SVP System Expansion Plan for TPP 23/24 (Draft)

Prepared for:

Prepared By:
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1.0 Executive Summary

The SVP System Expansion Plan for TPP 23/24, prepared by Electrical Consultants, Inc. (ECI) for Silicon Valley Power (SVP) presents an analysis of SVP's transmission system for a set of network configurations and network loading levels. This study has multiple purposes. One goal is to identify improvements for each of the Sensitivity cases for SVP to implement to maintain electric service reliability with consideration of replacements of end-of-life infrastructure and significant load growth as a result of proposed data center additions, residential, and commercial growth. The second goal is to analyze the network under normal operating conditions and determine the minimum reactive power needed to meet the PG&E power factor requirements for supplying power to SVP. The third goal is to analyze the SVP network for a specified set of contingencies or outages and determine the reactive power requirements needed to meet reliability standards for voltage performance of the SVP system. A Sensitivity case is a variation of load growth projections, network configurations, and new loads.

The load growth projections were provided by SVP which are identified in the *2022STEP Study Scope_rev8-3* spreadsheet. These projections assume different load growth profiles and include the following load levels:

- 739 MW peak system load projected in Sensitivity I 2024
- 954 MW peak system load projected in Sensitivity I 2027
- 1194 MW peak system load projected in Sensitivity I 2032
- 814 MW peak system load projected in Sensitivity I-1 2024
- 1067 MW peak system load projected in Sensitivity I-1 2027
- 1358 MW peak system load projected in Sensitivity I-1 2032
- 1306 MW peak system load projected in Sensitivity II 2032
- 1503 MW peak system load projected in Sensitivity II-1 2032

Steady state load flow analysis was performed for each sensitivity case with consideration of peak loading levels correlating with each of the respective years. All improvement projects mentioned in *Section 5* serve as either maintenance/replacement of end-of-life equipment or to create additional capacity.

1.1 Performance Criteria

Power system reliability performance is evaluated using performance criteria established by national, regional, and local standards. These include:

- NERC Standard TPL-001-4
- NERC Standard TPL-001-5
- WECC Criterion TPL-001-WECC-CRT-3.1
- SVP local standards - Criteria and Guideline 2022 DRAFT ver1.docx

The standards focus on two main parameters of the power system that define its performance. One is the voltage performance which is described by the allowable variation of the voltage at a bus around its nominal operating point. This voltage is allowed to vary between 95% and 105% of the nominal value during normal operations with all equipment

operational (no equipment outages). For example, a 60 kV bus is allowed to vary from 57.0 kV to 63.0 kV during normal operation as loads change from daytime maximum to nighttime lows. If an outage occurs, say a transformer or a line has a fault and is switched out of service, then the system voltage is allowed to operate between 93% and 107.5% of its nominal value. If the system is unable to operate within these limits, then there is a voltage violation, and some mitigation must be done to correct it.

The second performance metric is the level of current allowed on electrical equipment. All electrical power components that supply power to loads have current limits which could cause thermal damage (Thermal Overload) if they are exceeded. Since current causes heating, this is often referred to as the thermal limits of the electrical components and it is expressed either in terms of current level (Amperes) or MVA (Mega-Volt-Amps which is a measure of power in the circuit). Thermal limits cannot be violated at any time under normal operating conditions with all equipment in service. An outage or contingency that removes an element from service is also not allowed to cause any thermal (or current) limits to be violated although some equipment may allow some short-term overloads. If a violation occurs, then the standards require that steps be taken to remedy the situation. In the case of a thermal overload of a line, the line may need to be rebuilt with a larger conductor. In the case of an overloaded transformer, the transformer may have to be replaced with one having a higher thermal or MVA rating.

In addition, SVP specific performance criteria was also considered as part of the evaluation of the transmission system. SVP specific criteria includes consideration that the loading on each 60 kV loop between receiving stations should not exceed 280 MVA with a target around 250 MVA and the lines can be loaded up to 80% of thermal rating. Each loop is designed for 310 MVA of loading.

1.2 Sensitivity II Improvements

A summary of recommended improvements and corresponding costs, and duration for upgrades to meet established criteria with projected peak loads is provided in *Table 1-1*. These timeframes are only conceptual and will change as the projects are developed and the actual load occurs in the system. In addition, there are PG&E 115 kV line upgrades that are identified as a result of not meeting planning criteria; however, costs for these items are not included in the summary and will need to be coordinated directly with PG&E. The contingencies as well as the loading levels that trigger the upgrades can be found in *Section 5* of this report.

Item	Description	Indicative Cost ($M)	Estimated Duration (Design & Construction)
1	Re-conductor 0.2 miles, 115 kV transmission line connecting Duane and Scott Receiving Station (SRS) substations.	$1.62	30 months
2	Install two additional 115/60 kV 300 MVA auto transformers at NRS (TA, TD). Upgrade NRS 115 kV and 60 kV bus to mitigate various P2 contingencies identified due to main/transfer bus design. Options include DBDB (Double-Bus-Double-Breaker), BAAH (Breaker-and-A-Half), or RB (Ring Bus) bus configurations. Budget to be added CIP 2454.	$39.28	36 months
3	Addition of a third NRS 230/115 kV 500 MVA autotransformer and balance of plant for interconnection of new CAISO 500 MVA 230 kV AC line interconnection at NRS. Budget to be added to CIP 2430.	$7.27	36 months
4	Approved CIP 2431 “Homestead Substation Rebuild” will upgrade breakers and disconnects to 3000 amp rating in Q4, 2027	N/A	
5	Re-conductor 3.54 miles of 60 kV transmission line connecting the Homestead Substation and Scott Receiving Station (SRS).	$11.97	22 months
6	Re-conductor 0.62 miles of 60 kV transmission line connecting the Laurelwood Substation and Kifer Receiving Station (KRS) Substations	$3.05	22 months
7	Build 5.89 miles or 60 kV transmission line to build New Loop 1 (overhead).	$76.27	30 months
8	Build 6.98 miles or 60 kV transmission line to build New Loop 2 (overhead).	$97.07	30 months
9	Study VAR and Voltage mitigation technologies and develop implementation plan.	$1.5	10 months
10	Study PST overloading mitigations identified in Table 5-37 Contingency Analysis Thermal Violation; PG&E for short term Operation Procedures and long term mitigation solution that can include but not limited to installing a 2 PST at SSS, in addition to Transmission Access Charge (TAC) impacts	$0.25	10 months

Table 1-1
Recommended Improvements

The total estimated budgetary level cost for Sensitivity II improvements is $238.28M. The transmission line cost estimates do not include easement acquisitions or SVP internal costs.

2.0 Introduction

This report presents a detailed System Expansion Plan for TPP 23/24 for Silicon Valley Power's (SVP's) electric system expansion to service the projected load increases for the years 2024, 2027, and 2032.

2.1 Local Transmission System

SVP provides electrical service generally within the geographical limits of the City of Santa Clara. The transmission system presently includes almost 60 miles of transmission line, operating at voltages of 230 kV, 115 kV, and 60 kV. The 230 kV and 115 kV systems deliver power to three receiving stations where the voltage is transformed to 60 kV and power is delivered to loads through five geographic loops. SVP 2021 peak load was 595 MW confined to a 19 square mile service territory.

Santa Clara has become a major attraction for large data centers due to its location in Silicon Valley, competitive energy cost and available redundant communication networks. The load requests currently under discussion could add as many as twelve (12) substations each with loads raging from 25 to 100 MW which will exceed interconnection capacity of SVP ties to PG&E, the transformer capacity at SVP's receiving substations and 60 kV transmission facilities.

2.2 Study Objectives

The objective of this report is to meet the SVP Sensitivity forecasts for the TPP year 2023/2024 which provides a forecast out 10 years to 2032. This is a yearly process managed by the CAISO and which SVP participates as a Transmission Planner. The improvements are intended to upgrade the existing SVP transmission system to allow the network to serve up to 1503 MW of load capacity while keeping system performance secure. The system performance is secure in the sense that none of the outages included in the SVP contingency list will lead to excessive low voltage levels at any SVP bus, or cascading power outages or equipment failures on the network.

3.0 Study Methodology

3.1 Software Details

PowerWorld Simulator version 22 with a revision date of August 2022 is used for this analysis. PowerWorld Simulator is an interactive power system software package designed to simulate high voltage power system operation. The following simulation parameters were changed from their defaults for this analysis:

1) Generation lost during contingency analysis is balanced by all responsive generation in WECC.
2) The analysis utilizes PowerWorld's steady state load flow solutions for the analysis with automatic switched shunts and tap changer adjustments.
3) Performance violations in the Base Case are not re-reported during contingency analysis.
4) Generator MW limits are enforced.
5) Generator VAR limits are checked before each power flow solution.

3.2 Analysis Performed

Steady state power flow contingency analysis was performed for each Sensitivity case scenario analyzed in this report. If switching reactive devices are recommended for a Corrective Action Plan, step changes to voltage was also analyzed. No short circuit or transient stability analysis are presented in this report. PG&E lines and buses were not considered in this study except for the PG&E lines and buses directly connected or adjacent to SVP buses.

An aggregate power factor calculation is performed for each base case by adding up MW and MVAR line flows from the PG&E system to the SVP system under normal (P0) system conditions.

Contingency analysis is run for each case using the SVP contingency definitions (P1 – P7). In cases where substations upgrades have approved projects that would eliminate certain contingencies from occurring then those contingencies have been removed from the analysis. In particular the KRS and SRS P2 bus section faults have been removed from the contingency list since those substations are planning to go to breaker and half bus configurations which will eliminate the bus section faults from occurring.

An N-1-1 analysis is run for voltage performance for each case where P1 contingencies (single element outages) are applied to the system while DVR generation and load are off lines.

3.3 Performance Criteria

System performance is measured against the requirements of NERC Standard TPL-001-4, NERC Standard TPL-001-5, WECC Criterion TPL-001-WECC-CRT-3.1 and the 2022 SVP Criteria and Guideline (Draft). In general, applicable facility continuous thermal ratings cannot be violated at any time, and bus voltages must remain between 0.95 to 1.05 pu of nominal with all lines in service and 0.93 to 1.075 pu post-contingency.

SVP has some additional system performance criteria requirements for this study. For all Bulk Electric System (BES) elements (generally defined by NERC as 100 kV and above) TPL-001-5 also applies. For the 60 kV elements, a post-contingency load bus voltage cannot change by more than 8% compared to its pre-contingency value. Existing 60 kV loops are designed for 186 MVA to 310 MVA with an eventual goal of 310 MVA.

4.0 System Modeling

4.1 Study Case Used

SVP supplied the GBA-2023-SP_M, GBA-2026-SP-SCRD-fix, and GBA-2031-SP-SCRD models used for the analysis. SVP also supplied M files which contain model updates and system configuration changes. These M files were used to help create parts of the Sensitivity cases.

4.2 Study Case Assumptions

The following assumptions were considered throughout the analysis:

1) Line and equipment ratings were based on values in the existing system model provided by SVP and 2021 SVP system diagram.
2) Fault currents on 60 kV system limited to 80% of 40 kA (32 kA).
3) System upgrades from the 3-Year Development Plan (2021) are completed by the end of the calendar year as identified within that report. The list of upgrades from the 3-Year report is as follows: Upgraded KRS breakers to 3000 Amp breakers in 2024, Upgraded Fiberglass breakers to 3000 Amp breakers in 2024, Rebuild SRS and KRS in 2027, Building the new NRS to KRS 115 kV line in 2024, Reconductor Walsh to Uranium in 2024, Upgrade NRS 115/60 kV transformers with 300 MVA transformers, and add two 230/115 kV transformers at NRS.

4.3 Generation Dispatch and Load Growth

The SVP system has generation at Gianera Generating Station and at Duane Substation. Generation dispatch for these two locations is based on the SVP supplied models. The loads for SVP are dispatched for each case from the 2022STEP Study Scope_rev8-3 spreadsheet. This load forecast does not include distributed load growth or residential load growth.

4.4 Case Scenarios

Eight (8) study scenarios were created by adding spot loads, changing load growth rates, and network configuration changes to the supplied SVP base case. The tables in *Sections 4.4.1 – 4.4.10* show the loading levels for the 60 kV loops, receiving stations, and the generation facilities for each case.

Throughout the cases, some line capacity MVA flow ratings are limited by station breaker ratings and in some instances, line ratings were changed to match the 2021 SVP system diagram. The line from Bowers to Uranium is limited by a 2000 amp breaker at Uranium substation. There are two line ratings that were changed to match the SVP Transmission Map; the underground line from NRS 500 to Mission and the underground line from Mission to Juliette. These changes are only for the underground portions of the lines.

The following subsections are descriptions of how the cases were set up. This includes changes in load, configuration, and ratings that occur in each case. In all cases the upgrades from the 3-Year Development Plan are applied. Additionally, all cases include a series reactor between Nortech and Los Esteros. A configuration change is when a substation

moves to a different loop. The load for each case comes from the *2022STEP Study Scope_rev8-3* spreadsheet.

