THE STATE OF NEW HAMPSHIRE
BEFORE THE
PUBLIC UTILITIES COMMISSION

Unitil Energy Systems, Inc.

RELIABILITY PROGRAM AND VEGETATION MANAGEMENT PROGRAM ANNUAL REPORT – FISCAL YEAR 2019

1. Introduction

Pursuant to the Settlement Agreement approved by the New Hampshire Public Utilities Commission ("Commission") in Docket No. DE 10-055,[1] Unitil Energy Systems, Inc. ("UES" or "Company") is submitting the results of the Reliability Enhancement Plan ("REP") and Vegetation Management Plan ("VMP") for Fiscal Year 2019 ("FY 2019"), report the period, January 1, 2019 – December 31, 2019.

The Settlement Agreement provides that Unitil will provide an annual report to the Commission, Staff and OCA showing actual REP and VMP activities and costs for the previous calendar year, and its planned activities and costs for the current calendar year. Actual and planned REP and VMP costs shown in the report will be reconciled along with the revenue requirements associated with the actual and planned capital additions and expenses. This report includes the following information:

(A) A description of Unitil's VMP;
(B) A comparison of FY2019 actual to budgeted spending on O&M activities related to the VMP
(C) Detail on the O&M spending related to the FY2019 VMP estimated expenditures and work to be completed;
(D) A summary of the Vegetation Management Storm Hardening Program results;
(E) Detail on the O&M spending related to Enhanced Tree Trimming;
(F) Detail on the reliability capital spending for 2019 and 2020 budget; and
(G) Reliability performance of the UES Capital and UES Seacoast systems.

2. Vegetation Management Plan

[1] Order 25,214 dated April 26, 2011

The VMP is based upon the recommended program provided in the report of Unitil's consultant Environmental Consultants, Inc. ("ECI"),[2] modified to incorporate a 5-year prune cycle with 10-foot side and 15-foot top prune zones.

2.1. Plan Description

Unitil's VMP is comprised of five components; 1) circuit pruning; 2) hazard tree mitigation; 3) mid-cycle review; 4) forestry reliability assessment; and 5) storm resiliency work. This program is designed to support favorable reliability performance, reduce damage to lines and equipment, as well as provide a measure of public safety. The main benefits and risks addressed by these programs are reliability, regulatory, efficiency, safety and customer satisfaction.

2.1.1. Circuit Pruning

Vegetation maintenance pruning is done on a cyclical schedule by circuit. The optimal cycle length was calculated by balancing five important aspects: 1) clearance to be created at time of pruning; 2) growth rates of predominant species; 3) risk to system performance; 4) aesthetics / public acceptance of pruning; and 5) cost to implement. For New Hampshire, this optimal cycle length was calculated as 5 years for all lines.

2.1.2. Hazard Tree Mitigation

The Hazard Tree Mitigation program ("HTM") consolidates tree removal activities into a formalized program with risk tree assessment. This program is aimed at developing a more resistant electrical system that is more resilient under the impacts of typical wind, rain and snow events. The intention is to accomplish this through minimizing the incidence and resulting damage of large tree and limb failures from above and alongside the conductors through removal of biologically unhealthy or structurally unstable trees and limbs.

HTM circuits are identified and prioritized through reliability assessment risk ranking, identification as a worst performing circuit, field problem identification, and time since last worked. Once circuits are

[2] A copy of the ECI reliability report, originally provided in response to data request Staff 1-29 (Confidential), was made part of the record in DE 10-055, UES's 2010 base rate case, as a Confidential Exhibit, accompanied by a public redacted version, during the hearing before the Commission.

identified they are scheduled in two ways: 1) while the circuit is undergoing cycle pruning; or 2) scheduled independently of cycle pruning. In New Hampshire, HTM circuit selection corresponds closely with cycle pruning, as both pruning and HTM are on a 5 year cycle.

In order to produce the greatest reliability impact quickly and cost effectively, HTM circuit hazard tree assessment and removal is focused primarily on the three phase only, with most emphasis on the portion of the circuit from the substation to the first protection device. In circuits that have undergone storm resiliency work, the HTM focus also includes single phase circuitry.

2.1.3. Mid-Cycle Review

The mid-cycle review program targets circuits for inspection and pruning based on time since last circuit pruning and forecasted next circuit pruning. The aim of this program is to address the fastest growing tree species that will grow into the conductors prior to the next cyclic pruning, potentially causing reliability, restoration and safety issues. As the first full circuit pruning cycle is underway, mid-cycle review will be used to address only 13.8kV and above, three-phase portions of selected circuits. Circuit selection is based on number of years since last prune and field assessment.

2.1.4. Forestry Reliability Assessment

The Forestry Reliability Assessment program targets circuits for inspection, pruning, and hazard tree removal based on recent historic reliability performance. The goal of this program is to allow reactive flexibly to address immediate reliability issues not addressed by the scheduled maintenance programs. Using recent historic interruption data, poor performing circuits are selected for analysis of tree related interruptions. Circuits or portions of circuits showing a high number of tree related events per mile, customers interrupted per event, and/or customer minutes interrupted per event are selected for field assessment. After field assessment, suitable circuits are scheduled and a forestry work prescription is written for selected circuits or areas.

2.1.5. Storm Resiliency Work

The SRP targets critical sections of circuits for tree exposure reduction by removing all overhanging vegetation or pruning "ground to sky," as well as performing intensive hazard tree review and removal along these critical sections and the remaining three phase of the circuit. The goal of this program is to reduce tree related incidents and resulting customers interrupted along these portions in minor and major weather events. In turn, the aim is to reduce the overall cost of storm preparation and response, and improve restoration.

2.2. 2019 Actual Expenditures and Work Completed

Table 1 depicts the 2019 VMP expenditures by activity in relation to the anticipated budget expenditures. As the program progressed in 2019 there were some deviations in the anticipated expenditures. In the VMP spending, the Cycle Pruning and the Hazard Tree Mitigation work activities had the most deviation in spending relative to anticipated costs. Cycle Pruning had spending above anticipated levels by $468,033 due to increased cost of labor, equipment, and vendor overheads such as insurance and health care. Hazard Tree Mitigation has seen an increase due to forest health decline, especially the presence of Emerald Ash Borer infestations in the service territory. As a result of these overages in budget projections, the mid-cycle work was kept at a minimum ($100,845 underspend) with only high priority work being done and a plan of monitoring of other concern areas into the growing season of 2020. The work spending for the SRP was $188,777 above the anticipated level. This was due to additional hazard tree removals identified on the E7X2 circuit, and a high density of risk-trees on the E18X1 circuit, requiring more trees per mile removal than previous averages. As shown in the table below, total spending for all VMP and SRP components was above the budget by $692,604.

Table 1

2019 VMP O&M Activities		
VM Activity	**2019 Cost Proposal**	**2019 Actual Cost**
Cycle Prune	$ 1,163,894	$ 1,631,927
Hazard Tree Mitigation	$ 800,000	$ 912,401
Forestry Reliability Work	$ 24,857	$ 19,273
Mid-Cycle Review	$ 112,000	$ 11,155
Police / Flagger	$ 557,000	$ 447,877
Core Work	$ 150,000	$ 180,872
VMP Planning	$ -	$ -
Distribution Total	**$ 2,807,751**	**$ 3,203,506**
Sub-T	$ 623,090	$ 690,645
Substation Spraying	$ 10,700	$ 10,804
VM Staff	$ 322,876	$ 363,290
Program Total	**$ 3,764,417**	**$ 4,268,244**
Storm Resiliency Program	$ 1,690,556	$ 1,879,333
Grand Total	**$ 5,454,973**	**$ 6,147,577**

The following tables detail the 2019 VMP work completed by activity. Table 2 details the cycle pruning work. A total of 225 miles of cycle pruning was completed in 2019.

Table 2

2019 VMP Planned Cycle Pruning Details				
District	**Feeder**	**Overhead Miles**	**Scheduled Miles**	**Completed Miles**
Capital	C13W1	33.6	33.6	33.6
Capital	C22W1	4.4	4.4	4.4
Capital	C22W2	0.9	0.9	0.9
Capital	C38	8.3	8.3	8.3
Capital	C4W4	14.3	14.3	14.3
Capital	C4X1	24.0	24.0	24.0
Capital	C7W4	7.4	7.4	7.4
Capital	C8H1	1.2	1.2	1.2
Capital	C8H2	4.6	4.6	4.6
Capital	C8X5	7.4	7.4	7.4
Seacoast	E13W1	18.5	18.5	18.5
Seacoast	E18X1	18.4	14.7	14.7
Seacoast	E19H1	4.7	4.7	4.7
Seacoast	E21W1	29.7	29.7	29.7
Seacoast	E21W2	21.6	21.6	21.6
Seacoast	E47X1	14.7	14.7	14.7
Seacoast	E7X2	19.3	15.0	15.0
Total			**225**	**225**

Table 3 details the hazard tree mitigation work. A total of 94.6 miles of line across 22 circuits were mitigated for hazard tree risk. Unitil had estimated approximately 2,225 hazard tree removals in the budget. The actual results indicate 2,659 total hazard trees were removed on these circuits and various other circuits as found through the course of work over the year.

Table 3

2019 VMP Completed Hazard Tree Mitigation Details					
District	**Feeder**	**Overhead Miles**	**Scheduled Miles**	**Completed Miles**	**# of Removals**
Capital	C24H1	2.0	0.7	0.7	8
Capital	C24H2	2.0	1.3	1.3	4
Capital	C18W2	34.0	5.0	5.0	277
Capital	C6X3	15.2	4.7	4.7	190
Capital	C37X1	6.8	1.2	0	0
Capital	C4W3	18.6	7.5	7.5	6
Capital	C13W1	33.6	6.2	6.2	388
Capital	C4W4	14.3	4.0	4.0	61
Capital	C4X1	24.0	7.9	7.9	155
Capital	Various				631
Seacoast	E6W2	19.2	2.2	2.2	38
Seacoast	E13W2	29.0	3.0	3.0	73
Seacoast	E56X2	2.4	1.6	1.6	4
Seacoast	E58X1	31.0	6.3	6.3	108
Seacoast	E15X1	9.7	5.8	5.8	18
Seacoast	E17X1	8.9	3.5	3.5	26
Seacoast	E17W2	4.8	1.5	1.5	18
Seacoast	E2H1	2.3	1.4	1.4	5
Seacoast	E19X3	38.7	16.0	16.0	330
Seacoast	E43X1	30.8	7.8	3.9	19*
Seacoast	E51X1	30.1	10.3	5.2	6*
Seacoast	E59X1	15.4	7.3	0	0
Seacoast	E13W1	18.5	4.7	1.0	1*
Seacoast	E21W1	29.7	9.9	4.9	4
Seacoast	E21W2	21.6	8.5	1.0	3
Seacoast	Various				286
Total			**128.3**	**94.6**	**2,659**

* All hazard trees identified, marked, and approved for removal but not yet completed in the field – removals to carry over to 2020

Tables 4 and 5 detail the forestry reliability work and mid-cycle work respectively. A total of 7.4 miles of line underwent forestry reliability work and 27.6 miles of line were completed for mid-cycle work.

Table 4

2019 VMP Completed Reliability Analysis Details				
District	**Feeder**	**Overhead Miles**	**Scheduled Miles**	**Completed Miles**
Capital	C22W3	40.1	2.7	2.7
Capital	C8X3	105.8	4.7	4.7
Total			**7.4**	**7.4**

Table 5

2019 VMP Completed Mid-Cycle Review Details				
District	**Feeder**	**Overhead Miles**	**Scheduled Miles**	**Completed Miles**
Capital	C18W2	34.0	5.0	2.0*
Capital	C37X1	6.8	1.2	0
Capital	C4W3	18.6	7.5	0
Capital	C6X3	15.2	4.7	4.7
Seacoast	E19X3	38.7	16.0	16.0
Seacoast	E43X1	30.8	7.8	3.9*
Seacoast	E51X1	30.1	10.3	0
Seacoast	E59X1	15.4	7.3	0
Total			**59.8**	**27.6**

* All work identified, marked, and approved but not yet completed in the field – some work to carry over to 2020

Table 6 details the sub-transmission right-of-way clearing work. A total of 18.1 linear miles of right-of-way floor were cleared.

Table 6

2019 Sub Transmission Clearing Details			
District	**Feeder**	**Scheduled Miles**	**Completed Miles**
Capital	37	4.1	4.1
Capital	34/36	2.2	2.2
Seacoast	3359	7.5	7.5
Seacoast	3348/3350	4.3	4.3
Total		**18.1**	**18.1**

Additionally the sub-transmission right-of-way that was cleared in both Capital and Seacoast in 2018 underwent the integrated vegetation management (IVM) program's low-volume foliar herbicide application work in 2019. A total of approximately 177 acres were managed with IVM chemical control.

2.3. 2020 VMP Estimated Expenditures and Work To Be Completed

Table 7 depicts the 2020 VMP expenditures by activity and the proposed VMP activity details. Unitil proposes to spend $4,023,205 on VMP activities and another $1,423,000 on vegetation storm resiliency, explained in more detail below, for a total of $5,446,205. This amount includes the required work to complete the minor effort carried over from 2019.

Table 7

2020 VMP O&M Activities Cost Proposal		
VM Activity		**2020 Cost Proposal**
Cycle Prune	$	1,490,000
Hazard Tree Mitigation	$	800,000
Forestry Reliability Work	$	24,857
Mid-Cycle Review	$	112,000
Brush Control	$	-
Police / Flagger	$	529,500
Core Work	$	150,000
Distribution Total	**$**	**2,780,251**
Sub-T	$	528,000
Substation Spraying	$	11,021
VM Staff	$	377,827
Program Total	**$**	**4,023,205**
Storm Resiliency Program (SRP)	$	1,423,000
Grand Total	**$**	**5,446,205**

Tables 8 through 12 provide more detail on each of the VMP activities planned for 2020. The activities include 212.9 miles of cycle pruning (Table 8), 107.4 miles of hazard tree mitigation (Table 9) which estimates 2,242 hazard tree removals, 6.7 miles of forestry reliability work (Table 10), 62.2 miles of mid-cycle pruning (Table 11), and 13.7 miles of sub-transmission clearing (Table 12).

Table 8

2020 VMP Planned Cycle Pruning Details			
District	**Feeder**	**Overhead Miles**	**Scheduled Miles**
Capital	C14H1	1.1	1.1
Capital	C14H2	3.8	3.8
Capital	C14X3	0.3	0.3
Capital	C15W1	16.8	16.8
Capital	C15W2	5.8	2.2
Capital	C1H1	0.6	0.6
Capital	C1H2	0.6	0.6
Capital	C1H3	2.3	2.3
Capital	C1H4	1.6	1.6
Capital	C1H5	0.8	0.8
Capital	C1H6	1.6	1.6
Capital	C22W3	40.2	40.2
Capital	C3H1	2.5	2.5
Capital	C3H2	2.4	2.4
Capital	C3H3	1.0	1.0
Capital	C7W3	23.2	23.2
Capital	C7X1	2.6	2.6
Seacoast	E1H3	1.6	1.6
Seacoast	E1H4	3.2	3.2
Seacoast	E22X1	37.6	37.6
Seacoast	E22X2	4.9	4.9
Seacoast	E23X1	24.0	21.4
Seacoast	E6W1	27.0	22.8
Seacoast	E6W2	20.2	17.9
Total			**212.9**

Table 9

2020 VMP Planned Hazard Tree Mitigation Details			
District	**Feeder**	**Overhead Miles**	**Scheduled Miles**
Capital	C8X3	105.9	27.1
Capital	C22W3	40.2	11.3
Seacoast	E43X1	30.8	3.9*
Seacoast	E51X1	30.1	5.2*
Seacoast	E13W1	18.5	3.7*
Seacoast	E21W1	29.7	5.0*
Seacoast	E21W2	21.6	7.5*
Seacoast	E54X1	21.9	4.9
Seacoast	E54X2	22.1	5.6
Seacoast	E56X1	16.9	4.7
Seacoast	E11X2	11.9	6.6
Seacoast	E2X2	19.8	12.7
Seacoast	E22X1	37.6	9.2
Total			**107.4**

***Carry-over from 2019**

Table 10

2020 VMP Planned Reliability Analysis Details			
District	**Feeder**	**Overhead Miles**	**Scheduled Miles**
Capital	C4W3	18.5	0.5
Capital	C13W3	82.9	3.8
Capital	C18W2	34.0	0.6
Seacoast	C17W2	4.6	0.7
Seacoast	C2X3	13.7	1.1
Total			**6.7**

Table 11

2020 VMP Planned Mid-Cycle Review Details			
District	**Feeder**	**Overhead Miles**	**Scheduled Miles**
Capital	C18W2	34.0	2.0*
Capital	C8X3	105.9	27.1
Seacoast	E43X1	30.8	3.9*
Seacoast	E11X2	11.9	6.6
Seacoast	E19X2	2.8	1.8
Seacoast	E20H1	4.5	2.2
Seacoast	E28X1	10.2	5.1
Seacoast	E2X3	13.7	7.1
Seacoast	E2X2	19.8	7.2
Seacoast	E46X1	2.3	1.2
Total			**62.2**

*carry over from 2019

Table 12

2020 Sub Transmission Planned Clearing Details		
District	**Feeder**	**Scheduled Miles**
Capital	34	1.7
Capital	374	2.7
Capital	375	1.5
Seacoast	3342/3353	3.7
Seacoast	3346	2.0
Seacoast	3341/3352	2.1
Total		**13.7**

2.4. 2019 Vegetation Management Storm Resiliency Program Results

In 2019, Unitil continued the SRP, targeting the resiliency efforts in communities in the Seacoast area. This program, now through its eighth year, has been very successful. Unitil is experiencing less damage during storm events resulting in a quicker restoration and the ability to send line and tree crews to our neighboring utilities to assist with their restoration. As in previous program years, the 2019 circuits were selected through analysis of tree related reliability performance. The 2019 circuits are shown below in Table 13. In 2019, 40 miles of critical three phase line were worked planned for hazard tree removals and ground-to-sky pruning. A total of 3,412 hazard trees were removed along these portions of line.

Table 13

2019 Storm Program Work Details			
Circuit	**Scheduled Miles**	**Completed Miles**	**# of Removals**
E27X1	2.4	2.4*	205
E7X2	6.6	6.6*	690
E23X1	10.1	10.1	595
E59X1	7.3	7.3	508
E11X1	4.3	4.3	56
E18X1	9.3	9.3	1,358
Total	**40.0**	**40.0**	**3,412**

* carried-over from 2018

As table 13 shows, all carry over work from 2018 plus planned work in 2019 was completed. The company was able to bring in additional vendors from the extended region to combat the work force issue. Using this additional work force and a new request for pricing release schedule allowed for a large volume of work to be completed.

Again in 2019, Unitil continued tree growth regulator application, an additional measure to improve the health of the adjacent trees along the overhead electric line corridor. Trees remaining and being pruned were treated with the tree growth regulator chemical in order to reduce the resulting tree growth after pruning and positively affect the tree's health. The Cambistat tree growth regulator treatment creates other plant growth effects that are beneficial for tree health including increased root density, improved drought and heat resistance, and higher tolerance to insects and diseases.[3] 896 trees along the 2019 SRP corridor were treated with the tree growth regulator.

Due to the varying nature of storm resiliency work and traffic control, as well as the lack of workforce availability, the Company expects costs may continue to experience minor variances, with final annual costs being slightly above or below the estimated budget. Even with yearly fluctuations, the average cost for the SRP program has remained close to the original estimate.

