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Bluestone Valley Substation
System Impact Study
Last Revised: November 17, 2010

A. Executive Summary

The purpose of the study is to determine the reliability of the bulk transmission system to serve a proposed 120 MW load at a Customer substation called “Clear Creek”. The proposed in-service date for the Clear Creek Substation is 2014. The study assumed that the load would have an initial demand of 64 MW in 2014 ramping up to 120 MW in 2018. The Clear Creek Substation would be located in the Piceance Basin approximately fourteen miles NNW of the town of Debeque in western Colorado.

The study considered various alternatives to interconnect the Clear Creek load to points on the bulk transmission system in the study area. The 69kV system in the study area does not have sufficient capacity to serve this load; therefore, no 69kV alternatives were considered. Points on the 138kV, the 230kV, and the 345kV transmission system were considered for interconnection and the study examined nine alternatives that involve the 138kV, 230kV or 345kV systems.

The preferred alternative is to tap PSCo’s Parachute-Cameo 230kV line at a new 230kV tap substation called “Bluestone Valley” that would be located near the Debeque 69kV Substation. The Customer would construct an eighteen mile double circuit 230kV line from Bluestone Valley Substation to the Clear Creek Substation.

Serving the Clear Creek load at 64 MW will require the following:

- Increase the RiflePS-Parachute 230kV line rating to approximately 452 MVA.
- Replace the 50 MVA Grand Junction 138-115kV transformer with a 75 MVA transformer
- Add a second 280 MVA Grand Junction 345-230kV transformer
- Replace the 42 MVA Grand Junction 115-69kV transformer with a 65 MVA transformer
- Add 45 MVAR capacitor banks at Cameo, Bluestone Valley, and/or Parachute

Serving the Clear Creek load at 120 MW will require the following (in addition to facility additions to serve a 64 MW load at Clear Creek):

- Add a RiflePS-Parachute 230kV #2 line

B. Background

A Customer has requested electric service from PSCo to serve a new load in the Piceance Basin approximately fourteen miles NNW of the town of Debeque in western Colorado. The Piceance Basin is a dynamically developing load area in western Colorado. It is located north of Interstate-70 and south of Highway 64, the south end of the area enclosing the 69kV and 230kV transmission systems.

The proposed new 120 MW load would be located at a Customer station called “Clear Creek”. The proposed in-service date for the Clear Creek Substation is 2014. The load is expected to have an initial demand of 64 MW in 2014 ramping up to 120 MW in 2018.

.A diagram that displays the study area is provided in Figure 1 below.

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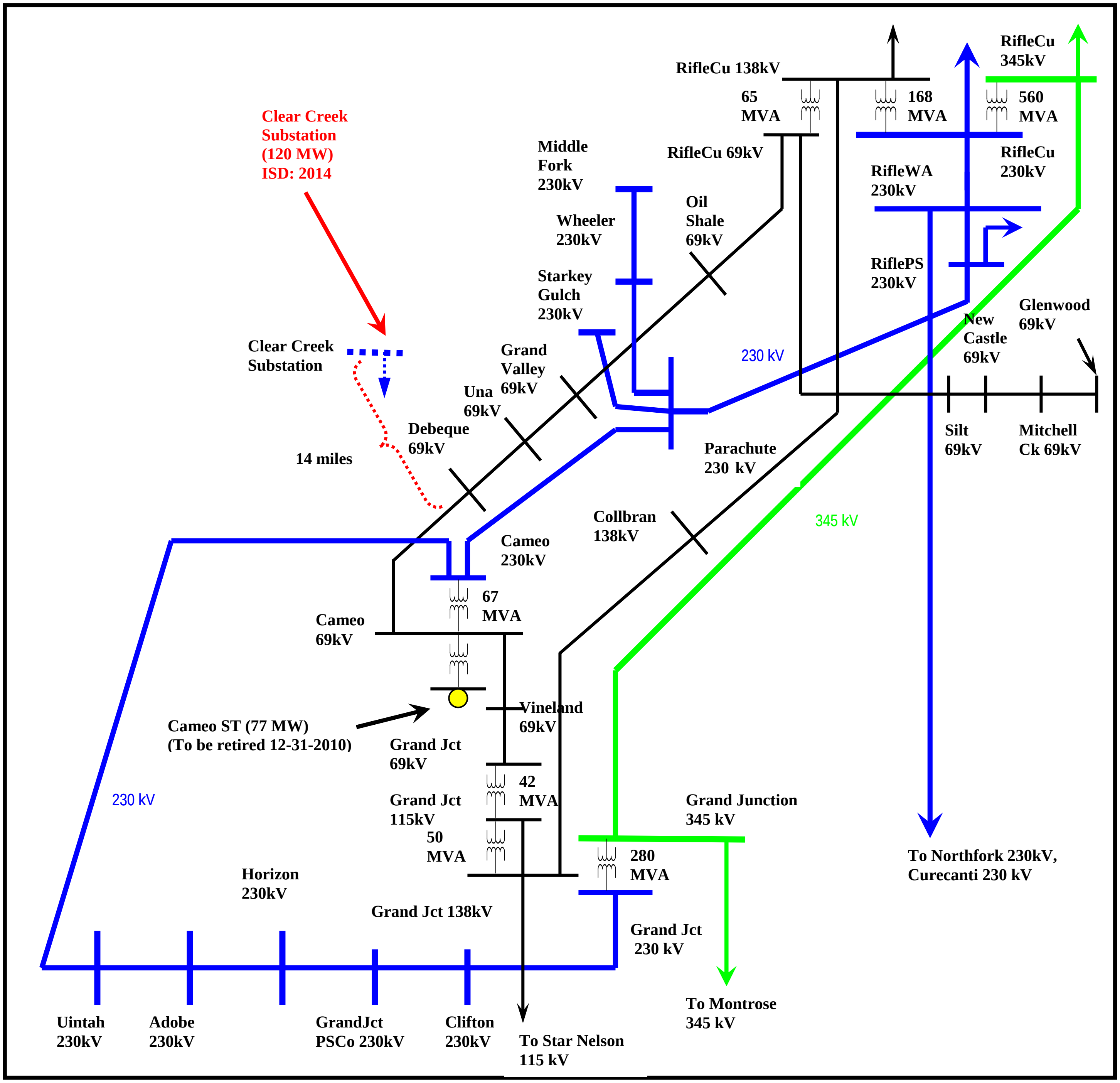
Figure 1. Conceptual One-Line of the Study Area (not geographical)



C. Study Criteria

The following criteria were used to evaluate system reliability:

Category A – System Normal
"N-0" System Performance Under Normal (No Contingency) Conditions (Category A)
NERC Standard TPL-001-0

Voltage:	0.95 to 1.05 per unit
Line Loading:	100 percent of continuous rating
Transformer Loading:	100% of highest 65 °C rating

Category B – Loss of generator, line, or transformer (Forced Outage)
"N-1" System Performance Following Loss of a Single Element (Category B)
NERC Standard TPL-002-0

Voltage:	0.90 to 1.10 per unit
Line Loading:	100 percent of continuous rating
Transformer Loading:	115% of highest 65 °C rating for load-serving transformers

Category C – Loss of Bus or a Breaker Failure (Forced Outage)
"N-2 or More" System Performance Following Loss of Two or More Elements (Category C)
NERC Standard TPL-003-0

Voltage and Thermal:	Allowable emergency limits will be considered as determined by the affected parties and the available emergency mitigation plan. Curtailment of firm transfers, generation redispatch, and load shedding will be considered if necessary.

D. Study Case Development

The Western Electricity Coordinating Council (WECC) 2014 Heavy Summer (on-peak) base case was selected for this study. The 2014 heavy summer base case reflects system conditions projected for the summer of 2014. The case includes the retirement of the Cameo generating station that is scheduled for the end of 2010.

The study area is greatly impacted by demand levels and dispatch scenarios; therefore, in addition to selecting a high load scenario, a high transfer dispatch scenario was developed. Three WECC power transfer paths are located in western Colorado. These include TOT1A (a power transfer path between northwest Colorado into northeast Utah), TOT5 (a power transfer between western Colorado and eastern Colorado), and TOT2A (a power transfer path between southwest Colorado and northwest New Mexico). Of these three paths, the TOT2A path flow is most critical. The study considered a very high TOT2A north-to-south flow of 500 MW.

Loads in the base case were modified to reflect projected demands for the summer of 2014. A table that lists the loads in the study area is included below.

Table 1. Loads in the Study Area

Bus No.	Bus Name	ID	IS	MW	MVAR	Bus No.	Bus Name	ID	IS	MW	MVAR
70268	ADOBE 230.00	GV	1	10.2	-1.9	70233	HORIZON 230.00	P2	1	26.0	12.9
70268	ADOBE 230.00	WA	1	0.3	0.0	70309	PARACHUT 230.00	P1	1	11.2	4.4
70357	BENCH 230.00	IN	1	60.0	19.7	70309	PARACHUT 230.00	HC	1	4.1	0.5
70076	CAMEO 69.000	P4	1	0.9	0.3	70309	PARACHUT 230.00	WA	1	0.3	0.0
70080	**CLEARCRK 230.0**	GV	1	**120.0**	21.1	79056	RIFLE_CU 138.00	P1	1	7.2	1.7
70113	CLIFTON 230.00	P1	1	16.5	-1.0	79056	RIFLE_CU 138.00	P5	1	0.0	0.0
70113	CLIFTON 230.00	P2	1	10.6	-1.0	79056	RIFLE_CU 138.00	HC	1	3.5	0.3
79047	COLBRAN 138.00	GV	1	5.2	1.5	79056	RIFLE_CU 138.00	WA	1	0.2	0.0
79047	COLBRAN 138.00	WA	1	0.1	0.0	79056	RIFLE_CU 138.00	TS	1	0.0	0.0
70140	DEBEQUE 69.000	P1	1	1.5	0.6	70299	STKGULCH 230.00	IN	1	18.0	5.4
70140	DEBEQUE 69.000	GV	1	0.9	0.3	70437	UINTAH 13.800	GV	1	0.7	0.1
70140	DEBEQUE 69.000	WA	1	0.0	0.0	70437	UINTAH 13.800	WA	1	0.0	0.0
70183	FRUITA 69.000	P1	1	10.0	4.3	70438	UINTAH 230.00	P1	1	24.3	10.8
70183	FRUITA 69.000	GV	1	1.3	0.4	70438	UINTAH 230.00	P3	1	9.5	3.9
70183	FRUITA 69.000	WA	1	0.0	0.0	70436	UINTAH 69.000	GV	1	20.9	4.0
70214	GRANDJCT 69.000	GV	1	16.8	3.2	70436	UINTAH 69.000	WA	1	0.5	0.1
70214	GRANDJCT 69.000	WA	1	0.4	0.1	70109	UNA_ORCH 69.00	IN	1	22.5	7.4
70206	GRANDJPS 230.00	P1	1	38.6	-2.6	70454	VINELAND 69.000	P1	1	5.1	2.1
70206	GRANDJPS 230.00	P2	1	42.2	-3.6	70454	VINELAND 69.000	NT	1	-0.7	-0.3
70233	HORIZON 230.00	P1	1	18.2	6.0	70356	WEELERPS 230.0	IN	1	2.9	0.2

The Clear Creek Substation demand is shown as 120 MW in the table. That value was varied from 0 MW, to 64 MW, to 120 MW to determine the transmission enhancements needed to serve the Clear Creek load in stages. In addition, the study notes that the Tri-State demand projected for the Piceance 345kV bus (Bus #79267) is 29.6 MW and 9.7 MVAR. This is considerably lower than Tri-State's earlier load projection. The study case includes the proposed Orchard 7.5 MW load addition at Una, a 7.5 MVAR capacitor bank at Una Substation, and the new 65 MVA RifleCu 138-69kV transformer. The Cameo generating station is not represented. The Starkey Gulch load is represented at 18 MW (at a 0.95 lagging power factor) while the Middle Fork (Bench) 230kV demand is 60 MW (at a 0.95 lagging power factor) in the case.

Generation in the study area was dispatched to reflect near maximum generation for those units that are scheduled to be in-service. Table 2 reflects the generation levels in the study area. In addition, to create a high north-south flow on TOT2A, schedules between the Western-RMR and New Mexico control areas were increased with the San Juan (Waterflow) and Shiprock phase-shifting transformers minimizing inadvertent to hold schedule until a TOT2A north-to-south flow level of 500 MW was obtained.