4.4.1 Sensitivity I 2024 Case

There are no configuration changes, new substations, or rating changes in the Sensitivity I 2024 case. *Table 4-1: Sensitivity I 2024 Case Loading Levels* shows load in each loop as well as total projected load used in the Sensitivity I 2024 case.

Location	Load Levels (MVA)	Percent Loading (%)
Center Loop	231.04	74.41
East Loop	140.34	45.20
Northeast Loop	77.79	44.94
Northwest Loop	136.69	78.97
South Loop	91.22	52.70
KRS / LAF	36.98	
SRS	26.76	
Generation Loads	5.87	
Total	**746.69**	

Table 4-1
Sensitivity I 2024 Case Loading Levels

4.4.2 Sensitivity I 2027 Case

There are no configuration changes, new substations, or rating changes in the Sensitivity I 2027 case. *Table 4-2: Sensitivity I 2027 Case Loading Levels* shows load in each loop as well as total projected load used in the Sensitivity I 2027 case.

Location	Load Levels (MVA)	Percent Loading (%)
Center Loop	271.26	87.36
East Loop	219.57	70.71
Northeast Loop	98.36	56.82
Northwest Loop	169.68	98.02
South Loop	126.09	72.84
KRS / LAF	33.46	
NRS	13.31	
SRS	27.27	
Generation Loads	5.87	
Total	**946.87**	

Table 4-2
Sensitivity I 2027 Case Loading Levels

4.4.3 Sensitivity I 2032 Case

The Sensitivity I 2032 case has many configuration changes; San Thomas substation was moved from the Northwest Loop to New Loop 1, Fairview substation was moved from the Center Loop to New Loop 1, Oak JCT and Pacific substations were moved from East Loop to New Loop 1, and Stender Way substation was moved from Center Loop to Northwest Loop. New Loop 1 requires new lines to be built to the following substations from NRS to SRS; San Thomas, Fairview, Oak JCT, and Pacific. Moving Stender Way requires new line to be built to Stender Way. The new lines for New Loop will be built to the substations in the order that they are listed. These new lines will be built with bundled 715 KCM

ACCR conductor. Configuration changes included two new 230/115 kV transformers at NRS substation to accommodate approved HVDC projects in CAISO's TPP2021-022 process. The HVDC line is 500 MW at 0.90 power factor with a dedicated 230 kV line to NRS. There are no rating changes in the Sensitivity I 2032 case. *Table 4-3: Sensitivity I 2032 Case Loading Levels* shows load in each loop as well as total projected load used in the Sensitivity I 2032 case.

Location	Load Levels (MVA)	Percent Loading (%)
Center Loop	216.87	69.85
East Loop	217.87	70.17
New Loop 1	175.31	56.46
Northeast Loop	117.86	68.09
Northwest Loop	188.05	108.64
South Loop	199.19	115.07
KRS / LAF	33.25	
NRS	21.37	
SRS	27.08	
Generation Loads	5.87	
Total	**1202.72**	

Table 4-3
Sensitivity I 2032 Case Loading Levels

4.4.4 Sensitivity I-1 2024 Case

There are no configuration changes, new substations, or rating changes in the Sensitivity I-1 2024 case. *Table 4-4: Sensitivity I-1 2024 Case Loading Levels* shows load in each loop as well as total projected load used in the Sensitivity I-1 2024 case.

Location	Load Levels (MVA)	Percent Loading (%)
Center Loop	251.02	80.84
East Loop	178.46	57.48
Northeast Loop	80.99	46.79
Northwest Loop	155.24	89.68
South Loop	96.65	55.83
KRS / LAF	36.92	
NRS	2.99	
SRS	26.77	
Generation Loads	5.87	
Total	**834.91**	

Table 4-4
Sensitivity I-1 2024 Case Loading Levels

4.4.5 Sensitivity I-1 2027 Case

There are no configuration changes, new substations, or rating changes in the Sensitivity I-1 2027 case. *Table 4-5: Sensitivity I-1 2027 Case Loading Levels* shows load in each loop as well as total projected load used in the Sensitivity I-1 2027 case.

Location	Load Levels (MVA)	Percent Loading (%)
Center Loop	286.59	92.30
East Loop	278.58	89.72
Northeast Loop	103.45	59.76
Northwest Loop	194.78	112.52
South Loop	137.48	79.42
KRS / LAF	33.46	
NRS	13.57	
SRS	27.27	
Generation Loads	5.87	
Total	**1080.99**	

Table 4-5
Sensitivity I-1 2027 Case Loading Levels

4.4.6 Sensitivity I-1 2032 Case

The Sensitivity I-1 2032 case has many configuration changes; San Thomas substation was moved from the Northwest Loop to New Loop 1, Fairview substation was moved from the Center Loop to New Loop 1, Oak JCT and Pacific substations were moved from East Loop to New Loop 1, Stender_W substations were moved from the Center Loop to the New Loop 2, and DCJ substation was moved from East Loop to New Loop 2. New Loop 1 requires new line to be built to the following substations from NRS to SRS; San Thomas, Fairview, Oak JCT, and Pacific. New Loop 2 requires new lines to be built to the following substations from SRS and NRS; Stender Way and DCJ. The new lines for New Loop 1 and New Loop 2 will be built to the substations in the order that they are listed. These new lines will be built with bundled 715 KCM ACCR conductor. Configuration changes included two new 230/115 kV transformers at NRS substation to accommodate approved HVDC projects in CAISO's TPP2021-22 process. The HVDC line is 500 MW at 0.90 power factor with a dedicated 230 kV line to NRS. There are no rating changes in the Sensitivity I-1 2032 case. *Table 4-6: Sensitivity I-1 2032 Case Loading Levels* shows load in each loop as well as total projected load used in the Sensitivity I-1 2032 case.

Location	Load Levels (MVA)	Percent Loading (%)
Center Loop	225.29	72.56
East Loop	213.47	68.75
New Loop 1	204.99	66.02
New Loop 2	92.44	29.77
Northeast Loop	126.44	73.04
Northwest Loop	185.11	106.94
South Loop	229.73	132.72
KRS / LAF	33.25	
NRS	21.37	
SRS	27.08	
Generation Loads	5.87	
Total	**1365.04**	

Table 4-6
Sensitivity I-1 2032 Case Loading Levels

4.4.7 Sensitivity II 2032 Case

The Sensitivity II 2032 case has many configuration changes; San Thomas substation was moved from the Northwest Loop to New Loop 1, Fairview substation was moved from the Center Loop to New Loop 1, Oak CJT and Pacific were moved from East Loop to New Loop 1, Stender Way substation was moved from Center Loop to New Loop 2, and DCJ and Memorex substations was moved from East Loop to New Loop 2. New Loop 1 requires new line to be built to the following substations from NRS to SRS; San Thomas, Fairview, DC16, DC27, Oak JCT, and Pacific. New Loop 2 requires new lines to be built to the following substations from SRS and NRS; Stender Way, DC15, Memorex, and DCJ. The new lines for New Loop 1 and New Loop 2 will be built to the substations in the order that they are listed. These new lines will be built with bundled 715 KCM ACCR conductor. Configuration changes included two new 230/115 kV transformers at NRS substation to accommodate approved HVDC projects in CAISO's TPP2021-22 process. The HVDC line is 500 MW at 0.90 power factor with a dedicated 230 kV line to NRS. There are no rating changes in the Sensitivity II 2032 case. *Table 4-7: Sensitivity II 2032 Case Loading Levels* shows load in each loop as well as total projected load used in the Sensitivity II 2032 case.

Location	Load Levels (MVA)	Percent Loading (%)
Center Loop	217.81	70.15
East Loop	189.59	61.06
New Loop 1	210.35	67.75
New Loop 2	140.32	45.19
Northeast Loop	118.39	68.39
Northwest Loop	165.47	95.59
South Loop	199.76	115.40
KRS / LAF	33.46	
NRS	21.37	
SRS	27.08	
Generation Loads	5.87	
Total	**1329.47**	

Table 4-7
Sensitivity II 2032 Case Loading Levels

4.4.8 Sensitivity II-1 2032 Case

The Sensitivity II-1 2032 case has many configuration changes; San Thomas substation was moved from the Northwest Loop to New Loop 1, Fairview substation was moved from the Center Loop to New Loop 1, Oak CJT and Pacific were moved from East Loop to New Loop 1, Stender Way substation was moved from Center Loop to New Loop 2, and DCJ and Memorex substations was moved from East Loop to New Loop 2. New Loop 1 requires new line to be built to the following substations from NRS to SRS; San Thomas, Fairview, DC16, DC27, Oak JCT, and Pacific. New Loop 2 requires new lines to be built to the following substations from SRS and NRS; Stender Way, DC15, Memorex, and DCJ. The new lines for New Loop 1 and New Loop 2 will be built to the substations in the order that they are listed. These new lines will be built with bundled 715 KCM ACCR conductor. Configuration changes included two new 230/115 kV transformers at

NRS substation to accommodate approved HVDC projects in CAISO's TPP2021-22 process. The HVDC line is 500 MW at 0.90 power factor with a dedicated 230 kV line to NRS. There are no rating changes in the Sensitivity II-1 2032 case. *Table 4-8: Sensitivity II-1 2032 Case Loading Levels* shows load in each loop as well as total projected load used in the Sensitivity II-1 2032 case.

Location	Load Levels (MVA)	Percent Loading (%)
Center Loop	226.23	72.86
East Loop	238.86	76.9.
New Loop 1	238.38	76.77
New Loop 2	181.42	58.43
Northeast Loop	126.97	73.35
Northwest Loop	185.86	107.37
South Loop	230.31	133.05
KRS / LAF	33.46	
NRS	21.37	
SRS	27.08	
Generation Loads	5.87	
Total	**1515.81**	

Table 4-8
Sensitivity II-1 2032 Case Loading Levels

5.0 Analysis

Through coordination with SVP, NERC TPL-001-4 P1 and select P2-P7 contingencies were evaluated for the SVP System Expansion Plan for TPP 23/24. The contingency definitions are edited and/or added to reflect changes to the system brought by configuration changes, new substations, and new lines. For each of the sensitivity case tables only the worst three preforming contingencies are shown for each circuit element.

5.1 Sensitivity I 2024 Case (Peak Load 739 MW)

5.1.1 Contingency Analysis

Contingency analysis of the SVP transmission system with projected Sensitivity I 2024 peak loads shows thermal violations on the MisNRS11 to NRS 500 and the NRS 600 to Agnew transmission lines. MisNRS11 is a fictitious bus used to model the change from overhead to underground transmission line. MisNRS11 to NRS 500 is the overhead portion of the NRS to Mission transmission line.

Row Labels	MVA	% Limit
KRS (36850) -> KRS_60 (36878)		
P2 – Bus Section – SRS 60 kV	227.79	122.47
P2 – Bus Section – SRS 115 kV	206.77	111.17
KRS (36850) -> KRS_60 (36878)		
P2 – Bus Section – SRS 60 kV	227.79	122.47
P2 – Bus Section – SRS 115 kV	206.77	111.17
SRS (36852) -> SRS_60 (36886)		
P2 – Bus Section – KRS 60 kV	241.46	129.81
P2 – Bus Section – KRS 115 kV	214.52	115.33
P1 – Transformer – SRS 115/60 kV #1	191.60	103.01
SRS (36852) -> SRS_60 (36886)		
P2 – Bus Section – KRS 60 kV	241.46	129.81
P2 – Bus Section – KRS 115 kV	214.52	115.33
P1 – Transformer – SRS 115/60 kV #2	191.60	103.01

Table 5-1
Contingency Analysis Thermal Violation; 115 kV System

Row Labels	MVA	% Limit
MisNRS11 (36884) -> NRS 500 (36862)		
P2 – Bus Section – SRS 115 kV	197.73	114.23

Table 5-2
Contingency Analysis Thermal Violation; Sensitivity I 2024 Case

Row Labels	MVA	% Limit
LSESTRSRCTR (65665) -> Nortech (35659)		
P6 – Multiple Contingency – NRS -NRS 400 & Newark D – NRS 400	332.97	118.92
P6 – Multiple Contingency – NRS -NRS 400 & Newark F – NRS 300	325.61	116.29
P2 – Bus Section – NRS 400	323.70	115.61
Newark D (35120) -> NRS 400 (36851)		
P5 – Bus Section – Los Esteros 230 kV BAAH Bus #1&2	189.38	113.33
P7 – Adjacent Circuits – Newark – Los Esteros & Los Esteros – Metcalf 230 kV Lines	170.43	101.99
Newark F (35120) -> NRS 300 (36853)		
P5 – Bus Section – Los Esteros 230 kV BAAH Bus #1&2	171.60	102.69
NRS 400 (36851) -> SRS (36852)		
P2 – Bus Section – NRS 300	313.13	110.66

Table 5-3
Contingency Analysis Thermal Violation; PG&E

A voltage change (Delta V) violation is based on the SVP performance criteria where voltage can not change by more than 8% from pre-contingency to post contingency conditions. A low voltage violation is based on the SVP performance criteria where voltage can not drop below 0.93 pu in post contingency conditions. No violations occur in this case.

