SOUTHWEST UTAH
Joint Planning Study Report

A Continuation of the
December 2007 Study Report

June 2009

July 16, 2009

Members of the Southwest Utah technical task force are pleased to provide the updated Southwest Utah Joint Planning Study report.

The updated report was a significant joint effort by PacifiCorp, Rocky Mountain Power, Utah Associated Municipal Power Systems (and its members in Southwest Utah), and Deseret Power Electric Cooperative (and its member Dixie Escalante). This effort has been ongoing since 2007 to update the previous report. Special thanks go to the dedicated personnel in each of these organizations that were part of the study group.

Inside you will find a comprehensive study that outlines the next steps over 10 years and beyond that are needed to provide safe, adequate, reliable power to Southwest Utah. Meeting the growing electrical needs of this area will come with challenges, but, as a group, our focused efforts will overcome any issues we face.

We are all committed to delivering the recommendations in this report. But this report is only the beginning. It is a planning tool. It identifies issues and recommends how to address them. If the issues change, the Planning Study will also change, so that the electrical needs of Southwest Utah continue to be met.

Our acknowledgement and acceptance of this study as approved is noted by our signatures below.

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Southwest Utah Technical Studies Group

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1.0 Executive Summary

The Southwest Utah Technical Task Force (SWTTF) was formed in 1987 as directed by the Public Service Commission of Utah with a purpose of having all southwest Utah electric utilities work and cooperate together regarding emergency outage planning and response and joint system planning. The primary goal of the task force is to ensure that service reliability in Washington County is maximized and, through joint planning, to identify ways to eliminate duplication of infrastructure.

Since the inception of this task force, multiple joint planning studies with actions have been completed with good success. In 2005 a Joint Operations Agreement (JOA) was entered into by UAMPS and PacifiCorp. Upon completion of Phase 1 and 2 under the JOA, an associated Integrated Transmission System (ITS) Operation and Maintenance Agreement was entered into in 2006 between UAMPS and PacifiCorp. These agreements were the first steps to enhancing service reliability and eliminating possible duplication of infrastructure to the area. As a result of continued growth in Washington County the present ITS capability is approaching capacity.

In 2007, an updated joint planning study was undertaken by the SWTTF to identify future system improvements to the ITS. This 2007 joint planning study was continued and updated again in 2008 and 2009, leading to the plan identified in this report.

The purpose of this joint study was to review and build upon previous joint study results that were presented to the Southwest Utah technical task force in a report entitled "Washington County, Utah - Joint Planning Study Report". The most recent study report was completed in December 2007, approximately a year and one-half prior to this study, and is referenced throughout this report as the "2007 Report". A primary finding of the 2007 Report was the proposal to introduce a second 345 kilovolt transmission point of delivery to serve forecasted load growth occurring in eastern Washington County, which would improve reliability through new transmission sources and optimize 138 kilovolt transmission line requirements in the region. A likely 345 kilovolt transmission line corridor would follow Interstate-15 between Cedar City and St. George, Utah (The preliminary routing for this alternative has been identified as Sigurd-Three Peaks-Hurricane West). Furthermore, this updated study includes preparation for the upcoming 2009 summer peak season by simulating projected conditions and potential outage scenarios. The 2009 study results are included in Appendix B of this report providing details for each of the possible scenarios and their respective mitigation plans.

Washington County is currently served with three 138 kilovolt circuits in a single corridor between the Red Butte and St. George substations and a 69 kilovolt line between Coleman and Toquerville substations. Two of the 138 kilovolt transmission lines share common structures. This configuration results in a potential risk for 90 percent or more of the load (at peak) in Washington County to be curtailed if two of the three 138 kilovolt transmission lines are out of service. Such service interruption of two or three of the lines can occur due to a structure failure, where two 138 kilovolt lines share a common structure, or a range fire in the transmission corridor damages structures supporting all three 138 kilovolt transmission lines. Range fires have caused outages to one or more of these transmission lines three of the last five calendar years during the peak fire season. During peak summer months, meeting the peak electric service demand to Washington County requires the

SVC ("static VAr Compensator") at St. George substation to be in-service as well as other voltage control devices on the system.

As described in section 2.0 below, the area load is forecasted to grow into the foreseeable future. Having all the major existing transmission line (three) sources in a single corridor increases the risk of possible widespread outages for Washington County as the load increases when outage initiating events occur in the transmission corridor between Red Butte and St. George substations. In order to mitigate the reliability risk of a single transmission corridor and optimize 138 kilovolt transmission line requirements in the region, it is proposed to construct a second 345 kilovolt transmission line into the area in a separate corridor and establish a new point-of-delivery.

In addition to the outage risk posed by having all the transmission sources routed through a single corridor, the concentration of transmission sources also poses land use issues for local sub-transmission facilities tied to these transmission sources. The St. George substation (a PacifiCorp/UAMPS jointly-owned facility) is located within a protected desert tortoise habitat and transmission lines into and out of the substation cross the desert tortoise habitat. Based on the recent transmission construction in this area, it is anticipated that the existence of the habitat and federally-managed land will make obtaining a new corridor between Red Butte and St. George substation extremely difficult where other alternative corridors may exist. While some construction will be required in tortoise habitat near the St. George substation in any event, the results of the study suggest a new eastern Washington County 345 kilovolt corridor reduces the number of necessary future planned transmission lines that would cross the habitat.

Accordingly, to mitigate system reliability concerns, the Washington County area should have a second point-of-delivery served by a major transmission line through a separate corridor other than the Red Butte-St. George corridor. The advantages of a second point-of-delivery addresses single corridor/cascading outage concerns, reduces dependence on single system elements (SVC's, shunt capacitors, substations, etc.), minimizes environmental (desert tortoise) issues, and reduces local 138 kilovolt line requirements.

Further, separate studies conducted by PacifiCorp have confirmed the projected need for not just one, but ***two*** additional 345 kilovolt lines into Washington County (in addition to the existing Sigurd-Red Butte line) within the study planning horizon in order to meet transmission obligations between Nevada and Utah and load service requirements in Washington County. It is expected that the first of these lines will be required by 2014 and the second by 2018 (depending on area load growth). Therefore, in addition to the 345 kilovolt line into eastern Washington County (Sigurd-Three Peaks-Hurricane West) described above, PacifiCorp is also moving forward with plans to construct a second Sigurd-Red Butte 345 kilovolt transmission line. From a sequencing perspective, this provides two options for the second delivery point in eastern Washington County as suggested by this 2009 Study: that is, establish this new point of delivery (and delivery corridor) in conjunction with either the first or the second of the two new 345-kV lines. The studies completed separately by PacifiCorp indicate that the near-term transmission obligations required to be delivered by PacifiCorp are met whether the second 345 kilovolt transmission line is routed via Sigurd-Red Butte or Sigurd-Three Peaks-Hurricane West-St. George-Red Butte, with the third line to follow. Accordingly, regardless of the sequence of their construction, the combination of the two new 345 kilovolt lines, one from Sigurd to Red Butte and the other from Sigurd to Three Peaks to Hurricane West, is needed to (i) serve expected load growth, (ii) address existing local transmission reliability and land use concerns, and (iii) provide for PacifiCorp's future delivery obligations to

and from Nevada. Both of these transmission line routes, of course, come with permitting and rights-of-way challenges that will need to be managed.

This study concludes that in order to meet forecasted load requirements and mitigate reliability concerns in Washington County, a second 345 kilovolt point-of-delivery should be established in Washington County, preferably located in western Hurricane City, and be served by a new 345 kilovolt transmission line in a new corridor. Also, the other system capacity projects identified in this study should be implemented as recommended.

Figure 1 – Construction Plan

	(For Reference) 2007 Study Construction Plan	2009 Study Proposed Construction Plan
2010	• Double circuit Red Butte-St. George 345 (initially operated as single circuit 138 kilovolt) • Fields-Majestic 138 kilovolt line built for load (per previous 2007 study) • Middleton-Gateway 69 kilovolt line portions rebuilt to 138 kilovolt (continue to operate at 69 kilovolt) to remove 4/0 • Fields-Mill Creek 138 kilovolt tie operated closed • SVC at Red Butte (timing provided by PAC transmission)	• Double circuit Red Butte-St. George 345 kilovolt line (initially operated as single circuit 138 kilovolt) • Fields-Majestic 138 kilovolt line built for load (per previous 2007 study) • Fields-Mill Creek 138 kilovolt tie operated closed, provided that operational, NERC compliance, contractual and Internal Revenue Service private use issues are resolved.
2011		• Middleton-Gateway 69 kilovolt line portions rebuilt to 138 kilovolt (continue to operate at 69 kilovolt) to remove 4/0 • SVC at Red Butte (per PacifiCorp Main-Grid studies, possibly Fall 2011) • Operate second Red Butte-St. George 138 kilovolt line
2013-2014	• 345 kilovolt line Sigurd to Three Peaks to Hurricane West • 345 kilovolt line Hurricane West to St. George substation • Energize one side of the Red Butte-St. George double circuit line at 345 kilovolt (no St. George 345 kilovolt transformation, the other circuit remains operated at 138 kilovolt) • Establish 345/138 kilovolt transformation at Hurricane West (possibly move one of the Central/Red Butte transformers) (Possible 138/69 kilovolt transformation) • Majestic-Hurricane West 138 kilovolt line • Gateway-Toquerville 69 kilovolt line rebuild to 138 kilovolt • Ft. Pierce-Green Valley 138 kilovolt line completed	• 345 kilovolt line Sigurd-Three Peaks-Hurricane Area-St. George-Red Butte (In-service date of 2014 per PacifiCorp Main-Grid studies. As mentioned, the alternative route for this line is Sigurd to Red Butte) • New Hurricane 138 kilovolt substation (138/69 kilovolt Hurricane West) • Finish Rebuild of Middleton-Gateway-Hurricane West 69 kilovolt line and operate at 138 kilovolt • Connect Gateway/Quail Creek substations to UAMPS Anticline or possibly convert to 138 kilovolt (one option is to establish a 138/69 kilovolt transformer at Hurricane West) • 138 kilovolt line(s) from Hurricane West to HD138-1 and HD 138-2 (near Clifton Wilson) • Ft. Pierce-Green Valley 138 kilovolt line completed

