in the San Luis Valley and Calumet/Walsenburg areas (CPCN Dockets, Exhibit TWG-1 at 2).[1] The Companies have estimated the cost of the Proposed Project to be approximately $180 million excluding Allowance for Funds Used During Construction ("AFUDC"). Approximately $90

[1]If transformer loadings other than those at Comanche substation are limited to 115.9% of their respective ratings and Black Hills' 115 kV transmission overloads in the Pueblo area are not considered limiting, the Companies' Proposed Project accommodates 750 MW of new generation in the San Luis Valley area, 1,400 MW in the Calumet/Walsenburg area, or between 750 and 1,400 MW on a combined basis from the two areas (depending how the additional generation is distributed between the two areas).

million of this amount is specifically associated with the proposed new double-circuit 230 kV transmission line between San Luis Valley and Calumet substations (CPCN Dockets, Exhibit TWG-1 at 1-2 and CPCN Dockets, Tri-State Response to Trinchera Ranch discovery at TSGT 00977).

Purpose of Study

The purpose of the study reported herein was to examine alternatives to the double-circuit 230 kV San Luis Valley to Calumet transmission line portion of the Proposed Project that in conjunction with the remainder of the Proposed Project (i) address the reliability issues in the San Luis Valley area and northern New Mexico and (ii) provide sufficient additional transmission capability to support the level of new generation additions that Public Service is currently proposing to potentially commit to in the San Luis Valley and Calumet/Walsenburg areas. As of the date of this report, the Companies have only publicly identified potential commitments for new generation of between 280 to 310 MW in the San Luis Valley area (Energy Resource Zone ("ERZ") 4) and between 200 to 250 MW in the Calumet/Walsenburg area ("ERZ 5").[2] These levels are much lower than the transmission capability for new generation provided by the Companies' Proposed Project, which provides 750 MW for San Luis Valley, 1,400 MW for Calumet/Walsenburg, or between 750 and 1,400 MW on a combined basis for the two areas when transformer loadings other than at Comanche are limited to 115.9% of rating and overloads of Black Hills' 115 kV transmission lines in the Pueblo area are not considered a limiting factor.

Study Results

The study results presented herein show that these publicly identified potential generation commitments can be readily accommodated along with a significant amount of other

[2]The actual level of generation pursued by Public Service may be affected by deliberations in Docket No. 07A-447E.

possible future generation additions in the San Luis Valley and Walsenburg areas without the addition of the San Luis Valley to Calumet portion of the Companies' Proposed Project. Specifically, the study shows that between 525 to 575 MW of new generation in the San Luis Valley area, 1,000 MW in the Walsenburg area, or between 525 MW and 1,325 MW from the two areas combined can be supported by the transmission system through the use of one of multiple transmission line alternatives to the Companies' proposed San Luis Valley to Calumet transmission line. None of these alternatives requires the addition of a new transmission line from San Luis Valley substation to either Calumet or Walsenburg substation, and all of them are significantly less expensive than the San Luis Valley to Calumet portion of the Companies' Proposed Project. They involve the addition of a new single-circuit 230 kV transmission line from San Luis Valley substation to a substation located somewhere along the existing single-circuit 230 kV transmission path that runs from Curecanti substation in Gunnison County, Colorado to Midway substation in El Paso County, Colorado. This existing 230 kV transmission path is located only 62 miles to the north of San Luis Valley substation.[3]

Also, even without the addition of one of the aforementioned transmission line alternatives to the Companies' proposed San Luis Valley to Calumet line: (i) up to 250 MW of additional generation can be accommodated by the existing transmission system in the San Luis Valley area with only minor 115 kV transmission upgrades (which are required by all of the alternatives including the Companies' Proposed Project[4]); and (ii) up to 525 MW of new generation could be accommodated by the existing San Luis Valley area transmission system by coupling these minor 115 kV upgrades with a new Poncha 230/115 kV transformer and a new generation Remedial Action Scheme ("RAS") that automatically trips or runbacks generation in the San Luis Valley area following the loss of the existing single-circuit 230 kV

[3]This distance is based on the length of the existing single-circuit 230 kV San Luis Valley to Poncha transmission line (CPCN Dockets, Public Service Response to Data Request WRA 2-3).

[4]These are the low cost uprates of the Poncha to Sargent and Sargent to San Luis Valley 115 kV transmission lines identified on page 9 of Exhibit TWG-1.

transmission line between San Luis Valley and Poncha substations such that the level of additional generation in the San Luis Valley area is reduced to a level that does not overload the Sargent to Poncha 115 kV transmission line.[5]

All of these alternatives to the Companies' proposed San Luis Valley to Calumet line address Tri-State's voltage stability-related reliability concern in the San Luis Valley area. They also address Tri-State's desire to remove the existing Comanche-Walsenburg 230 kV RAS in the Calumet/Walsenburg area since all of the alternatives assume the Calumet to Comanche and Calumet to Walsenburg portions of the Proposed Project would still be completed.[6] The results of the study are summarized in greater detail on page 6 in Table 1.

Conclusion

In a nutshell, the study shows:

- The San Luis Valley voltage collapse-related reliability issue would be reasonably resolved with no transmission line additions in the San Luis Valley if at least 150 MW of solar thermal generation with storage, or other synchronous generation with a similar level of dispatchability and capacity factor, is added in the San Luis Valley area.

- Without any transmission line additions in the San Luis Valley, up to 250 MW of generation can be accommodated in the San Luis Valley area. This amount can be expanded to 525 MW through the addition of a 230/115 kV transformer at Poncha and a San Luis Valley-Poncha 230 kV generation Remedial Action Scheme ("RAS"). This solution would cost less than one-sixth ($15 million) of the Companies' proposed $90 million San Luis Valley-Calumet transmission line.

- Alternatively, the San Luis Valley voltage collapse-related issue would be resolved with the addition of a new 230 kV transmission line from San Luis Valley to the north for a cost of approximately $40 to $50 million less than the

[5]The actual level to which generation must be reduced will vary with the level of load in the San Luis Valley area at the time of the loss of the 230 kV line.

[6]The existing Comanche-Walsenburg 230 kV RAS automatically opens the Walsenburg-Gladstone 230 kV transmission line when the existing Comanche-Walsenburg 230 kV transmission line is lost in order to mitigate overloads of the existing West Station-Stem Beach-Walsenburg 115 kV transmission line. However, when the RAS operates it can cause other automatic protection systems to shed Tri-State load in northern New Mexico. The Calumet to Comanche and Calumet to Walsenburg portions of the Proposed Project eliminate the need for this RAS by providing a second 230 kV or higher voltage source to the Calumet/Walsenburg area. (CPCN Dockets, Direct Testimony of Tri-State witness Leoni at 8-9).

cost of the Companies' proposed $90 million San Luis Valley-Calumet transmission line.

- If a new 230 kV transmission line addition from San Luis Valley to the north is pursued, between 525 and 575 MW of generation can be accommodated in the San Luis Valley area.

- All of the Trinchera Ranch alternatives support up to 1,000 MW of generation additions at Calumet on a non-simultaneous basis and allow removal of the existing Comanche-Walsenburg 230 kV RAS.

- All of the Trinchera Ranch alternatives can accommodate at least 525 MW to 1,275 MW of generation on a combined basis in the San Luis Valley and Calumet/Walsenburg areas depending on how that generation is distributed between the two areas. These levels are well in excess of potential commitments for new generation that the Companies have publicly identified for the San Luis Valley and Calumet/Walsenburg areas.

TABLE 1

Comparison of Companies Proposed Project (Alternative 1) to Trinchera Ranch Alternatives

Alternative	Upgrades Included in Addition to Calumet-Comanche and Calumet-Walsenburg Portions of the Companies' Proposed Project[1]	Significantly Reduces Risk of Undervoltage Load Shedding in the San Luis Valley Area	Maximum Additional San Luis Valley Generation (MW)	Maximum Additional Calumet Generation (MW)	Maximum Additional Simultaneous Generation (MW)	Estimated Cost of San Luis Valley Upgrades
1	New Double-Circuit 230 kV San Luis Valley-Calumet Line (proposed by Companies)	Yes	750	1,400	750-1,400	$90 M
TR1	New Single-Circuit 230 kV San Luis Valley-Poncha Line	Yes	525[2]	1,000	525-1,300	$39 M
TR2	New Single-Circuit 230 kV San Luis Valley-Sargent-Poncha Line plus Sargent 230/115 kV Transformer	Yes	575[2]	1,000	800-1,300	$48 M
TR3	New Single-Circuit 230 kV San Luis Valley-West Canon Line	Yes	525[2]	1,000	900-1,275	$66 M
TR1A	TR1 with New Poncha 230/115 kV Transformer	Yes	575	1,000	1,125-1,325	$39 M[4]
TR2A	TR2 with New Poncha 230/115 kV Transformer	Yes	575	1,000	875-1,325	$48 M[4]
TR3A	TR3 with New Poncha 230/115 kV Transformer	Yes	550[2]	1,000	900-1,300	$66 M[4]
TR4	Only Minor San Luis Valley-Sargent-Poncha 115 kV Upgrades	Yes[3]	250	1,000	1,250	Not Applicable
TR4AR	TR4 with New Poncha 230/115 kV Transformer and Generation Remedial Action Scheme	Yes[3]	525	1,000	525-1,325	<$15 M

Note: All of these alternatives, including the Companies' Alternative 1, assume (i) a relatively low cost upgrade of the ratings of the existing San Luis Valley to Sargent and Sargent to Poncha 115 kV transmission lines, (ii) resolution of various 115 kV overloads on the Black Hills transmission system (in the Pueblo area) and (iii) 345/230 kV, 230/115 kV and 115/69 kV transformer overloads up to 115.9% of rating can be mitigated at relatively low cost. For the Black Hills' West Canon to Portland 115 kV transmission path, it was assumed overloads could be resolved at a relatively low cost up to 133 MVA of post-contingency loading. This is the minimum rating of the upstream Poncha to West Canon 115 kV transmission path.

[1]All of these alternatives assume the completion of the Calumet to Comanche and Calumet to Walsenburg portions of the Companies' Proposed Project which will allow removal of the existing Comanche-Walsenburg 230 kV Remedial Action Scheme reducing the likelihood of automatic load shedding of Tri-State load in northeastern New Mexico.

[2]This level of additional San Luis Valley generation is achievable to the extent a new 230/115 kV transformer is added at Black Hills' West Canon substation or the overload of the existing West Canon substation 230/115 kV transformer for the loss of the Midway BR – West Canon 230 kV transmission line is otherwise mitigated. The cost estimates for the affected alternatives conservatively include the estimated cost of adding a new 230/115 kV transformer to Black Hills' West Canon substation.

[3]Provided at least 150 MW of new thermal solar generation with storage, or other synchronous generation with a similar level of dispatchability and capacity factor, is added to the San Luis Valley area.

[4]The TR1A, TR2A and TR3A alternatives are alternatives presented to show how the capability of the TR1, TR2 and TR3 alternatives would change if Public Service goes ahead with its $8.4 million Poncha 230/115 kV transformer project. As such, the $8.4 million cost for that project is not included in the cost of San Luis Valley area upgrades for Alternatives TR1A, TR2A and TR3A.

II. Background

As discussed in the Executive Summary, the purpose of this study was to examine alternatives to the double-circuit 230 kV San Luis Valley to Calumet transmission line portion of the Companies' Proposed Project. In the Companies' Exhibit TWG-1 study report in the CPCN Dockets ("TWG-1 Report" or "TWG-1 Study"), the Companies made the assumption that any alternative examined to accommodate new generation in the San Luis Valley and Walsenburg area must include a new west to east 230 kV (or higher voltage) transmission line from San Luis Valley substation to either Walsenburg substation or a new substation just north of Walsenburg called Calumet. This study shows that other lower cost alternatives exist which: (i) adequately address the voltage collapse-related reliability concern in the San Luis Valley area; (ii) adequately support Public Service's publicly identified proposed generation commitments in the San Luis Valley and Calumet/Walsenburg areas; (iii) provide significant support for other future generation additions in the San Luis Valley and Calumet/Walsenburg areas; and (iv) do not involve the addition of a new west to east transmission line between San Luis Valley and Calumet (or Walsenburg) substations.

III. Process

Brubaker & Associates, Inc. ("BAI") first reviewed:

- The Companies' filed direct testimony and exhibits in the CPCN Dockets, including, but not limited to, the TWG-1 Report.
- The transcripts of depositions taken in June and July of 2009 of the witnesses of the Companies in the CPCN Dockets.
- The Companies' responses to data requests and interrogatories in the CPCN Dockets, including, but not limited to, Tri-State's 1997 and 2004 Power-Voltage ("PV") studies of the San Luis Valley area.
- The public version of Public Service's 120-day report in Docket No. 07A-447E.
- Public Service's public response to the Commission's questions with respect to Public Service's 120-day report in CPUC Docket No. 07A-447E.

- Publicly available information regarding North American Electric Reliability Corporation ("NERC") and Western Electric Coordinating Council ("WECC") transmission planning standards and criteria.

- Publicly available information and recent industry technical articles related to state-of-the-art solar generation technology.

Having considered all of the above, BAI then conducted a PV analysis using the power flow models provided by Public Service in response to the CPUC Staff's second set of data requests in this proceeding to identify alternatives to a new 230 kV (or higher voltage) transmission line from San Luis Valley substation to Calumet (or Walsenburg) that adequately address Tri-State's reliability issue in the San Luis Valley area. This PV analysis was conducted in a manner generally consistent with Tri-State's 2004 PV Analysis except the straight-line mileage assumptions of the 2004 PV Analysis were replaced with actual expected mileage estimates for each alternative reflecting the additional mileage associated with the highly circuitous route of some alternatives (e.g., the actual expected route of a new double-circuit 230 kV transmission line between San Luis Valley and Calumet substations is significantly longer than the straight-line mileage between those two substations).

Once BAI's PV analysis was completed, BAI conducted a contingency analysis, comparable to the study presented in the TWG-1 Report, to examine the capability of the transmission system to support additional generation in the San Luis Valley and Calumet/Walsenburg areas with various alternatives to the Companies' proposed San Luis Valley to Calumet transmission line.

It should be noted that, in performing the study, BAI assumed the portions of the Proposed Project unrelated to the Companies' proposed San Luis Valley to Calumet transmission line would be completed. If those portions of the Proposed Project are scaled back in scope, it will likely reduce the amount of generation that could be accommodated in the Calumet/Walsenburg area and might require retention of the existing Comanche-Walsenburg 230 kV RAS. However, it would have very little effect, if any, on the amount of new generation

that could be accommodated in the San Luis Valley area by the alternatives reviewed in this study.

IV. Method of Study

Except as detailed below, this study was performed in the same manner as the Companies' TWG-1 Study using the same powerflow models that the Companies used for their studies.