Table 2. Generation in the Study Area

Bus No.	Bus Name	ID	ST	Pgen	Pmax	Bus No.	Bus Name	ID	ST	Pgen	Pmax
70180	FRUITA 13.800	G1	1	5.0	20.0	79157	BMESA1-2 12.500	2	1	43.0	43.2
70385	SHOSHA&B 4.000	H1	0	7.0	7.0	79158	NUCLA 1 13.800	1	1	14.0	14.0
70385	SHOSHA&B 4.000	H2	0	8.0	8.0	79159	NUCLA 2 13.800	1	1	14.0	14.0
79015	CRAIG 1 22.000	1	1	451.0	458.0	79160	NUCLA 3 13.800	1	1	14.0	14.0
79016	CRAIG 2 22.000	1	1	453.0	458.0	79161	NUCLA 4 13.800	1	1	68.0	68.0
79017	CRAIG 3 22.000	1	1	465.0	470.0	79162	CRYSTAL 12.500	1	1	27.0	27.5
79019	MORRO1-2 12.50	1	1	80.0	80.0	79164	TOWAOC 6.9000	1	1	12.0	12.0
79019	MORRO1-2 12.50	2	1	80.0	80.0	79166	MOLINA-L 4.2000	1	1	4.0	4.9
79040	HAYDEN1 18.00	1	1	210.0	212.0	79172	MOLINA-U 4.2000	1	1	8.0	8.6
79041	HAYDEN2 22.000	1	1	280.0	286.0	79176	MCPHEE 2.4000	1	1	1.0	1.3
79123	FONTNLLE 4.200	1	1	10.0	10.0	79251	QFATLAS1 13.800	1	0	0.0	31.2
79154	FLGORG1 12.500	1	1	40.0	50.0	79251	QFATLAS1 13.800	2	0	0.0	18.2
79155	FLGORG2 12.500	1	1	40.0	50.0	79252	QFATLAS2 13.80	3	0	0.0	18.2
79156	FLGORG3 12.500	1	1	40.0	50.0	79252	QFATLAS2 13.800	4	0	0.0	18.2
79157	BMESA1-2 12.500	1	1	43.0	43.2						

The case described above became the "Benchmark Case". That means that it represents the system prior to the addition of the Clear Creek load and interconnecting facilities. The benchmark case is called "14HS_T2+500PS_CC0" and represents the 2014 summer on-peak season with a TOT2A flow of 500 MW north-to-south and no load at Clear Creek. Outage simulations were conducted on the case and the results are listed in Table 3 below.

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Table 3. Benchmark Case Development – Clear Creek Demand at 0 MW

14HS_T2+500PS_CC0.sav						
Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
ADOBE 230.00		CLIFTON_____230.0-GRANDJCT____230.0-1				0.820
ADOBE 230.00		BASE CASE				0.944
BENCH 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.806
BENCH 230.00		BASE CASE				0.940
BLUE_STN 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.822
BLUE_STN 230.00		CLIFTON_____230.0-GRANDJCT____230.0-1				0.852
BLUE_STN 230.00		BASE CASE				0.943
CAMEO 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.828
CAMEO 230.00		BASE CASE				0.941
CLEARCRK 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.823
CLEARCRK 230.00		BASE CASE				0.944
CLIFTON 230.00		CLIFTON_____230.0-GRANDJCT____230.0-1				0.817
CLIFTON 230.00		BASE CASE				0.943
CRAIG 230.00-RIFLE WA 230.00	1	CRAIG_____345.0-MEEKER______345.0-1	478.0	582.8	121.9	
CURECANT 115.00-SOCANAL 115.00	1	GRANDJCT___345.0-MONTROSE___345.0-1	120.0	159.6	133.0	
GRANDJCT 115.00-GRANDJCT138.0	T2	GRANDJCT___345.0-RIFLE_CU___345.0-1	50.0	63.8	127.5	
GRANDJCT 230.00		GRANDJCT____230.0-GRANDJCT___345.0-T1				0.820
GRANDJCT 230.00		BASE CASE				0.944
GRANDJCT 230.00-GRANDJCT345.0	T1	PARACHUT___230.0-RIFLE_PS____230.0-1	280.0	307.6	109.9	
GRANDJCT 69.000-GRANDJCT115.0	T1	PARACHUT___230.0-RIFLE_PS___230.0-1	42.0	45.1	107.4	
GRANDJPS 230.00		CLIFTON_____230.0-GRANDJCT____230.0-1				0.817
GRANDJPS 230.00		BASE CASE				0.942
HORIZON 230.00		CLIFTON_____230.0-GRANDJCT____230.0-1				0.817
HORIZON 230.00		BASE CASE				0.942
MONTROSE 115.00-SOCANAL 115.0	1	GRANDJCT____345.0-MONTROSE____345.0-1	120.0	149.2	124.3	
PARACHUT 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.812
PARACHUT 230.00		BASE CASE				0.945
STKGULCH 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.812
STKGULCH 230.00		BASE CASE				0.944
UINTAH 230.00		CLIFTON_____230.0-GRANDJCT____230.0-1				0.823
UINTAH 230.00		BASE CASE				0.945
WEELERPS 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.810
WEELERPS 230.00		BASE CASE				0.943

Table 3 (benchmark case) shows that for the 2014 heavy (on-peak) summer season with TOT2A at 500 MW (north-to-south), criteria violations could occur in the study area prior to the addition of load at the proposed Clear Creek Substation. These include several system intact bus voltage violations (voltage less than 0.95 p.u.) as well as branch violations on the PSCo system, the Western Area Power Administration (WAPA) and Tri-State G&T systems that will need to be addressed by the respective utilities. PSCo will need to address the system intact low voltages with the addition of voltage support at Cameo and/or Parachute. The study case assumed that a 45 MVAR capacitor bank would be installed at the Cameo Substation. In addition, the Grand Junction 138-115kV transformer experiences a contingency overload of 127.5% of its 50 MVA rating for loss of the RifleCu-Grand Junction 345kV line. This transformer will need to be replaced and the study assumes a 75 MVA transformer will be installed. In addition, the Grand Junction 345-230kV transformer could experience a 109.9% overload of its 280 MVA rating for loss of the RifleCu-Parachute 230kV branch. This transformer serves both load and provides a path for bulk power transfers; therefore, the addition of a second Grand Junction 345-230kV transformer will need to be investigated by PSCo. Three transmission lines owned by WAPA could experience contingency overloads under these system conditions. These include the Craig-Rifle 230kV line, the Curecanti-South Canal 115kV line and the Montrose-South Canal 115kV line.

Table 4. Benchmark Case Adjustment – 45 MVAR Capacitor Bank at Cameo – Clear Creek Demand at 0 MW

14HS_T2+500PS_CC0_C1.sav						
Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
BENCH 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.894
CRAIG 230.00-RIFLE WA 230.00	1	CRAIG______345.0-MEEKER______345.0-1	478	578.2	121	
CRAIG 230.00-RIFLE WA 230.00	1	RIFLE_CU____345.0-MEEKER______345.0-1	478	563.1	117.8	
CURECANT 115.00-SOCANAL 115.0	1	GRANDJCT____345.0-MONTROSE____345.0-1	120	157.2	131	
CURECANT 115.00-SOCANAL 115.0	1	GRANDJCT____345.0-RIFLE_CU____345.0-1	120	150.8	125.6	
CURECANT 115.00-SOCANAL 115.0	1	CURECANT____230.0-LOSTCANY____230.0-1	120	143.1	119.2	
GRANDJCT 115.00-GRANDJCT 138.0	T2	GRANDJCT____345.0-RIFLE_CU____345.0-1	50	63.9	127.9	
GRANDJCT 115.00-GRANDJCT 138.0	T2	GRANDJCT____345.0-MONTROSE____345.0-1	50	61.2	122.4	
GRANDJCT 115.00-GRANDJCT 138.0	T2	PARACHUT____230.0-RIFLE_PS____230.0-1	50	50.8	101.6	
GRANDJCT 230.00-GRANDJCT 345.0	T1	PARACHUT____230.0-RIFLE_PS____230.0-1	280	295	105.3	
MONTROSE 115.00-SOCANAL 115.0	1	GRANDJCT____345.0-MONTROSE____345.0-1	120	147.2	122.7	
MONTROSE 115.00-SOCANAL 115.0	1	GRANDJCT____345.0-RIFLE_CU____345.0-1	120	141.3	117.8	
MONTROSE 115.00-SOCANAL 115.0	1	CURECANT____230.0-LOSTCANY____230.0-1	120	134.1	111.8	
NORTHFRK 115.00		NORTHFRK____115.0-NORTHFRK____230.0-1				0.893
PARACHUT 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.901
STKGULCH 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.899
WEELERPS 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.898

An additional capacitor bank is required to mitigate contingency voltage violations on PSCo 230kV busses. A 45 MVAR capacitor bank was added at Parachute due to contingency low voltages in the Parachute area. This provided a more level voltage profile in the study area.

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Table 5. Benchmark Case Adjustment – 45 MVAR Capacitor Bank at Parachute and Cameo – Clear Creek Demand at 0 MW

14HS_T2+500PS_CC0_C1P1						
Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
CRAIG 230.00-RIFLE WA 230.00	1	CRAIG______345.0-MEEKER______345.0-1	478.0	578.0	120.9	
CRAIG 230.00-RIFLE WA 230.00	1	RIFLE_CU____345.0-MEEKER______345.0-1	478.0	562.1	117.6	
CURECANT 115.00-SOCANAL 115.0	1	GRANDJCT____345.0-MONTROSE____345.0-1	120.0	156.2	130.2	
CURECANT 115.00-SOCANAL 115.0	1	GRANDJCT____345.0-RIFLE_CU____345.0-1	120.0	149.1	124.3	
CURECANT 115.00-SOCANAL 115.0	1	CURECANT____230.0-LOSTCANY____230.0-1	120.0	141.9	118.3	
GRANDJCT 115.00-GRANDJCT 138.0	T2	GRANDJCT____345.0-RIFLE_CU____345.0-1	50.0	63.9	127.7	
GRANDJCT 115.00-GRANDJCT 138.0	T2	GRANDJCT____345.0-MONTROSE____345.0-1	50.0	61.1	122.3	
GRANDJCT 115.00-GRANDJCT 138.0	T2	PARACHUT____230.0-RIFLE_PS____230.0-1	50.0	51.4	102.8	
GRANDJCT 230.00-GRANDJCT 345.0	T1	PARACHUT____230.0-RIFLE_PS____230.0-1	280.0	297.5	106.2	
MONTROSE 115.00-SOCANAL 115.0	1	GRANDJCT____345.0-MONTROSE____345.0-1	120.0	146.4	122.0	
MONTROSE 115.00-SOCANAL 115.0	1	GRANDJCT____345.0-RIFLE_CU____345.0-1	120.0	140.2	116.8	
MONTROSE 115.00-SOCANAL 115.0	1	CURECANT____230.0-LOSTCANY____230.0-1	120.0	133.4	111.1	

The addition of the 45 MVAR capacitor bank at Parachute mitigates the low voltage conditions in the area. The transformer overloads in the Grand Junction area will need to be addressed by PSCo. The other criteria violations need to be resolved by WAPA and Tri-State G&T.

The Clear Creek demand was increased to 64 MW to reflect the projected demand level. Outages were simulated and the results listed in Table 6.

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Table 6. Benchmark Case Adjustment–45 MVAR Capacitor Bank at Cameo and a 45 MVAR Capacitor Bank at Parachute–Clear Creek Demand at 64 MW

14HS_T2+500PS_CC64_C1P1						
Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
ADOBE 230.00		CLIFTON_____230.0-GRANDJCT____230.0-1				0.869
BENCH 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.850
BLUE_STN 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.858
CAMEO 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.862
CAMEO 69.000		PARACHUT____230.0-RIFLE_PS____230.0-1				0.876
CAMP 69.000		PARACHUT____230.0-RIFLE_PS____230.0-1				0.883
CLEARCRK 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.854
CLIFTON 230.00		CLIFTON_____230.0-GRANDJCT____230.0-1				0.866
CRAIG 230.00-RIFLE WA 230.00	1	CRAIG_______345.0-MEEKER______345.0-1	478.0	602.2	126.0	
CURECANT 115.00-SOCANAL 115.0	1	GRANDJCT____345.0-MONTROSE____345.0-1	120.0	160.3	133.5	
DEBEQUE 69.000		PARACHUT____230.0-RIFLE_PS____230.0-1				0.867
GRANDJCT 115.00-GRANDJCT 138.0	**T2**	GRANDJCT____345.0-RIFLE_CU____345.0-1	50.0	65.1	**130.2**	
GRANDJCT 230.00		GRANDJCT____230.0-GRANDJCT____345.0-T1				0.869
GRANDJCT 230.00-GRANDJCT 345.0	**T1**	PARACHUT____230.0-RIFLE_PS____230.0-1	280.0	353.5	**126.3**	
GRANDJCT 69.000-GRANDJCT 115.0	**T1**	PARACHUT____230.0-RIFLE_PS____230.0-1	42.0	50.4	**120.1**	
GRANDJPS 230.00		CLIFTON_____230.0-GRANDJCT____230.0-1				0.866
GRANDVLY 69.000		PARACHUT____230.0-RIFLE_PS____230.0-1				0.883
HORIZON 230.00		CLIFTON_____230.0-GRANDJCT____230.0-1				0.866
MONTROSE 115.00-SOCANAL 115.0	1	GRANDJCT____345.0-MONTROSE____345.0-1	120.0	150.0	125.0	
NORTHFRK 115.00		NORTHFRK____115.0-NORTHFRK____230.0-1				0.888
PARACHUT 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.855
PARACHUT 230.00-RIFLE_PS 230.0	**1**	GRANDJCT____345.0-RIFLE_CU____345.0-1	439.0	450.8	**102.7**	
UINTAH 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.871
UNA_ORCH 69.000		PARACHUT____230.0-RIFLE_PS____230.0-1				0.867
UNIONOIL 69.000		PARACHUT____230.0-RIFLE_PS____230.0-1				0.884
VINELAND 69.000		PARACHUT____230.0-RIFLE_PS____230.0-1				0.884
WEELERPS 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.854

Table 6 indicates the presence of contingency low voltages at study area busses. These can be mitigated by capacitor additions. A second capacitor bank was added in the case at Parachute. Outages were simulated and the results listed in Table 7.