The Company did experience an elevated number of major storms again in 2019, compared to the absence of major storms seen in 2016. The largest tree related event was the October 17th nor'easter wind event. The Company believes that the SRP program contributed significantly to the swift restoration times and shortened duration of the event, with all customers restored in just over 24 hours. It is evident

[3] 2014 Rainbow Treecare Scientific Advancements, Cambistat Customer Literature

from these most recent results, and results from previous events during the duration of the SRP program, like the October 2017 wind event, the 2015 Plaistow microburst, the 2014 Thanksgiving storm, and favorable results of the 2012 and 2013 storm resiliency pilot circuits over the last eight years, that the Storm Resiliency work has the ability to and was successful at preventing tree related failures and subsequent electric incidents. This reduction in incidents reduces damage to the electric infrastructure and the need for crews to respond, which reduces the overall storm costs and expedites the restoration.

In order to more thoroughly assess the program's results and provide future recommendations, the Company has brought industry expert consultants on board. In 2020 the Company will be using an assessment tool providing data analytics using the SRP work location data, customer restriction of work data, Outage Manage System data, Customer Information System data, Geographical Information System data, and storm duration and cost data. Using this assessment tool, a third party consultant will be performing a full assessment of the program. The analysis is expected to be completed by May 2020.

2.5. 2020 Vegetation Management Storm Resiliency Program Planned

For 2020, storm resiliency work on 34.7 miles of line in the Capital service area is proposed, at a total cost of $1,423,000. These planned circuits, shown in Table 14, were chosen for their recent historic reliability performance, number of customers served, field conditions, and location.

Table 14

2020 SRP Planned Work Details		
Circuit	**Overhead Miles**	**Scheduled Miles**
C15W2	5.8	4.3
C2H2	8.8	5.3
C13W2	18.0	5.0
C37X1	6.8	1.2
C4W4	14.2	4.0
C8X5	7.4	7.2
C16H1	3.2	2.1
C16H3	4.5	1.8
C16X4	6.6	3.8
Total		**34.7**

3. Reliability Planning and Performance

The Company approved total spending of $2,640,791 in the 2020 annual budget on capital reliability projects and $300,000 in reliability O&M expenditures. The capital budget includes costs that are carried over from reliability projects that were initiated in 2019 and are expected to be completed 2020.

The Reliability Program covers capital and O&M activities and projects intended to maintain or improve the reliability of the electric system including: (1) system hardening measures, i.e., equipment upgrades; installation of additional fuses, sectionalizers and reclosers; SCADA and automation projects; improvements to lightning protection; installation of animal guards; and other activities to mitigate the specific causes of outages; and (2) reliability-based inspections and maintenance, which will include inspections of tree growth and health and enhanced trimming in targeted areas on the system.

3.1. Annual Studies

Each year the Company completes an annual distribution planning study and reliability study in each of the operation areas. Both of these studies incorporate analysis to improved system reliability.

3.1.1. Distribution Planning Study

The Company conducts distribution planning studies on an annual basis. The purpose of this study is to identify when system load growth is likely to cause main elements of the distribution system to reach their operating limits, and to recommend plans for the most cost-effective system improvements.

Circuit analysis provides the basis for the distribution planning study. Circuit analysis is completed on a three year rotating cycle with the objective to perform a detailed review on one-third of the entire system each year. The Milsoft Windmil software application is used to perform circuit analysis to identify potential problem areas and to evaluate available alternatives for system improvements. Circuit analysis includes the following: 1) update of circuit model from GIS; 2) circuit diagnostics; 3) load allocation; 4) voltage drop and loading analysis; 5) fault current and protection device coordination analysis. Engineering work requests are initiated for any apparent miscoordination identified during this analysis. Projects are entered into the capital budget for projects that require replacement or installation of equipment.

In addition to the fuse coordination completed as part of circuit analysis, the Company reviews trouble interruption reliability reports on a daily basis. Any outage in which the fuse did not appear to operate correctly is further analyzed to determine the cause. Engineering Work Requests are issued to implement upgrades or changes on the system identified by the circuit analysis or an evaluation of an outage.

3.1.2. Reliability Studies

Each year, Unitil completes annual reliability studies for each of its operating areas. The purpose of these studies is to report on the overall reliability performance of the electric systems from January 1 through December 31 of the previous year (12 months total). The scope of this report also evaluates substation, subtransmission (34.5kV system generally off road and serving one or more substations or circuit taps) and individual circuit reliability performance over the same time period. The analysis also identifies common trends or themes based upon type of outage (i.e. tree, equipment failure, etc.). The Annual Reliability Analysis and Recommendations report for the UES Capital Operating Area and UES Seacoast Operating Area are attached to this report as Attachment 1 and Attachment 2 respectively.

The recommendations provided in the study are focused on improving the worst performing circuits as well as the overall system reliability. These recommendations are provided for budget consideration and will be further developed with the intention of incorporation into the capital budget development process.

There are several common solutions which can improve reliability depending upon the circumstance: 1) installation of reclosers or sectionalizers; 2) addition of fusing locations; 3) tree trimming; 4) installation of tree wire or spacer cable; and 5) implementation of automatic restoration schemes. These solutions are recommended most commonly; however, other solutions are also recommended for specific situations.

3.2. Reliability O&M Expenditures

The Company has allocated $300,000 to Reliability O&M expenditures for enhanced tree trimming. The Enhanced Tree Trimming funding is intended to target “problem” areas identified through engineering analysis.

3.2.1. Enhanced Tree Trimming

Each year, the Company completes reliability analysis on the distribution and subtransmission system. The reliability analysis identifies areas of the system which have experienced an abnormal or increasing amount of tree related outages in the previous year. Distribution Engineering provides the System Arborist a prioritized list of recommended subtransmission lines and/or distribution circuits which would benefit the most from enhanced tree trimming.

In 2019, Distribution Engineering recommended a thorough review of sub-transmission lines. Work was done on UES Capital circuits C38, 34, 37, 375, 374, 33 and 396X1. In total, $361,587 was spent on Enhanced Tree Trimming and 768 hazard tree removals were completed along with sideline clearing on selected portions.

For 2020, Distribution Engineering is recommending the continuation of enhanced tree trimming/ hazard tree removal on a the 38 Line emanating from one of the system supply substations as well as continuing thorough inspection of the trees along the sub-transmission lines that experienced a tree related outages in the UES Seacoast area. The work is budgeted not to exceed $300,000.

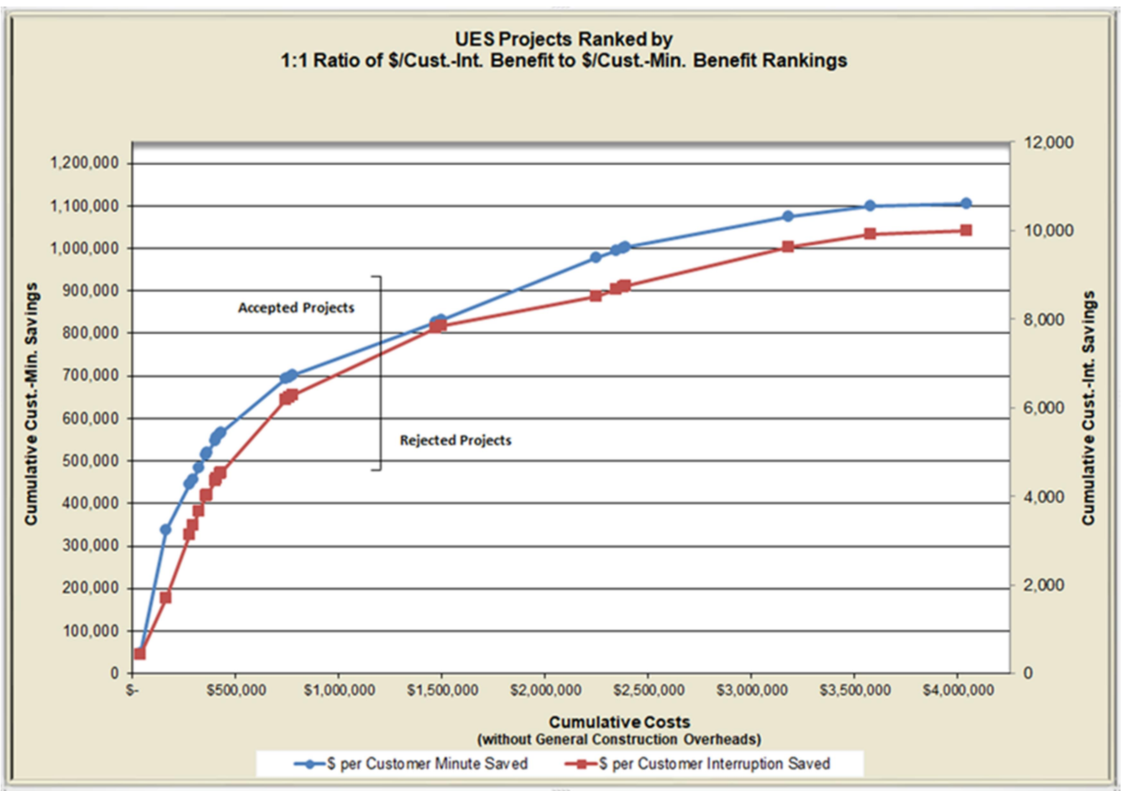
3.3. Reliability Capital Expenditures

As described in section 3.1.2 above, in addition to the annual pole inspection and replacement program, each year Unitil completes annual reliability studies for each of its operating areas. The recommendations provided in the study are focused on improving the worst performing circuits, as well as the overall system reliability. These reliability projects count for the majority or all of the "System Hardening/Reliability" spending for each year.

The reliability projects recommended for the budget include a project scope, construction cost estimate and estimated reliability improvements (annualized saved customer minutes and saved customer interruptions). All of the recommended projects are ranked against each other based upon two cost benefit comparisons (cost per saved customer minute and cost per saved customer interruption).

An overall project rank is derived from the sum of these two cost benefit rankings. In general, projects with low construction cost and high saved customer minutes or high saved customer interruptions are ranked highest on the list while those projects with high construction cost and low saved customer minutes or saved customer interruptions are ranked low on the list. Another way these projects are analyzed by Distribution Engineering is shown in Chart 1 below. This chart displays the cumulative project cost compared to the anticipated reliability benefits of all projects. Each data point pair represents a specific project and its associated reliability benefits (saved customer minutes and saved customer interruptions). This chart is used to compare the relative return of reliability benefits associated with project cost between all projects. The projects to the left of the cutoff line are those that are entered into the annual Capital Budget for approval. Those to the right have been rejected.

Chart 1



The reliability projects for 2020 presented in Table 15 below provide an illustration of the process used to identify reliability projects. Table 16 is a listing of reliability projects recommended by Distribution Engineering as part of the 2019 annual reliability studies for the UES system which have been accepted into the 2019 Capital Budget. This project-listing details the overall project ranking, scope, cost, and anticipated reliability benefits.

Table 15

Project Ranking	Budget No.	Description	Project Cost	Cumulative Cost	Customer Interruptions Saved Annually	Customer Minutes Saved Annually
1	DRBC08	Replace Hydaulic Recloser on Main St, Chichester - 8X3	$37,815	$37,815	439	46,125
2	DRBE02	3343 and 3354 Lines – Install Reclosers	$123,388	$161,203	1,250	290,000
3	DRBCF1	N. Main St Boscawen	$15,454	$176,657	195	13,095
4	DRBC10	Install Recloser on Pleasant St - 6X3	$32,706	$209,363	334	27,774
5	DRBC07	Install Recloser on Mountain Rd - 15W1	$33,670	$243,033	335	27,838
6	DRBCF4	Knox Rd, Bow	$5,720	$248,753	30	5,720
7	DRBC09	Install Recloser on Regional Dr - 8X5	$36,331	$285,084	330	27,429
8	DRBCF2	New Orchard Rd Epsom	$9,447	$294,531	31	10,111
9	DRBCF3	Stickney Hill Rd, Hopkinton	$15,454	$309,985	120	7,565
10	DRBCF9	Borough Rd Caterbury	$7,915	$317,900	20	4,200
11	DRBE01	Circuit 43X1 – Install Reclosers and Implement Distribution Automation	$312,497	$630,397	1,650	125,000
PROPOSED NH RELIABILITY PROJECTS			**$630,397**		**4,734**	**584,857**

Recommended 2020 Reliability Based Projects

Note the project list in the table above has been sorted by project rank in ascending order beginning with the project having the best composite cost benefit ranking. This list is used by Distribution Engineering as a guide for recommending projects to be included in the Capital Budget as reliability projects. The projects listed above are those projects that were accepted into the 2020 capital budget. However, it should be noted other projects were identified in the annual reliability analysis and were not accepted in the Capital Budget as providing adequate reliability compared to the cost. The Capital Budget process approves the amount of spending for reliability projects and allows for changes of projects, if it is later determined that there are better or more practical projects.

3.3.1. 2019 Actual Reliability Expenditures

The capital expenditures of reliability project construction for the Company in 2019, totaled $2,534,863[4]. This total includes the planned annual pole replacement projects in addition to the projects recommended as part of the 2018 annual reliability analysis.

Attachment 3 details the budgeted costs and actual expenditures of all capital reliability projects. This list includes the projects that were originally budgeted and those that were actually constructed. There were a few projects that were budgeted and then were replaced by other projects due to practicality of completing the construction.

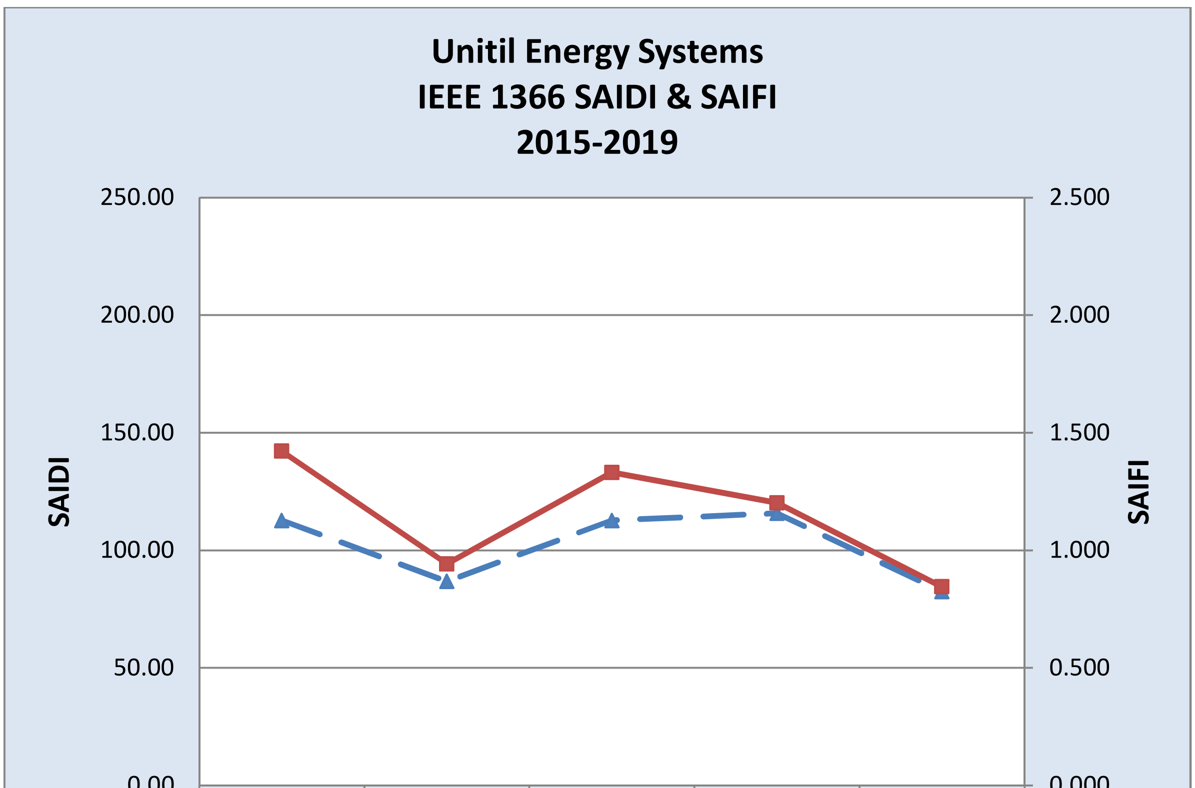
[4] Refer to Attachment 3 for reliability project spending

4. 2019 Reliability Performance

4.1. Historical Performance (2015-2019)

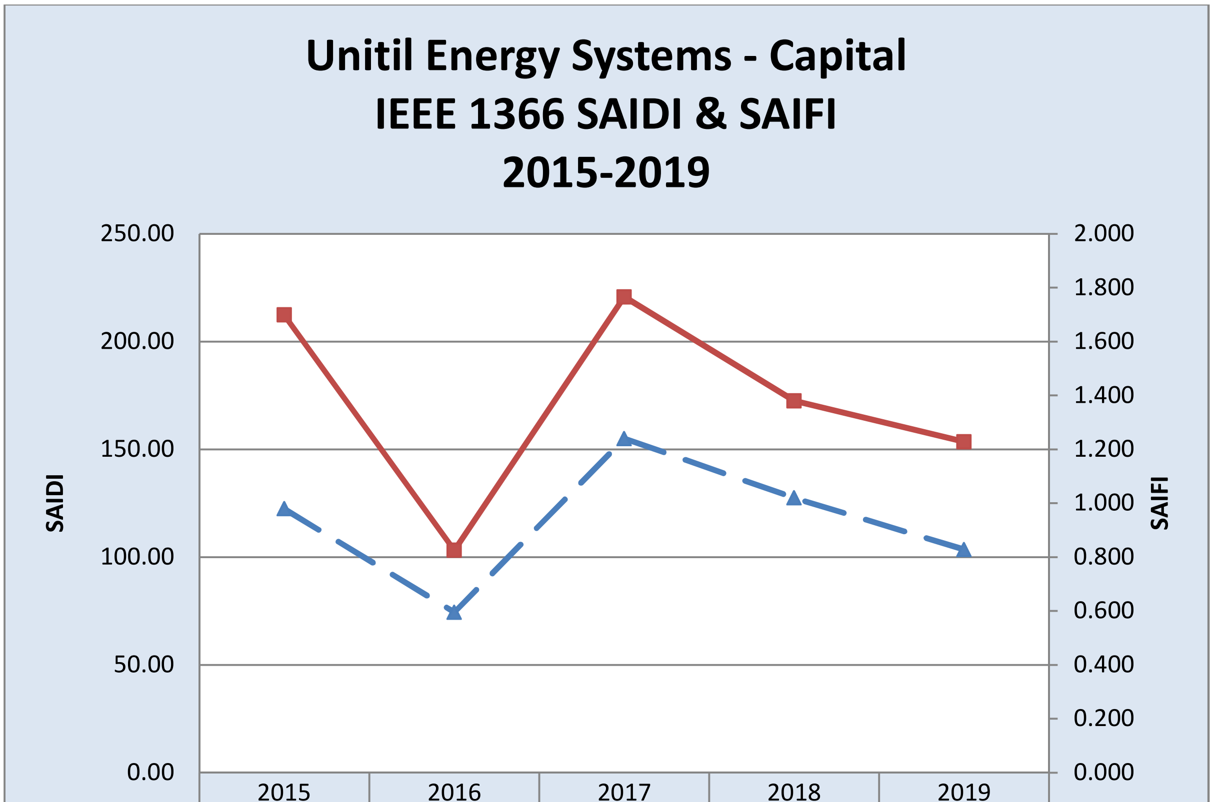
The historical reliability performance for the UES system for the time period from 2015-2019 is outlined in Charts 2-4 below. These charts display annual SAIDI and SAIFI for the combined UES systems as well as separate charts for each of the UES-Capital and UES-Seacoast service territories.

