APPENDIX I

UNITIL PROJECT EVALUATION PROCESS

Unitil	Engineering Procedure	Procedure No.	PR-DT-DS-11
	Distribution Engineering	Page No.	Cover
		Revision No.	0
	Project Evaluation Procedure	Revision Date	7/9/18
		Supersedes Date:	

FOREWORD

The purpose of this document is to define the process for evaluating electric construction projects that propose upgrades to substations, the distribution system or the subtransmission system.

Any questions or inquiries regarding information provided in this document should be referred to the Director of Engineering.

7/30/2018

Kevin E. Sprague
Director, Engineering

Date

July 30, 2018

John J. Bonazoli
Manager, Distribution Engineering

Date

REVISION HISTORY

Date of Review:

Revision #	Date	Description of Changes
0	07/09/2018	Initial Issue

Table of Contents

List of Appendices

1.0 Introduction

Project evaluation is an integral component of maintaining a cost effective system that ensures safe and reliable electric service to Unitil customers. It is imperative that Unitil has a consistent process and documentation criteria for project evaluation.

1.1 Purpose

The purpose of this document is to provide a consistent approach and procedure for project evaluation. This document establishes thresholds in which Unitil reviews non-wires alternative projects and performs detailed cost/benefit analyses that include reliability, environmental and economic impacts.

1.2 Applicability & Scope

The procedure defined in this document shall be applied whenever the need for a project is identified on the distribution or subtransmission systems and/or within a substation. This procedure also applies to projects identified as part of Unitil's Joint Planning Process with Eversource, NH.

This procedure does not apply to projects being justified based on condition replacement or reliability benefit only. It also does not apply to customer requested projects such as DG interconnections, line relocations to accommodate customer requests, the installation of new developments, etc. However, this procedure does apply to loading and/or voltage driven projects that are required due customer requested projects.

1.3 Updating the Guideline

The Director, Engineering is responsible for maintaining this guideline to ensure the guideline is current with changes in the company's organization, policies or to capture good utility practices. All revisions and/or additions shall detail a revision date and number on the top right corner of each page within the header, as well as a brief description in the *Revision History* section on the cover.

Comments are welcomed and should be documented (using the *Request for Procedure/Change Form* reference in Appendix C) and addressed to the Director, Engineering. All documented comments shall be retained in a separate file and reviewed each time this procedure is revised. These comments will keep the contents of the procedure current and enhance its usefulness.

1.4 Availability

Current copies of this procedure can be found on the Hampton Shared Drive. Hard copies are not version controlled.

NOTE: Only up-to-date versions of the documents are posted on the Hampton Shared Drive. All other revisions (both electronic and hardcopy) should not be referenced.

2.0 General Information

2.1 Cost Estimates

All dollar amounts and cost estimates referenced in this procedure are without general construction overhead costs unless otherwise noted.

2.2 Definitions

Constraint	A project driven by a violation of planning criteria such as low voltage, overloaded equipment, equipment replacement, etc.
Option	A project identified to address a system constraint.
Traditional Option	Conventional electric system upgrades such as reconductoring, voltage conversion, equipment upgrades, etc.
Non-wires / DER Alternatives	Non-conventional load reduction projects such as Distributed Generation (DG), Distributed Energy Resources (DER), energy storage, energy efficiency, Volt/VAR optimization (VVO), etc.

3.0 Project Evaluation Workflow

When a constraint is identified that will require upgrades to the distribution or subtransmission systems and/or within a substation the Project Evaluation Workflow Diagram in Appendix A shall be followed to determine the need to identify and review alternatives and the necessary detail of project evaluation that will be required.

The following sections will provide additional details regarding the Project Evaluation Workflow Diagram and examples of its use.

3.1 Project Evaluation Workflow Diagram – Details

3.1.1 BOX A – Project Need Identified

- Anytime a constraint is identified that involves upgrades to a substation, the distribution or subtransmission systems this project evaluation workflow tool shall be referenced.

3.1.2 BOX B – Traditional Option Estimate Greater than $100,000

- An initial traditional option shall be developed and estimated.
- If the estimate for the traditional option is less than $100,000 the option should be recommended for construction.
- If the initial traditional option is estimated to cost more than $100,000 proceed to BOX C.

$100,000 was chosen as a threshold to allow for small scale upgrades to be implemented with no additional evaluation required. Small scale upgrades include projects such as: regulator installations, step-down transformer upgrades, load transfers, etc.

3.1.3 BOX C – Multiple Traditional Options Required

- If the initial traditional option is estimated to cost more than $100,000 at least two traditional options shall be evaluated.
- A review of the cost, reliability impact and system master plan compliance is performed to determine a recommended traditional option. Preference should be given to the least cost option that meets the required criteria (i.e. loading, capacity, voltage, reliability, etc.)
- Proceed to BOX D once a recommended traditional option is selected.

3.1.4 BOX D – Recommended Traditional Option Greater than $250,000

- If the recommended traditional option estimate is less than $250,000 proceed to BOX H.
- If the recommended traditional option estimate is more than $250,000 proceed to BOX E.

Based on the estimated cost per MW (as of 4/10/18) to implement non-wires alternatives it was determined that non-wires alternatives would not be evaluated if the recommended traditional option has an estimated cost of less than $250,000. This amount may be reviewed in the future as advancements are made in technology that reduces the installed costs of non-wires alternatives.

3.1.5 BOX E – Required Construction Start Date

- The required construction start date of the recommended traditional option must be between three and five years into the future to proceed to BOX F. If it is less than three years or more than five years into the future proceed to BOX H.

It is assumed that it will take a minimum of three years to receive and evaluate proposals, implement the project and confirm the results of non-wires alternative projects.

3.1.6 BOX F – Loading and/or Voltage Criteria Violation(s)

- If the recommended traditional option addresses only loading and/or voltage violations proceed to BOX G.
    - An example of this type of option is a voltage conversion project that is being recommended to address a conductor loading constraint.
- If the recommended traditional option is not needed to address loading and/or voltage violations proceed to BOX I.
    - An example of this type of option is a breaker replacement project that is being recommended to address an aging piece of equipment.

- If the recommended traditional option has components that address loading and/or voltage concerns and non-loading and/or voltage constraints (i.e. condition based replacement) a more detailed cost breakdown will be necessary.
    - The overall estimate for the option must be broken down into an estimate to address the loading and/or voltage violation and an estimate for the non-loading/voltage component.
    - If the estimate to address the loading and/or voltage violation is more than $250,000 proceed to BOX G, otherwise proceed to BOX I.
    - An example of this type of option is a breaker being removed from service due to condition and a portion of a circuit needs to be reconductor to accommodate transferring load to remove the breaker from service. In this case the reconductoring portion of the option would need to be more than $250,000 to proceed to BOX G.

This step in the workflow is required to determine if non-wires alternatives will be considered. Typically, non-wires alternatives are only viable options to address loading and/or voltage constraints. Non-wires alternatives should not be considered for condition based replacement projects that do not have components to address loading and/or voltage concerns.

3.1.7 BOX G – Develop and Issue RFP for Non-Wires Alternative Project

- Develop and issue a request for proposal from non-wires alternative vendors. Once proposals are received proceed to BOX I.

3.1.8 BOX H – Planning Process Engineering Judgment Determines the Need to Review Non-Wires Alternatives

- If the constraint was not identified through the distribution system or system planning efforts (i.e. the project is required due to a condition replacement) proceed to BOX J.
- If the constraint was identified through the distribution or system planning efforts, the constraint and recommended traditional option shall be reviewed and engineering judgment shall be used to determine if a review of non-wires alternatives is required.
- Proceed to BOX J if non-wires alternative review is not required
- Proceed to BOX G if non-wires alternative review is required

3.1.9 BOX I – Complete Detailed Cost Benefit Analysis of Options

- Complete the Detailed Cost/Benefit Analysis spreadsheet in Appendix B.
    - See section 4.0 below for additional details about the spreadsheet.
- The results of the spreadsheet along with engineering and operational judgment shall be used to determine the recommended option.
- Proceed to Box J.

3.1.10 BOX J – Recommend Project

- For constraints identified as part of the distribution and/or system planning process the option shall be recommended for construction in the associated planning study.
- For projects identified outside of the planning process the option shall be submitted for acceptance to the necessary approvers.
- Preference should be given to the least cost option that meets the required criteria (i.e. loading, capacity, voltage, reliability, etc.)

3.2 Project Evaluation Workflow Diagram – Examples

3.2.1 Example 1 – Recommended Traditional Option Estimate less than $100,000

Circuit analysis identifies an overloaded step-down transformer. It is recommended that the step-down transformer should be replaced.

- Estimate Cost: Less than $100,000

Workflow Diagram Walkthrough

- BOX B – Estimated cost is less than $100,000
  - Proceed to BOX J
- BOX J – Recommend Option

3.2.2 Example 2A – Recommended Traditional Option between $100,000 and $250,000

Circuit analysis identifies low voltage at the end of a single-phase lateral. The initial traditional option is to reconductor the line with larger conductor.

- Estimated Cost: $100,000 – $250,000
- Engineering Judgment Determines that non-wires alternatives do not need to be reviewed

Workflow Diagram Walkthrough

- BOX B – Estimate more than $100,000
  - Proceed to BOX C
- BOX C – Develop additional traditional options and perform cost/benefit review to determine a recommended traditional option.
  - The second traditional option is to convert the lateral to a higher operating voltage and is estimated to cost more than $250,000.
  - Cost/benefit review results in the reconductoring option that is estimated to cost between $100,000 and $250,000 is the recommended traditional option.
  - Proceed to BOX D
- BOX D –Estimated cost is less than $250,000
  - Proceed to BOX H
- BOX H – Engineering judgment determines that a review of non-wires alternatives is not needed

  - Proceed to BOX J
- BOX J – Recommend Option

3.2.3 Example 2B – Recommended Traditional Option between $100,000 and $250,000

Circuit analysis identifies low voltage at the end of a single-phase lateral. The initial traditional option is to reconductor the line with larger conductor.

- Estimated Cost: $100,000 – $250,000
- Engineering judgment determines that non-wires alternatives do need to be reviewed

Workflow Diagram Walkthrough

- BOX B – Estimate more than $100,000
  - Proceed to BOX C
- BOX C – Develop additional traditional options and perform cost/benefit review to determine a recommended traditional option.
  - The second traditional option is to convert the lateral to a higher operating voltage and is estimated to cost more than $250,000.
  - Cost/benefit review results in the reconductoring project that is estimated to cost between $100,000 and $250,000 is the recommended traditional option.
  - Proceed to BOX D
- BOX D –Estimated cost is less than $250,000
  - Proceed to BOX H
- BOX H – Engineering judgment determines that a review of non-wires alternatives is needed
  - Proceed to BOX G
- BOX G – Develop and issue RFP for non-wires alternative projects
  - Receive and review proposals
  - Proceed to BOX I
- BOX I – Complete Detailed Cost/Benefit Analysis spreadsheet in Appendix B
  - Detail/Cost benefit analysis results in a recommended project.
  - Proceed to BOX J
- BOX J – Recommend Option

3.2.4 Example 3A – Recommended Traditional Option Greater than $250,000

Circuit analysis identifies low voltage and overloaded conductor. The initial traditional option is to convert this portion of the system to a higher operating voltage.

- Estimated Cost: More than $250,000
- Required Start Date: Two years in the future
- Engineering judgment determines that non-wires alternatives do not need to be reviewed

Workflow Diagram Walkthrough

- BOX B – Estimate more than $100,000
  - Proceed to BOX C
- BOX C – Develop additional traditional options and perform cost/benefit review to determine a recommended traditional option.
  - The second traditional option is to reconductor the area and install voltage regulators. Estimated Cost $175,000.
  - Cost/benefit review results in the conversion project that is estimated to cost more than $250,000 is the recommended traditional option.
  - Proceed to BOX D
- BOX D –Estimated cost is more than $250,000
  - Proceed to BOX E
- BOX E – Required start date is less than 3 years in the future
  - Proceed to BOX H
- BOX H – Engineering judgment determines that a review of non-wires alternatives is not needed
  - Proceed to BOX J
- BOX J – Recommend Option

3.2.5 Example 3B – Recommended Traditional Option Greater than $250,000

Circuit analysis identifies low voltage and overloaded conductor. The initial traditional option is to convert this portion of the system to a higher operating voltage.

- Estimated Cost: More than $250,000
- Required Start Date: Two years in the future
- Engineering judgment determines that non-wires alternatives do need to be reviewed

Workflow Diagram Walkthrough

- BOX B – Estimate more than $100,000
  - Proceed to BOX C
- BOX C – Develop additional traditional options and perform cost/benefit review to determine a recommended traditional option.
  - The second traditional option is to reconductor the area and install voltage regulators. Estimated Cost $175,000.
  - Cost/benefit review results in the conversion project that is estimated to cost more than $250,000 is the recommended traditional option.
  - Proceed to BOX D
- BOX D –Estimated cost is more than $250,000
  - Proceed to BOX E
- BOX E – Required start date is less than 3 years in the future

  - Proceed to BOX H
- BOX H – Engineering judgment determines that a review of non-wires alternatives is needed
  - Proceed to BOX G
- BOX G – Develop and issue RFP for non-wires alternative projects
  - Receive and review proposals
  - Proceed to BOX I
- BOX I – Complete Detailed Cost/Benefit Analysis spreadsheet in Appendix B
  - Detail/Cost benefit analysis results in a recommended project.
  - Proceed to BOX J
- BOX J – Recommend Option

3.2.6 Example 3C – Recommended Traditional Option Greater than $250,000

Distribution load projections identify overloaded substation equipment. The initial traditional option is to upgrade the equipment.

- Estimated Cost: More than $250,000
- Required Start Date: Four years in the future
- Project is loading related

<u>Workflow Diagram Walkthrough</u>

- BOX B – Estimate more than $100,000
  - Proceed to BOX C
- BOX C – Develop additional traditional options and perform cost/benefit review to determine a recommended traditional option.
  - The second traditional option is to convert circuit to 34.5 kV and remove substation equipment. Estimated Cost more than $250,000.
  - Cost/benefit review results in the conversion project that is estimated to cost more than $250,000 is the recommended traditional option.
  - Proceed to BOX D
- BOX D –Estimated cost is more than $250,000
  - Proceed to BOX E
- BOX E – Required start date is between 3 and 5 years in the future
  - Proceed to BOX F
- BOX F – Project is required to address loading violations
  - Proceed to BOX G
- BOX G – Develop and issue RFP for non-wires alternative projects
  - Receive and review proposals
  - Proceed to BOX I

- BOX I – Complete Detailed Cost/Benefit Analysis spreadsheet in Appendix B
  - Detail/Cost benefit analysis results in a recommended project.
  - Proceed to BOX J
- BOX J – Recommend Option

3.2.7 Example 3F – Recommended Traditional Option Greater than $250,000

The system planning study identifies a conductor loading constraint. The initial traditional option is to reconductor the identified line section.