5.1.2 Corrective Action Plans

This section covers corrective actions needed to mitigate performance violations created by the Sensitivity I load with projected 2024 load levels.

Upgrade KRS Transformers

Upgrade both KRS transformers with transformers capable of at least 228 MVA mitigates all thermal performance issues found

Upgrade SRS Transformer

Upgrade both SRS transformers with transformers capable of at least 242 MVA mitigates all thermal performance issues found

Re-conductor MisNRS11 – NRS 500 60 kV Line (CIP #2444)

Re-conductor the MisNRS11 – NRS 500 60 kV transmission line, which is approximately 0.79 miles of (2) bundled 954 KCM AAC, with conductor capable of at least 211 MVA mitigates all thermal performance issues found.

5.2 Sensitivity I 2027 Case (Peak Load 954 MW)

5.2.1 Contingency Analysis

Contingency analysis of the SVP transmission system with projected Sensitivity I 2027 peak loads show additional thermal violations from the 2024 case. The violations are on the Duane to SRS transmission line.

Row Labels	MVA	% Limit
Duane (36861) -> SRS (36852)		
P7 – Adjacent Circuits – NRS – SRS #1 & #2 115 kV Lines	340.44	102.60

Table 5-4
Contingency Analysis Thermal Violation; Sensitivity I 2027 Case

Row Labels	MVA	% Limit
LSESTRSRCTR (65665) -> Nortech (35659)		
P6 – Multiple Contingency – NRS -NRS 400 & Newark D – NRS 400	422.70	150.96
P6 – Multiple Contingency – NRS -NRS 400 & Newark F – NRS 300	416.13	148.62
P2 – Bus Section – NRS 400	410.91	146.75
Newark D (35120) -> NRS 400 (36851)		
P5 – Bus Section – Los Esteros 230 kV BAAH Bus #1&2	240.92	144.18
P7 – Adjacent Circuits – Newark – Los Esteros & Los Esteros – Metcalf 230 kV Lines	222.75	133.30
P5 – Bus Section – Palo Alto SW. STA> 115 kV DBDB Bus #1	191.57	114.64
Newark F (35120) -> NRS 300 (36853)		
P5 – Bus Section – Los Esteros 230 kV BAAH Bus #1&2	225.25	134.80
P7 – Adjacent Circuits – Newark – Los Esteros & Los Esteros – Metcalf 230 kV Lines	204.89	122.62
P5 – Bus Section – Palo Alto SW. STA> 115 kV DBDB Bus #1	171.60	102.69
NRS 400 (36851) -> SRS (36852)		
P2 – Bus Section – NRS 300	367.34	129.80
Nortech (35659) -> NRS 300 (36853)		
P6 – Multiple Contingency – NRS -NRS 400 & Newark D – NRS 400	374.52	121.99
P6 – Multiple Contingency – NRS -NRS 400 & Newark F – NRS 300	368.18	119.93
P2 – Bus Section – NRS 400	362.97	118.23
ZNKER J2 (35602) -> KRS (36850)		
P5 – Bus Section – Los Esteros 230 kV BAAH Bus #1&2	194.78	116.57
P7 – Adjacent Circuits – Newark – Los Esteros & Los Esteros – Metcalf 230 kV Lines	181.67	108.72
P2 – Bus Section – NRS 300	177.99	106.52

Table 5-5
Contingency Analysis Thermal Violation; PG&E

A voltage change (Delta V) violation is based on the SVP performance criteria where voltage can not change by more than 8% from pre-contingency to post contingency conditions. This case has low voltage violations based on the SVP performance criteria where voltage can not drop below 0.93 pu in post contingency conditions. The low voltage violations occur on the DVRbLoad bus with a minimum value of 0.91 pu.

5.2.2 Corrective Action Plans

This section covers corrective actions needed to mitigate performance violations created by the Sensitivity I load with projected 2027 load levels.

Re-conductor Duane – SRS 115 kV Line

Re-conductor the Duane – SRS 115 kV transmission line (0.20 miles) with a conductor capable of at least 341 MVA mitigates all thermal performance issues found.

5.3 Sensitivity I 2032 Case (Peak Load 1194 MW)

5.3.1 Thermal Analysis

Contingency analysis of the SVP transmission system with projected Sensitivity I 2032 peak loads show many thermal violations as defined in *Section 1.1*. These violations have been divided into separate tables based on location. SVP transmission lines and receiving stations experience thermal overloads because of the large increase in load. HomSRS11 is an old transition point between overhead to underground transmission lines.

Row Labels	MVA	% Limit
Duane (36861) -> SRS (36852)		
P7 – Adjacent Circuits – NRS – SRS #1 & #2 115 kV Lines	393.29	118.53

Table 5-6
Contingency Analysis Thermal Violation; 115 kV System

Row Labels	MVA	% Limit
NRS (38900) -> NRS 400 (36851)		
P2 – Bus Section – NRS 300	668.94	159.27

Table 5-7
Contingency Analysis Thermal Violation; NRS

Row Labels	MVA	% Limit
HomSRS11 (36897) -> SRS_60 (36886)		
P1 – Transmission Circuit – Laurelwood - KRS	216.36	124.99
Homestea (36876) -> HomSRS11 (36897)		
P1 – Transmission Circuit – Laurelwood - KRS	211.12	121.97
Serra (36887) -> Homestea (36876)		
P1 – Transmission Circuit – Laurelwood - KRS	174.45	100.78
KRS_60 (36878) -> Laurelwood (38912)		
P1 – Transmission Circuit – SRS – Homestead	200.70	115.94

Table 5-8
Contingency Analysis Thermal Violation; South Loop

Row Labels	MVA	% Limit
LS ESTRS (30731) -> SSS (38901)		
P1 – Transmission Circuit – NRS_injectio - NRS	443.49	105.59
P2 – Bus Section – NRS_injecctio	443.49	105.59
Nortech 35659(36851) -> NRS 300 (36853)		
P2 – Bus Section – NRS 230 kV	396.32	129.09
KRS (36850) -> FMC JCT (35617)		
P2 – Bus Section – NRS 230 kV	242.52	145.22
P2 – Bus Section – NRS 300	233.23	139.66
P5 – Bus Section – Los Esteros 239 kV BAAH Bus #1&2	189.88	113.70
LSESTRSRCTR (35665) -> Nortech (35659)		
P2 – Bus Section – NRS 230 kV	452.70	161.68
NRS 300 (36853) -> SRS (36852)		
P2 – Bus Section – NRS 400	350.34	123.79
P1 – Transmission Circuit – NRS 400 – SRS 115 kV	285.08	100.73
NRS 400 (36851) -> SRS (36852)		
P2 – Bus Section – NRS 300	475.81	168.13
P1 – Transmission Circuit – NRS 300 – SRS 115 kV CKT #2	284.18	100.42

Table 5-9
Contingency Analysis Thermal Violation; PG&E

5.3.2 Voltage Analysis

The minimum additional capacitance needed in the Sensitivity I 2032 case under N-0 conditions to get to 0.97 pu aggregate power factor is 16.0 MVARs. The overall N-0 power factor, before adding caps, is 0.966. The overall imports from the PG&E tie-lines are:

Total MW	Total MVAR	Overall PF
1016.26	270.67	0.9663

Fr_BNum	Fr_BNam	Nom_kV	To_BNum	To_BNam	MW	MVAR	MVA
36850	KRS	115.0	35602	ZNKER J2	-24.74	-27.26	36.8
36850	KRS	115.0	35617	FMC JCT	-128.51	22.74	130.5
36851	NRS 400	115.0	35120	NEWARK D	-2.82	-18.59	18.8
36853	NRS 300	115.0	35122	NEWARK F	15.67	-16.16	22.5
36853	NRS 300	115.0	35659	NORTECH	-86.42	-28.34	90.9
38900	NRS	230.0	389000	NRS_injec	-499.57	-180.32	531.1
38901	SSS	230.0	30731	LS ESTRS	-289.87	-22.74	290.8

Table 5-10
N-0 Monitored Line Flows

After capacitors are added to mitigate contingency voltage issues, the aggregate power factor seen by PG&E supply lines is 0.98. This represents an excess of 75 MVAR of capacitance over what is needed to meet the 0.97 power factor requirement with PG&E.

A contingency analysis (P1 contingencies only) was also run with the DVR generation off-line representing an N-1-1 condition. No additional voltage violations were encountered in this analysis.

A voltage change (Delta V) violation is based on the SVP performance criteria where voltage can not change by more than 8% from pre-contingency to post contingency conditions. A low voltage violation is based on the SVP performance criteria where voltage can not drop below 0.93 pu in post contingency conditions. This case contains 21 buses with low voltage violations prior to adding capacitors shown in *Table 5-11*.

Some of the buses in *Table 5-11* below are fictious buses. MisNRS11 and JulMis11 are fictitious buses used to indicate the change from overhead to underground transmission line. DVRPP 1M and DVRPP 2M are fictitious bus used to create a three-winding transformer in PowerWorld.

Bus Number	Bus Name	Nom_V	V_Low	Contingency
36857	Mission	60.0	0.925	P2 – Bus Section – NRS 300
36862	NRS 500	60.0	0.927	P2 – Bus Section – NRS 300
36863	DVRaGT1	13.8	0.922	P1 – Generator – DVTaGT1
36864	DVRbGt2	13.8	0.921	P1 – Generator DVRbGt2
36865	DVRaST3	13.8	0.922	P1 – Generator DVRaST3
36866	DVRbLoad	13.8	0.884	P2 – Bus Section – NRS 230 kV
36867	DVRPP 1M	13.8	0.889	P2 – Bus Section – NRS 230 kV
36868	DVRPP 2M	13.8	0.886	P2 – Bus Section – NRS 230 kV
36871	Brokaw	60.0	0.878	P1 – Transmission Circuit – Laurelwood - KRS
36872	Martin JCT	60.0	0.877	P1 – Transmission Circuit – Laurelwood - KRS
36873	Central	60.0	0.928	P2 – Bus Section – NRS 300
36875	Gia12	60.0	0.927	P2 – Bus Section – NRS 300
36877	Juliette	60.0	0.925	P2 – Bus Section – NRS 300
36884	MisNRS11	60.0	0.926	P2 – Bus Section – NRS 300
36885	JulMis11	60.0	0.925	P2 – Bus Section – NRS 300
36887	Serra	60.0	0.917	P1 – Transmission Circuit – Laurelwood - KRS
36889	Uranium	60.0	0.927	P2 – Bus Section – NRS 230 kV
36891	Zeno	60.0	0.928	P2 – Bus Section – NRS 230 kV
36898	BroSer11	60.0	0.889	P1 – Transmission Circuit – Laurelwood - KRS
38912	Laurelwood	60.0	0.877	P1 – Transmission Circuit – Laurelwood - KRS
38915	Bowers	60.0	0.927	P2 – Bus Section – NRS 230 kV

Table 5-11
Contingency Analysis Voltage Violation

The following capacitors were added to mitigate Sensitivity I 2032 case voltage violations:

SRS: 20 MVARs
KRS: 20 MVARs
DVRbLoad: 20 MVARs
Martin JCT: 28 MVARs
Laurelwood: 12 MVARs

Total Added = 100 MVARs

The N-1-1 analysis consisting of DVR generation and load offline and P1 contingencies yields the following results:

5.3.3 Corrective Action Plans

This section covers corrective actions needed to mitigate performance violations created by the Sensitivity I load with projected 2032 load levels.

Re-conductor Duane – SRS 115 kV Line

Re-conductor the Duane – SRS 115 kV transmission line (0.20 miles) with a conductor capable of at least 394 MVA mitigates all thermal performance issues found.

Upgrade NRS 115 kV and 60 kV Bus Configurations

Reconfigure NRS 115 kV and 60 kV buses to mitigate various P2 (NERC TPL bus outage) contingencies. Options include DBDB (double-bus-double-breaker), BAAH (breaker-and-a-half), or RB (ring bus) bus arrangements. Budget to be added into CIP 2454.

Addition of the third NRS 230/115 kV 500 MVA Transformer

Add a third 230/115 kV autotransformer (500 MVA rating) at NRS to accommodate CAISO's 500 MVA 230 kV HVDC/AC project interconnecting at NRS. Budget to be added to CIP 2430.

Homestead Substation Rebuild (CIP #2431)

This project will upgrade all substation breakers and disconnects to 3000 amps capability in Q4 of 2027.

Re-conductor Homestead – SRS 60 kV Line

Re-conductor the Homestead – HomSRS11 60 kV and HomSRS11 – SRS 60 kV transmission lines, which is approximately 3.54 mile of (2) bundled 954 KCM AAC, with conductor capable of at least 217 MVA mitigates all thermal performance issues found.

Re-conductor Serra – Homestead 60 kV Line

Re-conductor the Serra – Homestead 60 kV transmission lines, which is approximately 1.80 mile of (2) bundled 954 KCM AAC, with conductor capable of at least 175 MVA mitigates all thermal performance issues found.