A. Power Flow Models

The power flow models used for this study were provided on a highly confidential basis by Public Service in response to Data Requests CPUC 2-1a, CPUC 2-2 and TR 7-4.

The CPUC 2-1a model corresponds to the 600 MW at San Luis Valley -- 1,000 MW at Calumet -- Alternative 1 case whose contingency analysis is tabulated on page B-3 of Appendix B of the TWG-1 Report. However, BAI found that the version of the model provided by Public Service in response to Data Request CPUC 2-1a did not include all of the revised line ratings presented in Table 3 of page 9 of the TWG-1 Report. Therefore, BAI modified the model to reflect these missing line rating revisions. This modified CPUC 2-1a model was the starting point for the BAI analysis.

The CPUC 2-2 model corresponds to the TWG-1 Report "Benchmark Case" with no generation added to San Luis Valley or Calumet (or Walsenburg). As explained below, BAI compared this model to the CPUC 2-1a model to more specifically identify how the Companies made generation reductions in the TWG-1 Study.

The TR 7-4 model corresponds to the power flow model used by Public Service to estimate the amount of new generation in the San Luis Valley area that can be accommodated by the current transmission system. Public Service has estimated this to be 130 MW based on its assumption that voltage collapse will occur at 150 MW since it could not get the power flow

program to converge on a solution at that generation level (CPCN Dockets, Attachments TR2-5.A1 through TR2-5.A19 of Public Service's response to Data Request TR2-5). BAI used the TR 7-4 model to reconcile the results of its analysis of the capability of the existing San Luis Valley transmission system with those of Public Service.

On page 6 of the TWG-1 Report, the Companies indicated they balanced any generation additions in the San Luis Valley and Calumet/Walsenburg areas with corresponding generation reductions to the north of the Denver-Metro area at locations including Pawnee and Ft. St. Vrain. To more precisely identify how the reductions were made, BAI compared generation levels in the CPUC 2-1a model to those in the CPUC 2-2 model. In addition, to check the calibration of BAI's modified version of the CPUC 2-1a model and BAI's approach to emulating the way the Companies made generation reductions for the TWG-1 Study, BAI ran a single contingency analysis test of the modified CPUC 2-1a model with the Companies' Proposed Project (Alternative 1) in service with (1) 600 MW at San Luis Valley and 1,000 MW at Calumet, (ii) 800 MW at San Luis Valley and 0 MW at Calumet, and (iii) 0 MW at San Luis Valley and 1,400 MW at Calumet. Table 2 below compares the Companies' results presented in Appendix B of the TWG-1 Report to the results obtained by BAI. BAI's analysis was conducted using Version 31 of the Siemens-Power Technologies PSS/E power flow software.

TABLE 2

Comparison of BAI Analysis of Alternative 1 to Companies TWG-1 Analysis of Alternative 1

Alternative 1			SLV-Calumet double-circuit 230 kV and Calumet-Comanche double-circuit 345 kV					
Loaded Element/ Contingency	Rating (MVA)	Injection level at Calumet	0		1400		1000	
		Injection level at SLV	800		0		600	
		Owner	TWG-1	BAI	TWG-1	BAI	TWG-1	BAI
Burnt Mill – West Station 115 Pueblo Plant – Reader 115	100	Black Hills		107.4%	137.1%	137.4%	125.9%	125.9%
APT Park – APT Mem 115 NYBERG – Midway PS 230	105	Black Hills			104.6%	104.7%	102.4%	102.4%
Hyde Park – Pueblo Plant 115 Normal System	105	Black Hills			104.2%	104.4%		
Hyde Park – Pueblo Plant 115 Burnt Mill – West Station 115	105	Black Hills	107.1%	107.4%	146.5%	146.8%	134.7%	134.7%
Hyde Park – West Station 115 Burnt Mill – West Station 115	105	Black Hills			129.5%	129.8%	117.5%	117.5%
Portland – West Station 115 West Canon 230/115	80	Black Hills				128.6%	114.3%	114.3%
Desert Cov – West Station 115 Midway PS – Midway BR 230	105	Black Hills			116.7%	117.1%	107.7%	107.7%
West Canon 230/115 Portland – West Station 115	100	Black Hills				100.4%		
Alamosa TM 115/69 San Luis Valley – Sargent 115	25	Public Service of CO		102.0%				104.8%
Comanche 230/115 #1 Normal System	176	Public Service of CO			103.4%	103.4%		
Comanche 230/115 #1 Comanche 230/115 #2	176	Public Service of CO	130.4%	131.2%	159.8%	159.8%	152.8%	152.8%
Comanche 230/115 #2 Comanche 230/115 #1	185	Public Service of CO	125.2%	125.2%	152.5%	152.5%	145.9%	145.9%
Greenwood – Prairie 230 Daniels Park – Prairie 230	478	Public Service of CO			100.1%		104.2%	105.6%
Palmer – Monument 115 Daniels Park – Comanche 345	135	Public Service of CO					104.1%	104.0%
San Luis Valley 230/115 #1 San Luis Valley 230/115 #2	150	Public Service /Tri-State	116.1%	116.8%			121.1%	121.1%
San Luis Valley 230/115 #2 San Luis Valley 230/115 #1	150	Public Service /Tri-State	116.1%	116.9%			121.1%	121.1%
San Luis Valley 115/69 #1 San Luis Valley – Sargent 115	42	Public Service /Tri-State					102.0%	102.0%
San Luis Valley 115/69 #2 San Luis Valley – Sargent 115	42	Public Service /Tri-State					102.0%	102.0%
Midway BR 230/115 Midway BE – RD Nixon 230	100	Public Service /WAPA	110.7%	109.7%	116.1%	115.9%	122.6%	122.6%
Walsenburg 230/115 #1 Walsenburg 230/115 #2	100	Tri-State			114.8%	114.6%	117.0%	117.0%
Walsenburg 230/115 #2 Walsenburg 230/115 #1	100	Tri-State			115.0%	114.9%	117.0%	117.3%

As can be seen from Table 2, BAI's results very closely match the Companies' results presented in the TWG-1 Report for these cases. However, it appears that as an oversight the Companies failed to tabulate in Appendix B of the TWG-1 Report the 128.6% loading of the

Portland to West Station 115 kV transmission line for loss of the Burnt Mill to West Station 115 kV transmission line in the Alternative 1 case with 0 MW added at San Luis Valley and 1,400 MW added at Calumet. It should be noted that Table 2, the tables presented later in this report and the tables the Companies presented in Appendices A, B and C of the TWG-1 Report are abridged. They only list the single worst contingency case loading for each monitored element. For each of the monitored elements listed in the tables, there may be other contingencies that less severely overload the monitored element in question.

B. Significant Study Factors and Assumptions

For this study, BAI conformed to the significant study factors and assumptions outlined by the Companies in Section V.D. of the TWG-1 Report. However, as mentioned earlier in this report, BAI also performed a PV analysis of voltage stability in the San Luis Valley area. BAI's PV analysis was performed in a manner generally consistent with Tri-State's January 2004 PV Study Report: San Luis Valley Substation Second 230 kV Source ("2004 PV Study"), which was provided by Tri-State in response to discovery in the CPCN Dockets at TSGT 000791-000847. This is the latest PV Study that Tri-State has completed for the San Luis Valley area. Tri-State did not perform a new PV Study for its application in the CPCN Dockets.

C. General Criteria

BAI conducted its contingency analysis in a manner consistent with the TWG-1 Study and its PV analysis in a manner consistent with Tri-State's 2004 PV Study.[7] Consistent with both studies performed by the Companies, BAI in its study did not examine whether post-contingency voltage levels meet planning criteria. Like the Companies, BAI assumed post-contingency voltage levels could be brought within planning criteria with the addition of shunt capacitors, reconfiguration of facilities or some other manner provided the

[7]However, unlike in Tri-State's 2004 PV Study, BAI conservatively applied Tri-State's current voltage stability criteria margin that requires the MW capability available to support load be reduced by 5% from the predicted point of voltage collapse.

post-contingency system exhibited voltage stability in the PV analysis results. In addition, consistent with the Companies' approach in the TWG-1 Study, BAI assumed transformer overloads up to 115.9% of rating could be readily mitigated and overloads of Black Hills' 115 kV transmission facilities near the Pueblo area will not limit the addition of generation in the San Luis Valley and Calumet/Walsenburg areas. Also consistent with the Companies' approach in the TWG-1 Study, BAI assumed overloads of the Comanche 230/115 kV transformers would not limit the addition of generation in the San Luis Valley and Calumet/Walsenburg areas.[8] BAI did allow the three Black Hills' transmission lines that make up the West Canon to Portland 115 kV transmission path, which parallels WAPA's West Canon to Midway 230 kV transmission path,[9] to be loaded up to 133 MVA. This was based on the assumption the ratings for this transmission path could be upgraded to the 133 MVA rating of the upstream Poncha to West Canon 115 kV transmission path at relatively low cost.

Finally, the Town Lake Tap to Malta 115 kV transmission line section of Public Service's Poncha to Malta 115 kV transmission path, which runs north from Poncha, was allowed to be loaded up to 138 MVA (172% of its current 80 MVA rating). Public Service has identified that the rating of this line section can be raised by replacing the line traps at Poncha and Malta (Public Service Response to Data Requests TR 11-1 through 11-3). Such a replacement would have a relatively low cost and not be a limiting factor for generation additions.

V. PV Analysis of Alternatives to a San Luis Valley to Calumet (or Walsenburg) Transmission Line

The San Luis Valley area voltage collapse-related reliability issue concerns Tri-State's continued use of an automatic undervoltage load shedding system that trips Tri-State customer load in the San Luis Valley area automatically in order to minimize the likelihood of voltage

[8] A review of Appendix B of the TWG-1 Report showed the Companies did not consider the Comanche 230/115 kV transformers limiting even when the post-contingency loadings of the transformers exceeded 150% of rating (TWG-1 Report at B-2).

[9] West Canon-Canon City, Canon City-Skala and Skala-Portland.

collapse in that area following the loss of the existing single-circuit San Luis Valley to Poncha 230 kV transmission line. Past studies by Tri-State have shown that voltage collapse could occur following the loss of this transmission line when the net load in the San Luis Valley area exceeds 65 MW (CPCN Dockets, Direct Testimony of Tri-State witness Leoni at 5). It appears that Tri-State is now concerned that the likelihood and/or expected frequency of load shedding has grown to the point where Tri-State would like to significantly reduce that likelihood and/or frequency (Id.).

BAI performed a PV analysis of the Companies' Proposed Project both with the San Luis Valley - Calumet portion of the Companies' Proposed Project and with three different transmission line alternatives to that portion of the Companies' Proposed Project. The PV analysis was conducted with the existing San Luis Valley to Poncha 230 kV transmission line out of service and no new generation added to the San Luis Valley and Calumet/Walsenburg areas.[10] The results of this analysis are summarized in Table 3 below. The actual PV curves for each case can be found in **Appendix A**.

[10]San Luis Valley area loads in the CPUC 2-1a model had an average lagging power factor in excess of 98%, which is higher than the 95% lagging power factor used in the 2004 PV Study (Tri-State response to Data Request TR 11-1). To ensure BAI's PV analysis is conservative, BAI forced the power factor of San Luis Valley area loads to 95% lagging in the powerflow runs used for its PV analysis. Note that if the San Luis Valley area loads do have an expected lagging power factor of 98% or greater, the maximum voltage stable San Luis Valley area load values would be higher than the values I have listed above in Table 3.

TABLE 3

Results of BAI PV Analysis with Existing San Luis Valley-Poncha 230 kV Transmission Line Out of Service and No Generation Added at San Luis Valley or Calumet

Alternative	Included San Luis Valley 230 kV Upgrades	San Luis Valley Load at Estimated Point of Voltage Collapse (MW)	Maximum Voltage Stable San Luis Valley Area Load[1] (MW)	Estimated Cost of San Luis Valley Upgrades
1	New Double-Circuit 230 kV San Luis Valley-Calumet Line (proposed by Companies)	240	225	$90 M
TR1	New Single-Circuit 230 kV San Luis Valley-Poncha Line	195	185	$41 M
TR2	New Single-Circuit 230 kV San Luis Valley-Sargent-Poncha Line plus Sargent 230/115 kV Transformer	210	195	$48 M
TR3	New Single-Circuit 230 kV San Luis Valley-West Canon Line	190	180	$66 M

[1]Applying Tri-State 5% voltage stability margin criteria and rounding down to the nearest 5 MW.

These results show that all of these alternatives are more than adequate to dramatically reduce the likelihood of automatic load shedding in the San Luis Valley area for load levels well in excess of those forecasted through 2015 (approximately 155 MW of such load was previously forecasted by the Companies[11] for 2015.) In addition, the table shows the estimated costs of the three Trinchera Ranch alternatives (TR1, TR2 and TR3) are substantially lower in cost than the Companies' proposed double-circuit 230 kV San Luis Valley to Calumet transmission line.

[11]The Companies have indicated that they now do not forecast reaching the 155 MW level until beyond the 2015 horizon (TWG-1 Report at footnote 3 on page 7).

Details in regard to all of the cost estimates presented in this report can be found in **Appendix B** to this report.