Chart 2



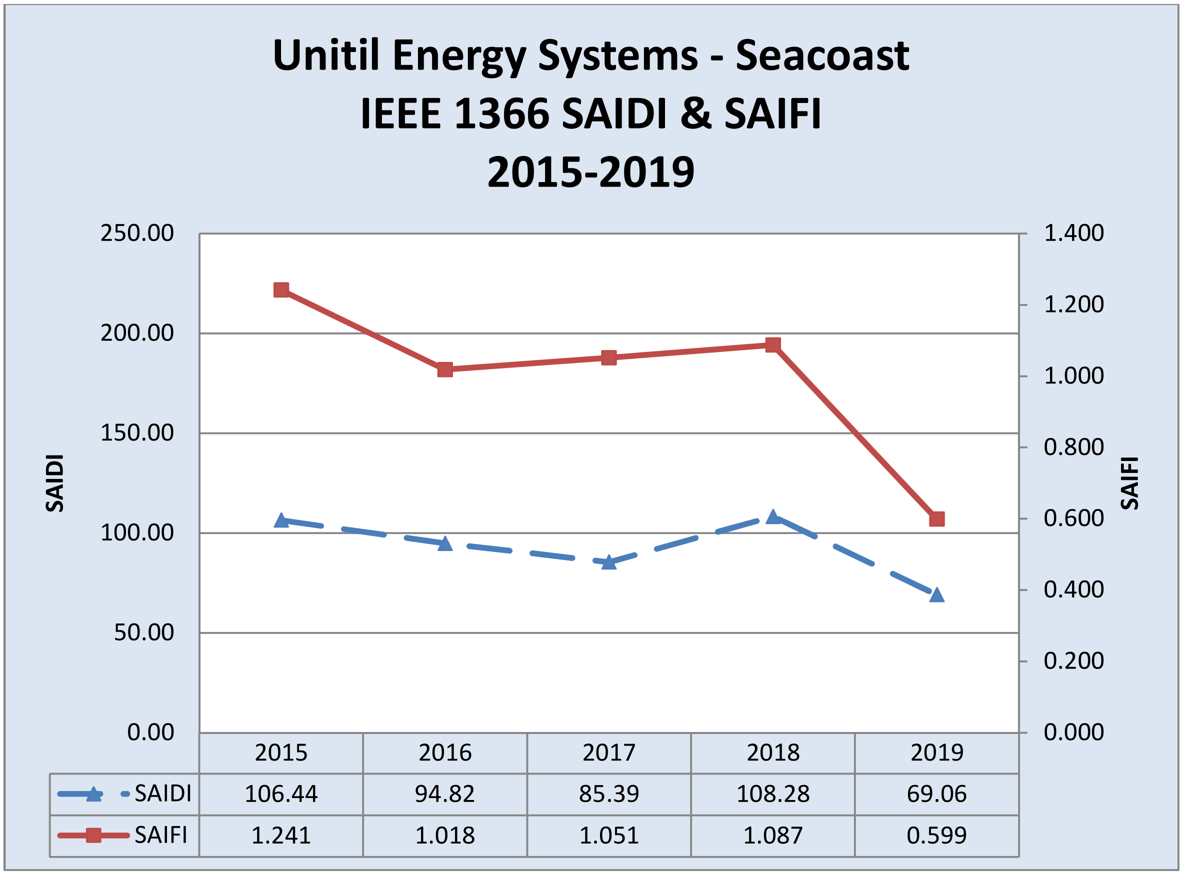
	2015	2016	2017	2018	2019
SAIDI	112.73	86.81	112.68	115.80	82.53
SAIFI	1.421	0.942	1.331	1.202	0.845

Chart 3



	2015	2016	2017	2018	2019
SAIDI	122.42	74.39	154.99	127.48	103.51
SAIFI	1.699	0.825	1.766	1.380	1.228

Chart 4



NOTE: Only those events causing an outage to 1 or more customers and lasting more than 5 minutes in duration are included in the calculation of these indices. In addition, events meeting any of the following criteria have also been excluded from these calculations:

- PUC Major Storm: All outages occurring in any day classified as an IEEE-1366 Major Event Day
- Interruptions/outages involving the failure of customer owned equipment
- Off system power supply interruptions

4.2. Summary of 2019 Performance

The reported reliability performance of the UES systems in 2019 (based on IEEE-1366) was the best performance in the last five years in terms of SAIDI. The combined UES system SAIDI of 82.53 minutes is approximately 20% lower than the 5 year average of 102.11 minutes. The UES combined system SAIFI for 2019 was 0.845 interruptions which was the best performance in the last five years. The system SAIFI is approximately 26% lower than the 5 year average of 1.148. The total number of interruption events recorded in 2019 was 838.

In 2019, there were two events that met the IEEE -1366 criteria for a Major Event Day which were therefore not included in the calculation of UES system SAIDI and SAIFI. These Major Event Days are listed below:

- June 30th – Wind Event (Capital Region
- October 17th – Wind Event (Capital and Seacoast Region)

Table 16 below shows a breakdown of the reliability performance of the UES system by individual cause codes.

Table 16

Cause of Outage	No of Troubles	Cust Int	Cust Hrs	SAIDI	% Total (SAIDI)	SAIFI	% Total (SAIFI)
Action by Others	12	919	1,985	1.53	1.9%	0.012	1.4%
Animal - Other	3	44	71	0.05	0.1%	0.001	0.1%
Bird	26	2,251	1,926	1.48	1.8%	0.029	3.4%
Civil Emergency (fire,flood,etc.)	3	18	9	0.01	0.0%	-	0.0%
Equipment Failure Company	137	9,217	10,185	7.84	9.5%	0.118	13.9%
Equipment Failure Customer	4	11	48	0.04	0.0%	-	0.0%
Lightning Strike	6	160	285	0.22	0.3%	0.002	0.2%
Loose/Failed Connection	15	615	1,120	0.86	1.0%	0.008	0.9%
Operator Error/System Malfunction	1	1	1	-	0.0%	-	0.0%
Other	9	763	1,808	1.39	1.7%	0.010	1.2%
Overload	8	138	243	0.19	0.2%	0.002	0.2%
Patrolled, Nothing Found	74	4,915	6,734	5.18	6.3%	0.063	7.4%
Scheduled, Planned Work	109	5,287	4,830	3.72	4.5%	0.068	8.0%
Squirrel	49	1,160	1,340	1.03	1.2%	0.015	1.8%
Tree/Limb Contact - Broken Limb	161	11,126	16,622	12.79	15.5%	0.143	16.9%
Tree/Limb Contact - Broken Trunk	137	19,065	43,432	33.43	40.5%	0.245	28.9%
Tree/Limb Contact - Growth into Line	14	555	808	0.62	0.8%	0.007	0.8%
Tree/Limb Contact - Uprooted Tree	32	4,345	4,384	3.37	4.1%	0.056	6.6%
Tree/Limb Contact - Vines	9	744	773	0.59	0.7%	0.010	1.2%
Vehicle Accident	29	4,528	10,631	8.18	9.9%	0.058	6.8%

As observed from the preceding table, tree related outages had the greatest impact on the UES system reliability in terms of both SAIDI and SAIFI performance in 2019. Tables 17 and 18 below shows how the top three causes during 2019 have trended over the last three years[5].

Table 17

	SAIDI (% Total)		
Cause	**2019**	**2018**	**2017**
Tree Related	51%	65%	54%
Vehicle Accident	10%	7%	7%
Equipment Failure	10%	20%	18%

Table 18

	SAIFI (% Total)		
Cause	**2019**	**2018**	**2017**
Tree Related	59%	62%	48%
Equipment Failure	15%	17%	19%
Patrolled, Nothing Found	8%	10%	5%

[5] Percentages based on reliability data after removing exclusionary events based on the PUC exclusionary criteria in effect for the respective year.

Unitil Energy Systems, Inc.
Reliability Program
Vegetation Management Program
Annual Report 2019
Attachment 1

Attachment 1

UES – Capital

Reliability Study 2019

UES Capital

Reliability Study

2019

Prepared By:

T. Glueck

Unitil Service Corp.

10/28/2019

Table of Contents

1 Executive Summary

The purpose of this document is to report on the overall reliability performance of the UES Capital system from January 1, 2018 through December 31, 2018. The scope of this report will also evaluate individual circuit reliability performance over the same time period. The outage data used in this report excludes the data in Section 5 (sub-transmission and substation outages), as well as outage data from IEEE Major Event Days (MEDs). UES-Capital MEDs are listed in the table below:

Date	Type of Event	Interruptions	Customer Interruptions	Cust-Min of Interruption
5/4/2018	Thunderstorm	33	3082	1,438,447
6/18/2018	Thunderstorm	27	11351	1,726,076

The following projects are proposed from the results of this study and are focused on improving the worst performing circuits as well as the overall UES Capital system reliability. These recommendations are provided for consideration and will be further developed with the intention to be incorporated into the 2020 budget development process.

Circuit / Line / Substation	Proposed Project	Cost ($)
15W1	Install Recloser on Mountain Rd	$32,401
8X3	Replace Hydraulic Recloser on Main St	$35,967
8X5	Install Recloser on Regional Dr	$34,531
6X3	Install Recloser on Pleasant St	$31,492
4W4	Install Recloser and Switches on Fisherville Rd	$85,802
Various	Fusesaver Installations	$143,506

Note: estimates do not include general construction overheads

UES Capital SAIDI was 127.48 minutes in 2018 after removing Major Event Days. The UES Capital target was 130 minutes. Charts 1, 2, and 3 below show UES Capital SAIDI, SAIFI, and CAIDI, respectively, over the past five years.

Chart 1: Annual Capital SAIDI

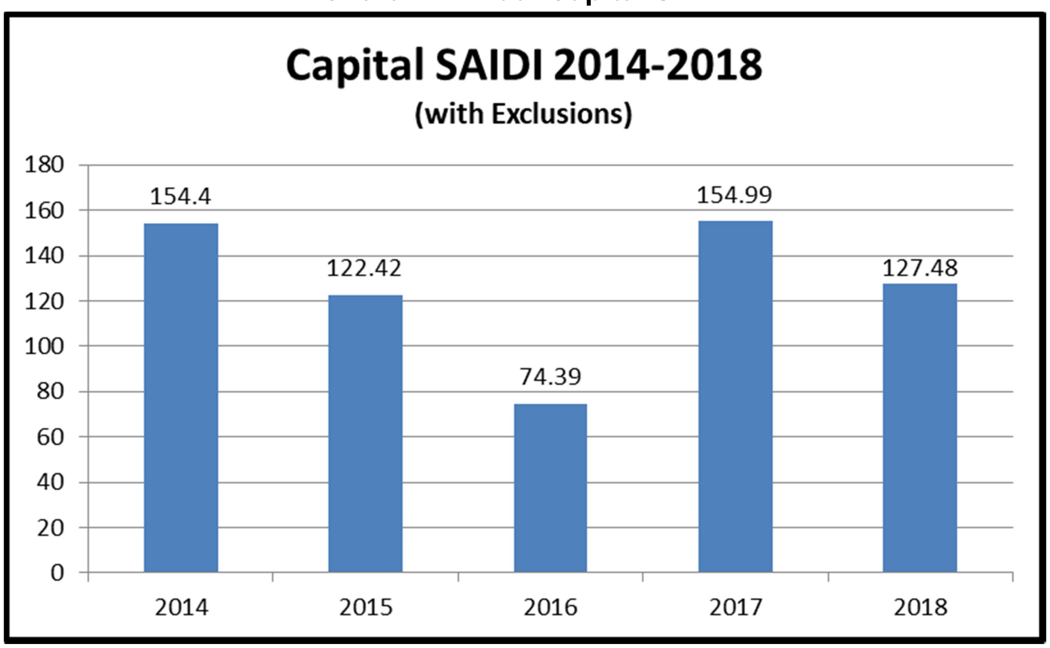


Chart 2: Annual Capital SAIFI

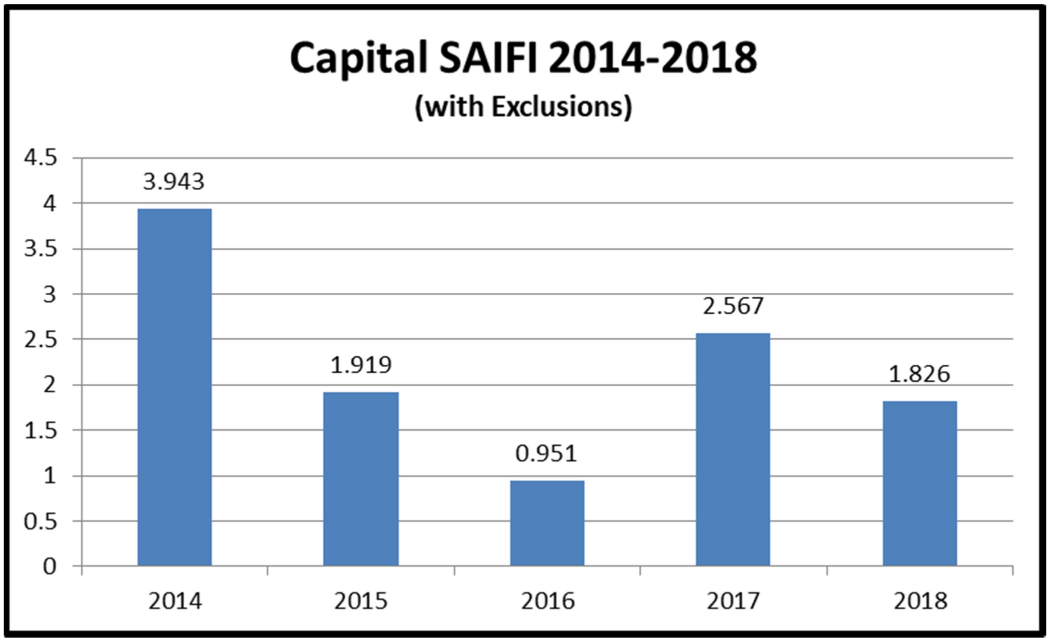
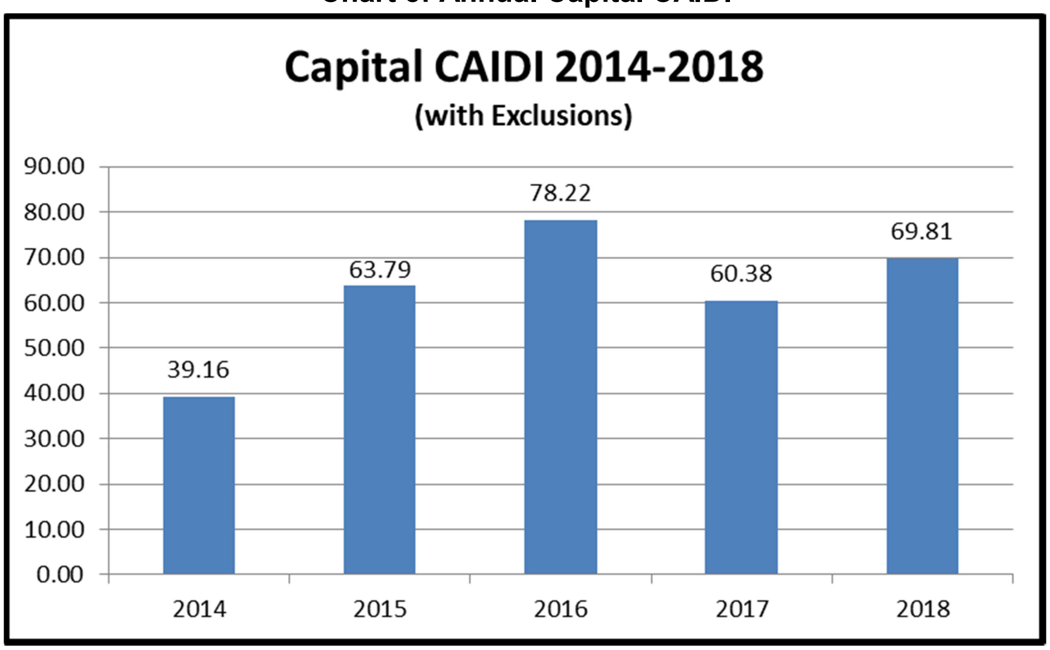


Chart 3: Annual Capital CAIDI



2 Reliability Goals

The annual UES Capital system reliability goal for 2019 has been set at 147.45 SAIDI minutes. This was developed by calculating the contribution of UES Capital to the Unitil system performance using the past five year average. The contribution factor was then set against the 2019 Unitil System goal. The 2019 Unitil System goal was developed through benchmarking the Unitil system performance with nationwide utilities.

Individual circuits will be analyzed based upon circuit SAIDI, SAIFI, and CAIDI. Analysis of individual circuits along with analysis of the entire UES Capital system is used to identify future capital improvement projects and/or operational enhancements which may be required in order to achieve and maintain these goals.

3 Outages by Cause

This section provides a breakdown of all outages by cause code experienced during 2018. Charts 4, 5, and 6 show the number of interruptions, the number of customer interruptions, and total customer-minutes of interruptions due to each cause, respectively. Only the causes contributing 3% or greater of the total are labeled. Table 1 shows the number of interruptions for the top three trouble causes for the previous five years.