- Estimated Cost: More than $250,000
- Required Start Date: More than five years in the future
- Engineering judgment determines that non-wires alternatives do not need to be reviewed at this time (review maybe required when the project start date is three to five years in the future).

<u>Workflow Diagram Walkthrough</u>

- BOX B – Estimate more than $100,000
  - Proceed to BOX C
- BOX C – Develop additional traditional options and perform cost/benefit review to determine a recommended traditional option.
  - The second traditional option is to construct a second line. Estimated Cost more than $250,000.
  - Cost/benefit review results in the reconductoring project is the recommended traditional option.
  - Proceed to BOX D
- BOX D –Estimated cost is more than $250,000
  - Proceed to BOX E
- BOX E – Required start date is more than 5 years in the future
  - Proceed to BOX H
- BOX H – Engineering judgment determines Project does not need non-wires alternatives reviewed
  - Proceed to BOX J
- BOX J – Recommend Option

3.2.8 Example 3G – Recommended Traditional Option Greater than $250,000

The system planning study identifies a conductor loading constraint. The initial traditional option is to reconductor the identified line section.

- Estimated Cost: More than $250,000
- Required Start Date: More than five years in the future
- Engineering judgment determines that non-wires alternatives do need to be reviewed

Workflow Diagram Walkthrough

- BOX B – Estimate more than $100,000
  - Proceed to BOX C
- BOX C – Develop additional traditional options and perform cost/benefit review to determine a proposed traditional option.
  - The second traditional option is to construct a second line. Estimated Cost more than $250,000.
  - Cost/benefit review results in the reconductoring project is the recommended traditional option.
  - Proceed to BOX D
- BOX D –Estimated cost is more than $250,000
  - Proceed to BOX E
- BOX E – Required start date is more than 5 years in the future
  - Proceed to BOX H
- BOX H – Engineering judgment determines Project does need non-wires alternatives reviewed
  - Proceed to BOX G
- BOX G – Develop and issue RFP for non-wires alternative projects
  - Receive and review proposals
  - Proceed to BOX I
- BOX I – Detailed Cost/Benefit Analysis spreadsheet in Appendix B
  - Complete Detail/Cost benefit analysis results in a recommended project.
  - Proceed to BOX J
- BOX J – Recommend Option

3.2.9 Example 4 – Customer Requested Project

A proposed commercial development is expected to cause mainline loading and/or voltage concerns on the circuit. The project evaluation for the necessary upgrades to address the mainline loading and/or voltage concerns shall be evaluated per this procedure with a process similar to what is described in examples 3.2.1 through 3.2.10.

3.2.10 Example 4 – Projects to Address Condition Concerns

Inspections identify the need to address condition concerns associated with a piece of substation equipment. The desired project is to transfer load to adjacent circuits and retire the aging piece of equipment. Circuit upgrades are required to accommodate the load transfer. The project evaluation for the necessary circuit upgrades to accommodate the load transfer shall be evaluated per this procedure with a process similar to what is described in examples 3.2.1 through 3.2.10.

3.2.11 Example 5 – Reliability Project

A reliability project is proposed to create a circuit tie between two circuits. To accommodate the creation of the circuit tie a portion of the circuit(s) must be reconductored. This project would not be evaluated per this guideline, because it is justified based on reliability benefit only. However, engineering judgment shall be used to determine if non-wires alternatives should be evaluated as options to the reconductoring.

4.0 Detailed Cost/Benefit Analysis Spreadsheet

The spreadsheet included in Appendix B shall be used to evaluate options that are estimated to cost over $250,000 and are between three and five years in the future. Additionally all constraints that include the evaluation of non-wires alternatives shall be evaluated using this spreadsheet.

For constraints identified through the distribution or system planning efforts, engineering judgment may result in the Detailed Cost/Benefit Analysis Spreadsheet being used to evaluate options that do not meet the requirements above.

Additionally, this spreadsheet can be used at the request of a project approver for any project that is recommended for construction.

It is expected that this spreadsheet will be modified to include all the options being considered to resolve the identified constraint.

An example of a competed Detailed Cost/Benefit Analysis spreadsheet is included in Appendix C.

4.1 Scoring Methodology

A weighted scoring methodology is used to calculate an overall option ranking. The evaluation criteria and the default weighting factors can be modified per engineering and operational judgment. The default weighting factors will be reviewed and updated on an as needed basis.

A brief summary of each of the criteria is included below. It is acceptable for multiple options to have the same ranking for each criterion. For example, options with the same tree clearing impacts would get scored the same.

4.1.1 Functionality

The overall functionality score is calculated from the functionality subcategories.

- Operating Flexibility – how the option affects the operating flexibility of the system.
  - Example – An option that creates a new circuit tie or provides SCADA functionality would score higher than an option that does not.
- Availability – is the benefit of the option expected to be available at all times.
  - Example – A PV installation may have a lower availability score than a reconductoring option due to the timing of the peak load.
  - Example – A PV installation with storage would rank higher than a PV installation without storage.

- Maintenance – future maintenance requirements
  - Example – An option that requires minimal future maintenance would have a higher maintenance score than an option that requires annual maintenance.
- Load Servicing Capacity – ability of the option to accommodate future load additions.
  - Example – An option that accommodates 3 MW of future load would score higher than an option that accommodates 2 MW of future load.
- DG Interconnect Capacity – ability of the option to accommodate future DG additions.
  - Example – An option that increases the area's ability to accommodate additional DG would score higher than an option that does not.
- System Master Plan
  - Example – An option that works towards the master plan for the area would score higher than an option that does not.

4.1.2 Environmental

The overall environmental score is calculated from the environmental subcategories.

- Wetland Impacts
  - Example – Options with the least impact to wetlands and wetland buffers score the highest.
- Tree Clearing
  - Example – Options with the least amount of tree removals score the highest.
- Residential Area Impact – how the option impacts the residential community
  - Example – Options that require a significant amount of new infrastructure to be constructed in residential neighborhoods would score lower than options that involve upgrades to existing facilities.
- Municipal Considerations – how is the option viewed by the local municipals
  - Example – An option that requires more municipal, state or federal permitting and/or review and approval would rank lower than a project that requires less.
  - Example – A project that requires the construction of a new substation in a highly populated area would ran lower than a project to upgrade and existing substation within the confines of the existing substation footprint.

4.1.3 Reliability

The overall reliability score is calculated from the reliability subcategories.

- Customer Exposure
  - Example – Options that decrease customer exposure would score higher than options that increase customer exposure.
- Miles/Equipment Exposure

  - Example – Options that decrease miles of exposure would score higher than options that increase miles exposure.
- Automatic Restoration
  - Example – Options that include the installation of automatic restoration or work towards an automatic restoration scheme would score higher than options that do not.
- Power Quality
  - Example – Options that are expected to improve power quality would score higher than options that do not.

4.1.4 Feasibility

The overall feasibility score is calculated from the feasibility subcategories.

- Likelihood of Completion – confidence in the project being completed on schedule
  - Example – An option being constructed with plenty of slack in the schedule would score higher than an option being constructed with no schedule slack time.
- Long Term Solution
  - Example – An option that is expected to resolve the identified constraint for the next ten years would rank higher than an option that is expected to resolve the constraint for five years.
- Life Span
  - Example – An option that is expected to be in-service for thirty years would score higher than an option that has an expected service life of twenty years.
- Design Standards – how the project complies with company standards, materials and practices.
  - Example – An option that involves new materials and/or technology not previously deployed by Unitil would score lower than options that comply with existing practices.

4.1.5 Unitil Cost

Unitil cost includes all costs to Unitil for the installation of the option. In the event a non-wires alternative has costs that will not be paid by Unitil, the costs not being paid by Unitil will not be included in the evaluation.

  - Example – The option with the lowest cost to Unitil would have the highest score and the option with the highest cost to Unitil would have the lowest score.

4.1.6 Value Added Benefit of DG

Value added benefits of DG are quantifiable and unquantifiable benefits of DG and other non-wires alternatives. These benefits would be detailed in the non-wires alternative proposals. The benefits considered here are benefits to the distribution system (and its customers) as opposed to the benefits to owner/operator of the DG system.

Traditional options would all get a score of 1 (lowest score).

- Example – Options with the most value added benefits of DG would score the highest and traditional options would score the lowest.

5.0 Documentation of the Evaluation of Options

This section describes the documentation required for projects that are evaluated utilizing the Project Evaluation Workflow and/or Detail Cost/Benefit Analysis Spreadsheet detailed in this procedure.

5.1 Projects Less than $100,000

5.1.1 Projects Identified through the Planning Process

Project need, scope and cost estimate shall be documented in the body of planning study.

5.1.2 Projects Identified Outside of the Planning Process

Project need, scope and cost estimate shall be documented in the Capital Budget and/or sent to the necessary project approvers for acceptance.

5.2 Projects Over $100,000 that do not Require Detailed Cost/Benefit Analysis

5.2.1 Project Identified through the Planning Process

The project need and scopes and cost estimates of the recommended option and all other options considered shall be documented in the body of planning study. The justification for selecting the recommended option and a statement regarding non-wires alternatives not needing to be reviewed shall also be documented in the body of planning study.

5.2.2 Project Identified Outside of the Planning Process

The project need, project scopes and cost estimates of the recommended option and all other options considered shall be documented in a company memo or email to the necessary project approvers. The justification for selecting the recommended option shall also be included in the email or memo.

5.3 Projects that Require Detailed Cost/Benefit Analysis

5.3.1 Projects Identified through the Planning Process

The body of the planning study shall include the project need, summaries of the options considered with the cost estimates and an explanation for selecting the recommended option.

An appendix shall be added to the planning study for each project that requires Detail Cost/Benefit Analysis. The appendix shall include:

- Detailed description of each option including costs, benefits and negatives
- Description and reasons behind the path taken on the Project Evaluation Workflow Diagram

- Copy of the Detail Cost/Benefit Analysis Spreadsheet

5.3.2 Projects Identified Outside of the Planning Process

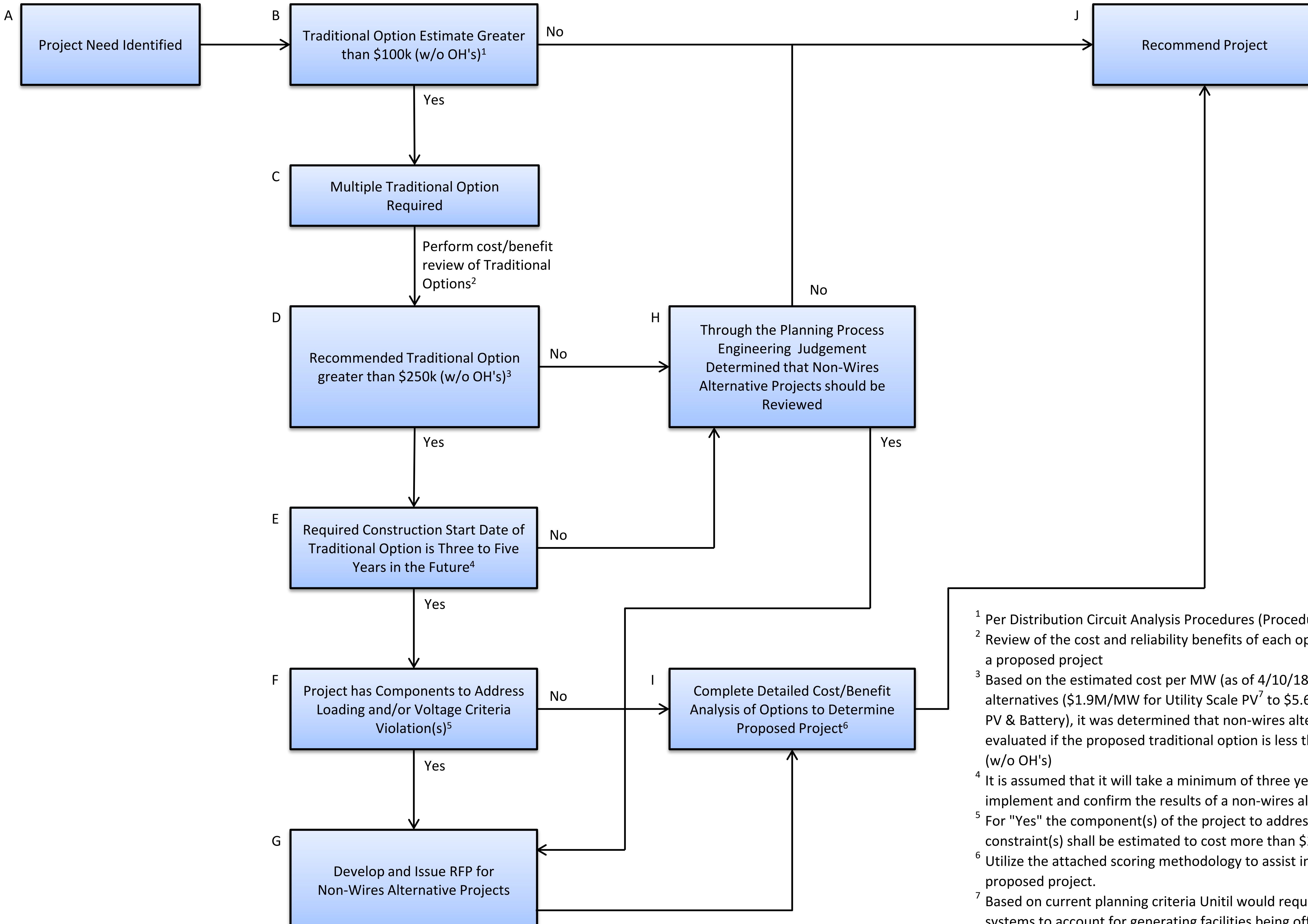
A company memo or study document shall be provided to necessary project approvers. The memo or study document shall include:

- Need for the project
- Detailed description of each option including costs, benefits and negatives
- Description and reasons behind the path taken on the Project Evaluation Workflow Diagram
- Copy of the Detail Cost/Benefit Analysis Spreadsheet
- Justification for selecting the recommended option

Appendix A
Project Evaluation Workflow Diagram

Project Evaluation Workflow

7/9/2018



[1] Per Distribution Circuit Analysis Procedures (Procedure No. PR-DT-DS-03).

[2] Review of the cost and reliability benefits of each option to determine a proposed project

[3] Based on the estimated cost per MW (as of 4/10/18) to implement non-wires alternatives ($1.9M/MW for Utility Scale PV[7] to $5.6M/MW for Roof Top PV & Battery), it was determined that non-wires alternatives would not be evaluated if the proposed traditional option is less than $0.25M (w/o OH's)

[4] It is assumed that it will take a minimum of three years to evaluate, implement and confirm the results of a non-wires alternative project.

[5] For "Yes" the component(s) of the project to address loading and/or voltage constraint(s) shall be estimated to cost more than $250k (w/o OH's).

[6] Utilize the attached scoring methodology to assist in selecting a proposed project.