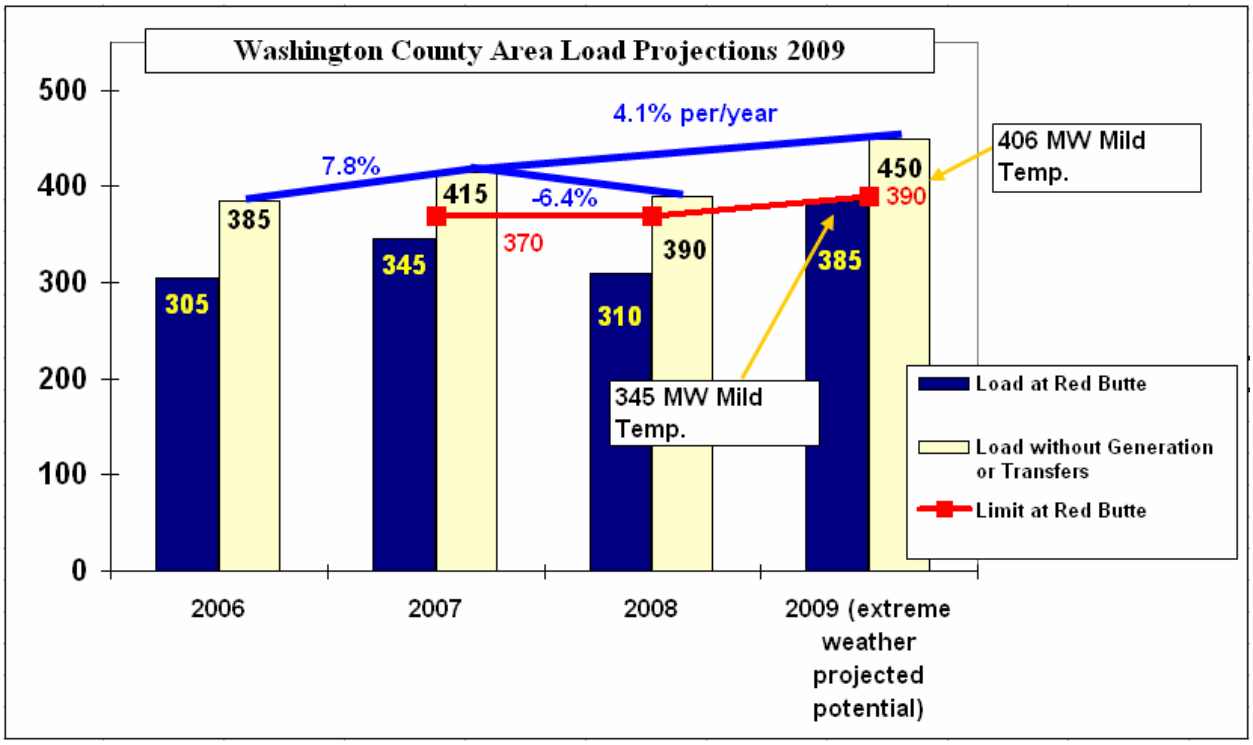
	(For Reference) 2007 Study Construction Plan	2009 Study Proposed Construction Plan
		• Majestic-Hurricane 138 kilovolt line (accelerated from 2016 to alleviate Middleton-Gateway outage) • Additional 345/138 transformer capacity at Hurricane West/St. George (preferred) or Red Butte (alternative)
2016	• Majestic-Ft. Pierce 138 kilovolt line • Second 345/138 kilovolt transformer at Hurricane West	• Majestic-Ft. Pierce 138 kilovolt line (in-service date could vary depending on additional studies)
2017-2019	• Establish 345/138 kilovolt transformation at St. George	• (if not previously done) Construct St. George-Hurricane West 345 kilovolt line (recommend operating at 345 kilovolt initially but consideration could be given to operating at 138 kilovolt for short time) • Establish 345-138 kilovolt Hurricane substation (if not previously completed) • (if not previously done) Complete construction of 345 kilovolt line between Hurricane and Three Peaks (PacifiCorp Main-Grid studies project 2018 in-service date requirement. It is possible that the Toquerville-Coleman 69 kilovolt line may be paralleled or double circuited) • 345/138 kilovolt substation at St. George • Convert both Red Butte-St. George 138 kilovolt lines to 345 kilovolt (only one line may need to be converted if 345 kilovolt line is routed through St. George previously)
2020-2022		• (if not previously done) Terminate new 345 kilovolt Toquerville line at Three Peaks and Hurricane West

Note: This schedule does not address all underlying system requirements (138-69 kilovolt transformation and 69 kilovolt system additions/upgrades that may be necessary for separate internal system operation).

2.0 Historical and Projected Loads

Three years of historical peak loading for the southwest Utah area are summarized in Figure 2, which depicts the effect of local generation and load transfers to the net load served at the Red Butte substation. The existing transmission capability limitation is shown in red. The transfers included shifting loads typically served from Red Butte over to Iron County in the Enterprise, New Castle, and Toquerville areas. Of note, the 2008 peak loading was down from the previous year. Likely factors that may have caused this include a slow down in economic growth and 2008 summer temperatures with fewer consecutive days with high temperature (105+ degrees) than in pervious years. Appendix A includes several charts showing the 2008 summer temperatures in St. George compared to previous years.

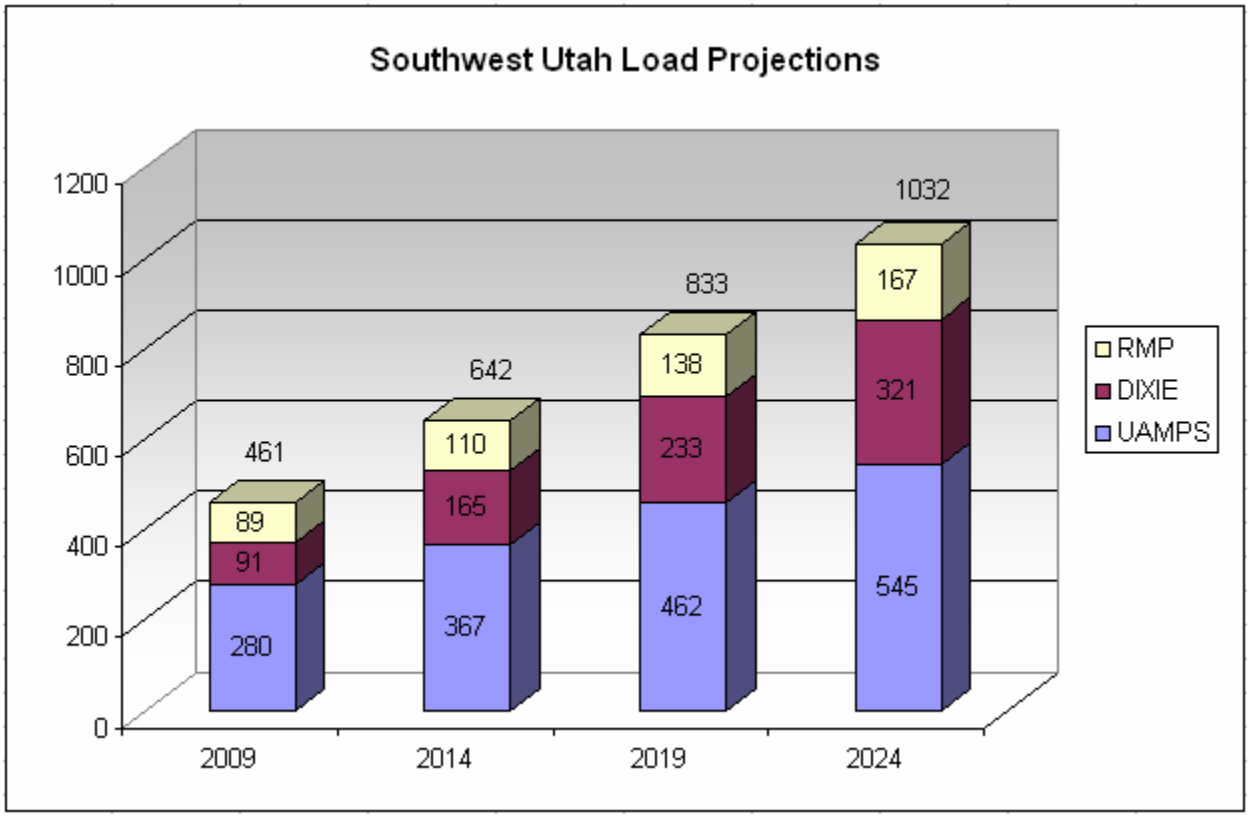
Figure 2 – Washington County Loads



Load projections were provided by each of the participating utilities and are summarized in Figure 3 below. Each participant was requested to provide load information consistent with the most recent **Loads and Resources 10 Year Forecast** submitted annually to PacifiCorp transmission services.

The projections suggest a substantial growth rate throughout the study period. The study group considered revising the growth rates downward to reflect the lower 2008 peak: however, it was decided to perform the studies with the existing projections that are based on longer historical growth patterns.

Figure 3 – L&R Forecasts[1]



3.0 Projected Summer 2009 Study Results

Detailed studies were performed for the upcoming 2009 summer as part of a "Summer Preparation" initiative. This included a detailed review of the projected transmission constraints, an updated transfer capability nomogram (Red Butte load versus Red Butte-Harry Allen non-simultaneous transfer capability), simulation of 17 different outage scenarios, simulation of the backup capability of the system for each of the outages, and a review of each of the outage scenarios with local generation on-line and with local generation off-line. Studies concluded that to meet peak system demand, operating local generation is presently required to meet transmission service to Nevada and to meet load obligations in Washington County.

[1] This chart does not reflect a potential transfer of the 10 megawatt Twin Cities' load from UAMPS to Garkane (served through RMP sub-transmission system): however, the studies were done assuming this transfer takes place in 2009

See Appendix B at the end of this report for a summary of the 2009 study results.

4.0 Comparison of Capabilities between Two 345 Kilovolt Line Options

Of the two 345 kilovolt line options, the option that brings the line into the Three Peaks 345 kilovolt substation and continues to the Hurricane West area provides the greater load serving and transfer capabilities. Whenever similar parallel lines are interconnected near the middle of the lines the resulting configuration has a higher capability because a single contingency outage results in the loss of a smaller part of the transmission system. The Sigurd-Red Butte #2 345 kilovolt line option capability can be enhanced to provide a similar overall capability, as measured at the Red Butte substation, by increasing the size of the SVC and the series compensation at Red Butte. However, the Sigurd-Three Peaks-Hurricane-St. George 345 kilovolt line option provides better local area support for the Cedar City area, because of the tie into Three Peaks, and the Washington County area with the line into the Hurricane West and St. George substations.