Table 7. Benchmark Case Adjustment – 64 MW Load at Clear Creek, one 45 MVAR capacitor at Cameo, two 45 MVAR capacitors at Parachute

14HS_T2+500PS_CC64_C1P2.						
Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
CRAIG 230.00-RIFLE WA 230.00	1	CRAIG_______345.0-MEEKER______345.0-1	478.0	601.7	125.9	
CRAIG 230.00-RIFLE WA 230.00	1	RIFLE_CU____345.0-MEEKER______345.0-1	478.0	586.3	122.7	
CURECANT 115.00-SOCANAL 115.0	1	GRANDJCT____345.0-MONTROSE____345.0-1	120.0	159.1	132.6	
CURECANT 115.00-SOCANAL 115.0	1	GRANDJCT____345.0-RIFLE_CU____345.0-1	120.0	154.8	129.0	
CURECANT 115.00-SOCANAL 115.0	1	CURECANT____230.0-LOSTCANY____230.0-1	120.0	146.4	122.0	
CURECANT 115.00-SOCANAL 115.0	1	NORTHFRK____115.0-NORTHFRK____230.0-1	120.0	120.8	100.7	
GRANDJCT 115.00-GRANDJCT 138.0	**T2**	GRANDJCT____345.0-RIFLE_CU____345.0-1	50.0	65.4	**130.7**	
GRANDJCT 115.00-GRANDJCT 138.0	T2	GRANDJCT____345.0-MONTROSE____345.0-1	50.0	62.0	124.0	
GRANDJCT 115.00-GRANDJCT 138.0	T2	PARACHUT____230.0-RIFLE_PS____230.0-1	50.0	54.6	109.1	
GRANDJCT 230.00-GRANDJCT 345.0	**T1**	PARACHUT____230.0-RIFLE_PS____230.0-1	280.0	350.3	**125.1**	
GRANDJCT 69.000-GRANDJCT 115.0	**T1**	PARACHUT____230.0-RIFLE_PS____230.0-1	42.0	49.1	**116.8**	
MONTROSE 115.00-SOCANAL 115.0	1	GRANDJCT____345.0-MONTROSE____345.0-1	120.0	149.1	124.3	
MONTROSE 115.00-SOCANAL 115.0	1	GRANDJCT____345.0-RIFLE_CU____345.0-1	120.0	145.4	121.1	
MONTROSE 115.00-SOCANAL 115.0	1	CURECANT____230.0-LOSTCANY____230.0-1	120.0	137.5	114.6	
NORTHFRK 115.00		NORTHFRK____115.0-NORTHFRK____230.0-1				0.896
PARACHUT 230.00-RIFLE_PS 230.0	**1**	GRANDJCT____345.0-RIFLE_CU____345.0-1	439.0	451.2	**102.8**	

Table 7 shows that additional voltage support at Parachute mitigates the low voltages in the study when the Clear Creek 230kV load at 64 MW is added. The Bluestone Valley Substation would have been an acceptable alternate location for the capacitor banks. The following needs to be completed:

- Increase the RiflePS-Parachute 230kV line rating from 439 MVA to approximately 452 MVA.
- Replace the 50 MVA Grand Junction 138-115kV transformer with a 75 MVA transformer
- Add a second 280 MVA Grand Junction 345-230kV transformer
- Replace the 42 MVA Grand Junction 115-69kV transformer with a 65 MVA transformer

The next load stage to consider is the Clear Creek Substation demand at 120 MW. It is clear that increasing the Clear Creek Substation demand from 64 MW to 120 MW would only worsen the RiflePS-Parachute 230kV contingency overload; therefore, the study considered alternatives to mitigate this and other violations when the demand increases to 120 MW.

E. Alternatives to Serve Clear Creek at 120 MW

The Customer plans to increase the Clear Creek demand in stages from 64 MW in 2014 to 120 MW in 2018. That represents a nearly doubling in demand at the Clear Creek Substation. To accommodate this demand increase, the study considered what network upgrades would be needed to mitigate the RiflePS-Parachute 230kV contingency overload that would already occur at 64 MW. Preliminary studies with the Clear Creek Substation demand increased to 120 MW indicate that the loss of the RiflePS-Parachute 230kV line would cause serious voltage violations in the study area requiring the potential loss of load. Therefore, increasing the Clear Creek 230kV load to 120 MW is not possible without network upgrades. In addition, the RiflePS-Parachute 230kV line flow could reach nearly 500 MW (on a line rated at 439 MVA) for an outage of the RifleCu-Grand Junction 345kV transmission line.

The study examined nine alternatives that would allow the Clear Creek Substation demand to be increased to 120 MW. Three of the alternatives involve the 230kV system, three alternatives involve the 138kV system, and three alternatives involve the 345kV system.

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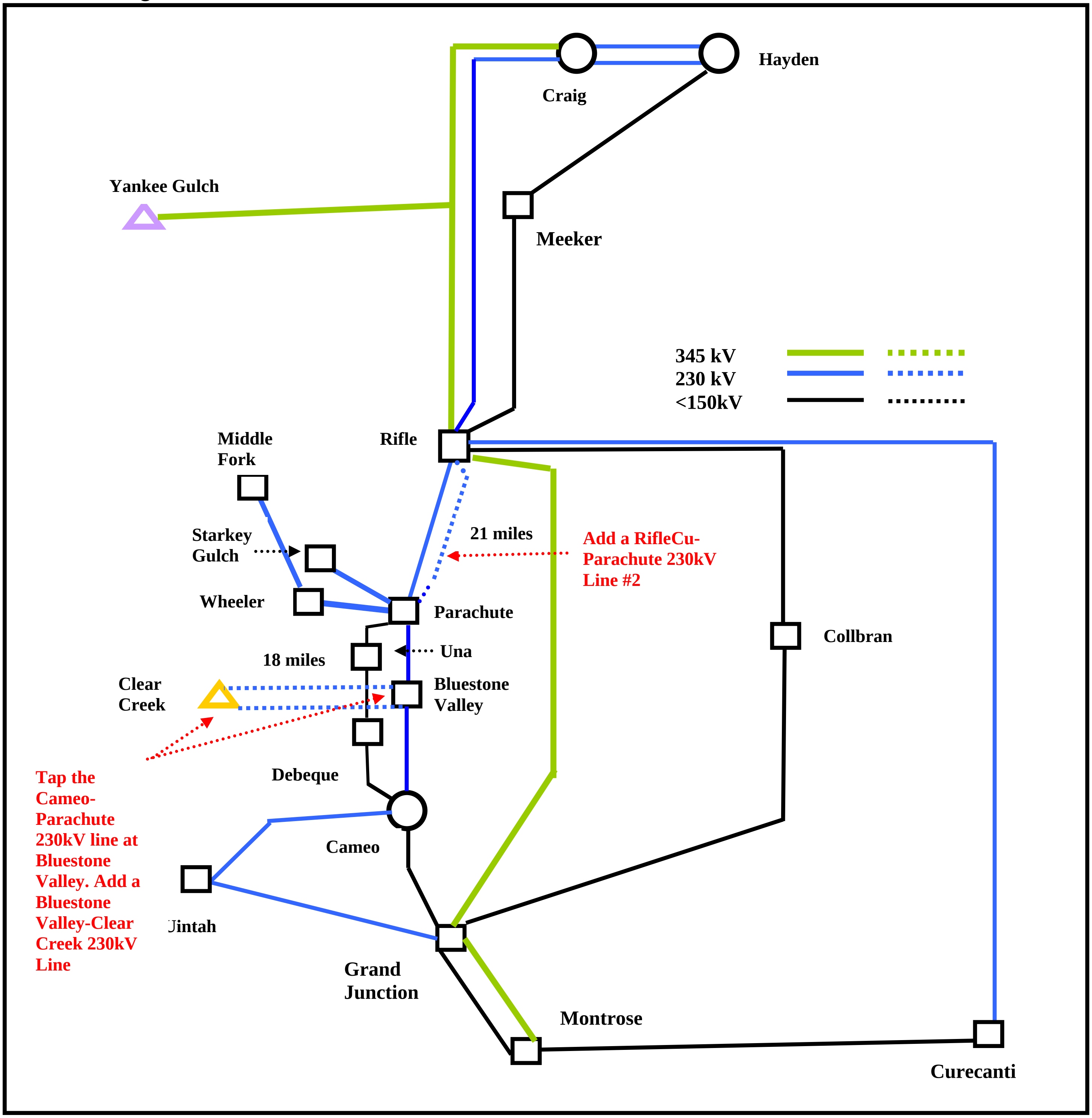
1. Alternative 1

Alternative 1 consists of a Clear Creek-Bluestone Valley 230kV double circuit line and a RifleCu-Parachute 230kV line #2. See Figure 2 below.

Figure 2 – Alternative 1



Alternative 1 was modeled without the RiflePS-Parachute 230kV line #2 to demonstrate the need for this network upgrade. To do this, the benchmark case was obtained and modified as follows:

- The Parachute-Cameo 230kV line was tapped at Bluestone Valley
- An 18-mile 230kV transmission line was modeled from the Bluestone Valley Substation to the Clear Creek Substation
- A 120 MW load was represented at Clear Creek
- One 45 MVAR capacitor bank was modeled at the Cameo 230kV bus
- Two 45 MVAR capacitor banks were modeled at the Bluestone Valley 230kV bus.

Facility outages were simulated and the results are show below. The study demonstrates that an outage of the RiflePS-Parachute 230kV line #1 (the existing line) could cause a severe voltage depression at the facilities in the study area with probable loss of load when the Clear Creek demand is increased to 120 MW. The results are listed in Table 6 below.

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Table 8 – Alternative 1 prior to the addition of the RiflePS-Parachute 230kV Line #2 (Benchmark Case), with two capacitors at Bluestone Valley, one capacitor at Cameo

14HS_T2+500PS_CC120_SWB2C1_ALT1_1						
Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
ADOBE 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.605
BENCH 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.483
BLUE_STN 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.506
CAMEO 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.523
CLEARCRK 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.495
CLIFTON 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.668
COLBRAN 115.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.834
COLBRAN 138.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.813
CRAIG 230.00-RIFLE WA 230.00	1	CRAIG_______345.0-MEEKER______345.0-1	478.0	624.6	130.7	
CURECANT 115.00-SOCANAL 115.00	1	GRANDJCT____345.0-MONTROSE____345.0-1	120.0	163.1	135.9	
GRANDJCT 115.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.753
GRANDJCT 115.00-GRANDJCT 138.00	T2	GRANDJCT____345.0-RIFLE_CU____345.0-1	50.0	66.7	133.5	
GRANDJCT 138.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.778
GRANDJCT 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.685
GRANDJCT 230.00-GRANDJCT 345.00	T1	PARACHUT____230.0-RIFLE_PS____230.0-1	280.0	451.0	161.1	
GRANDJCT 345.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.789
GRANDJCT 69.000-GRANDJCT 115.00	T1	PARACHUT____230.0-RIFLE_PS____230.0-1	42.0	66.4	158.2	
GRANDJPS 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.637
HORIZON 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.621
MONTROSE 115.00-SOCANAL 115.00	1	GRANDJCT____345.0-MONTROSE____345.0-1	120.0	152.7	127.2	
PARACHUT 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.491
PARACHUT 230.00-RIFLE_PS 230.00	**1**	GRANDJCT____345.0-RIFLE_CU____345.0-1	439.0	494.4	**112.6**	
RIFLE WA 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.898
RIFLE_CU 138.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.874
RIFLE_CU 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.888
RIFLE_CU 345.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.867
RIFLE_PS 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.898
STKGULCH 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.490
UINTAH 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.591
WEELERPS 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.488

Table 8 demonstrates that serving the 120 MW Customer load at Clear Creek will require more support than capacitor banks alone can provide. For example, an outage of the RiflePS-Parachute 230kV line #1 (the existing line) results in a severe voltage depression in the study area with probable loss of load. In addition, the RifleCu-Parachute 230kV line can experience overloads for an outage of the Grand Junction-RifleCu 345kV line. Based on these results, adding a second RiflePS-Parachute 230kV line could help alleviate these issues. A second RiflePS-Parachute 230kV line was added to the study case and outages simulated. Table 9 below lists criteria violations.