[7] Based on current planning criteria Unitil would require multiple utility scale systems to account for generating facilities being off-line.

Appendix B
Detailed Cost/Benefit Analysis Spreadsheet
Blank

Constraint / Need for Project:

Project Need Year:
Date Evaluation Performed:
Traditional Alternative Construction Start Year:

	Project Scope
Option 1	
Option 2	
Option 3	
Option 4	
Option 5	

User Input (cell will turn white once value is enetered)

Evaluation Criteria	Weight Factor	Ranked Score (N Best, 1 Worst, N= # of Options) Option 1	Option 2	Option 3	Option 4	Option 5
Functionality *(See Below)*	15%	1	1	1	1	1
Environemental *(See Below)*	10%	1	1	1	1	1
Reliability *(See Below)*	15%	1	1	1	1	1
Feasibility *(See Below)*	25%	1	1	1	1	1
Unitil Cost	30%					
Value Added Benefit of DG	5%					
Totals	100%	**0.65**	**0.65**	**0.65**	**0.65**	**0.65**
	Overall Rankings	1	1	1	1	1

Functionality Evaluation Criteria	Weight Factor	Ranked Score (N Best, 1 Worst, N= # of Options) Option 1	Option 2	Option 3	Option 4	Option 5
Operating Flexibility	15%					
Availability	30%					
Maintenance	10%					
Load Servicing Capacity	20%					
DG Interconnect Capacity	10%					
System Master Plan	15%					
Totals	100%	**0**	**0**	**0**	**0**	**0**
	Rankings	1	1	1	1	1

Environmental Evaluation Criteria	Weight Factor	**Ranked Score (N Best, 1 Worst, N= # of Options)** Option 1	Option 2	Option 3	Option 4	Option 5
Wetland Impact	25%					
Tree Clearing	25%					
Residential Area Impacts	25%					
Municipal Considerations	25%					
Totals	100%	**0**	**0**	**0**	**0**	**0**
	Rankings	1	1	1	1	1

Reliability Evaluation Criteria	Weight Factor	**Ranked Score (N Best, 1 Worst, N= # of Options)** Option 1	Option 2	Option 3	Option 4	Option 5
Customer Exposure	30%					
Miles / Equipment Exposure	30%					
Automatic Restoration	20%					
Power Quality	20%					
Totals	100%	**0**	**0**	**0**	**0**	**0**
	Rankings	1	1	1	1	1

Feasibility Evaluation Criteria	Weight Factor	**Ranked Score (N Best, 1 Worst, N= # of Options)** Option 1	Option 2	Option 3	Option 4	Option 5
Likelihood of Completion	50%					
Long Term Solution	25%					
Life Span	20%					
Design Standards	5%					
Totals	100%	**0**	**0**	**0**	**0**	**0**
	Rankings	1	1	1	1	1

Note: Weight factors and evaluation criteria shall be adjusted as needed

Appendix C
Detailed Cost/Benefit Analysis Spreadsheet
Example

Constraint / Need for Project: Example

Project Need Year: 2020
Date Evaluation Performed: 7/9/2018
Traditional Alternative Construction Start Year: 2019

	Project Scope
Option 1	Traditional Option 1
Option 2	Traditional Option 2
Option 3	Non-Wires 1
Option 4	Non-Wires 2
Option 5	Non-Wires 3

User Input (cell will turn white once value is enetered)

		Ranked Score (N Best, 1 Worst, N= # of Options)				
Evaluation Criteria	Weight Factor	Option 1	Option 2	Option 3	Option 4	Option 5
Functionality *(See Below)*	15%	4	2	4	1	3
Environemental *(See Below)*	10%	1	2	4	5	3
Reliability *(See Below)*	15%	1	5	3	4	2
Feasibility *(See Below)*	25%	3	5	3	2	1
Unitil Cost	30%	5	3	1	4	2
Value Added Benefit of DG	5%	1	1	5	3	2
Totals	100%	**3.15**	**3.45**	**2.75**	**3.1**	**2**

	Option 1	Option 2	Option 3	Option 4	Option 5
Overall Rankings	2	1	4	3	5

Functionality		Ranked Score (N Best, 1 Worst, N= # of Options)				
Evaluation Criteria	Weight Factor	Option 1	Option 2	Option 3	Option 4	Option 5
Operating Flexibility	15%	2	4	3	5	1
Availability	30%	1	2	3	5	4
Maintenance	10%	3	5	2	4	1
Load Servicing Capacity	20%	4	5	2	1	3
DG Interconnect Capacity	10%	5	2	1	3	4
System Master Plan	15%	4	1	5	2	3
Totals	100%	**2.8**	**3.05**	**2.8**	**3.45**	**2.9**
Rankings		4	2	4	1	3

Environmental Evaluation Criteria	Weight Factor	**Ranked Score (N Best, 1 Worst, N= # of Options)** Option 1	Option 2	Option 3	Option 4	Option 5
Wetland Impact	25%	4	1	2	3	5
Tree Clearing	25%	4	3	5	2	1
Residential Area Impacts	25%	4	5	2	1	3
Municipal Considerations	25%	4	5	1	3	2
Totals	100%	**4**	**3.5**	**2.5**	**2.25**	**2.75**
	Rankings	1	2	4	5	3

Reliability Evaluation Criteria	Weight Factor	**Ranked Score (N Best, 1 Worst, N= # of Options)** Option 1	Option 2	Option 3	Option 4	Option 5
Customer Exposure	30%	4	1	2	3	5
Miles / Equipment Exposure	30%	4	3	5	2	1
Automatic Restoration	20%	1	2	3	5	4
Power Quality	20%	4	5	2	1	3
Totals	100%	**3.4**	**2.6**	**3.1**	**2.7**	**3.2**
	Rankings	1	5	3	4	2

Feasibility Evaluation Criteria	Weight Factor	**Ranked Score (N Best, 1 Worst, N= # of Options)** Option 1	Option 2	Option 3	Option 4	Option 5
Likelihood of Completion	50%	1	2	3	5	4
Long Term Solution	25%	4	5	2	1	3
Life Span	20%	4	1	2	3	5
Design Standards	5%	5	1	3	4	2
Totals	100%	**2.55**	**2.5**	**2.55**	**3.55**	**3.85**
	Rankings	3	5	3	2	1

Note: Weight factors and evaluation criteria shall be adjusted as needed

Appendix D - Request for Procedure/Change Form

Requestor: ____________________ Item(s)/Section to be changed (if applicable):
Title: ____________________ Section: ____________________
Department: ____________________ Page: ____________________
Location/DOC: ____________________ Figure: ____________________
Date: ____________________ Appendix ____________________
Procedure No.: ____________________ Other: ____________________

For New Procedures

Description of new procedure to be developed: ____________________

Reason for new procedure: ____________________

For Changes to Existing Procedures

Description of requested change(s): ____________________

Reason for requested change(s): ____________________

Instructions: The individual requesting a new procedure or change(s) to existing procedures shall complete this form and submit it to the Director of the applicable department. For changes to procedures please attach a copy of the existing procedure with revisions marked on the copy.

Requestors Signature: ____________________ Date: ____________________

For Reviewers Use Only	
Change(s) Approved? YES NO If No, briefly explain ____________________	
Changes Implemented? YES NO Date Implemented: ____________________	
Reviewers Signature:	Date:

APPENDIX L

UES-CAPITAL 2020-2024 DISTRIBUTION SYSTEM PLANNING STUDY

Unitil Energy Systems - Capital

Distribution System Planning Study 2020-2024

Prepared By:

Tyler Glueck
Unitil Service Corp.

11/5/2019

TABLE OF CONTENTS

1. Executive Summary

This study is an evaluation of the Unitil Energy Systems Capital (UES-Capital) electric distribution system. 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 prepare plans for the most cost-effective system improvements. The timeframe of this study is the winter and summer peak load periods over the next five years, from the summer of 2020 through the summer of 2024.

Circuit	Year	Project	Cost
Various	2020	Fuse Changes	Minimal
18W2	2020	Configuration Change for Overloaded Recloser	$105,839
7T2	2020	Bow Junction High Side Fuse Replacement	$155,515
21W1A/P	2020	Downtown Underground Restoration	Completed in 2019
22T1	2022	Iron Works Rd High Side Fuse Replacement	$157,105
24H1	2022	Configuration Change for Overloaded Conductor	$47,875

2. System Configuration

The UES-Capital operating system takes service from Eversource Energy. 34.5 kV service is taken at Garvins Substation and at Penacook Substation via the 3122 and 317 lines (fed from Eversource Energy's Oak Hill Substation). 115kV service is taken at Broken Ground Substation via the T1 & T2 lines from Eversource Energy's Curtisville Substation.

The 34.5kV subtransmission system serves 16 distribution substations which serve distribution circuits at 34.5 kV, 13.8 kV, and 4.16 kV. The distribution system is equipped with various circuit ties that permit load swap between circuits.

3. Study Focus

This study is primarily focused on the 34.5, 13.8 and 4.16 kV distribution substations and circuits. System modifications are based upon general distribution planning criteria. An evaluation of the 34.5 kV subtransmission system is made under a separate electric system planning study.

The first objective of this distribution planning study is to identify and correct specific conditions that do not meet design or operating criteria. The second objective is to develop and communicate a master plan for the development of a robust and efficient distribution system to accommodate long-term improvement and expansion throughout and beyond the study years. Recommendations are based on system adequacy, reliability and economy among available alternatives.

4. Load Projections

A five year history of summer and winter peak demands for each individual circuit was developed from the monthly peak demand readings. A linear regression analysis was performed on the historical loads to forecast future peak demands for substation transformers, circuits and other major devices. Attempts were made to take into account known significant load additions, shifts in load between circuits, etc. Large (>500KVA) DG interconnections were taken into account. In some instances, the peak loads did not present a confident trend over the historical period, so estimates were made using the best available information and knowledge of the circuit. In general, one standard deviation was added into these forecasts to account for differences from year to year in the severity of summer heat and other varying factors.

This methodology does not directly forecast future DG interconnections or other DER projects/initiatives such as energy efficiency programs. Rather the impact of DG and other DER programs are inherent in the historical regression analysis by offsetting most recent peak loads thereby reducing projected growth rates at the circuit level. It is recognized that the reduction in circuit growth rates will lag DG interconnections and other DER projects implemented in a given year. However, since load forecasts are completed annually, the timing of projects identified in the planning process is continually reviewed and updated. In addition, during the annual capital budget development process, a more detailed review of the most recent circuit peak loads, known load additions and interconnection applications either in study or recently processed is performed in order to ensure the timing of investments in system improvement projects is appropriate.

The following table shows the five circuits with the highest estimated growth rates.

Ranking	**Circuit**	**Average Annual Growth Rate (%) 2020-2024**	**Loading Increase 2020-2024 (KVA)**
1	24H1	3.17	253
2	14H2	3.1	288
3	18W2	2.17	421
4	22W3	1.79	478
5	16H3	1.51	121

The projection analysis can be referenced in Appendix A.

5. Rating Analysis

A detailed review of the limiting factors associated with each circuit was completed. The limiting factors included current transformers (CT), protection device settings, switches, circuit exit conductors, regulators, and transformers. Overall circuit ratings are based upon the most restrictive of these limiting elements. The distribution system circuit limitations can be referenced in Appendix B. Summer and winter peak load projections for the five year study period, listed in Appendix A, were compared to these circuit ratings.

Projected loads reaching certain thresholds prompted a closer assessment of the conditions. Shading, as shown below, has been added to the projection analysis to provide a visual representation of potential problem areas. The analysis of circuits and transformers reaching 90% or higher of the normal rating is described in the following section.

Legend

loading < 50% of Normal Limit
50% ≤ loading ≤ 90% of Normal Limit
90% < loading ≤ 100% of Normal Limit
100% of Normal Limit < loading

The details of this review are provided in Section 6 of this report. In the five year period of this study, a single substation transformer and a single distribution circuit are projected to be loaded over 90% of the normal limit. There are 29 of 49 circuits and 12 of 19 transformers that are projected to be in the 50-90% loading section. Two high-side protective fuses are projected to be loaded over 90% of the normal limit.

6. Transformer and Circuit Loading Analysis

Transformer and circuit loadings have been compared to the limiting circuit elements. The monthly per phase transformer load readings are added together and then converted to kVA. In order to maintain some conservatism, those transformers and circuits which have reached 90% of the limiting factor have been highlighted and will be discussed later in the section. The threshold of 90% was taken to account for phase loading imbalance.

This section details the findings resulting from the analysis described in Section 5 as well as an analysis of stepdown transformer loadings and a review of circuit load phase imbalance. Individual project descriptions, justification, predicted benefits and associated cost estimates intended to address each of the identified issues are included in Section 8.

6.1. Substation Transformer Loadings

There are no substation transformers that are projected to be loaded above 90% of its protective rating.

There are two protective fuses on the primary side of two substation transformers that are projected to be above 90% of their protective ratings. The Bow Junction FA7T1 fuse is projected to be above 90% of its protective rating in 2020. The Iron Works Rd FA22T1 fuse is projected to be above 90% of its protective rating in 2022.

6.2. Distribution Circuit Loadings

There are no circuits that are projected to be above 90% loading of its lowest rated element.

6.3. Distribution Stepdown Transformer Loadings

The Summer Normal Limit used for distribution stepdown transformer loading analysis is 120% of the nameplate rating. This is based upon the “Normal Life Expectancy Curve” in ANSI/IEEE C57.91-latest. The ambient temperature assumed is 30°C (86°F).

There are no stepdown transformers that are loaded above 120% of their nameplate rating.

6.4. Phase Imbalances

All of the circuits within the UES-Capital service territory were reviewed for phase balance. The individual phase loading for each circuit was averaged over a timeframe of January 2018 through December 2018. Circuits and substation transformers were ranked based upon the worst average phase imbalances (greatest deviation from the average).

In general, the goal for phase balancing is 10%. The following is a list of circuits where the imbalance is greater than 20%, which is considered severe. The circuits below will be looked at in more detail to determine the severity of the problem and Engineering Work Requests (EWRs) will be issued to reduce the phase imbalances if required. It is important to note that the phase imbalance experienced by transformers will be reduced as the circuits fed from that transformer are balanced. The values listed below are an absolute seasonal average and do not take diversity factor into consideration.

Circuit	% Imbalance	Solution	Expected % imbalance
1H4	50%	• Transfer 59 kVA from phase A to phase B • Transfer 104 kVA from phase A to phase C	<5%
13W1	42%	• Transfer 14 kVA from phase A to phase B • Transfer 47 kVA from phase A to phase C	<5%
14H1	42%	• Transfer 11 kVA from phase B to phase A • Transfer 18 kVA from phase B to phase C	<5%
15W2	40%	• Transfer 16 kVA from phase A to phase C • Transfer 2 kVA from phase B to phase C	<5%
4W3	28%	• Transfer 16 kVA from phase A to phase C • Transfer 74 kVA from phase B to phase C	<5%
2H2	28%	• Transfer 102 kVA from phase A to phase B • Transfer 58 kVA from phase A to phase C	<5%
24H1	22%	• Transfer 19 kVA from phase A to phase B • Transfer 55 kVA from phase A to phase C	<5%

7. Circuit Analysis Results

Circuit analysis is completed for the UES-Capital distribution system on a three year rotating cycle, where each circuit is reviewed once every three years. Windmil circuit analysis is used to identify potential problem areas. The circuit analysis performed includes voltage drop, load flow, and protection analysis. Milsoft Windmil software is used to model the system impedances and loads to identify potential problems areas. All identified problems should be followed up with verification from field measurements. Solutions to the deficiencies noted below are detailed in Section 8.

