

Foothills Joint Queue Study

2007-T19: Ron Carey

2008-T1: Gateway

2008-T3: Timnath2

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Rocky Mountain Region

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Executive Summary

Tri-State Generation & Transmission (Tri-State) and Xcel Energy (Xcel) have made requests to serve future load growth within their respective service territories connecting to The Western Area Power Administration's (Western's) transmission system. Tri-State's formal requests are for their Ron Carey (Carey), 2007-T19 and Gateway, 2008-T1 substations. Xcel's request is for their Timnath (Timnath2) substation, 2008-T3. All three proposed substations are located East of I-25 in a corridor that spans approximately 20 miles in length and (possibly) a few miles wide. Pending final locations, Timnath2 and Carey are separated by approximately three miles and Gateway roughly fifteen miles south of Carey. Because of this close proximity and possible cost savings, a decision was made to combine the requests into this 'Joint Study'. Gateway remains in this final draft, however, because of possible annexation issues its development may be abandoned by Tri-State. A fourth load request made by Xcel, Kelim, was included in early study stages of the joint effort but because of its in-service date, it was removed from the Joint Study and will be performed separately.

Multiple configurations at various voltages were simulated over the summer of 2008. One variant proposed connections to the Platt River Power Authority's (PRPA's) Ault-Timberline and Boyd-Longs Peak 230 kV transmission lines. Because of the relative small system impact and these lines offering the closest proximity, further development will concentrate on exploring this option. These lines are not property of Western and results obtained herein will be presented as part of the formal request process and as shared knowledge for PRPA's, Tri-State's, Xcel's and Western's future efforts.

This study shows minimal impacts to the Western system due to proposed loads additions. However, there are existing issues within the East-West 115 kV transmission corridor that encompass the Weld-Windsor (tap)-Airport-Boyd substations this study will address. An additional objective of this study is to document the shortcomings within this 115 kV corridor and propose a solution that includes adding a substation (Promontory) East of Windsor Tap and rebuilding the single circuit 115 kV transmission sections of this line to double circuit 230 kV operation. Table A contains preliminary construction costs of the East-West corridor upgrades.

Section of Corridor Upgraded	Subtotal (millions)
Weld to Promontory (includes new 'Promontory' substation East of Windsor Tap)	8.7
Promontory to Airport (includes new 230/115 kV 200 MVA transformer)	7.6
Airport to Boyd (transmission only)	5
Estimated Total:	21.3

I. Introduction

The purpose of this study is to incorporate three load requests made to WAPA. Two of the requests have been made by Tri-State and one by XCEL. These three requests reside East of I-25 between South Fort Collins and Johnstown, spread out over approximately over 20 miles. Because they generally lie on a plane which is parallel to I-25 and the potential for a combined project exists, the decision was made to combine the studies. The tentative name, approximate location, MVA requirements and pertinent information are summarized in the following table:

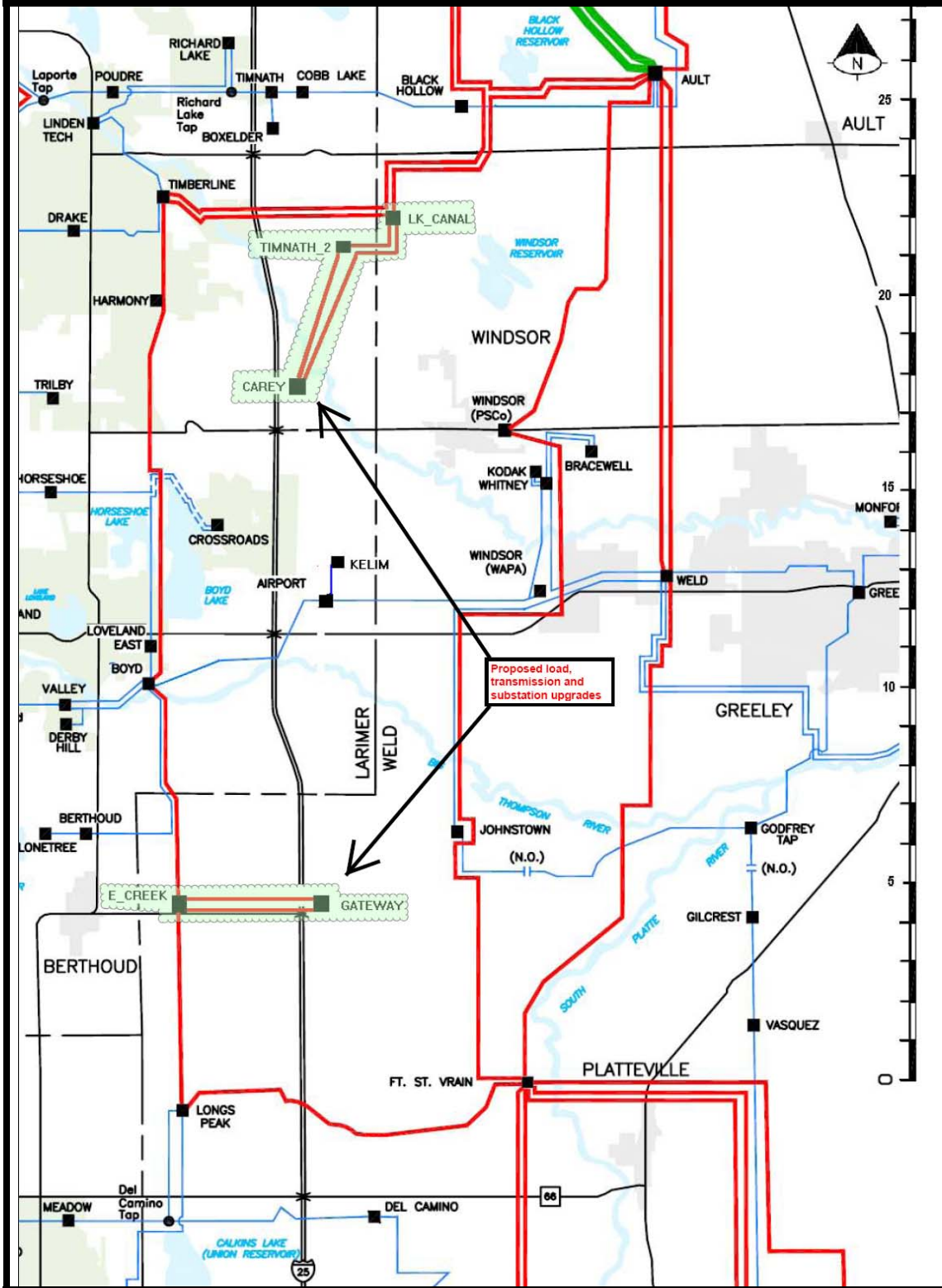
Request #	Substation Name	Approximate Distance (N or S) from Airport substation	Requested In-service date	Size MW	Requesting entity
2007-T16	Timnath2	Nine North	5/31/2009	10	XCEL
2007-T19	Carey	Six North	12/01/2008	20.2	Tri-State G&T
2008-T3	Gateway	Five South	12/01/2009	11.4	Tri-State G&T

Because of anticipated growth, existing infrastructure in the area and potential interconnection options, several variations of a North-South route were studied. The joint effort intention was to combine load service and enhance transfer capability around the TOT7. Preliminary studies explored variants of a single transmission line connecting at North-East Ft. Collins, traveling South (East of I-25), then turning West at Johnstown and terminating North-East of Berthoud. The decision to explore minimum transmission necessary while maximizing shared infrastructure to serve load with options for future transmission expansion is what the final iteration of this report contains.

This study will first perform power flow analysis on the system as is expected to exist in the 2012 time frame. (Case A) Second, the load requests will be simulated in the model and power flow analysis will be rerun. (Case B)

Additionally, all entities are aware of increasing loading and congestion issues in the East-West corridor on the Weld-Windsor (tap)-Airport-Boyd segment. Because of the proximity to load requests to the aforementioned East-West corridor issues, a series of upgrades was simulated and studied as part of the joint effort with the intention of documenting these issues and possible future solutions. The three aforementioned East-West upgrades will be progressively added to case 1 and power flow will be performed on these three cases (Case C, Case D, and Case E)

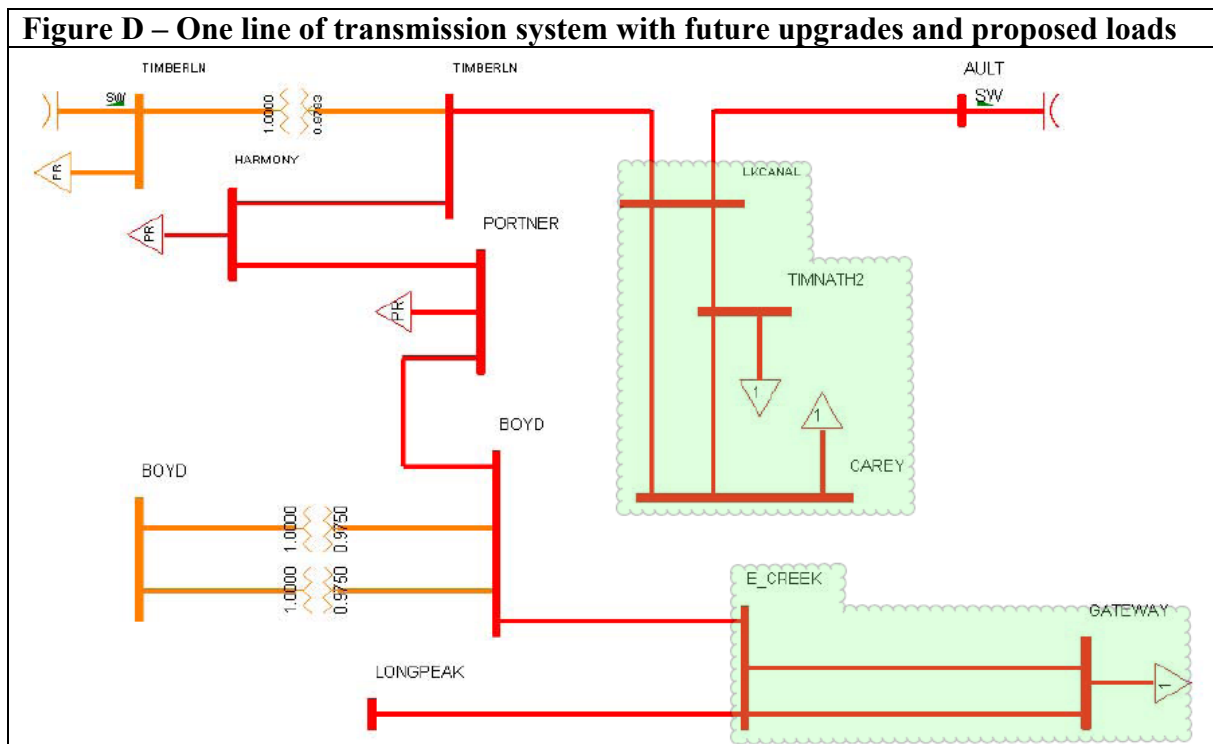
Figure B: System Configuration – Proposed Loads shown (Case B)