VI. Contingency Analysis of Transmission Line Alternatives to the Proposed Double-Circuit 230 kV San Luis Valley-Calumet Transmission Line Without the Addition of a Poncha 230/115 kV Transformer

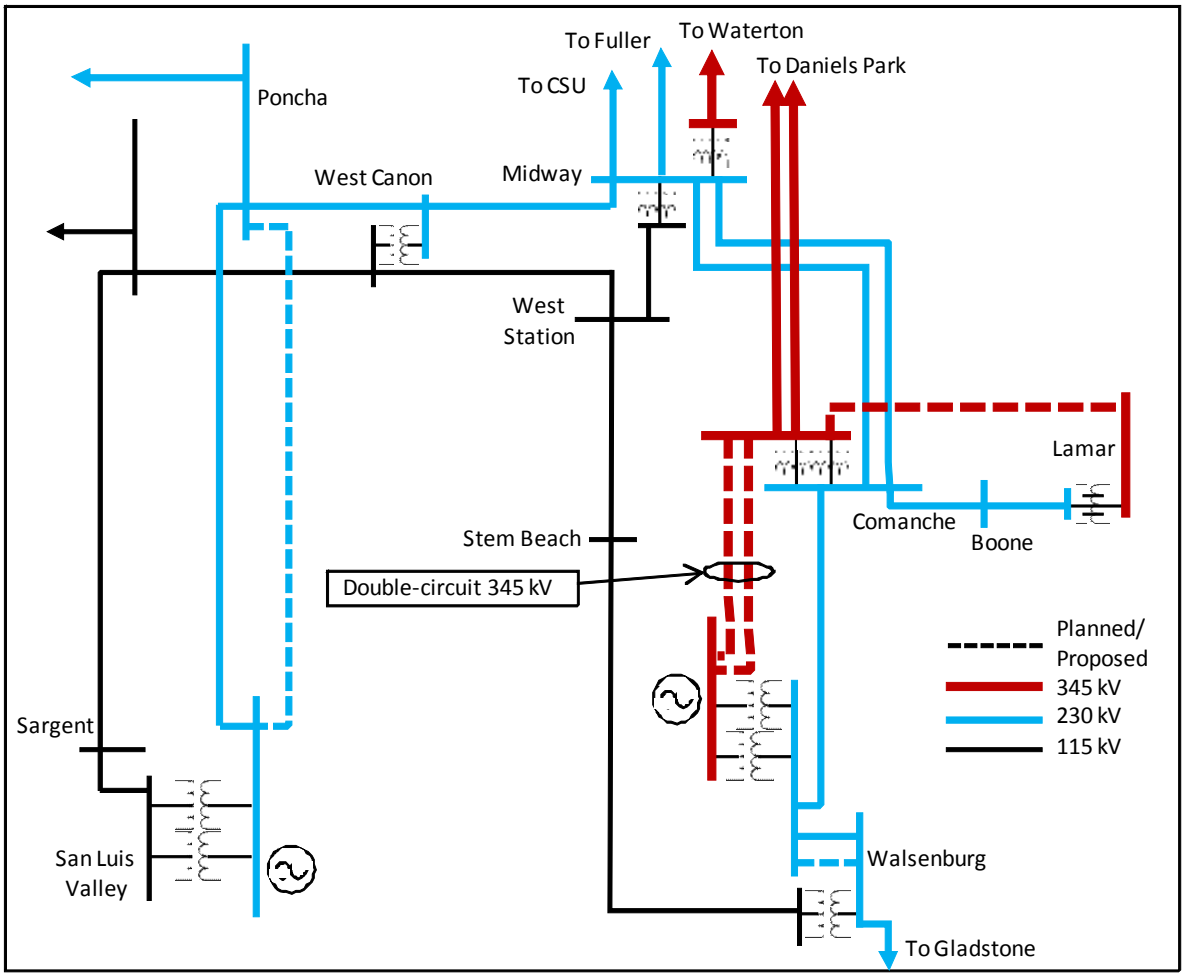
BAI also examined the ability of the three Trinchera Ranch transmission line alternatives, when combined with the Calumet-Comanche and Calumet-Walsenburg portions of the Companies' Proposed Project, to support generation additions in the San Luis Valley and Calumet/Walsenburg areas. All of these alternatives involve the addition of a new transmission line to provide a second 230 kV source to San Luis Valley substation from the north rather than from the Calumet/Walsenburg area.

A. Alternative TR1: San Luis Valley-Poncha and Calumet-Comanche Transmission

1. Description

This alternative, shown below in Figure 1, replaces the $90 million, 95-mile double-circuit 230 kV San Luis Valley to Calumet transmission line part of the Companies' Alternative 1 (the Proposed Project) with a $39 million, 62-mile second single-circuit 230 kV San Luis Valley to Poncha transmission line.

Figure 1: Alternative TR1



As in the Companies' TWG-1 Study, three sets of generation injection studies were performed. Generation was first added incrementally to the San Luis Valley 230 kV bus in ERZ 4 with no generation added at Calumet in ERZ 5. Then generation was incrementally added at the Calumet 345 kV bus in ERZ 5 with no generation added at San Luis Valley. Finally, consistent with the Companies' approach in their TWG-1 Study, a "simultaneous" evaluation was performed to determine the total amount of generation that could be injected at both locations at the same time.

2. Results - San Luis Valley Only

Table 4 below summarizes the non-simultaneous results for generation injections at San Luis Valley. The limiting conditions are shaded in grey below. In a manner similar to TWG-1 Report, more detailed contingency results are provided in **Appendix C** to this report.

TABLE 4

Alternative TR1 Generation at San Luis Valley 230 kV Only

			Incremental Injection at San Luis Valley 230 kV Bus				
Loaded Element / Contingency	Rating (MVA)	Owner	400	500	525	550	600
West Canon 230/115 Midway BR – West Canon 230	100	BH	109.0%	133.4%	139.4%	145.2%	156.8%
West Canon – Canon City 115 Midway BR – West Canon 230	120	BH			101.3%	106.4%	116.6%
Canon City – Skala 115 Midway BR – West Canon 230	105	BH			102.7%	108.6%	120.7%
Skala – Portland 115 Midway BR – West Canon 230	105	BH				101.3%	113.5%
Alamosa TM 115/69 San Luis Valley – Sargent 115	25	PS			100.7%	102.1%	105.3%
San Luis Valley 115/69 #1 San Luis Valley – Sargent 115	42	PS/TS					103.2%
San Luis Valley 115/69 #2 San Luis Valley – Sargent 115	42	PS/TS					103.2%
San Luis Valley 230/115 #1 San Luis Valley 230/115 #2	150	PS/TS	103.7%	112.5%	114.8%	117.1%	121.6%
San Luis Valley 230/115 #2 San Luis Valley 230/115 #1	150	PS/TS	103.7%	112.5%	114.8%	117.1%	121.6%
Midway BR 230/115 Midway BR – RD Nixon 230	100	PS/WA	104.4%	107.5%	108.3%	109.0%	110.4%
Curecanti – So Canal 115 Poncho BR – West Canon 230	133	WA					100.3%

The results above show that post-contingency loading on the San Luis Valley 230/115 transformers is the limiting factor and sets a limit of approximately 525 MW for generation only added at San Luis Valley with transformers being allowed to be loaded up to approximately 115% of their respective ratings.

The loading of Black Hills' West Canon 230/115 transformer does exceed approximately 115% of its rating with 525 MW of generation injected at San Luis Valley. Therefore, BAI's estimate cost for Alternative TR1 ($41 million) includes the cost for an additional 230/115 kV

transformer at West Canon in order to resolve this particular overload. It may be possible to mitigate this overload without incurring the cost for a new transformer.

As noted in Section IV.C. of this report, it was assumed the Black Hills' West Canon to Portland 115 kV transmission path would not be limiting to generation additions until its post-contingency loading exceeded 133 MVA (111% of 120 MVA and 127% of 105 MVA). If the path cannot be upgraded from its current rating at a relatively low cost, the amount of generation accommodated on a non-simultaneous basis at San Luis Valley by this alternative would fall from 525 MW to 500 MW.

3. Results – Calumet Injection Only

Table 5 summarizes the non-simultaneous results for generation additions only at Calumet. Once again, the limiting conditions are shaded in grey and more detailed contingency results can be found in **Appendix C** to this report.

TABLE 5

Alternative TR1 Generation at Calumet 345 kV Only

			Incremental Injection at Calumet 345 kV Bus	
Loaded Element / Contingency	Rating (MVA)	Owner	1000	1200
Burnt Mill – West Station 115 Reader – Pueblo Plant 115	100	BH	140.8%	147.8%
Hyde Park – Pueblo Plant 115 Burnt Mill – West Station 115	105	BH	150.4%	157.7%
West Canon 230/115 Portland – West Station 115	100	BH	101.4%	103.2%
Midway BR 230/115 Midway BR – RD Nixon 230	100	PS	104.4%	107.6%
Walsenburg 230/115 #1 Walsenburg 230/115 #2	100	TS	115.2%	121.7%
Walsenburg 230/115 #2 Walsenburg 230/115 #1	100	TS	115.4%	122.0%

The results above show the post-contingency loading on the Walsenburg 230/115 kV transformers is the limiting factor and sets a limit of approximately 1,000 MW for generation only

added at Calumet with transformers being allowed to be loaded up to approximately 115% of their respective ratings. As in the TWG-1 Study, overloads of Black Hills' 115 kV transmission lines in the Pueblo area are not considered a limiting condition.

4. Results – San Luis Valley and Calumet Simultaneous Injection

Several different power flow cases were subject to contingency analysis in order to evaluate the interaction between generation injections at the San Luis Valley and Calumet substations. BAI first started at the non-simultaneous limit for San Luis Valley injections and evaluated how much power could simultaneously be injected at Calumet. BAI then moved to the non-simultaneous limit for injections at Calumet and evaluated how much power could be simultaneously injected at San Luis Valley. The results of the contingency tests are summarized in Table 6 below. Detailed results from these tests can also be found in **Appendix C**.

TABLE 6

Alternative TR1 Simultaneous Limit

San Luis Valley	Calumet	Total	Limiting Element
525	0	525	San Luis Valley 230/115 Transformers
500	500	1,000	Midway BR 230/115 Transformer
300	1,000	1,300	Midway BR 230/115 Transformer

As can be seen from Table 6, when San Luis Valley is at its non-simultaneous limit of 525 MW, no injections can be supported at Calumet due to the latter injections contributing to post-contingency loadings on the San Luis Valley 230/115 transformers, which are already at 115% of their limit without Calumet injections.

However, the results in Table 6 also show that, when Calumet is at its non-simultaneous limit of 1,000 MW, up to 300 MW of injection can also be accommodated at San Luis Valley before the Midway BR 230/115 transformer's post-contingency loading exceeds approximately

115% of its rating. This is a result of the fact that generation injections at San Luis Valley reduce the post-contingency loading of the Walsenburg 230/115 transformers.

Finally, the results show that 500 MW of generation can be accommodated at San Luis Valley when the generation added to Calumet is limited to 500 MW.

5. Cost

It is estimated that the Proposed Project, as modified by this alternative, would have a total cost of approximately $129 million as a result of replacing the San Luis Valley-Calumet portion of the Proposed Project with a new single-circuit 230 kV San Luis Valley to Poncha transmission line.

6. Conclusion

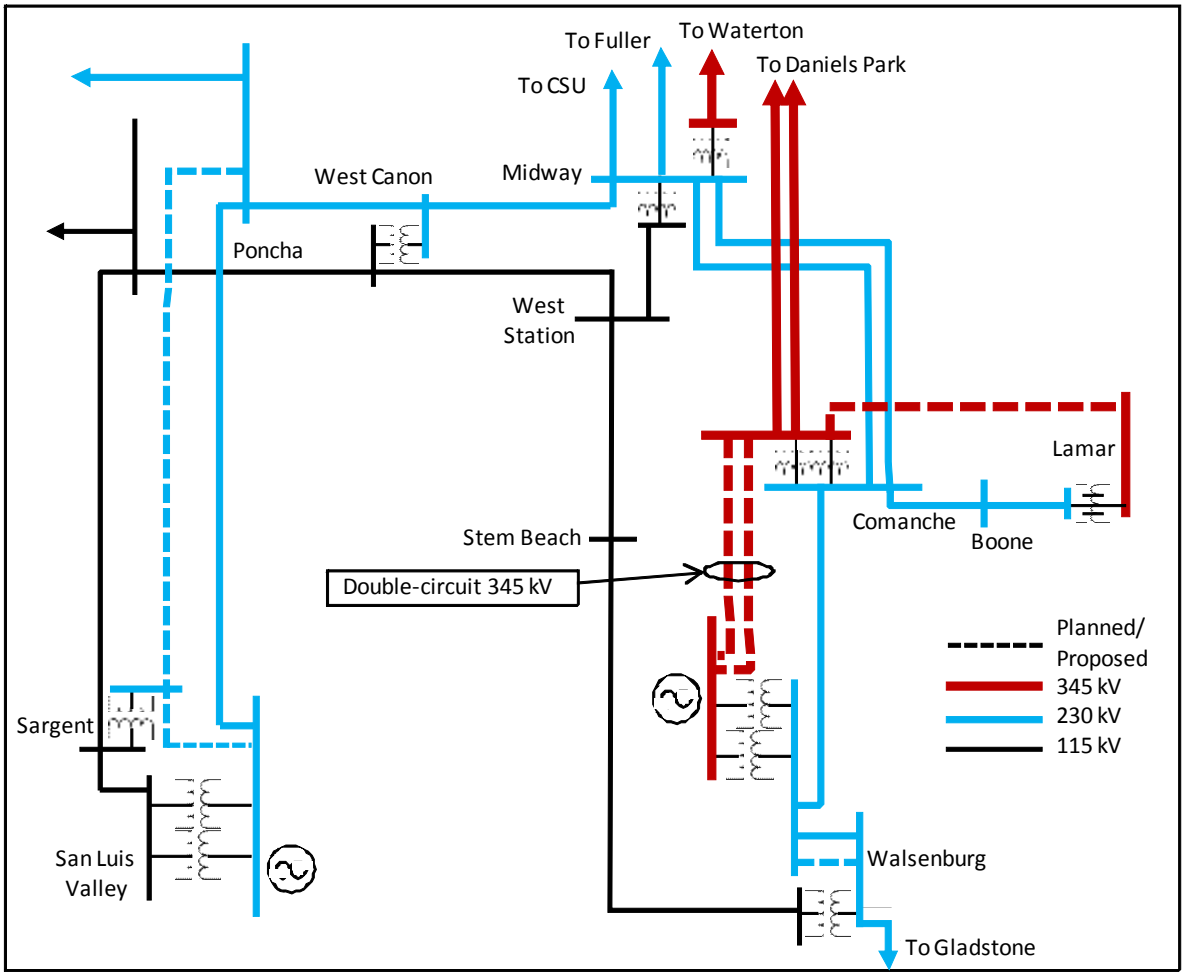
- As identified in Section V of this report, this alternative adequately addresses the voltage collapse-related reliability issue in the San Luis Valley by providing an additional transmission source to San Luis Valley.
- As noted earlier in the report, this alternative eliminates the Comanche-Walsenburg 230 kV RAS since a parallel path is provided between Comanche and Walsenburg.
- The non-simultaneous generation limit at San Luis Valley is approximately 525 MW with the San Luis Valley 230/115 kV transformers as the limit.
- The non-simultaneous generation limit at Calumet is approximately 1,000 MW with the Walsenburg 230/115 kV transformers as a limit.
- The simultaneous generation limit varies between 525 MW and 1,300 MW with the San Luis Valley 230/115 kV and Midway BR 230/115 kV transformers as limits.
- The exact simultaneous generation limit is a function of how generation injections are distributed between San Luis Valley and Calumet.

B. Alternative TR2: San Luis Valley-Sargent-Poncha and Calumet-Comanche Transmission

1. Description

This alternative, shown in Figure 2 below, replaces the $90 million, 95-mile double-circuit 230 kV San Luis Valley to Calumet transmission line part of the Proposed Project with a new 72-mile, single-circuit 230 kV San Luis Valley to Sargent to Poncha transmission line and a new Sargent 230/115 kV transformer that have a combined estimated cost of approximately $48 million. More detailed results for the contingency analysis which presented below for this alternative can be found in **Appendix D** to this report.