The following is a list of the circuits analyzed in 2019. Other circuits not shown on this listing were reviewed for planning purposes. However, those circuits were not part of the three year cycle.

Substation	Circuit	Substation	Circuit
Hazen Dr	24H1	Hollis	8H1
	24H2		8H2
Iron Works Rd	22W1	Bow Junction	7X1
	22W2		7W3
	22W3		7W4
Bow Bog	18W2	Terrill Park	16H1
			16H3
			16X4

7.1. Voltage Concerns

Voltage drop analysis is performed to identify areas where the primary voltage on the circuit may be outside of a pre-determined acceptable range. The acceptable range used for this analysis is 117-125 V on a 120 V base on the circuit primary conductor. The following table summarizes the areas where voltage is expected to be outside of this range. The table is sorted by circuit and year.

Circuit	Year	Voltage	Location
2H1	2020	114.7	Tremont St, Concord
13W1	2020	116.6	Borough Rd, Canterbury
2H2	2020	116.0	Ridge Rd, Concord
6X3	2020	116.4	Dunbarton Rd, Concord
8X3	2020	116.5	Copperline Dr, Epsom
15H3	2024	116.6	Technical Institute Dr, Concord

7.2. Overload Conditions

The following table summarizes distribution equipment which is expected to be loaded above 80% of normal limits during the five year study period. The table is sorted by circuit and year.

Circuit	Year	Overload Amps	Device	Location
2H1	2020	81%	Fuse	P.30 N. State St, Concord
13W2	2020	83%	Fuse	P.1 Sweatt St, Boscawen
14H2	2020	92%	Fuse	P.3 Kimball St, Concord
15W1	2020	84%	Fuse	P.61 Mountain Rd, Concord
18W2	2020	99%	Fuse	P.75 Brown Hill Rd, Bow
18W2	2020	91%	Recloser	P.1 Dunbarton Center Rd, Bow
24H1	2020	180%	Fuse	P.12 East Side Dr, Concord
2H2	2020	105%	Solid	P.58 Rumford St, Concord
14H2	2021	83%	Fuse	P.14 Spruce St, Concord
14H2	2021	81%	Fuse	P.20 West St, Concord
22W3	2022	91%	Conductor	Iron Works Rd Circuit Exit
24H1	2022	92%	Conductor	Hazen Dr, Concord
14H2	2023	82%	Fuse	P.2 Broadway, Concord
24H2	2023	82%	Fuse	P.4 Prescott St, Concord
24H1	2024	80%	Fuse	P.13 East Side Dr, Concord

7.3. Protection Concerns

Analysis is performed on the circuits to identify protective devices that violate Unitil's distribution protection sensitivity and coordination criteria. EWR's or capital budget projects are issued to address the concerns identified. The analysis identified 11 fuse replacements, 1 fuse additions, and 3 substation settings change requests.

7.4. Underground Circuit Concerns

Analysis is performed on the Concord Downtown Underground System to identify violations of Unitil's underground mainline restoration criteria. The Concord Downtown Underground System is comprised of Storrs Street substation, Montgomery Street substation and the circuits which they supply. Capital budget projects were developed and estimated to address the concerns identified.

The following analysis was performed with the five year projected loads. The columns detailing the number of switching steps identify how many steps it takes to traditionally restore all load, depending on the fault location.

Violation	Year	% Rating	Fault Location	# Traditional Switching Steps To Restore Load	% Rating	# Additional Switching Steps To Restore Load
21W1A Cable - 21T1 to MH15 (165A)	2020	110	21W1P - MH15 to MH16	3	106	2
	2020	110	21W1P - MH16 to MH17	3	104	4
	2020	110	21W1P - MH17 to MH23	3	104	4
	2020	110	21W1P - MH23 to MH25	3	100	6
22W1 - S/S Regulators (180A)	2020	140	21W1P - 23T1 to MH25	2		
21W1P Cable - 23T1 to MH25 (165A)	2020	106	21W1A - MH15 to MH16	3		
	2020	104	21W1A - MH16 to MH17	3		
	2020	104	21W1A - MH17 to MH23	3		
	2020	100	21W1A - MH23 to MH25	3		

Note that the first loading violation occurs in the year 2020. Based upon the historical load data, full circuit restoration cannot occur during the months of May through October in 2020.

8. Detailed Recommendations

The following sections detail system improvement projects to address the deficiencies listed above. All cost estimates provided in this report are without general construction overheads.

8.1. Overload Concerns

To address overload concerns, several fuse replacements will be scheduled for 2020. Projects to address fuse overloads listed in years after 2020 are not detailed here. All other overload concern projects are detailed here.

<u>13W2 – Pole 1 Sweatt St, Concord:</u>

The 75N fuse is expected to be loaded at 83% of its continuous current rating in 2020.

Proposed Solution:

Replace the 75N fuse with a 95N fuse.

Estimated Cost: Minimal

<u>14H2 – Pole 3 Kimball St, Concord:</u>

The 10N fuse is expected to be loaded at 92% of its continuous current rating in 2020.

Proposed Solution:

Replace the 10N fuse with a 25N fuse.

Estimated Cost: Minimal

15W1 – Pole 61 Mountain Rd, Concord:

The 50N fuse is expected to be loaded at 84% of its continuous current rating in 2020.

Proposed Solution:

Replace the 50N fuse with a 65N fuse. Replace the 50N fuses at Pole 10 Country Club Ln, Concord with 65N fuses as well. The fuses on Country Club lane are normally open and act as the backup supply to the residential underground.

Estimated Cost: Minimal

24H1 – Pole 12 East Side Dr, Concord:

The 25N fuse is expected to be loaded at 180% of its continuous current rating in 2020.

Proposed Solution:

Replace the 25N fuses with 75N fuses.

Estimated Cost: Minimal

2H1 – Pole 30 N. State St, Concord:

The 50N fuse is expected to be loaded at 81% of its continuous current rating in 2020.

Proposed Solution:

Replace the 50N fuses with 75N fuses.

Estimated Cost: Minimal

2H2 – Pole 58 Rumford St, Concord:

The 300A Solid Blades are expected to be loaded at 105% of their continuous current rating in 2020.

Proposed Solution:

Remove the cutouts and solid blades. Install 600A in-line disconnects in the same area.

Estimated Cost: Minimal

18W2 – Pole 1 Dunbarton Rd, Bow

A hydraulic recloser on P.1 Dunbarton Rd, Bow and single phase fuse on P.75 Brown Hill Rd, Bow are expected to be loaded at 91% and 99% of their continuous current ratings, respectively, in 2020.

Proposed Solution:

Install a second phase on Dunbarton Rd, Bow totaling 6,643ft. Also, install an additional 100A, V4L hydraulic recloser at P.1 Dunbarton Rd, Bow.

Estimate: Alternate selected

Alternate Solution:

Extend 22W3 1200ft to connect with 18W2 along Brown Hill Rd, Bow. Install a regulator at Pole 16 Brown Hill Rd, Bow. Replace approximately 350ft of 1/0 ACSR with 336 AAC on Iron Works Rd, Concord. This solution also encompasses the future necessary upgrades for 22W3 on Iron Works Rd.

Estimate: $105,839

22W3 – Iron Works Rd, Concord

The 1/0 ACSR on Iron Works Rd is expected to be loaded at 91% of its continuous current rating in 2022.

Proposed Solution:

Replace approximately 350ft of 1/0 ACSR with 336 AAC.

Estimate: Encompassed in 18W2 solution

24H1 – Hazen Dr, Concord

The 1/0 ACSR on Hazen Dr is expected to be loaded at 92% of its continuous current rating in 2022. Two solutions have been developed due to the master plan for the area. Ultimately, the goal is to convert Loudon Rd to 34.5kV from Hollis to Bridge St. This will connect the Broken Ground capacity with the main UES Capital sub-transmission system. As such, the following solutions take into account the future plans so as to not hinder them.

Proposed Solution:

Replace approximately 2000ft of 1/0 ACSR with 336 AAC. Insulate the area to 15kV. This solves the loading issue while also improving tie capability. The new constraint is the recloser trip limit at the substation, an increase of approximately 100A of circuit tie carrying capacity. The loading after reconductoring is 41% of the continuous current rating of 336 AAC.

The Hazen Dr substation will no longer be in service when the mainline conversion occurs. Reinsulating this portion of the line allows for 34.5 to 13.8kV step down transformation, increasing the area (compared to 34.5 to 4.16kV) a set of step down transformers can serve.

Estimate: Alternate selected

Alternative Solution:

Transfer load from 24H1 to 8H1. Install a switch at P.5 East Side Dr. Transfer the 24H1 load from that point to 8H1 via 8H1J24H1. This load transfer eliminates the loading violation; however it does not improve circuit tie capability. Additional switching steps will need to be added to be able to tie 8H1 and 8H2. The loading after this transfer is 68% of the continuous current rating of 1/0 ACSR on 24H1 and 76% of the current rating of the current transformer at the Hollis S/S.

In regards to the master plan, this solution does not have much of an effect on it, but more importantly, it does not hinder it.

Estimate: $47,875

8.2. Low Voltage Concerns

All low voltage concerns are solved by putting existing capacitors into service during seasonal switching.

8.3. Substation Transformer Loading Solutions

Bow Junction Substation

Replace the substation transformer high-side protective fuses with a high side recloser.

Estimate: $155,515

Iron Works Rd Substation

Replace the substation transformer high-side protective fuses with a high side recloser.

Estimate: $157,105

8.4. Underground Circuit Restoration Solutions

The following four options have been identified as potential solutions to the Concord Downtown Underground restoration violation.

Option 1: Install an Additional Circuit

This solution is to install a new run (~1700ft) of 1/0 Al conductor from 23T1 to MH25. A new underground switch will be required in MH25. This new conductor will serve as an alternate to both 21W1P and 21W1A, depending on the circuit where a fault occurs. This will require the removal of abandoned conductor.

Loading after Project Completion:

New Conductor restoring 21W1P = 58% of 1/0Al rating
New Conductor restoring 21W1A = 52% of 1/0Al rating

Challenges:

This new conductor would run from the Montgomery St substation, but would not be a new circuit unless a new circuit position was created at Montgomery St. This solution utilizes a capped T-body at the origin of 21W1P. The new conductor will also use the only spare conduit in some of the ductbanks.

Benefits:

This option allows the downtown underground to be fully isolated with complete restoration ability, which is part of the master plan. It also will require removing all the abandoned cable.

Limitations: None

Estimate: $750,000

<u>Option 2: Replace 21W1P and 21W1A</u>

This solution is to replace the existing mainline of 21W1P and 21W1A with 350Cu from their respective origins to MH25, approximately 3,550ft of total replacement. Additionally, all 200A mainline connections will need to be replaced with 600A connectors.

Loading after Project Completion:

Total loading after restoration = 44% of 350Cu rating

Challenges:

This project will take a long time to complete with tap cutovers and switching time. Copper conductor is more costly than aluminum. The mainline connectors will be much larger, in some cases, than what currently exists. Some manholes may be too small to house the larger conductor and connectors.

Benefits:

The existing conductor and connections are reaching their manufactured lifetime or have already passed it. Replacing it will prevent failures due to material breakdown. It also presents an opportunity to clean up the manholes.

Limitations: Physical space in manholes.

Estimate – Project determined to be not operationally feasible; requirement of 600A t-body connectors does not work with physical limitations of existing manholes

Option 3: Shift 21W1P Overhead Load to 22W1

21W1P does not currently serve any load along the underground manhole path. This circuit's entire load is overhead construction at the end of the circuit. This project shifts the overhead load from 21W1P to 22W1. 22W1 cannot accommodate the added load under peak, so several sections of 1/0 ACSR and the substation regulators will need to be replaced.

Loading after Project Completion:

21W1A and 21W1P combined = 52% of 1/0Al rating
22W1 = 49% of 336AA rating and 52% of regulator rating
22T1 = 90% of transformer rating

Challenges:

The first major challenge is that this project would drive a new transformer at Iron Works Rd substation as no significant amount of load can be transferred to another circuit.

Benefits:

The downtown underground will be able to self-restore all year long. A new transformer at Iron Works Rd, or wherever it is determined to go, will further along the master plan.

Limitations:

The transformer capacity would limit the ability to carry this transferred load.

Estimate: $1,880,000

Option 4: Shift 21W1P Overhead Load to Gulf St

With the conversion of the Gulf St substation to 13.8kV, one of the new circuits, designated here as 3W4, will be close to the 21W1P overhead load. This project will consist of converting approximately 1000ft of 1H2 on Warren St and Green St to 13.8kV, transferring that to 3W4, and then tying 3W4 with 21W1P. In addition to reconductoring to 336AA and reinsulating to 15kV, two new switches will also be installed.

Loading after Project Completion:

21W1P and 21W1A combined = 52% of 1/0 Al rating
3W4 = 67% of substation regulator rating
3T3 = 69% of substation transformer rating
3W4 carrying 22W1 = 102% of 336AA spacer rating
3T3 carrying 22W1 = 96% of substation transformer rating

Challenges:

This circuit configuration heavily loads the Gulf St transformer under peak while tied. 3W4 would be a very large circuit.

Benefits:

This circuit configuration allows for increased tie capability. It does not add much exposure to 3W4 as the majority of the added load is downline of a recloser. The downtown underground can self-restore all year.

Limitations:

3W4 cannot carry 22W1 all year, however it does increase the amount of time during the year that it can back it up compared to the current tie with 21W1P

Estimate – Planning determined that a 13.8kV circuit should not be normally loaded above ~6MW.

Option 5: Additional Transformer and 13.8kV Circuit at Gulf St

Instead of installing a 4kV transformer and retaining a single 4kV circuit at Gulf St, install a second 34.5Y/19.92kV to 13.8Y/7.97kV, 10/14MW transformer at Gulf St. This will require the conversion of 3H2 to 13.8kV. This is approximately 7,000ft of conversion, which includes reinsulating and reconductoring, as well as distribution transformer replacements.

Loading after Project Completion:

3W4: 3,299KVA – 28% of regulator rating
3W5: 2,470KVA – 21% of regulator rating
3T3: 6,769KVA – 54% of mobile rating
3W2: 4,766KVA – 41% of regulator rating
3T2: 4,766KVA – 38% of mobile rating
3W2 carrying 22W1 – 8,456KVA – 72% of regulator rating

Challenges:

The timeline of ordering another 13.8kV transformer in time for summer loading 2020 may not work. This does not address some of the condition-based concerns in the downtown underground.