Chart 4: Number of Interruptions by Cause

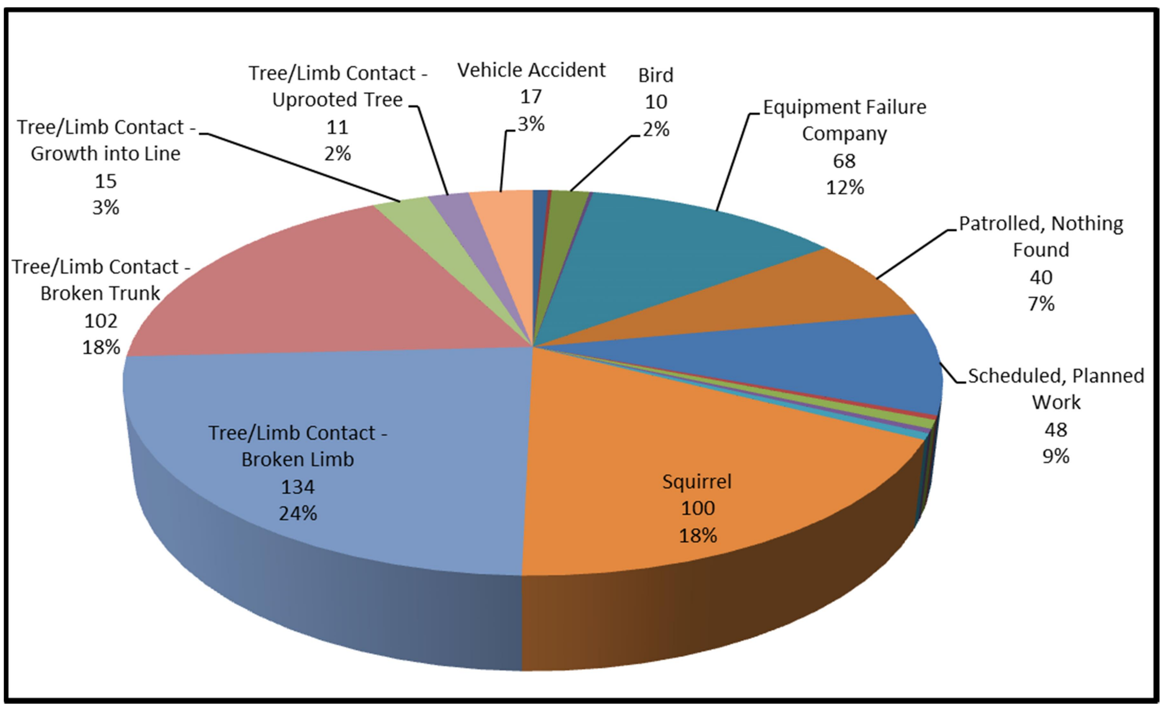


Chart 5: Number of Customer Interrupted by Cause

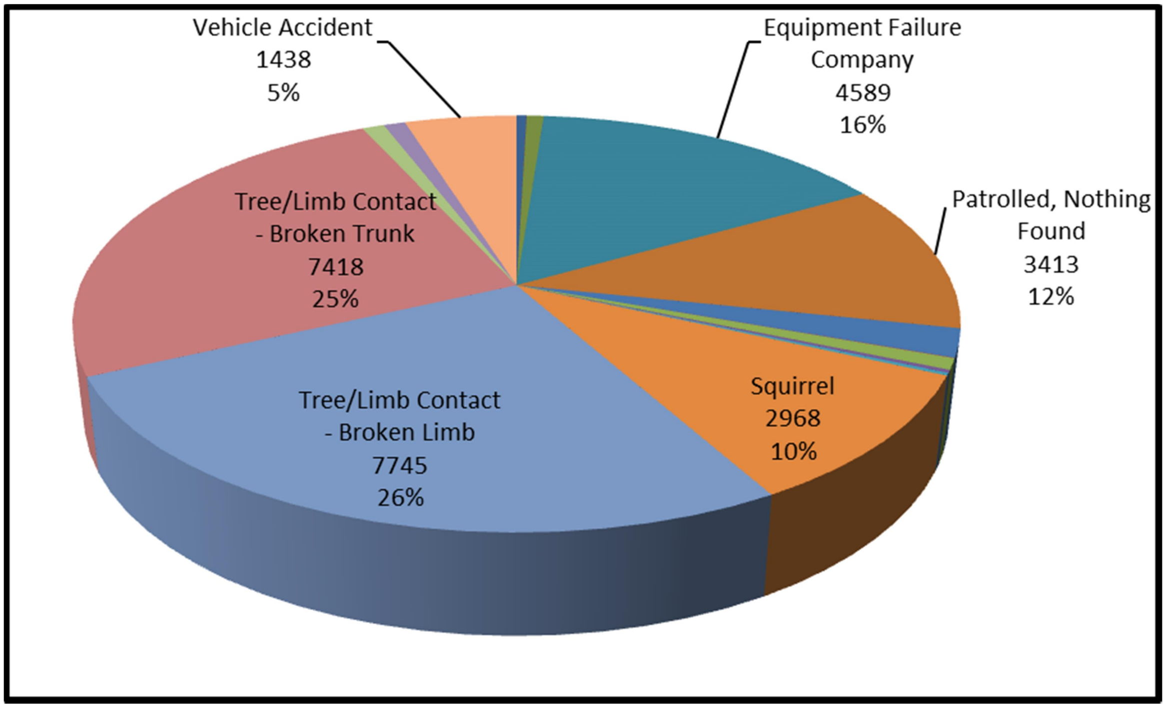


Chart 6: Percent of Customer-Minutes of Interruption by Cause

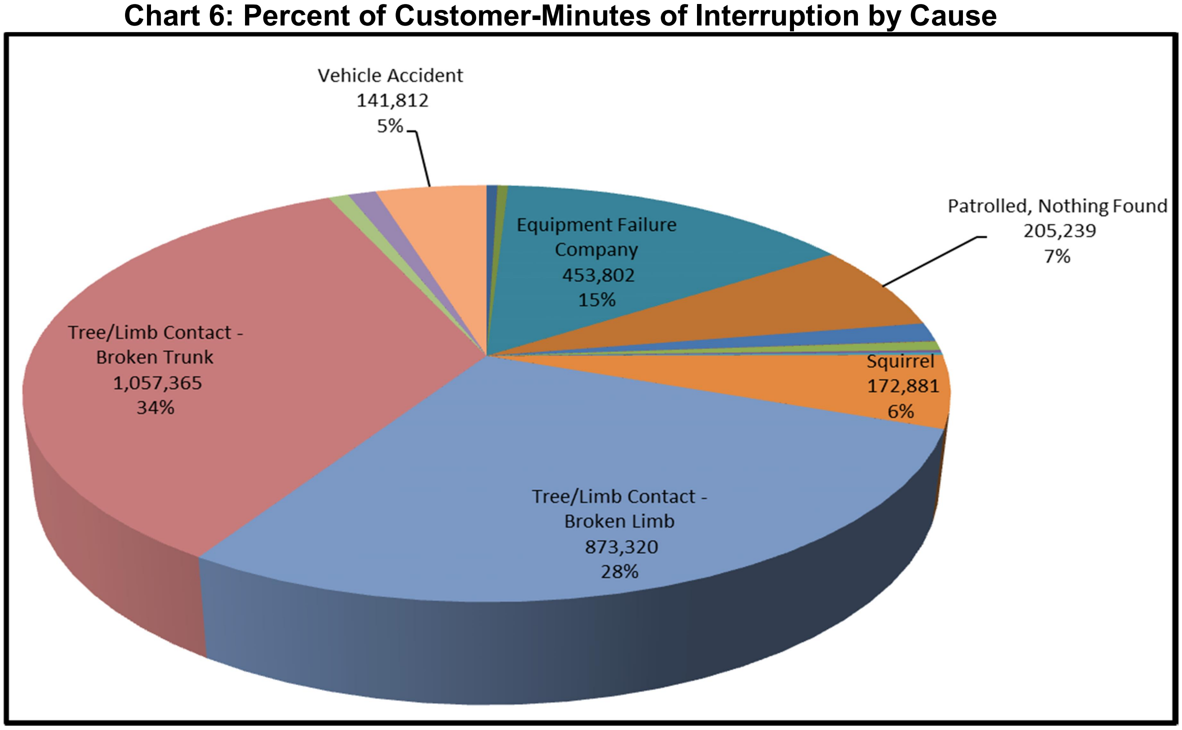


Table 1

Five-Year History of the Number of

Interruptions for the Worst Three Trouble Causes

Year	Tree/Limb Contact - Broken Limb	Tree/Limb Contact - Broken Trunk	Squirrel
2014	117	37	53
2015	134	44	53
2016	117	34	93
2017	86	37	112
2018	134	102	100

4 10 Worst Distribution Outages

The ten worst distribution outages ranked by customer-minutes of interruption during the time period from January 1, 2018 through December 31, 2018 are summarized in Table 2 below.

Table 2

Worst Ten Distribution Outages

Circuit	Description **(Date/Cause)**	No. of Customers Affected	No. of Customer Minutes	Capital SAIDI (min.)	Capital SAIFI
C13W3	11/10/2018 Tree/Limb Contact - Broken Trunk	1,615	155,709	5.13	0.053
C8X3	04/16/2018 Tree/Limb Contact - Broken Limb	1,139	140,192	4.62	0.038
C22W3	07/15/2018 Tree/Limb Contact - Broken Trunk	915	133,491	4.40	0.030
C13W3	07/10/2018 Tree/Limb Contact - Broken Trunk	401	92,484	3.05	0.013
C8X3	02/17/2018 Equipment Failure Company	892	70,914	2.34	0.029
C13W2	05/22/2018 Patrolled, Nothing Found	1,480	68,198	2.25	0.049
C38	07/21/2018 Equipment Failure Company	155	66,082	2.18	0.005
C13W2	07/10/2018 Tree/Limb Contact - Broken Limb	240	63,600	2.09	0.008
C13W3	01/23/2018 Tree/Limb Contact - Broken Limb	585	59,085	1.95	0.019
C15W2	12/17/2018 Tree/Limb Contact - Broken Trunk	251	57,547	1.90	0.008

Note: This table does not include outages that occurred at substations or on the subtransmission system, scheduled/planned work outages, or outages that occurred during excludable events.

5 Subtransmission and Substation Outages

This section describes the contribution of sub-transmission line and substation outages on the UES Capital system.

All substation and sub-transmission outages ranked by customer-minutes of interruption during the time period from January 1, 2018 through December 31, 2018 are summarized in Table 3 below.

Table 4 shows the circuits that have been affected by sub-transmission line and substation outages. The table illustrates the contribution of customer minutes of interruption for each circuit affected.

In aggregate, sub-transmission line and substation outages accounted for 24% of the total customer-minutes of interruption for UES Capital.

Table 3

Subtransmission and Substation Outages

Trouble Location	Description (Date/Cause)	No. Customers Affected	No. of Customer Minutes	UES CAPITAL SAIDI (min)	UES Capital SAIFI	No. Times on List (past 4 yrs)
Line 38	12/17/2018 Tree/Limb Contact - Broken Limb	1,804	253,850	8.39	0.059	4
Line 34	11/06/2018 Tree/Limb Contact - Uprooted Tree	1,715	246,325	8.11	0.056	2
Line 35	02/16/2018 Equipment Failure Company	1,279	122,558	4.04	0.042	1
Line 34	07/04/2018 Tree/Limb Contact - Broken Trunk	1,710	90,674	2.99	0.056	2
Line 36	02/16/2018 Equipment Failure Company	10	410	0.01	0.000	0

Table 4

Contribution of Subtransmission and Substation Outages

Circuit	Trouble Location	Customer-Minutes of Interruption	% of Total Circuit Minutes	Circuit SAIDI Contribution	Number of Events
C2H4	Line 33 / Line 34	43,483	90%	836.21	2
C2H1	Line 33 / Line 34	69,631	100%	144.76	1
C33X4	Line 33 / Line 34	9,536	99%	146.71	2
C2H2	Line 33 / Line 34	211,208	88%	198.69	2
C33X5	Line 33 / Line 34	447	100%	149.00	2
C33X3	Line 33 / Line 34	149	100%	149.00	2
C33X6	Line 33 / Line 34	149	73%	3.73	2
C34X2	Line 33 / Line 34	2,025	100%	225.00	2
C34X4	Line 33 / Line 34	372	100%	371.80	2
C1X7P	Line 1X7P	349	100%	43.57	1
C21W1P	Line 1X7P	18,656	82%	43.49	3
C35X2	Line 36 / Line 35	644	100%	161.00	2
C35X3	Line 36 / Line 35	805	100%	161.00	2
C35X4	Line 36 / Line 35	161	100%	161.00	2
C15W2	Line 35	23,940	21%	72.33	1
C15W1	Line 35	94,145	74%	94.90	1
C15H3	Line 35	1,425	100%	95.00	1
C35X1	Line 35	1,848	100%	123.20	1

*Note that 2H1 and 2H4 were tied during some of the outages, which effects their event totals.

6 Worst Performing Circuits

This section compares the reliability of the worst performing circuits using various performance measures. All circuit reliability data presented in this section includes sub-transmission or substation supply outages unless noted otherwise.

6.1 Worst Performing Circuits in Past Year (1/1/18 – 12/31/18)

A summary of the worst performing circuits during the time period between January 1, 2018 and December 31, 2018 is included in the tables below.

Table 5 shows the ten worst circuits ranked by the total number of Customer-Minutes of interruption. The SAIFI and CAIDI for each circuit are also listed in this table.

Table 6 provides detail on the major causes of the outages on each of these circuits. Customer-Minutes of interruption are given for the six most prevalent causes during 2018.

Circuits having one outage contributing more than 80% of the Customer-Minutes of interruption were excluded from this analysis.

Table 5

Worst Performing Circuits Ranked by Customer-Minutes

Circuit	Customer Interruptions	Worst Event (% of CI)	Cust-Min of Interruption	Worst Event (% of CMI)	SAIDI	SAIFI	CAIDI
C13W3	8,906	18%	857,816	18%	532.47	5.528	96.32
C8X3	4,223	27%	470,644	30%	164.27	1.474	111.45
C22W3	4,679	34%	387,272	34%	242.20	2.926	82.77
C13W2	3,881	38%	359,001	19%	327.56	3.541	92.50

C38	754	21%	142,781	46%	128.52	0.679	189.37
C7W3	1,248	14%	129,571	27%	142.86	1.376	103.82
C4W3	1,541	30%	116,834	29%	73.62	0.971	75.82
C18W2	1,061	20%	97,330	16%	83.62	0.912	91.73
C15W2	517	49%	88,754	65%	268.14	1.562	171.67
C13W1	801	16%	75,936	13%	155.29	1.638	94.80

Note: all percentages and indices are calculated on a circuit basis

Table 6

Circuit Interruption Analysis by Cause

	Customer – Minutes of Interruption / # of Outages					
Circuit	Tree/Limb Contact - Broken Trunk	Tree/Limb Contact - Broken Limb	Equipment Failure Company	Patrolled, Nothing Found	Vehicle Accident	Squirrel
C13W3	490,316 / 29	218,235 / 37	2,483/ 6	54,908 / 10	29,058 / 4	12,812 / 13
C8X3	69,595 / 20	244,196 / 33	94,108/ 12	14,261 / 7	411 / 1	29,420 / 24
C22W3	245,240 / 9	79,321 / 16	22,258 / 9	9,999 / 3	0 / 0	7,452 / 9
C13W2	73,965 / 12	184,454 / 10	4,375 / 2	68,312 / 2	0 / 0	8,176 / 4
C38	1,408 / 2	1,602 / 2	131,284 / 6	7,065 / 1	0 / 0	0 / 0
C7W3	17,177 / 4	25,329 / 4	18,643 / 4	335 / 1	59,533 / 2	7,280 / 4
C4W3	0 / 0	17,452 / 4	40,990 / 4	68 / 1	36,204 / 4	14,067 / 4
C18W2	50,273 / 8	12,296 / 5	135 / 1	1,192 / 1	0 / 0	33,056 / 13

C15W2	57,546 / 1	3,296 / 1	4,017 / 2	0 / 0	0 / 0	7,292 / 4
C13W1	25,406 / 9	18,208 / 7	1450 / 3	7,839 / 4	13,955 / 2	2,764 / 6

6.2 Worst Performing Circuits of the Past Five Years (2014 – 2018)

The annual performance of the ten worst circuits in terms of circuit SAIDI and SAIFI for each of the past five years is shown in the tables below. Table 7 lists the ten worst performing circuits ranked by SAIDI and Table 8 lists the ten worst performing circuits ranked by SAIFI. Table 9 lists the ten worst performing circuits ranked by SAIDI and SAIFI over the past five years.

The data used in this analysis includes all system outages except those outages that occurred during the 2016 July Wind/Thunder storm, 2014 November Cato Snowstorm, 2017 March Windstorm, 2017 October Tropical Storm, 2018 May Windstorm, and 2018 June Thunderstorm.

The data used in this analysis includes all distribution circuits except those that do not have an interrupting device, e.g. fuse or recloser, at their tap location.

Table 7

Circuit SAIDI

Circuit Ranking (1 = worst)	2018		2017		2016		2015		2014	
	Circuit	**SAIDI**	**Circuit**	**SAIDI**	**Circuit**	**SAIDI**	**Circuit**	**SAIDI**	**Circuit**	**SAIDI**
1	C13W3	532.47	C13W2	577.74	C21W1A	892.82	C21W1A	803.71	C15W2	794.83
2	C13W2	327.55	C18W2	560.64	C7W3	272.49	C34X2	399.45	C22W3	729.57
3	C15W2	268.13	C13W1	555.75	C34X2	244.80	C13W3	357.44	C35X1	573.63
4	C22W3	242.19	C13W3	496.50	C37X1	176.22	C375X1	318.05	C24H1	570.48
5	C21W1A	166.73	C396X2	454.70	C18W2	155.42	C14H2	288.10	C24H2	545.14
6	C8X3	164.27	C17X1	410.37	C15W1	147.96	C16X4	281.37	C22W1	534.36
7	C13W1	155.28	C16H3	403.03	C4X1	146.38	C16H1	281.30	C22W2	512.65
8	C7W3	142.85	C8X3	326.03	C13W1	140.76	C7W3	281.18	C15W1	499.87
9	C38	128.51	C33X4	246.98	C22W3	136.51	C16H3	280.82	C7W3	444.56
10	C2H4	87.84	C8H2	246.67	C13W3	117.09	C16X5	280.05	C38W	441.97

Table 8

Circuit SAIFI

Circuit Ranking (1 = worst)	2017		2016		2015		2014		2013	
	Circuit	SAIDI	Circuit	SAIDI	Circuit	SAIDI	Circuit	SAIDI	Circuit	SAIDI
1	C2H4	10.981	C13W2	6.694	C21W1 A	3.993	C21W1 A	6.356	C24H1	7.143
2	C13W3	5.528	C13W1	5.818	C37X1	2.418	C16X4	5.023	C24H2	6.987
3	C13W2	3.541	C13W3	5.267	C18W2	1.995	C16H1	5.020	C15W2	6.597
4	C22W3	2.926	C16H3	4.693	C15W1	1.938	C16X5	5.000	C22W3	5.832
5	C8X5	1.795	C18W2	4.131	C13W1	1.785	C16X6	5.000	C3H1	4.251
6	C13W1	1.638	C8H2	3.122	C1X7P	1.778	C375X1	5.000	C22W1	4.034
7	C15W2	1.562	C8X3	3.108	C4X1	1.738	C16H3	4.998	C38W	4.022
8	C8X3	1.474	C17X1	3.000	C22W3	1.509	C7W3	4.850	C22W2	4.000
9	C7W3	1.376	C396X 2	3.000	C7W3	1.396	C13W3	4.567	C7W3	3.982
10	C21W1 A	1.239	C37X1	2.770	C13W3	1.348	C18W2	4.127	C14X3	3.500

Table 9

Worst Performing Circuit past Five Years

SAIDI			SAIFI		
Circuit Ranking	**Circuit**	**# Appearances**	**Circuit Ranking**	**Circuit**	**# Appearances**
1	C13W3	4	**1**	C21W1A	3
2	C21W1A	3	**2**	C13W1	3
3	C13W2	2	**3**	C13W3	4
4	C15W2	2	**4**	C13W2	2
5	C22W3	3	**5**	C22W3	3
6	C34X2	2	**6**	C18W2	3
7	C7W3	4	**7**	C15W2	2
8	C13W1	3	**8**	C16H3	2
9	C18W2	2	**9**	C24H1	1
10	C15W1	2	**10**	C2H4	1

6.3 System Reliability Improvements (2018 and 2019)

Vegetation management projects completed in 2018 or planned for 2019 that are expected to improve the reliability of the 2018 worst performing circuits are included in table 10 below. Table 11 below details electric system upgrades that are scheduled to be completed in 2019, or were completed in 2018, that were performed to improve system reliability.

Table 10

Vegetation Management Projects on Worst Performing Circuits

Circuit(s)	Year of Completion	Project Description
C13W3	2018	Planned Cycle Pruning
C13W2	2018	Planned Cycle Pruning & Hazard Tree Mitigation
C38	2019	Planned Cycle Pruning
C7W3	2018	Planned Hazard Tree Mitigation / Mid-Cycle Pruning
C4W3	2018 / 2019	Planned Reliability Analysis / Planned Mid-Cycle Pruning
C18W2	2019	Planned Mid-Cycle Pruning
C15W2	2018	Planned Mid-Cycle Pruning & Hazard Tree Mitigation
C13W1	2018 / 2019	Planned Reliability Analysis / Planned Cycle Pruning

Table 11

Electric System Improvements Performed to Improve Reliability

Circuit(s)	Year of Completion	Project Description
18W2	2018	Microprocessor Controlled Recloser Installation
13W3	2018	Sectionalizer Replacement (increased zone of protection)

Circuit(s)	Year of Completion	Project Description
8X3	2018	Fusesaver Installation
18W2	2019	Microprocessor Controlled Recloser Installation
18W2	2019	Fusesaver Installation
13W3	2019	Hydraulic Recloser Replacement (for coordination)
VARIOUS	2019	Porcelain Cutout Replacements
8X3 and 8X5	2019	New Circuit Tie
38	2019	UG Cable Injection
16H3	2019	UG Cable Injection
2H2	2019	Spacer Cable Replacement
1H2 and 1H3	2019	Replace Switchgear and add Tie
VARIOUS	2019	Animal Guard Installation
396X1	2019	Microprocessor Controlled Recloser Installation

7 Tree Related Outages in Past Year (1/1/18 – 12/31/18)

This section summarizes the worst performing circuits by tree related outage during the time period between January 1, 2018 and December 31, 2018.