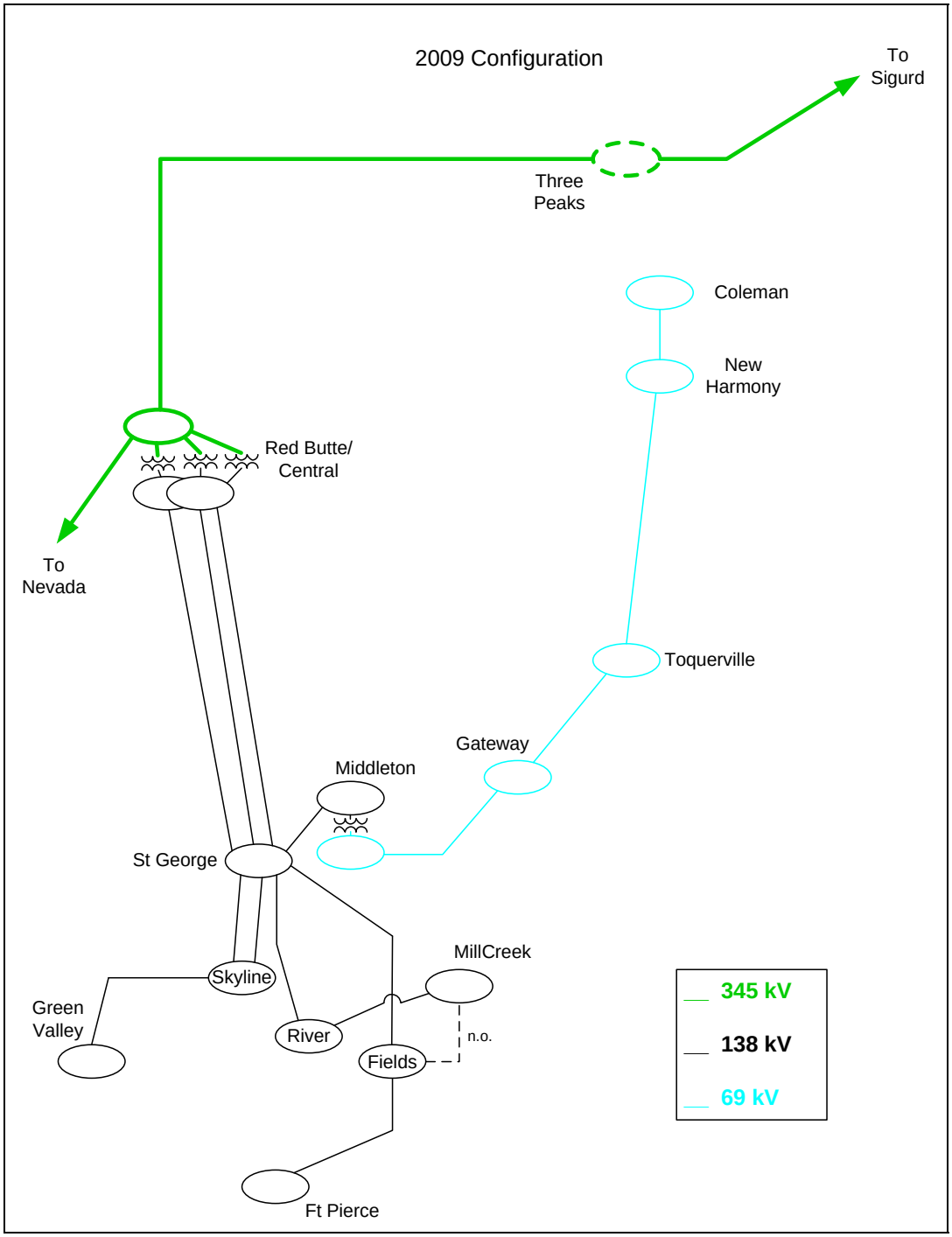
5.0 Proposed 345 Kilovolt and 138 Kilovolt Joint Plan

From a system reliability standpoint, in order to reduce the expected impact to the Red Cliffs Desert Reserve, and to avoid multiple 138 kilovolt lines, the Washington County area needs to have an additional major transmission line into the area in a corridor other than the Red Butte-St. George corridor. To efficiently address transmission and reliability issues and eliminate potential extra transmission lines, the recommendation of this report is therefore to provide a second 345 kilovolt line and point-of-delivery in Washington County, located somewhere in the Hurricane City west area. There is some probability that this can be done jointly with the planned construction of a second Sigurd-Red Butte line, but it may be necessary to construct one line several years before the other. Both transmission lines present rights-of-way and Bureau of Land Management permitting and timing issues, thus the following proposed plan was developed to:

- Provide a long term fix to the single corridor issue
- Provide a construction plan using a “one utility plan”
- Minimize the number of new 138 kilovolt lines in the area
- Minimize requirements for new rights-of-way across tortoise habitat in/out of the St. George substation
- Provide a framework and justification for a 345 kilovolt line in the Hurricane City west area

Figure 4 is a single-line diagram that depicts the current situation showing service to the Washington County area.

Figure 4 - Existing 2009 Southwest Utah System



In the following pages, items from the 2007 Report along with updated information were used to develop the present project schedule. Items that differ or were not mentioned in the previous report are highlighted in red.

This proposed plan requires looping the existing 138 kilovolt lines out of the St. George and Skyline substations to reduce the need for additional lines and rights-of-way.

Figures 5 through 10 provide sketches of a proposed 345 kilovolt and 138 kilovolt build-out plan. It is expected that additional studies and communication between the participants will refine each of the steps along the way to ensure accuracy, consider alternatives, and ensure least-cost options as loads develop. This study did not address expected 138-69 kilovolt transformer issues or 69 kilovolt system issues.

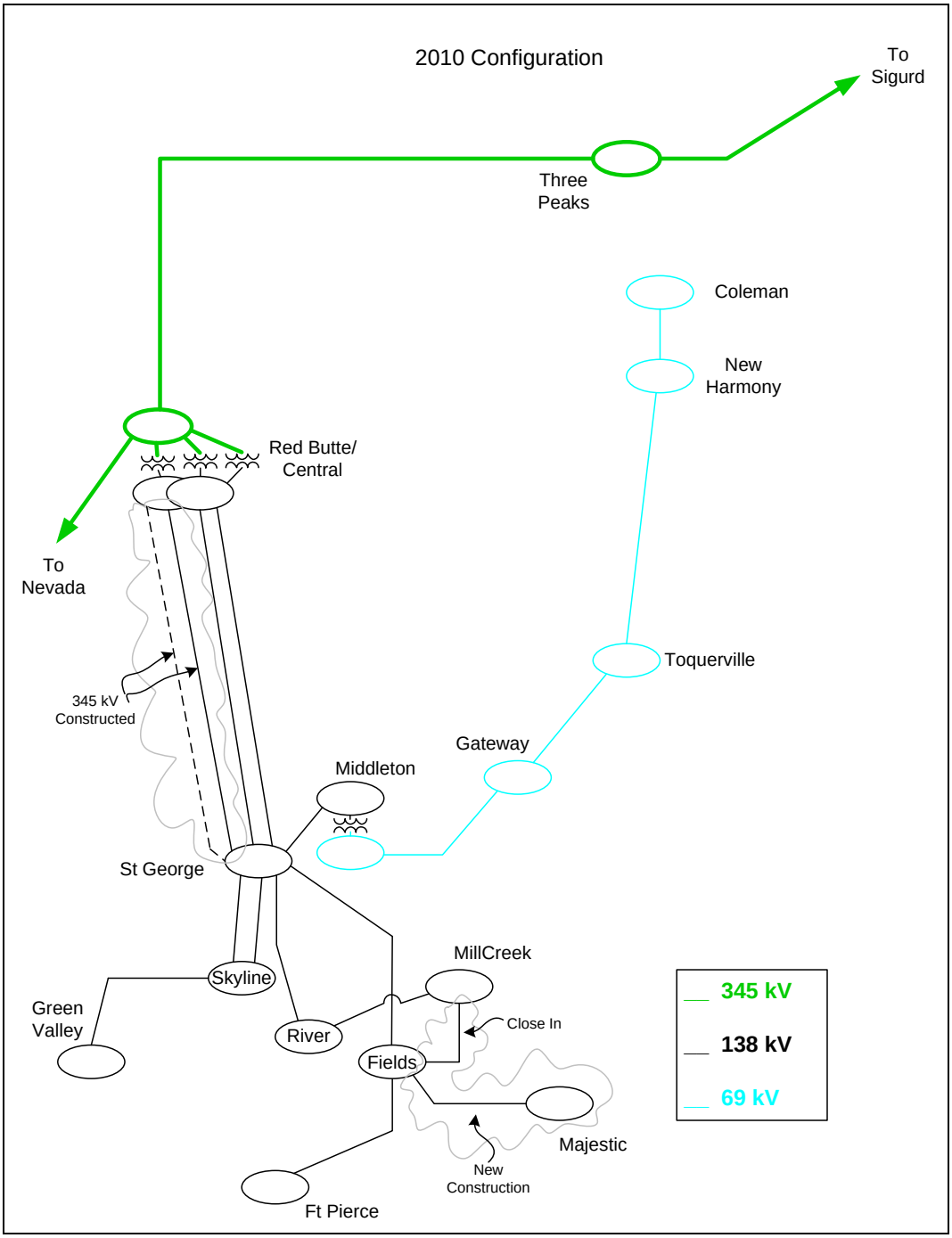
The proposed plan to operate separately-owned 138 kilovolt transmission lines in a normally-closed looped configuration will require operational, NERC compliance and contractual details to be agreed upon among the various utilities that will be involved. For UAMPS and its members, compliance with Internal Revenue Service rules on private use of their facilities financed using tax exempt debt will need to be determined prior to any looped configuration being implemented.

Initial studies were performed with the assumption that 54 megawatts of "local generation" is on-line throughout the study period. While this is typical based on historical operations, additional studies will need to be performed to assess operating without "local generation."

2010

- Construct double circuit Red Butte-St. George 345 kilovolt line (initially operated at 138 kilovolt)
- Fields-Majestic 138 kilovolt line built for load (per previous 2007 study)
- Fields-Millcreek 138 kilovolt tie operated closed, provided that operational, NERC compliance, contractual and Internal Revenue Service private use issues are resolved.