Figure 2: Alternative TR2



2. Results – San Luis Valley Only

Table 7 below summarizes the non-simultaneous results for generation injections only at San Luis Valley.

TABLE 7

Alternative TR2 Generation at San Luis Valley 230 kV Only

			Incremental Injection at San Luis Valley 230 kV Bus				
Loaded Element / Contingency	Rating (MVA)	Owner	500	525	550	575	600
West Canon 230/115 Midway BR – West Canon 230	100	BH	131.1%	136.9%	142.7%	148.4%	154.1%
West Canon – Canon City 115 Midway BR – West Canon 230	120	BH		101.1%	106.1%	111.1%	116.3%
Canon City – Skala 115 Midway BR – West Canon 230	105	BH		102.3%	108.2%	114.2%	120.3%
Skala – Portland 115 Midway BR – West Canon 230	105	BH			100.9%	107.0%	113.1%
Poncha – Sargent 115 Poncha BR – West Canon 230	128	PS					102.0%
Midway BR 230/115 Midway BR – RD Nixon 230	100	PS/WA	107.4%	108.1%	108.9%	109.6%	110.3%
Curecanti – So Canal 115 Poncho BR – West Canon 230	133	WA					100.2%

The results show that post-contingency loading on the 115 kV Poncha-Sargent transmission line is the limiting factor and sets a limit of approximately 575 MW for generation only added at San Luis Valley. In addition, the post-contingency loading of the Black Hills' West Canon to Canon City 115 kV transmission line also begins to exceed 133 MVA (111% of its current 120 MVA rating) above 575 MW of generation added at San Luis Valley.

The estimated cost for a new 230/115 kV transformer was included in the cost estimate for this alternative to address the Black Hills' West Canon 230/115 kV transformer overload. This overload may be able to be mitigated without expending the cost for a new transformer. As with Alternative TR1, the Black Hills' 115 kV transmission lines in the West Canon to Portland transmission path were not considered limiting until their respective post-contingency loadings exceeded 133 MVA. If the current ratings of these lines cannot be raised at a relatively low

cost, the amount of generation that can be accommodated at San Luis Valley on a non-simultaneous basis by this alternative would fall from 575 MW to 500 MW.

3. Results – Calumet Injection Only

Table 8 summarizes the non-simultaneous results for this alternative for generation additions only at Calumet.

TABLE 8

Alternative TR2 Generation at Calumet 345 kV Only

			Incremental Injection at Calumet 345 kV Bus		
Loaded Element / Contingency	Rating (MVA)	Owner	975	1000	1025
Burnt Mill – West Station 115 Reader – Pueblo Plant 115	100	BH	139.9%	140.7%	141.6%
Hyde Park – Pueblo Plant 115 Burnt Mill – West Station 115	105	BH	149.4%	150.3%	151.2%
West Canon 230/115 Portland – West Station 115	100	BH	100.2%	100.4%	100.6%
Midway BR 230/115 Midway BR – RD Nixon 230	100	PS	104.0%	104.4%	104.7%
Walsenburg 230/115 #1 Walsenburg 230/115 #2	100	TS	114.4%	115.2%	116.0%
Walsenburg 230/115 #2 Walsenburg 230/115 #1	100	TS	114.6%	115.4%	116.2%

The results show the post-contingency loading on the Walsenburg 230/115 kV transformers is the limiting factor and sets a limit of approximately 1,000 MW for generation only added at Calumet with transformers being allowed to be loaded up to approximately 115% of their respective ratings. As in the TWG-1 Study, overloads of the Black Hills' transmission lines in the Pueblo area are not considered a limiting factor.

4. Results – San Luis Valley and Calumet Simultaneous Injection

The results of simultaneous contingency analysis for this alternative are summarized in Table 9.

TABLE 9

Alternative TR2 Simultaneous Limit

San Luis Valley	Calumet	Total	Limiting Element
575	225	800	Curecanti – So Canal 115
525	500	1,025	Midway BR 230/115 Transformer
300	1,000	1,300	Midway BR 230/115 Transformer

As can be seen from Table 9, up to 225 MW can be injected at Calumet when San Luis Valley is at its non-simultaneous limit of 575 MW, and up to 300 MW can be injected at San Luis Valley when Calumet is at its non-simultaneous limit of 1,000 MW. Furthermore, 525 MW can be accommodated at San Luis Valley when injections at Calumet are limited to 500 MW.

5. Cost

It is estimated that the Proposed Project, as modified by this alternative, would have a total cost of approximately $138 million.

6. Conclusion

- As identified in Section V of this report, this alternative adequately addresses the voltage collapse-related reliability issue in the San Luis Valley by providing an additional transmission source to San Luis Valley.

- As noted earlier in the report, this alternative eliminates the Comanche-Walsenburg 230 kV RAS since a parallel path is provided between Comanche and Walsenburg.

- The non-simultaneous generation limit at San Luis Valley is approximately 575 MW with the Poncha-Sargent 115 kV transmission line as the limit.

- The non-simultaneous generation limit at Calumet is approximately 1,000 MW with the Walsenburg 230/115 kV transformers as a limit.

- The simultaneous generation limit varies between 800 MW and 1,300 MW with the Curecanti-So Canal 115 kV transmission line and Midway BR 230/115 kV transformer as limits.

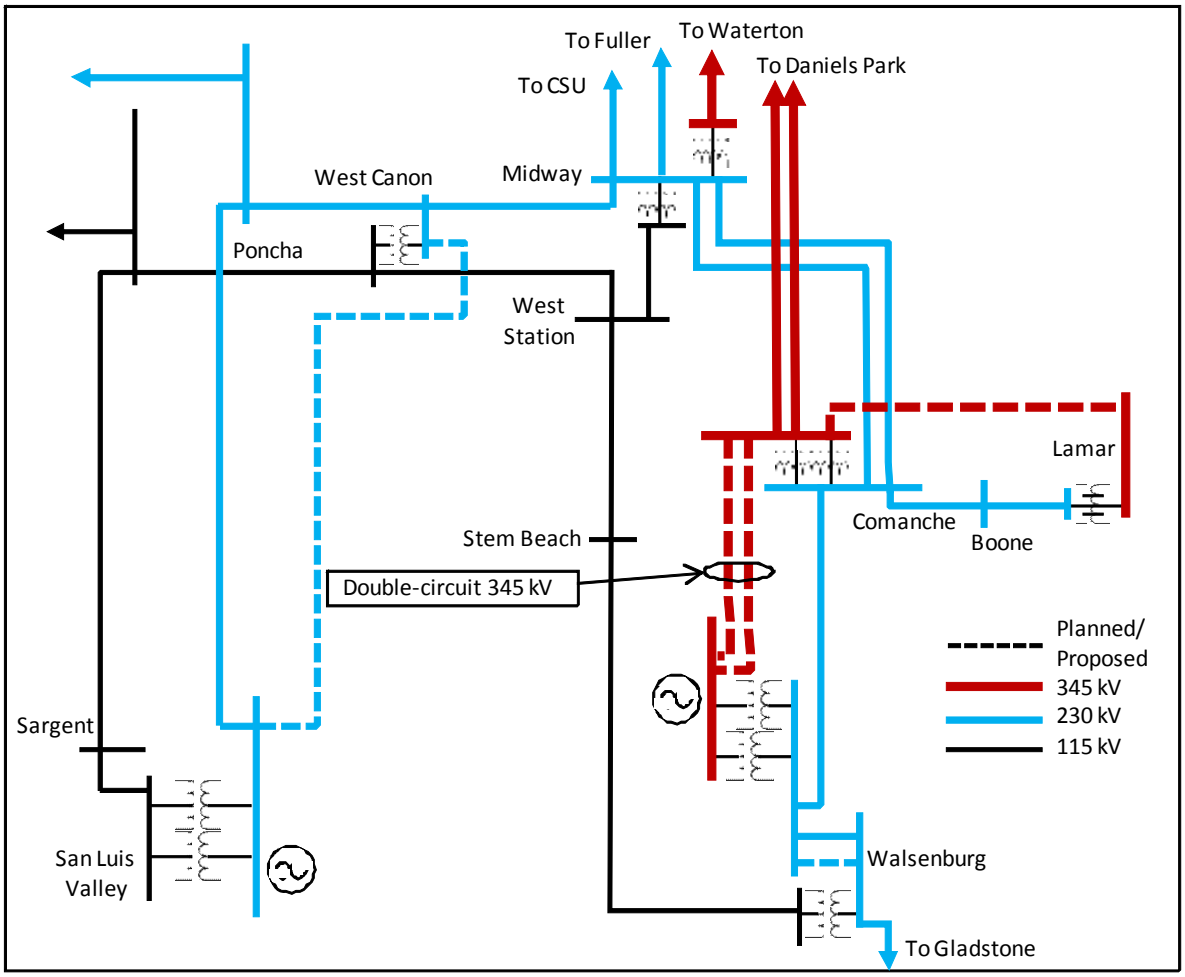
- The exact simultaneous generation limit is a function of how generation injections are distributed between San Luis Valley and Calumet.

C. Alternative TR3: San Luis Valley-West Canon and Calumet-Comanche Transmission

1. Description

This alternative, shown in Figure 3 below, replaces the $90 million, 95-mile double-circuit 230 kV San Luis Valley to Calumet transmission line with a new 108-mile, single-circuit 230 kV San Luis Valley to West Canon transmission line that has an estimated cost of approximately $66 million. More detailed results for the contingency analysis which is presented below for this alternative can be found in **Appendix E**.

Figure 3: Alternative TR3



2. Results – San Luis Valley Only

Table 10 below summarizes the non-simultaneous contingency analysis results for this alternative for generation injections only at San Luis Valley.

TABLE 10

Alternative TR3 Generation at San Luis Valley 230 kV Only

			Incremental Injection at San Luis Valley 230 kV Bus				
Loaded Element / Contingency	Rating (MVA)	Owner	475	525	550	575	600
West Canon 230/115 Midway BR – West Canon 230	100	BH	143.8%	157.8%	164.7%	171.5%	178.3%
West Canon – Canon City 115 Midway BR – West Canon 230	120	BH		108.5%	114.0%	119.5%	125.1%
Canon City – Skala 115 Midway BR – West Canon 230	105	BH		111.2%	117.6%	124.1%	130.7%
Skala – Portland 115 Midway BR – West Canon 230	105	BH		103.6%	110.2%	116.7%	123.3%
Alamosa TM 115/69 San Luis Valley – Sargent 115	25	PS				100.1%	101.3%
San Luis Valley 230/115 #1 San Luis Valley 230/115 #2	150	PS/TS	106.2%	110.1%	112.1%	114.1%	116.1%
San Luis Valley 230/115 #2 San Luis Valley 230/115 #1	150	PS/TS	106.2%	110.1%	112.1%	114.1%	116.1%
Midway BR 230/115 Midway BR – RD Nixon 230	100	PS/WA	108.8%	110.5%	111.4%	112.3%	113.1%

The results show that above 525 MW of generation at San Luis Valley, the Black Hills' West Canon to Canon City 115 kV transmission path begins to be loaded in excess of 133 MVA (approximately 111% of its current 120 MVA rating). Note that the cost for a 230/115 kV transformer has been conservatively included in the cost estimate for this alternative to address the Black Hills' West Canon transformer overload. As with Alternatives TR1 and TR2, this overload may be able to be mitigated without expending the cost for a new transformer. Finally, as previously discussed, the Black Hills' West Canon to Portland 115 kV transmission path was not considered limiting unless the post-contingency load on the lines that make up this path exceeded 133 MVA. If the current ratings of these lines cannot be raised at a relatively low cost, the amount of generation accommodated at San Luis Valley on a non-simultaneous basis by this alternative would fall from 525 MW to 475 MW.

3. Results – Calumet Injection Only

Table 11 summarizes the non-simultaneous contingency analysis results for this alternative for generation additions only at Calumet.

TABLE 11

Alternative TR3 Generation at Calumet 345 kV Only

			Incremental Injection at Calumet 345 kV Bus		
Loaded Element / Contingency	Rating (MVA)	Owner	975	1000	1025
Burnt Mill – West Station 115 Reader – Pueblo Plant 115	100	BH	140.2%	141.0%	141.9%
Hyde Park – Pueblo Plant 115 Burnt Mill – West Station 115	105	BH	149.7%	150.6%	151.5%
Midway BR 230/115 Midway BR – RD Nixon 230	100	PS/WA	103.5%	103.9%	104.3%
Walsenburg 230/115 #1 Walsenburg 230/115 #2	100	TS	114.6%	115.4%	116.2%
Walsenburg 230/115 #2 Walsenburg 230/115 #1	100	TS	114.8%	115.6%	116.4%

The results show the post-contingency loading on the Walsenburg 230/115 kV transformers is the limiting factor and sets a limit of approximately 1,000 MW for generation only added at Calumet with transformers being allowed to be loaded up to approximately 115% of their respective ratings. As previously discussed, the overload of the Black Hills' transmission lines in the Pueblo area is not considered a limiting condition.

4. Results – San Luis Valley and Calumet Simultaneous Injection

The results of the simultaneous contingency analysis for this alternative are summarized in Table 12.

TABLE 12

Alternative TR3 Simultaneous Limit

San Luis Valley	Calumet	Total	Limiting Element
525	375	900	Midway BR 230/115 Transformer
450	500	950	Midway BR 230/115 Transformer
275	1,000	1,275	Midway BR 230/115 Transformer

These results show that Calumet generation injections of up to 300 MW can be accommodated when San Luis Valley is at its non-simultaneous limit of 525 MW, and up to 275 MW of injections at San Luis Valley can be accommodated when Calumet is at its non-simultaneous limit of 1,000 MW. They also show 450 MW of generation injections can be accommodated at San Luis Valley when Calumet is limited to 500 MW of injections.

5. Cost

It is estimated that the Proposed Project, as modified by this alternative, would have a total cost of approximately $156 million.

6. Conclusion

- As identified in Section V of this report, this alternative adequately addresses the voltage collapse-related reliability issue in the San Luis Valley by providing an additional transmission source to San Luis Valley.
- As noted earlier in the report, this alternative eliminates the Comanche-Walsenburg 230 kV RAS since a parallel path is provided between Comanche and Walsenburg.
- The non-simultaneous generation limit at San Luis Valley is approximately 525 MW with the Black Hills' West Canon to Canon City 115 kV transmission line as the limit.
- The non-simultaneous generation limit at Calumet is approximately 1,000 MW with the Walsenburg 230/115 kV transformers as a limit.
- The simultaneous generation limit varies between 900 MW and 1,275 MW with the San Luis Valley 230/115 and Midway BR 230/115 transformers as limits.

- The exact simultaneous generation limit is a function of how generation injections are distributed between San Luis Valley and Calumet.