Re-conductor KRS – Laurelwood 60 kV Line

Re-conductor the KRS – Laurelwood 60 kV transmission line, which is approximately 0.62 mile of (2) bundled 954 KCM AAC, with conductor capable of at least 201 MVA mitigates all thermal performance issues found.

5.4 Sensitivity I-1 2024 Case (Peak Load 814 MW)

5.4.1 Contingency Analysis

Contingency analysis of the SVP transmission system with shows thermal violations on the NRS 600 to Agnew, the MisNRS11 to NRS 500, Mission to MisNRS11, and the Juliette to JulMis11 transmission lines. MisNRS11 and JulMis11 are fictitious buses used to indicate the change from overhead to underground transmission line. MisNRS11 to NRS 500 is the overhead portion and Mission to MisNRS11 is the underground portion of the NRS to Mission transmission line. Juliette to JulMis11 is the overhead portion of the Mission to Juliette transmission line.

Row Labels	MVA	% Limit
KRS (36850) -> Duane (36861)		
P2 – Bus Section – SRS 60 kV	333.27	100.44
KRS (36850) -> KRS_60 (36878)		
P2 – Bus Section – SRS 60 kV	259.61	139.58
P2 – Bus Section – SRS 115 kV	234.74	126.21
P1 – Transformer – KRS 115/60 kV #1	201.12	108.13
KRS (36850) -> KRS_60 (36878)		
P2 – Bus Section – SRS 60 kV	259.61	139.58
P2 – Bus Section – SRS 115 kV	234.74	126.21
P1 – Transformer – KRS 115/60 kV #2	201.12	108.13
SRS (36852) -> SRS_60 (36886)		
P2 – Bus Section – KRS 60 kV	278.78	149.88
P2 – Bus Section – KRS 115 kV	242.78	130.53
P1 – Transformer – SRS 115/60 kV #1	217.32	116.84
SRS (36852) -> SRS_60 (36886)		
P2 – Bus Section – KRS 60 kV	278.78	149.88
P2 – Bus Section – KRS 115 kV	242.78	130.53
P1 – Transformer – SRS 115/60 kV #2	217.32	116.84

Table 5-12
Contingency Analysis Thermal Violation; 115 kV System

Row Labels	MVA	% Limit
MisNRS11 (36884) -> NRS 500 (36862)		
P2 – Bus Section – SRS 115 kV	221.54	127.98
P2 – Bus Section – KRS 60 kV	180.82	104.46
NRS 600 (36892) -> Agnew (36870)		
P2 – Bus Section – KRS 115 kV	187.77	108.47
Uranium (36889) -> Zeno (36891)		
P2 – Bus Section – SRS 60 kV	175.33	101.29
P1 – Transmission Circuit – SRS – Stender_W	175.24	101.23

Table 5-13
Contingency Analysis Thermal Violation; Sensitivity I-1 2024 Case

Row Labels	MVA	% Limit
LSESTRSRCTR (65665) -> Nortech (35659)		
P6 – Multiple Contingency – NRS -NRS 400 & Newark D – NRS 400	364.80	130.28
P6 – Multiple Contingency – NRS -NRS 400 & Newark F – NRS 300	358.22	127.94
P2 – Bus Section – NRS 400	354.57	126.63
Newark D (35120) -> NRS 400 (36851)		
P5 – Bus Section – Los Esteros 230 kV BAAH Bus #1&2	207.07	123.92
P7 – Adjacent Circuits – Newark – Los Esteros & Los Esteros – Metcalf 230 kV Lines	188.53	112.83
Newark F (35120) -> NRS 300 (36853)		
P5 – Bus Section – Los Esteros 230 kV BAAH Bus #1&2	191.11	114.37
P7 – Adjacent Circuits – Newark – Los Esteros & Los Esteros – Metcalf 230 kV Lines	170.96	102.31
Nortech (35659) -> NRS 300 (36853)		
P6 – Multiple Contingency – NRS -NRS 400 & Newark D – NRS 400	317.47	103.41
P6 – Multiple Contingency – NRS -NRS 400 & Newark F – NRS 300	311.17	101.36
P2 – Bus Section – NRS 400	307.41	100.13
NRS 400 (36851) -> SRS (36852)		
P2 – Bus Section – NRS 300	328.52	116.08

Table 5-14
Contingency Analysis Thermal Violation; PG&E

A voltage change (Delta V) violation is based on the SVP performance criteria where voltage can not change by more than 8% from pre-contingency to post contingency conditions. This case has low voltage violations based on the SVP performance criteria where voltage can not drop below 0.93 pu in post contingency conditions. The low voltage violation occurs across some of the SVP transmission system.

5.4.2 Corrective Action Plans

This section covers corrective actions needed to mitigate performance violations created by the Sensitivity I-1 load with projected 2024 load levels.

Re-conductor KRS – Duane 115 kV Line

Re-conductor the KRS – Duane 115 kV transmission line (0.02 miles) with a conductor capable of at least 334 MVA mitigates all thermal performance issues found.

Upgrade KRS Transformers

Upgrade both KRS transformers with transformers capable of at least 228 MVA mitigates all thermal performance issues found

Upgrade SRS Transformer

Upgrade both SRS transformers with transformers capable of at least 242 MVA mitigates all thermal performance issues found

Re-conductor MisNRS11 – NRS 500 60 kV Line (CIP #2444)

Re-conductor the MisNRS11 – NRS 500 60 kV transmission line, which is approximately 0.79 miles of (2) bundled 954 KCM AAC, with conductor capable of at least 222 MVA mitigates all thermal performance issues found.

Re-conductor NRS 600 – Agnew 60 kV Line

Re-conductor the NRS 600 – Agnew 60 kV transmission line, which is approximately 1.00 mile of (2) bundled 954 KCM AAC, with conductor capable of at least 188 MVA mitigates all thermal performance issues found.

Re-conductor Uranium – Zeno 60 kV Line

Re-conductor the Uranium – Zeno 60 kV transmission line, which is approximately 1.53 mile of (2) bundled 954 KCM AAC, with conductor capable of at least 176 MVA mitigates all thermal performance issues found.

5.5 Sensitivity I-1 2027 Case (Peak Load 1067 MW)

5.5.1 Contingency Analysis

Contingency analysis of the SVP transmission system with projected Sensitivity I-1 2027 peak loads show many thermal violations as defined in *Section 1.1*. These violations have been divided into separate tables based on location. SVP transmission lines and NRS receiving station experience thermal overloads because of the large increase in load.

Row Labels	MVA	% Limit
Duane (36861) -> SRS (36852)		
P7 – Adjacent Circuits – NRS – SRS #1 & #2 115 kV Lines	387.68	116.84

Table 5-15
Contingency Analysis Thermal Violation; 115 kV System

Row Labels	MVA	% Limit
Central (36873) -> SRS_60 (36886)		
P2 – Bus Section – NRS 500	197.42	114.05
P1 – Transmission Circuit – NRS 500 – Mission	197.41	114.04
P2 – Bus Section – NRS 300	188.47	108.88

Table 5-16
Contingency Analysis Thermal Violation; Northwest Loop

Row Labels	MVA	% Limit
Parker (38906) -> Mathew (36882)		
P1 – Transmission Circuit – SRS - Kenneth	174.85	101.01
Mathew (36882) -> DCJ (38904)		
P1 – Transmission Circuit – SRS - Kenneth	201.91	116.66
P2 – Bus Section – Kenneth	179.86	103.90

Table 5-17
Contingency Analysis Thermal Violation; East Loop

Row Labels	MVA	% Limit
Uranium (36889) -> Zeno (36891)		
P1 – Transmission Circuit – SRS – Srender_W	182.54	105.45
Bowers (38915) -> Uranium (36889)		
P1 – Transmission Circuit – SRS – Srender_W	215.91	103.90

Table 5-18
Contingency Analysis Thermal Violation; Center Loop

Row Labels	MVA	% Limit
LSESTRSRCTR (65665) -> Nortech (35659)		
P6 – Multiple Contingency – NRS -NRS 400 & Newark D – NRS 400	474.33	169.40
P6 – Multiple Contingency – NRS -NRS 400 & Newark F – NRS 300	468.20	167.21
P2 – Bus Section – NRS 400	461.75	164.91
Newark D (35120) -> NRS 400 (36851)		
P5 – Bus Section – Los Esteros 230 kV BAAH Bus #1&2	269.19	161.09
P7 – Adjacent Circuits – Newark – Los Esteros & Los Esteros – Metcalf 230 kV Lines	251.44	150.47
P5 – Bus Section – Palo Alto SW. STA. 115 kV DBDB Bus #1	220.22	131.79
Newark F (35120) -> NRS 300 (36851)		
P5 – Bus Section – Los Esteros 230 kV BAAH Bus #1&2	254.28	152.17
P7 – Adjacent Circuits – Newark – Los Esteros & Los Esteros – Metcalf 230 kV Lines	235.36	140.85
P5 – Bus Section – Palo Alto SW. STA> 115 kV DBDB Bus #1	202.17	120.99
Nortech (35659) -> NRS 300 (36853)		
P6 – Multiple Contingency – NRS -NRS 400 & Newark D – NRS 400	425.16	138.49
P6 – Multiple Contingency – NRS -NRS 400 & Newark F – NRS 300	419.28	136.57
P2 – Bus Section – NRS 400	412.93	134.51
ZNKER J2 (35602) -> KRS (36850)		
P2 – Bus Section – NRS 300	220.39	131.89
P5 – Bus Section – Los Esteros 230 kV BAAH Bus #1&2	219.63	131.44
P7 – Adjacent Circuits – Newark – Los Esteros & Los Esteros – Metcalf 230 kV Lines	207.70	124.30
KRS (36850) -> FMC JCT (35617)		
P2 – Bus Section – NRS 300	183.42	109.83
NRS 400 (36851) -> SRS (36852)		
P2 – Bus Section – NRS 300	393.53	139.06

Table 5-19
Contingency Analysis Thermal Violation; PG&E

A voltage change (Delta V) violation is based on the SVP performance criteria where voltage can not change by more than 8% from pre-contingency to post contingency conditions. This case has low voltage violations based on the SVP performance criteria where voltage can not drop below 0.93 pu in post contingency conditions. The low voltage violation occurs across some of the SVP transmission system.

5.5.2 Corrective Action Plans

This section covers corrective actions needed to mitigate performance violations created by the Sensitivity I-1 load with projected 2027 load levels.

Re-conductor Duane – SRS 115 kV Line

Re-conductor the Duane – SRS 115 kV transmission line (0.20 miles) with a conductor capable of at least 388 MVA mitigates all thermal performance issues found.

Re-conductor Central – SRS 60 kV Line

Re-conductor the Central – SRS 60 kV transmission line, which is approximately 1.43 mile of (2) bundled 954 KCM AAC, with conductor capable of at least 198 MVA mitigates all thermal performance issues found.

Re-conductor Parker – Mathew 60 kV Line

Re-conductor the Parker – Mathew 60 kV transmission line, which is approximately 0.13 mile of (2) bundled 954 KCM AAC, with conductor capable of at least 175 MVA mitigates all thermal performance issues found.

Re-conductor Mathew – DCJ 60 kV Line

Re-conductor the Mathew – DCJ 60 kV transmission line, which is approximately 0.11 mile of (2) bundled 954 KCM AAC, with conductor capable of at least 202 MVA mitigates all thermal performance issues found.

Re-conductor Uranium – Zeno 60 kV Line

Re-conductor the Uranium – Zeno 60 kV transmission line, which is approximately 1.53 mile of (2) bundled 954 KCM AAC, with conductor capable of at least 183 MVA mitigates all thermal performance issues found.

Replace Uranium Breakers

Replacing the 2000 Amp Uranium breakers with 3000 Amp breakers is needed to mitigate the thermal overload on the Bowers - Uranium 60 kV transmission line.

Re-conductor Bowers – Uranium 60 kV Line

Re-conductor the Bowers – Zeno 60 kV transmission line, which is approximately 0.02 mile of (2) bundled 954 KCM AAC, with conductor capable of at least 216 MVA mitigates all thermal performance issues found.

5.6 Sensitivity I-1 2032 Case (Peak Load 1358 MW)

5.6.1 Contingency Analysis

Contingency analysis of the SVP transmission system with projected Sensitivity I-1 2032 peak loads shows many thermal violations as defined in *Section 1.1*. These violations have been divided into separate tables based on location. SVP transmission lines and receiving stations experience thermal overloads because of the large increase in load. BroSer11 is a transition point between the bundled 954 KCM AAC and the 715 KCM ACCR conductors. HomSRS11 is an old transition point between overhead to underground transmission lines.