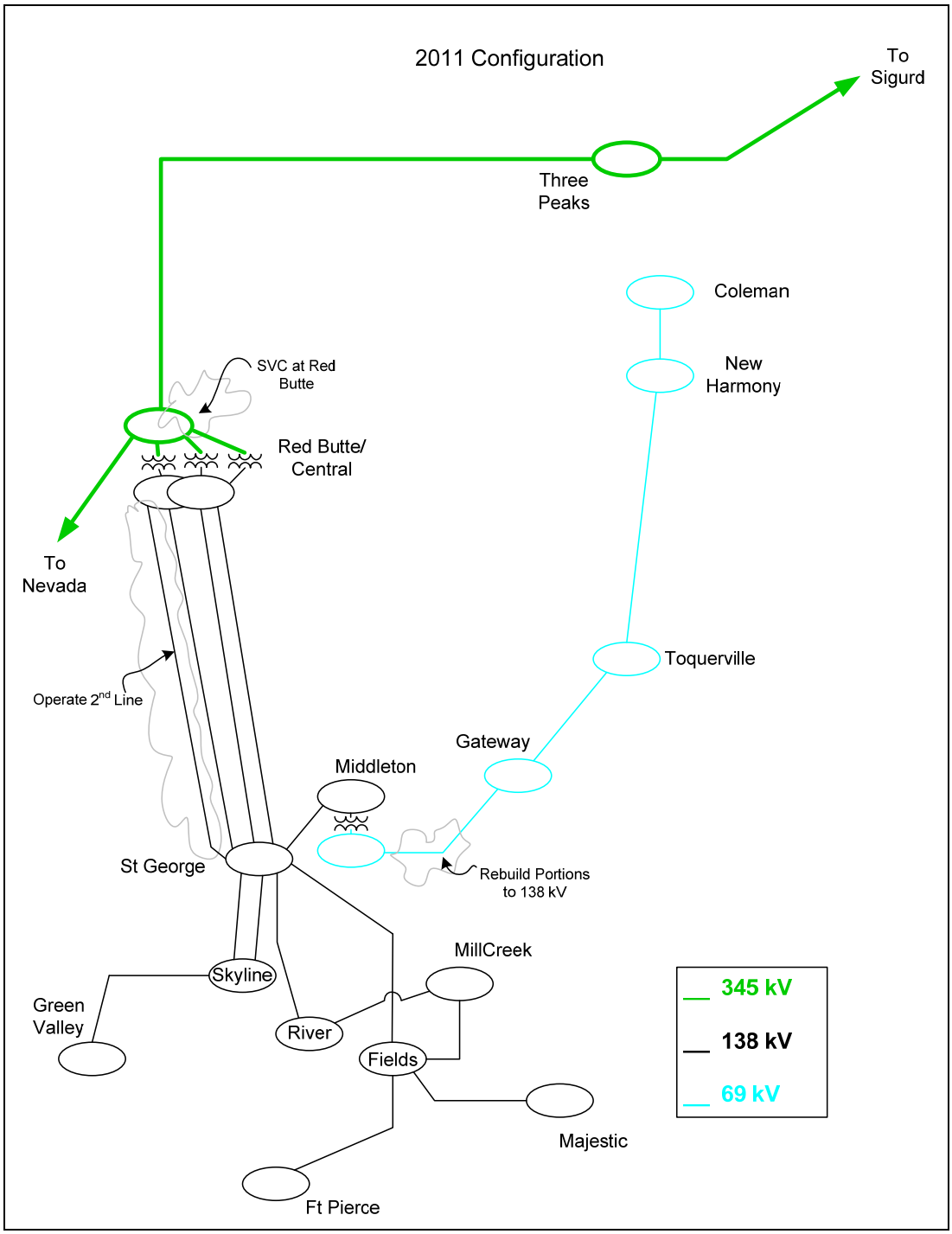
Figure 5 – 2010 Configuration



2011

- Middleton-Gateway 69 kilovolt line portions rebuilt to 138 kilovolt (continue to operate at 69 kilovolt) to remove 4/0 sections
- SVC at Red Butte (possibly Fall 2011)
- Operate second Red Butte-St. George 138 kilovolt line

Figure 6 – 2011 Configuration



2013-2014

- New Hurricane West 138 kilovolt substation
- Finish rebuild of Middleton-Gateway-Hurricane West 69 kilovolt line and operate at 138 kilovolt (note: this is a proposed joint project despite the timing requirement difference between the UAMPS load in Hurricane and Rocky Mountain Power load in Toquerville area)
- Connect Gateway/Quail Creek substations to UAMPS Anticline or possibly convert to 138 kilovolt (one option is to establish a 138/69 kilovolt transformer at Hurricane West)
- 138 kilovolt lines(s) from Hurricane West to HD138-1 and HD 138-2 (near Clifton Wilson)
- Ft. Pierce-Green Valley 138 kilovolt line completed
- Majestic-Hurricane 138 kilovolt line (accelerated from 2016 to alleviate Middleton-Gateway outage)
- Install additional 345/138 kilovolt transformer capability at Red Butte
- It is preferred that the second Sigurd-Red Butte 345 kilovolt line be routed near the I-15 corridor in this timeframe and that a 345/138 transformer be placed at either Hurricane West or St. George substation. However, it is recognized that a third 345 kilovolt line is required in Southwest Utah by 2018 to meet additional transmission obligations. Based on where PacifiCorp is in the permitting process for the Sigurd-Red Butte line, that line may be the most likely route that can be completed by 2014. In that case, the third 345 kilovolt line in Southwest Utah would align with the preferred configuration from Sigurd to Hurricane West.
- In view of the foregoing, for all diagrams 2016 and later, the alternative 345 kilovolt configuration (Sigurd-Red Butte) will be shown as the initial build-out plan. It should be noted, however, that if the permitting process permits, the preference from a transmission service perspective is to build the Sigurd-Three Peaks-Hurricane-St. George-Red Butte line first, and the second Sigurd-Red Butte line second.

Figure 7a – 2014 Preferred Configuration

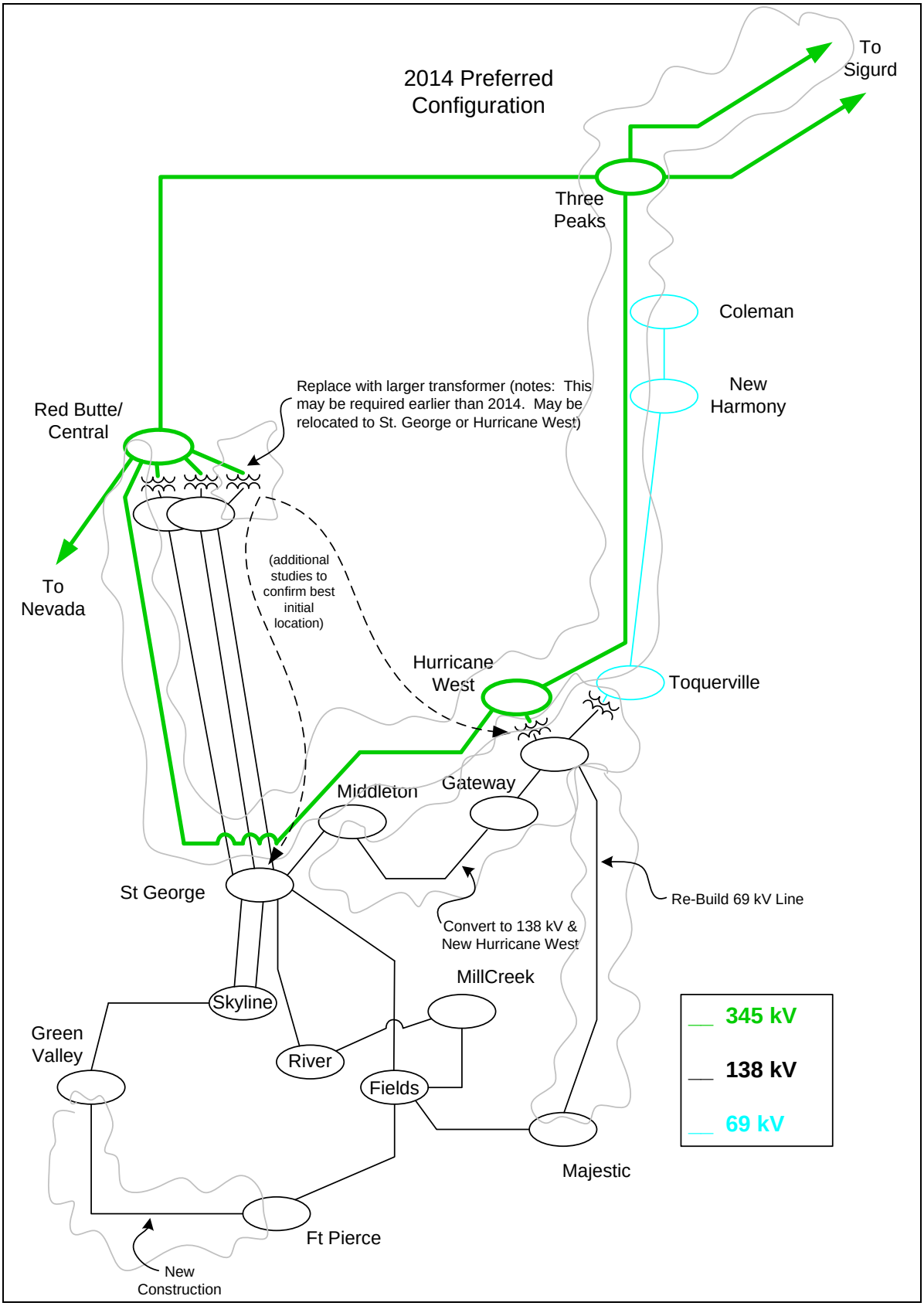


Figure 7b – 2014 Alternate Configuration (Note: This configuration will be used for the initial build-out plan if the permitting process does not allow the preferred configuration (Figure 7a) to be completed first.)