Benefits:

21W1P and 21W1A are able to completely back the other up. No single circuit is loaded above 6MW under normal conditions. Shifting load does not overload other circuits or equipment. A major component to the master plan is accomplished.

Limitations: None

Estimate: $1,600,000

9. Circuit Tie Analysis

A detailed analysis was performed on ten mainline distribution circuit ties in the UES-Capital System. The circuit ties were evaluated using 2020 projected summer peak loads and were evaluated for loading and voltage violations. It is understood that marginal low voltage, coordination and protection sensitivity concerns may exist while circuits are tied. For the purpose of this review all elements were allowed to operate up to their long term emergency ratings while circuits are tied.

Detailed results of this analysis can be found in appendix E.

A full district circuit tie analysis was performed and included in this report.

Projects to create additional circuit ties or increase circuit tie capability will be identified and justified as part of the UES-Capital Reliability Study.

10. Master Plan

This section describes a long range master plan for the UES-Capital system. The purpose of this plan is to provide strategic direction for the development of the electric distribution system as a whole. It does not, in and of itself, represent a cost-benefit justification for major system investments. Instead, it is intended to guide design decisions for various individual projects incrementally towards broader system objectives. The concepts detailed below should be considered in all future designs of the system, including designing the system for future grid modernization initiatives. It is expected that this Master Plan will be modified, adjusted, and refined as system challenges and opportunities evolve.

This master plan has been separated into two different parts. The first part of the plan consists of an overview map of the UES-Capital distribution system. The second part of the master plan consists of more detailed future considerations. At this time some of these future considerations are not detailed.

10.1. Master Plan Map

The map in Appendix F identifies existing and future main line backbones at 34.5 kV, 13.8 kV and 4.16 kV. The map should be used as a tool when designing system improvement projects. Sections of conductor which have been identified as backbones should be constructed to 336.4 AA open wire conductor or equivalent and the appropriate insulation level should be used, even if conditions do not require it at the time of construction. Underground mainline conductor spans will be constructed or replaced with 350 kcmil CU, even if conditions do not require it at the time of construction.

10.2. Future Considerations

10.2.1. Bow Junction, Iron Works Rd and Bow Bog Substation Area

When load levels grow beyond the transformation capacity in this area, upgrade options include adding capacity at Bow Bog Substation, adding capacity at Bow Junction Substation or adding capacity at Iron Works Substation. Replacements will be with delta-wye transformers instead of wye-wye transformers for protection reasons.

Upgrades to mainline construction on Clinton St, Silk Farm Rd, and Iron Works Rd improve the circuit tie capability of 22W1 and 22W3.

Upgrades to mainline construction on Iron Works Rd, Silk Farm Rd, Albin Rd, Bow Center Rd, Logging Hill Rd, Grandview Rd, and Robinson Rd improve the circuit tie capabilities between 18W2 and 22W3, 7W3 and 22W3, and 7W3 and 18W2.

Extending three phase mainline construction along Page Rd and White Rock Hill Road will create a new tie between 18W2 and 22W3. Upgrades to Iron Works Rd, Silk Farm Rd, Clinton St, and Birchdale Rd are also necessary.

Extending three phase mainline construction along Woodhill Rd, South Bow Rd, and Allen Rd will create a loop within 18W2, which is otherwise a radial circuit with circuit ties that have limited restoration capability.

Extending three phase mainline construction along River Rd and Route 3A will create a loop within 7W3, which is otherwise a radial circuit with ties that have limited restoration capability.

Upgrades to mainline construction along Iron Works Rd improve the circuit tie capabilities between 7W4 and 22W2.

Upgrades to mainline construction along South St and Clinton St improve the circuit tie capabilities between 7W4 and 22W1.

10.2.2. Montgomery St and Storrs St Substations

Montgomery St and Storrs St are planned to remain in a wye-wye configuration. This will be an islanded system that will be dead-tie only. Circuit configuration changes will eventually restore 22W1 from Gulf St.

An additional circuit in the downtown underground or upgrading the existing circuits to 350MCM Cu will allow the downtown underground to serve as a looped system. If the path of upgrading the existing cable is taken, then the mainline connections need to be upgraded to 600A connectors as well. The additions and/or upgrades allow switching between 21W1A and 21W1P all year.

10.2.3. Bridge St, Gulf St, and Langdon Ave Area

When additional transformer capacity is needed in this area, a second 13.8kV transformer will be installed at Gulf St (replacing the existing 4.16kV transformer) and at least one 13.8kV transformer will be installed at Bridge St, replacing all the 4.16kV circuits in the area.

There are four 13.8kV circuits planned for Gulf St. Two circuits are planned to extend north/northwest towards Bridge St and 22W1. The other two circuits are planned to extend south/southwest towards Bow Junction and 22W2. The 4.16kV circuits from Langdon Ave will be converted to 13.8kV and transferred to the Gulf St substation, leaving Langdon Ave as a sub-transmission switching point and a single 34.5kV distribution circuit.

10.2.4. Pleasant St

To create restoration capability for 6X3, 2H2 on Penacook St and Rumford St and 6X3 on Washington St, Pine St, and Warren St will be converted to 34.5kV. A new tie for this circuit will be built at the 33 Line on Little Pond Rd. The master plan map provides the geographic visual. For reliability exposure, it is advantageous to split this large circuit into two pieces, with the tie in the middle at Washington St and Rumford St.

10.2.5. West Concord Substation

When this substation requires additional transformation capacity, a new 13.8kV transformer will be installed, replacing the 4.16kV transformer. 2H2 will be transferred according to 10.2.4. 2H1 and 2H4 will be converted to 13.8kV. 2H1 will tie with the planned 13.8kV at Bridge St. 2H4 will tie with 4W4, creating the only tie 4W4 has with a circuit from a different substation.

10.2.6. Penacook and Boscawen Substations

When additional capacity is required in the Penacook Substation area, install an additional transformer.

The Boscawen Substation is currently served radially via the 37 line from Penacook. In order to create a backup for this substation, 13W2 will be converted from 13.8kV to 34.5kV. Additionally, a new tie between the converted circuit and 4X1 will be created near the Village St Bridge. There is a four-conduit ductbank already installed to tie the two circuits.

When additional capacity is required in the Boscawen Substation area, one or both of the 13.8kV transformers should be replaced with higher capacity transformers.

Due to the radial nature of 13W3, a loop internal to 13W3 can be achieved by extending three phase mainline on N. Water St. and a transfer scheme at the intersection of Old Turnpike Rd and Rabbit Rd.

With additional capacity at Penacook and Boscawen, a new tie between 4W3 and 13W1 can be created by eliminating the 37X1 circuit. It exists currently as a single phase, 13.8kV circuit served from a 37 line tap. Mainline upgrades will be required on Carter Hill Rd, South West Rd, and Mountain Rd, as well as three phase line extensions on South West Rd and Mountain Rd to connect the two circuits. This will allow an otherwise radial 13W1 and partly radial 4W3 to have greater restoration capabilities.

10.2.7. Hollis, Hazen Dr, and Terrill Park Dr Area

When additional capacity is required in this area, or system planning determines Loudon Rd is going to be the path to connect Broken Ground and Bridge St, convert all substations to 34.5kV distribution circuit positions. Two 34.5kV distribution circuits will tie the Hollis and Terrill Park substations and connect to the 38 line at the Hazen Dr substation. All three substations will no longer have any transformation. The mainline of Loudon Rd, Airport Rd, Terrill Park Dr, Hazen Dr, and East Side Dr will be converted to 34.5kV. All other laterals or groups of laterals can be stepped down to 4.16kV.

10.2.8. Broken Ground, 15W2, and 8X3

From Broken Ground, a path to tie into the northern system loop is through West Portsmouth. As such, 15W2 can be converted to 34.5kV and be a supply from Broken Ground to West Portsmouth.

8X3 stands a UES-Capital's largest circuit, which also happens to be a radial circuit. The master plan map shows how a new circuit served from Hollis or Broken Ground can be built without utilizing the same pole line as 8X3. The new circuit will be built by converting and upgrading to three-phase mainline along Horse Corner Rd, Lane Rd, Mill House Rd, Short Falls Rd, Black Hall Rd, and Dover Rd. The new circuit ties will be built at Horse Corner Rd and Dover Rd and Black Hall Rd and Dover Rd. The new circuit can be built in pieces over several years.

11. Conclusion

The projects identified in this study attempt to address all of the system constraints that have been identified. The future of the UES–Capital system will rely predominantly on where load enters the system and growth occurs. In the future, projects will continue to focus on improving system voltages and loading constraints to support long term system growth and improve system reliability. Implementation of the master plan will enable the system to grow towards one common vision in a direct and cost effective manner. It is recognized that this study is a living document and it will be continually updated as the system's needs change or new system deficiencies are identified.

Appendix A

Summer and Winter Load Forecasts

Summer Peak Loads (three-phase kVA)						
		5 Year Projected Summer Peak Load (kVA)				
Distribution Element	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Bridge Street 1T1 Xfmr	4,426	4,478	4,529	4,580	4,631	4,682
1H3	1,608	1,623	1,637	1,652	1,667	1,682
1H4	998	1,008	1,017	1,026	1,035	1,044
1H5	1,678	1,687	1,695	1,703	1,712	1,720
Bridge Street 1T2 Xfmr	5,498	3,613	3,656	3,700	3,743	3,786
1H1	2,452	2,475	2,498	2,520	2,543	2,565
1H2	1,196	1,217	1,237	1,257	1,277	1,298
1H6	2,018	0	0	0	0	0
Bridge Street 1X7P	2,303	2,327	2,351	2,375	2,399	2,423
Bridge Street 1X7A	2,513	2,537	2,560	2,583	2,606	2,629
West Concord 2T1 Xfmr	3,671	3,704	3,738	3,772	3,806	3,840
2H1	1,439	1,452	1,465	1,479	1,492	1,505
2H2	1,850	1,867	1,884	1,901	1,918	1,935
2H4	1,189	1,200	1,211	1,222	1,233	1,244
Gulf Street 3T1 Xfmr	3,311	3,313	3,315	3,316	3,318	3,320
3H1	1,865	1,882	1,899	1,916	1,933	1,951
3H2	1,395	1,408	1,420	1,433	1,446	1,459
Gulf Street 3T2 Xfmr	0	0	0	0	0	0
3H3	0	0	0	0	0	0
Gulf Street 3T3 Xfmr	0	6,877	7,006	7,071	7,136	7,200
3W4	0	4,407	4,490	4,531	4,573	4,614
3W5	0	2,470	2,516	2,540	2,563	2,586
Penacook 4X1	6,220	6,277	6,335	6,392	6,449	6,507
Penacook 4T3 Xfmr	8,572	8,651	8,730	8,809	8,889	8,968
4W3	3,442	3,473	3,505	3,537	3,569	3,600
4W4	5,065	5,112	5,159	5,206	5,252	5,299
Pleasant Street 6X3	10,005	10,097	10,189	10,282	10,374	10,466
Bow Junction 7X1	2,577	2,592	2,606	2,621	2,635	2,650
Bow Junction 7T2 Xfmr	9,583	9,693	9,802	9,912	10,021	10,131
7W3	6,842	6,896	6,949	7,003	7,057	7,110
7W4	2,834	2,860	2,887	2,913	2,939	2,965
Hollis 8T1 Xfmr	2,246	2,267	2,288	2,309	2,329	2,350
8H1	1,224	1,235	1,246	1,257	1,269	1,280
8H2	1,124	1,127	1,130	1,133	1,136	1,139
Hollis 8X3	12,298	12,411	12,525	12,638	12,752	12,865
Hollis 8X5	8,945	8,971	8,997	9,023	9,049	9,075
Boscawen 13T1 Xfmr	3,785	3,852	3,919	3,987	4,054	4,121
13W1	1,454	1,467	1,481	1,494	1,507	1,521
13W2	2,533	2,556	2,579	2,603	2,626	2,650
Boscawen 13T2 Xfmr	4,852	4,873	4,895	4,916	4,938	4,959
13W3	4,852	4,873	4,895	4,916	4,938	4,959
Boscawen 13X4	2,917	2,944	2,971	2,998	3,024	3,051
Langdon Street 14T1 Xfmr	1,782	1,843	1,905	1,966	2,028	2,089
14H1	342	345	349	352	355	358
14H2	1,499	1,571	1,643	1,715	1,787	1,859
Langdon 14X3	712	721	729	738	746	755
West Portsmouth 15T1 Xfmr	3,531	3,564	3,596	3,629	3,661	3,694
15W1	2,878	2,915	2,953	2,990	3,028	3,065
15W2	682	688	694	700	707	713
West Portsmouth 15T2 Xfmr	529	533	538	543	548	553
15H3	529	533	538	543	548	553
Terrill Park 16T1 Xfmr	2,467	2,489	2,512	2,535	2,558	2,580
16H1	1,233	1,245	1,256	1,267	1,279	1,290
16H3	1,446	1,476	1,506	1,536	1,566	1,597
Terrill Park 16X4	2,801	2,827	2,852	2,878	2,904	2,930
Terrill Park 16X5	1,602	1,616	1,631	1,646	1,661	1,675
Terrill Park 16X6	308	311	313	316	319	322

UES-Capital
5-Year Load Forecast
2020-2024

		5 Year Projected Summer Peak Load (kVA)				
Distribution Element	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Bow Bog 18T2 Xfmr	2,344	2,449	2,555	2,660	2,765	2,870
18W2	2,344	2,449	2,555	2,660	2,765	2,870
Storrs Street 21T1 Xfmr	2,095	2,114	2,133	2,153	2,172	2,191
21W1P	2,213	2,257	2,301	2,345	2,389	2,433
21W1A	2,142	2,154	2,165	2,176	2,187	2,198
Iron Works Road 22T1 Xfmr	8,572	8,651	8,730	8,809	8,889	8,968
22W1	3,734	3,768	3,803	3,837	3,872	3,906
22W2	208	218	228	238	248	258
22W3	4,751	4,871	4,990	5,110	5,230	5,349
Montgomery Street 23T1 Xfmr	2,213	2,257	2,301	2,345	2,389	2,433
21W1P	2,213	2,257	2,301	2,345	2,389	2,433
21W1A	2,142	2,154	2,165	2,176	2,187	2,198
Hazen Drive 24T1 Xfmr	1,282	1,345	1,409	1,472	1,535	1,599
24H1	1,282	1,345	1,409	1,472	1,535	1,599
Hazen Drive 24T2 Xfmr	1,703	1,719	1,735	1,751	1,766	1,782
24H2	1,703	1,719	1,735	1,751	1,766	1,782
24H3	1,703	1,719	1,735	1,751	1,766	1,782
33 Line - Little Pond Rd	171	173	174	176	177	179
37X1 37X1	374	377	381	384	388	391