VII. Contingency Analysis of Transmission Line Alternatives to the Proposed Double-Circuit 230 kV San Luis Valley-Calumet Transmission Line With the Addition of a Poncha 230/115 kV Transformer

Public Service's April 30, 2009 Rule 3206 Report included a reference to the addition of a 280 MVA, 230/115 kV transformer at Poncha with an in-service date of May 31, 2013 (CPCN Dockets, Public Service's response to Data Request CPUC 5-1). This transformer addition would be placed at the Poncha 115 KV substation and a one-mile length of single-circuit 230 kV transmission line would connect it to the Poncha 230 kV substation (CPCN Dockets, Attachment TR5-4.A3 to Public Service's response to Data Request TR 5-4). The transformer project would establish a transmission contract path between Public Service's facilities at the Poncha 115 kV and 230 kV substations and have an estimated cost of $8.4 million (Id.). The addition of this project would reduce post-contingency loadings on the San Luis Valley and West Canon 230/115 kV transformers following certain contingencies, which could in turn increase the amount of new generation that could be accommodated in the San Luis Valley area. For this reason, BAI re-evaluated each of the Trinchera Ranch alternatives with a new Poncha 230/115 kV transformer in-service. These variants of Alternatives TR1, TR2 and TR3 are respectively designated in this report as alternatives TR1A, TR2A and TR3A.

A. Alternative TR1A: San Luis Valley-Poncha Transmission, Poncha 230/115 Transformer and Calumet-Comanche Transmission

1. Description

This alternative is Alternative TR1 with the $8.4 million Poncha 230/115 kV transformer project added. More detailed results for the contingency analysis which is presented below for this alternative can be found in **Appendix F**.

2. Results – San Luis Valley Only

Table 13 below summarizes the non-simultaneous contingency analysis results for this alternative for generation injections only at San Luis Valley.

TABLE 13

Alternative TR1A (TR1 with Poncha 230/115 Transformer)
Generation at San Luis Valley 230 kV Only

			Incremental Injection at San Luis Valley 230 kV Bus				
Loaded Element / Contingency	Rating (MVA)	Owner	525	550	575	600	625
West Canon – Canon City 115 Midway BR – West Canon 230	120	BH		103.6%	108.4%	113.3%	118.3%
West Canon 230/115 Midway BR – West Canon 230	100	BH	105.7%	109.8%	113.9%	117.9%	121.9%
Skala – Portland 115 Midway BR – West Canon 230	105	BH			103.7%	109.5%	115.4%
Canon City – Skala 115 Midway BR – West Canon 230	105	BH		105.3%	111.0%	116.8%	122.7%
Town Lake Tap – Malta 115 Poncha BR – West Canon 230	80	PS		100.4%	108.5%	116.7%	125.0%
San Luis Valley 230/115 #1 San Luis Valley 230/115 #2	150	PS/TS		100.8%	102.3%	103.7%	105.2%
San Luis Valley 230/115 #2 San Luis Valley 230/115 #1	150	PS/TS		100.8%	102.3%	103.8%	105.2%
Midway BR 230/115 Midway BR – RD Nixon 230	100	PS/WA	106.9%	107.6%	108.3%	108.9%	109.6%
Curecanti – So Canal 115 Curecanti – Lost Canyon 230	133	WA					101.5%

The results show that the addition of the Poncha 230/115 kV transformer project would raise the Alternative TR1 non-simultaneous limit for San Luis Valley generation additions from 525 MW to 575 MW with post-contingency loading of the Black Hills' West Canon to Canon City 115 kV transmission line becoming the limiting factor as its post-contingency loading exceeds 133 MVA (111% of its current 120 MVA rating). The Town Lake Tap-Malta 115 kV line section is not limiting because Public Service has identified that the 80 MVA rating for the line section can be feasibly raised to 138 MVA (172% of 80 MVA) through the relatively low cost replacement of line traps at Malta and Poncha.

If the current ratings of the three transmission lines that make up the Black Hills' West Canon to Portland 115 kV transmission path cannot be raised at a relatively low cost, the generation accommodated at San Luis Valley on a non-simultaneous basis by this alternative would fall from 575 MW to 525 MW.

3. Results – Calumet Injection Only

Table 14 below summarizes the non-simultaneous contingency analysis results for this alternative for generation injections only at Calumet.

TABLE 14

Alternative TR1A (TR1 with Poncha 230/115 Transformer)
Generation at Calumet 345 kV Only

			Incremental Injection at Calumet 345 kV Bus		
Loaded Element / Contingency	Rating (MVA)	Owner	975	1000	1025
Burnt Mill – West Station 115 Reader – Pueblo Plant 115	100	BH	139.9%	140.8%	141.6%
Hyde Park – Pueblo Plant 115 Burnt Mill – West Station 115	105	BH	149.4%	150.3%	151.2%
Midway BR 230/115 Midway BR – RD Nixon 230	100	PS	104.0%	104.3%	104.7%
Walsenburg 230/115 #1 Walsenburg 230/115 #2	100	TS	114.4%	115.2%	116.0%
Walsenburg 230/115 #2 Walsenburg 230/115 #1	100	TS	114.6%	115.4%	116.3%

The results above show that the addition of the Poncha 230/115 kV transformer project does not impact the non-simultaneous generation addition limit for Alternative TR1 at Calumet, which remains at 1,000 MW.

4. Results – San Luis Valley and Calumet Simultaneous Injection

The results of simultaneous contingency analysis for this alternative are summarized in Table 15.

TABLE 15

Alternative TR1A (TR1 with Poncha 230/115 Transformer) Simultaneous Limit

San Luis Valley	Calumet	Total	Limiting Element
575	550	1,125	Midway BR 230/115 Transformer
325	1,000	1,325	Midway BR 230/115 Transformer

The results above show that the addition of the Poncha 230/115 kV transformer project would increase the simultaneous limit for San Luis Valley and Calumet for Alternative TR1 from a range of 525 MW to 1,300 MW to a range of 1,125 MW to 1,325 MW.

5. Conclusion

The addition of the Poncha 230/115 kV transformer project to Alternative TR1 would:

- Raise the non-simultaneous generation limit at San Luis Valley for Alternative TR1 from approximately 525 MW with the San Luis Valley 230/115 kV transformers as the limit to approximately 575 MW with the Town Lake Tap-Malta 115 kV transmission line section as the limit.

- Have no impact on the non-simultaneous generation limit at Calumet for Alternative TR1, which remains approximately 1,000 MW with the Walsenburg 230/115 kV transformers as a limit.

- Raise the simultaneous generation limit for Alternative TR1 from a range of 525 MW to 1,300 MW to a range of 1,125 MW to 1,325 MW.

B. Alternative TR2A: San Luis Valley-Sargent-Poncha Transmission, Poncha 230/115 Transformer and Calumet-Comanche Transmission

1. Description

This alternative is Alternative TR2 with the $8.4 million Poncha 230/115 kV transformer project added. More detailed results for the contingency analysis which is presented below for this alternative can be found in **Appendix G**.

2. Results – San Luis Valley Only

Table 16 below summarizes the non-simultaneous contingency analysis results for this alternative for generation injections only at San Luis Valley.

TABLE 16

Alternative TR2A (TR2 with Poncha 230/115 Transformer)
Generation at San Luis Valley 230 kV Only

			Incremental Injection at San Luis Valley 230 kV Bus				
Loaded Element / Contingency	Rating (MVA)	Owner	500	525	550	575	600
West Canon – Canon City 115 Midway BR – West Canon 230	120	BH			103.4%	108.3%	113.2%
West Canon 230/115 Midway BR – West Canon 230	100	BH	101.0%	105.2%	109.3%	113.3%	117.3%
Skala – Portland 115 Midway BR – West Canon 230	105	BH				103.5%	109.4%
Canon City – Skala 115 Midway BR – West Canon 230	105	BH			105.2%	110.9%	116.7%
Town Lake Tap – Malta 115 Poncha BR – West Canon 230	80	PS			100.7%	108.8%	117.0%
Midway BR 230/115 Midway BR – RD Nixon 230	100	PS/WA	106.2%	106.9%	107.5%	108.2%	108.9%

The results show that the addition of the Poncha 230/115 kV transformer project would have no significant effect on the Alternative TR2 non-simultaneous limit for San Luis Valley generation additions and post-contingency loading of the Black Hills' West Canon to Canon City 115 kV transmission line remains the limiting factor as its post-contingency loading begins to exceed 133 MVA (111% of its current 120 MVA rating). As with Alternative TR1A, the Town Lake Tap-Malta 115 kV transmission line section was not considered a limiting factor.

If the current ratings of the three transmission lines that make up the Black Hills' West Canon to Portland 115 kV transmission path cannot be raised at a relatively low cost, the San Luis Valley generation accommodated on a non-simultaneous basis by this alternative would fall from 575 MW to 525 MW.

3. Results – Calumet Injection Only

Table 17 below summarizes the non-simultaneous contingency analysis results for this alternative for generation injections only at Calumet.

TABLE 17

Alternative TR2A (TR2 with Poncha 230/115 Transformer)
Generation at Calumet 345 kV Only

			Incremental Injection at Calumet 345 kV Bus		
Loaded Element / Contingency	Rating (MVA)	Owner	975	1000	1025
Burnt Mill – West Station 115 Reader – Pueblo Plant 115	100	BH	139.9%	140.7%	141.6%
Hyde Park – Pueblo Plant 115 Burnt Mill – West Station 115	105	BH	149.4%	150.3%	151.2%
Midway BR 230/115 Midway BR – RD Nixon 230	100	PS/WA	104.0%	104.3%	104.7%
Walsenburg 230/115 #1 Walsenburg 230/115 #2	100	TS	114.4%	115.2%	116.0%
Walsenburg 230/115 #2 Walsenburg 230/115 #1	100	TS	114.6%	115.4%	116.2%

The results above show that the addition of the Poncha 230/115 kV transformer project does not impact the non-simultaneous generation addition limit for Alternative TR2 at Calumet, which remains at 1,000 MW.

4. Results – San Luis Valley and Calumet Simultaneous Injection

The results of simultaneous contingency analysis for this alternative are summarized in Table 18.

TABLE 18

Alternative TR2A (TR2 with Poncha 230/115 Transformer) Simultaneous Limit

San Luis Valley	Calumet	Total	Limiting Element
575	300	875	Curecanti-So Canal 115
550	500	1,050	Curecanti-So Canal 115 and Midway BR 230/115 Transformer
325	1,000	1,325	Midway BR 230/115 Transformer

The results above show that the addition of the Poncha 230/115 kV transformer project would change the simultaneous limit for San Luis Valley and Calumet for Alternative TR2 from a range of 800 MW to 1,300 MW to a range of 875 MW to 1,325 MW. They also show that the limit at San Luis Valley is 550 MW when a limit of 500 MW is enforced at Calumet.

5. Conclusion

The addition of the Poncha 230/115 kV transformer project to Alternative TR2 would:

- Have no significant impact on the non-simultaneous generation limit at San Luis Valley for Alternative TR2 with the Black Hills' West Canon to Canon City 115 kV line remaining the limiting factor.
- Have no impact on the non-simultaneous generation limit at Calumet for Alternative TR2, which remains approximately 1,000 MW with the Walsenburg 230/115 kV transformers as a limit.
- Raise the simultaneous generation limit for Alternative TR2 from a range of 800 MW to 1,300 MW to a range of 875 MW to 1,325 MW.

C. Alternative TR3A: San Luis Valley-West Canon Transmission, Poncha 230/115 Transformer and Calumet-Comanche Transmission

1. Description

This alternative is Alternative TR3 with the $8.4 million Poncha 230/115 kV transformer project added. More detailed results for the contingency analysis presented below for this alternative can be found in **Appendix H**.

2. Results – San Luis Valley Only

Table 19 below summarizes the non-simultaneous contingency analysis results for this alternative for generation injections only at San Luis Valley.

TABLE 19

Alternative TR3A (TR3 with Poncha 230/115 Transformer)
Generation at San Luis Valley 230 kV Only

			Incremental Injection at San Luis Valley 230 kV Bus				
Loaded Element / Contingency	Rating (MVA)	Owner	475	500	550	600	625
West Canon – Canon City 115 Midway BR – West Canon 230	120	BH		100.8%	111.4%	122.1%	127.6%
West Canon 230/115 Midway BR – West Canon 230	100	BH	117.3%	122.7%	133.4%	143.9%	149.1%
Skala – Portland 115 Midway BR – West Canon 230	105	BH			107.1%	119.8%	126.3%
Canon City – Skala 115 Midway BR – West Canon 230	105	BH		102.1%	114.6%	127.3%	133.7%
Town Lake Tap – Malta 115 Poncha BR – West Canon 230	80	PS				100.3%	108.2%
San Luis Valley 230/115 #1 San Luis Valley 230/115 #2	150	PS/TS			101.4%	104.5%	106.0%
San Luis Valley 230/115 #2 San Luis Valley 230/115 #1	150	PS/TS			101.5%	104.5%	106.0%
Midway BR 230/115 Midway BR – RD Nixon 230	100	PS/WA	107.8%	108.7%	110.3%	111.9%	112.7%

The results show that the addition of the Poncha 230/115 kV transformer project would raise the Alternative TR3 non-simultaneous limit for San Luis Valley generation additions from 525 MW to 550 MW with post-contingency loading of the Black Hills' West Canon to Canon City 115 kV transmission line section exceeding 133 MVA (approximately 111% of its current 120 MVA rating) remaining the limiting factor. If the current ratings of the three transmission lines that make up the Black Hills' West Canon to Portland 115 kV transmission path cannot be raised at a relatively low cost, the San Luis Valley generation accommodated by this alternative on a non-simultaneous basis would fall from 550 MW to 475 MW.

3. Results – Calumet Injection Only

Table 20 below summarizes the non-simultaneous contingency analysis results for this alternative for generation injections only at Calumet.

TABLE 20

Alternative TR3A (TR3 with Poncha 230/115 Transformer)
Generation at Calumet 345 kV Only

			Incremental Injection at Calumet 345 kV Bus		
Loaded Element / Contingency	Rating (MVA)	Owner	975	1000	1025
Burnt Mill – West Station 115 Reader – Pueblo Plant 115	100	BH	140.1%	140.9%	141.8%
Hyde Park – Pueblo Plant 115 Burnt Mill – West Station 115	105	BH	149.6%	150.5%	151.4%
Midway BR 230/115 Midway BR – RD Nixon 230	100	PS/WA	103.3%	103.6%	104.0%
Walsenburg 230/115 #1 Walsenburg 230/115 #2	100	TS	114.6%	115.4%	116.2%
Walsenburg 230/115 #2 Walsenburg 230/115 #1	100	TS	114.8%	115.6%	116.4%

The results above show that the addition of the Poncha 230/115 kV transformer project does not impact the non-simultaneous generation addition limit for Alternative TR3 at Calumet, which remains at 1,000 MW.