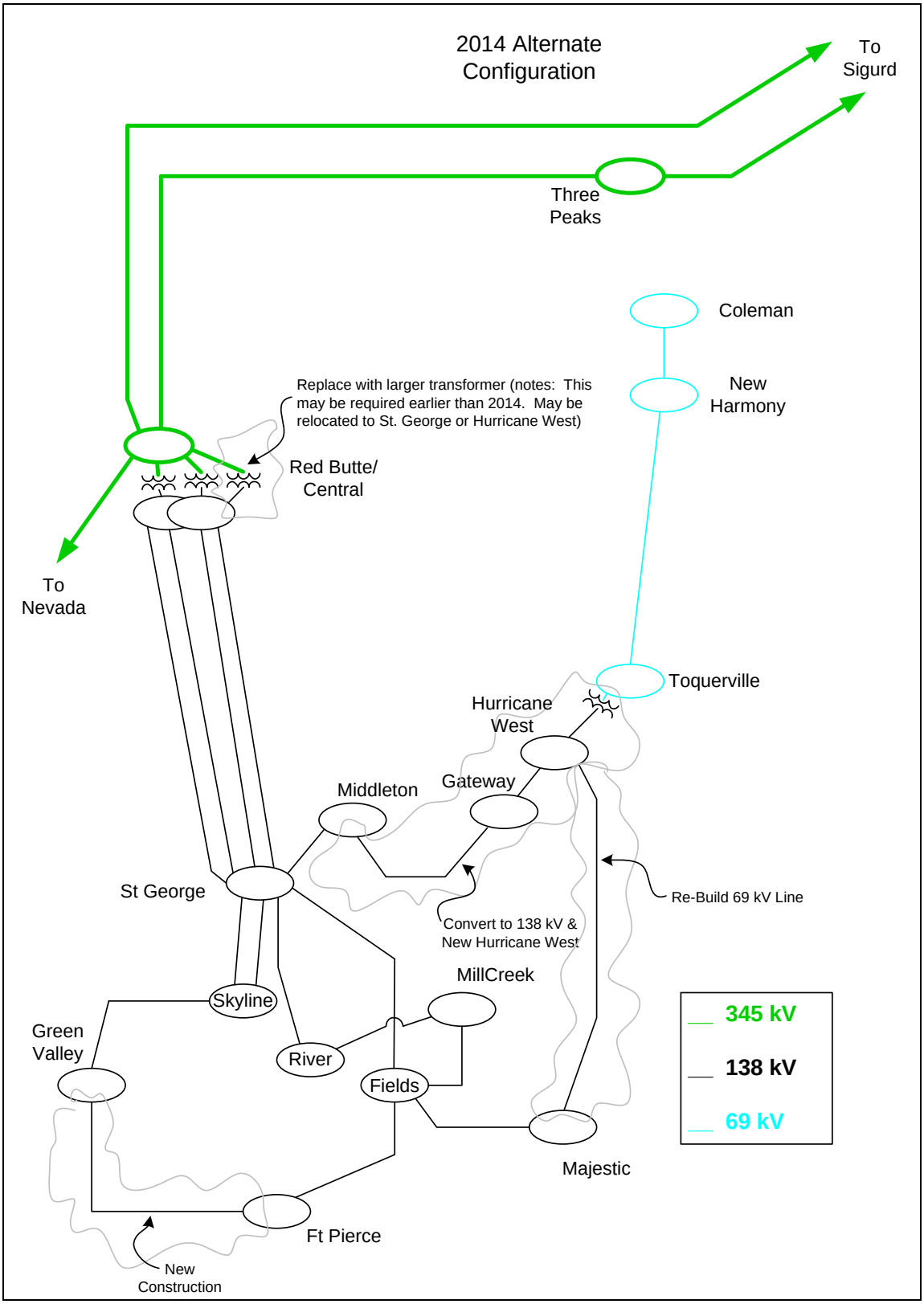


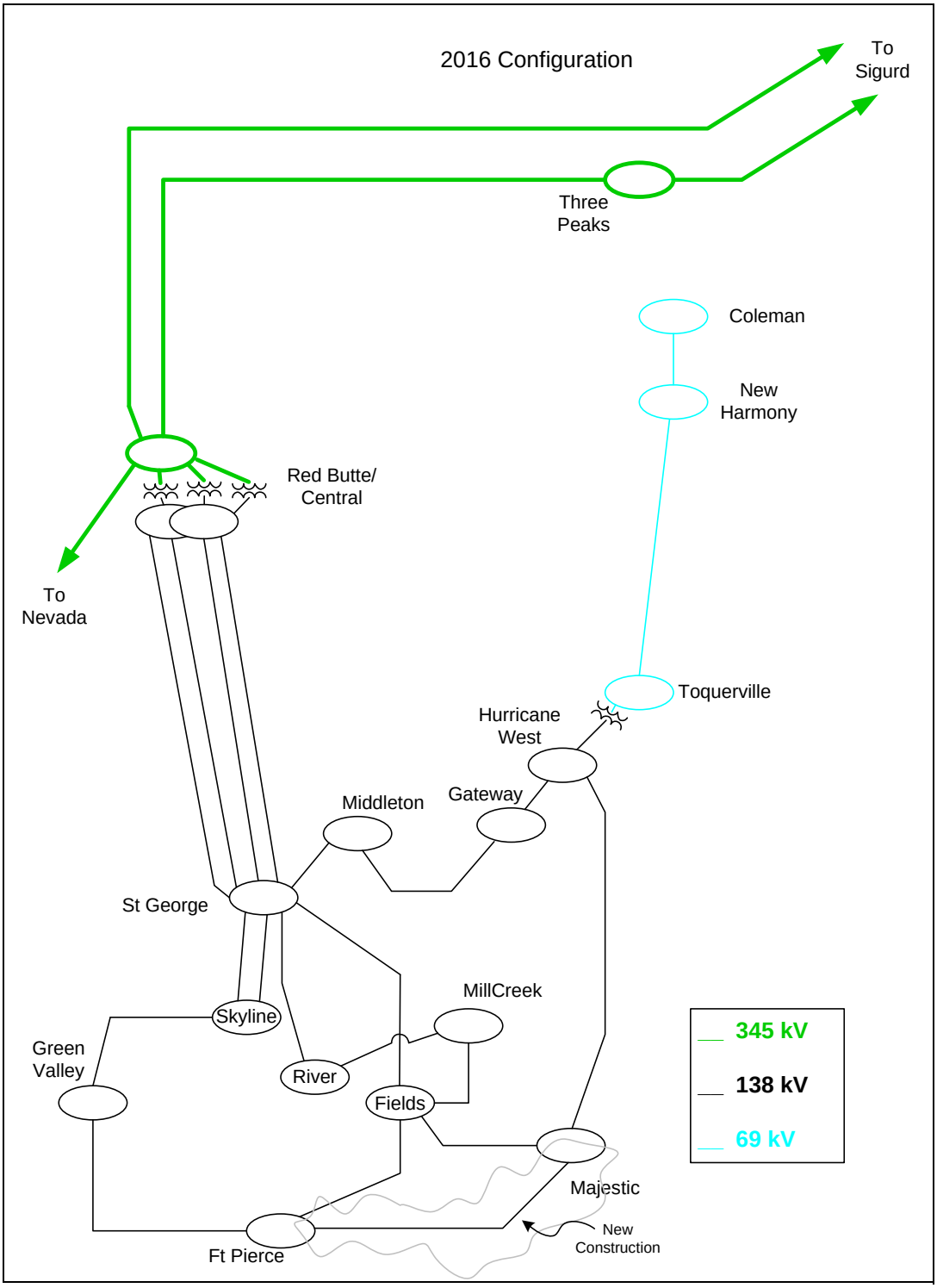
Table 1 – 2014 Outage Table

2014 Outage Analysis		
Outage	**Result**	**Additional**
Middleton-Gateway	No load lost Acceptable flows Acceptable voltages	
Majestic-Hurricane	No load lost Acceptable flows Acceptable voltages	
St. George-Fields	No load lost Acceptable flows Acceptable voltages	St. George-River 86% of 200 megavolt-amperes
St. George-River	No load lost Acceptable flows Acceptable voltages	St. George-Fields 92% of 200 megavolt-amperes
Fields-Ft. Pierce	No load lost Acceptable flows Acceptable voltages	Skyline-Green Valley 76% of 200 megavolt-amperes
Fields-Majestic	No load lost Acceptable flows Acceptable voltages	
Majestic-Ft. Pierce	(not installed yet)	
Skyline-Green Valley	No load lost Acceptable flows Acceptable voltages	Fields-Ft. Pierce 80% of 208 megavolt-amperes

2016

- Majestic-Ft. Pierce 138 kilovolt line (this in-service date could vary depending on additional studies)

Figure 8 – 2016 Configuration (Note: Uses alternative configuration from Figure 7B)



2017-2019

Results of this study suggest that at least by the 2019 timeframe, a commitment to building a 345 kilovolt line to the Hurricane area from the St. George substation versus multiple 138 kilovolt lines is required from a system capacity standpoint. In other words, the next 138 kilovolt line requirement from St. George to Fields (#2 line) in this timeframe could be built as a next step but would not be necessary or useful once a 345 kilovolt source is established in the Hurricane area. Results of this study also suggested that this 345 kilovolt line be continued on and looped from the Hurricane area up to Three Peaks in the 2020-2022 timeframe. However, because it is anticipated that this requirement will be met previously in either 2014 or 2018 based on the requirements and in-service dates suggested by PacifiCorp studies (mentioned previously), the proposed construction plan will be shown with the 2018 in-service date.

The 345 kilovolt constructed line from St. George to Hurricane could be operated at 138 kilovolt initially, however, as shown in Table 4 below, there are two outage scenarios that result in overloaded 138 kilovolt facilities. Because of this, it is recommended that this new line be operated at 345 kilovolt as soon as possible.

- If not completed previously: St. George-Hurricane 345 kilovolt line (recommend operating at 345 kilovolt initially but consideration could be given to operating at 138 kilovolt for a short period of time)
- Establish 345-138 kilovolt Hurricane substation
- As part of the 2018 requirement based on PacifiCorp studies, and if not completed earlier, complete construction of 345 kilovolt line between Hurricane and Three Peaks (it is possible that the Toquerville-Coleman 69 kilovolt line may be paralleled or double circuited)
- 345/138 kilovolt substation at St. George
- Convert two Red Butte-St. George 138 kilovolt lines to 345 kilovolt