II. Methodology

A. Load requests:

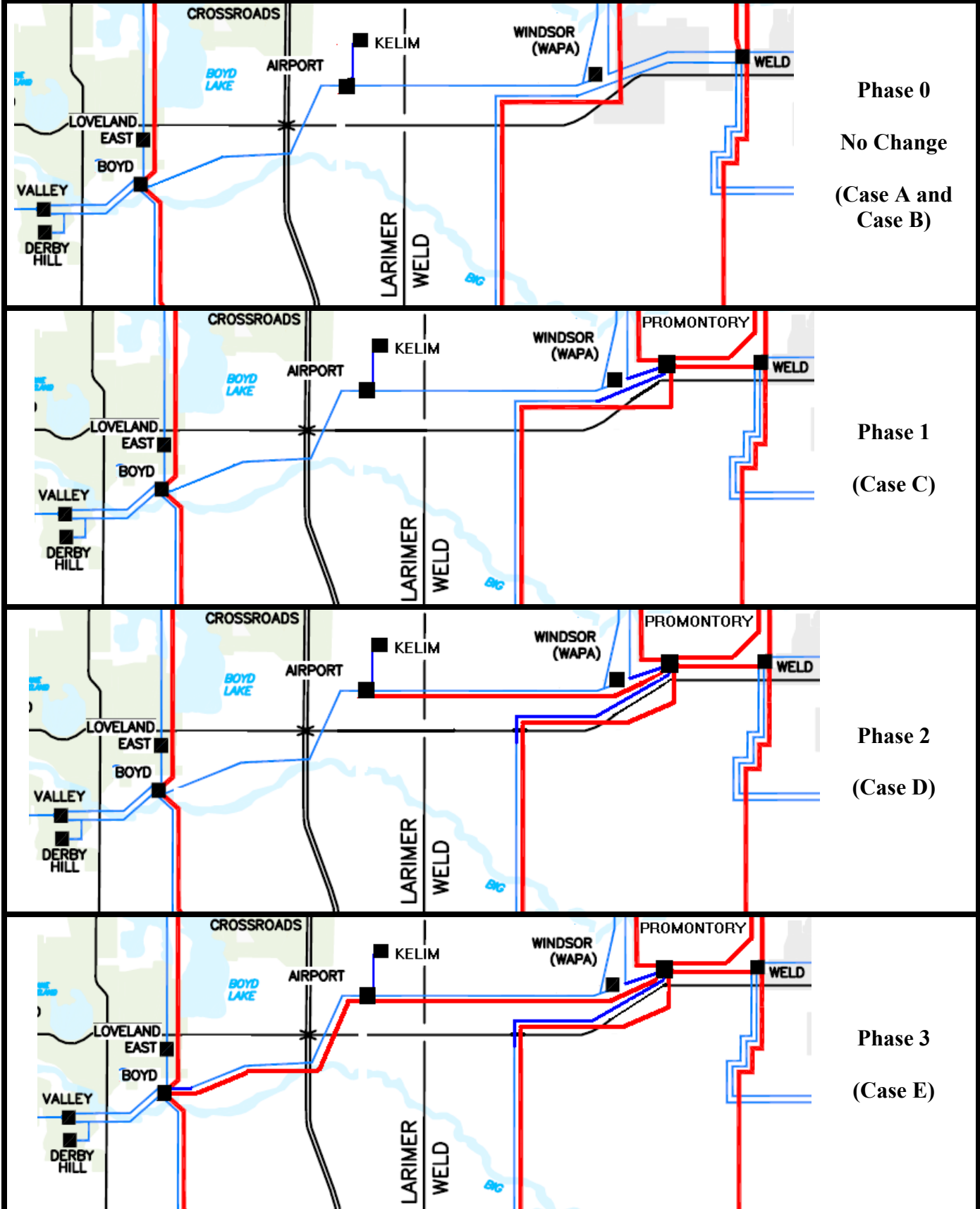
- i. Carey and Timnath2 Substation load service: The proposed locations for both Carey and Timnath2 substations are relatively close to the Ault-Timberline 230 kV transmission line. Both entities expressed desire to serve their loads at 230 kV in anticipation of future load growth. As such, Platte River Power Authority articulated willingness to sectionalize this line at an appropriate location with a proper switchyard to accommodate these load service requests. A preliminary configuration agreed upon was a double circuit from a proposed switchyard named Lake Canal to Carey substation. One of the circuits will terminate at Timnath2 before continuing on to Carey. See figure D for a one-line representation of these circuits.
- ii. Gateway Substation load service: Service of the proposed Gateway load, East of Johnstown, was simulated in various configurations. The final design requested was a double 230 kV circuit originating at a newly proposed switchyard named East Creek. East Creek will sectionalize the Boyd-Longs peak 230 kV line roughly midway, east of Johnstown. Gateway remains in this final draft for informational purposes, however, because of annexation issues; its development may be abandoned by Tri-State. See figure D for a one-line representation of these circuits.



B. Weld – Boyd (East-West) Proposed Transmission Corridor Upgrades

- i. No Change (Phase 0): This option makes no changes to the established Weld-Boyd corridor and should be considered the ‘base’ to which each North-South proposal begins its analysis. This East-West configuration will be referred to as phase 0. Refer to Figure C.
- ii. Weld- Promontory Park 230 kV (Phase 1): This option proposes rebuilding the two 115 kV circuits West of Weld and adding the Promontory Park substation situated East of WAPA’s Windsor tap. The rebuilt circuits will be constructed and operated at 230 kV. In this corridor, one of the circuits will originate from the Weld 230 kV bus, the other will be the re-routing of the Ault-Weld #1 line to bypass Weld substation and terminate directly at Promontory. The Windsor-Ft. St Vrain 230 kV line will now terminate at Promontory, forming Windsor-Promontory and Promontory-Ft. ST Vrain 230 kV circuits. The former Whitney-Weld and Johnstown-Weld 115 kV circuits will now terminate at Promontory Park 115 kV bus forming Whitney-Promontory and Johnstown-Promontory 115 kV circuits. One 230/115 kV 200 MVA transformer was studied at the proposed Promontory Park. This East-West configuration will be referred to as phase 1. Refer to Figure C.
- iii. Weld-Promontory Park-Airport 230 kV (Phase 2): This option includes all the upgrades listed above (ii.) and adds a 230 kV circuit between Promontory Park and Airport substation. Studies were performed with a 230/115 kV 200 MVA transformer and 230 kV bus at Airport substation and should be considered an integral part of the upgrade. This East-West configuration will be referred to as phase 2. Refer to Figure C.
- iv. Weld-Promontory Park-Airport-Boyd 230 kV (Phase 3): This option includes all upgrades listed above (iii) and adds a 230 kV circuit between Airport and Boyd. This East-West configuration will be referred to as phase 3. Refer to Figure C.

Figure C: Transmission Corridor Configuration Phases



C. TOT7 Considerations

TOT7 includes three 230-kV transmission lines, consisting of:

- Weld – Ft. St Vrain
- Ault/Windsor – Ft. St Vrain
- Longs Peak – Ft. St Vrain

Because the configurations studied are directly North of TOT7, it was stressed for all contingency runs. According to the nomogram, TOT7 was estimated to be 750 MW based on projected load and output of the Colorado Big Thomson project (CBT) generation for that time frame.

III. Base Case

A. Inclusions to request/study

For this study, a WECC 2012HS2AP case was utilized as the starting point to build upon. Extensive system configuration upgrades that did not make it in to this case during its original construction are included. Entities involved with providing data include, but are not limited to: Black Hills Power and Light, Western Area Power Administration, XCEL energy, Tri-State G&T, Platte River Power Authority and PacifiCorp. A copy of the compiled changes in the format of a Python file may be obtained upon request.

Noteworthy changes included in the study case are the following:

- Western's Miracle Mile – Ault 230 kV rebuild.
- Western's Eastern Colorado 115 kV to 230 kV system upgrades.
- Platte River Power Authority's foothills system upgrades.
- 230 kV system upgrades in Northern Wyoming.
- Topology corrections in the Dave Johnston area.
- Removal of the Eastern Plains Transmission Project.
- Numerous load, line, generation and transformer corrections and/or additions from all contributing entities.

IV. Criteria

A. System Intact

Voltages will remain within the required 0.95 to 1.05 per unit range. Transmission lines and transformers may not exceed 100 % of their nominal rating.

B. Contingencies

Voltages will remain between 0.90 and 1.10 per unit. Transmission lines and transformers may not exceed either 100% of their nominal rating or an established emergency rating.

V. Results

Overload table:

PROPOSED LOADS STATUS →			OUT	IN	IN	IN	IN	
PROMONTORY STATUS →			PHASE 0	PHASE 0	PHASE 1	PHASE 2	PHASE 3	
CASE REFERENCE →			A	B	C	D	E	
MONITORED ELEMENT		CONTINGENCY						
70410 ST.VRAIN	230	WLD_M.B.*C	107.0%	106.9%				This simulated contingency replicates the tripping of actual elements during a Weld.LM-Weld.PS main bus fault. A bus fault trips the bus, both Ault-Weld lines and effectively knocks out the Weld.LM 230/115 XFMR. Cases A&B cannot really be compared to C,D&E b/c it would not act the same way with a new configuration and the lack of the Ault-Weld#2 line, currently terminating at Weld. However, Promontory does 'act' to fix this overload.
70474 WINDSOR	230 1		533MVA	532MVA				
70474 WINDSOR	230	WLD_M.B.*C	112.6%	112.5%				Promontory does 'act' to fix this overload.
73011 AULT	230 1		561MVA	560MVA				
73095 KERSEYTP	115	WLD_M.B.*C	101.8%	103.0%				Promontory does fix this overload.
73158 PROSPEC	115 1		112MVA	113MVA				
73211 WELD LM	115	WLD.PS.LM230	150.3%	150.9%	103.0%	100.4%		If the current WAPA.LM 230 kV bus were reconfigured to allow a single line outage (Ault-Weld #1 or #2), then this becomes a valid comparison and overloads are fixed or improved.
73212 WELD LM	230 1		225MVA	226MVA	154MVA	151MVA		
70410 ST.VRAIN	230	WLD.PS.LM230			117.4%	112.2%	103.6%	This will be the next challenge to face if Promontory is constructed. When either the Ault-Weld#1 or proposed Ault-Promontory (formerly Ault-Weld#2) relays, small overloads occur on the opposite line.
94201 PROMONTORY	230 1				587MVA	561MVA	518MVA	
73011 AULT	230	AULT_PROM				101.3%	103.0%	Promontory does improve this overloading.
73212 WELD LM	230 1					522MVA	530MVA	
73011 AULT	230	*AULT_WELD#1				101.3%	103.4%	
94201 PROMONTORY	230 1					522MVA	532MVA	
73198 TIMBERLN	115	LPRT_DIX.CK	116.9%	116.9%	114.7%	107.9%	108.5%	
73199 TIMBERLN	230 1		196MVA	196MVA	193MVA	181MVA	182MVA	

CONTINGENCY LEGEND:

WLD_M.B.*C : TRIP LINE FROM BUS 73212 [WELD LM 230] TO BUS 70471 [WELD PS 230] CKT 1
 TRIP LINE FROM BUS 73212 [WELD LM 230] TO BUS 73011 [AULT 230] CKT 1
 TRIP LINE FROM BUS 73212 [WELD LM 230] TO BUS 73011 [AULT 230] CKT 2
 TRIP LINE FROM BUS 73212 [WELD LM 230] TO BUS 73211 [WELD LM 115] CKT 1
 WLD.PS.LM230: TRIP LINE FROM BUS 70471 [WELD PS 230] TO BUS 73212 [WELD LM 230] CKT 1
 *AULT_WELD#1: TRIP LINE FROM BUS 73011 [AULT 230] TO BUS 73212 [WELD LM 230] CKT 1
 LPRT_DIX.CK : TRIP LINE FROM BUS 73106 [LAPORTE 230] TO BUS 73467 [DIXON CK 230] CKT 1
 AULT_PROM : TRIP LINE FROM BUS 73011 [AULT 230] TO BUS 94201 [PROMONTORY 230] CKT 1

VI. Conclusion

In 2008, the Foothills Joint Study simulated several topology options with the intention of serving new load requests while combining transmission in an effort to minimize costs. Load service at both 115 kV and 230 kV were simulated and options explored. After several iterations, the topology detailed in this report was considered for power flow analysis. Adding the Carey, Timnath2 and Gateway loads revealed no significant impact to Western's transmission system.