Winter Peak Loads (three-phase kVA)						
	5 Year Projected Winter Peak Load (kVA)					
Distribution Element	**2019/20**	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**
Bridge Street 1T1 Xfmr	3,994	4,031	4,067	4,104	4,141	4,178
1H3	1,479	1,493	1,506	1,520	1,534	1,547
1H4	866	874	882	890	898	906
1H5	1,413	1,420	1,427	1,434	1,441	1,448
Bridge Street 1T2 Xfmr	4,467	2,936	2,971	3,006	3,041	3,077
1H1	2,090	2,109	2,128	2,147	2,167	2,186
1H2	988	1,005	1,022	1,038	1,055	1,072
1H6	1,219	0	0	0	0	0
Bridge Street 1X7P	2,232	2,253	2,273	2,294	2,315	2,335
Bridge Street 1X7A	2,251	2,271	2,292	2,313	2,334	2,354
West Concord 2T1 Xfmr	3,137	3,166	3,195	3,224	3,253	3,282
2H1	1,165	1,176	1,187	1,197	1,208	1,219
2H2	1,762	1,778	1,794	1,810	1,827	1,843
2H4	1,130	1,141	1,151	1,162	1,172	1,183
Gulf Street 3T1 Xfmr	2,636	2,637	2,639	2,640	2,641	2,643
3H1	1,395	1,408	1,420	1,433	1,446	1,459
3H2	1,245	1,254	1,262	1,271	1,280	1,288
Gulf Street 3T2 Xfmr	854	0	0	0	0	0
3H3	854	0	0	0	0	0
Gulf Street 3T3 Xfmr	0	6,189	6,306	6,364	6,422	6,480
3W4	0	3,966	4,041	4,078	4,115	4,153
3W5	0	2,223	2,265	2,286	2,307	2,327
Penacook 4X1	7,570	7,639	7,709	7,779	7,849	7,919
Penacook 4T3 Xfmr	7,657	7,782	7,906	8,030	8,154	8,278
4W3	2,955	2,982	3,009	3,036	3,064	3,091
4W4	4,415	4,456	4,497	4,538	4,578	4,619
Pleasant Street 6X3	7,042	7,107	7,172	7,237	7,302	7,367
Bow Junction 7X1	1,469	1,475	1,481	1,487	1,493	1,499
Bow Junction 7T2 Xfmr	7,526	7,595	7,665	7,734	7,803	7,873
7W3	5,252	5,300	5,349	5,397	5,446	5,494
7W4	2,960	2,994	3,028	3,062	3,095	3,129
Hollis 8T1 Xfmr	2,621	2,642	2,662	2,683	2,703	2,724
8H1	1,661	1,676	1,691	1,707	1,722	1,737
8H2	1,028	1,037	1,047	1,056	1,066	1,075
Hollis 8X3	10,147	10,240	10,334	10,428	10,521	10,615
Hollis 8X5	7,813	7,885	7,957	8,029	8,101	8,173
Boscawen 13T1 Xfmr	2,980	3,014	3,047	3,081	3,114	3,148
13W1	1,216	1,226	1,237	1,247	1,257	1,268
13W2	2,112	2,136	2,160	2,184	2,207	2,231
Boscawen 13T2 Xfmr	4,278	4,317	4,357	4,396	4,436	4,475
13W3	4,278	4,317	4,357	4,396	4,436	4,475
Boscawen 13X4	2,579	2,602	2,626	2,650	2,674	2,698
Langdon Street 14T1 Xfmr	1,545	1,552	1,559	1,566	1,573	1,580
14H1	289	291	294	297	299	302
14H2	1,386	1,434	1,482	1,529	1,577	1,625
Langdon 14X3						
West Portsmouth 15T1 Xfmr	2,443	2,466	2,488	2,511	2,533	2,556
15W1	2,208	2,228	2,248	2,269	2,289	2,310
15W2	430	434	438	442	446	450
West Portsmouth 15T2 Xfmr	440	445	449	453	457	461
15H3	440	445	449	453	457	461
Terrill Park 16T1 Xfmr	1,918	1,936	1,954	1,972	1,989	2,007
16H1	940	948	957	966	974	983
16H3	1,251	1,268	1,286	1,303	1,320	1,338
Terrill Park 16X4	2,422	2,444	2,466	2,489	2,511	2,533
Terrill Park 16X5	0	0	0	0	0	0
Terrill Park 16X6						

UES-Capital
5-Year Load Forecast
2020/21-2024/25

		5 Year Projected Winter Peak Load (kVA)				
Distribution Element	**2019/20**	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**
Bow Bog 18T2 Xfmr	2,435	2,457	2,480	2,502	2,525	2,547
18W2	2,725	2,732	2,739	2,746	2,753	2,761
Storrs Street 21T1 Xfmr	1,293	1,351	1,409	1,467	1,525	1,583
21W1P	0	0	0	0	0	0
21W1A	1,762	1,778	1,794	1,810	1,827	1,843
Iron Works Road 22T1 Xfmr	7,013	7,078	7,143	7,208	7,272	7,337
22W1	2,857	2,884	2,910	2,936	2,963	2,989
22W2	204	206	208	209	211	213
22W3	3,945	3,981	4,018	4,054	4,090	4,127
Montgomery Street 23T1 Xfmr	1,851	1,868	1,885	1,902	1,919	1,937
21W1P	1,851	1,868	1,885	1,902	1,919	1,937
21W1A	1,772	1,788	1,804	1,821	1,837	1,853
Hazen Drive 24T1 Xfmr	1,371	1,371	1,371	1,371	1,371	1,371
24H1	1,371	1,371	1,371	1,371	1,371	1,371
Hazen Drive 24T2 Xfmr	1,500	1,502	1,505	1,507	1,510	1,512
24H2	1,500	1,502	1,505	1,507	1,510	1,512
24H3	1,500	1,502	1,505	1,507	1,509	1,512
33 Line - Little Pond Rd	157	158	160	161	163	164
37X1 37X1	433	449	465	481	497	513

Appendix B

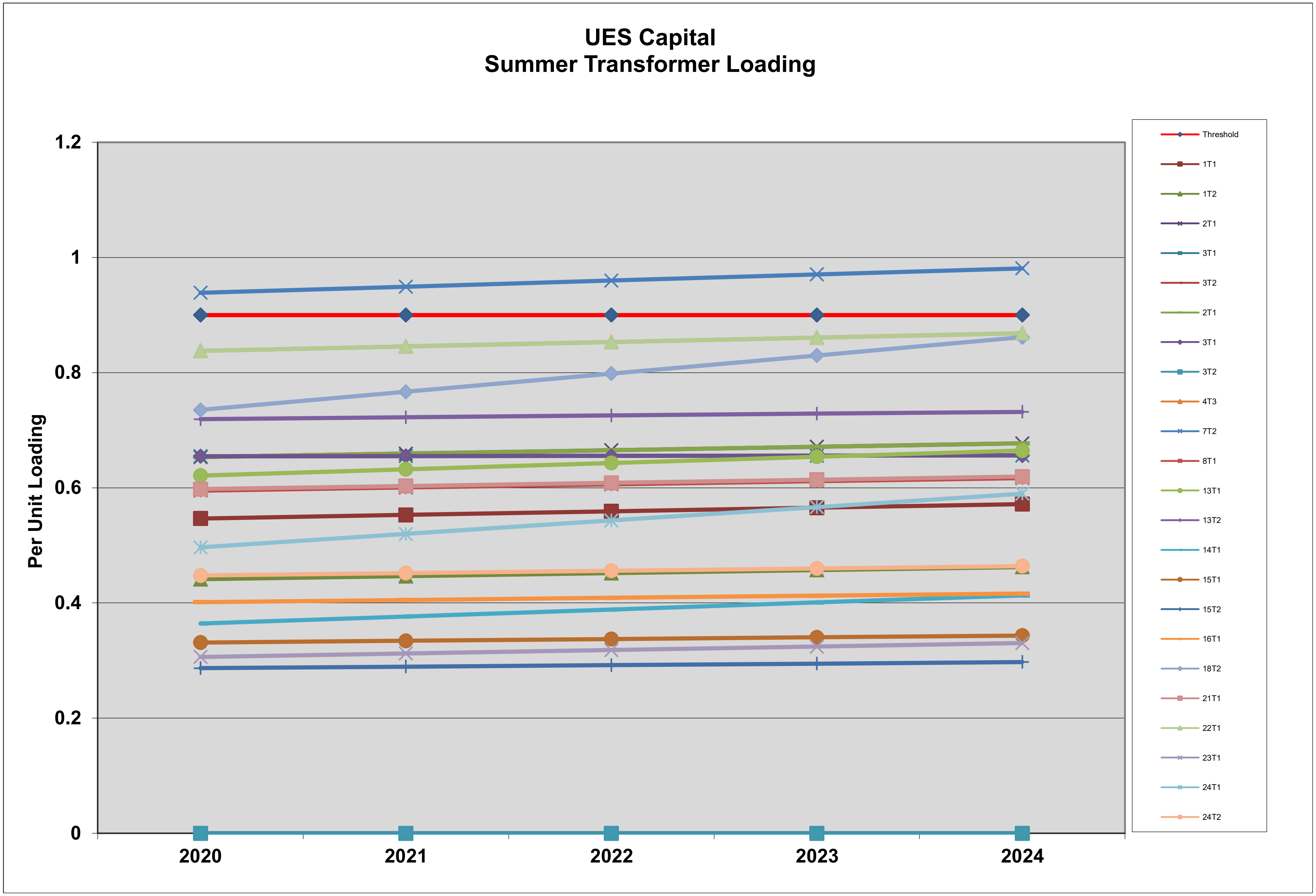
Distribution Circuit Ratings and Limitations