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Table 9. Alternative 1 with the RiflePS-Parachute 230kV Line No. 2 added, two capacitors at Bluestone Valley, one capacitor at Cameo

14HS_T2+500PS_CC120_SWB2C1_ALT1_2						
Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
CRAIG 230.00-RIFLE WA 230.00	1	CRAIG_______345.0-MEEKER______345.0-1	478.0	624.3	130.6	
CURECANT 115.00-SOCANAL 115.00	1	GRANDJCT____345.0-MONTROSE____345.0-1	120.0	160.7	133.9	
GRANDJCT 115.00-GRANDJCT 138.00	**T2**	GRANDJCT____345.0-RIFLE_CU____345.0-1	50.0	61.5	**122.9**	
GRANDJCT 230.00-GRANDJCT 345.00	T1	BLUE_STN____230.0-PARACHUT____230.0-1	280.0	317.8	113.5	
GRANDJCT 69.000-GRANDJCT 115.00	T1	BLUE_STN____230.0-PARACHUT____230.0-1	42.0	44.1	104.9	

Table 9 shows that the addition of the RiflePS-Parachute 230kV line #2 mitigates the severe voltage depression scenario as well the line overload issue. Table 7 shows that transformer replacements or possible additions may be required in addition to the RiflePS-Parachute 230kV line and capacitor additions. For example, an outage of the RifleCu-Grand Junction 345kV line results in the contingency flow on the Grand Junction 138-115kV transformer reaching 122.9% of its 50 MVA limit. That transformer would be replaced with a 75 MVA transformer in the case. The Grand Junction 345-230kV transformer has a dual role as bulk a power transfer device and for load serving. The contingency flow across this transformer reaches 113.5% of its 280 MVA rating for an outage of the Parachute-Bluestone Valley 230kV line. Since the transformer provides for bulk power transfers, a second Grand Junction 345-230kV transformer should be considered for reliability.

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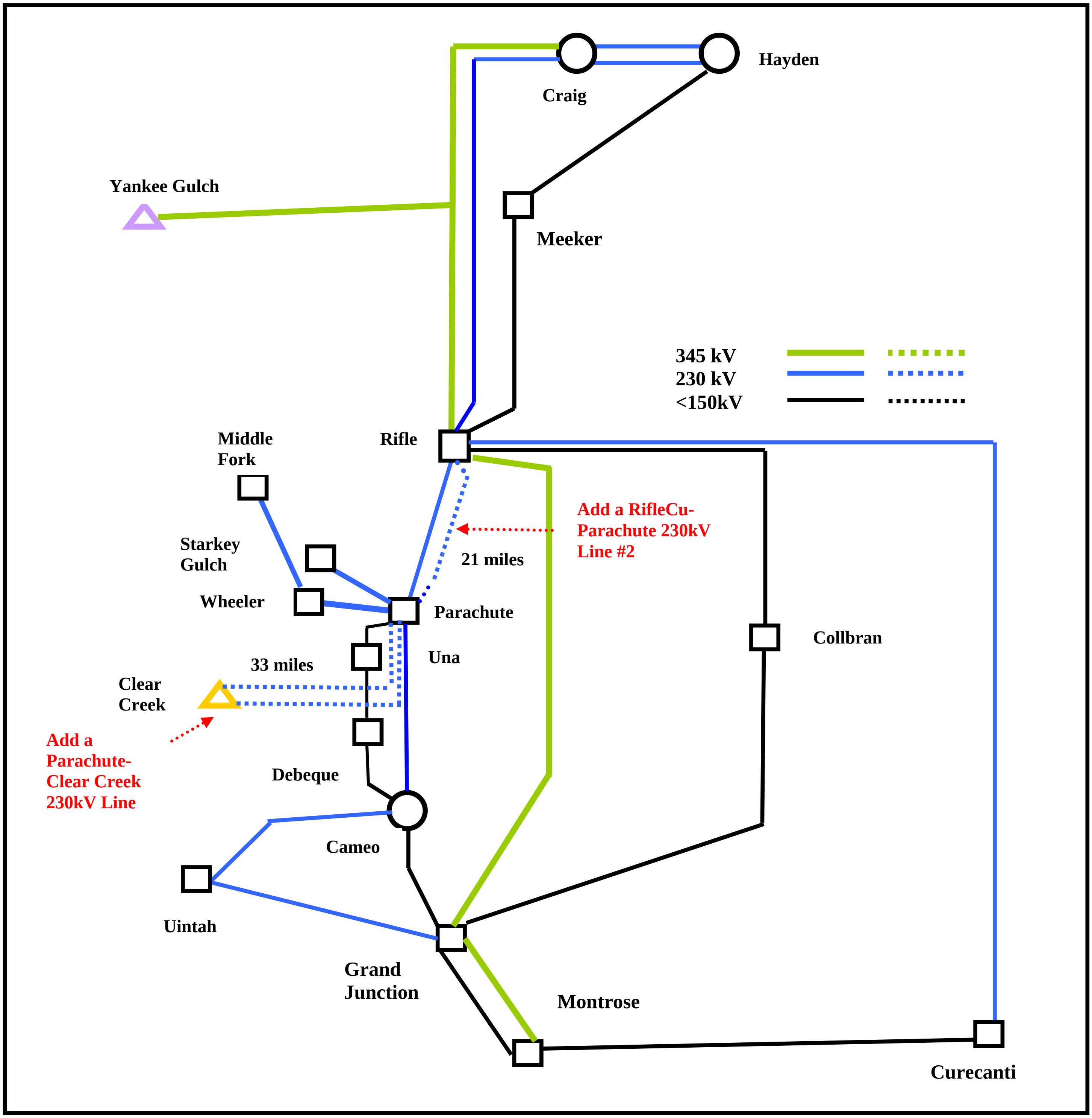
2. Alternative 2

Alternative 2 consists of a Clear Creek-Parachute 230kV double circuit line and a RifleCu-Parachute 230kV line #2. See Figure 3 below.

Figure 3 – Alternative 2



Alternative 2 was modeled without the RiflePS-Parachute 230kV line #2 to demonstrate the need for this network upgrade. To do this, the benchmark case was obtained and modified as follows:

- A 33-mile 230kV transmission line was modeled from Parachute to the Customer Substation called Clear Creek.
- A 120 MW load was represented at Clear Creek
- A 45 MVAR capacitor bank was modeled at the Cameo 230kV bus
- Two 45 MVAR capacitor banks were modeled at the Parachute 230kV bus.

Facility outages were simulated and the results are show below.

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Table 10. Alternative 2 Add a Clear Creek-Parachute 230kV Dbl Ckt Line. Add one a capacitor bank at Cameo, two capacitor banks at Parachute

14HS_T2+500PS_CC120_SWC1P2_ALT2_1						
Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
ADOBE 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.594
BENCH 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.434
CAMEO 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.495
CLEARCRK 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.422
CLIFTON 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.663
CRAIG 230.00-RIFLE WA 230.00	1	CRAIG_______345.0-MEEKER______345.0-1	478.0	624.4	130.6	
CURECANT 115.00-SOCANAL 115.00	1	GRANDJCT____345.0-MONTROSE____345.0-1	120.0	162.2	135.2	
GRANDJCT 115.00-GRANDJCT 138.00	T2	GRANDJCT____345.0-RIFLE_CU____345.0-1	50.0	65.9	131.8	
GRANDJCT 138.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.780
GRANDJCT 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.681
GRANDJCT 230.00-GRANDJCT 345.00	T1	PARACHUT____230.0-RIFLE_PS____230.0-1	280.0	439.9	157.1	
GRANDJCT 345.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.788
GRANDJCT 69.000-GRANDJCT 115.00	T1	PARACHUT____230.0-RIFLE_PS____230.0-1	42.0	64.4	153.4	
GRANDJPS 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.630
HORIZON 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.612
MONTROSE 115.00-SOCANAL 115.00	1	GRANDJCT____345.0-MONTROSE____345.0-1	120.0	151.9	126.6	
MONTROSE 345.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.839
PARACHUT 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.442
PARACHUT 230.00-RIFLE_PS 230.00	**1**	GRANDJCT____345.0-RIFLE_CU____345.0-1	439.0	501.6	**114.3**	
RIFLE WA 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.899
RIFLE_CU 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.889
RIFLE_CU 345.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.868
RIFLE_PS 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.899
STKGULCH 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.441
UINTAH 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.577
WEELERPS 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.440

Table 10 shows that the Clear Creek load at 120 MW cannot be served using Alternative 2 without the addition of a RiflePS-Parachute 230kV line #2. Without the second RiflePS-Parachute 230kV line, an outage of the RiflePS-Parachute 230kV line #1 results in a severe voltage depression scenario with probable loss of load. To mitigate this issue, a second RifleCu-Parachute 230kV line was modeled in the cases. Outages were simulated and the results listed in Table 11 below.

Table 11. Alternative 2 with the RiflePS-Parachute 230kV Line No. 2 added, one 45 MVAR capacitor at Cameo, two 45 MVAR capacitors at Parachute

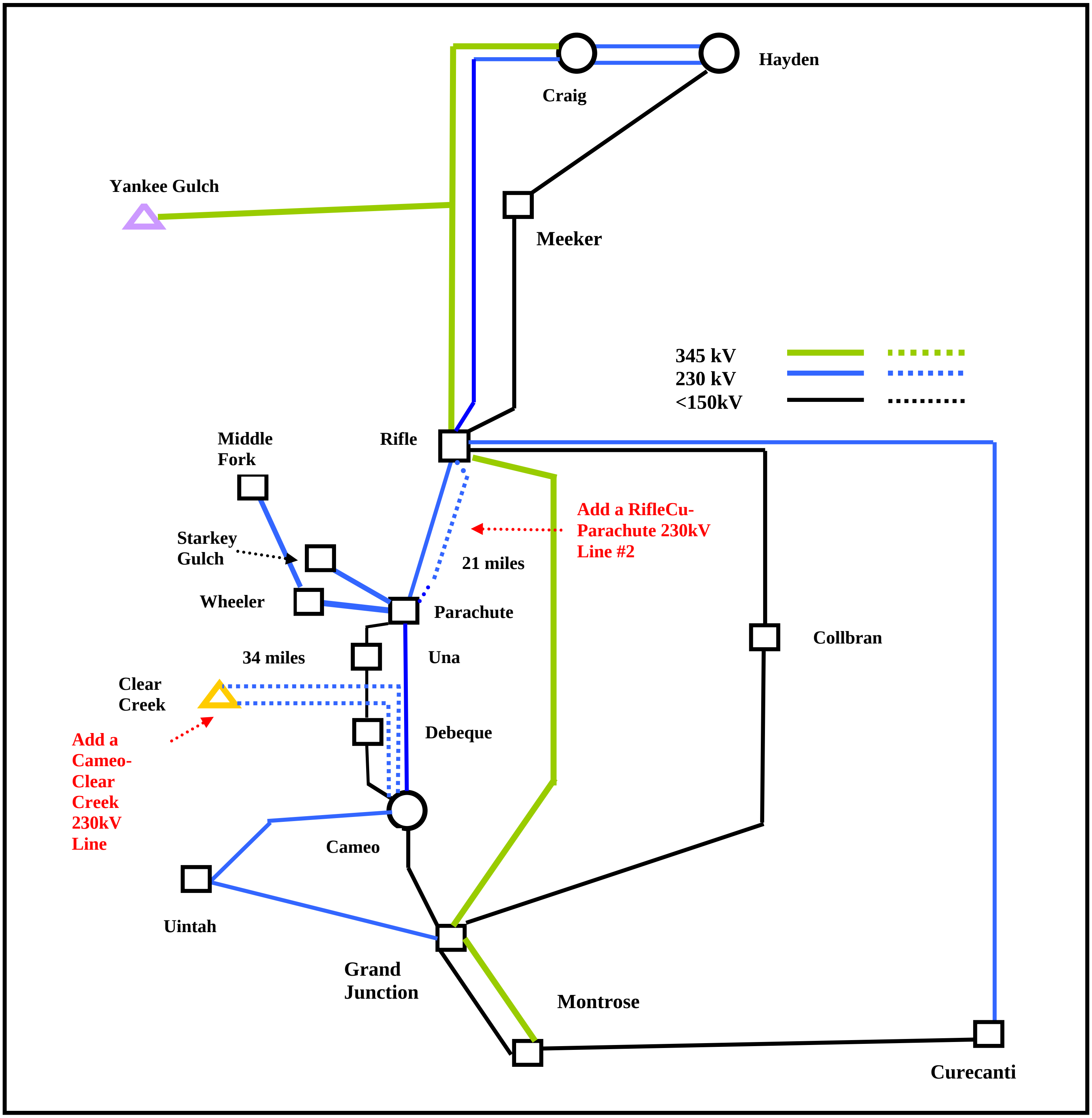
14HS_T2+500PS_CC120_SWC1P2_ALT2_2						
Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
CRAIG 230.00-RIFLE WA 230.00	1	CRAIG______345.0-MEEKER_____345.0-1	478.0	624.1	130.6	
CURECANT 115.00-SOCANAL 115.00	1	GRANDJCT____345.0-MONTROSE____345.0-1	120.0	159.7	133.1	
GRANDJCT 115.00-GRANDJCT 138.00	**T2**	GRANDJCT____345.0-RIFLE_CU____345.0-1	50.0	60.4	**120.8**	
MONTROSE 115.00-SOCANAL 115.00	1	GRANDJCT____345.0-MONTROSE____345.0-1	120.0	149.7	124.7	

Table 11 demonstrates that adding a second RiflePS-Parachute 230kV line helps alleviate the low bus voltage and branch flow issues. In addition, Table 9 shows that an outage of the RifleCu-Grand Junction 345kV line results in the contingency flow on the Grand Junction 138-115kV transformer reaching 120.8% of its 50 MVA limit. That transformer would need to be replaced with a 75 MVA transformer. An advantage of Alternative 2 over Alternative 1 is that Alternative 2 reduces flows in the Grand Junction area. For example, for Alternative 1, the contingency flow across the Grand Junction 345-230kV transformer is 113.5% while for Alternative 2, the contingency flow across the Grand Junction 345-230kV transformer is less than 100%. Similarly, for Alternative 1, the contingency flow across the Grand Junction 115-69kV transformer is 104.9% while for Alternative 2, the contingency flow across the Grand Junction 115-69kV transformer is less than 100%. Unfortunately, Alternative 2 would require approximately 15 miles of additional double circuit 230kV transmission to interconnect the Clear Creek Substation to the bulk transmission system.