Currently, the 230 kV transmission system between Ault and Ft.St. Vrain leaves Ault as four circuits and terminates in Ft. St Vrain as three circuits in the following configuration:

Ault-Timberline-Boyd-Longs Peak - Ft. St Vrain
Ault-Windsor- Ft.St. Vrain
Ault-Weld #1- } Ft. St. Vrain
Ault Weld #2- }

Two 230 kV circuits leave Ault and terminate at Weld, but only one leaves Weld and continues to Ft. St Vrain. This two-to-one reduction can create a bottleneck at Weld. In an effort to reduce this bottleneck an additional substation, Promontory, was simulated. The addition of Promontory substation effectively 'moves' part of the Weld 230 kV bus a few miles West, significantly reducing the Weld bottleneck. Final build out of the 230 kV East-West (Weld-Promontory-Airport-Boyd) portion of the upgrade significantly reduces power being 'trapped at' or 'pushed away' from Weld substation.

Comparing overloads before and after the simulation of Promontory substation are complex because of the fundamentally different topology contained within each system. Forced outages that can occur currently would not arise based on topologies studied. If an equivalent comparison of the current and potential future Weld 230 kV bus tie is considered, overloads on the Weld transformers are effectively eliminated. However, this now pushes loading of the Ault-Weld #1 and #2 circuits to their limit and additional load relying on these transmission lines require careful consideration.

VII. Cost Estimates

A. East-West Corridor upgrades: The following figures are high level cost estimates for the proposed corridor upgrades that were considered in this study and should be considered for informational purposes only. Other configurations may prove to be more cost effective.

i. Phase 0: No costs are associated with zero upgrades

ii. Phase 1: Weld to Promontory

Equipment	# of units	Cost per unit (millions)	Length Multiplier*	Subtotal (millions)
230-kV transmission lines, single pole steel-double circuit-1272 conductor. (3.75 mile section of Weld.LM-Windsor and Weld.PS Johnstown line)	3.75 miles	.666	1.4	3.5
230/115 kV 200 MVA transformer	1	2.5	N/A	2.5
Substation (less transformer) 2 x 230 bays & 1 x 115 bays	1	2.65	N/A	2.7
		Total:		8.7

iii. Phase 2: Promontory to Airport

Equipment	# of units	Cost per unit (millions)	Length Multiplier*	Subtotal (millions)
115/230-kV transmission lines, single pole steel-double circuit-1272 conductor. (5.5 mile section of Windsor.LM tap-WAPA line)	5.5 miles	0.666	1.4	5.1
230/115 kV 200 MVA transformer	1	2.5	N/A	2.5
		Total:		7.6

iv. Phase 3: Airport to Boyd

Equipment	# of units	Cost per unit (millions)	Length Multiplier*	Subtotal (millions)
115/230-kV transmission lines, single pole steel-double circuit-1272 conductor. (5.4 mile section of Airport-Boyd line)	5.4 miles	0.666	1.4	5
		Total:		5

*Length Multiplier of 1.4 was used for the total length of transmission line considered in the scope of this rebuild. In the event that the total line length would not be used as a cost multiplier, each section may require a different multiplier as follows: For zero to five miles, the multiplier is 2.0 and for six to ten miles, the multiplier is 1.8 (15-20 mile distance the multiplier is 1.4)

Total estimated cost to upgrade the Weld-Boyd Corridor to double-circuit, single pole steel utilizing 1272 ACSR

Section of Corridor Upgraded	Subtotal (millions)
Weld to Promontory (includes new 'Promontory' substation East of Windsor Tap)	8.7
Promontory to Airport (includes new 230/115 kV 200 MVA transformer)	7.6
Airport to Boyd (transmission only)	5
Estimated Total:	21.3

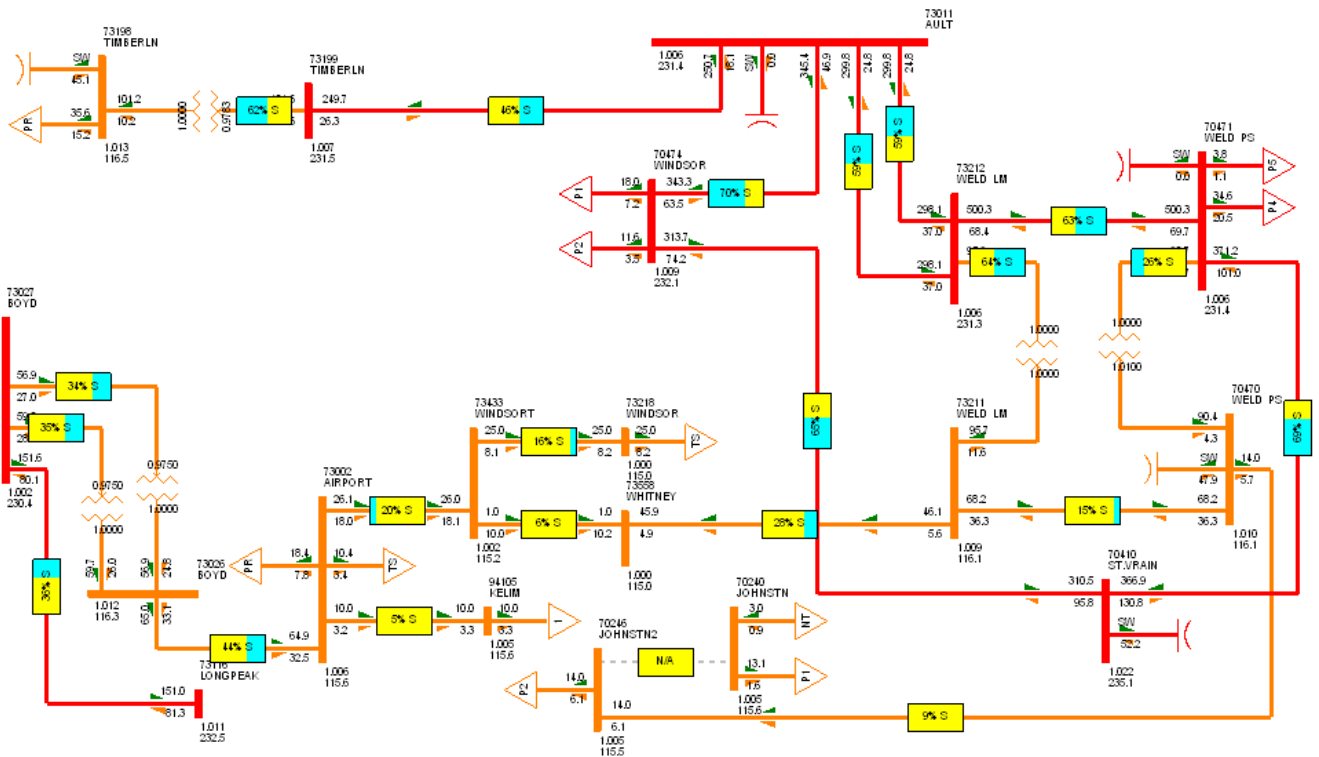
Appendices

A. Single Line Diagrams

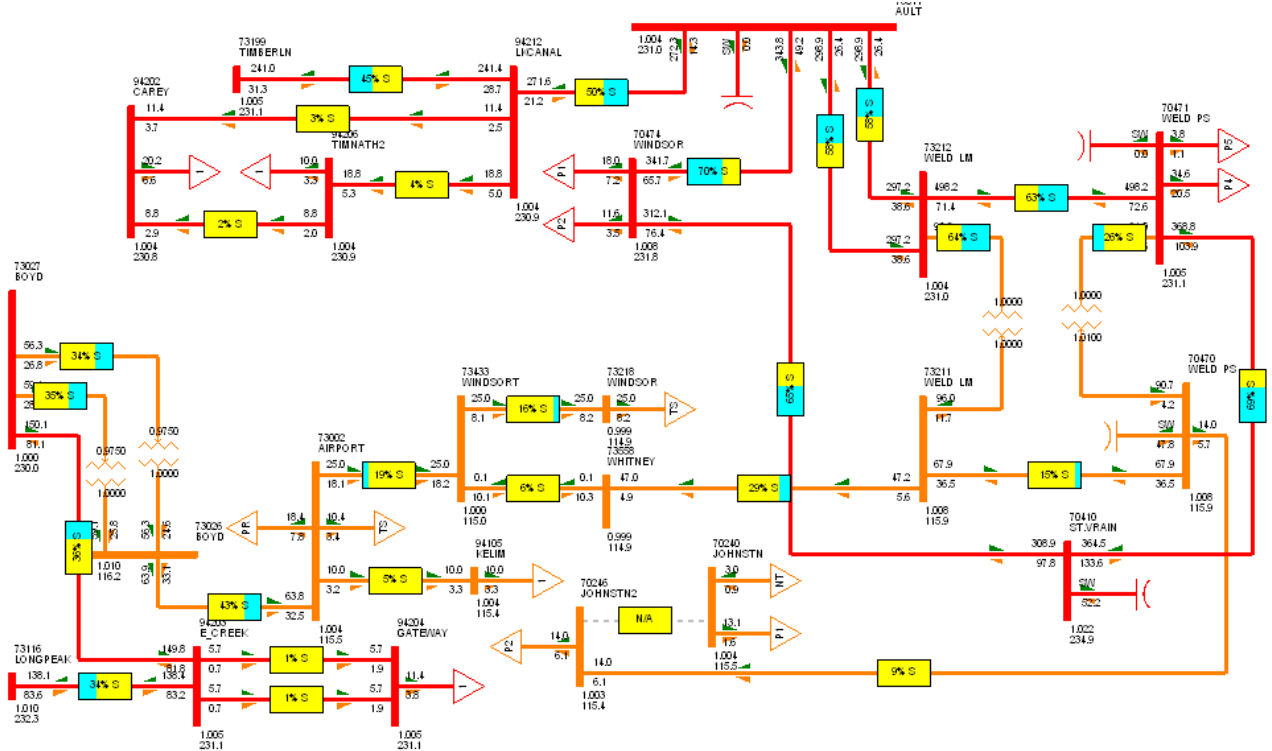
1. Voltage Legend

- PURPLE = 345KV
- RED = 230KV
- PINK = 138KV & 161KV
- ORANGE = 115KV
- CYAN = 57KV & 69KV
- GREEN = 11.4KV – 46KV
- BLACK = BELOW 11KV