Figure 9 – 2019 Configuration

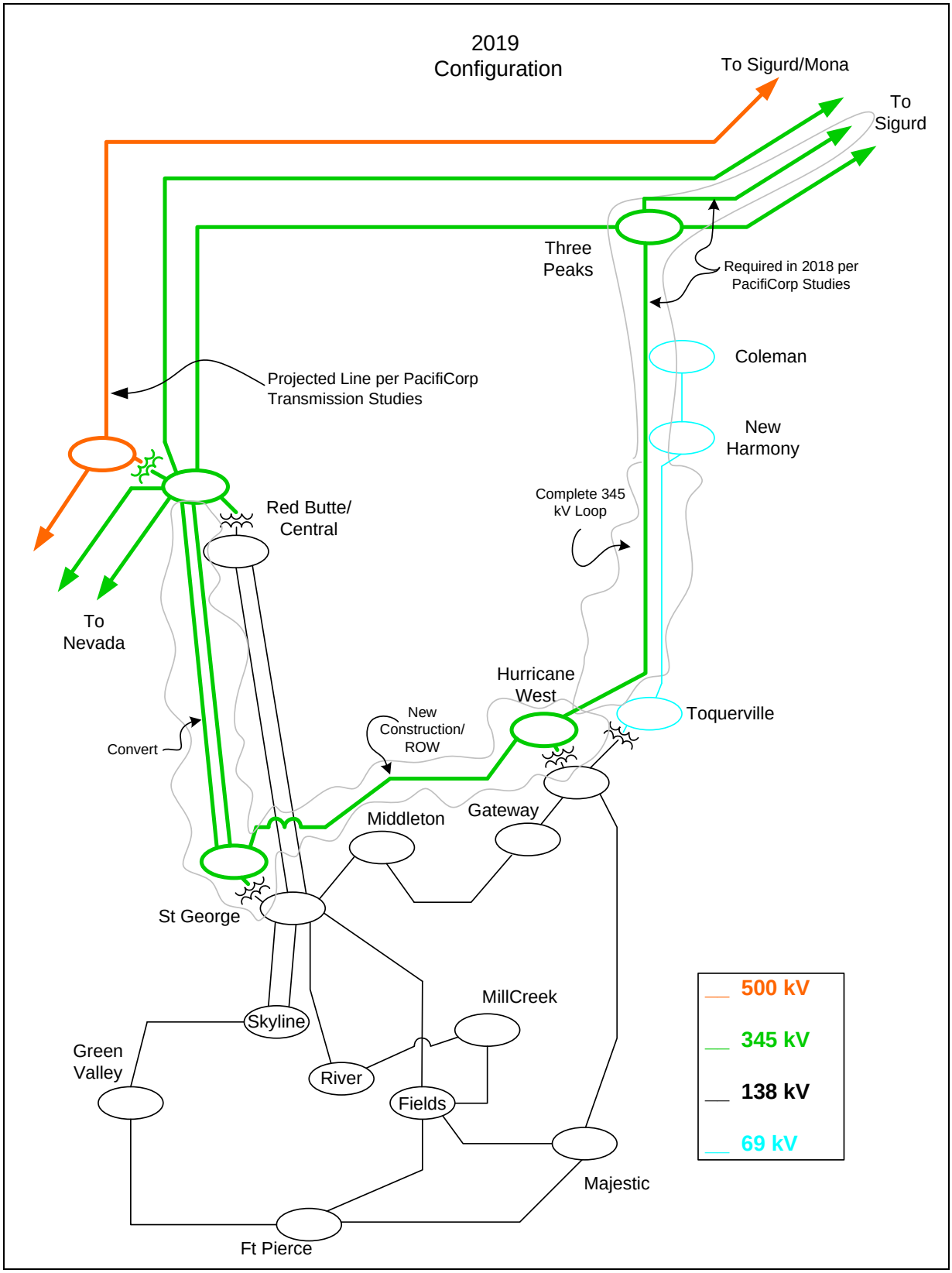


Table 2 – 2019 Outage Table A

2019 Outage Analysis St. George-Hurricane 345 kilovolt (No 2nd St. George-Fields 138 kilovolt line)		
Outage	**Result**	**Additional**
Middleton-Gateway	No load lost Acceptable flows Acceptable voltages	
Majestic-Hurricane	No load lost Acceptable flows Acceptable voltages	
St George-Fields	No load lost Acceptable flows Acceptable voltages	St. George-River 77% of 200 megavolt-amperes
St George-River	No load lost Acceptable flows Acceptable voltages	St. George-Fields 79% of 200
Fields-Ft. Pierce	No load lost Acceptable flows Acceptable voltages	
Fields-Majestic	No load lost Acceptable flows Acceptable voltages	
Majestic-Ft. Pierce	No load lost Acceptable flows Acceptable voltages	
Skyline-Green Valley	No load lost Acceptable flows Acceptable voltages	
St. George-Hurricane 345 kilovolt	No load lost Acceptable flows Acceptable voltages	St. George-Fields 76% of 200
Red Butte-St. George 345 kilovolt	No load lost Acceptable flows Acceptable voltages	Assumes both 345 kilovolt lines in service

Table 3 – 2019 Outage Table B

Alternate 1 - 2019 Outage Analysis St. George-Hurricane 345 kilovolt @ 138 kilovolt (No 2nd St. George-Fields 138 kilovolt line)		
Outage	**Result**	**Additional**
Middleton-Gateway	No load lost Acceptable flows Acceptable voltages	
Majestic-Hurricane	No load lost Acceptable flows Acceptable voltages	
St. George-Fields	No load lost High flows Acceptable voltages	106% of 200 St.George-River
St. George-River	Possible load loss High flows Acceptable voltages	118% of 200 St.George-Fields
Fields-Ft. Pierce	No load lost Acceptable flows Acceptable voltages	
Fields-Majestic	No load lost Acceptable flows Acceptable voltages	
Majestic-Ft. Pierce	No load lost Acceptable flows Acceptable voltages	
Skyline-Green Valley	No load lost High flows Acceptable voltages	96% of 200 St.George-Fields

Table 4 – 2019 Outage Table C

Alternate 2 – 2019 Outage Analysis St. George-Fields 138 kilovolt #2 (No St. George-Hurricane 345 kilovolt @ 138 kilovolt line)		
Outage	**Result**	**Additional**
Middleton-gateway	No load lost High flows Acceptable voltages	106% of 208 on Fields-Majestic
Majestic-Hurricane	No load lost Acceptable flows Acceptable voltages	
St. George-Fields	No load lost Acceptable flows Acceptable voltages	
St. George-River	No load lost Acceptable flows Acceptable voltages	
Fields-Ft. Pierce	No load lost Acceptable flows Acceptable voltages	
Fields-Majestic	No load lost Acceptable flows Acceptable voltages	
Majestic-Ft. Pierce	No load lost Acceptable flows Acceptable voltages	
Skyline-Green Valley	No load lost Acceptable flows Acceptable voltages	

2024

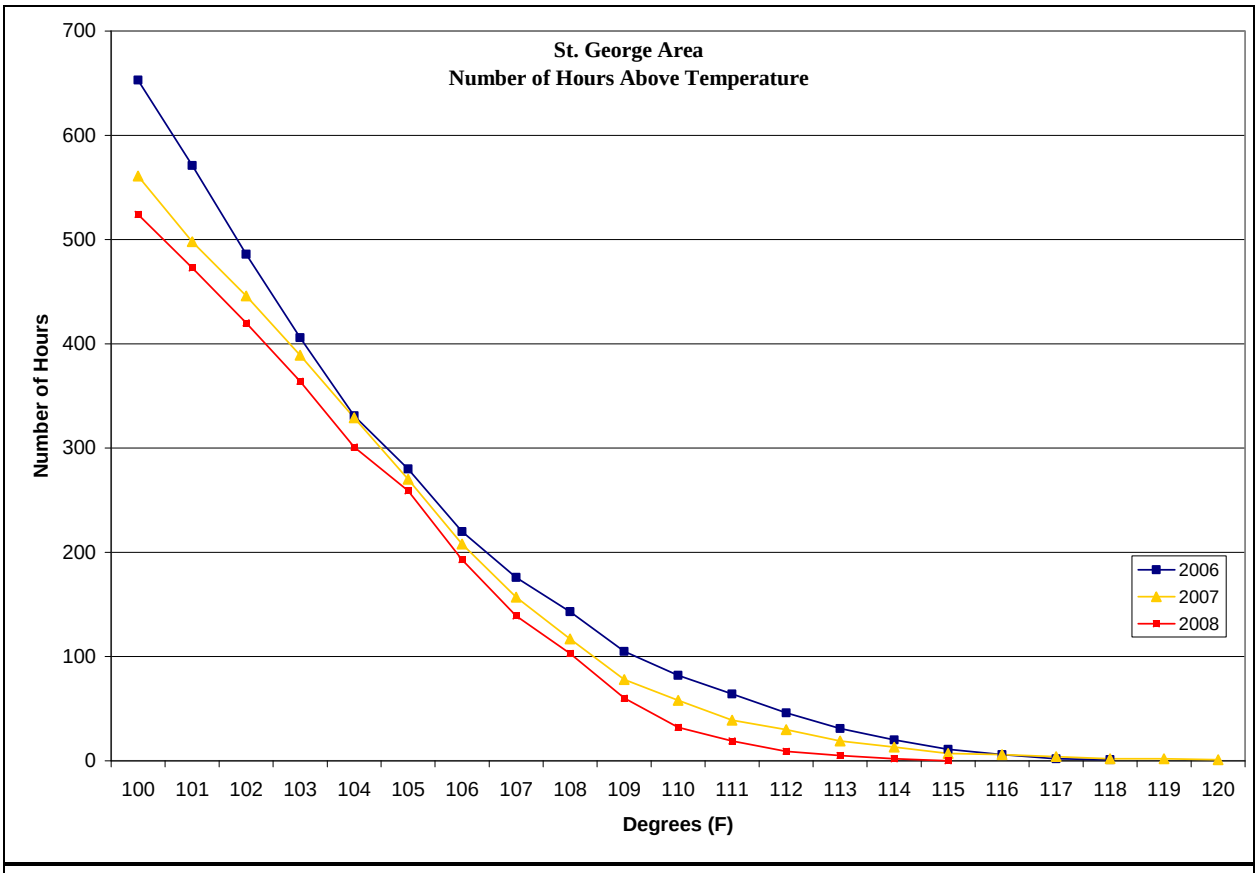
- Possibly St. George-Fields 138 kilovolt line (studies below were done without this line and other possible alternatives should be reviewed in greater detail)