3. Alternative 3

Alternative 3 consists of a Clear Creek-Cameo 230kV double circuit line and a second RifleCu-Parachute 230kV line #2. See Figure 4 below.

Figure 4 – Alternative 3



Alternative 3 was developed in the following way. To demonstrate the need for network upgrades, the benchmark case was obtained and modified as follows:

- A 34-mile 230kV transmission line was modeled from Cameo to the Clear Creek Substation.
- A 120 MW load was represented at Clear Creek
- Two 45 MVAR capacitor banks were modeled at the Cameo 230kV bus
- One 45 MVAR capacitor bank was modeled at the Parachute 230kV bus.

Facility outages were simulated and the results are show below.

Table 12. Alternative 3 prior to the addition of the RiflePS-Parachute 230kV line #2 with one two capacitor banks at Cameo, one capacitor bank at Parachute

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Table 12 indicates that an outage of the RiflePS-Parachute 230kV line #1 (the existing line) could cause a severe voltage depression of the facilities in the study area with probably loss of load. It should be noted that two 45 MVAR capacitor

14HS_T2+500PS_CC120_SWC2P1_ALT3_1						
Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
ADOBE 230.00		CLIFTON_____230.0-GRANDJCT____230.0-1				0.529
BENCH 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.523
CAMEO 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.548
CLEARCRK 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.529
CLIFTON 230.00		CLIFTON_____230.0-GRANDJCT____230.0-1				0.524
CRAIG 230.00-RIFLE WA 230.00	1	CRAIG_______345.0-MEEKER______345.0-1	478.0	624.5	130.6	
CRAIG 230.00-RIFLE WA 230.00	1	RIFLE_CU____345.0-MEEKER______345.0-1	478.0	610.4	127.7	
CURECANT 115.00-SOCANAL 115.00	1	GRANDJCT____345.0-MONTROSE____345.0-1	120.0	163.4	136.2	
GRANDJCT 115.00-GRANDJCT 138.00	T2	GRANDJCT____345.0-RIFLE_CU____345.0-1	50.0	67.3	134.6	
GRANDJCT 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.695
GRANDJCT 230.00-GRANDJCT 345.00	T1	PARACHUT____230.0-RIFLE_PS____230.0-1	280.0	454.3	162.3	
GRANDJCT 345.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.794
GRANDJCT 69.000-GRANDJCT 115.00	T1	PARACHUT____230.0-RIFLE_PS____230.0-1	42.0	66.5	158.3	
GRANDJPS 230.00		CLIFTON_____230.0-GRANDJCT____230.0-1				0.524
HENDERPS 115.00-PORTAL 115.00	1	PTARMGN_____230.0-DILLON______230.0-1	80.0	86.0	107.5	
HORIZON 230.00		CLIFTON_____230.0-GRANDJCT____230.0-1				0.525
MONTROSE 115.00-SOCANAL 115.00	1	GRANDJCT____345.0-MONTROSE____345.0-1	120.0	153.0	127.5	
MONTROSE 345.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.844
PARACHUT 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.531
PARACHUT 230.00-RIFLE_PS 230.00	1	CLIFTON_____230.0-GRANDJCT____230.0-1	439.0	545.8	124.3	
RIFLE WA 230.00		CLIFTON_____230.0-GRANDJCT____230.0-1				0.871
RIFLE_CU 345.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.870
RIFLE_PS 230.00		CLIFTON_____230.0-GRANDJCT____230.0-1				0.869
STKGULCH 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.531
UNA_ORCH 69.000		PARACHUT____230.0-RIFLE_PS____230.0-1				0.661
WEELERPS 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.529

banks at Cameo and one 45 MVAR capacitor bank at Parachute was modeled instead of three capacitor banks at Cameo because adding the third bank at Parachute rather than Cameo provided a flatter voltage profile in the study area.

The RiflePS-Parachute 230kV line #2 was added to the case to mitigate the low voltage issues. Facility outages were simulated and the results are show below.

Table 13. Alternative 3 after the addition of the RiflePS-Parachute line #2, two capacitor banks at Cameo, one capacitor bank at Parachute

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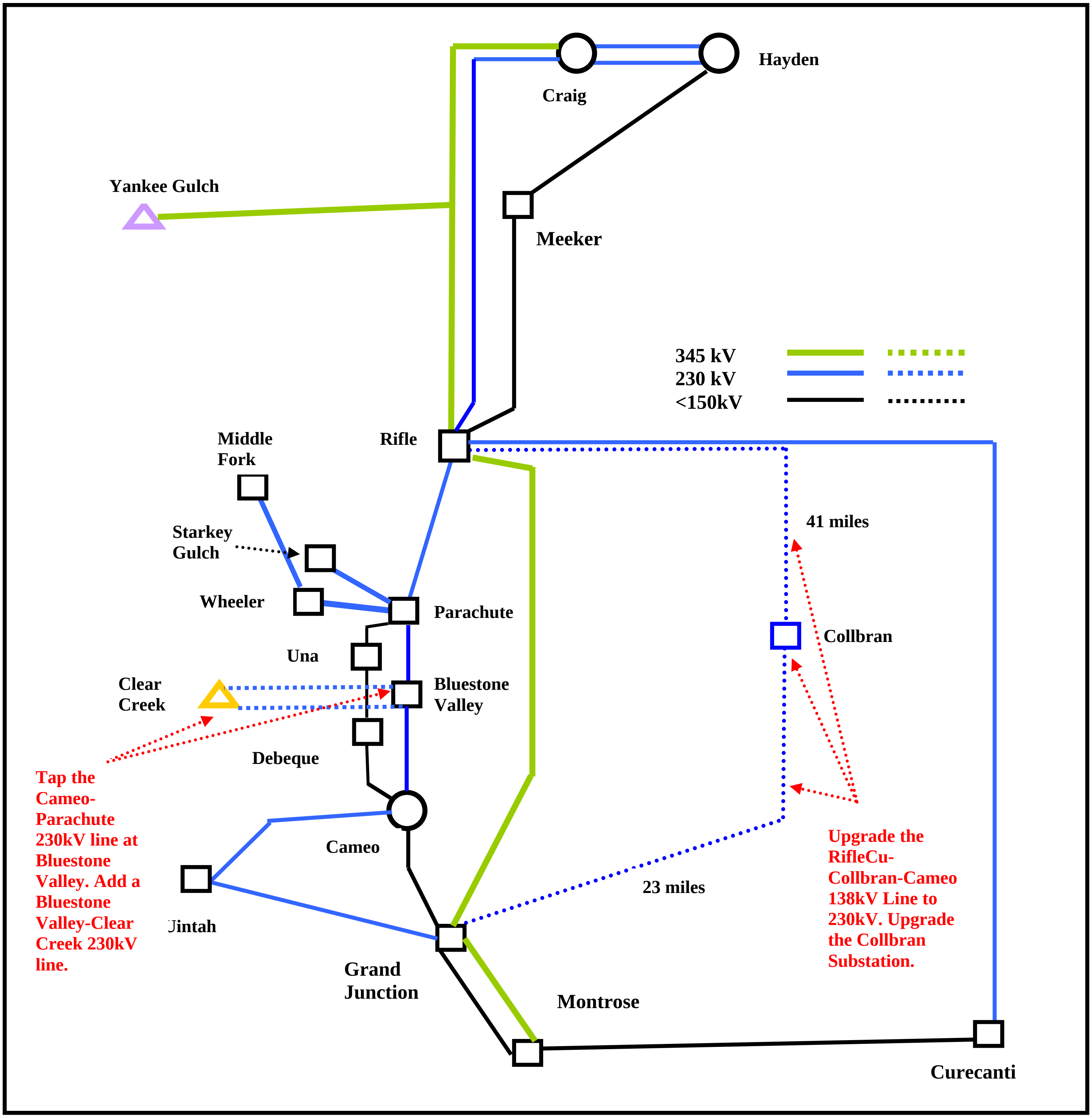
14HS_T2+500PS_CC120_SWC2P1_ALT3_2						
Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
CRAIG 230.00-RIFLE WA 230.00	1	CRAIG_______345.0-MEEKER______345.0-1	478.0	624.3	130.6	
CURECANT 115.00-SOCANAL 115.00	1	GRANDJCT____345.0-MONTROSE____345.0-1	120.0	161.0	134.2	
GRANDJCT 115.00-GRANDJCT 138.00	**T2**	GRANDJCT____345.0-RIFLE_CU____345.0-1	50.0	62.2	**124.4**	
GRANDJCT 230.00-GRANDJCT 345.00	**T1**	CAMEO_______230.0-PARACHUT____230.0-1	280.0	313.5	**112.0**	
GRANDJCT 69.000-GRANDJCT 115.00	T1	CAMEO_______230.0-PARACHUT____230.0-1	42.0	43.3	103.0	
MONTROSE 115.00-SOCANAL 115.00	1	GRANDJCT____345.0-MONTROSE____345.0-1	120.0	150.9	125.7	

Table 13 demonstrates that a second RiflePS-Parachute 230kV line would help alleviate the low voltage issues. Table 13 also shows that an outage of the RifleCu-Grand Junction 345kV line results in the contingency flow on the Grand Junction 138-115kV transformer reaching 124.4% of its 50 MVA limit. That transformer should be replaced with a 75 MVA transformer. The Grand Junction 345-230kV transformer has a dual role as bulk a power transfer device and for load serving. Therefore, a second Grand Junction 345-230kV transformer should be considered for reliability.

4. Alternative 4

Alternative 4 consists of a Bluestone Valley-Clear Creek 230kV double circuit line and a RifleCu-Collbran-Grand Junction 138kV to 230kV Upgrade. See Figure 5 below.

Figure 5 – Alternative 4



Alternative 4 prior to the upgrade of the RifleCu-Collbran-Grand Junction 138kV to 230kV is the same as Alternative 1 prior to the addition of the RiflePS-Parachute 230kV line #2. Therefore Alternative 4 prior to the upgrade of the RifleCu-Collbran-Grand Junction 138kV to 230kV upgrade has been studied in Alternative 1. The RifleCu-Collbran-Grand Junction 138kV to 230kV upgrade was made to the case. Outages were simulated and the results listed in the table below.

Table 14. Alternative 4 after the RifleCu-Collbran-Grand Junction 138kV to 230kV upgrade, two capacitor banks at Bluestone Valley, one capacitor bank at Cameo

14HS_T2+500PS_CC120_SWB2C1_ALT4_2						
Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
BENCH 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.892
CLEARCRK 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.900
CRAIG 230.00-RIFLE WA 230.00	1	CRAIG_______345.0-MEEKER______345.0-1	478.0	625.7	130.9	
CURECANT 115.00-SOCANAL 115.00	1	GRANDJCT____345.0-MONTROSE____345.0-1	120.0	168.8	140.6	
MONTROSE 115.00-SOCANAL 115.00	1	GRANDJCT____345.0-MONTROSE____345.0-1	120.0	158.5	132.1	
PARACHUT 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.898
STKGULCH 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.897
WEELERPS 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.896

Table 14 demonstrates that the RifleCu-Collbran-Grand Junction 138kV to 230kV upgrade removes the risk of a severe voltage depression; however, the study shows that additional reactive support is needed at Parachute. Clearly, this alternative is not as effective as the addition of the RiflePS-Parachute #2 line. Adding a third 45 MVAR Bluestone Valley capacitor bank was attempted. Outages were simulated and the results are found in Table 13 below.

Table 15. Alternative 4 after the RifleCu-Collbran-Grand Junction 138kV to 230kV upgrade, three capacitor banks at Bluestone Valley, one capacitor bank at Cameo

14HS_T2+500PS_CC120_SWB3C1_ALT4_3						
Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
BLUE_STN 230.00		BLUE_STN____230.0-PARACHUT____230.0-1				1.112
CLEARCRK 230.00		BLUE_STN____230.0-PARACHUT____230.0-1				1.106
CRAIG 230.00-RIFLE WA 230.00	1	CRAIG_______345.0-MEEKER______345.0-1	478	625	130.7	
CURECANT 115.00-SOCANAL 115.00	1	GRANDJCT____345.0-MONTROSE____345.0-1	120	167.5	139.6	
MONTROSE 115.00-SOCANAL 115.00	1	GRANDJCT____345.0-MONTROSE____345.0-1	120	157.5	131.2	

Table 15 indicates the potential high voltage problems at Bluestone Valley and Clear Creek with three capacitors placed at Bluestone Valley and one capacitor at Cameo. The third capacitor at Bluestone Valley was moved to Parachute and outages were simulated. The results are found in Table 16 below.