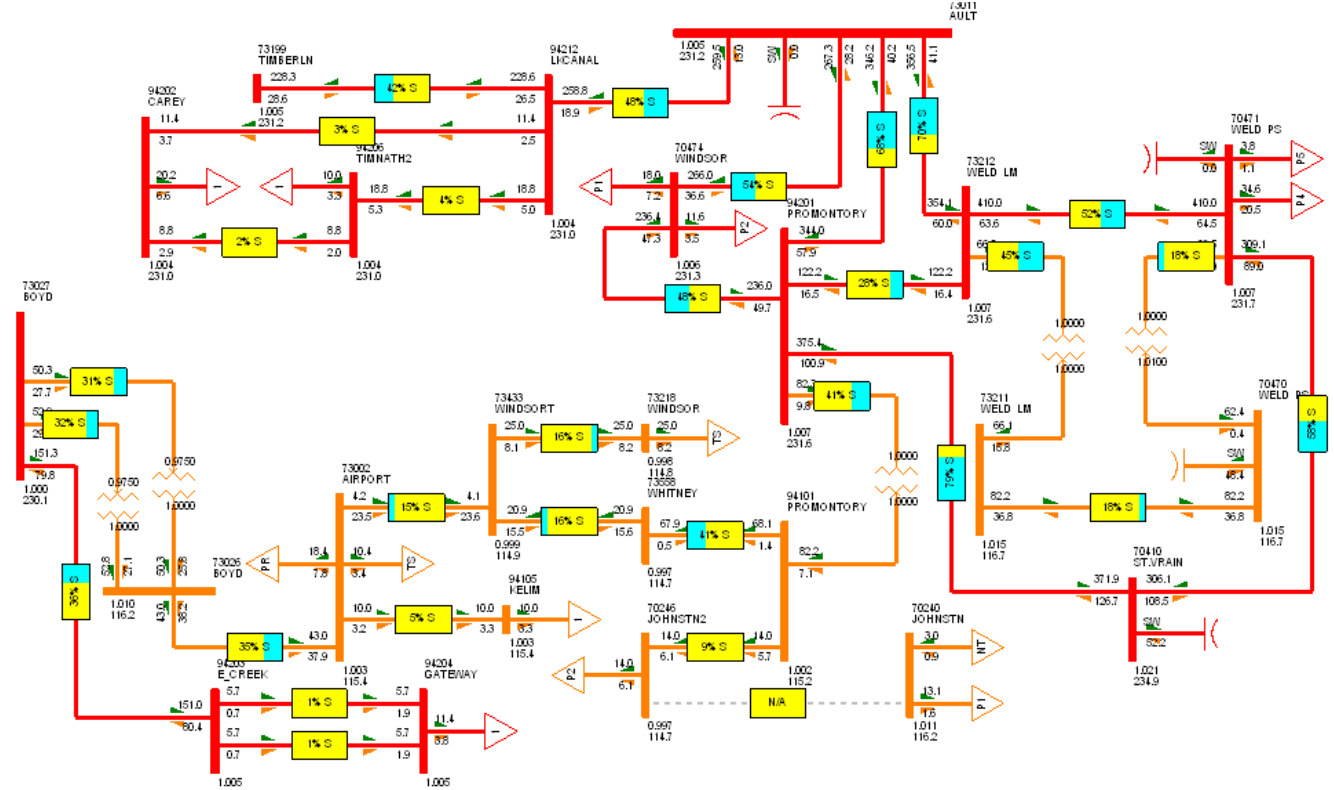
2. Case A



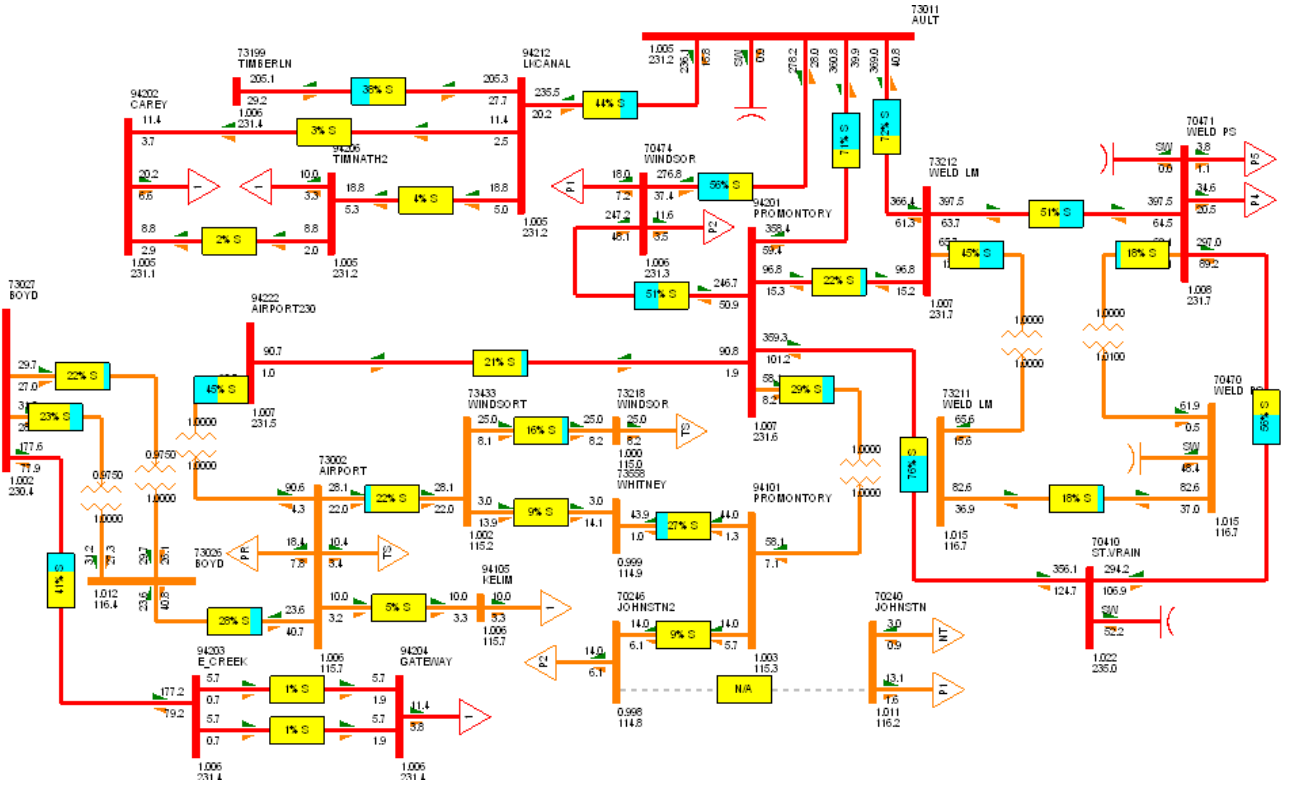
3. Case B



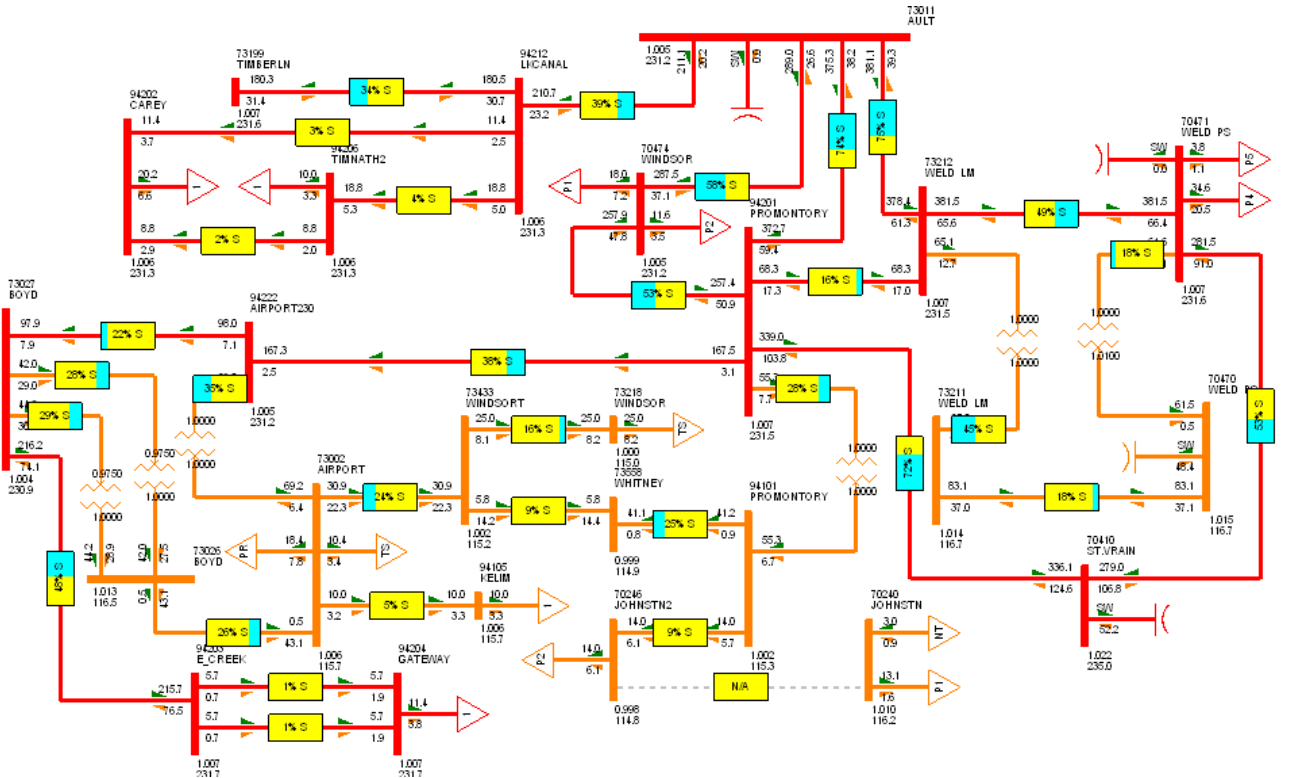
4. Case C



5. Case D



6. Case E



B. Contingency Legend

Contingency Name	From Bus			To Bus			CKT #
	Number	Name	kV	Number	Name	kV	
D.C.3TL-LP*C:	73049	[DELCAMIN	115]	73048	[DEL CTAP	115]	CKT 1
	73133	[MEADOW	115]	73048	[DEL CTAP	115]	CKT 1
	73115	[LONGPEAK	115]	73048	[DEL CTAP	115]	CKT 1
	73115	[LONGPEAK	115]	73465	[CNTYLINE	115]	CKT 1
RAW.LP.DX*C :	73165	[RAWHIDE	230]	73106	[LAPORTE	230]	CKT 1
	73165	[RAWHIDE	230]	73106	[LAPORTE	230]	CKT 2
RAW.TB.ALT*C:	73165	[RAWHIDE	230]	73199	[TIMBERLN	230]	CKT 1
	73165	[RAWHIDE	230]	73011	[AULT	230]	CKT 1
AULT_LRS.345:	73108	[LAR.RIVR	345]	73129	[MBPP-1	24.]	CKT 1
	73012	[AULT	345]	73108	[LAR.RIVR	345]	CKT 1
LRS_STORY345:	73108	[LAR.RIVR	345]	73129	[MBPP-1	24.]	CKT 1
	73108	[LAR.RIVR	345]	73193	[STORY	345]	CKT 1
PROM_XFMR :	94201	[PROMONTORY	230]	94101	[PROMONTORY	115]	CKT 1
ARPT_XFMR :	73002	[AIRPORT	115]	94222	[AIRPORT230	230]	CKT 1
BRUS_B.CK#1 :	70005	[BRUSH SS	115]	70397	[B.CK PS	115]	CKT 1
BRUS_B.CK#2 :	70005	[BRUSH SS	115]	70397	[B.CK PS	115]	CKT 2
GRLY_ST.VRN :	70048	[GREENVAL	230]	70410	[ST.VRAIN	230]	CKT 1
FTLUP_ST.V#1:	70192	[FTLUPTON	230]	70410	[ST.VRAIN	230]	CKT 1
FTLUP_ST.V#2:	70192	[FTLUPTON	230]	70410	[ST.VRAIN	230]	CKT 2
GDF_TP_GRLY :	70202	[GODFRETP	115]	70209	[GREELEY	115]	CKT 1
GDF_TP_JNST :	70202	[GODFRETP	115]	70240	[JOHNSTN	115]	CKT 1
GRLT_MNFRT :	70209	[GREELEY	115]	70290	[MONFORT	115]	CKT 1
GRLY_WELD :	70209	[GREELEY	115]	70470	[WELD PS	115]	CKT 1
LPT.T.PS_LPT:	70256	[LAPORTPS	115]	73105	[LAPORTE	115]	CKT 1
MNFRT_UNC :	70290	[MONFORT	115]	70439	[UNC	115]	CKT 1
MNFRT_COWHRD:	70290	[MONFORT	115]	70497	[COWHERD	115]	CKT 1
PNEE_BRC.CTR:	70311	[PAWNEE	230]	70545	[BRICKCTR	230]	CKT 1
PNEE_PTZLGN :	70311	[PAWNEE	230]	70711	[PTZLOGN	230]	CKT 1
RSEDL_E_UNC :	70368	[ROSEDALE	115]	70439	[UNC	115]	CKT 1
RSEDL_E_ARHLK:	70368	[ROSEDALE	115]	70475	[ARROWHLK	115]	CKT 1
B.CK.PS_BEAV:	70397	[B.CK PS	115]	73020	[BEAVERCK	115]	CKT 1
B.CK.PS_STOR:	70399	[B.CK PS	230]	73192	[STORY	230]	CKT 1
ST.V_WELD :	70410	[ST.VRAIN	230]	70471	[WELD PS	230]	CKT 1
ST.V_ISABLE :	70410	[ST.VRAIN	230]	70544	[ISABELLE	230]	CKT 1
ST.V_SPNDL :	70410	[ST.VRAIN	230]	70592	[SPNDLE	230]	CKT 1
ST.V_LG.PK :	70410	[ST.VRAIN	230]	73116	[LONGPEAK	230]	CKT 1
ST.V_FRD.HM :	70410	[ST.VRAIN	230]	73562	[FORDHAM	230]	CKT 1
WELD.PS_ARRO:	70470	[WELD PS	115]	70475	[ARROWHLK	115]	CKT 1
WELD_BYD.JCT:	70470	[WELD PS	115]	70496	[BOYDJCT	115]	CKT 1
WLD.PS.LM115:	70470	[WELD PS	115]	73211	[WELD LM	115]	CKT 1
WLD.PS.LM230:	70471	[WELD PS	230]	73212	[WELD LM	230]	CKT 1
WIND_AULT :	70474	[WINDSOR	230]	73011	[AULT	230]	CKT 1
BYD_JT_CW.HD:	70496	[BOYDJCT	115]	70497	[COWHERD	115]	CKT 1
BTHD_LN.TRE :	70534	[BERTHOUD	115]	73114	[LONETREE	115]	CKT 1
BR_TD_GATEWY:	70534	[BERTHOUD	115]	73561	[GATEWYTS	115]	CKT 1
RDG.CR_PEETZ:	70722	[RDGCREST	115]	73150	[PEETZ	115]	CKT 1
AIRP_BOYD :	73002	[AIRPORT	115]	73026	[BOYD	115]	CKT 1
AIRP_WIND :	73002	[AIRPORT	115]	73433	[WINDSORT	115]	CKT 1
AKRN_OTIS :	73003	[AKRON	115]	73372	[OTIS LM	115]	CKT 1

AKRN_WND.HLT:	73003	[AKRON	115]	73606	[WNDYHLTS	115]	CKT	1