Table 12 shows the ten worst circuits ranked by the total number of Customer-Minutes of interruption. The number of customer-interruptions and number of outages are also listed in this table.

All streets on the UES CAPITAL system with three or more tree related outages are shown in Table 13 below. The table is sorted by number of interruptions and customer-minutes of interruption.

Table 12

Worst Performing Circuits – Tree Related Outages

Circuit	Customer-Minutes of Interruption	Number of Customers Interrupted	No. of Interruptions
C13W3	714,927	5,624	72
C22W3	327,711	3,945	27
C8X3	321,818	2,399	55
C13W2	269,881	2,177	25
C15W2	63,370	303	5
C18W2	62,570	558	13
C13W1	44,275	392	17
C7W3	42,656	492	10
C7W4	32,542	505	3
C15W1	26,856	391	4

Table 13

Multiple Tree Related Outages by Street

Circuit	Street, Town	# Outages	Customer-Minutes of Interruption	No. of Customer Interruptions
C13W3	Old Turnpike Rd, Salisbury	10	210,337	1,278
C13W3	Daniel Webster Hwy, Boscawen	6	36,500	221
C13W1	Borough Rd, Canterbury	6	20,531	145
C13W3	Battle St, Webster	5	58,423	545
C8X3	New Orchard Rd, Epsom	4	32,119	98
C8X3	Swamp Rd, Epsom	4	19,503	218
C13W3	Mutton Rd, Webster	4	9,865	88
C38	Curtisville Rd, Concord	4	3,011	48
C13W3	High St, Boscawen	3	158,343	1,624
C13W3	White Plains Rd, Webster	3	37,120	324
C13W3	Corn Hill Rd, Boscawen	3	33,806	226
C18W2	Morse Rd, Dunbarton	3	33,728	263
C13W1	Pickard Rd, Canterbury	3	18,139	135
C13W3	Warner Rd, Salisbury	3	15,494	101
C22W3	Page Rd, Bow	3	15,220	118
C13W2	Elm St, Penacook	3	14,904	154
C13W1	Morrill Rd, Canterbury	3	14,497	121
C13W3	Whittemore Rd, Salisbury	3	5,839	67

C13W3	Battle St, Salisbury	3	5,469	84
C15W2	W. Portsmouth St, Concord	3	5,095	45
C13W1	Hackleboro Rd, Canterbury	3	2,986	46
C8X3	Sanborn Hill Rd N., Epsom	3	2,591	21
C13W1	Wilson Rd, Canterbury	3	2,410	22
C22W3	Brown Hill Rd, Bow	3	965	4

During 2018, 13W1, 13W2, and 13W3 was undergoing cycle pruning. These circuits will be re-evaluated in next years' study now that forestry has completed the work in these areas. In the meantime, all of these streets have been given to the forestry team to do hazard tree mitigation. Additionally, a new outage mapping program has been created. This will assist the forestry group to identify problem areas, particularly for hazard tree mitigation. Finally, projects to add reclosing to heavily treed circuits are being proposed for the 2020 budget.

8 Failed Equipment

This section is intended to clearly show all equipment failures throughout the study period from January 1, 2018 through December 31, 2018. Chart 7 shows all equipment failures throughout the study period. Chart 8 shows each equipment failure as a percentage of the total failures within this same study period. The number of equipment failures in each of the top three categories of failed equipment for the past five years are shown below in Chart 9.

Chart 7

Equipment Failure Analysis by Cause

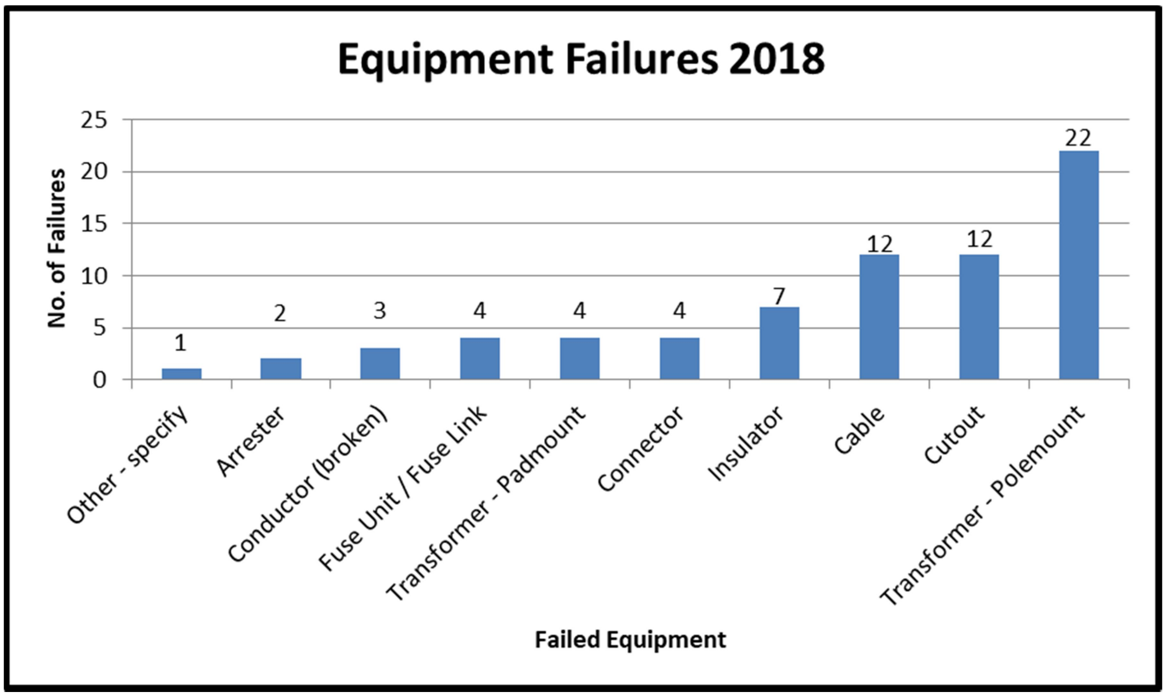


Chart 8

Equipment Failure Analysis by Percentage of Total Failures

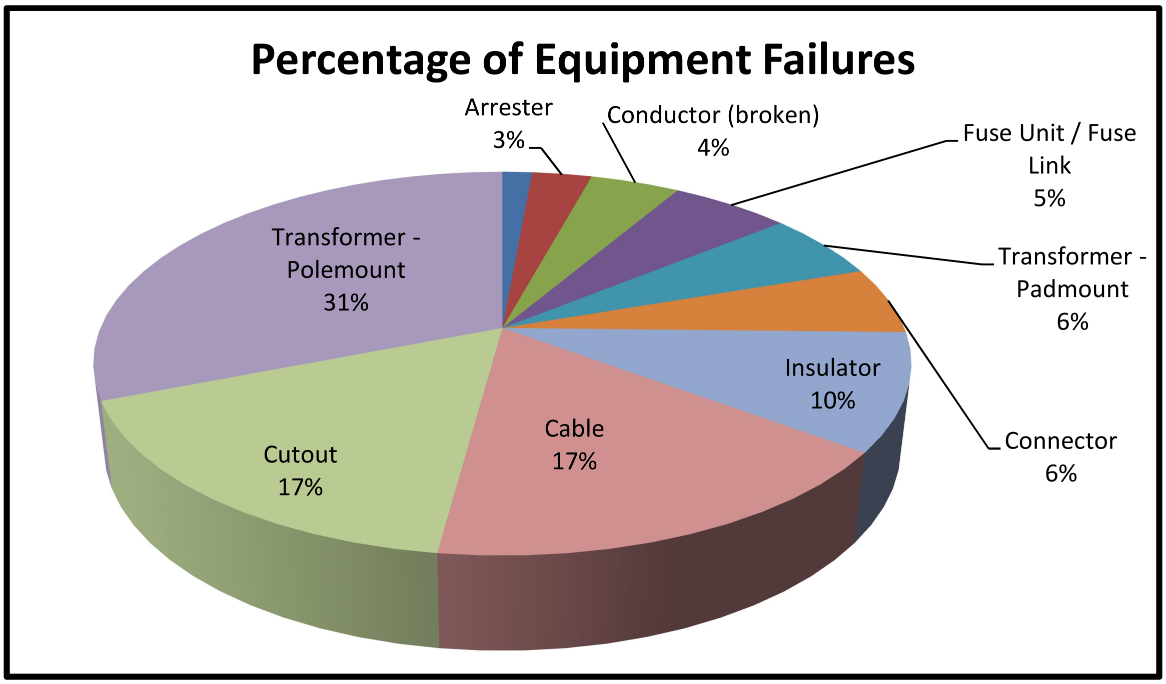
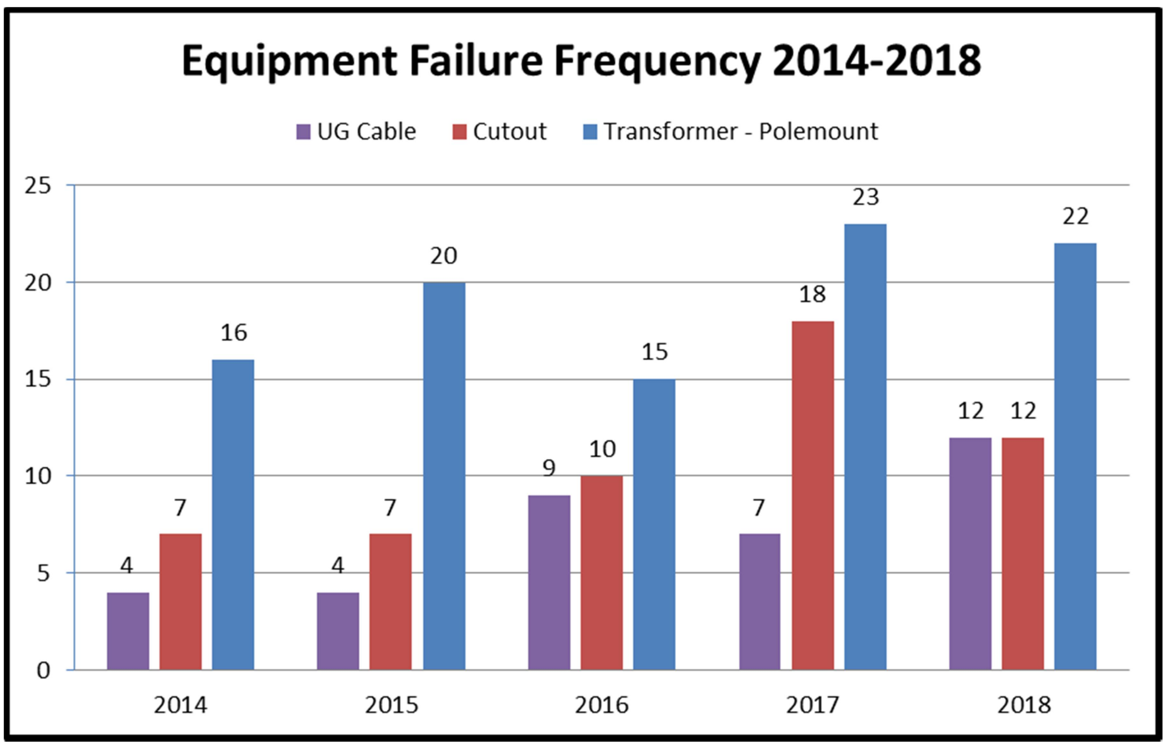


Chart 9

Annual Equipment Failures by Category (top three)

The top three equipment failures continue to be underground cable, cutouts, and polemount transformers. Underground cable failures have generally increased over the last five years. Two life-extending cable injections were executed in 2019. Additional cable injections and direct-buried cable replacement projects are planned for 2020-2021. Cutout failures experienced a slight reprieve in 2018; however they have trended upward over the course of five years. A porcelain cutout replacement program is planned for 2019-2021. Polemount transformer failures continue to be the highest rate of failure with a general, five-year upward trend. There is no planned program to address the transformer failure.



9 Multiple Device Operations and Streets with Highest Number of Outages

A summary of the devices that have operated four or more times from January 1, 2018 to December 31, 2018 are included in table 14 below. Refer to section 11 for project recommendations that address some of the areas identified.

A summary of the streets on the UES Capital system that had customers with 7 or more non-exclusionary outages in 2018 is included in Table 15 below. The table is sorted by circuit and then the maximum number of outages seen by a single customer on that street.

Table 14

Multiple Device Operations

Circuit	Device	Number of Operations	Customer Minutes	Customer Interruptions	# of Times on List in Previous 4 Years
C38	Fuse, Pole 25, Line 38 - East, Concord	5	121,042	716	0
C13W2	Fuse, Pole 50, Borough Rd, Canterbury	5	18,209	98	0
C13W3	Fuse, Pole 145, Old Turnpike Rd, Salisbury	5	10,234	105	0
C15W2	Fuse, Pole 8, W. Portsmouth St, Concord	5	6,564	75	1
C13W3	Recloser, Pole 84, High St, Boscawen	4	133,773	1130	1
C13W3	Fuse, Pole 75, Old Turnpike Rd, Salisbury	4	112,580	812	0
C15W2	Recloser, Pole S/S, Foundry St, Concord	4	71,664	834	0
C13W1	Recloser, Pole 1, Morrill Rd, Canterbury	4	21,599	240	0
C8X3	Fuse, Pole 2, Swamp Rd, Epsom	4	16,858	164	0
C13W2	Fuse, Pole 1, Randall Rd, Canterbury	4	15,579	80	0
C13W3	Fuse, Pole 30, Long St, Webster	4	9,865	88	0
C8X3	Fuse, Pole 1, Sanborn Hill Rd North, Epsom	4	5,347	40	1
C38	Fuse, Pole 7, Curtisville Rd, Concord	4	3,011	48	0

Table 15

Streets with the Highest Number of Outages

Circuit	Street	Max Number of Outages Seen by a Single Customer	Number of Times on List in Previous 4 Years
C13W3	OLD TURNPIKE RD	13	1
C13W3	WHITE PLAINS RD	12	2
C13W1	BOROUGH RD	11	2
C13W3	LITTLE HILL RD	9	2
C13W3	BATTLE ST	8	2
C13W3	MUTTON RD	8	2
C15W2	W PORTSMOUTH ST	8	1
C13W2	ELM ST	7	1
C13W1	TIOGA RD	7	1
C13W1	RANDALL RD	7	1
C13W1	MORRILL RD	7	1
C13W1	OLD TILTON RD	7	1
C8X3	SANBORN HILL RD	7	0
C22W3	BEAVER BROOK DR	7	0
C22W3	TONGA DR	7	1

10 Other Concerns

This section is intended to identify other reliability concerns that would not necessarily be identified from the analysis above.

10.1 13.8kV Underground Electric System Improvements

There are condition concerns in the 13.8kV Concord Downtown Underground. Portions of the cable have been replaced due to faults. There is historical evidence of connector failure as well. Transformers with primary switches are still in the process of being installed in place of the existing transformers. By the end of 2019, 18 of 21 transformers will have switches in them. A 2020 proposed budget project will address three more of these transformers. The same project will also create a loop out of manhole 25, allowing for additional restoration switching. A 2020 proposed budget project will allow switching all times of the year. This is expected to reduce outage duration and allow time for condition-based replacement as opposed to a quick fix to restore customers quickly.

10.2 URD Cable Failure

URD cables are failing at an average rate of 10 failures per year, from 2016 through 2018. There is a trend of increasing cable failures each year from 2015 to 2018. When a direct buried cable fails, Unitil splices in a small section of new cable into the existing cable. Generally, cable failures in conduit result in cable replacement. The remaining aged cable in the area is still susceptible to failure. Options to decrease the number of failures include: direct replacement, rejuvenation, and replacement with conduit (for existing direct buried options). Projects for rejuvenation and replacement with conduit are underway in 2019 and further proposed for the 2020 budget.

11 Recommendations

This following section describes recommendations on circuits, sub-transmission lines and substations to improve overall system reliability. The recommendations listed below will be compared to the other proposed reliability projects on a system-wide basis. A cost benefit analysis will determine the priority ranking of projects for the 2020 capital budget. All project costs are shown without general construction overheads.

11.1. Circuit 13W3: Create a Loop between Water St and High St

11.1.1. Identified Concerns

Circuit 13W3 had three of the worst distribution outages in 2018, including the number one worst outage. It has been on the list of worst performing circuits four out of the last five years, ranked by SAIDI and SAIFI.

11.1.2. Recommendations

Build N. Water St, Boscawen from single phase to three phase spacer cable. Extend the phases through to P.50 Old Turnpike Rd, Salisbury. Install two Reclosers and one three-phase, remote and motor operated switch. Implement an auto transfer scheme.

Estimated Project Cost (without construction overheads): $1,200,000

Estimated Annual Savings:

Customer Minutes: 144,600

Customer Interruptions: 673

11.1.3. Alternate Option

Install a recloser at P.49 Old Turnpike Rd, Salisbury.

Estimate Project Cost (without construction overheads): $50,000

Estimated Annual Savings:

Customer Minutes: 1,746

Customer Interruptions: 21

11.2. Circuit 15W1: Install Recloser on Mountain Rd

11.2.1. Identified Concerns

15W1 has experienced several operations on the fuses at P.5 Mountain Rd. Replacing the fuses with a recloser allows reclosing to eliminate some of the outages; particularly the patrolled, nothing found outages, squirrel and animal-related outages, and some broken limb outages.

11.2.2. Recommendations

Replace cutouts and fuses at P.5 Mountain Rd, Concord with a Recloser.

Estimated Project Cost (without construction overheads): $32,401

Estimated Annual Savings:

Customer Minutes: 27,838

Customer Interruptions: 335

11.3. Circuit 8X3: Replace Hydraulic Recloser with Digital Relay/Recloser

11.3.1. Identified Concern

The hydraulic recloser at P.167 Main St, Chichester does not coordinate well with downline devices. As such, there is low-side fusing for the step down transformers at P.164 and 166. These low-side fuses have operated multiple times in the last three years. The hydraulic recloser does allow for fuse savings downline. Replacing the hydraulic recloser and low-side fuses with a microprocessor-based recloser will allow reclosing for the 451 exposed customers.

11.3.2. Recommendation

Install a Recloser at P.168 Main St, Chichester.

Estimated Project Cost (without construction overheads): $35,967

Estimated Annual Savings:

Customer Minutes of Interruption: 33,655

Customer Interruptions: 405

11.4. Circuit 13W2: Reconductor N. Main St, Boscawen with Spacer

11.4.1. Identified Concern

The master plan is to create a backup for the 37 Line, as it radially feeds the Boscawen S/S. The 13W2 circuit will be converted to 34.5kV and tie with 4X1 from Penacook. This project is expected to provide increased reliability for 13W2 right now, but also establish the back bone for even greater reliability at the sub-transmission and distribution levels.

11.4.2. Recommendation

Reconductor 13W2 mainline from the S/S, down N. Main St, Boscawen, and end at the Village St bridge in Penacook. The reconductoring and reinsulating will be done to system planning capacity and 34.5kV construction. This construction is approximately 2.5 miles of spacer cable construction.