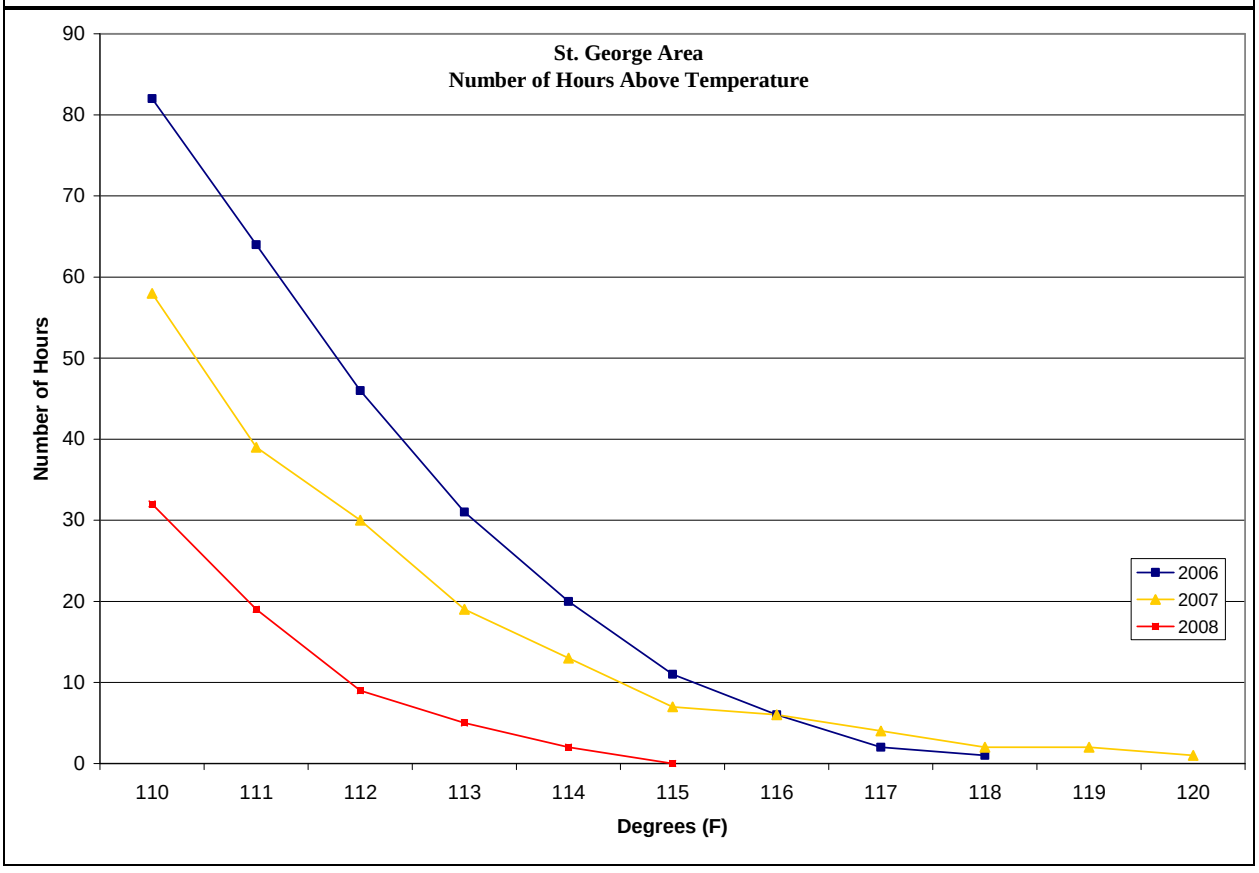
Table 5 – 2024 Outage Table

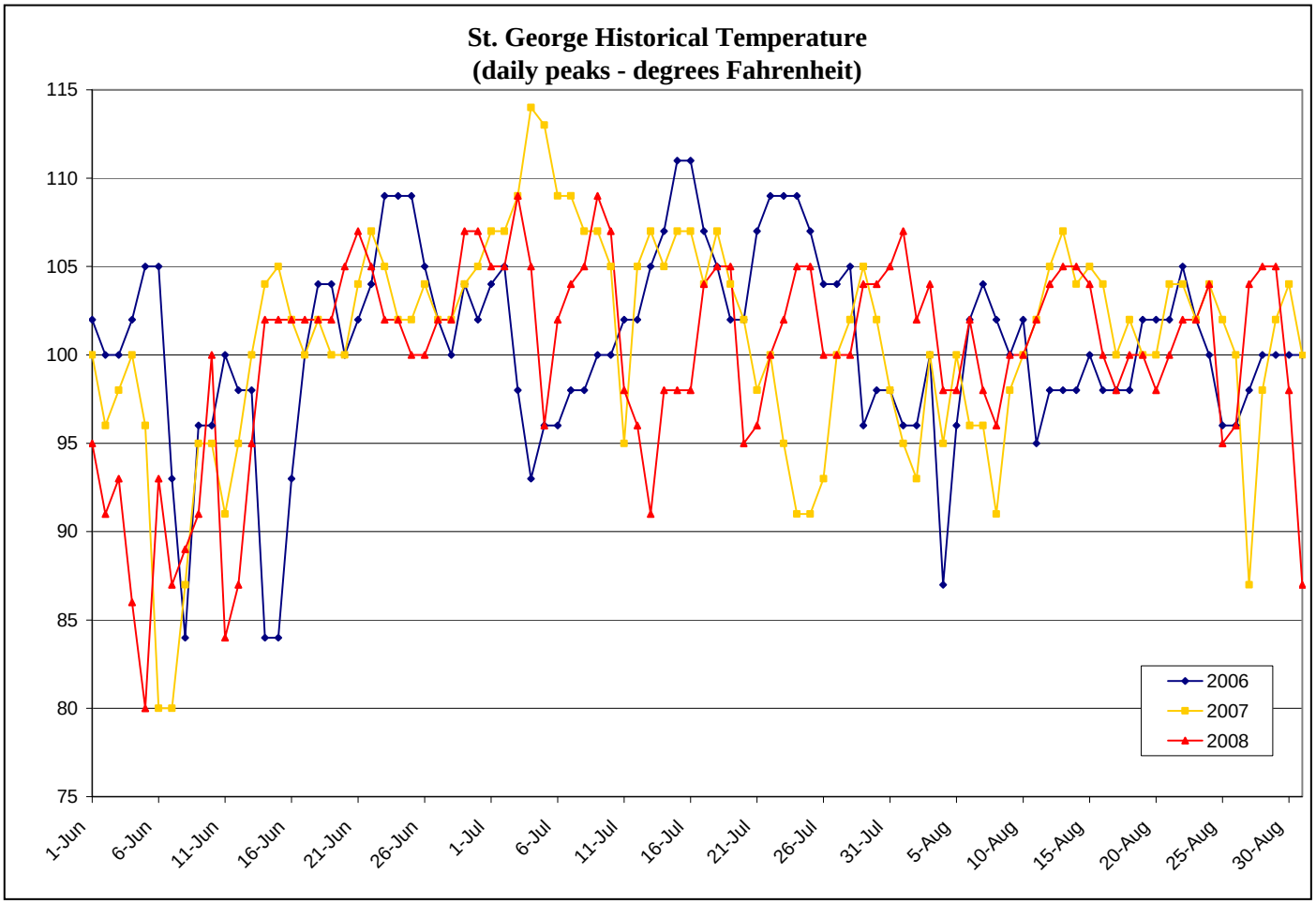
2024 Outage Analysis		
Outage	**Result**	**Additional**
Red Butte-St. George 345 kilovolt #1 and #2	Possible load loss Central-St. George lines at 111% of 200 megavolt-amperes	
Three Peaks-Hurricane 345 kilovolt	No load lost Acceptable flows Acceptable voltages	
Majestic-Hurricane	High flows	- St. George-Fields 108% of 200 megavolt-amperes - St. George-River 99% of 200 megavolt-amperes
St George-Fields 138 kilovolt	No load lost Acceptable flows Acceptable voltages	
St. George-River	High flows	St. George-Fields 117% of 200 megavolt-amperes
Fields-Ft. Pierce	No load lost Acceptable flows Acceptable voltages	
Fields-Majestic	No load lost Acceptable flows Acceptable voltages	
Majestic-Ft. Pierce	No load lost Acceptable flows Acceptable voltages	
Skyline-Green Valley	No load lost Acceptable flows Acceptable voltages	

Appendix A

(St. George Historical Temperatures)


St. George Area
Number of Hours Above Temperature
Number of Hours
Degrees (F)
2006
2007
2008


St. George Area
Number of Hours Above Temperature
Number of Hours
Degrees (F)
2006
2007
2008


St. George Historical Temperature
(daily peaks - degrees Fahrenheit)
115
110
105
100
95
90
85
80
75
1-Jun
6-Jun
11-Jun
16-Jun
21-Jun
26-Jun
1-Jul
6-Jul
11-Jul
16-Jul
21-Jul
26-Jul
31-Jul
5-Aug
10-Aug
15-Aug
20-Aug
25-Aug
30-Aug
2006
2007
2008

Appendix B

(2009 Summer Preparation Studies)

Southwest Utah 2009 Summer Prep Studies-Contingency List and Results
Set A - Local Generation On (54MW)
Initial Conditions:
Gross Load: 467 MW (includes 39 MW transfer of Enterprise, NewCastle, and Toquerville 34.5)
Net at Red Butte: 374 MW | 60 MVAr at Red Butte | 60 MVAr at Saint George | Modeled Power Factor 0.98
SVC Output: 8 MVAr | RMP Load Transfers: Enterprise/New Castle/Toquerville (total of 39 MW)

	Contingency	General Results	Initial Load Lost	Restoration and Switching	Additional
0	No Outage		na	na	na
1	Loss of Red Butte 345-138 Transformer	no issues			
2	Loss of Central-St. George #1 138 kV Line	Central-St. George #2 Loads to 111% of 200 MVA Normal Limit (92% of SPOL) Red Butte-St. George Loads to 105 % of 136 MVA Normal Limit SVC Output to 36 MVAr	None	None available	Curtailment of up to 31 MW during peak if it is an extended outage New double circuit 345 (138 operated) Red Butte-St. George project expected in 2010
3	Loss of Red Butte-St. George 138 kV Line	109% of 200 MVA limit in Base Case	None	na	Meter Limitation on RedButte-Central Bus Tie?? (200 MVA)
4	SVC Outage	see Main-Grid Nomogram Results			
5	Sigurd-Red Butte Outage	see Main-Grid Nomogram Results			
6	Red Butte-Harry Allen Outage	see Main-Grid Nomogram Results			
7	Loss of St George-Qail Ck 138 kV	Dixie out of power	91 MW initial load lost	Quail Ck-Mill Ck 138 kV line switched in	all 91 MW restored 138 kV Loop operation would minimize initial load lost
8	Loss of Quail Ck-Ft. Pierce 138 kV line	Dixie out of power	91 MW initial load lost	Bloomington 69 kV tie closed in Brentwood 69 kV tie closed in Bloomington Generation turned on (7MW)	Restored 35 MW from Bloomington tie Restored 18 MW from Brentwood 37 MW cannot be restored
9	Loss of St. George-Middleton 138 kV tie	RMP load out of power	50 MW load initially lost	Pick up 12.5 kV Toquerville load out of Coleman (8 of 10MW restored) ClifWil 69 kV tie closed in (up to 9 MW of 13 MW restored) 0 of 9 MW on 34.5 can backup Santa Clara-Red Mtn tie closed in (restore all 18 MW if Santa Clara Gen is on)	35 MW of 50 can be restored if extended outage

Page 1 of 5 (Set A)

Southwest Utah 2009 Summer Prep Studies-Contingency List and Results
Set A - Local Generation On (54MW)
Initial Conditions:
Gross Load: 467 MW (includes 39 MW transfer of Enterprise, NewCastle, and Toquerville 34.5)
Net at Red Butte: 374 MW | 60 MVAr at Red Butte | 60 MVAr at Saint George | Modeled Power Factor 0.98
SVC Output: 8 MVAr | RMP Load Transfers: Enterprise/New Castle/Toquerville (total of 39 MW)