ARCHER_AULT :	73009	[ARCHER	230]	73011	[AULT	230]	CKT	1
AULT_RAWHYD :	73011	[AULT	230]	73165	[RAWHIDE	230]	CKT	1
*AULT_WELD#1:	73011	[AULT	230]	73212	[WELD LM	230]	CKT	1
AULT_CHEYNE :	73011	[AULT	230]	73536	[CHEYENNE	230]	CKT	1
AULT_WILOBY :	73011	[AULT	230]	73542	[WILOBY	230]	CKT	1
AULT_CRG.345:	73012	[AULT	345]	79014	[CRAIG	345]	CKT	1
B.CK_TS_B.CK:	73015	[B.CK TRI	115]	73020	[BEAVERCK	115]	CKT	1
B.CK_STORY :	73016	[B.CK TRI	230]	73192	[STORY	230]	CKT	1
B.CK_BRUSH :	73020	[BEAVERCK	115]	73031	[BRUSHTAP	115]	CKT	1
B.CK_GARY :	73020	[BEAVERCK	115]	73065	[GARY	115]	CKT	1
B.CK_MSSX :	73020	[BEAVERCK	115]	73136	[MESSEX	115]	CKT	1
B.CK_ADEN :	73020	[BEAVERCK	115]	73464	[ADENA	115]	CKT	1
B.CK_WNDYHL :	73020	[BEAVERCK	115]	73606	[WNDYHLTS	115]	CKT	1
BIJ_TP_KW.CK:	73023	[BIJOUTAP	115]	73097	[KIOWA CK	115]	CKT	1
BIJ_TP_FM.W :	73023	[BIJOUTAP	115]	73379	[FMWEST	115]	CKT	1
BLKH_CBLK_TP:	73024	[BLKHLWTP	115]	73044	[COBBLKTP	115]	CKT	1
BLKH_TP_AULT:	73024	[BLKHLWTP	115]	73552	[AULT	115]	CKT	1
BOYD_LOVE.E :	73026	[BOYD	115]	73118	[LOVE E	115]	CKT	1
BOYD_VLY.LM :	73026	[BOYD	115]	73373	[VALLEYLM	115]	CKT	1
BOYD_GTWY_TS:	73026	[BOYD	115]	73561	[GATEWYTS	115]	CKT	1
BOYD_DBHL_TP:	73026	[BOYD	115]	73595	[DERBHILT	115]	CKT	1
BRIG_SAND.CK:	73030	[BRIGHTNW	115]	73493	[SANDCRK	115]	CKT	1
BRGT_NW_ERIE:	73030	[BRIGHTNW	115]	73503	[ERIE SW	115]	CKT	1
BRUS_EFMO_TP:	73031	[BRUSHTAP	115]	73305	[EFMORGTP	115]	CKT	1
CART_LK_FLAT:	73039	[CARTERLK	115]	73058	[FLATIRON	115]	CKT	1
CART_LK_LOVE:	73039	[CARTERLK	115]	73124	[LOVEWTAP	115]	CKT	1
CHEY_PONNQ :	73043	[CHEYENNE	115]	73504	[PONNEQUI	115]	CKT	1
COBB_TIMN_TP:	73044	[COBBLKTP	115]	73201	[TIMNTHTP	115]	CKT	1
CBLK_TP_CBLK:	73044	[COBBLKTP	115]	73600	[COBBLAKE	115]	CKT	1
DEL_TP_DELC :	73048	[DEL CTAP	115]	73049	[DELCAMIN	115]	CKT	1
DEL_TP_LONG :	73048	[DEL CTAP	115]	73115	[LONGPEAK	115]	CKT	1
DEL_TP_MDOW :	73048	[DEL CTAP	115]	73133	[MEADOW	115]	CKT	1
DELC_RINN.VL:	73049	[DELCAMIN	115]	73501	[RINNVALL	115]	CKT	1
DIXO_DRAKE :	73051	[DIXON CK	115]	73052	[DRAKE RD	115]	CKT	1
DIXO_HRST_TP:	73051	[DIXON CK	115]	73089	[HRSTHTAP	115]	CKT	1
DIXO_SOVE.TL:	73051	[DIXON CK	115]	73599	[SOVERTRL	115]	CKT	1
DRAKE_TIMBLN:	73052	[DRAKE RD	115]	73198	[TIMBERLN	115]	CKT	1
ESTES_POLE.H:	73056	[ESTES	115]	73155	[POLEHILL	115]	CKT	1
ESTES_MARYS :	73056	[ESTES	115]	73232	[MARYLKS	115]	CKT	1
ESTE_MRYS_TP:	73056	[ESTES	115]	73233	[MARYLKTP	115]	CKT	1
ESTE_WAGOWHL:	73056	[ESTES	115]	73556	[WAGONWHL	115]	CKT	1
FLAT_HRST :	73058	[FLATIRON	115]	73089	[HRSTHTAP	115]	CKT	1
FLAT_POLE.HL:	73058	[FLATIRON	115]	73155	[POLEHILL	115]	CKT	1
FLEM_HAXTN :	73059	[FLEMING	115]	73080	[HAXTUN	115]	CKT	1
FLEM_GALIEN :	73059	[FLEMING	115]	73478	[GALIEN	115]	CKT	1
HRMNY_TIMBLN:	73078	[HARMONY	230]	73199	[TIMBERLN	230]	CKT	1
HRMNY_PRTNR :	73078	[HARMONY	230]	73604	[PORTNER	230]	CKT	1
H_SHO_LOVE.W:	73086	[HORSESHO	115]	73120	[LOVE W	115]	CKT	1
H_SHO_CRS.RD:	73086	[HORSESHO	115]	73499	[CROSSRDS	115]	CKT	1
HOYT_L_MDOW :	73088	[HOYT	115]	73103	[L.MEADOW	115]	CKT	1
HOYT_ADENA :	73088	[HOYT	115]	73464	[ADENA	115]	CKT	1
HOYT_SAND.CK:	73088	[HOYT	115]	73493	[SANDCRK	115]	CKT	1
KERSY_PROSCT:	73095	[KERSEYTP	115]	73158	[PROSPEC	115]	CKT	1