Estimated Project Cost (without construction overheads): $674,174

Estimated Annual Savings:

Customer Minutes of Interruption: 107,510

Customer Interruptions: 1,294

11.5 Circuit 13W1: Reconductor Morrill Rd, Canterbury

11.5.1 Identified Concern

A number of tree related outages on this single phase lateral occurred in 2018. There are limited trimming abilities in the area. Reconductoring with insulated wire will reduce the number of outages.

11.5.2 Recommendation

Reconductor approximately 14,000 ft of #6 Cu with insulated 1/0 ACSR on Morrill Rd, Canterbury.

Estimated Project Cost (without construction overheads): $445,000

Estimated Annual Savings:

Customer Minutes of Interruption: 7,630

Customer Interruptions: 84

11.6 Circuit 8X5: Install a Recloser on Regional Dr.

11.6.1 Identified Concern

A number of motor vehicle accidents and large tree related outages occurred in 2018 that caused the substation recloser to trip to lockout. A mid-line recloser will be another sectionalizing point with reclosing that will help lessen the effect of a mainline fault beyond the recloser.

11.6.2 Recommendation

Install a Recloser at P.5 Regional Dr., Concord.

Estimated Project Cost (without construction overheads): $34,531

Estimated Annual Savings:

Customer Minutes of Interruption: 27,429

Customer Interruptions: 330

11.7 Circuit 6X3: Install a Recloser on Pleasant St

11.7.1 Identified Concern

6X3 exits the Pleasant St S/S and branches to the left and right. In order to limit the scale of the outage, a sectionalizing device in each direction will prevent a full circuit outage. This project is for a recloser in the east direction of Pleasant St. It will replace a set of fuses on P.78.

11.7.2 Recommendation

Install a Recloser at P.78 Pleasant St, Concord.

Estimated Project Cost (without construction overheads): $31,492

Estimated Annual Savings:

Customer Minutes of Interruption: 27,774

Customer Interruptions: 334

11.8 Circuit 13W3: Reconductor Long St, Webster with Spacer Cable

11.8.1 Identified Concern

The sectionalizers on P.138 Long St, Boscawen operated several times in 2018, most as patrolled, nothing found outages. Reconductoring approximately 1.6 miles of three phase mainline will reduce the number of outages normally associated with trees and animals.

11.8.2 Recommendation

Reconductor approximately 1.6 miles of three-phase mainline on Long St, Boscawen and Webster with 13.8kV, 336AAC spacer.

Estimated Project Cost (without construction overheads): $533,936

Estimated Annual Savings:

Customer Minutes of Interruption: 23,315

Customer Interruptions: 281

11.9 Circuit 13W1: Reconductor West Rd, Canterbury and Install Recloser

11.9.1 Identified Concern

13W1 does not have a circuit tie that can back feed the circuit for restoration. This project aims to harden the stand alone system, lessen overall outage impact with an additional reclosing point, and prepare for a potential future tie, according to the master plan.

11.9.2 Recommendation

Reconductor approximately 4 miles of three phase mainline on West Rd, Canterbury with 13.8kV, 336AAC spacer.

Install a Recloser at P.31 North West Rd, Canterbury.

Estimated Project Cost (without construction overheads): $750,000

Estimated Annual Savings:

Customer Minutes of Interruption: 73,583

Customer Interruptions: 886

11.10 Circuit 8X3: Install a Recloser on Dover Rd, Epsom

11.10.1 Identified Concern

8X3 does not currently have a circuit backup to restore load for an outage outside of the substation. Adding sectionalizing points will limit the impact of outages beyond the new recloser.

11.10.2 Recommendations

Install a Recloser at P.5 Dover Rd, Epsom.

Estimated Project Cost (without construction overheads): $50,000

Estimate Annual Savings:

Customer Minutes of Interruption: 50,025

Customer Interruptions: 602

11.11 Fusesaver Installation Locations

11.11.1 Identified Concern

In an effort to continually improve upon reliability, fusesavers have been identified as capable to eliminate most momentary outages by allowing for a single trip clearing time. The following is a list of locations in which fusesavers have been identified as beneficial additions.

11.11.2 Recommendations

1) Install a fusesaver at P.22 N. Main St, Boscawen.

Estimated Project Cost (without construction overheads): Minimal

Estimated Annual Savings:

Customer Minutes of Interruption: 13,095

Customer Interruptions: 195

2) Install a fusesaver at P.1 New Orchard Rd, Epsom.

Estimated Project Cost (without construction overheads): Minimal

Estimated Annual Savings:

Customer Minutes of Interruption: 10,111

Customer Interruptions: 31

3) Install a fusesaver at P.16 Stickney Hill Rd, Hopkinton

Estimated Project Cost (without construction overheads): Minimal

Estimated Annual Savings:

Customer Minutes of Interruption: 7,565

Customer Interruptions: 120

4) Install a fusesaver at P.56 Knox Rd, Bow.

Estimated Project Cost (without construction overheads): Minimal

Estimated Annual Savings:

Customer Minutes of Interruption: 5,720

Customer Interruptions: 30

5) Install three fusesavers at P.4 King Rd, Chichester.

Estimated Project Cost (without construction overheads): Minimal

Estimated Annual Savings:

Customer Minutes of Interruption: 5,565

Customer Interruptions: 67

6) Install three fusesavers at P.1 Rocky Point Dr., Bow.

Estimated Project Cost (without construction overheads): Minimal

Estimated Annual Savings:

Customer Minutes of Interruption: 5,073

Customer Interruptions: 61

7) Install a fusesaver at P.62 Elm St, Boscawen.

Estimated Project Cost (without construction overheads): Minimal

Estimated Annual Savings:

Customer Minutes of Interruption: 4,733

Customer Interruptions: 57

8) Install a fusesaver at P.145 Old Turnpike Rd, Salisbury.

Estimated Project Cost (without construction overheads): Minimal

Estimated Annual Savings:

Customer Minutes of Interruption: 4,271

Customer Interruptions: 35

9) Install a fusesaver at P.50 Borough Rd, Canterbury.

Estimated Project Cost (without construction overheads): Minimal

Estimated Annual Savings:

Customer Minutes of Interruption: 4,200

Customer Interruptions: 20

10) Install a fusesaver at P.8 W. Portsmouth St, Concord.

Estimated Project Cost (without construction overheads): Minimal

Estimated Annual Savings:

Customer Minutes of Interruption: 2,166

Customer Interruptions: 25

11.12 Circuit 37X1: Install a Recloser at the 37X1 Tap

11.12.1 Identified Concern

37X1 is a lateral on the radial 37 line that is unprotected. This recloser will prevent 37 line outages when the fault occurs somewhere on 6,615 feet of unprotected lateral. Outages that occur here would no longer affect the Boscawen S/S and its 2,253 customers.

11.12.2 Recommendation

Install a Recloser on transmission Pole 42 of the 37 line, i.e. the 37X1 tap.

Estimated Project Cost (without construction overheads): $71,000

Estimated Annual Savings:

Customer Minutes of Interruption: 187,095

Customer Interruptions: 2,253

11.13. Miscellaneous Circuit Improvements to Reduce Recurring Outages

11.13.1. Identified Concerns & Recommendations

The following concerns were identified based on a review of Tables 10 & 11 of this report; Multiple Tree Related Outages by Street and Multiple Device Operations respectively.

Mid-Cycle Forestry Reviews

The areas identified below experienced three or more tree related outages in 2018. It is recommended that a forestry review of these areas be performed in 2019 in order to identify and address any mid-cycle growth or hazard tree problems.

- C13W1
    - Borough Rd, Canterbury
    - Pickard Rd, Canterbury
    - Morrill Rd, Canterbury
    - Hackleboro Rd, Canterbury
    - Wilson Rd, Canterbury
- C13W2
    - Elm St, Penacook
- C13W3
    - Battle St, Salisbury
    - Old Turnpike Rd, Salisbury
    - Warner Rd, Salisbury
    - White Plains Rd, Salisbury
    - Whittemore Rd, Salisbury
    - Battle St, Webster
    - Mutton Rd, Webster
    - White Plains Rd, Webster
    - Corn Hill Rd, Boscawen
    - Daniel Webster Hwy, Boscawen
    - High St, Boscawen
- C15W2
    - W. Portsmouth St, Concord
- C18W2
    - Morse Rd, Dunbarton
- C22W3
    - Brown Hill Rd, Bow
    - Page Rd, Bow
- C38
    - Curtisville Rd, Concord
- C8X3
    - New Orchard Rd, Epsom

- Sanborn Hill Rd N., Epsom
- Swamp Rd, Epsom

Animal Guard Installation Recommendations

The areas identified below experienced three or more patrolled nothing found / animal outages in 2018.

- Woodhill Rd, Bow
- Stickney Hill Rd, Hopkinton
- Allen Rd, Bow
- Mountain Rd, Concord
- Morrill Rd, Canterbury

12 Conclusion

During 2018, tree related outages still present one of the largest problems in the UES-Capital System, compared to other causes. Although compared to previous years, the worst performing circuits have seen a dramatic decrease in Customer Minutes of Interruption from tree related outages. Enhanced tree trimming efforts are still being implemented, which is expected to improve reliability for most of the worst performing circuits identified in this study.

Squirrel related outages saw a sharp decrease in outages in 2018, which is expected to continue into 2019. Animal guards were installed during 2018. A further project to target specific areas is in progress in 2019. Animal guards are continually being placed on equipment whenever an animal causes an outage. In addition, when there is an animal-related outage, any equipment in the vicinity will be checked. If nearby equipment does not have animal guards, the animal guards will be installed at that location. Also, all streets and circuits identified as having high numbers of animal related outages will be checked and proper animal protection will be installed where applicable.

Recommendations developed from this study are mainly focused on reducing the impact of multiple permanent outages and improving reliability of the sub transmission system. This report is also intended to assist Unitil Forestry in identifying areas of the system that are being frequently affected by tree related outages to allow proactive measures to be taken. In addition, new ideas and solutions to reliability problems are always being explored in an attempt to provide the most reliable service possible.

Attachment 2

UES - Seacoast

Reliability Study 2019

Unitil Energy Systems – Seacoast

Reliability Study

2019

Prepared By:

Jake Dusling

Unitil Service Corp.

October 25, 2019

Table of Contents

1 Executive Summary

The purpose of this document is to report on the overall reliability performance of the Unitil Energy Systems – Seacoast (UES-Seacoast) system from January 1, 2018 through December 31, 2018. The scope of this report will also evaluate individual circuit reliability performance over the same time period. The outage data used in this report excludes the data in Section 5 (sub-transmission and substation outages), as well as the outage data from IEEE Major Event Days (MEDs). UES-Seacoast MEDs are listed in the table below:

# MEDs in Event	Dates of MEDs	Interruptions	Customer Interruptions	Cust-Min of Interruption
3	3/7/18 – 3/9/18	186	40,438	24,792,654

The following projects are proposed from the results of this study and are focused on improving the worst performing circuits as well as the overall UES-Seacoast system reliability. These recommendations are provided for consideration and will be further developed with the intention to be incorporated into the 2020 budget development process.

Circuit / Line / Substation	Proposed Project	Cost ($)
6W1	Re-conductor portion of South Road with Spacer Cable	$250,000
43X1	Install Reclosers and Implement Distribution Automation	$350,000
3343 and 3354	Install Reclosers	$150,000
58X1	Install Reclosing Devices	$120,000

Note: estimates do not include general construction overheads

The 2018 annual UES-Seacoast system reliability goal was set at 105.61 SAIDI minutes, after removing exclusionary outages. UES-Seacoast's SAIDI performance in 2018 was 108.28 minutes. Charts 1, 2, and 3 below show UES-Seacoast's SAIDI, SAIFI, and CAIDI performance over the past five years.

Chart 1

Annual UES-Seacoast SAIDI

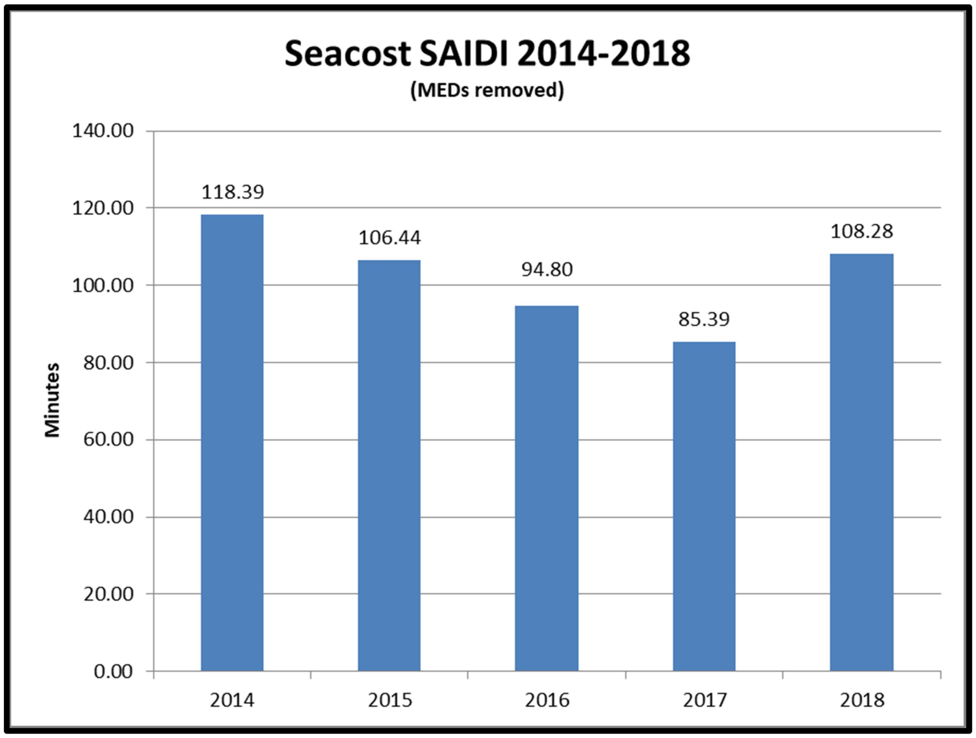


Chart 2

Annual UES-Seacoast SAIFI

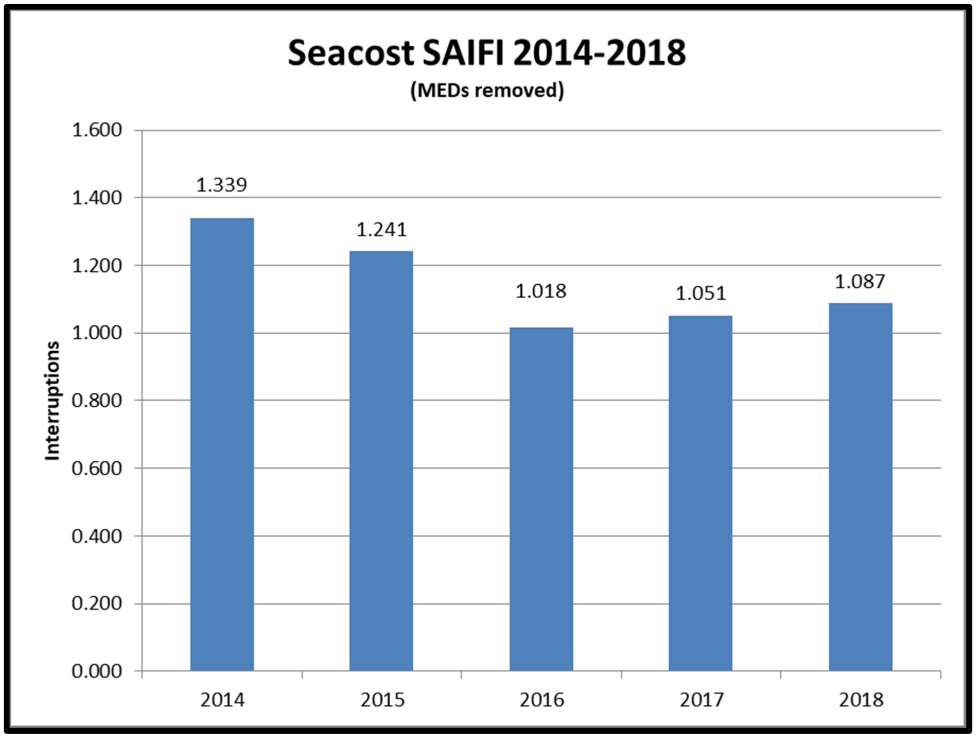
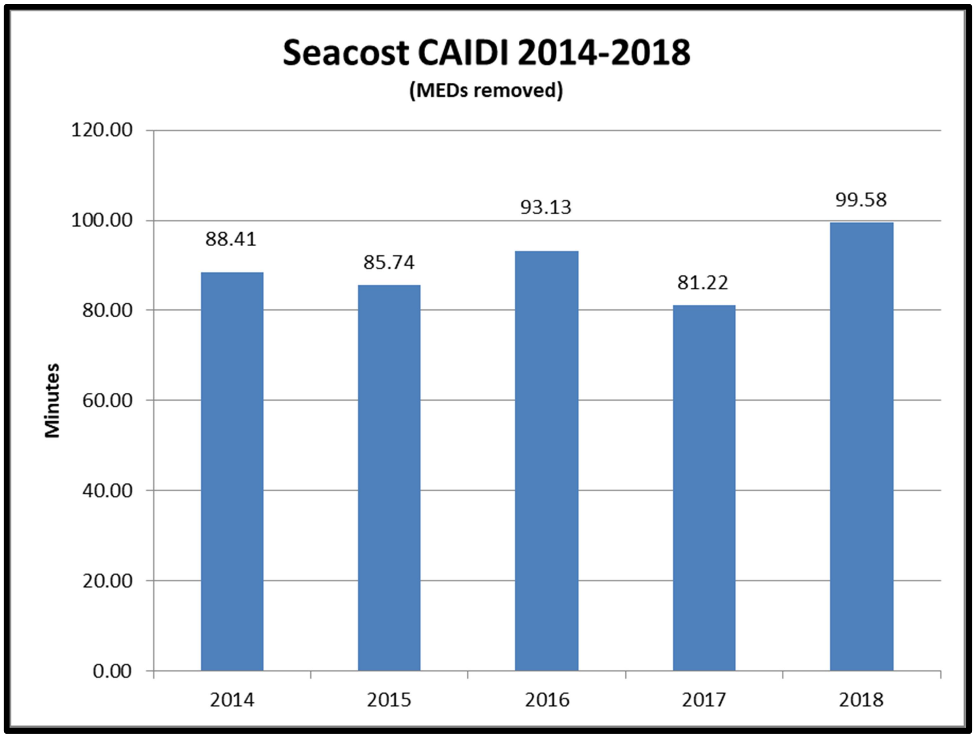


Chart 3
Annual UES-Seacoast CAIDI



2 Reliability Goals

The new annual UES-Seacoast system reliability goal for 2019 has been set at 113.25 SAIDI minutes. This was developed by calculating the contribution of UES-Seacoast to the Unitil system performance using the past five year average. The contribution factor was then set against the 2019 Unitil system goal. The 2019 Unitil system goal was developed through benchmarking the Unitil system performance with nationwide utilities.

Individual circuits will be analyzed based upon circuit SAIDI, SAIFI, and CAIDI. Analysis of individual circuits along with analysis of the entire UES-Seacoast system is used to identify future capital improvement projects and/or operational enhancements which may be required in order to achieve and maintain these goals.

3 Outages by Cause

This section provides a breakdown of all outages by cause code experienced during 2018. Charts 4, 5, and 6 list the number of interruptions, the number of customer interruptions, and total customer-minutes of interruption due to each cause respectively. Only the causes contributing 3% or greater of the total are labeled. Table 1 shows the number of interruptions for the top three trouble causes for the previous five years.