Row Labels	MVA	% Limit
Duane (36861) -> SRS (36852)		
P7 – Adjacent Circuits – NRS – SRS #1 & #2 115 kV Lines	443.59	133.69

Table 5-20
Contingency Analysis Thermal Violation; 115 kV System

Row Labels	MVA	% Limit
NRS (38900) -> NRS 400 (36851)		
P2 – Bus Section – NRS 300	719.64	171.34

Table 5-21
Contingency Analysis Thermal Violation; NRS

Row Labels	MVA	% Limit
Central (36873) -> SRS_60 (36886)		
P2 – Bus Section – NRS 500	187.39	108.26
P1 – Transmission Circuit – NRS 500 - Mission	187.39	108.25
P2 – Bus Section – NRS 300	187.26	108.18

Table 5-22
Contingency Analysis Thermal Violation; Northwest Loop

Row Labels	MVA	% Limit
KRS_60 (36878) -> Mathew (36882)		
P1 – Transmission Circuit – SRS – Kenneth	214.83	103.38

Table 5-23
Contingency Analysis Thermal Violation; East Loop

Row Labels	MVA	% Limit
HomSRS11 (36897) -> SRS_60 (36886)		
P1 – Transmission Circuit – Laurelwood - KRS	256.77	148.34
P1 – Transmission Circuit – Martin JCT - Laurelwood	189.57	109.52
P2 – Bus Section – Laurelwood	189.43	109.43
Homestea (36876) -> HomSRS11 (36897)		
P1 – Transmission Circuit – Laurelwood - KRS	248.60	143.62
P1 – Transmission Circuit – Martin JCT - Laurelwood	185.95	107.42
P2 – Bus Section – Laurelwood	185.86	107.37
Serra (36887) -> Homestea (36876)		
P1 – Transmission Circuit – Laurelwood - KRS	210.54	121.63
Laurelwood (38912) -> Martin JCT (36872)		
P1 – Transmission Circuit – SRS - Homestead	179.08	103.46
KRS_60 (36878) -> Laurelwood (38912)		
P1 – Transmission Circuit – SRS - Homestead	231.42	133.69
P2 – Bus Section – Homestead	196.34	113.42
P1 – Transmission Circuit – Homestead - Serra	196.31	113.41

Table 5-24
Contingency Analysis Thermal Violation; South Loop

Row Labels	MVA	% Limit
LS ESTRS (30731) -> SSS (38901)		
P1 – Transmission Circuit – NRS_injectio - NRS	464.92	110.70
P2 – Bus Section – NRS_injectio	464.92	110.70
P5 – Bus Section – Palo Alto SW. STA. 115 kV DBDB Bus #1	420.98	100.23
LSESTRSRCTR (35665) -> Nortech (35659)		
P2 – Bus Section – SSS	318.35	113.70
P1 – Transmission Circuit – SSS – NRS Riser	318.35	113.70
P2 – Bus Section – NRS_injectio	306.63	109.51
ZNKER J2 (35602) -> KRS (36850)		
P2 – Bus Section – NRS 300	175.23	104.87
NRS 300 (36853) -> SRS (36852)		
P2 – Bus Section – NRS 400	397.46	140.46
P1 – Transmission Circuit – NRS 400 – SRS 115 kV	324.19	114.55
P1 – Transmission Circuit – NRS 300 – KRS 115 kV	309.35	109.31
NRS 400 (36851) -> SRS (36852)		
P2 – Bus Section – NRS 300	527.49	186.39
P1 – Transmission Circuit – NRS 300 – SRS 115 kV CKT #2	323.13	114.18
P1 – Transmission Circuit – NRS 300 – KRS 115 kV	307.20	108.55
KRS (36850)) -> FMC JCT (35617)		
P2 – Bus Section – NRS 300	283.19	169.58
P2 – Bus Section – Los Esteros 230 kV BAAH Bus #1&2	22.21	132.46
P1 – Transmission Circuit – NRS_injectio - NRS	216.56	129.67

Table 5-25
Contingency Analysis Thermal Violation; PG&E

A voltage change (Delta V) violation is based on the SVP performance criteria where voltage can not change by more than 8% from pre-contingency to post contingency conditions. This case has low voltage violations based on the SVP performance criteria where voltage can not drop below 0.93 pu in post contingency conditions. The low voltage violation occurs across most of the SVP transmission system.

5.6.2 Corrective Action Plans

This section covers corrective actions needed to mitigate performance violations created by the Sensitivity I-1 load with projected 2032 load levels.

Re-conductor Duane – SRS 115 kV Line

Re-conductor the Duane – SRS 115 kV transmission line (0.20 miles) with a conductor capable of at least 444 MVA mitigates all thermal performance issues found.

Upgrade NRS 115 kV and 60 kV Bus Configurations

Reconfigure NRS 115 kV and 60 kV buses to mitigate various P2 (NERC TPL bus outage) contingencies. Options include DBDB (double-bus-double-breaker),

BAAH (breaker-and-a-half), or RB (ring bus) bus arrangements. Budget to be added into CIP 2454.

Addition of the third NRS 230/115 kV 500 MVA Transformer
Add a third 230/115 kV autotransformer (500 MVA rating) at NRS to accommodate CAISO's 500 MVA 230 kV HVDC/AC project interconnecting at NRS. Budget to be added to CIP 2430.

Re-conductor Central – SRS 60 kV Line
Re-conductor the Central – SRS 60 kV transmission line, which is approximately 1.43 mile of (2) bundled 954 KCM AAC, with conductor capable of at least 188 MVA mitigates all thermal performance issues found.

Replace Mathew Breakers
Replacing the 2000 Amp Mathew breakers with 3000 Amp breakers is needed to mitigate the thermal overload on the Mathew - KRS 60 kV transmission lines.

Re-conductor KRS – Mathew 60 kV Line
Re-conductor the KRS – Mathew 60 kV transmission line, which is approximately 1.14 mile of (2) bundled 954 KCM AAC, with conductor capable of at least 215 MVA mitigates all thermal performance issues found.

Homestead Substation Rebuild (CIP #2431)
This project will upgrade all substation breakers and disconnects to 3000 amps capability in Q4 of 2027.

Re-conductor Homestead – SRS 60 kV Line
Re-conductor the Homestead – HomSRS11 60 kV and HomSRS11 – SRS 60 kV transmission lines, which is approximately 3.54 mile of (2) bundled 954 KCM AAC, with conductor capable of at least 257 MVA mitigates all thermal performance issues found.

Re-conductor Serra – Homestead 60 kV Line
Re-conductor the Serra – Homestead 60 kV transmission lines, which is approximately 1.80 mile of (2) bundled 954 KCM AAC, with conductor capable of at least 211 MVA mitigates all thermal performance issues found.

Re-conductor Laurelwood – Martin JCT 60 kV Line
Re-conductor the Laurelwood – Martin JCT 60 kV transmission line, which is approximately 0.24 mile of (2) bundled 954 KCM AAC, with conductor capable of at least 180 MVA mitigates all thermal performance issues found.

Re-conductor KRS – Laurelwood 60 kV Line
Re-conductor the KRS – Laurelwood 60 kV transmission line, which is approximately 0.62 mile of (2) bundled 954 KCM AAC, with conductor capable of at least 232 MVA mitigates all thermal performance issues found.

5.7 Sensitivity II 2032 Case (Peak Load 1306 MW)

5.7.1 Contingency Analysis

Contingency analysis of the SVP transmission system with projected Sensitivity II 2032 peak loads shows many thermal violations as defined in *Section 1.1*. These violations have been divided into separate tables based on location. SVP transmission lines and receiving stations experience thermal overloads because of the large increase in load. HomSRS11 is an old transition point between overhead to underground transmission lines.

Row Labels	MVA	% Limit
Duane (36861) -> SRS (36852)		
P7 – Adjacent Circuits – NRS – SRS #1 & #2 115 kV Lines	439.45	132.44

Table 5-26
Contingency Analysis Thermal Violation; 115 kV System

Row Labels	MVA	% Limit
NRS (38900) -> NRS 400 (36851)		
P2 – Bus Section – NRS 300	638.66	152.06

Table 5-27
Contingency Analysis Thermal Violation; NRS

Row Labels	MVA	% Limit
HomSRS11 (36897) -> SRS_60 (36886)		
P1 – Transmission Circuit – Laurelwood - KRS	218.38	126.16
Homestea (36876) -> HomSRS11 (36897)		
P1 – Transmission Circuit – Laurelwood - KRS	212.66	122.85
Serra (36887) -> Homestea (36876)		
P1 – Transmission Circuit – Laurelwood - KRS	175.50	101.39
KRS_60 (36878) -> Laurelwood (38912)		
P1 – Transmission Circuit – SRS - Homestead	201.35	116.32

Table 5-28
Contingency Analysis Thermal Violation; South Loop

Row Labels	MVA	% Limit
LS ESTRS (30731) -> SSS (38901)		
P1 – Transmission Circuit – NRS_injectio - NRS	458.46	109.16
P2 – Bus Section – NRS_injectio	458.46	109.16
P5 – Bus Section – Palo Alto SW. STA. 115 kV DVDV Bus #1	440.67	104.92

Table 5-29
Contingency Analysis Thermal Violation; PG&E

5.7.2 Voltage Analysis

The minimum additional capacitance needed for the Sensitivity II 2032 case under N-0 conditions to get to 0.97 pu aggregate power factor is 16.0 MARs. The overall N-0 power factor, before adding caps, is 0.9664 pu. The overall imports from the PG&E tie-lines are:

Total MW	Total MVAR	Overall PF
1133.08	301.08	0.96646

Fr_BNum	Fr_BNam	Nom_kV	To_BNum	To_BNam	MW	MVAR	MVA
36850	KRS	115.0	35602	ZNKER J2	-53.06	-30.93	61.4
36850	KRS	115.0	35617	FMC JCT	-160.07	-6.49	160.2
36851	NRS 400	115.0	35120	NEWARK D	-35.07	-24.57	42.8
36853	NRS 300	115.0	35122	NEWARK F	-17.13	-22.56	28.3
36853	NRS 300	115.0	35659	NORTECH	-138.08	-55.55	148.8
38900	NRS	230.0	389000	NRS_injec	-399.73	-118.62	417.0
38901	SSS	230.0	30731	LS ESTRS	-329.94	-42.36	332.6

Table 5-30
N-0 Monitored Line Flows

After capacitors are added to mitigate contingency voltage issues, the aggregate power factor seen by PG&E supply lines is 0.986. This represents an excess of 98.0 MVARs of capacitance over what is needed to meet the PG&E requirement for a 0.97 power factor.

A voltage change (Delta V) violation is based on the SVP performance criteria where voltage can not change by more than 8% from pre-contingency to post contingency conditions. A low voltage violation is based on the SVP performance criteria where voltage can not drop below 0.93 pu in post contingency conditions. This case contains 54 buses with low voltage violations prior to adding capacitors shown in *Table 5-31*.

Some of the buses in *Table 5-31* below are fictious buses. BroSer11 is a transition point between the bundled 954 KCM AAC and the 715 KCM ACCR conductors. KRSPal11 is a transition point between the bundled 954 KCM AAC and the bundled 715 KCM ACCR conductors. HomSRS11 is an old transition point between overhead to underground transmission lines. MisNRS11 and JulMis11 are fictitious buses used to indicate the change from overhead to underground transmission line. DVRPP 1M and DVRPP 2M are fictitious bus used to create a three-winding transformer in PowerWorld.