	Contingency	General Results	Initial Load Lost	Restoration and Switching	Additional
10	Coleman-New Harmony 69 kV outage	Toquerville/NewHaromny loads lost	9.3 MW lost initially	Open NewHarmony-Coleman, close Toquerville tie	all 9.3 MW restored
11	St. George-Skyline 138 kV #1 or #2	No load lost	none	na	na
12	St. George-River 138 kV line	River Substation Load Lost	121 MW lost initially	Quail Ck-MillCk 138 kV tie close in	All load restored by bringing Mill Creek back on-line 138 kV Loop operation would minimize initial load lost
13	Skyline-Green Valley 138 kV line	Green Valley Load Lost	54 MW lost initially	Sunset-SnowCyn tie closed in	All load restored
14	Skyline 138-69 kV outage (93MVA bank)		none (Transformer #4 loads to 109%)	Shift 10 MW to either River or Green Valley Substations	
15	Green Valley 138-69 outage	same as Outage 13			
16	River 138-69 kV #1 or #2 outage	Overload backup transformer	Potential of up to 150% overload on the other transformer and loss of 121 MW	Shift East Ridge to Green Valley Shift Panorama, Hillside, Washington Main and Buena Vista to Skyline	All load restored
17	Purgatory-Brentwood 69 kV line		34 MW lost Initially	Shift Brentwood, ClifWilson, Twin Cities to RMP Middleton line	All loads restored with 11 MW Gen. restored at Clifton Wilson

Page 2 of 5 (Set A)

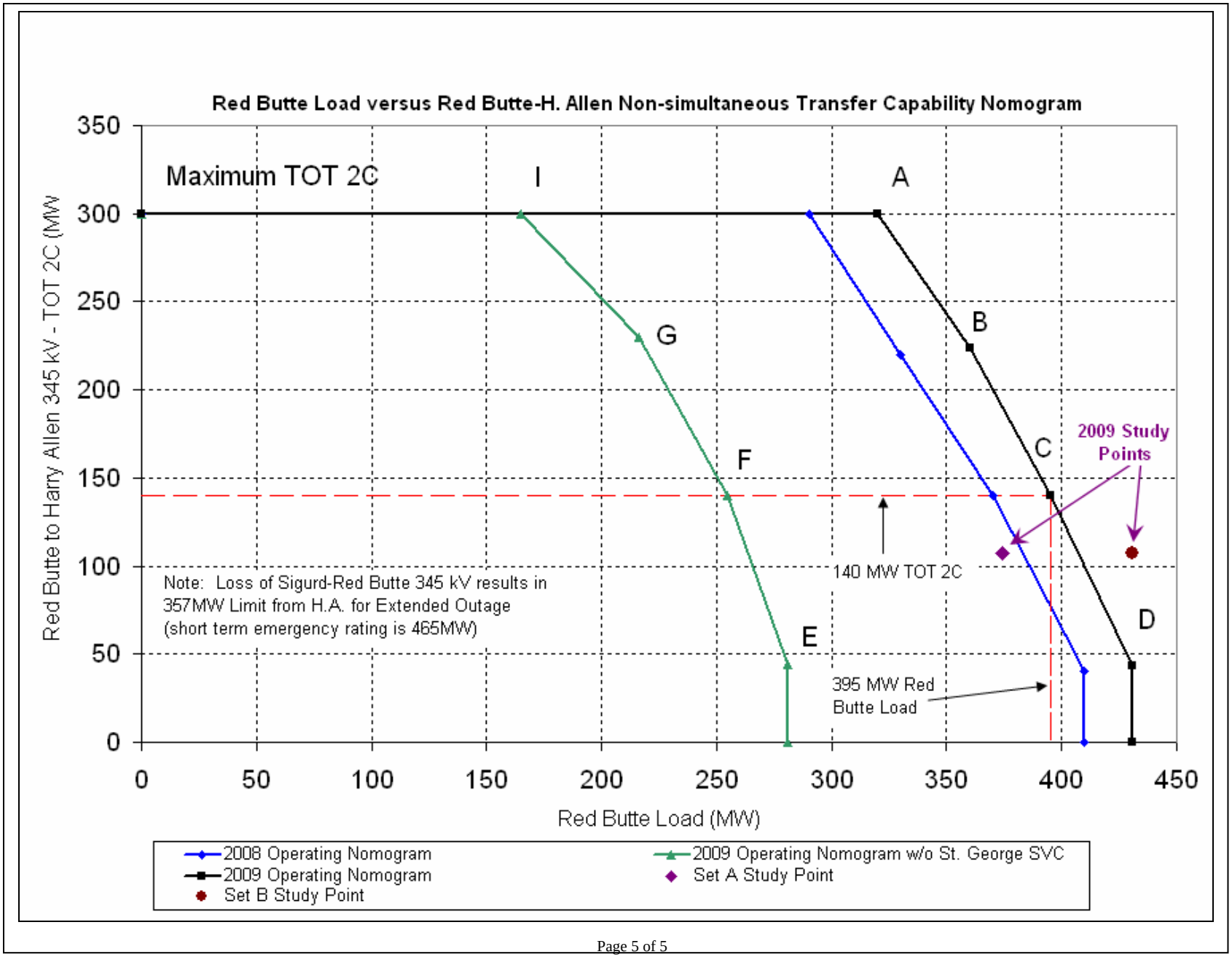
Southwest Utah 2009 Summer Prep Studies-Contingency List and Results
Set B - Local Generation Off (0MW)
Initial Conditions:
Gross Load: 470 MW (includes 39 MW transfer of Enterprise, NewCastle, and Toquerville 34.5)
Net at Red Butte: 431 MW | 60 MVAr at Red Butte | 60 MVAr at Saint George | Modeled Power Factor 0.98
SVC Output: 42 MVAr | RMP Load Transfers: Enterprise/New Castle/Toquerville (total of 39 MW)

	Contingency	General Results	Initial Load Lost	Restoration and Switching	Additional
0	No Outage		na	na	na
1	Loss of Red Butte 345-138 Transformer	no issues			
2	Loss of Central-St. George #1 138 kV Line	Central-St. George #2 Loads to 128% of 200 MVA Normal Limit (107% of SPOL) Red Butte-St. George Loads to 122% of 136 MVA Normal Limit (102% of SPOL) SVC Output to 79 MVAr	Potential of up to 431 MW	Up to 336 MW can be restored	Up to 94 MW curtailment if extended line outage and local generation off-line New double circuit 345 (138 operated) Red Butte-St. George project expected in 2010
3	Loss of Red Butte-St. George 138 kV Line	Central-St. George #1 and #2 lines load to 106% of Normal Limit	Note: RedButte-Central Tie loads to 124% of 200 MVA limit in Case	None available	Curtailment of up to 31 MW during peak if it is an extended outage
4	SVC Outage	see Main-Grid Nomogram Results			
5	Sigurd-Red Butte Outage	see Main-Grid Nomogram Results			
6	Red Butte-Harry Allen Outage	see Main-Grid Nomogram Results			
7	Loss of St George-Qail Ck 138 kV	Dixie out of power	91 MW lost initially	Quail Ck-Mill Ck 138 kV line switched in	Restore all but curtail possible of up to 16 MW (69 kV system could likely restore through bloomington tie connection or bring on generation at Mill Ck or Hurricane) 138 kV Loop operation would minimize initial load lost
8	Loss of Quail Ck-Ft. Pierce 138 kV line	Dixie out of power	91 MW initial load lost	Bloomington 69 kV tie closed in Brentwood 69 kV tie closed in Bloomington Generation turned on (7MW)	Restored 35 MW from Bloomington tie Restored 18 MW from Brentwood 37 MW cannot be restored
9	Loss of St. George-Middleton 138 kV tie	RMP load out of power	50 MW load initially lost	Santa Clara-Red Mtn tie closed in (restore up to 10 of 18 MW because gen is off) Pick up 12.5 kV Toquerville load out of Coleman (8 of 10MW restored) ClifWil 69 kV tie closed in (4 MW of 13 MW restored-Gen Off) 0 of 9 MW on 34.5 can backup	22 MW of 50 can be restored if extended outage (without Santa Clara and ClifWilson Gen)

Southwest Utah 2009 Summer Prep Studies-Contingency List and Results
Set B - Local Generation Off (0MW)
Initial Conditions:
Gross Load: 470 MW (includes 39 MW transfer of Enterprise, NewCastle, and Toquerville 34.5)
Net at Red Butte: 431 MW | 60 MVAr at Red Butte | 60 MVAr at Saint George | Modeled Power Factor 0.98
SVC Output: 42 MVAr | RMP Load Transfers: Enterprise/New Castle/Toquerville (total of 39 MW)

	Contingency	General Results	Initial Load Lost	Restoration and Switching	Additional
10	Coleman-New Harmony 69 kV outage	Toquerville/NewHaromny loads lost	9.3 MW lost initially	Open NewHarmony-Coleman, close Toquerville tie	all 9.3 MW restored
11	St. George-Skyline 138 kV #1 or #2	No load lost	none	na	na
12	St. George-River 138 kV line	River Substation Load Lost	121 MW lost initially	Quail Ck-MillCk 138 kV tie close in	105MW can be restored w/o MillCk Gen & avoid overload on St.G-QuailCk line-all restored w Gen 138 kV Loop operation would minimize initial load lost
13	Skyline-Green Valley 138 kV line	Green Valley Load Lost	54 MW lost initially	Sunset-SnowCyn tie closed in	All load restored
14	Skyline 138-69 kV outage (93MVA bank)		none (Transformer #4 loads to 117%)	Shift 15 MW to either River or Green Valley Substations	All load restored by transferring 15 MW
15	Green Valley 138-69 outage	same as Outage 13			
16	River 138-69 kV #1 or #2 outage	Overload backup transformer	Potential of up to 166% overload on the remaining transformer and loss of 121 MW	Shift East Ridge to Green Valley Shift Panorama, Hillside, Washington Main and Buena Vista to Skyline	All load restored with transfers
17	Purgatory-Brentwood 69 kV line		34 MW lost Initially	Shift Brentwood, ClifWilson, Twin Cities to RMP Middleton line 20 of 34 MW can be restored	20 of 34MW can be restored or all loads restored w 11 MW Gen. at Clifton Wilson

Page 4 of 5 (Set B)


Red Butte Load versus Red Butte-H. Allen Non-simultaneous Transfer Capability Nomogram
Maximum TOT 2C
I
A
B
C
D
E
F
G
2009 Study Points
140 MW TOT 2C
395 MW Red Butte Load
Note: Loss of Sigurd-Red Butte 345 kV results in 357MW Limit from H.A. for Extended Outage (short term emergency rating is 465MW)
Red Butte to Harry Allen 345 kV - TOT 2C (MW
Red Butte Load (MW)
0
50
100
150
200
250
300
350
400
450
2008 Operating Nomogram
2009 Operating Nomogram
Set B Study Point
2009 Operating Nomogram w/o St. George SVC
Set A Study Point