Chart 4

Number of Interruptions by Cause

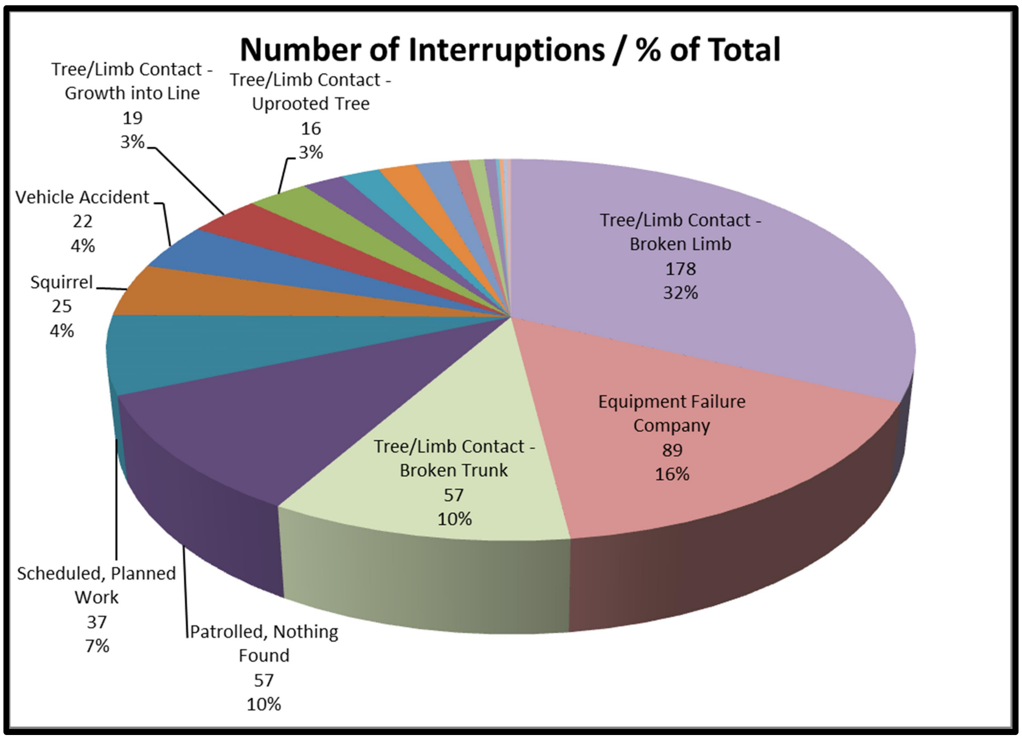


Chart 5

Number of Customer Interruptions by Cause

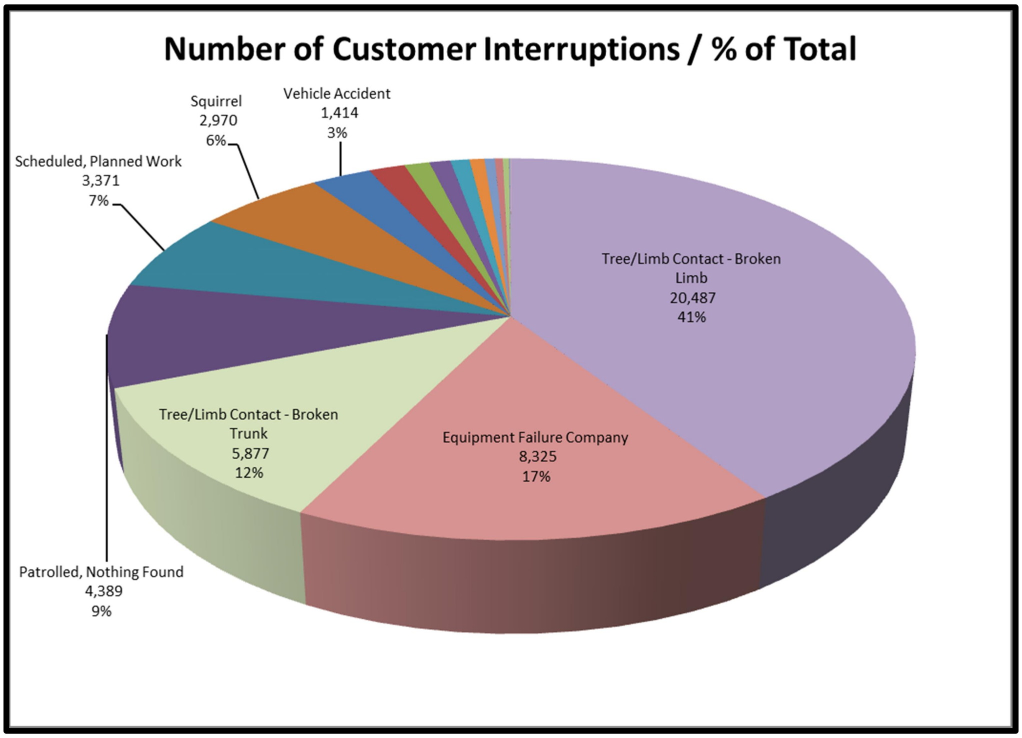


Chart 6

Percent of Customer-Minutes of Interruption by Cause

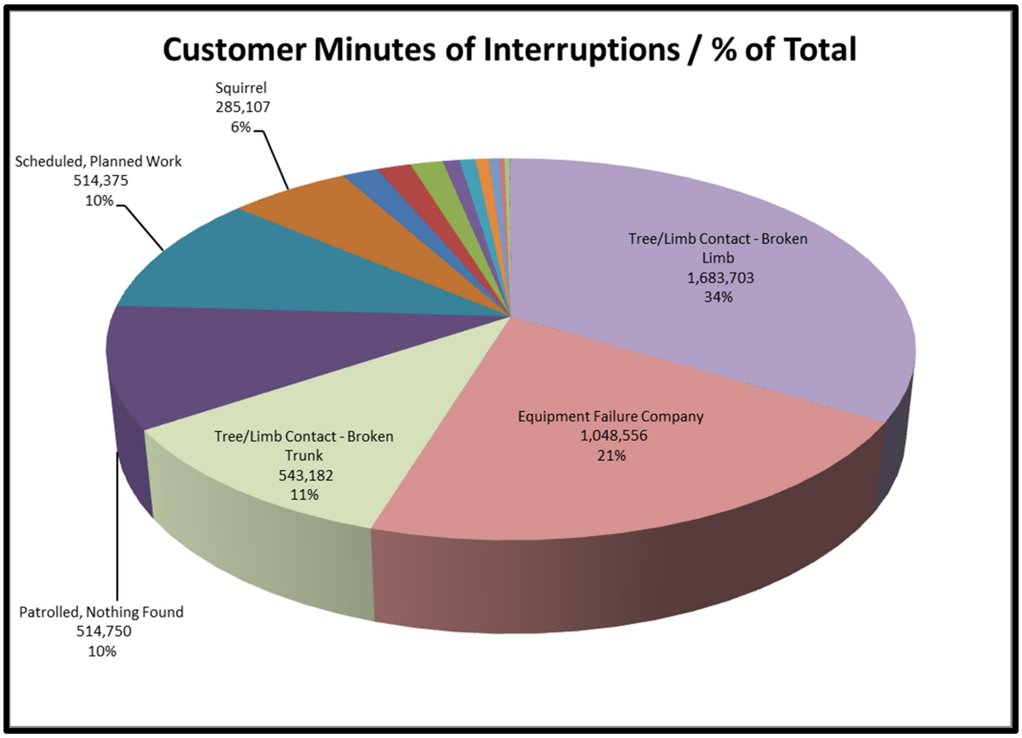


Table 1

Five-Year History of the Number of

Interruptions for the Worst Three Trouble Causes

Year	Tree/Limb Contact - Broken Limb	Equipment Failure Company	Patrolled, Nothing Found
2018	178	89	57
2017	121	78	43
2016	147	79	46
2015	87	88	62
2014	131	70	63

4 10 Worst Distribution Outages

The ten worst distribution outages ranked by customer-minutes of interruption during the time period from January 1, 2018 through December 31, 2018 are summarized in Table 2 below.

Table 2

Worst Ten Distribution Outages

Circuit	Date/Cause	Customer Interruptions	Cust-Min of Interruption	SAIDI	SAIFI
E7W1	5/14/2018 Equipment Failure Company	1,226	231,891	4.90	0.026
E13W2	10/27/2018 Equipment Failure Company	1,629	199,227	4.21	0.034
E22X1	1/4/2018 Tree/Limb Contact - Broken Limb	1,159	196,898	4.16	0.024
E54X1	6/1/2018 Vehicle Accident	1,019	192,079	4.06	0.022
E58X1	3/13/2018 Equipment Failure Company	1,143	186,990	3.95	0.024
E54X2	1/23/20 Tree/Limb Contact - Broken Limb	1,020	186,660	3.94	0.022
E21W1	3/22/2018 Equipment Failure Company	1,366	178,445	3.77	0.029
E59X1	10/27/2018 Tree/Limb Contact - Broken Trunk	262	125,448	2.65	0.006
E58X1	7/31/2018 Tree/Limb Contact - Uprooted Tree	737	109,149	2.31	0.016
E7W1	12/20/2018 Vehicle Accident	1,250	107,965	2.28	0.026

5 Sub-transmission and Substation Outages

This section describes the contribution of sub-transmission line and substation outages on the UES-Seacoast system.

All substation and sub-transmission outages ranked by customer-minutes of interruption during the time period from January 1, 2018 through December 31, 2018 are summarized in Table 3 below.

Table 4 shows the circuits that have been affected by sub-transmission line and substation outages. The table illustrates the contribution of customer minutes of interruption for each circuit affected.

In aggregate, sub-transmission line and substation outages accounted for 11% of the total customer-minutes of interruption for UES-Seacoast.

Table 3

Sub-transmission and Substation Outages

Line / Substation	Date/Cause	Customer Interruptions	Cust-Min of Interruption	SAIDI	SAIFI	Number of Outages in Prior Four Years
3348/3350 Line	9/10/2018 Equipment Failure Company	1,112	120,096	2.54	0.023	0

Table 4
Contribution of Sub-transmission and Substation Outages

Circuit	Substation / Transmission Line Outage	Cust-Min of Interruption	% of Total Circuit CMI	Circuit SAIDI Contribution	Number of Events
7W1	3348/50	53,460	8%	43.68	1
7X2	3348/50	66,636	27%	37.27	1

6 Worst Performing Circuits

This section compares the reliability of the worst performing circuits using various performance measures.

6.1 Worst Performing Circuits in Past Year (1/1/18 – 12/31/18)

A summary of the worst performing circuits during the time period between January 1, 2018 and December 31, 2018 is included in the tables below.

Table 5 shows the ten worst circuits ranked by the total number of Customer-Minutes of interruption. The SAIFI and CAIDI for each circuit are also listed in this table.

Table 6 provides detail on the major causes of the outages on each of these circuits. Customer-Minutes of interruption are given for the six most prevalent causes during 2018.

Circuits having one outage contributing more than 80% of the Customer-Minutes of interruption were excluded from this analysis.

Table 5: Worst Performing Circuits Ranked by Customer-Minutes

Circuit	Customer Interruptions	Worst Event (% of CI)	Cust-Min of Interruption	Worst Event (% of CMI)	SAIDI	SAIFI	CAIDI
E7W1	7,545	17%	584,159	40%	477.25	6.164	77.42
E21W1	3,411	40%	390,105	4%	285.58	2.519	113.37
E58X1	2,597	44%	375,007	50%	167.86	1.162	144.40
E54X2	1,991	51%	322,312	58%	315.37	1.948	161.88
E13W2	2,896	56%	319,857	62%	196.23	1.777	110.45
E54X1	5,003	77%	309,716	62%	304.24	4.915	61.91
E22X1	1,974	59%	284,263	69%	209.94	1.458	144.00
E19X3	2,155	22%	236,890	23%	68.88	0.627	109.93
E21W2	3,118	34%	197,626	34%	130.10	2.053	63.38
E51X1	1,522	26%	169,504	32%	88.51	0.795	111.37

Note: all percentages and indices are calculated on a circuit basis

Table 6

Circuit Interruption Analysis by Cause

Circuit	Customer-Minutes of Interruption / # of Outages					
	Tree/Limb Contact - Broken Limb	Tree/Limb Contact - Broken Trunk	Equipment Failure Company	Squirrel	Patrolled, Nothing Found	Loose/Failed Connection
E7W1	0 / 0	233,688 / 3	0 / 0	185,495 / 4	107,965 / 1	0 / 0
E21W1	100,535 / 7	180,654 / 2	20,651 / 4	3,593 / 2	8,019 / 3	0 / 0
E58X1	32,709 / 9	191,126 / 7	27,806 / 2	7102 / 3	1,300 / 2	110,518 / 3
E54X2	221,962 / 8	1,247 / 2	67,816 / 2	23,431 / 3	0 / 0	2,720 / 1
E13W2	73,169 / 9	20,133 / 5	4,340 / 2	30,374 / 5	5,247 / 1	0 / 0
E54X1	113,046 / 3	1,774 / 3	78 / 1	764 / 1	192,079 / 1	0 / 0
E22X1	223,665 / 11	8,014 / 3	15,035 / 2	9,399 / 2	3,444 / 1	0 / 0
E19X3	13,940 / 7	8,700 / 9	9,443 / 2	61,514 / 3	38,417 / 2	67,817 / 2
E21W2	153,214 / 15	0 / 0	29,825 / 1	4,612 / 4	0 / 0	0 / 0
E7X2	697 / 1	7,216 / 2	7,101 / 2	228 / 1	99,161 / 1	0 / 0
E51X1	99,216 / 16	9,235 / 6	3,073 / 3	17,417 / 3	9,539 / 1	0 / 0

6.2 Worst Performing Circuits of the Past Five Years (2014 – 2018)

The annual performance of the ten worst circuits in terms of SAIDI and SAIFI for each of the past five years is shown in the tables below. Table 7 lists the ten worst performing circuits ranked by SAIDI and Table 7 lists the ten worst performing circuits ranked by SAIFI. Table 8 lists the ten worst overall performing circuits ranked by average SAIDI and SAIFI over the past five years. Table 9 lists the ten worst circuits in terms of SAIFI and SAIDI for the past five years.

The data used in this analysis includes all system outages except those outages that occurred during Snowstorm Cato in 2014 and IEEE MEDs in 2015 through 2018.

Table 7

Circuit SAIDI

Circuit Ranking (1=worst)	2018		2017		2016		2015		2014	
	Circuit	SAIDI	Circuit	SAIDI	Circuit	SAIDI	Circuit	SAIDI	Circuit	SAIDI
1	E7W1	520.93	E54X2	275.94	E3H2	463.53	E6W1	429.2	E6W1	392.13
2	E54X2	338.4	E6W1	269.71	E7W1	375.29	E58X1	371.96	E19X3	358.77
3	E21W1	285.58	E19H1	254.56	E3H3	255.03	E47X1	362.03	E54X1	304.14
4	E54X1	221.9	E22X1	238.1	E54X2	249.35	E6W2	306.7	E20H1	271.23
5	E22X1	209.94	E5H1	200.6	E6W1	241.11	E51X1	201.87	E18X1	258.98
6	E6W1	205.87	E15X1	192.52	E43X1	226.55	E22X1	168.43	E43X1	183.86
7	E13W2	196.23	E51X1	158.75	E21W2	214.57	E56X2	138.86	E51X1	180.9
8	E2H1	192.59	E58X1	134.36	E17W2	210.69	E17W2	136.96	E21W1	170.41
9	E23X1	176.73	E59X1	125.01	E58X1	203.82	E27X1	126.5	E1H3	158.85
10	E58X1	167.86	E22X2	117.33	E54X1	196.61	E3W4	97.95	E1H4	158.03

Table 8

Circuit SAIFI

Circuit Ranking (1=worst)	2018		2017		2016		2015		2014	
	Circuit	SAIFI	Circuit	SAIFI	Circuit	SAIFI	Circuit	SAIFI	Circuit	SAIFI
1	E7W1	6.569	E6W1	4.096	E43X1	2.945	E47X1	3.824	E20H1	4.287
2	E6W1	3.257	E22X1	2.606	E3H2	2.867	E6W1	2.871	E51X1	3.558
3	E54X2	2.949	E15X1	2.536	E21W2	2.641	E51X1	2.511	E6W2	3.288
4	E21W1	2.519	E54X2	2.271	E17W2	2.309	E58X1	2.354	E19X3	3.09
5	E6W2	2.334	E19H1	2.012	E21W1	2.198	E2X3	2.176	E6W1	2.73
6	E54X1	2.115	E23X1	1.527	E58X1	2.107	E22X1	1.922	E11X1	2.451
7	E21W2	2.053	E59X1	1.496	E22X1	1.922	E17W2	1.86	E21W1	2.315
8	E13W2	1.777	E43X1	1.481	E27X1	1.917	E13X3	1.466	E43X1	2.133
9	E43X1	1.465	E18X1	1.414	E54X1	1.892	E13W1	1.444	E22X1	2.12
10	E22X1	1.458	E19X2	1.387	E6W1	1.772	E21W2	1.425	E18X1	1.84

Table 9

Worst Performing Circuits in Past Five Years

SAIDI			SAIFI		
Circuit Ranking (1=worst)	**Circuit**	**# of Times in Worst 10**	**Circuit Ranking (1=worst)**	**Circuit**	**# of Times in Worst 10**
1	E6W1	5	**1**	E6W1	5
2	E7W1	2	**2**	E22X1	5
3	E58X1	4	**3**	E21W1	3
4	E54X2	3	**4**	E7W1	1
5	E22X1	3	**5**	E6W2	2
6	E21W1	2	**6**	E43X1	3
7	E54X1	3	**7**	E51X1	2
8	E6W2	1	**8**	E21W2	3
9	E51X1	3	**9**	E54X2	2
10	E43X1	2	**10**	E47X1	1

6.3 System Reliability Improvements (2018 and 2019)

Vegetation management projects completed in 2018 or planned for 2019 that are expected to improve the reliability of the 2018 worst performing circuits are included in Table 10 below. Table 11 below details electric system upgrades that are scheduled to be completed in 2019 or were completed in 2018 that were performed to improve system reliability.

Table 10: Vegetation Management Projects Worst Performing Circuits

Circuit(s)	Year of Completion	Project Description
E6W1	2018	Hazard Tree Mitigation Storm Resiliency Pruning
E58X1	2018	Cycle Pruning Hazard Tree Mitigation
E22X1	2018	Mid-Cycle Pruning
E21W1	2019	Cycle Pruning Hazard Tree Mitigation
E21W2	2019	Cycle Pruning Hazard Tree Mitigation
E54X1	2019	Hazard Tree Mitigation
E6W2	2018	Storm Resiliency Pruning
E51X1	2019	Hazard Tree Mitigation Mid-Cycle Pruning
E43X1	2019	Hazard Tree Mitigation Mid-Cycle Pruning
E47X1	2019	Cycle Pruning
E13W2	2018	Cycle Pruning Hazard Tree Mitigation
E19X3	2019	Hazard Tree Mitigation Mid-Cycle Pruning

Table 11

Electric System Improvements Performed to Improve Reliability

Circuit(s)	Year of Completion	Project Description
E43X1	2018	Replace Willow Road tap recloser and install distribution recloser on Exeter Road
E43X1	2018	Install Electronically Controlled Recloser – Exeter Road
Guinea Sw/S	2018	Installation of additional animal protection, replacement aging insulators and arresters that have been prone to failure.
Various	2018/2019	Various protection changes identified through the distribution planning process and the review of outage reports.
	2019	Porcelain Cutout Replacements
E5X3/E58X1	2019	Establish Distribution Circuit Tie
3346 Line	2019	Install Reclosers and Implement an Automatic Transfer Scheme
E17W1	2019	Install Hydraulic Reclosers – North Shore Road
E17W2	2019	Install Electronically Controlled Recloser – Little River Road
E3W1, E3W4, E17W1	2019	Conversion of Hampton Beach area included the creation of distribution circuit ties between circuits 3W1/3W4 and 3W1/17W1 and the installation of two electronically controlled reclosers.