Bus Number	Bus Name	Nom_V	V_Low	Contingency
36850	KRS	115.0	0.929	P2 – Bus Section – NRS 300
36852	SRS	115.0	0.928	P2 – Bus Section – NRS 300
36857	Mission	60.0	0.893	P2 – Bus Section – NRS 300

36858	Gia100	13.8	0.922	P2 – Bus Section – NRS 300
36860	Palm	60.0	0.902	P2 – Bus Section – NRS 300
36861	Duane	115.0	0.929	P2 – Bus Section – NRS 300
36862	NRS 500	60.0	0.895	P2 – Bus Section – NRS 300
36863	DVRaGT1	13.8	0.905	P1 – Generator – DVTaGT1
36864	DVRbGt2	13.8	0.904	P1 – Generator – DVRaGt2
36865	DVRaST3	13.8	0.905	P1 – Generator – DVRaST3
36866	DVRbLoad	13.8	0.859	P2 – Bus Section – NRS 300
36867	DVRPP 1M	13.8	0.865	P2 – Bus Section – NRS 300
36868	DVRPP 2M	13.8	0.862	P2 – Bus Section – NRS 300
36869	Northwes	60.0	0.898	P2 – Bus Section – NRS 300
36870	Agnew	60.0	0.907	P2 – Bus Section – NRS 300
36871	Brokaw	60.0	0.850	P1 – Transmission Circuit – Laurelwood - KRS
36872	Martin JCT	60.0	0.849	P1 – Transmission Circuit – Laurelwood - KRS
36873	Central	60.0	0.896	P2 – Bus Section – NRS 300
36874	Fibergla	60.0	0.901	P2 – Bus Section – NRS 300
36875	Gia12	60.0	0.895	P2 – Bus Section – NRS 300
36876	Homestea	60.0	0.896	P2 – Bus Section – NRS 300
36877	Juliette	60.0	0.893	P2 – Bus Section – NRS 300
36878	KRS_60	60.0	0.902	P2 – Bus Section – NRS 300
36879	Laf T1	60.0	0.902	P2 – Bus Section – NRS 300
36880	Laf T2	60.0	0.902	P2 – Bus Section – NRS 300
36881	Laf T3	60.0	0.902	P2 – Bus Section – NRS 300
36882	Mathew	60.0	0.899	P2 – Bus Section – NRS 300
36883	NAJ	60.0	0.904	P2 – Bus Section – NRS 300
36884	MisNRS11	60.0	0.894	P2 – Bus Section – NRS 300
36885	JulMis11	60.0	0.893	P2 – Bus Section – NRS 300
36886	SRS_60	60.0	0.901	P2 – Bus Section – NRS 300
36887	Serra	60.0	0.891	P1 – Transmission Circuit – Laurelwood - KRS
36888	KRSPal11	60.0	0.902	P2 – Bus Section – NRS 300
36889	Uranium	60.0	0.895	P2 – Bus Section – NRS 300
36890	Walsh	60.0	0.8989	P2 – Bus Section – NRS 300
36891	Zeno	60.0	0.896	P2 – Bus Section – NRS 300
36892	NRS 600	60.0	0.910	P2 – Bus Section – NRS 300
36894	Gia32	60.0	0.911	P2 – Bus Section – NRS 300
36895	Gia200	13.8	0.914	P1 – Generator – Gia200
36896	FairView	60.0	0.901	P2 – Bus Section – NRS 300
36897	HomSRS11	60.0	0.898	P2 – Bus Section – NRS 300
36898	BroSer11	60.0	0.861	P1 – Transmission Circuit – Laurelwood - KRS
38904	DCJ	60.0	0.897	P2 – Bus Section – NRS 300
38905	Kenneth	60.0	0.900	P2 – Bus Section – NRS 300
389051	BESS	60.0	0.900	P2 – Bus Section – NRS 300
38906	Parker	60.0	0.899	P2 – Bus Section – NRS 300
38907	Freedom_JC	60.0	0.906	P2 – Bus Section – NRS 300
38908	Oak JCT	60.0	0.899	P2 – Bus Section – NRS 300
38909	San Thomas	60.0	0.903	P2 – Bus Section – NRS 300
38911	Memorex	60.0	0.896	P2 – Bus Section – NRS 300
38912	Laurelwood	60.0	0.848	P1 – Transmission Circuit – Laurelwood - KRS
38913	Stender_W	60.0	0.899	P2 – Bus Section – NRS 300
38914	Pacific	60.0	0.900	P2 – Bus Section – NRS 300
38915	Bowers	60.0	0.895	P2 – Bus Section – NRS 300

Table 5-31
Contingency Analysis Voltage Violation

The following capacitors were added to mitigate Sensitivity II 2032 case voltage violations:

SRS: 30 MVARs
KRS: 30 MVARs
DVRbLoad: 24 MVARs
Martin JCT: 28 MVARs
Laurelwood: 28 MVARs

Total Added = 140 MVARs

The N-1-1 analysis consisting of DVR generation and load offline and P1 contingencies shows that an additional 12 MVAR of capacitance is needed at Laurelwood to mitigate a low voltage condition. This is already included in the summary shown above.

5.7.3 Corrective Action Plans

This section covers corrective actions needed to mitigate performance violations created by the Sensitivity II load with projected 2032 load levels.

Re-conductor Duane – SRS 115 kV Line

Re-conductor the Duane – SRS 115 kV transmission line (0.20 miles) with a conductor capable of at least 440 MVA mitigates all thermal performance issues found.

Upgrade NRS 115 kV and 60 kV Bus Configurations

Reconfigure NRS 115 kV and 60 kV buses to mitigate various P2 (NERC TPL bus outage) contingencies. Options include DBDB (double-bus-double-breaker), BAAH (breaker-and-a-half), or RB (ring bus) bus arrangements. Budget to be added into CIP 2454.

Addition of the third NRS 230/115 kV 500 MVA Transformer

Add a third 230/115 kV autotransformer (500 MVA rating) at NRS to accommodate CAISO's 500 MVA 230 kV HVDC/AC project interconnecting at NRS. Budget to be added to CIP 2430.

Homestead Substation Rebuild (CIP #2431)

This project will upgrade all substation breakers and disconnects to 3000 amps capability in Q4 of 2027.

Re-conductor Homestead – SRS 60 kV Line

Re-conductor the Homestead – HomSRS11 60 kV and HomSRS11 – SRS 60 kV transmission lines, which is approximately 3.54 mile of (2) bundled 954 KCM AAC, with conductor capable of at least 219 MVA mitigates all thermal performance issues found.

Re-conductor BroSer11 – Serra 60 kV Line

Re-conductor the BroSer11 – Serra 60 kV transmission line with conductor capable of at least 156 MVA mitigates all thermal performance issues found. This is the 715 KCM ACCR portion of the Brokaw to Serra line.

Re-conductor KRS – Laurelwood 60 kV Line

Re-conductor the KRS – Laurelwood 60 kV transmission line, which is approximately 0.62 mile of (2) bundled 954 KCM AAC, with conductor capable of at least 202 MVA mitigates all thermal performance issues found.

Build New 60 kV Loop 1

Build 5.89 miles of 60 kV transmission lines (New Loop 1) starting at NRS and terminating at SRS. This loop will connect existing and future substations (data centers).

Build New 60 kV Loop 2

Build 6.98 miles of 60 kV transmission lines (New Loop 2) starting at SRS and terminating at NRS. This loop will connect existing and future substations (data centers).

Analyze Reactive Power Compensation Technologies

Initial power flow study has identified up to 200 MVAR reactive power needs in SVP's transmission system to meet power factor requirements with PG&E and to maintain voltage at acceptable level. Further detailed studies are needed to investigate various technologies for reactive power compensation.

Analyze Mitigations for PST Overloading

In 2032, PST is overloaded at 109% when the Newark – NRS 230 kV HVDC source is out of service. Further study is needed to examine near-term operating procedure (with PG&E) and long-term mitigations that can include but not limited to: installing a 2nd PST at SSS, in addition to Transmission Access Charge (TAC) impacts.

5.8 Sensitivity II-1 2032 Case (Peak Load 1503 MW)

5.8.1 Contingency Analysis

Contingency analysis of the SVP transmission system with projected Sensitivity II-1 2032 peak loads shows many thermal violations as defined in *Section 1.1*. These violations have been divided into separate tables based on location. SVP transmission lines and receiving stations experience thermal overloads because of the large increase in load. BroSer11 is a transition point between the bundled 954 KCM AAC and the 715 KCM ACCR conductors. HomSRS11 is an old transition point between overhead to underground transmission lines

Row Labels	MVA	% Limit
Duane (36861) -> SRS (36852)		
P7 – Adjacent Circuits – NRS – SRS #1 & #2 115 kV Lines	512.50	154.46
KRS (36850) -> Duane (36861)		
P7 – Adjacent Circuits – NRS – SRS #1 & #2 115 kV Lines	363.75	109.63

Table 5-32
Contingency Analysis Thermal Violation; 115 kV System

Row Labels	MVA	% Limit
NRS (38900) -> NRS 400 (36851)		
P2 – Bus Section – NRS 300	680.03	161.91

Table 5-33
Contingency Analysis Thermal Violation; NRS

Row Labels	MVA	% Limit
Central (36873) -> SRS_60 (36886)		
P2 – Bus Section – NRS 300	188.22	108.74
P2 – Bus Section – NRS 500	187.97	108.59
P1 – Transmission Circuit – NRS 500 - Mission	187.96	108.59

Table 5-34
Contingency Analysis Thermal Violation; Northwest Loop

Row Labels	MVA	% Limit
Parker (38906) -> Mathew (36882)		
P1 – Transmission Circuit – SRS - Kenneth	191.65	110.72
Mathew (36882) -> KRS_60 (36878)		
P1 – Transmission Circuit – SRS - Kenneth	241.14	116.04
P1 – Transmission Circuit – BESS – Fiber (Amazon)	218.69	105.24
P1 – Transmission Circuit – Kennth - BESS	218.69	105.24

Table 5-35
Contingency Analysis Thermal Violation; East Loop

Row Labels	MVA	% Limit
HomSRS11 (36897) -> SRS_60 (36886)		
P1 – Transmission Circuit – Laurelwood - KRS	261.70	151.19
P1 – Transmission Circuit – Martin JCT - Laurelwood	191.43	110.59
P2 – Bus Section – Laurelwood	191.12	110.41
Homestea (36876) -> HomSRS11 (36897)		
P1 – Transmission Circuit – Laurelwood - KRS	252.09	145.63
P1 – Transmission Circuit – Martin JCT - Laurelwood	187.36	108.24
P2 – Bus Section – Laurelwood	187.16	108.12
Serra (36887) -> Homestea (36876)		
P1 – Transmission Circuit – Laurelwood - KRS	213.16	123.14
Laurelwood (38912) -> Martin JCT (36872)		
P1 – Transmission Circuit – SRS - Homestead	179.75	103.84
KRS_60 (36878) -> Laurelwood (38912)		
P1 – Transmission Circuit – SRS - Homestead	232.13	134.10
P1 – Transmission Circuit – Mathew - KRS	198.69	114.79
P1 – Transmission Circuit – Fiberglass - KRS	198.11	114.45

Table 5-36
Contingency Analysis Thermal Violation; South Loop

Row Labels	MVA	% Limit
LS ESTRS (30731) -> SSS (38901)		
P5 – Bus Section – Palo Alto SW. STA 115 kV DBDB Bus #1	479.37	114.13
P5 – Bus Section – Los Esteros 115 kV BAAH Bus #2	452.44	107.72
P1 – Transmission Circuit – Los Esteros – Nortech 115 kV	442.80	105.43

Table 5-37
Contingency Analysis Thermal Violation; PG&E

A voltage change (Delta V) violation is based on the SVP performance criteria where voltage can not change by more than 8% from pre-contingency to post contingency conditions. This case has low voltage violations based on the SVP performance criteria where voltage can not drop below 0.93 pu in post contingency conditions. The low voltage violation occurs across most of the SVP transmission system.

5.8.2 Corrective Action Plans

This section covers corrective actions needed to mitigate performance violations created by the Sensitivity II-1 load with projected 2032 load levels.

Re-conductor Duane – SRS 115 kV Line

Re-conductor the Duane – SRS 115 kV transmission line (0.20 miles) with a conductor capable of at least 513 MVA mitigates all thermal performance issues found.

Re-conductor KRS – Duane 115 kV Line

Re-conductor the KRS – Duane 115 kV transmission line (0.02 miles) with a conductor capable of at least 364 MVA mitigates all thermal performance issues found.

Upgrade NRS 115 kV and 60 kV Bus Configurations

Reconfigure NRS 115 kV and 60 kV buses to mitigate various P2 (NERC TPL bus outage) contingencies. Options include DBDB (double-bus-double-breaker), BAAH (breaker-and-a-half), or RB (ring bus) bus arrangements. Budget to be added into CIP 2454.

Addition of the third NRS 230/115 kV 500 MVA Transformer

Add a third 230/115 kV autotransformer (500 MVA rating) at NRS to accommodate CAISO's 500 MVA 230 kV HVDC/AC project interconnecting at NRS. Budget to be added to CIP 2430.

Homestead Substation Rebuild (CIP #2431)

This project will upgrade all substation breakers and disconnects to 3000 amps capability in Q4 of 2027.

Re-conductor Central – SRS 60 kV Line

Re-conductor the Central – SRS 60 kV transmission line, which is approximately 1.43 mile of (2) bundled 954 KCM AAC, with conductor capable of at least 189 MVA mitigates all thermal performance issues found.

Re-conductor Parker – Mathew 60 kV Line

Re-conductor the Parker – Mathew 60 kV transmission line, which is approximately 0.13 mile of (2) bundled 954 KCM AAC, with conductor capable of at least 192 MVA mitigates all thermal performance issues found.

Replace Mathew Breakers

Replacing the 2000 Amp Mathew breakers with 3000 Amp breakers is needed to mitigate the thermal overload on the Mathew – KRS 60 kV transmission lines.

Re-conductor KRS – Mathew 60 kV Line

Re-conductor the KRS – Mathew 60 kV transmission line, which is approximately 1.14 mile of (2) bundled 954 KCM AAC, with conductor capable of at least 242 MVA mitigates all thermal performance issues found.

Re-conductor Homestead – SRS 60 kV Line

Re-conductor the Homestead – HomSRS11 60 kV and HomSRS11 – SRS 60 kV transmission lines, which is approximately 3.54 mile of (2) bundled 954 KCM AAC, with conductor capable of at least 262 MVA mitigates all thermal performance issues found.

Re-conductor Serra – Homestead 60 kV Line

Re-conductor the Serra – Homestead 60 kV transmission lines, which is approximately 1.80 mile of (2) bundled 954 KCM AAC, with conductor capable of at least 262 MVA mitigates all thermal performance issues found.