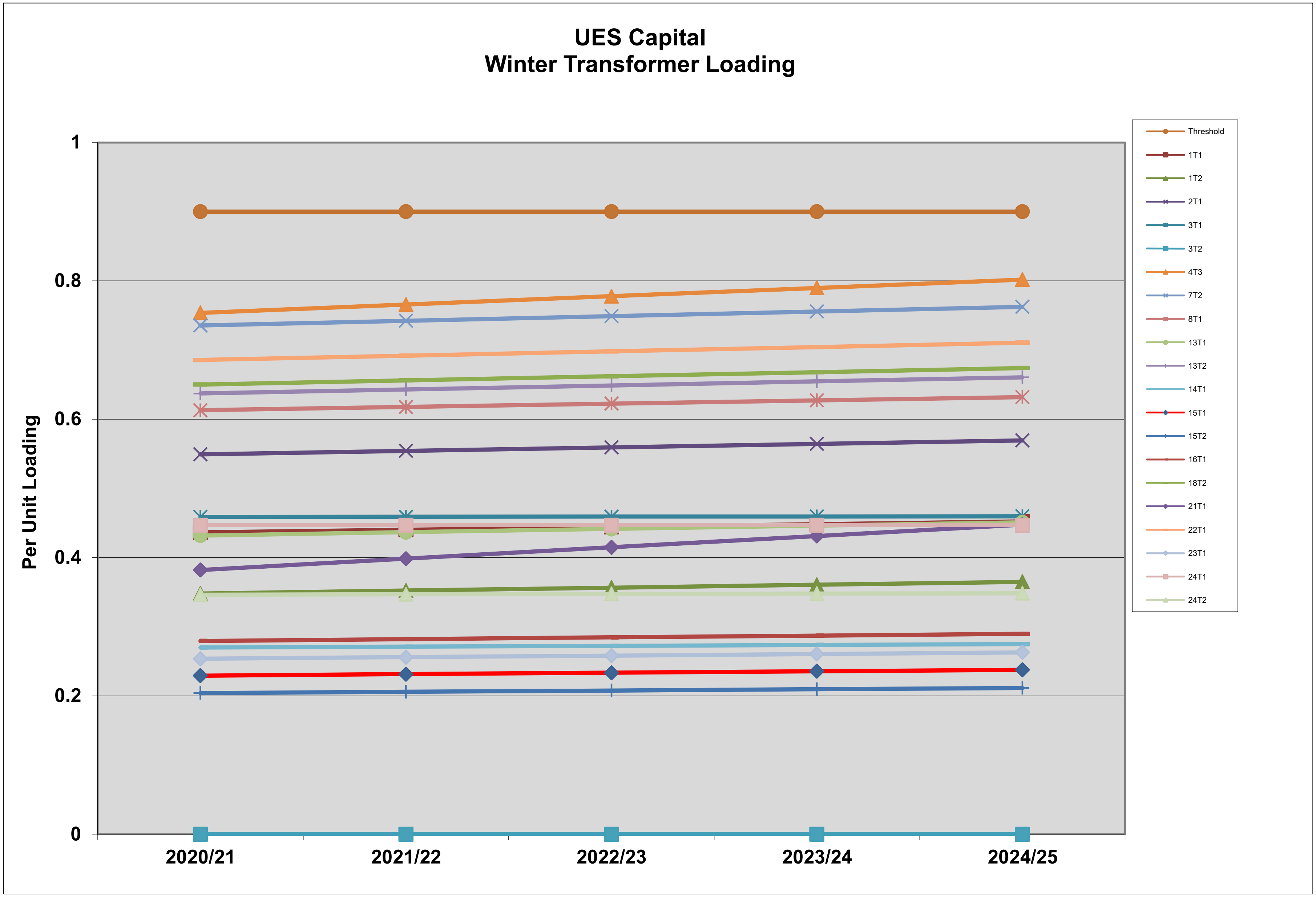
Distribution Element	Voltage Base (kV)	Breaker or Recloser: Continuous Rating Normal (Amps)	Breaker or Recloser: Continuous Rating LTE (Amps)	Breaker or Recloser: Trip Level Normal (Amps)	Breaker or Recloser: Trip Level LTE (Amps)	Breaker or Recloser: Load Enchroachment Normal (Amps)	Breaker or Recloser: Load Enchroachment LTE (Amps)	Current Transformer Present Tap Selection Normal (Amps)	Current Transformer Present Tap Selection LTE (Amps)	Switch Continuous Rating Normal (Amps)	Switch Continuous Rating LTE (Amps)	Fuse Limit Normal (Amps)	Fuse Limit LTE (Amps)	Regulator Limit Normal (Amps)	Regulator Limit LTE (Amps)	Conductor Rating Normal (Amps)	Conductor Rating LTE (Amps)	Transformer Rating Normal (Amps)	Transformer Rating LTE (Amps)	Overall Rating Normal (kVA)	Overall Rating LTE (kVA)	Overall Rating Normal (Amps)	Overall Rating LTE (Amps)	Limiting Element Normal	Limiting Element LTE
Bridge Street 1T1 Xfmr	4.16											1493	1493					1137	1171	8,190	8,436	1137	1171	Xfmr	Xfmr
1H3	4.16	560	560	414	448									480	480	325	325			2,342	2,342	325	325	Wire	Wire
1H4	4.16	560	560	296	320									480	480	500	607			2,133	2,306	296	320	Relay Set	Relay Set
1H5	4.16	600	600	444	480									480	480	415	415			2,990	2,990	415	415	Wire	Wire
Bridge Street 1T2 Xfmr	4.16											1493	1493					1137	1171	8,190	8,436	1137	1171	Xfmr	Xfmr
1H1	4.16	560	560	414	448									480	480	531	645			2,986	3,228	414	448	Relay Set	Relay Set
1H2	4.16	560	560	414	448									480	480	325	325			2,342	2,342	325	325	Wire	Wire
1H6	4.16	560	560	414	448									480	480	531	645			2,986	3,228	414	448	Relay Set	Relay Set
Bridge Street 1X7P	34.5	560	560											160	160	165	165			9,561	9,561	160	160	Reg	Reg
Bridge Street 1X7A	34.5											180	180			165	165			9,860	9,860	165	165	Wire	Wire
West Concord 2T1 Xfmr	4.16							800	800			1090	1090					787	811	5,670	5,764	787	800	Xfmr	CT
2H1	4.16	600	600	311	336									480	480	283	336			2,039	2,421	283	336	Wire	Relay Set
2H2	4.16	600	600	444	480									480	480	500	620			3,199	3,459	444	480	Relay Set	Relay Set
2H4	4.16	560	560	296	320									480	480	373	451			2,133	2,306	296	320	Relay Set	Relay Set
Gulf Street 3T1 Xfmr	4.16											1090	1090					702	716	5,060	5,160	702	716	Xfmr	Xfmr
3H1	4.16	600	600	311	336									480	480	500	620			2,239	2,421	311	336	Relay Set	Relay Set
3H2	4.16	600	600	311	336									480	480	373	451			2,239	2,421	311	336	Relay Set	Relay Set
Gulf Street 3T2 Xfmr	4.16											597	597					573	587	4,130	4,230	573	587	Xfmr	Xfmr
3H3	4.16	560	560	370	400											325	385			2,342	2,774	325	385	Wire	Wire
Gulf Street 3T3 Xfmr	13.8																								
3W4	13.8																								
3W5	13.8																								
Penacook 4X1	34.5	560	560	243	262							441	441			531	645			14,504	15,680	243	262	Relay Set	Relay Set
Penacook 4T3 Xfmr	13.8							600	600			432	432					521	530	10,326	10,326	432	432	Fuse	Fuse
4W3	13.8	400	400	296	320									240	240	415	415			5,737	5,737	240	240	Reg	Reg
4W4	13.8	400	400	296	320			400	400					394	459	283	336			6,764	7,649	283	320	Wire	Relay Set
Pleasant Street 6X3	34.5	800	800											241	281	500	620			14,413	16,815	241	281	Reg	Reg
Bow Junction 7X1	34.5	560	560	178	192			600	600							247	294			10,613	11,473	178	192	Relay Set	Relay Set
Bow Junction 7T2 Xfmr	13.8											432	432					516	529	10,326	10,326	432	432	Fuse	Fuse
7W3	13.8	800	800	355	384			600	600					394	459	531	645			8,490	9,178	355	384	Relay Set	Relay Set
7W4	13.8	800	800	444	480			600	600					589	668	531	645			10,613	11,473	444	480	Relay Set	Relay Set
Hollis 8T1 Xfmr	4.16											746	746					529	540	3,810	3,890	529	540	Xfmr	Xfmr
8H1	4.16	600	600	355	384			300	300	300	300					500	620			2,162	2,162	300	300	CT	CT
8H2	4.16	600	600	355	384			300	300	300	300					531	645			2,162	2,162	300	300	CT	CT
Hollis 8X3	34.5	560	560	370	400									668	668	373	451			22,110	23,902	370	400	Relay Set	Relay Set
Hollis 8X5	34.5	560	560	370	400									668	668	373	451			22,110	23,902	370	400	Relay Set	Relay Set
Boscawen 13T1 Xfmr	13.8											329	329					259	264	6,200	6,320	259	264	Xfmr	Xfmr
13W1	13.8	560	560	207	224			300	300	600	600			240	240	382	472			4,953	5,354	207	224	Relay Set	Relay Set
13W2	13.8	560	560	207	224			300	300	600	600			240	240	370	438			4,953	5,354	207	224	Relay Set	Relay Set
Boscawen 13T2 Xfmr	13.8											284	284					343	353	6,776	6,776	284	284	Fuse	Fuse
13W3	13.8	560	560	281	304			600	600	600	600			440	514	531	645			6,721	7,266	281	304	Relay Set	Relay Set
Boscawen 13X4	34.5	560	560	252	272							182	182			247	294			10,864	10,864	182	182	Fuse	Fuse
Langdon Street 14T1 Xfmr	4.16											1090	1090					702	716	5,060	5,160	702	716	Xfmr	Xfmr
14H1	4.16	560	560	414	448									480	480	463	562			2,986	3,228	414	448	Relay Set	Relay Set
14H2	4.16	560	560	414	448									480	480	537	653			2,986	3,228	414	448	Relay Set	Relay Set
Langdon 14X3	34.5											36	36							2,151	2,151	36	36	Fuse	Fuse
West Portsmouth 15T1 Xfmr	13.8											450	450					520	528	10,756	10,756	450	450	Fuse	Fuse
15W1	13.8	600	600	229	248									240	240	240	289			5,483	5,737	229	240	Relay Set	Reg
15W2	13.8	600	600	296	320									240	240	531	645			5,737	5,737	240	240	Reg	Reg
West Portsmouth 15T2 Xfmr	4.16											363	363					258	268	1,860	1,930	258	268	Xfmr	Xfmr
15H3	4.16															240	289			1,729	2,082	240	289	Wire	Wire
Terrill Park 16T1 Xfmr	4.16											1090	1090					860	877	6,200	6,320	860	877	Xfmr	Xfmr
16H1	4.16	560	560	296	320									480	480	340	411			2,133	2,306	296	320	Relay Set	Relay Set
16H3	4.16	560	560	414	448									480	480	531	645			2,986	3,228	414	448	Relay Set	Relay Set
Terrill Park 16X4	34.5	560	560	207	224															12,381	13,385	207	224	Relay Set	Relay Set
Terrill Park 16X5	34.5											81	81							4,840	4,840	81	81	Fuse	Fuse
Terrill Park 16X6	34.5											101	101							6,023	6,023	101	101	Fuse	Fuse
Bow Bog 18T2 Xfmr	13.8																	139	141	3,332	3,375	139	141	Xfmr	Xfmr
18W2	13.8	560	560	148	160			600	600	200	200	252	252			165	165			3,538	3,824	148	160	Relay Set	Relay Set
Storrs Street 21T1 Xfmr	13.8											148	160					377	388	3,538	3,824	148	160	Fuse	Fuse
21W1P	13.8									600	600					165	165			3,944	3,944	165	165	Wire	Wire
21W1A	13.8															165	165			3,944	3,944	165	165	Wire	Wire
Iron Works Road 22T1 Xfmr	13.8											432	432					521	530	10,326	10,326	432	432	Fuse	Fuse
22W1	13.8	560	560	207	224									240	240	247	294			4,953	5,354	207	224	Relay Set	Relay Set
22W2	13.8	560	560	207	224									240	240	531	645			4,953	5,354	207	224	Relay Set	Relay Set
22W3	13.8	560	560	296	320			300	300					394	459	531	645			7,075	7,171	296	300	Relay Set	CT
Montgomery Street 23T1 Xfmr	13.8							600	600			308	308					377	388	7,368	7,368	308	308	Fuse	Fuse
21W1P	13.8									600	600					165	165			3,944	3,944	165	165	Wire	Wire
21W1A	13.8															165	165			3,944	3,944	165	165	Wire	Wire
Hazen Drive 24T1 Xfmr	4.16											582	582					376	383	2,710	2,760	376	383	Xfmr	Xfmr
24H1	4.16	560	560	355	384											247	294			1,780	2,118	247	294	Wire	Wire
Hazen Drive 24T2 Xfmr	4.16											940	940					533	544	3,840	3,920	533	544	Xfmr	Xfmr
24H2	4.16	1200	1200	355	384											385	385			2,559	2,767	355	384	Relay Set	Relay Set
24H3	4.16	1200	1200	355	384											385	385			2,559	2,767	355	384	Relay Set	Relay Set
33 Line - Little Pond Rd	13.8											237	237	120	140	141	168	17	17	400	400	17	17	Xfmr	Xfmr
37X1	34.5															364	364			21,751	21,751	364	364	Wire	Wire

Distribution Element	Voltage Base	Breaker or Recloser Continuous Rating		Breaker or Recloser Trip Level		Breaker or Recloser Load Enchroachment		Current Transformer Present Tap Selection		Switch Continuous Rating		Fuse Limit		Regulator Limit		Conductor Rating		Transformer Rating		Overall Rating		Overall Rating		Limiting Element	
	(kV)	Normal (Amps)	LTE (Amps)	Normal (Amps)	LTE (Amps)	Normal (Amps)	LTE (Amps)	Normal (Amps)	LTE (Amps)	Normal (Amps)	LTE (Amps)	Normal (Amps)	LTE (Amps)	Normal (Amps)	LTE (Amps)	Normal (Amps)	LTE (Amps)	Normal (Amps)	LTE (Amps)	Normal (kVA)	LTE (kVA)	Normal (Amps)	LTE (Amps)	Normal	LTE
Bridge Street 1T1 Xfmr	4.16											1493	1493					1282	1347	9,240	9,702	1282	1347	Xfmr	Xfmr
1H3	4.16	560	560	414	448									480	480	325	325			2,342	2,342	325	325	Wire	Wire
1H4	4.16	560	560	296	320									480	480	653	731			2,133	2,306	296	320	Relay Set	Relay Set
1H5	4.16	600	600	444	480									480	480	415	415			2,990	2,990	415	415	Wire	Wire
Bridge Street 1T2 Xfmr	4.16											1493	1493					1171	1171	8,436	8,436	1171	1171	Xfmr	Xfmr
1H1	4.16	560	560	414	448									480	480	694	777			2,986	3,228	414	448	Relay Set	Relay Set
1H2	4.16	560	560	414	448									480	480	325	325			2,342	2,342	325	325	Wire	Wire
1H6	4.16	560	560	414	448									480	480	694	777			2,986	3,228	414	448	Relay Set	Relay Set
Bridge Street 1X7P	34.5	560	560											160	160	165	165			9,561	9,561	160	160	Reg	Reg
Bridge Street 1X7A	34.5											180	180			165	165			9,860	9,860	165	165	Wire	Wire
West Concord 2T1 Xfmr	4.16							800	800			1090	1090					910	960	5,764	5,764	800	800	CT	CT
2H1	4.16	600	600	311	336									480	480	369	405			2,239	2,421	311	336	Relay Set	Relay Set
2H2	4.16	600	600	444	480									480	480	696	778			3,199	3,459	444	480	Relay Set	Relay Set
2H4	4.16	560	560	296	320									480	480	486	543			2,133	2,306	296	320	Relay Set	Relay Set
Gulf Street 3T1 Xfmr	4.16											1090	1090					798	838	5,750	6,040	798	838	Xfmr	Xfmr
3H1	4.16	600	600	311	336									480	480	696	778			2,239	2,421	311	336	Relay Set	Relay Set
3H2	4.16	600	600	311	336									480	480	486	543			2,239	2,421	311	336	Relay Set	Relay Set
Gulf Street 3T2 Xfmr	4.16											597	597					647	679	4,302	4,302	597	597	Fuse	Fuse
3H3	4.16	560	560	370	400											424	464			2,666	2,882	370	400	Relay Set	Relay Set
Gulf Street 3T3 Xfmr																									
3W4																									
3W5																									
Penacook 4X1	34.5	560	560	243	262							441	441			694	777			14,504	15,680	243	262	Relay Set	Relay Set
Penacook 4T3 Xfmr	13.8							600	600			432	432					584	584	10,326	10,326	432	432	Fuse	Fuse
4W3	13.8	400	400	296	320									240	240	415	415			5,737	5,737	240	240	Reg	Reg
4W4	13.8	400	400	296	320			400	400					476	476	369	405			7,075	7,649	296	320	Relay Set	Relay Set
Pleasant Street 6X3	34.5	800	800											291	291	696	778			17,416	17,416	291	291	Reg	Reg
Bow Junction 7X1	34.5	560	560	178	192			600	600							322	354			10,613	11,473	178	192	Relay Set	Relay Set
Bow Junction 7T2 Xfmr	13.8											432	432					575	575	10,326	10,326	432	432	Fuse	Fuse
7W3	13.8	800	800	355	384			600	600					476	476	694	777			8,490	9,178	355	384	Relay Set	Relay Set
7W4	13.8	800	800	444	480			600	600					668	668	694	777			10,613	11,473	444	480	Relay Set	Relay Set
Hollis 8T1 Xfmr	4.16											746	746					598	634	4,310	4,570	598	634	Xfmr	Xfmr
8H1	4.16	600	600	355	384			300	300	300	300					696	778			2,162	2,162	300	300	CT	CT
8H2	4.16	600	600	355	384			300	300	300	300					694	777			2,162	2,162	300	300	CT	CT
Hollis 8X3	34.5	560	560	370	400									668	668	486	543			22,110	23,902	370	400	Relay Set	Relay Set
Hollis 8X5	34.5	560	560	370	400									668	668	486	543			22,110	23,902	370	400	Relay Set	Relay Set
Boscawen 13T1 Xfmr	13.8											329	329					292	304	6,980	7,260	292	304	Xfmr	Xfmr
13W1	13.8	560	560	207	224			300	300	600	600			240	240	530	591			4,953	5,354	207	224	Relay Set	Relay Set
13W2	13.8	560	560	207	224			300	300	600	600			240	240	483	528			4,953	5,354	207	224	Relay Set	Relay Set
Boscawen 13T2 Xfmr	13.8											284	284					384	403	6,776	6,776	284	284	Fuse	Fuse
13W3	13.8	560	560	281	304			600	600	600	600			525	525	694	777			6,721	7,266	281	304	Relay Set	Relay Set
Boscawen 13X4	34.5	560	560	252	272							182	182			322	354			10,864	10,864	182	182	Fuse	Fuse
Langdon Street 14T1 Xfmr	4.16											1090	1090					798	838	5,750	6,040	798	838	Xfmr	Xfmr
14H1	4.16	560	560	414	448									480	480	605	677			2,986	3,228	414	448	Relay Set	Relay Set
14H2	4.16	560	560	414	448									480	480	702	787			2,986	3,228	414	448	Relay Set	Relay Set
Langdon 14X3	34.5											36	36							2,151	2,151	36	36	Fuse	Fuse
West Portsmouth 15T1 Xfmr	13.8											450	450					584	610	10,756	10,756	450	450	Fuse	Fuse
15W1	13.8	600	600	229	248									240	240	312	348			5,483	5,737	229	240	Relay Set	Reg
15W2	13.8	600	600	296	320									240	240	694	777			5,737	5,737	240	240	Reg	Reg
West Portsmouth 15T2 Xfmr	4.16											363	363					303	321	2,180	2,310	303	321	Xfmr	Xfmr
15H3	4.16															312	348			2,248	2,507	312	348	Wire	Wire
Terrill Park 16T1 Xfmr	4.16											1090	1090					962	1001	6,930	7,210	962	1001	Xfmr	Xfmr
16H1	4.16	560	560	296	320									480	480	443	495			2,133	2,306	296	320	Relay Set	Relay Set
16H3	4.16	560	560	414	448									480	480	694	777			2,986	3,228	414	448	Relay Set	Relay Set
Terrill Park 16X4	34.5	560	560	207	224															12,381	13,385	207	224	Relay Set	Relay Set
Terrill Park 16X5	34.5											81	81							4,840	4,840	81	81	Fuse	Fuse
Terrill Park 16X6	34.5											101	101							6,023	6,023	101	101	Fuse	Fuse
Bow Bog 18T2 Xfmr	13.8																	158	167	3,780	3,980	158	167	Xfmr	Xfmr
18W2	13.8	560	560	148	160			600	600	200	200	252	252			165	165			3,538	3,824	148	160	Relay Set	Relay Set
Storrs Street 21T1 Xfmr	13.8											148	160					433	459	3,538	3,824	148	160	Fuse	Fuse
21W1P	13.8									600	600					165	165			3,944	3,944	165	165	Wire	Wire
21W1A	13.8															165	165			3,944	3,944	165	165	Wire	Wire
Iron Works Road 22T1 Xfmr	13.8											432	432					582	611	10,326	10,326	432	432	Fuse	Fuse
22W1	13.8	560	560	207	224									240	240	322	354			4,953	5,354	207	224	Relay Set	Relay Set
22W2	13.8	560	560	207	224									240	240	694	777			4,953	5,354	207	224	Relay Set	Relay Set
22W3	13.8	560	560	296	320			300	300					476	476	694	777			7,075	7,171	296	300	Relay Set	CT
Montgomery Street 23T1 Xfmr	13.8							600	600			308	308					430	451	7,368	7,368	308	308	Fuse	Fuse
21W1P	13.8									600	600					165	165			3,944	3,944	165	165	Wire	Wire
21W1A	13.8															165	165			3,944	3,944	165	165	Wire	Wire
Hazen Drive 24T1 Xfmr	4.16											582	582					426	450	3,070	3,240	426	450	Xfmr	Xfmr
24H1	4.16	560	560	355	384											322	354			2,320	2,551	322	354	Wire	Wire
Hazen Drive 24T2 Xfmr	4.16											940	940					602	636	4,340	4,580	602	636	Xfmr	Xfmr
24H2	4.16	1200	1200	355	384											385	385			2,559	2,767	355	384	Relay Set	Relay Set
24H3	4.16	1200	1200	355	384											385	385			2,559	2,767	355	384	Relay Set	Relay Set
33 Line - Little Pond Rd	13.8											237	237	145	145	184	203	17	17	400	400	17	17	Xfmr	Xfmr
37X1	34.5															694	777			41,470	46,430	694	777	Wire	Wire