4. Results – San Luis Valley and Calumet Simultaneous Injection

The results of simultaneous contingency analysis for this alternative are summarized in Table 22.

TABLE 22

Alternative TR3A (TR3 with Poncha 230/115 Transformer) Simultaneous Limit

San Luis Valley	Calumet	Total	Limiting Element
550	350	900	Midway BR 230/115 Transformer
500	500	1,000	Midway BR 230/115 Transformer
300	1,000	1,300	Midway BR 230/115 Transformer

The results above show that the addition of the Poncha 230/115 kV transformer project would increase the simultaneous limit for San Luis Valley and Calumet for Alternative TR3 from

a range of 900 MW to 1,275 MW to a range of 900 MW to 1,300 MW. They also show the limit at San Luis Valley is 500 MW when a limit of 500 MW is enforced at Calumet.

5. Conclusion

The addition of the Poncha 230/115 kV transformer project to Alternative TR3 would:

- Raise the non-simultaneous generation limit at San Luis Valley for Alternative TR3 from approximately 525 MW to approximately 550 MW with the Black Hills' West Canon to Canon City 115 kV transmission line section as the limit.
- Have no impact on the non-simultaneous generation limit at Calumet for Alternative TR3, which remains approximately 1,000 MW with the Walsenburg 230/115 kV transformers as a limit.
- Raise the simultaneous generation limit for Alternative TR3 from a range of 900 MW to 1,275 MW to a range of 900 MW to 1,300 MW.

VIII. Analysis of the Current San Luis Valley System with the Calumet-Comanche and Calumet-Walsenburg Portions of the Companies' Proposed Project In Service

In the TWG-1 Study, the Companies included a "Benchmark Analysis" that examined the capability of the transmission system to support additional generation in the San Luis Valley and Calumet/Walsenburg areas if Tri-State's originally proposed single-circuit 230 kV San Luis Valley-Walsenburg and single-circuit 230 kV Boone-Stem Beach-Walsenburg transmission line projects were pursued rather than the Companies' Proposed Project. BAI did not review this alternative for two reasons. First, the Companies' "Benchmark" presumes that a west to east 230 kV (or higher voltage) line from San Luis Valley substation to either Calumet or Walsenburg substation must be included in any project in order for the project to adequately address Tri-State's reliability issue in the San Luis Valley area. As was shown in Section V. of this report, this is not the case. Second, BAI was not asked to examine alternatives to the Calumet to Comanche and Calumet to Walsenburg portions of the Companies' Proposed Project. BAI's focus was on how alternatives to the double-circuit 230 kV San Luis Valley to Calumet portion of

the Proposed Project would change the overall transmission capability provided by the Proposed Project. Therefore, in place of the Companies' "Benchmark Analysis," BAI performed an analysis of the performance of the Proposed Project with no transmission line additions in the San Luis Valley area in order to identify (i) the degree to which the San Luis Valley area reliability issue can be adequately addressed without transmission line additions and (ii) the level of new generation additions that can be accommodated in the San Luis Valley area by the transmission system without transmission line additions in the San Luis Valley area.

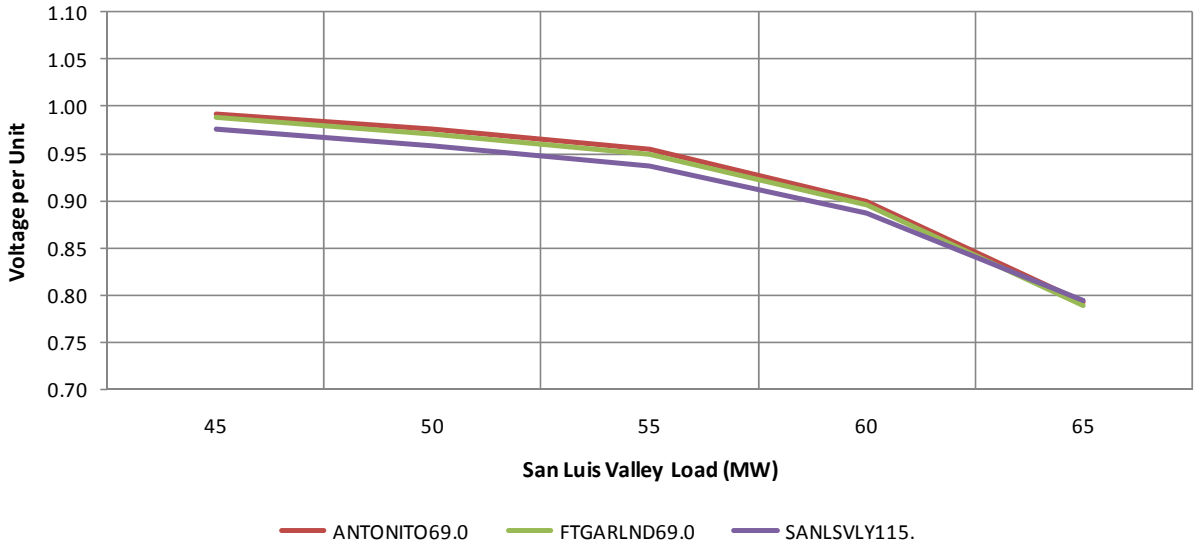
A. San Luis Valley Area Voltage Collapse-Related Reliability Issue

Figure 4 below shows that, with the Proposed Project without the San Luis Valley to Calumet line addition and no generation additions at either San Luis Valley or Calumet, voltage collapse would likely occur just above 65 MW of San Luis Valley area load following the loss of the existing San Luis Valley to Poncha 230 kV transmission line, but for the existing automatic undervoltage load shedding system in the San Luis Valley area.[12]

[12]Note that all of the PV analysis reported in this section of the report was performed with San Luis Valley area loads conservatively forced to a 95% lagging power factor. If the actual power factor in the San Luis Valley area is 98% lagging or higher (as modeled in the CPUC 2-1a model as it was received from Public Service), the voltage stability limits discussed in this section would be higher than the values reported in this section.

Figure 4

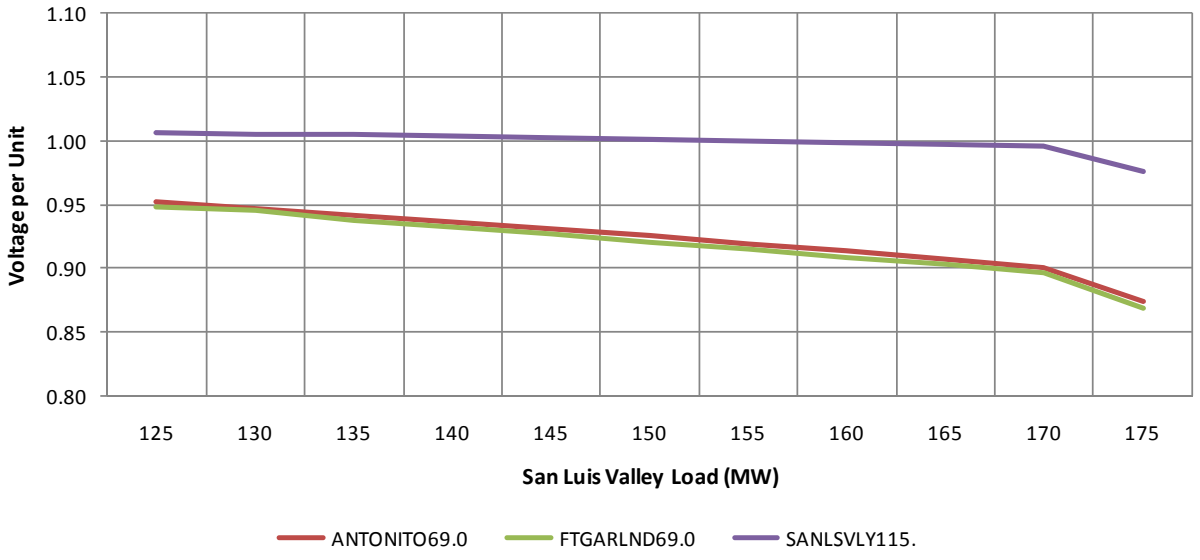
Proposed Project with No San Luis Valley Area Transmission Line Additions
No Additional Generation at San Luis Valley



However, Figure 5 shows that if at least 150 MW of synchronous generation is added at San Luis Valley (with a minimum lagging power factor capability of 95%) and on-line prior to the loss of the existing San Luis Valley to Poncha 230 kV line, voltage collapse can be averted for up to 165 MW of load in the San Luis Valley area (approximately 5% less than the 175 MW estimated collapse point). This is well in excess of the 155 MW peak load that the Companies were formerly forecasting for 2015 and are now not expecting until after the 2015 horizon.

Figure 5

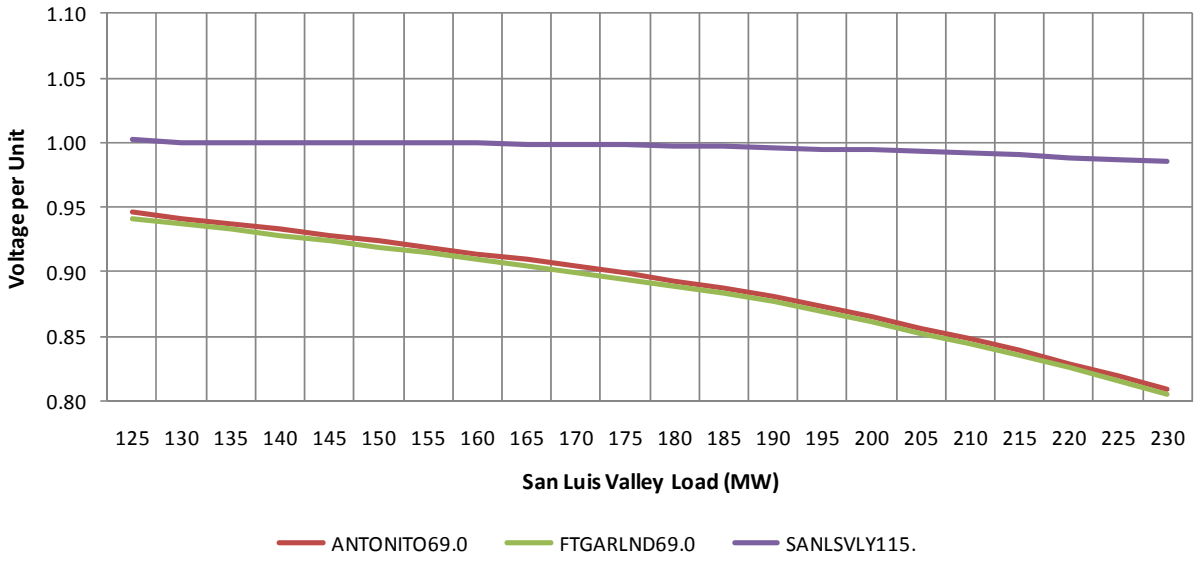
Proposed Project with No San Luis Valley Area Transmission Line Additions
150MW New Generation at San Luis Valley



Finally, Figure 6 shows that if at least 250 MW of synchronous generation is added at San Luis Valley (again, with a minimum lagging power factor capability of 95%) and on-line prior to the loss of the existing San Luis Valley to Poncha 230 kV line, up to 215 MW of load in the San Luis Valley area (5% less than the 230 MW estimated collapse point) can be reliably served without voltage collapse.

Figure 6

Proposed Project with No San Luis Valley Area Transmission Line Additions
250MW New Generation at San Luis Valley



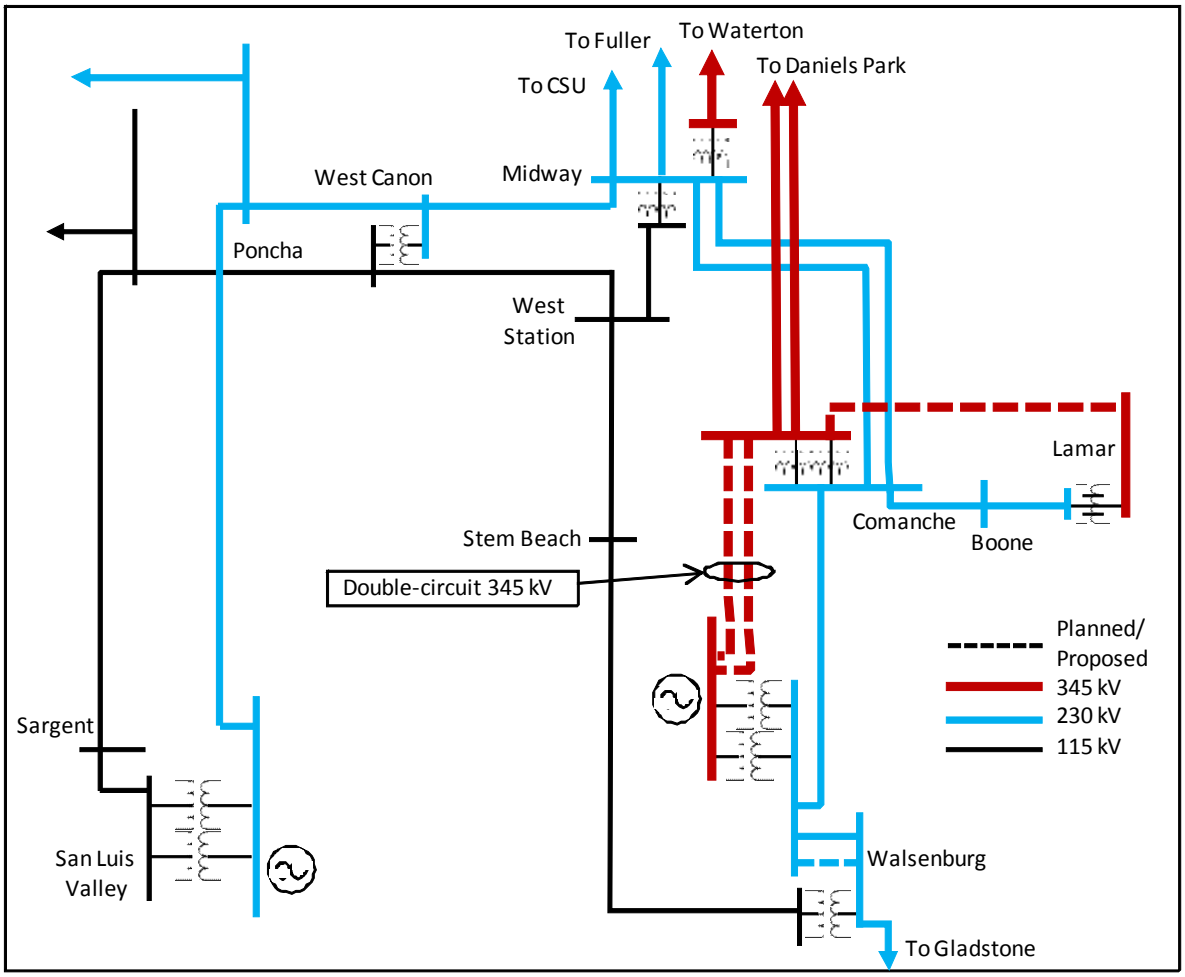
The synchronous generation in question could be provided by the addition of natural gas or steam turbine generation that has a level dispatchability and capacity factor that is high enough to dramatically reduce the number of hours in which the existing automatic undervoltage load shedding system would have to be relied upon to minimize the likelihood of voltage collapse following the loss of the existing San Luis Valley to Poncha 230 kV transmission line. Candidate generation would include, but not be limited to, new coal-fired steam or natural gas-fired combined cycle generation. However, in the case of the San Luis Valley area, the most likely candidate is new thermal solar generation with storage due to the attractiveness of the area for new solar generation and Public Service's intention to pursue a new thermal solar generation with storage facility in its preferred portfolio from its 2009 All-Source Solicitation (Docket No. 07A-447E, Public Service's Public Response to Commission Question 1-10).