Re-conductor Laurelwood – Martin JCT 60 kV Line

Re-conductor the Laurelwood – Martin JCT 60 kV transmission line, which is approximately 0.24 mile of (2) bundled 954 KCM AAC, with conductor capable of at least 180 MVA mitigates all thermal performance issues found.

Re-conductor KRS – Laurelwood 60 kV Line

Re-conductor the KRS – Laurelwood 60 kV transmission line, which is approximately 0.62 mile of (2) bundled 954 KCM AAC, with conductor capable of at least 233 MVA mitigates all thermal performance issues found.

6.0 Conclusions and Estimates

This section discusses conclusions from the voltage and power factor analysis as well as recommended improvements for the Sensitivity II 2032 case. Details pertaining to cost estimates are included in *Appendix A*. The recommended projects are based specifically on their ability to mitigate thermal violations and improve voltage issues. In addition, all improvement projects mentioned serve as maintenance/replacement of obsolete equipment or to create additional capacity.

6.1 Voltage/Power Factor Analysis Conclusion

Table 6-1 summarizes the capacitors added to the SVP network for the Sensitivity I 2032, Sensitivity II 2032, and Sensitivity III 2032 cases. The Sensitivity II case needs an additional 12 MVAR of capacitance for the N-1-1 voltage mitigation beyond what was already in place for mitigation for the base Sensitivity II case. *Table 6-1* includes the additional capacitance needed for the Sensitivity II N-1-1 voltage mitigation.

Sensitivity I 2032			Sensitivity II 2032		
Bus Number	**Name**	**MVAR**	**Bus Number**	**Name**	**MVAR**
36878	KRS	20.0	36878	KRS	30.0
36886	SRS	20.0	36886	SRS	30.0
36866	DVRbLoad	20.0	36866	DVRbLoad	24.0
36872	Martin JCT	28.0	36872	Martin JCT	28.0
38912	Laurelwood	12.0	38912	Laurelwood	28.0
	Total	**100.0**		**Total**	**140.0**

Table 6-1
Capacitor Summary

6.2 Duane to SRS 115 kV Re-conductor

Re-conductor the 0.2-mile Duane to SRS 115 kV transmission line.

Estimated Cost: $1,620,000

6.3 Upgrade NRS 115 kV and 60 kV Bus Configurations

Reconfigure NRS 115 kV and 60 kV buses to mitigate various P2 (NERC TPL bus outage) contingencies. Options include DBDB (double-bus-double-breaker), BAAH (breaker-and-a-half), or RB (ring bus) bus arrangements. Budget to be added into CIP 2354.

Estimated Cost: $39,280,000

6.4 Addition of the third NRS 230/115 kV 500 MVA Transformer

Add a third 230/115 kV autotransformer (500 MVA rating) at NRS to accommodate CAISO's 500 MVA 230 kV HVDC/AC project interconnecting at NRS. Budget to be added to CIP 2430.

Estimated Cost: $7,270,000

6.5 Homestead Substation Rebuild (CIP #2431)

This project will upgrade all substation breakers and disconnects to 3000 amps capability in Q4 of 2027.

Estimated Cost: N/A

6.6 Homestead to SRS 60 kV Re-conductor

Re-conductor the 3.54-mile Homestead – SRS 60 kV line from (2) 954 KCM AAC to (2) 715 KCM ACCR.

Estimated Cost: $11,970,000

6.7 Laurelwood to KRS 60 kV Re-conductor

Re-conductor the 0.62-mile Laurelwood – KRS 60 kV line from (2) 954 KCM AAC to (2) 715 KCM ACCR.

Estimated Cost: $3,050,000

6.8 Build New Loop 1

Build 5.89 miles of 60 kV transmission line with (2) 715 KCM ACCR. The routing for this loop is shown in *Appendix A*.

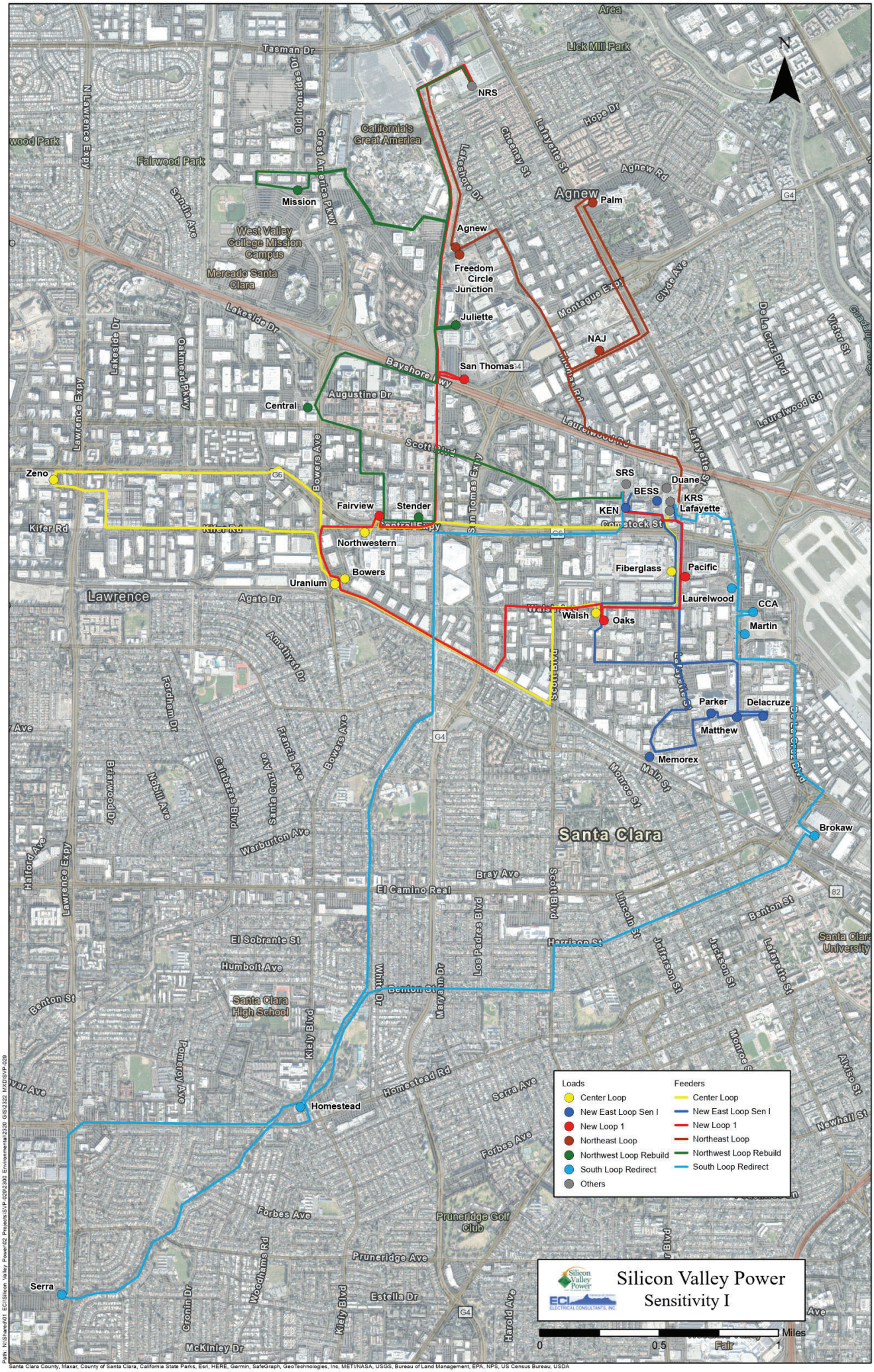
Estimated Cost: $76,270,000

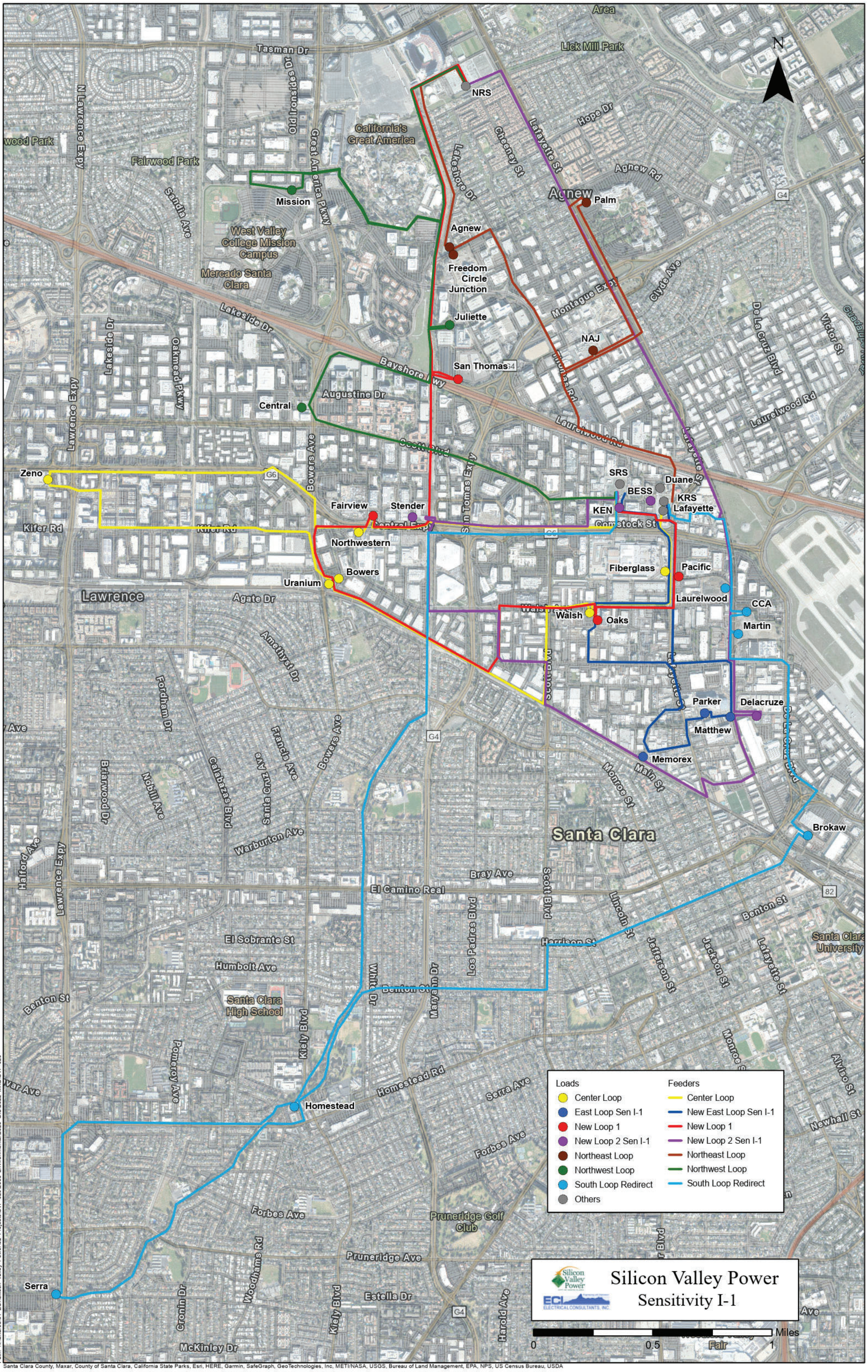
6.9 Build New Loop 2

Build 6.98 miles of 60 kV transmission line with (2) 715 KCM ACCR. The routing for this loop is shown in *Appendix A*.