KERS_BOOM	:	73095	[KERSEYTP	115]	73554	[BOOMERNG	115]	CKT	1
KWA_CK_OCHD	:	73097	[KIOWA CK	115]	73147	[ORCHARD	115]	CKT	1
KWA_CK_PROSP	:	73097	[KIOWA CK	115]	73158	[PROSPEC	115]	CKT	1
KWA_CK_WIGNS	:	73097	[KIOWA CK	115]	73213	[WIGGINS	115]	CKT	1
KODAK_WHIT#1	:	73098	[KODAK	115]	73558	[WHITNEY	115]	CKT	1
KODAK_WHIT#2	:	73098	[KODAK	115]	73558	[WHITNEY	115]	CKT	2
L_MEDW_WIGNS	:	73103	[L.MEADOW	115]	73213	[WIGGINS	115]	CKT	1
LPRT_BELL.TP	:	73105	[LAPORTE	115]	73298	[BELLVUTP	115]	CKT	1
LPRT_RHDE#1	:	73106	[LAPORTE	230]	73165	[RAWHIDE	230]	CKT	1
LPRT_RHDE#2	:	73106	[LAPORTE	230]	73165	[RAWHIDE	230]	CKT	2
LPRT_TIMBLN	:	73106	[LAPORTE	230]	73199	[TIMBERLN	230]	CKT	1
LPRT_DIX.CK	:	73106	[LAPORTE	230]	73467	[DIXON CK	230]	CKT	1
LNDN_RCHRDS	:	73111	[LINDEN	115]	73169	[RICHARDS	115]	CKT	1
LINDN_TIMBL	:	73111	[LINDEN	115]	73198	[TIMBERLN	115]	CKT	1
LNGM_NW_MDW	:	73113	[LNGMNTNW	115]	73133	[MEADOW	115]	CKT	1
LNGM_NW_T.TP	:	73113	[LNGMNTNW	115]	73578	[TERRYTP	115]	CKT	1
LG_PK_CTY.LN	:	73115	[LONGPEAK	115]	73465	[CNTYLINE	115]	CKT	1
LST_CK_LC.TP	:	73117	[LOST CK	115]	73370	[LOSTCKTP	115]	CKT	1
LOV_E_CRSRDS	:	73118	[LOVE E	115]	73499	[CROSSRDS	115]	CKT	1
LOV_W_LOV.TP	:	73120	[LOVE W	115]	73124	[LOVEWTAP	115]	CKT	1
LOV_VLY.LM	:	73124	[LOVEWTAP	115]	73373	[VALLEYLM	115]	CKT	1
LS_CH_S.WDRW	:	73125	[LSCHANCE	115]	73194	[SWOODROW	115]	CKT	1
LYON_WAGO.WH	:	73127	[LYONS	115]	73556	[WAGONWHL	115]	CKT	1
N_YMA_STORY	:	73143	[N.YUMA	230]	73192	[STORY	230]	CKT	1
N_YUA_WRAY	:	73143	[N.YUMA	230]	73224	[WRAY	230]	CKT	1
N_YUA_SGC	:	73143	[N.YUMA	230]	73579	[SPRNGCAN	230]	CKT	1
NUNN_ROCKPRT	:	73145	[NUNN	115]	73172	[ROCKPRTP	115]	CKT	1
NUNN_AULT	:	73145	[NUNN	115]	73552	[AULT	115]	CKT	1
POUD_RICH.TP	:	73156	[POUDRE	115]	73466	[RICHRDTP	115]	CKT	1
POUD_LAPO.TP	:	73156	[POUDRE	115]	73506	[LAPORTAP	115]	CKT	1
PRSC_LOST.TP	:	73158	[PROSPEC	115]	73370	[LOSTCKTP	115]	CKT	1
PSVL_LSCK.TP	:	73159	[PROSPVAL	115]	73370	[LOSTCKTP	115]	CKT	1
RAWH_TIMBL	:	73165	[RAWHIDE	230]	73199	[TIMBERLN	230]	CKT	1
RICH_WAVE.PV	:	73169	[RICHARDS	115]	73469	[WAVER PV	115]	CKT	1
RICH_FORTNE	:	73169	[RICHARDS	115]	73557	[FORTNE	115]	CKT	1
ROCK_OWL.CK	:	73172	[ROCKPRTP	115]	73597	[OWL_CRK	115]	CKT	1
STORY_B.CK	:	73192	[STORY	230]	73537	[BEAVERCK	230]	CKT	1
S.WDRW_WDRW	:	73194	[SWOODROW	115]	73221	[WOODROW	115]	CKT	1
TERR_CNTY.LN	:	73196	[TERRY	115]	73465	[CNTYLINE	115]	CKT	1
TERR_ERIE.SW	:	73196	[TERRY	115]	73503	[ERIE SW	115]	CKT	1
TERR_TERR.TP	:	73196	[TERRY	115]	73578	[TERRYTP	115]	CKT	1
TIMN_TIMN.TP	:	73200	[TIMNATH	115]	73201	[TIMNTHTP	115]	CKT	1
TIMN_RICH.TP	:	73201	[TIMNTHTP	115]	73466	[RICHRDTP	115]	CKT	1
TMN_TP_BXLDR	:	73201	[TIMNTHTP	115]	73553	[BOXELDER	115]	CKT	1
WELD_LM_BMRG	:	73211	[WELD LM	115]	73554	[BOOMERNG	115]	CKT	1
WNZ_WNZ.TP	:	73218	[WINDSOR	115]	73433	[WINDSORT	115]	CKT	1
BIGT_FLAT1	:	73300	[BIGTHOMP	13.8]	73448	[FLATIRN1	13.8]	CKT	1
EFMO_TP_BARL	:	73305	[EFMORGTP	115]	73309	[BARLOW	115]	CKT	1
EFMO_TP_FMN	:	73305	[EFMORGTP	115]	73378	[FMN	115]	CKT	1
EFMO_TP_FMWE	:	73305	[EFMORGTP	115]	73379	[FMWEST	115]	CKT	1
FME_EXCEL	:	73310	[FME	115]	73377	[EXCEL	115]	CKT	1
FMS_EXCEL	:	73311	[FMS	115]	73377	[EXCEL	115]	CKT	1
FMS_FMWE	:	73311	[FMS	115]	73379	[FMWEST	115]	CKT	1
WRAY_WRAY	:	73331	[WRAYWAPA	115]	73607	[WRAYTPW	115]	CKT	1

VALY_DBY.HL :	73373	[VALLEYLM	115]	73595	[DERBHILT	115]	CKT	1
WNZ_TP_WHIT :	73433	[WINDSORT	115]	73558	[WHITNEY	115]	CKT	1
RGR_RD_TY_TP :	73437	[ROGERSRD	115]	73578	[TERRYTP	115]	CKT	1
DIX_CK_HSHOE :	73467	[DIXON CK	230]	73535	[HORSESHO	230]	CKT	1
RIN_VL_DACO :	73501	[RINNVALL	115]	73502	[DACONO	115]	CKT	1
DACO_ERIE_SW :	73502	[DACONO	115]	73503	[ERIE SW	115]	CKT	1
PONN_OWL_CK :	73504	[PONNEQUI	115]	73597	[OWL CRK	115]	CKT	1
LPT_TP_S_TRL :	73506	[LAPORTAP	115]	73599	[SOVERTRL	115]	CKT	1
B_CK_HOYT :	73537	[BEAVERCK	230]	73539	[HOYT	230]	CKT	1
B_CK_WILOBY :	73537	[BEAVERCK	230]	73542	[WILOBY	230]	CKT	1
HOYT_ERIE_SW :	73539	[HOYT	230]	73574	[ERIE SW	230]	CKT	1
BXLDR_FORTNE :	73553	[BOXELDER	115]	73557	[FORTNE	115]	CKT	1
BRAC_WHIT#1 :	73555	[BRACEWLL	115]	73558	[WHITNEY	115]	CKT	1
BRAC_WHIT#2 :	73555	[BRACEWLL	115]	73558	[WHITNEY	115]	CKT	2
JOHN2_PROM :	70246	[JOHNSTN2	115]	94101	[PROMONTORY	115]	CKT	1
WHIT_PROM :	73558	[WHITNEY	115]	94101	[PROMONTORY	115]	CKT	1
AIRPT_KELIM :	73002	[AIRPORT	115]	94105	[KELIM	115]	CKT	1
ST_V_PROM :	70410	[ST.VRAIN	230]	94201	[PROMONTORY	230]	CKT	1
WNDZ_PROM :	70474	[WINDSOR	230]	94201	[PROMONTORY	230]	CKT	1
AULT_PROM :	73011	[AULT	230]	94201	[PROMONTORY	230]	CKT	1
WELD_PROM :	73212	[WELD LM	230]	94201	[PROMONTORY	230]	CKT	1
BOYD_E-CK :	73027	[BOYD	230]	94203	[E_CREEK	230]	CKT	1
LG_PK_E-CK :	73116	[LONGPEAK	230]	94203	[E_CREEK	230]	CKT	1
E-CK_GTWAY :	94203	[E_CREEK	230]	94204	[GATEWAY	230]	CKT	1
E_CR_GTWAY :	94203	[E_CREEK	230]	94204	[GATEWAY	230]	CKT	2
CARE_TMNT2 :	94202	[CAREY	230]	94206	[TIMNATH2	230]	CKT	1
AULT_LK_CANL :	73011	[AULT	230]	94212	[LKCANAL	230]	CKT	1
TIMB_LK_CANL :	73199	[TIMBERLN	230]	94212	[LKCANAL	230]	CKT	1
CARE_LK_CANL :	94202	[CAREY	230]	94212	[LKCANAL	230]	CKT	1
TIMN_LK_CANL :	94206	[TIMNATH2	230]	94212	[LKCANAL	230]	CKT	1
BOYD_AIRP230 :	73027	[BOYD	230]	94222	[AIRPORT230	230]	CKT	1
PROM_AIRP230 :	94201	[PROMONTORY	230]	94222	[AIRPORT230	230]	CKT	1
WLD_MB*D.BF :	73212	[WELD LM	230]	70471	[WELD PS	230]	CKT	1
	73212	[WELD LM	230]	73011	[AULT	230]	CKT	1
	73212	[WELD LM	230]	73011	[AULT	230]	CKT	2
	73212	[WELD LM	230]	73211	[WELD LM	115]	CKT	1
AU_TBL_RH*C :	73011	[AULT	230]	73199	[TIMBERLN	230]	CKT	1
	73011	[AULT	230]	73165	[RAWHIDE	230]	CKT	1
JOHN2_WELD :	70246	[JOHNSTN2	115]	70470	[WELD PS	115]	CKT	1
ST_V_WIND :	70410	[ST.VRAIN	230]	70474	[WINDSOR	230]	CKT	1
AULT_TIMBLNE :	73011	[AULT	230]	73199	[TIMBERLN	230]	CKT	1
*AULT_WELD#2 :	73011	[AULT	230]	73212	[WELD LM	230]	CKT	2
BOYD_LONG.PK :	73027	[BOYD	230]	73116	[LONGPEAK	230]	CKT	1
WELD_LM_WHIT :	73211	[WELD LM	115]	73558	[WHITNEY	115]	CKT	1

C. Monitored Buses and Elements List

Bus #	INTERFACE	kV	Bus #		kV	ckt	Rate
	TOT3						1680
70005	BRUSH SS	115	70397	B.CK PS	115	1	162
70005	BRUSH SS	115	70397	B.CK PS	115	2	187
70005	BRUSH SS	115	70498	QF BCP2T	13.8	2T	83
70005	BRUSH SS	115	70499	QF B4-4T	13.8	4T	75
70005	BRUSH SS	115	70500	QF CPP1T	13.8	1T	56
70005	BRUSH SS	115	70501	QF CPP3T	13.8	3T	56
70005	BRUSH SS	115	70556	QF B4D4T	12.5	4A	112
70010	QF MNFRT	13.8	70290	MONFORT	115	U1	50
70068	BURROCYN	115	70272	LUDLOTAP	115	1	69.9
70091	CASTLRCK	115	70117	CRWFTVLY	115	1	155.6
70091	CASTLRCK	115	70308	PALMER	115	1	134.8
70091	CASTLRCK	115	70518	BAYOU	115	1	134.8
70091	CASTLRCK	115	70520	WOLFSBTP	115	1	186.6
70091	CASTLRCK	115	70584	CRYSTVA	115	1	188
70093	CF&IEAST	115	70099	CF&ISETP	115	1	108
70094	CF&IFURN	230	70122	COMANCHE	230	1	434.6
70095	CF&ISE1	69	70096	CF&ISE1	115	1	67.2
70096	CF&ISE1	115	70097	CF&ISE1-	69	T1	67.2
70096	CF&ISE1	115	70099	CF&ISETP	115	1	108
70097	CF&ISE1-	69	70098	CF&ISE2	115	T2	67.2
70119	COMAN 1	24	70122	COMANCHE	230	U1	459.2
70120	COMAN 2	24	70122	COMANCHE	230	U2	470
70122	COMANCHE	230	70286	MIDWAYPS	230	1	506
70122	COMANCHE	230	70286	MIDWAYPS	230	2	506
70122	COMANCHE	230	70459	WALSENBG	230	1	444
70157	DIVIDE	115	70419	LKGRGE	115	1	186.6
70157	DIVIDE	115	70576	SPRNGVLY	115	1	186.6
70188	FTLUP1-2	13.8	70191	FTLUPTON	115	T2	123.2
70191	FTLUPTON	115	70192	FTLUPTON	230	T3	280
70192	FTLUPTON	230	70311	PAWNEE	230	1	518
70192	FTLUPTON	230	70410	ST.VRAIN	230	1	444
70192	FTLUPTON	230	70410	ST.VRAIN	230	2	444
70192	FTLUPTON	230	70487	QF TC-T4	13.8	T4	112
70192	FTLUPTON	230	70490	QF TC-T3	13.8	T3	112
70192	FTLUPTON	230	70493	QF TI-T2	13.8	T2	112
70192	FTLUPTON	230	70495	QF TI-T1	13.8	T1	112