B. Contingency Analysis of Alternative TR4: Current San Luis Valley System with Only Minor 115 kV Upgrades and Calumet-Comanche Transmission

1. Description

This alternative, shown in Figure 7 below, eliminates the $90 million, 95-mile double-circuit 230 kV San Luis Valley to Calumet transmission line portion of the Companies' Proposed Project. In the San Luis Valley area, the only upgrades included for this alternative are the minor San Luis Valley-Sargent-Poncha 115 kV transmission line uprates, which are included in the Companies' Alternative 1 and all of the alternatives BAI reviewed in this study. Detailed results for the contingency analysis which is presented below for this alternative can be found in **Appendix I** to this report.

Figure 7: Alternative TR4



2. Results – San Luis Valley Only

Table 23 below summarizes the non-simultaneous results for generation injections only at San Luis Valley.

TABLE 23

Alternative TR4 Generation at San Luis Valley 230 kV Only

			Incremental Injection at San Luis Valley 230 kV Bus		
Loaded Element / Contingency	Rating (MVA)	Owner	225	250	275
Hyde Park – Pueblo Plant 115 Burnt Mill – West Station 115	105	BH	106.7%	105.7%	104.7%
Poncha – Sargent 115 San Luis Valley – Poncha 230	128	PS			113.5%
Midway BR 230/115 Midway BR – RD Nixon 230	100	PS/WA			100.1%

The results show that post-contingency loading on the 115 kV Poncha-Sargent transmission line is the limiting factor and sets a limit of approximately 250 MW for generation only added at San Luis Valley. The Black Hills' 115 kV transmission line overloads in the Pueblo area were not considered limiting.

3. Results – Calumet Injection Only

Table 24 summarizes the non-simultaneous results for this alternative for generation additions only at Calumet.

TABLE 24

Alternative TR4 Generation at Calumet 345 kV Only

			Incremental Injection at Calumet 345 kV Bus		
Loaded Element / Contingency	Rating (MVA)	Owner	975	1000	1025
Burnt Mill – West Station 115 Reader – Pueblo Plant 115	100	BH	140.3%	141.1%	142.0%
Hyde Park – Pueblo Plant 115 Burnt Mill – West Station 115	105	BH	150.0%	150.7%	150.7%
West Canon 230/115 Portland – West Station 115	100	BH	103.2%	103.5%	103.7%
Midway BR 230/115 Midway BR – RD Nixon 230	100	PS	104.1%	104.5%	104.8%
Walsenburg 230/115 #1 Walsenburg 230/115 #2	100	TS	114.5%	115.3%	116.1%
Walsenburg 230/115 #2 Walsenburg 230/115 #1	100	TS	114.7%	115.5%	116.3%

The results show the post-contingency loading on the Walsenburg 230/115 kV transformers is the limiting factor and sets a limit of approximately 1,000 MW for generation only added at Calumet with transformers being allowed to be loaded up to approximately 115% of their respective ratings. As in the TWG-1 Study, overloads of the Black Hills' 115 kV transmission lines in the Pueblo area are not considered a limiting factor.

4. Results – San Luis Valley and Calumet Simultaneous Injection

The results of simultaneous contingency analysis for this alternative are summarized in Table 25.

TABLE 25

Alternative TR4 Simultaneous Limit

San Luis Valley	Calumet	Total	Limiting Element
250	1,000	1,250	None

As can be seen from Table 25, the simultaneous injections at San Luis Valley and Calumet at their respective non-simultaneous limits for this alternative can be accommodated.

5. Cost

There would be no San Luis Valley area costs for this alternative outside of the costs associated with the minor San Luis Valley-Sargent-Poncha 115 kV uprates that are assumed in place for the Companies' Alternative 1 and all of the alternatives analyzed in this study. Thus, the total cost of the Companies' Proposed Project, as modified by this alternative, is estimated to be $90 million--$90 million less than the Companies' Proposed Project with their proposed double-circuit 230 kV San Luis Valley to Calumet transmission line included.

6. Conclusion

- As identified in Section VII.A of this report, this alternative adequately addresses the reliability issue in the San Luis Valley provided at least 150 MW of thermal solar generation with storage, or other synchronous generation with a similar level of dispatchability and capacity factor, is added in the San Luis Valley area.

- This alternative eliminates the Comanche-Walsenburg 230 kV RAS since a parallel path is provided between Comanche and Walsenburg since it includes the Calumet-Comanche and Calumet-Walsenburg portions of the Companies' Proposed Project.

- The non-simultaneous generation limit at San Luis Valley is approximately 250 MW with the Poncha-Sargent 115 kV transmission line as the limit.

- The non-simultaneous generation limit at Calumet is approximately 1,000 MW with the Walsenburg 230/115 kV transformers as a limit.

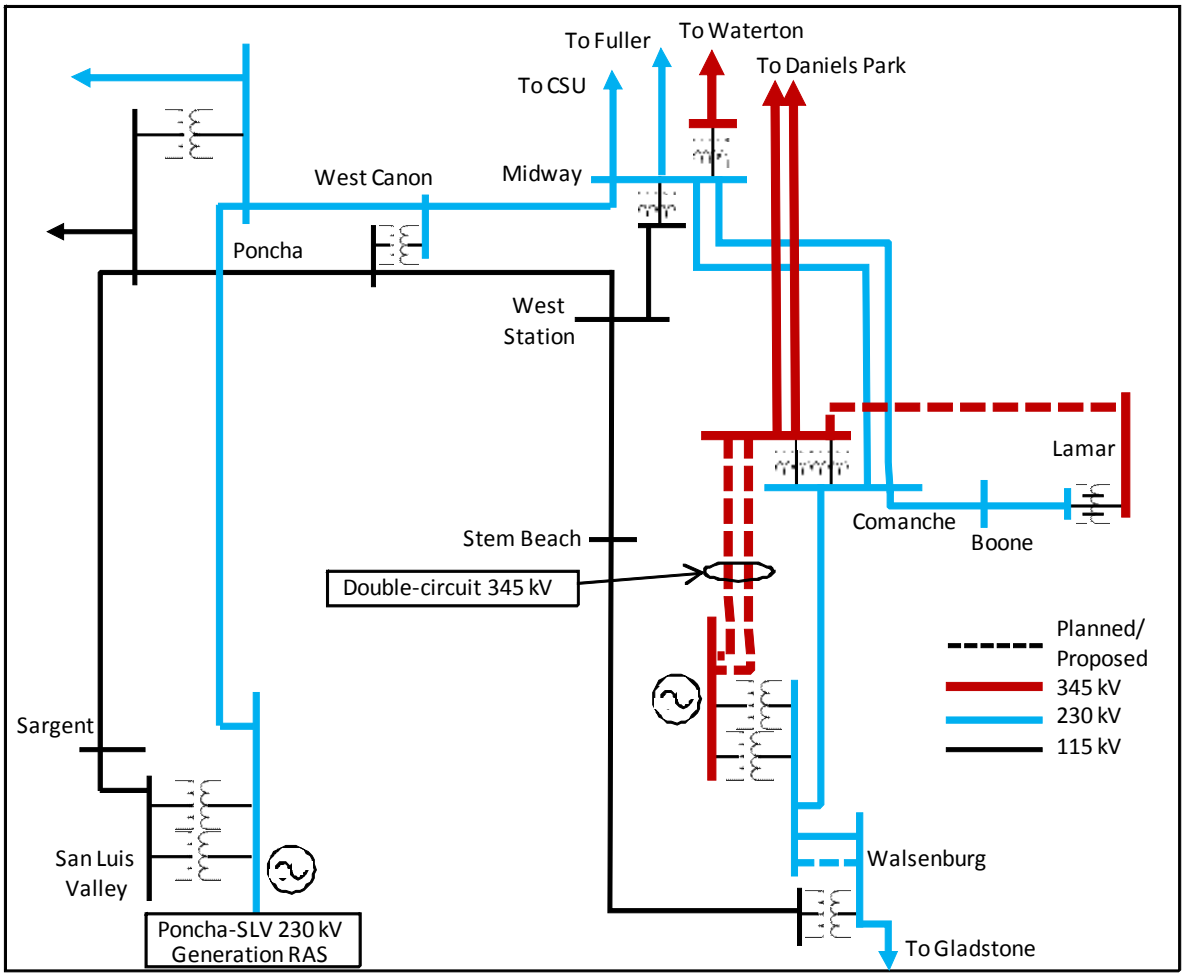
- The simultaneous generation limit for this alternative is the sum of the non-simultaneous limits for this alternative (i.e., 1,250 MW) provided the non-simultaneous limits at San Luis Valley and Calumet are not individually exceeded.

C. Contingency Analysis of Alternative TR4AR: Poncha 230/115 Transformer, San Luis Valley Generation RAS and Calumet-Comanche Transmission

1. Description

This alternative, shown in Figure 8 below, is Alternative TR4 with the $8.4 million Poncha 230/115 kV transformer project and a new generation RAS added. The new generation RAS would automatically trip or runback the added generation in the San Luis Valley area when the existing San Luis Valley-Poncha 230kV transmission line is lost such that the output of the generation does not overload the Sargent-Poncha 115 kV transmission line. As shown by the contingency analysis for Alternative TR4, this output level is approximately 250 MW when the San Luis Valley load is at 125 MW – the load level the San Luis Valley is at in the TWG-1 Study. In practice, the generation RAS would need to be designed to trip or runback the generation to a level that will vary with the level of load in the San Luis Valley area. The cost of such a generation RAS would very likely be less than $5 million. Detailed results for the contingency analysis which is presented below for this alternative can be found in **Appendix J** to this report.

Figure 8: Alternative TR4AR



2. Results – San Luis Valley Only

Table 26 below summarizes the non-simultaneous results for generation injections only at San Luis Valley.

TABLE 26

Alternative TR4AR Generation at San Luis Valley 230 kV Only

			Incremental Injection at San Luis Valley 230 kV Bus		
			500	525	550
West Canon – Canon City 115 Midway BR – West Canon 230	120	BH			103.1%
West Canon 230/115 Midway BR – West Canon 230	100	BH		101.6%	105.3%
Canon City – Skala 115 Midway BR – West Canon 230	105	BH			104.7%
Alamosa TM 115/69 San Luis Valley – Sargent 115	25	PS		100.2%	101.7%
Town Lake Tap – Malta 115 Poncha BR – West Canon 230	80	PS			102.9%
San Luis Valley 230/115 #1 San Luis Valley 230/115 #2	150	PS/TS	112.4%	114.9%	117.4%
San Luis Valley 230/115 #2 San Luis Valley 230/115 #1	150	PS/TS	112.4%	114.9%	117.4%
Midway BR 230/115 Midway BR – RD Nixon 230	100	PS/WA	105.8%	106.4%	107.1%

The results show that the addition of the Poncha 230/115 kV transformer project and a new generation RAS post-contingency raises the non-simultaneous limit at San Luis Valley from 250 MW to 525 MW with the limiting post-contingency loading moving from the Poncha-Sargent 115 kV transmission line to the San Luis Valley 230/115 kV transformers. The three transmission lines of the Black Hills' West Canon to Portland 115 kV path were allowed to be loaded up to 133 MVA on a post-contingency basis. If the current ratings of these three lines cannot be raised at a relatively low cost, the San Luis Valley generation accommodated by this alternative on a non-simultaneous basis would fall from 525 MW to 500 MW.

3. Results – Calumet Injection Only

Table 27 summarizes the non-simultaneous results for this alternative for generation additions only at Calumet.

TABLE 27

Alternative TR4AR Generation at Calumet 345 kV Only

			Incremental Injection at Calumet 345 kV Bus		
Loaded Element / Contingency	Rating (MVA)	Owner	975	1000	1025
Burnt Mill – West Station 115 Reader – Pueblo Plant 115	100	BH	140.2%	141.0%	141.9%
Hyde Park – Pueblo Plant 115 Burnt Mill – West Station 115	105	BH	149.7%	150.6%	151.5%
West Canon 230/115 Portland – West Station 115	100	BH		100.0%	100.2%
Walsenburg 230/115 #1 Walsenburg 230/115 #2	100	TS	114.4%	115.3%	116.1%
Walsenburg 230/115 #2 Walsenburg 230/115 #1	100	TS	114.7%	115.5%	116.3%

The results show the post-contingency loading on the Walsenburg 230/115 kV transformers is the limiting factor and sets a limit of approximately 1,000 MW for generation only added at Calumet with transformers being allowed to be loaded up to approximately 115% of their respective ratings. As in the TWG-1 Study, overloads of the Black Hills' transmission lines in the Pueblo area are not considered a limiting factor.

4. Results – San Luis Valley and Calumet Simultaneous Injection

The results of simultaneous contingency analysis for this alternative are summarized in Table 28.

TABLE 28

Alternative TR4AR Simultaneous Limit

San Luis Valley	Calumet	Total	Limiting Element
525	0	525	San Luis Valley 230/115 Transformers
500	700	1,200	Midway BR 230/115 Transformer
325	1,000	1,325	Midway BR 230/115 Transformer

As can be seen from Table 28, the simultaneous limit changes from a flat 1,250 MW to a range of 525 MW to 1,325 MW depending on how generation is distributed between San Luis Valley and Calumet. In addition, it can be seen the limit at San Luis Valley is 500 MW when a limit of 675 MW is enforced upon Calumet.

5. Cost

The total cost for the Proposed Project, as modified by this alternative, is estimated to be no more than $105 million--$75 million less than the Companies' Proposed Project with their proposed double-circuit 230 kV San Luis Valley to Calumet transmission line included.