Estimated Cost: $97,070,000

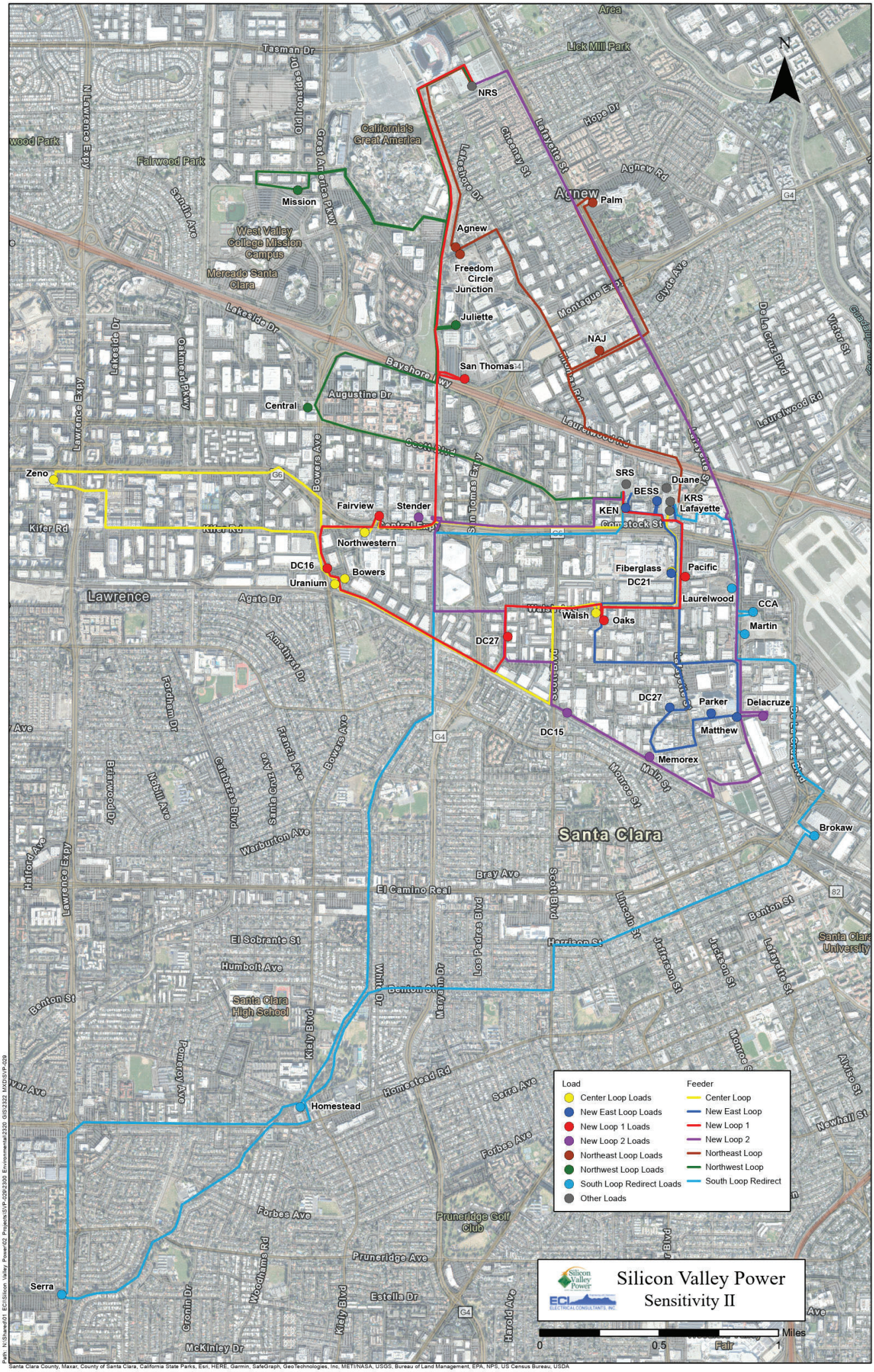
Appendix A
Sensitivity Cases Transmission Routing


Silicon Valley Power
Sensitivity I
Loads
Center Loop
New East Loop Sen I
New Loop 1
Northeast Loop
Northwest Loop Rebuild
South Loop Redirect
Others
Feeders
Center Loop
New East Loop Sen I
New Loop 1
Northeast Loop
Northwest Loop Rebuild
South Loop Redirect
Miles
0
0.5
1
N
NRS
Mission
Agnew
Palm
Freedom Circle Junction
Juliette
NAJ
San Thomas
Central
Zeno
Fairview
Stender
Northwestern
Uranium
Bowers
SRS
BESS
KEN
Duane
KRS
Lafayette
Fiberglass
Pacific
Laurelwood
CCA
Martin
Walsh
Oaks
Parker
Delacruze
Matthew
Memorex
Brokaw
Homestead
Serra
Santa Clara
Lawrence
Agnew
Fairwood Park
West Valley College Mission Campus
Mercado Santa Clara
California's Great America
Lick Mill Park
Pruneridge Golf Club
Santa Clara High School
Santa Clara University
Kifer Rd
Agate Dr
Amethyst Dr
Fordham Dr
Briarwood Dr
Nobili Ave
Caribbean Blvd
Francis Ave
Santa Cruz Ave
Warburton Ave
Halford Ave
El Camino Real
Bray Ave
El Sobrante St
Humbolt Ave
Benton St
Harrison St
Homestead Rd
Serra Ave
Forbes Ave
Pruneridge Ave
Estella Dr
McKinley Dr
Cronin Dr
Pomeroy Ave
Kiely Blvd
Woodhams Rd
Maryann Dr
Los Padres Blvd
Scott Blvd
Lincoln St
Jefferson St
Jackson St
Monroe St
Main St
Aviso St
Newhall St
Tasman Dr
Old Ironsides Dr
Great America Pkwy
Lakeshore Dr
Chesney St
Lafayette St
Hope Dr
Agnew Rd
Montague Expy
Clyde Ave
De La Cruz Blvd
Victor St
Laurelwood Rd
Lakeside Dr
Oakmead Pkwy
Lawrence Expy
N Lawrence Expy
Sandia Ave
Bayshore Hwy
Augustine Dr
Scott Blvd
San Tomas Expy
Bowers Ave
Cramstock St
Walsh Ave
Monroe St
Path: N:\Shared\01 ECI\Silicon Valley Power\02 Projects\SVP-0292\2300 Environmental\2320 GIS\2322 MXD\SVP-029
Santa Clara County, Maxar, County of Santa Clara, California State Parks, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, US Census Bureau, USDA



Santa Clara County, Maxar, County of Santa Clara, California State Parks, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, US Census Bureau, USDA

Path: N:\Shared\01 ECI\Silicon Valley Power\02 Projects\SVP-029\2300 Environmental\2320 GIS\2322 MXD\SVP-029


Silicon Valley Power
Sensitivity II
Load
Center Loop Loads
New East Loop Loads
New Loop 1 Loads
New Loop 2 Loads
Northeast Loop Loads
Northwest Loop Loads
South Loop Redirect Loads
Other Loads
Feeder
Center Loop
New East Loop
New Loop 1
New Loop 2
Northeast Loop
Northwest Loop
South Loop Redirect
NRS
Mission
Agnew
Palm
Freedom Circle Junction
Juliette
NAJ
San Thomas
Central
Zeno
Fairview
Stender
Northwestern
DC16
Uranium
Bowers
SRS
Duane
BESS
KRS
Lafayette
KEN
Fiberglass
DC21
Pacific
Laurelwood
CCA
Martin
Walsh
Oaks
DC27
Parker
Delacruze
Matthew
Memorex
DC15
Brokaw
Homestead
Serra
Miles
0
0.5
1
Santa Clara County, Maxar, County of Santa Clara, California State Parks, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, US Census Bureau, USDA

Appendix B
Detailed Cost Estimates

Silicon Valley Power
COST SUMMARY BREAKDOWN
Item #1, Re-conductor 0.2 Miles of 60 kV from Duane Substation to SRS
Oct. 2022

DESCRIPTION	ITEM COST	SUBTOTAL
1 MATERIALS		
Materials procured by SVP - poles, conductor, and minor materials	$104,558	
		$104,558
2 CONSTRUCTION COSTS		
T-Line Contractor (Total Value of Public Works Bid)	$539,124	
		$539,124
3 ENGINEERING AND CONSTRUCTION MANAGEMENT		
Engineering, LIDAR Survey, Geotech, Potholing, Permitting, R.O.W	$337,500	
		$337,500
4 COST OF EASEMENTS	$0	
New easements should not be needed for existing Lines		**$0**
GRAND TOTAL		**$1,619,909**

NRS Cost Estimates; CIP 2454 for TPP 23/24

Description:
Install two additional 115/60kV 300MVA autotransformers at NRS (TA, TD). Upgrade NRS 115kV and 60kV bus to mitigate various P2 contingencies identified due to main/transfer bus design. Options include DBDB (Double-Bus-Double-Breaker), BAAH (Breaker-and-A-Half), or RB (Ring Bus) bus configurations. Budget to be added CIP 2454

115/60 kV Transformer estimates;
Based on 2 x 115/60 kV, 300 MVA transformers
$/MVA for 115/60 kV Transformer = $4,139

unit cost ($/MVA)	**number of units**	**115/60 kV MPT Cost**	**cost for (2) MPTs**
$ 4,139	300	$1.2417M	$2.4834M

115 kV estimates;
Based on 10 position Breaker and a half bus configuraiton
Cost adder for 2 positions in BAAH configuration at 115 kV = $3.3M

unit cost	**number of units**	**115 kV Upgrade Cost**
$3.3M	5	$16.5M

60 kV estimates;
Based on 14 position Breaker and a half bus configuraiton
Cost adder for 2 positions in BAAH configuration at 69 kV = $2.9M

unit cost	**number of units**	**60 kV Upgrade Cost**
$2.9M	7	$20.3M

<u>Total Exploratory Cost estimate for (2) 115/60 kV Transformers & Upgrade of NRS 115 kV, 60 kV</u> $39.2834M

NRS Cost Estimates; CIP 2430 for TPP 23/24

Description:
Addition of third NRS 230/115 kV 500 MVA autotransformer and balance of plant for interconnection of new CAISO 500 MVA 230kV AC line interconnection at NRS. Budget to be added to CIP 2430.

230/115 kV Transformer estimates;
Based on 1 x 230/115 kV, 500 MVA transformer
$/MVA for 230/115 kV Transformer = $5,348

unit cost ($/MVA)	**number of units**	**230/115 kV MPT Cost**
$ 5,348	500	$2.674M

230 kV estimates;
Based on 1 position Breaker and a half bus configuration
Cost adder for 1 position in BAAH configuration at 230 kV = $2.8M

unit cost	**number of units**	**230 kV Upgrade Cost**
$2.8M	1	$2.8M

115 kV estimates;
Based on 1 position Breaker and a half bus configuration
Cost adder for 1 position in BAAH configuration at 115 kV = $1.8M

unit cost	**number of units**	**115 kV Upgrade Cost**
$1.8M	1	$1.8M

Total Exploratory Cost estimate for (1) 230/115 kV Transformers & Upgrade of NRS 230 kV, 115 kV $7.274M

Silicon Valley Power
COST SUMMARY BREAKDOWN
Item #5, Re-conductor 3.54 miles of 60 kV from Homestead Sub to SRS
Oct. 2022

DESCRIPTION	ITEM COST	SUBTOTAL
1 MATERIALS		
Materials procured by SVP - poles, conductor, and minor materials	$1,764,438	
		$1,764,438
2 CONSTRUCTION COSTS		
T-Line Contractor (Total Value of Public Works Bid)	$8,782,478	
		$8,782,478
3 ENGINEERING AND CONSTRUCTION MANAGEMENT		
Engineering, LIDAR Survey, Geotech, Potholing, Permitting, R.O.W	$784,375	
		$784,375
4 COST OF EASEMENTS	$0	
New easements should not be needed for existing Lines		
		$0
GRAND TOTAL		**$11,970,019**

Silicon Valley Power
COST SUMMARY BREAKDOWN
Item #6, Re-conductor 0.62 miles of 60 kV from Laurelwood Sub to KRS
Oct. 2022

DESCRIPTION	ITEM COST	SUBTOTAL
1 MATERIALS		
Materials procured by SVP - poles, conductor, and minor materials	$388,039	
		$388,039
2 CONSTRUCTION COSTS		
T-Line Contractor (Total Value of Public Works Bid)	$1,638,174	
		$1,638,174
3 ENGINEERING AND CONSTRUCTION MANAGEMENT		
Engineering, LIDAR Survey, Geotech, Potholing, Permitting, R.O.W	$387,500	
		$387,500
4 COST OF EASEMENTS	$0	
New easements should not be needed for existing Lines		
		$0
GRAND TOTAL		**$3,052,441**

Silicon Valley Power
COST SUMMARY BREAKDOWN
Item #7, Build 5.89 miles of new 60 kV Transmission Line, Loop #1
Oct. 2022

DESCRIPTION	ITEM COST	SUBTOTAL
1 MATERIALS		
Materials procured by SVP - poles, conductor, and minor materials	$6,265,053	
		$6,265,053
2 CONSTRUCTION COSTS		
T-Line Contractor (Total Value of Public Works Bid)	$25,117,010	
		$25,117,010
3 ENGINEERING AND CONSTRUCTION MANAGEMENT		
Engineering, LIDAR Survey, Geotech, Potholing, Permitting, R.O.W	$4,006,250	
		$4,006,250
4 COST OF EASEMENTS	$40,241,963	
Cost is based on square foot price seen on recent SVP projects		
		$40,241,963
GRAND TOTAL		**$76,269,004**

Silicon Valley Power
COST SUMMARY BREAKDOWN
Item #8, Build 6.98 miles of new 60 kV Transmission Line, Loop #2
Oct. 2022

DESCRIPTION	ITEM COST	SUBTOTAL
1 MATERIALS		
Materials procured by SVP - poles, conductor, and minor materials	$6,651,826	
		$6,651,826
2 CONSTRUCTION COSTS		
T-Line Contractor (Total Value of Public Works Bid)	$29,765,149	
		$29,765,149
3 ENGINEERING AND CONSTRUCTION MANAGEMENT		
Engineering, LIDAR Survey, Geotech, Potholing, Permitting, R.O.W	$4,687,500	
		$4,687,500
4 COST OF EASEMENTS	$55,326,640	
Cost is based on square foot price seen on recent SVP projects		
		$55,326,640
GRAND TOTAL		**$97,069,843**