70192	FTLUPTON	230	70529	JLGREEN	230	1	495
70192	FTLUPTON	230	70605	HENRYLAK	230	1	527
70202	GODFRETP	115	70209	GREELEY	115	1	136
70202	GODFRETP	115	70240	JOHNSTN	115	1	161.9
70209	GREELEY	115	70210	GREELEY1	46	T1	41.7
70209	GREELEY	115	70210	GREELEY1	46	T2	33.3
70209	GREELEY	115	70290	MONFORT	115	1	186.6
70209	GREELEY	115	70470	WELD PS	115	1	186.6
70238	IDEALCEM	46	70255	LAPORTE	46	1	39.5
70246	JOHNSTN2	115	70470	WELD PS	115	1	161.9
70255	LAPORTE	46	70256	LAPORTPS	115	1	33
70256	LAPORTPS	115	73105	LAPORTE	115	1	189
70272	LUDLOTAP	115	70321	PINONCYN	115	1	57
70272	LUDLOTAP	115	70458	WALSENBG	115	1	69.9
70285	MIDWAYPS	115	70286	MIDWAYPS	230	T1	100
70286	MIDWAYPS	230	70577	FTNVL1-2	13.8	T1	106.7
70286	MIDWAYPS	230	70578	FTNVL3-4	13.8	T2	106.7
70286	MIDWAYPS	230	70579	FTNVL5-6	13.8	T3	106.7
70290	MONFORT	115	70439	UNC	115	1	186.6
70290	MONFORT	115	70497	COWHERD	115	1	184
70308	PALMER	115	70582	GREENLND	115	1	188
70310	PAWNEE	22	70311	PAWNEE	230	1A	364
70310	PAWNEE	22	70311	PAWNEE	230	1B	364
70311	PAWNEE	230	70314	MANCHEF1	16	11	200
70311	PAWNEE	230	70315	MANCHEF2	16	12	200
70311	PAWNEE	230	70711	PTZLOGN	230	1	500
70311	PAWNEE	230	73192	STORY	230	1	625
70335	PUEB W	115	70336	PUEB-TAP	115	1	77
70350	RAWHIDE	24	73165	RAWHIDE	230	1	316
70351	RAWHIDEA	13.8	73165	RAWHIDE	230	1	112
70368	ROSEDALE	115	70439	UNC	115	1	207
70368	ROSEDALE	115	70475	ARROWHLK	115	1	134.8
70381	SEDALIA	115	70514	PLUMCRK	115	1	186.6
70381	SEDALIA	115	70522	ROXBOROU	115	1	134.8
70397	B.CK PS	115	70399	B.CK PS	230	T1	224
70397	B.CK PS	115	73020	BEAVERCK	115	1	319
70399	B.CK PS	230	73192	STORY	230	1	413.5
70410	ST.VRAIN	230	70471	WELD PS	230	1	564
70410	ST.VRAIN	230	70474	WINDSOR	230	1	498
70410	ST.VRAIN	230	70950	ST.VR_5	18	U4	290

70410	ST.VRAIN	230	70951	ST.VR_6	18	U4	232
70410	ST.VRAIN	230	73116	LONGPEAK	230	1	377.7
70410	ST.VRAIN	230	73562	FORDHAM	230	1	472
70413	STMBEACH	69	70457	WALSENBG	69	1	40
70419	LKGRGE	115	70426	TARRYALL	115	1	186.6
70426	TARRYALL	115	70427	TARRYALL	230	T1	168
70439	UNC	115	70502	QF UNC	13.8	T1	86
70457	WALSENBG	69	70458	WALSENBG	115	1	37
70458	WALSENBG	115	70459	WALSENBG	230	1	100
70458	WALSENBG	115	70459	WALSENBG	230	2	100
70459	WALSENBG	230	70510	STEM BCH	230	1	612
70469	WELD	46	70470	WELD PS	115	T2	46.7
70470	WELD PS	115	70471	WELD PS	230	T1	350
70470	WELD PS	115	70475	ARROWHLK	115	1	134.8
70470	WELD PS	115	70496	BOYDJCT	115	1	184
70470	WELD PS	115	73211	WELD LM	115	1	500
70471	WELD PS	230	73212	WELD LM	230	1	797
70474	WINDSOR	230	73011	AULT	230	1	498
70496	BOYDJCT	115	70497	COWHERD	115	1	184
70503	PONNEQUI	26.1	73504	PONNEQUI	115	T1	33.6
70514	PLUMCRK	115	70520	WOLFSBTP	115	1	186.6
70515	DAVIDSON	115	70516	PONDERSA	115	1	186.6
70515	DAVIDSON	115	70521	PEAKVIEW	115	1	186.6
70516	PONDERSA	115	70581	GRNDVIEW	115	1	186.6
70517	PARKERPS	115	70518	BAYOU	115	1	186.6
70517	PARKERPS	115	70581	GRNDVIEW	115	1	186.6
70518	BAYOU	115	70583	ELIZABTH	115	1	186.6
70519	WOLFSBRG	115	70520	WOLFSBTP	115	1	186.6
70534	BERTHOUD	115	73114	LONETREE	115	1	130
70534	BERTHOUD	115	73561	GATEWYTS	115	1	130
70561	RAWHIDEF	18	73165	RAWHIDE	230	1	212
70567	RAWHIDED	13.8	73165	RAWHIDE	230	1	112
70568	RAWHIDEB	13.8	73165	RAWHIDE	230	1	112
70569	RAWHIDEC	13.8	73165	RAWHIDE	230	1	112
70575	KIOWA	115	70583	ELIZABTH	115	1	186
70582	GREENLND	115	70584	CRYSTVA	115	1	188
70605	HENRYLAK	230	70606	HENRYLAK	115	1	100
70606	HENRYLAK	115	70607	BROMLEY	115	1	166
70710	PTZLOGN1	34.5	70711	PTZLOGN	230	1	220
70711	PTZLOGN	230	70712	PTZLOGN2	34.5	1	110

70711	PTZLOGN	230	70713	PTZLOGN3	34.5	1	110
70722	RDGCREST	115	70723	RDGCREST	34.5	1	50
70722	RDGCREST	115	73150	PEETZ	115	1	108
70820	KEENSBG	230	70821	CEDARCRK	230	1	800
70821	CEDARCRK	230	70822	CEDARCK1	34.5	1	167
70821	CEDARCRK	230	70823	CEDARCK2	34.5	1	167
73002	AIRPORT	115	73026	BOYD	115	1	166
73002	AIRPORT	115	73433	WINDSORT	115	1	159
73003	AKRON	115	73372	OTIS LM	115	1	84.9
73003	AKRON	115	73606	WNDYHLTS	115	1	84.9
73005	ALVIN	115	73175	SANDHILL	115	1	95
73005	ALVIN	115	73210	WAUNETA	115	1	67
73005	ALVIN	115	73304	CRETESWT	115	1	95
73006	ANTON	115	73010	ARICKARE	115	1	55
73006	ANTON	115	73125	LSCHANCE	115	1	67
73007	ARAPASUB	115	73207	WAANIBE	115	1	67
73010	ARICKARE	115	73094	JOES	115	1	95
73011	AULT	230	73012	AULT	345	1	500
73011	AULT	230	73012	AULT	345	2	500
73011	AULT	230	73012	AULT	345	3	560
73011	AULT	230	73165	RAWHIDE	230	1	378
73011	AULT	230	73199	TIMBERLN	230	1	543
73011	AULT	230	73212	WELD LM	230	1	513
73011	AULT	230	73212	WELD LM	230	2	513
73011	AULT	230	73542	WILOBY	230	1	442
73015	B.CK TRI	115	73016	B.CK TRI	230	1	224
73015	B.CK TRI	115	73020	BEAVERCK	115	1	200
73016	B.CK TRI	230	73192	STORY	230	1	413.5
73017	B.SANDY	115	73018	B.SANDY	230	1	167
73017	B.SANDY	115	73125	LSCHANCE	115	1	109
73017	B.SANDY	115	73318	LIMON	115	1	85.1
73018	B.SANDY	230	73036	BURLNGTN	230	1	281
73018	B.SANDY	230	73531	LINCOLNT	230	1	612
73020	BEAVERCK	115	73031	BRUSHTAP	115	1	220
73020	BEAVERCK	115	73065	GARY	115	1	109
73020	BEAVERCK	115	73136	MESSEX	115	1	121.7
73020	BEAVERCK	115	73464	ADENA	115	1	220
73020	BEAVERCK	115	73537	BEAVERCK	230	1	224
73020	BEAVERCK	115	73606	WNDYHLTS	115	1	84.9
73023	BIJOUTAP	115	73097	KIOWA CK	115	1	220

73023	BIJOUTAP	115	73379	FMWEST	115	1	220
73024	BLKHLWTP	115	73044	COBBLKTP	115	1	236
73024	BLKHLWTP	115	73552	AULT	115	1	110
73025	BONNY CK	115	73035	BURLNGTN	115	1	146
73025	BONNY CK	115	73185	SO. FORK	115	1	146
73026	BOYD	115	73027	BOYD	230	1	184
73026	BOYD	115	73027	BOYD	230	2	187
73026	BOYD	115	73118	LOVE E	115	1	136
73026	BOYD	115	73373	VALLEYLM	115	1	220
73026	BOYD	115	73561	GATEWYTS	115	1	126.7
73026	BOYD	115	73595	DERBHILT	115	1	185
73027	BOYD	230	73116	LONGPEAK	230	1	472
73027	BOYD	230	73604	PORTNER	230	1	472
73030	BRIGHTNW	115	73493	SANDCRK	115	1	220
73030	BRIGHTNW	115	73503	ERIE SW	115	1	220
73031	BRUSHTAP	115	73305	EFMORGTP	115	1	160
73034	BURL PSC	115	73209	WANIBETP	115	1	67
73034	BURL PSC	115	73485	BURL KC	115	1	67
73035	BURLNGTN	115	73036	BURLNGTN	230	1	100
73035	BURLNGTN	115	73036	BURLNGTN	230	2	167
73035	BURLNGTN	115	73302	BRLNGTN1	13.8	1	70
73035	BURLNGTN	115	73303	BRLNGTN2	13.8	1	70
73035	BURLNGTN	115	73485	BURL KC	115	1	67
73039	CARTERLK	115	73058	FLATIRON	115	1	220
73039	CARTERLK	115	73124	LOVEWTAP	115	1	220
73044	COBBLKTP	115	73201	TIMNTHTP	115	1	236
73044	COBBLKTP	115	73600	COBBLAKE	115	1	100
73047	DEERINGL	115	73053	ECKLEY	115	1	84.9
73047	DEERINGL	115	73142	N.YUMA	115	1	146
73047	DEERINGL	115	73230	YUMA	115	1	55
73047	DEERINGL	115	73372	OTIS LM	115	1	84.9
73048	DEL CTAP	115	73049	DELCAMIN	115	1	130
73048	DEL CTAP	115	73115	LONGPEAK	115	1	236
73048	DEL CTAP	115	73133	MEADOW	115	1	236
73049	DELCAMIN	115	73501	RINNVALL	115	1	166
73050	DERBYHIL	115	73595	DERBHILT	115	1	236
73051	DIXON CK	115	73052	DRAKE RD	115	1	136
73051	DIXON CK	115	73089	HRSTHTAP	115	1	236
73051	DIXON CK	115	73467	DIXON CK	230	1	187
73051	DIXON CK	115	73467	DIXON CK	230	2	187