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Table 16. Alternative 4 after the RifleCu-Collbran-Grand Junction 138kV to 230kV upgrade, two capacitor banks at Bluestone Valley, one capacitor bank at Cameo, and one capacitor at Parachute

14HS_T2+500PS_CC120_SWB2C1P1_ALT4_4						
Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
CRAIG 230.00-RIFLE WA 230.00	1	CRAIG______345.0-MEEKER_____345.0-1	478.0	625.0	130.7	
CURECANT 115.00-SOCANAL 115.00	1	GRANDJCT____345.0-MONTROSE____345.0-1	120.0	167.6	139.7	
MONTROSE 115.00-SOCANAL 115.00	1	GRANDJCT____345.0-MONTROSE____345.0-1	120.0	157.5	131.3	

Table 16 shows placing a 45 MVAR capacitor bank at Parachute instead of placing a third 45 MVA capacitor bank at Bluestone Valley results in a more level voltage profile in the study area.

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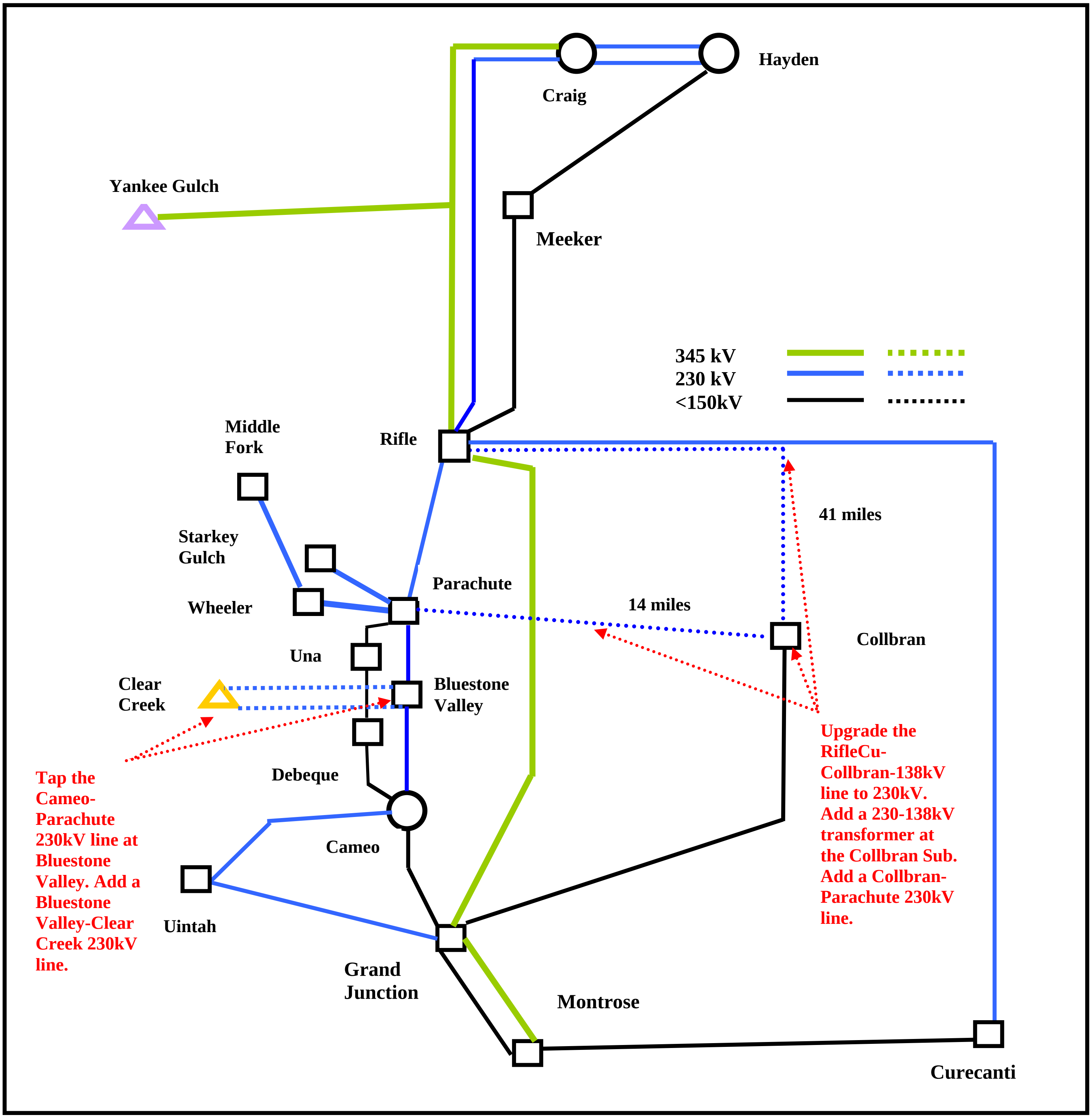
5. Alternative 5

Alternative 5 consists of a Bluestone Valley-Clear Creek 230kV double circuit line, a RifleCu-Collbran 138kV to 230kV Upgrade, a Colbran-Parachute 230kV line, and a Colbran 230-138kV transformer. See Figure 6 below.

Figure 6 – Alternative 5



Alternative 5 prior to the upgrade of the RifleCu-Collbran 138kV to 230kV and Collbran-Parachute 230kV line added is the same as Alternative 1 prior to the addition of the RiflePS-Parachute 230kV line #2. Therefore Alternative 5 prior to the upgrade of the RifleCu-Collbran 138kV to 230kV upgrade and Collbran-Parachute 230kV line has been studied in Alternative 1. The RifleCu-Collbran 138kV to 230kV upgrade was made to the case and the Collbran-Parachute 230kV line was added to the case. Outages were simulated and the results listed in the table below.

Table 17. Alternative 5 after the RifleCu-Collbran 138kV to 230kV upgrade, Collbran-Parachute 230kV line, two capacitor banks at Bluestone Valley, one capacitor bank at Cameo

14HS_T2+500PS_CC120_SWB2C1_ALT5_2						
Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
CRAIG 230.00-RIFLE WA 230.00	1	CRAIG______345.0-MEEKER_____345.0-1	478.0	624.7	130.7	
CURECANT 115.00-SOCANAL 115.00	1	GRANDJCT___345.0-MONTROSE___345.0-1	120.0	161.2	134.3	
GRANDJCT 115.00-GRANDJCT 138.00	T2	GRANDJCT___345.0-MONTROSE___345.0-1	50.0	64.6	129.2	
GRANDJCT 230.00-GRANDJCT 345.00	T1	BLUE_STN___230.0-PARACHUT___230.0-1	280.0	315.2	112.6	
GRANDJCT 69.000-GRANDJCT 115.00	T1	BLUE_STN___230.0-PARACHUT___230.0-1	42.0	45.9	109.3	
MONTROSE 115.00-SOCANAL 115.00	1	GRANDJCT___345.0-MONTROSE___345.0-1	120.0	151.1	125.9	

Alternative 5 is a superior alternative to Alternative 4 because it provides another source to the Parachute Substation.

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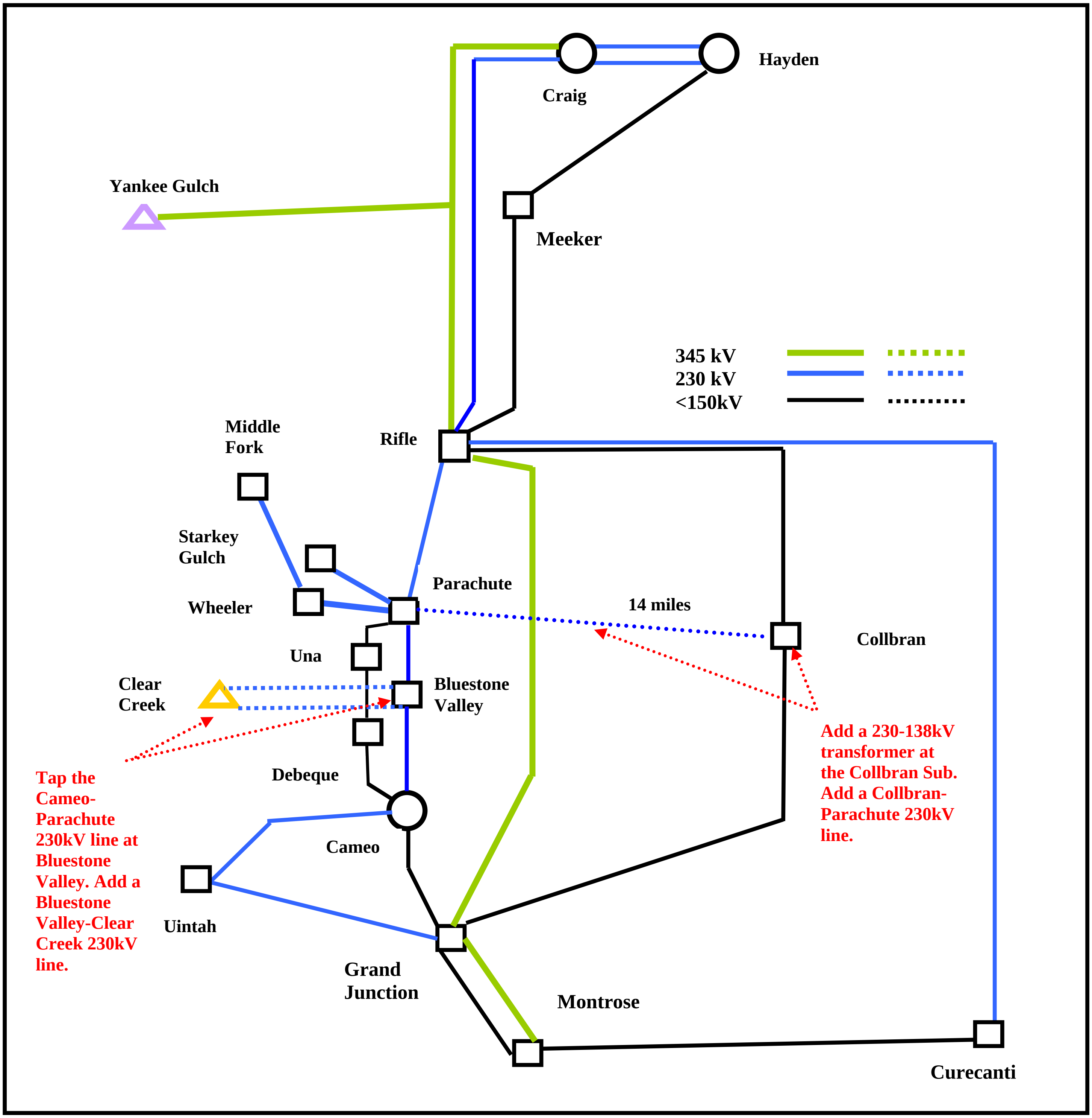
6. Alternative 6

Alternative 6 consists of a Bluestone Valley-Clear Creek 230kV double circuit line, a Collbran-Parachute 230kV Line, and a Collbran 230-138kV Transformer. See Figure 7 below.

Figure 7 – Alternative 6



Alternative 6 prior to the Collbran-Parachute 230kV line is the same as Alternative 1 prior to the addition of the RiflePS-Parachute 230kV line #2. Therefore Alternative 6 prior to the Collbran-Parachute 230kV line has been studied in Alternative 1. The Collbran-Parachute 230kV line was added to the case. Outages were simulated and the results listed in the table below.