7 Tree Related Outages in Past Year

This section summarizes the worst performing circuits by tree related outage during the time period between January 1, 2018 and December 31, 2018.

Table 12 shows the ten worst circuits ranked by the total number of Customer-Minutes of interruption. The number of customer-interruptions and number of outages are also listed in this table.

All streets on the UES-Seacoast system with three or more tree related outages are shown in Table 13 below. The table is sorted by number of interruptions and customer-minutes of interruption.

Table 12

Worst Performing Circuits – Tree Related Outages

Circuit	Customer Minutes of Interruption	Number of Customers Interrupted	No. of Interruptions
E54X2	292,498	1,778	11
E22X1	263,032	1,779	14
E21W2	183,712	2,944	17
E58X1	172,018	1,265	16
E59X1	146,825	506	6
E6W1	139,972	1,805	14
E21W1	122,266	1,760	13
E43X1	119,412	2,530	16
E19X3	115,900	836	14
E54X1	114,399	3,947	5

Table 13

Multiple Tree Related Outages by Street

Circuit(s)	Street, Town	# Outages	Customer-Minutes of Interruption	Number of Customer Interruptions
E21W2	Maple Ave, Atkinson	4	772	5
E22X1	Sandown Rd, Danville	4	5,420	79
E51X1	Squamscott Rd, Stratham	4	14,058	195
E6W1	Haverhill Rd, East Kingston	4	18,794	245
E13W1	North Main St, Plaistow	3	1,260	10
E13W1	Old County Rd, Plaistow	3	10,043	138
E13W2	Main St, Newton	3	5,506	76
E13W2	Thornell Rd, Newton	3	67,902	492
E21W1	Meditation Ln, Atkinson	3	48,341	256
E27X2	North Rd, East Kingston	3	12,717	155
E51X1	High St, Stratham	3	4,111	66
E51X1	Jack Rabbit Lane, Stratham	3	2,978	30
E54X2	Ball Rd, Kingston	3	211,072	1407
E6W1	South Rd, East Kingston	3	91,209	1100
E6W2	Main St, Kingston	3	52,207	1001

8 Failed Equipment

This section is intended to clearly show all equipment failures throughout the study period from January 1, 2018 through December 31, 2018. Chart 7 shows all equipment failures throughout the study period. Chart 8 shows each equipment failure as a percentage of the total failures within this same study period. The number of equipment failures in each of the top three categories of failed equipment for the past five years are shown below in Chart 9.

Chart 7

Equipment Failure Analysis by Cause

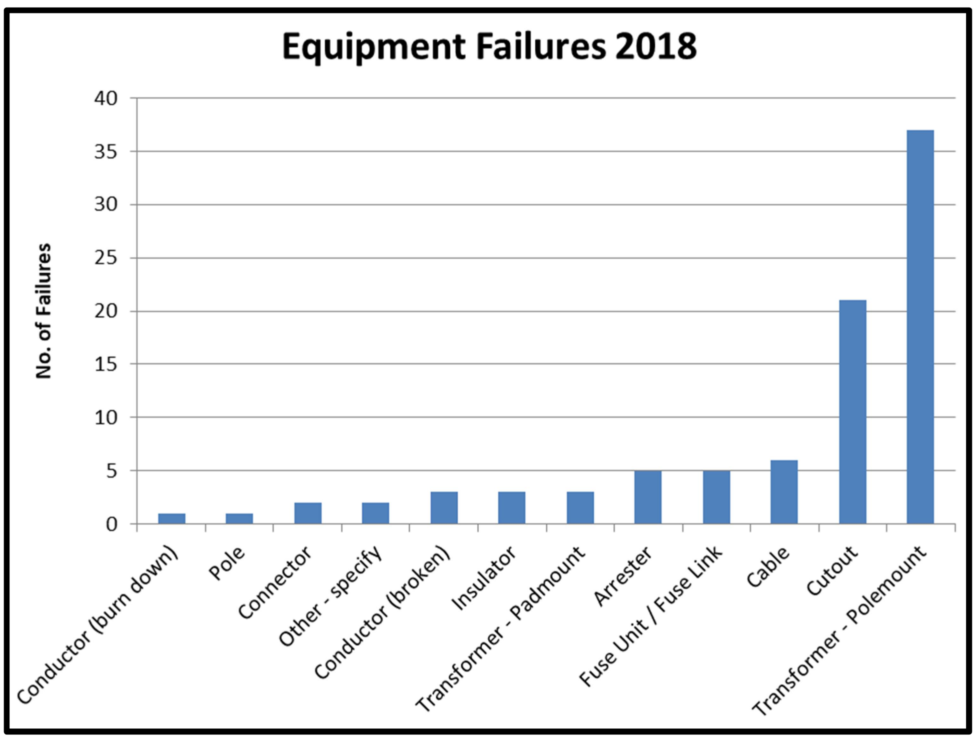


Chart 8

Equipment Failure Analysis by Percentage of Total Failures

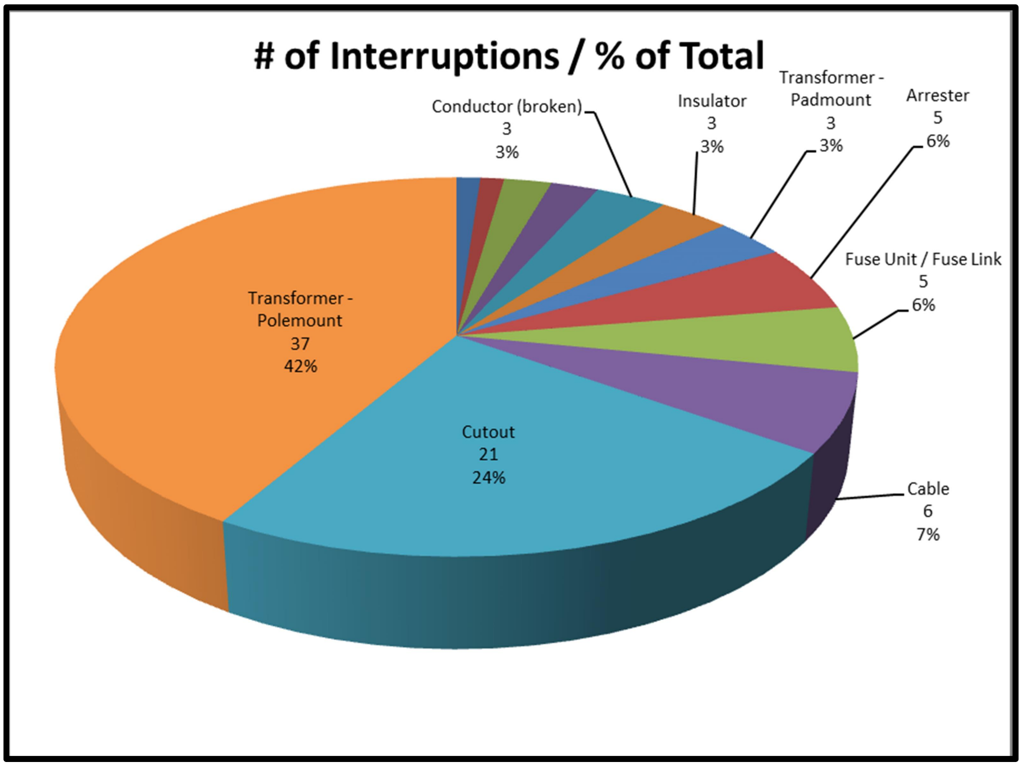
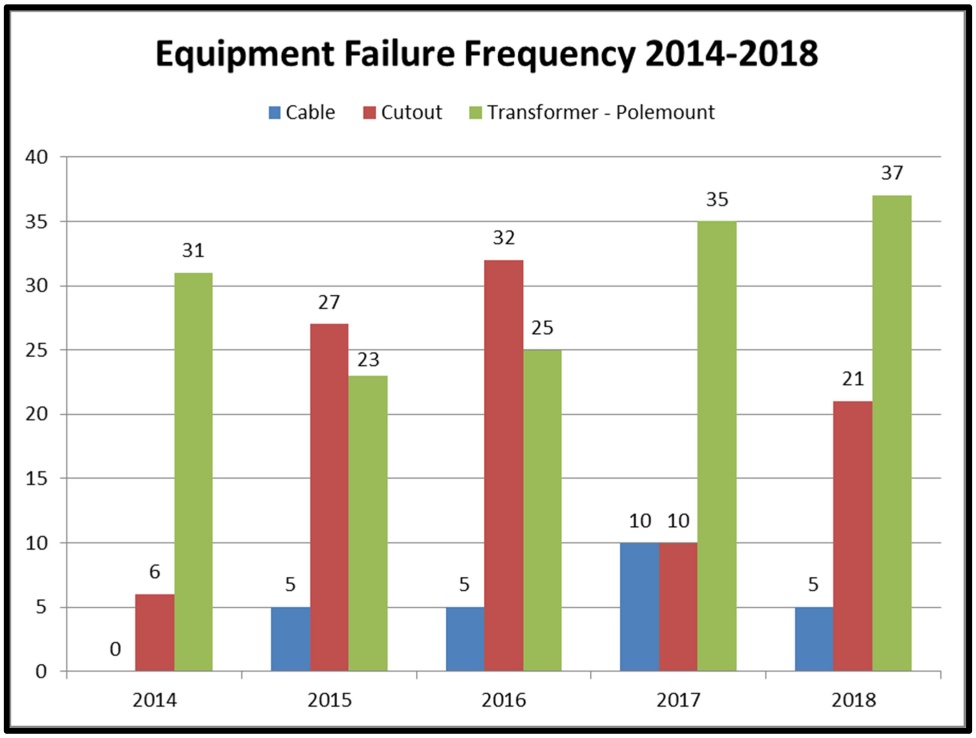


Chart 9

Annual Equipment Failures by Category (top three)



9 Multiple Device Operations and Streets with Highest Number of Outages

A summary of the devices that have operated three or more times from January 1, 2018 to December 31, 2018 is included in Table 14 below. Refer to section 11.6 for recommendations to address some of the areas identified that have experienced recurring outages in 2018.

A summary of the streets on the UES-Seacoast system that had customers with 7 or more non-exclusionary outages in 2018 is included in Table 15 below. The table is sorted by circuit and then the maximum number of outages seen by a single customer on that street.

Table 14

Multiple Device Operations

Circuit	Number of Operations	Device	Customer Minutes	Customer Interruptions	# of Times on List in Previous 4 Years
E7W1	6[6]	7W1 Recloser, Seabrook S/S	566,353	7,354	0
E13W2	4	Fuse, Pole 29/33 Thornell Rd, Newton	78,984	596	0
E51X1	4	Fuse, Pole 47/1, Jack Rabbit Lane, Stratham	3,483	40	0

Table 15

Streets with the Highest Number of Outages

Circuit	Street	Max Number of Outages Seen by a Single Customer	Number of Times on List in Previous 4 Years
7W1	Various, Seabrook	9	0
21W1	Sawyer Ave, Atkinson	8	0
13W2	Wentworth Drive, Newton	7	0

[6] Four of these outages were a result of patrolled nothing found and occurred within a period in which the 7W1 reclosing functionality was not functioning and has since been repaired.

10 Other Concerns

This section is intended to identify other reliability concerns that would not necessarily be identified from the analysis above.

10.1 Subtransmission Lines across Salt Marsh

The 3348 and 3350 lines are constructed through salt marsh, making them very difficult to access and repair. There are significant condition related concerns associated with their aging infrastructure

Over the last five years these lines have experienced damage on multiple occasions resulting in outage to circuits 7W1 and 7X2. In addition, damage to these lines results in the lines being out of service months at time while repairs are permitted, scheduled and executed.

In 2019 a detailed assessment of the present condition of these lines was completed. Following the completion of the assessment options for repairs, replacement, or relocation of these lines will be evaluated to mitigate the identified concerns.

11 Recommendations

This following section describes recommendations on circuits, sub-transmission lines and substations to improve overall system reliability. The recommendations listed below will be compared to the other proposed reliability projects on a system-wide basis. A cost benefit analysis will determine the priority ranking of projects for the 2019 capital budget. All project costs are shown without general construction overheads.

11.1 Miscellaneous Circuit Improvements to Reduce Recurring Outages

11.1.1 Forestry Review

Table 13 of this report; Multiple Tree Related Outages by Street indicates that there were fifteen streets that experienced three or more tree related outages in 2018.

It is recommended that a forestry review of the areas identified in Table 13 be performed in 2019 in order to identify and address any growth or hazard tree problems.

11.2 Circuit 6W1 – Re-conductor Portion of South Road with Spacer Cable

11.2.1 Identified Concerns

6W1 has been on the worst performing SAIDI and SAIFI list for the last five consecutive years. The owner of a section of property along South has repeatedly refused to allow effective pruning and hazard tree mitigation. This section of South Road has experienced five interruptions due to tree contacts, totaling 1,557 customer interruptions and 696,479 customer minutes of interruption since January 1st, 2017.

11.2.2 Recommendation

Re-conductor South Road from pole 28 to pole 49 with spacer cable.

Customer Exposure = 367 customers

The projected average annual savings for this project is 230,000 customer minutes of interruptions and 500 customer interruptions.

Estimated Project Cost: $250,000

Forestry and operations are currently reviewing this project to determine if the appropriate pruning can be performed to increase pole height to accommodate spacer cable construction.

11.3 Circuit 43X1 – Install Reclosers and Implement Distribution Automation

11.3.1 Identified Concerns

Circuit 43X1 is typically one of the worst performing circuits on the UES-Seacoast system. It is on both the Worst Performing Circuits in the Past Five Years SAIDI and SAIFI lists.

11.3.2 Recommendation

This project will consist of installing four electronically controlled reclosers along circuit 43X1 and 19X3.

Two of the reclosers will be installed along the mainline of circuit 43X1 between 43X1R1 and 19X3J43X1 tie. The 43X1J19X3 tie switch will be replaced with a recloser.

In order to increase the load carrying capability of the 19X3J43X1 tie the cutout mounted sectionalizers along Pine Street will be replaced with a recloser and the solid blades on Court Street will be replaced with a switch. Additionally, circuits 43X1 and 19X3 will be balanced to reduce loading on phase B.

Once installed a distribution automation scheme will be implemented between the new reclosers and the existing 43X1R1 recloser. The intent of the scheme is to have 43X1 and 19X3 automatically reconfigure for permanent faults on the mainline of circuit 43X1.

- Fault between 43X1 and 43X1R1 – 43X1 and 43X1R1 lockout and 19X3J43X1 closes.
- Fault between 43X1R1 and 43X1R2 – 43X1R1 and 43X1R2 lockout and 19X3J43X1 closes.
- Fault between 43X1R2 and 43X1R3 – 43X1R2 and 43X1R3 lockout and 19X3J43X1 closes.
- Fault between 43X1R3 and 19X3J43X1 – 43X1R3 lockout and 19X3J43X1 remains open.

Customer Exposure = 1,200 customers

The projected average annual savings for this project is 125,000 customer minutes of interruptions and 1,650 customer interruptions.

Estimated Project Cost: $350,000 (4 reclosers @ $75,000 per location plus switch replacement)

11.4 3343 and 3354 Lines – Install Reclosers

11.4.1 Identified Concerns

The 3343 and 3354 lines have historically experienced one interruption per year and are routinely damaged during major storms.

11.4.2 Recommendation

This project will consist of installing electronically controlled reclosers, one on the 3354 line and one on the 3343 line between East Kingston substation and Willow Road tap.

These reclosers will be programmed to coordinate with Kingston and operate for downline faults. Additionally, these reclosers will be remotely opened in the event of a lockout of the 03343 or 03354 at Kingston allowing load on the Guinea side of the reclosers to be restored remotely without patrolling.

In order to obtain the desired benefit East Kingston substation will be transferred to the 3343 line and Willow Road Tap will be transferred to the 3354 line.

Customer Exposure = 7,150 customers

The projected average annual savings for this project is 290,000 customer minutes of interruptions and 1,250 customer interruptions.

Estimated Project Cost: $150,000 (2 reclosers @ $75,000 per location plus)

11.5 58X1 – Install Reclosing Devices Wentworth Ave

11.5.1 Identified Concerns

The Wentworth Avenue Plaistow and Atkinson area has experienced eleven patrolled nothing found outages since January 1, 2017. Additionally, circuit 58X1 is typically one of the worst performing circuits on the UES-Seacoast system. It is currently on the Worst Performing Circuits in the Past Five Years SAIDI list.

11.5.2 Recommendation

This project will consist of installing an electronically controlled recloser between pole 6 and 7 on Wentworth Ave.

In addition to the recloser installation the 200QA's at pole 20 Atkinson Depot Road will be replaced with solid blades. The 125QAs at poles 28 and 29 and the 75QAs at pole 75/1 Sawyer Avenue will be replaced with S&C TripSavers.

Customer Exposure = 315 customers

The projected average annual savings for this project is 17,800 customer minutes of interruptions and 140 customer interruptions.

Estimated Project Cost: $120,000

12 Conclusion

The annual electric service reliability of the UES-Seacoast system over the last few years has been some of the best years on record after discounting MEDs. The improvement in reliability can be largely attributed to an aggressive vegetation management program. Still, the most significant risk to reliability of the electric system continues to be vegetation.

The recommendations in this report focus on addressing equipment concerns as well as increasing the flexibility of the system to facilitate quicker restoration of customers that can be isolated from a faulted section of the system. This includes upgrading equipment and adding additional circuit sectionalizing points and protection where it will be most effective. This report is also intended to assist Unitil Forestry in identifying areas of the system that are being frequently affected by tree related outages to allow proactive measure to be taken.

Attachment 3

Reliability Project Listing

2019 Budget Versus Actual Expenditures

Reliability Project Listing
2019 Budget Versus Actual Expenditures

DOC	Bud #	Description	Auth #	Budgeted	Authorized	Actual 2019 Exp.	Comment
UES Capital	DPBC01	Distribution Pole Replacement	190112	$566,446	$874,500	$936,170	Complete
UES Seacoast	DPBE01	Distribution Pole Replacement	191010	$986,235	$986,235	$1,129,997	Complete
UES Capital		Reliability Enhancement Projects		$229,462	$274,008	$191,199	
	DRBC13	396X1 Tap - Install Recloser	190119		$94,208	$56,700	Active into 2020
	DRBC04	Install Recloser & Fuse Saver - Bow Bog Rd., Bow	190140		$139,800	$109,474	Complete
	DRBC07	Install Animal Protection on Distribution Transformers	190136		$40,000	$25,025	Complete
UES Seacoast		Reliability Enhancement Projects		$799,818	$596,291	$277,497	
	DRBE14	Circuit 19X2 - Distribution Automation Scheme with Portsmouth Ave.	191040		$205,291	$56,164	Active into 2020
	DRBE07	Install Hydraulic Reclosers, North Shore Rd., Hampton	191032		$40,000	$29,182	Complete
	DRBE08	Install Electronic Recloser, Little River Road, Hampton	191033		$101,000	$100,761	Complete
	DRBE09	Circuit 13W2, Install Reclosers, Various Locations, Newton	191058		$250,000	$91,390	Active into 2020
Total				$2,581,961	$2,731,034	$2,534,863	