73051	DIXON CK	115	73599	SOVERTRL	115	1	236
73052	DRAKE RD	115	73198	TIMBERLN	115	1	211
73053	ECKLEY	115	73225	WRAY TAP	115	1	84.9
73053	ECKLEY	115	73326	ROBB	115	1	67
73053	ECKLEY	115	73371	BETHELLM	115	1	67
73056	ESTES	115	73155	POLEHILL	115	1	80
73056	ESTES	115	73232	MARYLKSB	115	1	80
73056	ESTES	115	73233	MARYLKTP	115	1	80
73056	ESTES	115	73556	WAGONWHL	115	1	109
73058	FLATIRON	115	73089	HRSTHTAP	115	1	109
73058	FLATIRON	115	73155	POLEHILL	115	1	80
73059	FLEMING	115	73080	HAXTUN	115	1	121.7
73059	FLEMING	115	73478	GALIEN	115	1	80
73060	FORDHAM	115	73196	TERRY	115	1	165
73060	FORDHAM	115	73437	ROGERSRD	115	1	159
73060	FORDHAM	115	73562	FORDHAM	230	1	187
73060	FORDHAM	115	73562	FORDHAM	230	2	187
73063	FRENCHCK	115	73080	HAXTUN	115	1	121.7
73063	FRENCHCK	115	73210	WAUNETA	115	1	80
73065	GARY	115	73221	WOODROW	115	1	109
73078	HARMONY	230	73199	TIMBERLN	230	1	733
73078	HARMONY	230	73604	PORTNER	230	1	472
73079	HARVARD	115	73113	LNGMNTNW	115	1	110
73083	HELL CK	115	73084	HELL TAP	115	1	95
73083	HELL CK	115	73174	SAGEBRSH	115	1	95
73084	HELL TAP	115	73110	LIBERTY	115	1	95
73084	HELL TAP	115	73185	SO. FORK	115	1	95
73086	HORSESHO	115	73120	LOVE W	115	1	170
73086	HORSESHO	115	73499	CROSSRDS	115	1	165
73086	HORSESHO	115	73535	HORSESHO	230	1	187
73086	HORSESHO	115	73535	HORSESHO	230	2	187
73088	HOYT	115	73103	L.MEADOW	115	1	80
73088	HOYT	115	73464	ADENA	115	1	220
73088	HOYT	115	73493	SANDCRK	115	1	220
73088	HOYT	115	73539	HOYT	230	1	167
73089	HRSTHTAP	115	73203	TRILBY	115	1	236
73089	HRSTHTAP	115	73235	MASONVIL	115	1	146
73090	HYGIENE	115	73113	LNGMNTNW	115	1	109
73090	HYGIENE	115	73127	LYONS	115	1	109
73091	IDALIA	115	73185	SO. FORK	115	1	146

73091	IDALIA	115	73206	VERNONTP	115	1	146
73094	JOES	115	73110	LIBERTY	115	1	60
73095	KERSEYTP	115	73158	PROSPEC	115	1	109
73095	KERSEYTP	115	73554	BOOMERNG	115	1	121.7
73097	KIOWA CK	115	73147	ORCHARD	115	1	121.7
73097	KIOWA CK	115	73158	PROSPEC	115	1	220
73097	KIOWA CK	115	73213	WIGGINS	115	1	60
73098	KODAK	115	73558	WHITNEY	115	1	120
73098	KODAK	115	73558	WHITNEY	115	2	120
73103	L.MEADOW	115	73213	WIGGINS	115	1	121
73105	LAPORTE	115	73106	LAPORTE	230	1	184
73105	LAPORTE	115	73298	BELLVUTP	115	1	67
73106	LAPORTE	230	73165	RAWHIDE	230	1	472
73106	LAPORTE	230	73165	RAWHIDE	230	2	472
73106	LAPORTE	230	73199	TIMBERLN	230	1	472
73106	LAPORTE	230	73467	DIXON CK	230	1	472
73111	LINDEN	115	73169	RICHARDS	115	1	236
73111	LINDEN	115	73198	TIMBERLN	115	1	236
73113	LNGMNTNW	115	73133	MEADOW	115	1	236
73113	LNGMNTNW	115	73578	TERRYTP	115	1	239
73115	LONGPEAK	115	73116	LONGPEAK	230	1	168
73115	LONGPEAK	115	73116	LONGPEAK	230	2	168
73115	LONGPEAK	115	73465	CNTYLINE	115	1	236
73117	LOST CK	115	73370	LOSTCKTP	115	1	5
73118	LOVE E	115	73499	CROSSRDS	115	1	136
73120	LOVE W	115	73124	LOVEWTAP	115	1	136
73124	LOVEWTAP	115	73373	VALLEYLM	115	1	220
73125	LSCHANCE	115	73194	SWOODROW	115	1	109
73127	LYONS	115	73171	ROCKMTCM	115	1	67
73127	LYONS	115	73556	WAGONWHL	115	1	109
73136	MESSEX	115	73191	STERLING	115	1	121.7
73142	N.YUMA	115	73143	N.YUMA	230	1	167
73142	N.YUMA	115	73166	REDWILLW	115	1	166
73143	N.YUMA	230	73192	STORY	230	1	281
73143	N.YUMA	230	73224	WRAY	230	1	281
73145	NUNN	115	73172	ROCKPRTP	115	1	230
73145	NUNN	115	73552	AULT	115	1	230
73150	PEETZ	115	73191	STERLING	115	1	109
73156	POUDRE	115	73466	RICHRDTP	115	1	120
73156	POUDRE	115	73506	LAPORTAP	115	1	120

73158	PROSPEC	115	73370	LOSTCKTP	115	1	59.6
73158	PROSPEC	115	73542	WILOBY	230	1	168
73159	PROSPVAL	115	73370	LOSTCKTP	115	1	59.6
73165	RAWHIDE	230	73199	TIMBERLN	230	1	378
73166	REDWILLW	115	73208	WAGES	115	1	166
73169	RICHARDS	115	73557	FORTNE	115	1	236
73172	ROCKPRTP	115	73597	OWL_CRK	115	1	230
73175	SANDHILL	115	73223	WRAY	115	1	95
73184	SMOKYHLW	115	73209	WANIBETP	115	1	67
73191	STERLING	115	73478	GALIEN	115	1	120
73192	STORY	230	73193	STORY	345	1	500
73192	STORY	230	73193	STORY	345	2	500
73192	STORY	230	73537	BEAVERCK	230	1	612
73194	SWOODROW	115	73221	WOODROW	115	1	109
73196	TERRY	115	73465	CNTYLINE	115	1	236
73196	TERRY	115	73503	ERIE SW	115	1	109
73196	TERRY	115	73578	TERRYTP	115	1	109
73198	TIMBERLN	115	73199	TIMBERLN	230	1	168
73200	TIMNATH	115	73201	TIMNTHTP	115	1	109
73201	TIMNTHTP	115	73466	RICHRDTP	115	1	236
73201	TIMNTHTP	115	73553	BOXELDER	115	1	236
73206	VERNONTP	115	73223	WRAY	115	1	146
73207	WAANIBE	115	73209	WANIBETP	115	1	67
73208	WAGES	115	73210	WAUNETA	115	1	67
73211	WELD LM	115	73212	WELD LM	230	1	150
73211	WELD LM	115	73554	BOOMERNG	115	1	121.7
73211	WELD LM	115	73558	WHITNEY	115	1	166
73218	WINDSOR	115	73433	WINDSORT	115	1	160
73223	WRAY	115	73224	WRAY	230	1	186
73223	WRAY	115	73225	WRAY TAP	115	1	95
73223	WRAY	115	73607	WRAYTPW	115	2	95
73231	MARYLKPP	115	73233	MARYLKTP	115	1	98
73232	MARYLKSB	115	73233	MARYLKTP	115	1	98
73232	MARYLKSB	115	73436	MARYLKSB	69	1	25
73297	BELLEVUE	115	73298	BELLVUTP	115	1	55
73305	EFMORGTP	115	73309	BARLOW	115	1	60
73305	EFMORGTP	115	73378	FMN	115	1	60
73305	EFMORGTP	115	73379	FMWEST	115	1	220
73310	FME	115	73377	EXCEL	115	1	120
73311	FMS	115	73377	EXCEL	115	1	60
73311	FMS	115	73379	FMWEST	115	1	60

73331	WRAYWAPA	115	73607	WRAYTPW	115	1	85
73371	BETHELLM	115	73374	VERNONLM	115	1	67
73373	VALLEYLM	115	73595	DERBHILT	115	1	236
73433	WINDSORT	115	73558	WHITNEY	115	1	166
73437	ROGERSRD	115	73578	TERRYTP	115	1	159
73467	DIXON CK	230	73535	HORSESHO	230	1	472
73501	RINNVALL	115	73502	DACONO	115	1	166
73502	DACONO	115	73503	ERIE SW	115	1	166
73503	ERIE SW	115	73574	ERIE SW	230	1	250
73504	PONNEQUI	115	73597	OWL_CRK	115	1	230
73506	LAPORTAP	115	73599	SOVERTRL	115	1	236
73531	LINCOLNT	230	73532	LINCOLN1	13.8	1	120
73531	LINCOLNT	230	73533	LINCOLN2	13.8	1	120
73537	BEAVERCK	230	73539	HOYT	230	1	442
73537	BEAVERCK	230	73542	WILOBY	230	1	442
73539	HOYT	230	73574	ERIE SW	230	1	442
73553	BOXELDER	115	73557	FORTNE	115	1	236
73555	BRACEWLL	115	73558	WHITNEY	115	1	166
73555	BRACEWLL	115	73558	WHITNEY	115	2	166
73597	OWL_CRK	115	73598	OWLCRKL	12.47	1	20.2
73597	OWL_CRK	115	73598	OWLCRKL	12.47	2	20.2
73002	AIRPORT	115	94105	KELIM	115	1	221
73011	AULT	230	94212	LKCANAL	230	1	543
73027	BOYD	230	94203	E_CREEK	230	1	472
73116	LONGPEAK	230	94203	E_CREEK	230	1	472
73199	TIMBERLN	230	94212	LKCANAL	230	1	543
94202	CAREY	230	94206	TIMNATH2	230	1	442
94202	CAREY	230	94212	LKCANAL	230	1	442
94203	E_CREEK	230	94204	GATEWAY	230	1	442
94203	E_CREEK	230	94204	GATEWAY	230	2	442
94206	TIMNATH2	230	94212	LKCANAL	230	1	442
70246	JOHNSTN2	115	94101	PROMONTORY	115	1	161.9
70410	ST.VRAIN	230	94201	PROMONTORY	230	1	498
70474	WINDSOR	230	94201	PROMONTORY	230	1	498
73011	AULT	230	94201	PROMONTORY	230	1	513
73212	WELD LM	230	94201	PROMONTORY	230	1	442
73558	WHITNEY	115	94101	PROMONTORY	115	1	166
94101	PROMONTORY	115	94201	PROMONTORY	230	1	200
73002	AIRPORT	115	94222	AIRPORT230	230	1	200
94201	PROMONTORY	230	94222	AIRPORT230	230	1	442
73027	BOYD	230	94222	AIRPORT230	230	1	442