6. Conclusion

- As identified in Section VII.A of this report, this alternative adequately addresses the reliability issue in the San Luis Valley provided at least 150 MW of thermal solar generation with storage, or other synchronous generation with a similar level of dispatchability and capacity factor, is added in the San Luis Valley area.

- This alternative eliminates the Comanche-Walsenburg 230 kV RAS since a parallel path is provided between Comanche and Walsenburg since it includes the Calumet-Comanche and Calumet-Walsenburg portions of the Companies' Proposed Project.

- The non-simultaneous generation limit at San Luis Valley is approximately 525 MW with the Town Lake Tap-Malta 115 kV transmission line section as the limit.

- The non-simultaneous generation limit at Calumet is approximately 1,000 MW with the Walsenburg 230/115 kV transformers as a limit.

- The simultaneous generation limit for this alternative ranges from 525 MW and 1,325 MW and depends on the distribution of generation injections between San Luis Valley and Calumet.

D. Reconciliation of BAI's Analysis of Public Service's Analysis of the Existing San Luis Valley System

As outlined above, BAI found that the likelihood of the existing automatic undervoltage load shedding system actually tripping load to prevent voltage collapse in the San Luis Valley area can be dramatically reduced through the addition of at least 150 MW of new solar thermal generation with storage, or other synchronous generation, to the San Luis Valley area that can reliably and economically operate when San Luis Valley area loads are in excess of 65 MW. In addition, BAI's analysis showed that 250 MW of new generation in the San Luis Valley area can be accommodated by the Proposed Project without the Companies' proposed San Luis Valley to Calumet line, or any other major transmission line addition. Finally, BAI's analysis showed this generation level could be raised to 525 MW through the addition of (i) a new 230/115 kV transformer at Poncha and (ii) a new generation RAS that automatically reduces the new San Luis Valley area generation down to a level that does not overload the Sargent to Poncha 115 kV transmission line following the loss of the existing San Luis Valley to Poncha 230 kV line.

However, as discussed in Section IV.A. of this report, Public Service has stated that the existing system can only support 130 MW of additional generation in the San Luis Valley area. Public Service's conclusion is based on an informal analysis that was provided in response to Data Request TR 2-5. This informal analysis by Public Service concluded voltage collapse would occur above 145 MW of added generation based on the inability to obtain a power flow solution at the 150 MW level with the loss of the existing San Luis Valley to Poncha 230 kV transmission line. A copy of Public Service correspondence related to this analysis is provided in **Appendix K** to this report. To resolve the conflict between the BAI analysis and Public

Service's informal analysis, BAI reviewed Public Service's informal analysis and the power flow model used by Public Service to conduct that analysis (the TR 7-4 model).

BAI concurs that Public Service's model for the existing system does not solve with the San Luis Valley to Poncha 230 kV line out when (i) 150 MW is added to the San Luis Valley area in the manner that Public Service added it to the TR 7-4 model and (ii) San Luis Valley area load is at approximately 55% of the level it was at in the CPUC 2-1a model. However, the lack of solution at this level of generation is not due to voltage collapse, but rather due to the way Public Service modeled the generation additions, which was unreasonable and inconsistent with the way such additions were modeled in the TWG-1 Study. Specifically, Public Service in its informal analysis unreasonably modeled the generation additions as having no reactive power capability. By doing so, Public Service made it difficult for the Newton-Raphson solution method of the power flow program to converge on a power flow solution.

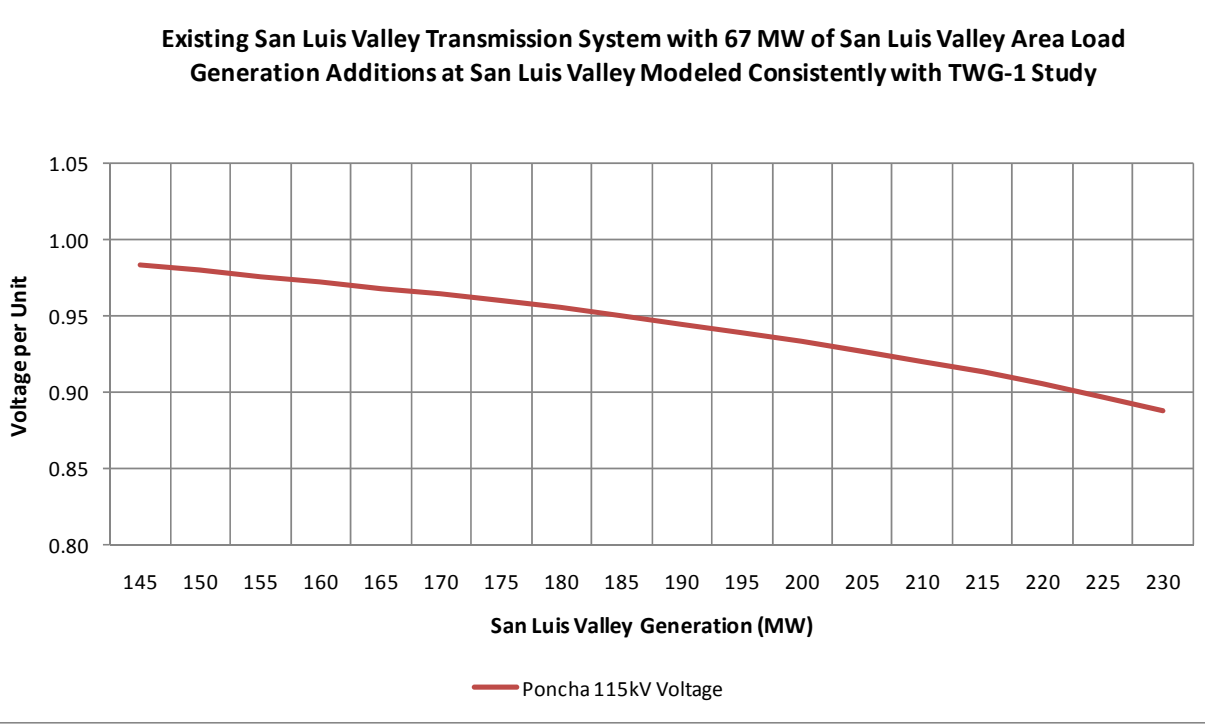
If the San Luis Valley generation additions in the TR 7-4 model are modified such that they are reasonably allowed to have a very modest total amount of reactive power capability (up to 95% lagging power factor) and are allowed to regulate their terminal voltage,[13] the TR 7-4 model power flow case readily solves with the existing San Luis Valley to Poncha 230 kV transmission line out-of-service and 150 MW of generation additions at San Luis Valley. Furthermore, this case did not exhibit depressed voltages either in the San Luis Valley area or at the Poncha 115 kV bus. Finally, Public Service in a response to a data request in the CPCN Dockets has indicated that it did not perform a PV analysis to confirm its conclusion that voltage collapse was the cause of its failure to obtain a power flow solution with 150 MW of additional

[13]"Parabolic Trough" and "Power Tower" thermal solar generation technologies generally involve producing steam to drive a steam turbine that in turn drives a synchronous generator. Thus, such solar thermal generation would provide the same type of reactive power support and voltage control that is provided by conventional fossil fuel-fired turbine-driven generation. In addition, photovoltaic solar generation can provide reactive power support and voltage control by oversizing the inverter used to convert the direct current output of the photovoltaic units to alternating current.

generation added at San Luis Valley (CPCN Dockets, Public Service response to Data Request TR 6-8).

Exploring this issue further, BAI found when it pushed the generation additions in the TR 7-4 model above 150 MW with the aforementioned changes to generation modeling, the voltage at the Poncha 115 kV bus did begin to fall and ultimately collapsed when a total of 235 MW of generation was added at San Luis Valley substation with 67 MW of load in the San Luis Valley area.

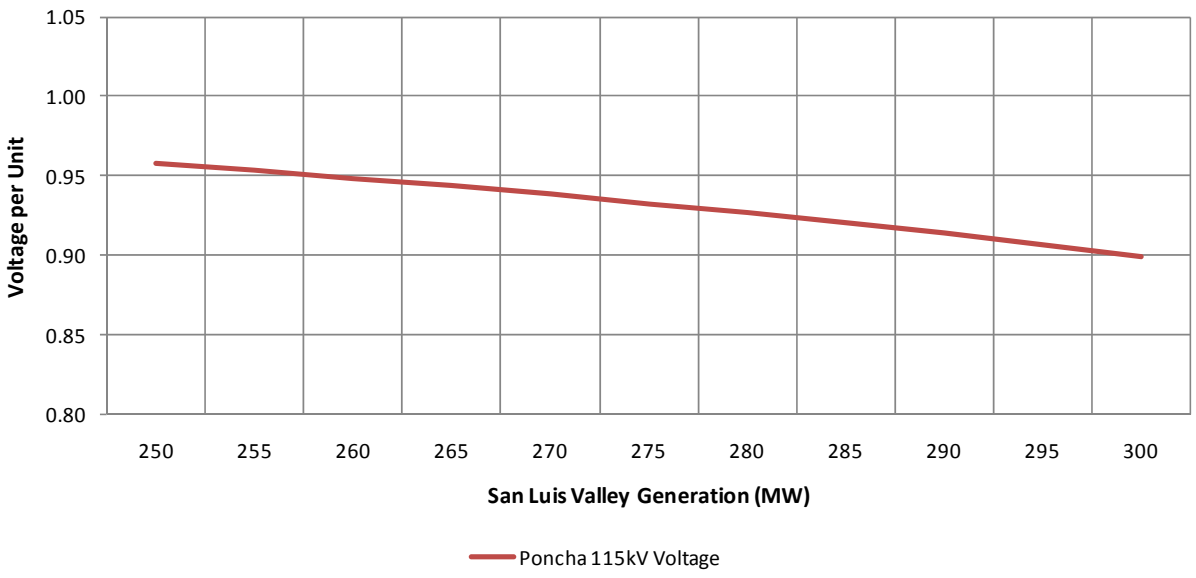
Figure 9



However, BAI also found that the Sargent-Poncha 115 kV transmission line (with a 128 MVA rating in place) overloaded well before then at 185 MW of added generation with the existing San Luis Valley to Poncha 230 kV transmission line out-of-service and 67 MW of load in the San Luis Valley area. Thus, voltage collapse at the Poncha 115 kV substation is not the limiting factor for generation additions at San Luis Valley.

BAI also performed a PV curve analysis of the Poncha 115 kV substation voltage for its Alternative TR4 case with the existing San Luis Valley-Poncha 230 kV transmission line out-of-service. The result through 300 MW of generation additions at San Luis Valley is shown in Figure 10 below. While the Poncha 115 kV voltage is depressed, it does not collapse with up to 300 MW of generation additions at San Luis Valley, which is well above the 250 MW point where generation additions at San Luis Valley begin to overload the San Luis-Poncha 115 kV transmission line in the case. This further confirms voltage collapse at the Poncha 115 kV substation is not the limiting factor for generation additions at San Luis Valley.

Figure 10



To conclude, Public Service's conclusion that voltage collapse would likely occur above 145 MW of generation additions in the San Luis Valley area is in error. BAI found that with 67 MW of load in the San Luis Valley, voltage collapse would not occur at Poncha 115 kV until 235 MW of generation is added at San Luis Valley. BAI also found that with 125 MW of load in San

Luis Valley, voltage collapse would not occur until somewhere above 300 MW of generation additions at San Luis Valley. Public Service's error is a result of Public Service modeling the generation additions in an unreasonable manner inconsistent with the way they were modeled in the TWG-1 Study. Provided the new generation is synchronous generation (or possibly non-synchronous generation interconnected to the transmission system via a sufficiently oversized inverter), voltage regulation will be available in the San Luis Valley area such that voltage collapse would not occur at Poncha 115 kV substation if generation additions at San Luis Valley are limited below the level that would overload of the Sargent-Poncha 115 kV transmission line following the loss of the San Luis Valley-Poncha 230 kV transmission line.

E. Current San Luis Valley Analysis Conclusions

The San Luis Valley reliability issue can be resolved with the addition of at least 150 MW of new thermal solar generation with storage (or other synchronous generation of comparable dispatchability and capacity factor) in the San Luis Valley area. Also, if the Proposed Project is implemented without the addition of the double-circuit 230 kV San Luis Valley to Calumet transmission line, or any other transmission line additions in the San Luis Valley area, up to 250 MW of San Luis Valley area can be accommodated by the transmission system. If a new 230/115 kV transformer is added at Poncha, along with a new generation RAS that automatically trips, or runs back, the output of the new generation down to a level that does not overload the Sargent to Poncha 115 kV transmission line following the loss of the existing San Luis Valley to Poncha 230 kV line, the total amount of new generation that can be accommodated in the San Luis Valley area can be expanded to 525 MW. This is significantly above Public Service's publicly indicated proposed commitment to new generation in the San Luis Valley area, which is between 280 to 310 MW. In addition, this alternative can be accomplished at an estimated cost less than one-sixth of the projected $90 million cost of the Companies' proposed double-circuit 230 kV San Luis Valley to Calumet transmission line.

IX. Final Conclusions

As summarized in detail in Table 1 on page 6 of this report, the existing transmission system in the San Luis Valley can support up to 250 MW of generation additions with only minor 115 kV transmission upgrades, and, if that generation includes at least 150 MW of synchronous generation, such as thermal solar generation with storage, no other additions will be needed to address the voltage stability-related reliability issue in the San Luis Valley area. In addition, the existing system can potentially be stretched to support up to 525 MW of new generation in the San Luis Valley area by adding a Poncha 230/115 kV transformer and a generation RAS that would automatically trip or runback the additional San Luis Valley generation down to a level that does not overload the Sargent to Poncha 115 kV transmission line following the loss of the existing San Luis Valley to Poncha 230 kV transmission line. This can be done at an estimated cost less than one-sixth the estimated cost of the Companies' proposed double-circuit 230 kV San Luis Valley to Calumet transmission line.

The study presented herein also showed that between 525 and 575 MW of additional generation at San Luis Valley, 1,000 MW of additional generation at Calumet or between 525 MW and 1,325 MW of generation combined from the two locations can be provided by a number of new transmission line alternatives to the San Luis-Calumet portion of the Companies' Proposed Project.

Each of these alternatives (i) is significantly lower in estimated cost than the Companies' proposed double-circuit 230 kV San Luis Valley to Calumet transmission line and (ii) adequately addresses the voltage stability-related reliability issue in the San Luis Valley area. In addition, when coupled with the Calumet-Comanche and Calumet-Walsenburg portions of the Companies' Proposed Project, the alternatives allow the removal of the existing Comanche-Walsenburg 230 kV RAS reducing the likelihood of automatic load shedding of Tri-State load in northern New Mexico. Finally, the transmission capability provided by these

alternatives is well in excess of Public Service's publicly indicated preferred portfolio ranges for its All-Source Solicitation for the San Luis Valley and Calumet/Walsenburg areas.

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