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Table 18. Alternative 6 after the addition of the Collbran-Parachute 230kV line, two capacitor banks at Bluestone Valley, one capacitor bank at Cameo

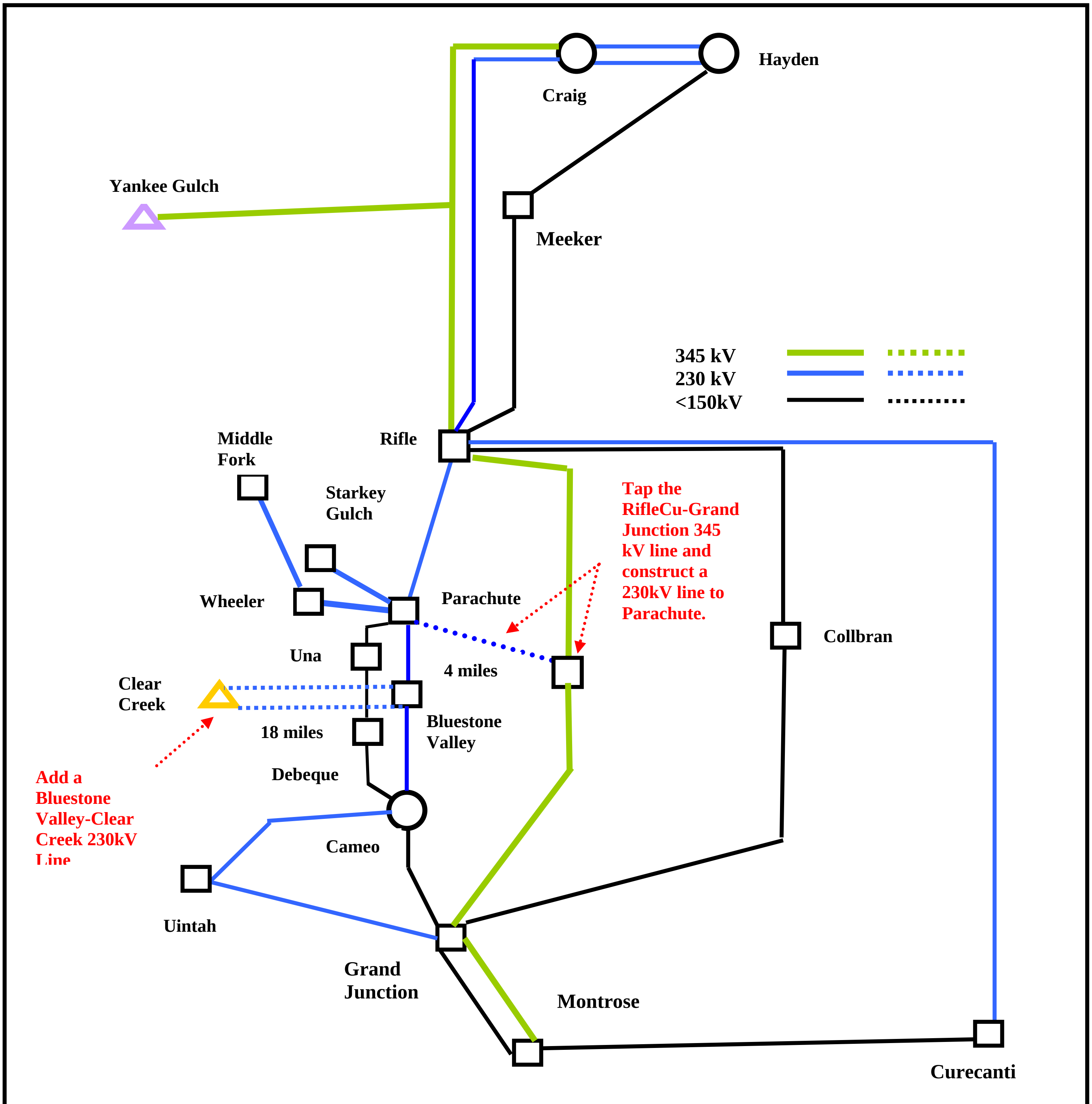
14HS_T2+500PS_CC120_SWB2C1_ALT6_2						
Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
ADOBE 230.00		CLIFTON_____230.0-GRANDJCT____230.0-1				0.867
BENCH 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.880
BLUE_STN 230.00		CLIFTON_____230.0-GRANDJCT____230.0-1				0.888
CAMEO 230.00		CLIFTON_____230.0-GRANDJCT____230.0-1				0.884
CLEARCRK 230.00		CLIFTON_____230.0-GRANDJCT____230.0-1				0.881
CLIFTON 230.00		CLIFTON_____230.0-GRANDJCT____230.0-1				0.864
CLIFTON 230.00		GRANDJCT___230.0-GRANDJCT____345.0-T1				0.868
COLBRAN 138.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.888
COLBRAN 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.883
COLBRAN 230.00-COLBRAN 138.00	1	PARACHUT____230.0-RIFLE_PS____230.0-1	100.0	123.3	123.3	
CRAIG 230.00-RIFLE WA 230.00	1	CRAIG_______345.0-MEEKER______345.0-1	478.0	622.5	130.2	
CURECANT 115.00-SOCANAL 115.00	1	GRANDJCT____345.0-MONTROSE____345.0-1	120.0	162.6	135.5	
GRANDJCT 115.00-GRANDJCT 138.00	T2	GRANDJCT____345.0-MONTROSE____345.0-1	50.0	64.8	129.7	
GRANDJCT 138.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.891
GRANDJCT 230.00		GRANDJCT___230.0-GRANDJCT____345.0-T1				0.868
GRANDJCT 230.00-GRANDJCT 345.00	T1	BLUE_STN____230.0-PARACHUT____230.0-1	280.0	315.5	112.7	
GRANDJCT 69.000-GRANDJCT 115.00	T1	BLUE_STN____230.0-PARACHUT____230.0-1	42.0	46.4	110.6	
GRANDJPS 230.00		CLIFTON_____230.0-GRANDJCT____230.0-1				0.864
HORIZON 230.00		CLIFTON_____230.0-GRANDJCT____230.0-1				0.864
MEEKER 138.00-RIFLE_CU 138.00	1	CRAIG_______345.0-MEEKER______345.0-1	124.0	124.3	100.2	
MONTROSE 115.00-SOCANAL 115.00	1	GRANDJCT____345.0-MONTROSE____345.0-1	120.0	152.3	126.9	
PARACHUT 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.885
PARACHUT 230.00-RIFLE_PS 230.00	1	GRANDJCT____345.0-RIFLE_CU____345.0-1	439.0	469.1	106.8	
STKGULCH 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.885
UINTAH 230.00		CLIFTON_____230.0-GRANDJCT____230.0-1				0.870
WEELERPS 230.00		PARACHUT____230.0-RIFLE_PS____230.0-1				0.884

Table 18 shows that Alternative 6 is inferior to Alternative 5. Although the Collbran-Parachute 230kV line prevented a severe voltage depression, it did not mitigate low voltages in the area. In addition, the RiflePS-Parachute 230kV line #2 is still required because of the contingency overload of the RiflePS-Parachute line for loss of the RifleCu-Grand Junction 345kV line.

7. Alternative 7

Alternative 7 consists of the Clear Creek-Bluestone Valley 230kV double circuit line, tap of the RifleCu-Grand Junction 345kV line, and construction of a 230kV line from the tap to Parachute. See Figure 8 below.

Figure 8 – Alternative 7



Alternative 7 prior to the Tap-Parachute 230kV line is the same as Alternative 1 prior to the addition of the RiflePS-Parachute 230kV line #2. Therefore Alternative 7 prior to the Tap-Parachute 230kV line has been studied in Alternative 1.

The RifleCu-Grand Junction 345kV line was tapped at a new substation. A 345-230kV transformer was added at the tap and a 230kV transmission line was added from the tap substation to the Parachute Substation. Outages were simulated and the results listed in the table below.

Table 19. Alternative 7 after the addition of the Tap-Parachute 230kV line, two capacitor banks at Bluestone Valley, one capacitor bank at Cameo

14HS_T2+500PS_CC120_SWB2C1_ALT7-2						
Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
BLUE_STN 230.00-PARACHUT 230.00	**1**	GRANDJCT____345.0-RIFGRATP____345.0-1	436.0	440.3	**101.0**	
CRAIG 230.00-RIFLE WA 230.00	1	CRAIG______345.0-MEEKER______345.0-1	478.0	622.8	130.3	
CRAIG 230.00-RIFLE WA 230.00	1	RIFLE_CU____345.0-MEEKER______345.0-1	478.0	608.5	127.3	
CURECANT 115.00-SOCANAL 115.00	1	GRANDJCT____345.0-MONTROSE____345.0-1	120.0	162.7	135.6	
CURECANT 115.00-SOCANAL 115.00	1	CURECANT____230.0-LOSTCANY____230.0-1	120.0	152.8	127.3	
CURECANT 115.00-SOCANAL 115.00	1	GRANDJCT____345.0-RIFGRATP____345.0-1	120.0	152.3	126.9	
CURECANT 115.00-SOCANAL 115.00	1	RIFLE_CU____345.0-RIFGRATP____345.0-1	120.0	142.8	119.0	
CURECANT 115.00-SOCANAL 115.00	1	NORTHFRK____115.0-NORTHFRK____230.0-1	120.0	126.9	105.8	
GRANDJCT 115.00-GRANDJCT 138.00	T2	GRANDJCT____345.0-MONTROSE____345.0-1	50.0	61.2	122.4	
GRANDJCT 115.00-GRANDJCT 138.00	T2	RIFLE_CU____345.0-RIFGRATP____345.0-1	50.0	61.1	122.2	
GRANDJCT 115.00-GRANDJCT 138.00	T2	GRANDJCT____345.0-RIFGRATP____345.0-1	50.0	60.1	120.2	
GRANDJCT 115.00-GRANDJCT 138.00	T2	BLUE_STN____230.0-PARACHUT____230.0-1	50.0	52.2	104.3	
GRANDJCT 230.00-GRANDJCT 345.00	T1	BLUE_STN____230.0-PARACHUT____230.0-1	280.0	318.3	113.7	
GRANDJCT 69.000-GRANDJCT 115.00	T1	BLUE_STN____230.0-PARACHUT____230.0-1	42.0	43.8	104.2	
MONTROSE 115.00-SOCANAL 115.00	1	GRANDJCT____345.0-MONTROSE____345.0-1	120.0	152.3	126.9	
MONTROSE 115.00-SOCANAL 115.00	1	CURECANT____230.0-LOSTCANY____230.0-1	120.0	143.2	119.3	
MONTROSE 115.00-SOCANAL 115.00	1	GRANDJCT____345.0-RIFGRATP____345.0-1	120.0	142.8	119.0	
MONTROSE 115.00-SOCANAL 115.00	1	RIFLE_CU____345.0-RIFGRATP____345.0-1	120.0	133.9	111.6	
PARACHUT 230.00-RIFLE_PS 230.00	**1**	RIFLE_CU____345.0-RIFGRATP____345.0-1	439.0	592.5	**135.0**	
RIFGRATP 345.00-RIFGRATP 230.00	T1	GRANDJCT____345.0-RIFGRATP____345.0-1	280.0	302.0	107.8	
RIFGRATP 345.00-RIFGRATP 230.00	T1	PARACHUT____230.0-RIFLE_PS____230.0-1	280.0	280.9	100.3	

Alternative 7 is not reliable. Contingency overloads occur for several facilities including the RiflePS-Parachute 230kV line for an outage of the RifleCu-RifGraTap 345kV line and the Parachute-Bluestone Valley 230kV line for an outage of the RifGraTap-Grand Junction 345kV line.

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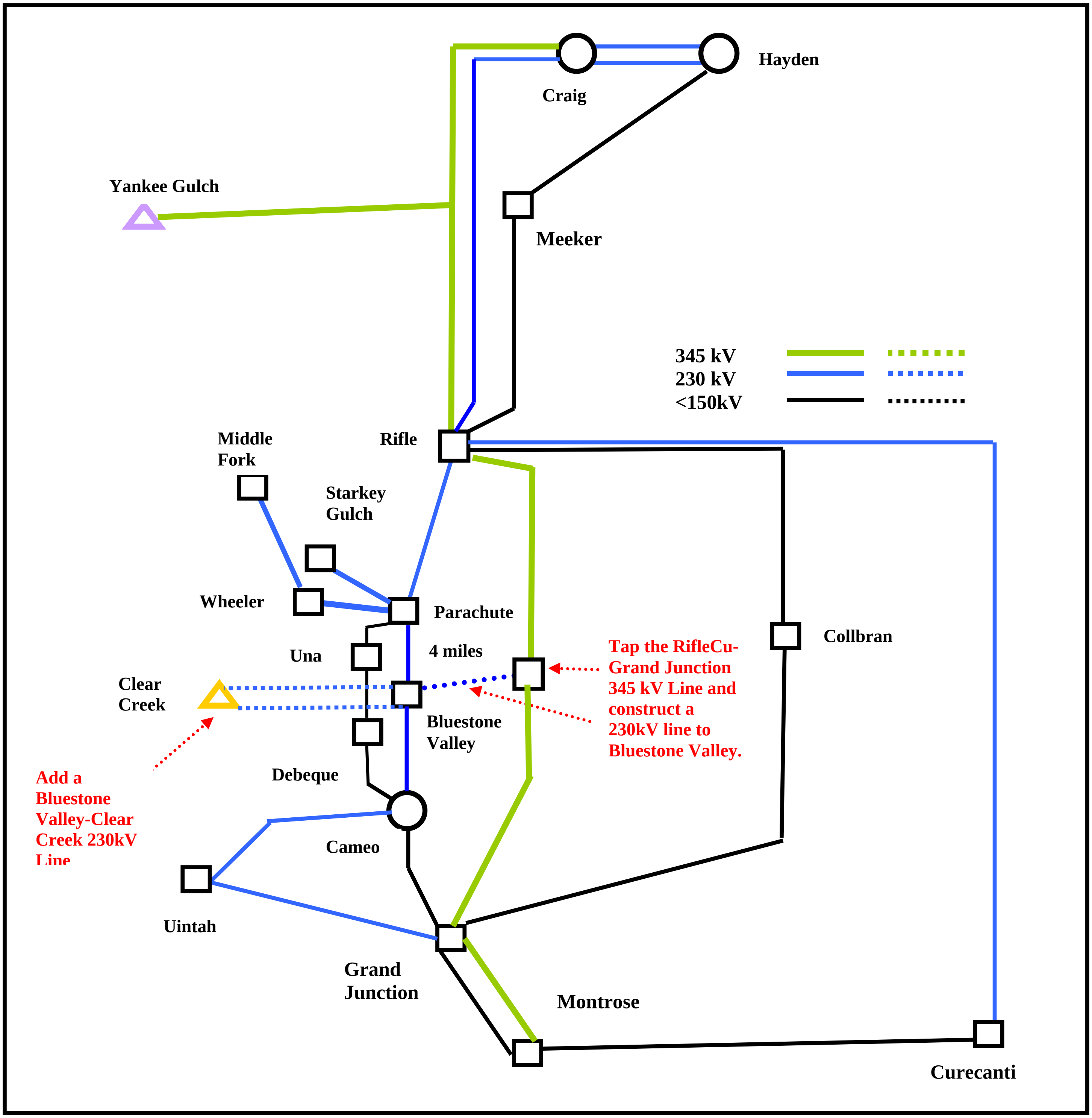
8. Alternative 8

Alternative 8 consists of the Clear Creek-Bluestone Valley 230kV double circuit line, tap of the RifleCu-Grand Junction 345kV line and construction of a 230kV line from the tap to Bluestone Valley. See Figure 9 below.

Figure 9 – Alternative 8



Alternative 8 prior to the Tap-Bluestone Valley 230kV line is the same as Alternative 1 prior to the addition of the RiflePS-Parachute 230kV line #2. Therefore Alternative 8 prior to the Tap-Bluestone Valley 230kV line has been studied with Alternative 1.

The RifleCu-Grand Junction 345kV line was tapped at a new substation. A 345-230kV transformer was added at the tap and a 230kV transmission line was added from the tap substation to the Bluestone Valley Substation. Outages were simulated and the results listed in the table below.

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Table 20. Alternative 8 after the addition of the Tap-Bluestone Valley 230kV line, two capacitor banks at Bluestone Valley, one capacitor bank at Cameo

Case: 14HS_T2+500PS_CC120_SWB2C1_M5.sav						
Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
BENCH 230.00		RIFLE_CU____345.0-RIFGRATP____345.0-1				0.899
BLUE_STN 230.00-PARACHUT 230.00	**1**	RIFLE_CU____345.0-RIFGRATP____345.0-1	436.0	440.7	**101.1**	
CRAIG 230.00-RIFLE WA 230.00	1	CRAIG_______345.0-MEEKER______345.0-1	478.0	621.5	130.0	
CRAIG 230.00-RIFLE WA 230.00	1	RIFLE_CU____345.0-MEEKER______345.0-1	478.0	607.1	127.0	
CURECANT 115.00-SOCANAL 115.00	1	GRANDJCT____345.0-MONTROSE____345.0-1	120.0	161.9	134.9	
CURECANT 115.00-SOCANAL 115.00	1	CURECANT____230.0-LOSTCANY____230.0-1	120.0	151.9	126.6	
CURECANT 115.00-SOCANAL 115.00	1	RIFLE_CU____345.0-RIFGRATP____345.0-1	120.0	149.2	124.3	
CURECANT 115.00-SOCANAL 115.00	1	GRANDJCT____345.0-RIFGRATP____345.0-1	120.0	146.2	121.9	
CURECANT 115.00-SOCANAL 115.00	1	NORTHFRK____115.0-NORTHFRK____230.0-1	120.0	125.9	104.9	
GRANDJCT 115.00-GRANDJCT 138.00	T2	RIFLE_CU____345.0-RIFGRATP____345.0-1	50.0	63.8	127.6	
GRANDJCT 115.00-GRANDJCT 138.00	T2	GRANDJCT____345.0-MONTROSE____345.0-1	50.0	60.0	119.9	
GRANDJCT 115.00-GRANDJCT 138.00	T2	GRANDJCT____345.0-RIFGRATP____345.0-1	50.0	56.2	112.4	
MONTROSE 115.00-SOCANAL 115.00	1	GRANDJCT____345.0-MONTROSE____345.0-1	120.0	151.5	126.2	
MONTROSE 115.00-SOCANAL 115.00	1	CURECANT____230.0-LOSTCANY____230.0-1	120.0	142.4	118.7	
MONTROSE 115.00-SOCANAL 115.00	1	RIFLE_CU____345.0-RIFGRATP____345.0-1	120.0	139.9	116.6	
MONTROSE 115.00-SOCANAL 115.00	1	GRANDJCT____345.0-RIFGRATP____345.0-1	120.0	137.3	114.4	
PARACHUT 230.00-RIFLE_PS 230.00	**1**	RIFLE_CU____345.0-RIFGRATP____345.0-1	439.0	557.0	**126.9**	
RIFGRATP 345.00-RIFGRATP 230.00	T1	GRANDJCT____345.0-RIFGRATP____345.0-1	280.0	342.1	122.2	
RIFGRATP 345.00-RIFGRATP 230.00	T1	PARACHUT____230.0-RIFLE_PS____230.0-1	280.0	304.5	108.7	

Alternative 8 is not reliable. Contingency overloads occur for several facilities including the RiflePS-Parachute 230kV line for an outage of the RifleCu-RifGraTap 345kV line and the Parachute-Bluestone Valley 230kV line for an outage of the RifGraTap-Grand Junction 345kV line.

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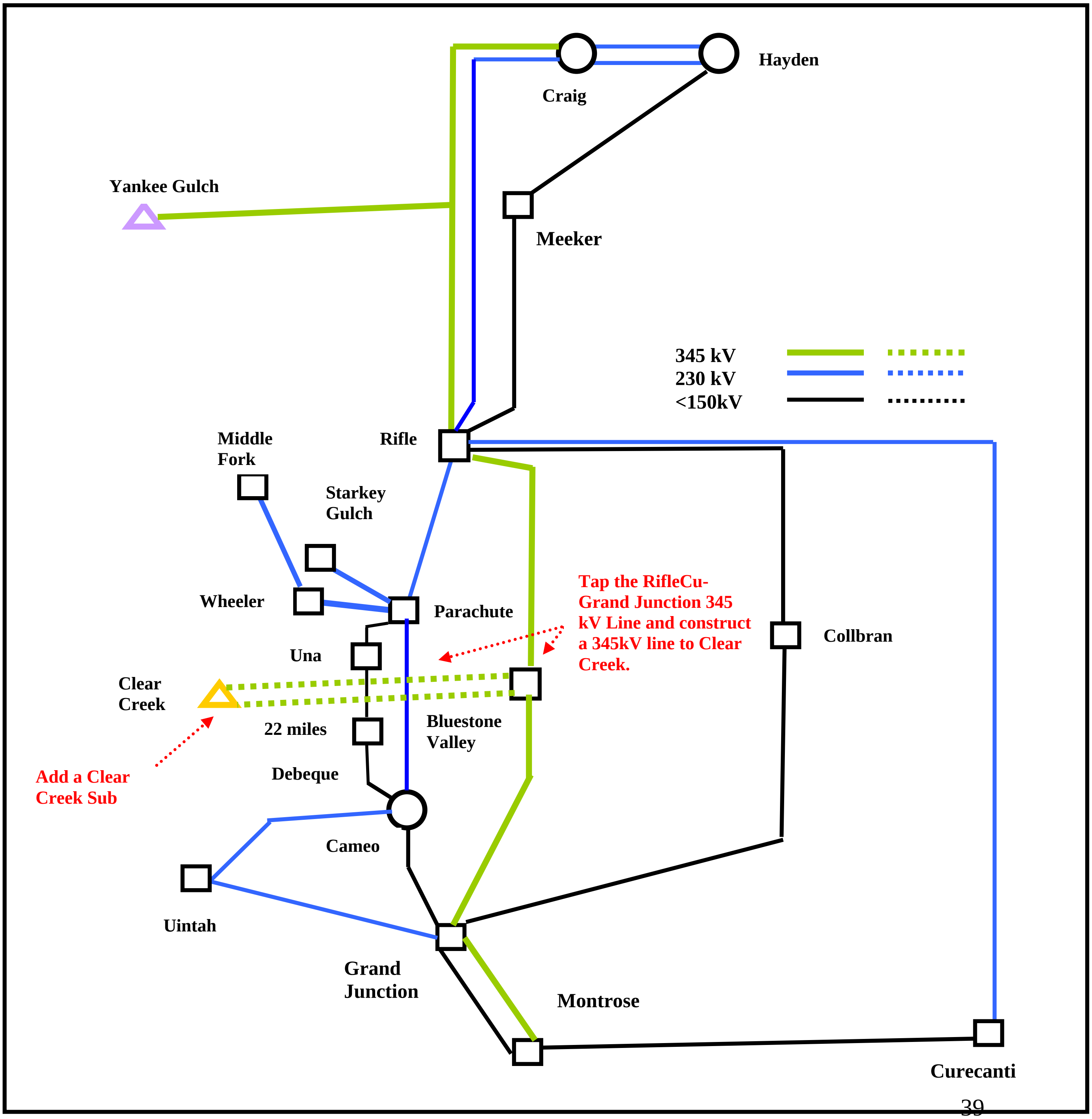
9. Alternative 9

Alternative 9 consists of the tap of the RifleCu-Grand Junction 345kV line and the construction of a 345kV double circuit line from the tap to Clear Creek. See Figure 10 below.

Figure 10 – Alternative 9



Alternative 9 was modeled as follows:

- The RifleCu-Grand Junction 345kV line was tapped at a new tap substation and a 22-mile 230kV transmission line was modeled from the tap substation to the Customer Substation called Clear Creek.
- A 120 MW load was represented at Clear Creek

Facility outages were simulated and the results are listed in the table below.

Table 21. Alternative 9 with one capacitor bank at Cameo, two capacitor banks at Parachute

14HS_T2+500PS_CC120_SWC1P2_ALT9_1						
Monitored Element	Ckt	Limiting Contingency	Rating	LnFlow	%O/L	V-Cont
CRAIG 230.00-RIFLE WA 230.00	1	CRAIG______345.0-MEEKER______345.0-1	478.0	620.5	129.8	
CURECANT 115.00-SOCANAL 115.00	1	RIFLE_CU____345.0-RIFGRATP____345.0-1	120.0	169.0	140.8	
GRANDJCT 115.00-GRANDJCT 138.00	T2	RIFLE_CU____345.0-RIFGRATP____345.0-1	50.0	68.7	137.3	
GRANDJCT 230.00-GRANDJCT 345.00	T1	PARACHUT____230.0-RIFLE_PS____230.0-1	280.0	299.4	106.9	
GRANDJCT 69.000-GRANDJCT 115.00	T1	PARACHUT____230.0-RIFLE_PS____230.0-1	42.0	42.5	101.1	
MONTROSE 115.00-SOCANAL 115.00	1	RIFLE_CU____345.0-RIFGRATP____345.0-1	120.0	157.9	131.6	
PARACHUT 230.00-RIFLE_PS 230.00	**1**	RIFLE_CU____345.0-RIFGRATP____345.0-1	439.0	445.5	**101.5**	

The table shows that even moving the Clear Creek load over to the 345kV system does not result in a reliable system. Loss of the 345kV line between Rifle and the proposed 345kV tap substation results in the overload of the RiflePS-Parachute 230kV line as the power finds an alternative path to the 120 MW load.

F. Conclusions

Three alternatives were considered for the preferred alternative - Alternative 1, Alternative 2, and Alternative 5.

Alternative 1 consists of the construction of an 18-mile Clear Creek-Bluestone Valley 230kV double circuit line and a 21-mile RifleCu-Parachute 230kV line #2.

Alternative 1 consists of the construction of a 33-mile Clear Creek-Parachute 230kV double circuit line and a 21-mile RifleCu-Parachute 230kV line #2.

Alternative 5 consists of the construction of an 18-mile Clear Creek-Bluestone Valley 230kV double circuit line, the upgrade of the 41-mile RiflePS-Collbran 138kV line to 230kV, and the construction of a 14-mile Collbran-Parachute 230kV line.

All three alternatives will require capacitor bank additions, transformer additions, and/or transformer replacements and transmission line additions. Alternative 1 and Alternative 2 have the advantage over Alternative 5 as they provide opportunity to serve load more easily in the Piceance Basin. The RifleCu-Collbran-Parachute 230kV line would be several miles from this load development. Alternative 5 is a desirable alternative because it requires less miles of new construction; however, this advantage may be more than offset by the large number of miles of transmission rebuild. Alternative 5 is also beneficial because it allows PSCo the opportunity to replace old 138kV transmission facilities with new 230kV transmission facilities.

Alternative 1 has fewer miles of double circuit 230kV construction than Alternative 2 and the siting would likely be easier. Alternative 2 would not require a new substation (Bluestone Valley) and has less impact on the transformers at Grand Junction Substation; however it will require work at Parachute Substation to terminate the double circuit line. Alternative 1 has the cheapest total cost of the three alternatives.

The conclusion of the study is that Alternative 1 is the preferred alternative.