Appendix C

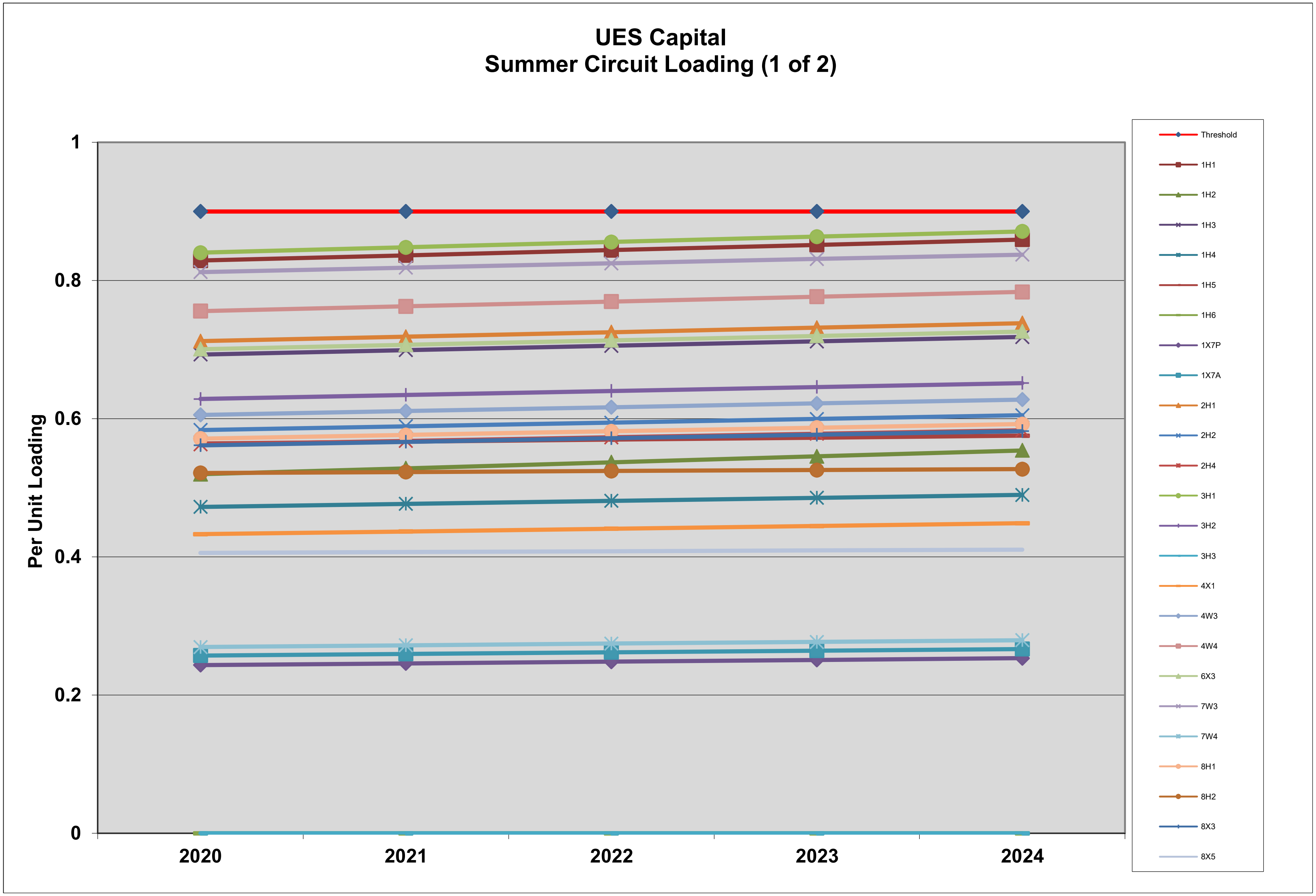
Transformer Loading Charts
(In Per Unit)

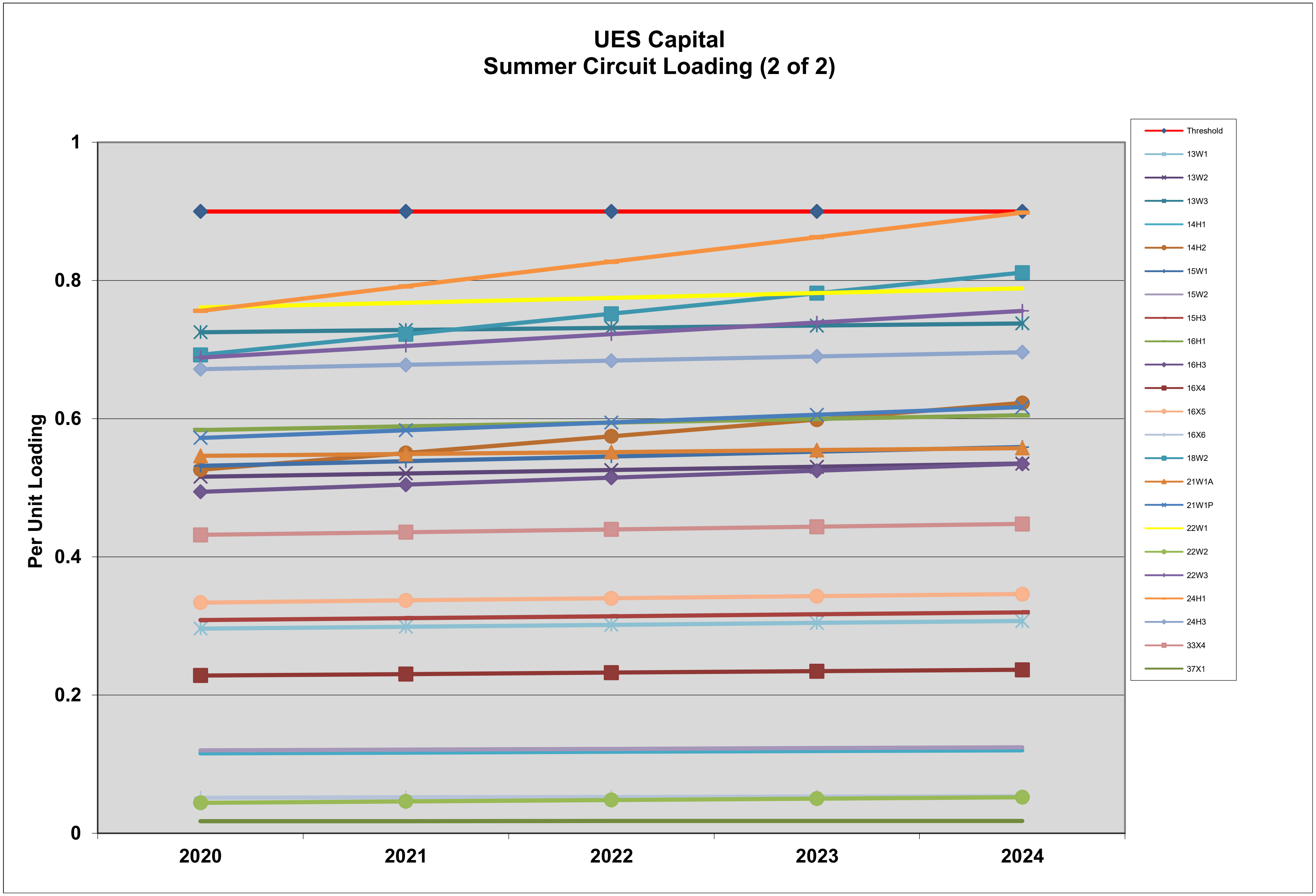

UES Capital
Summer Transformer Loading
Per Unit Loading
1.2
1
0.8
0.6
0.4
0.2
0
2020
2021
2022
2023
2024
Threshold
1T1
1T2
2T1
3T1
3T2
2T1
3T1
3T2
4T3
7T2
8T1
13T1
13T2
14T1
15T1
15T2
16T1
18T2
21T1
22T1
23T1
24T1
24T2

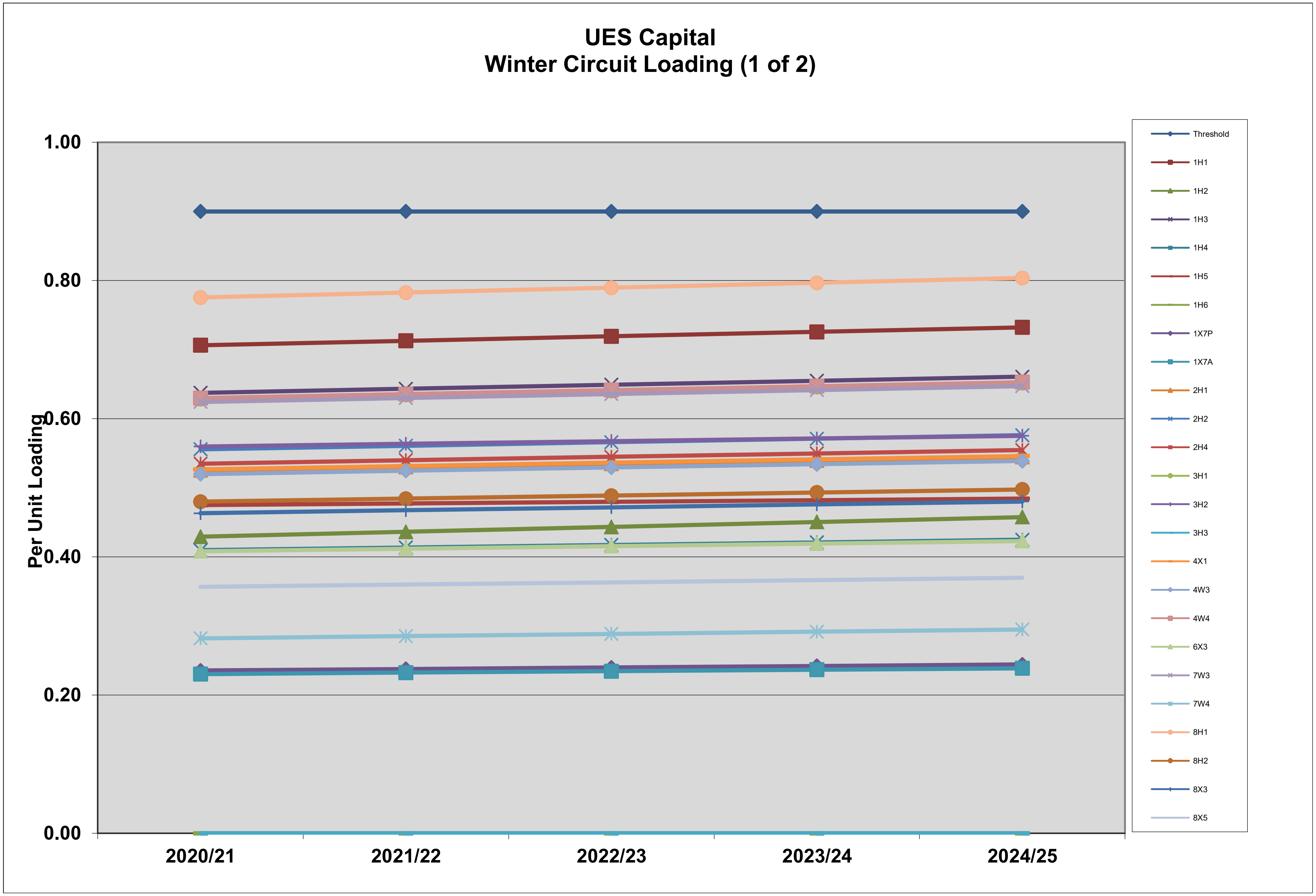

UES Capital
Winter Transformer Loading
Per Unit Loading
1
0.8
0.6
0.4
0.2
0
2020/21
2021/22
2022/23
2023/24
2024/25
Threshold
1T1
1T2
2T1
3T1
3T2
4T3
7T2
8T1
13T1
13T2
14T1
15T1
15T2
16T1
18T2
21T1
22T1
23T1
24T1
24T2

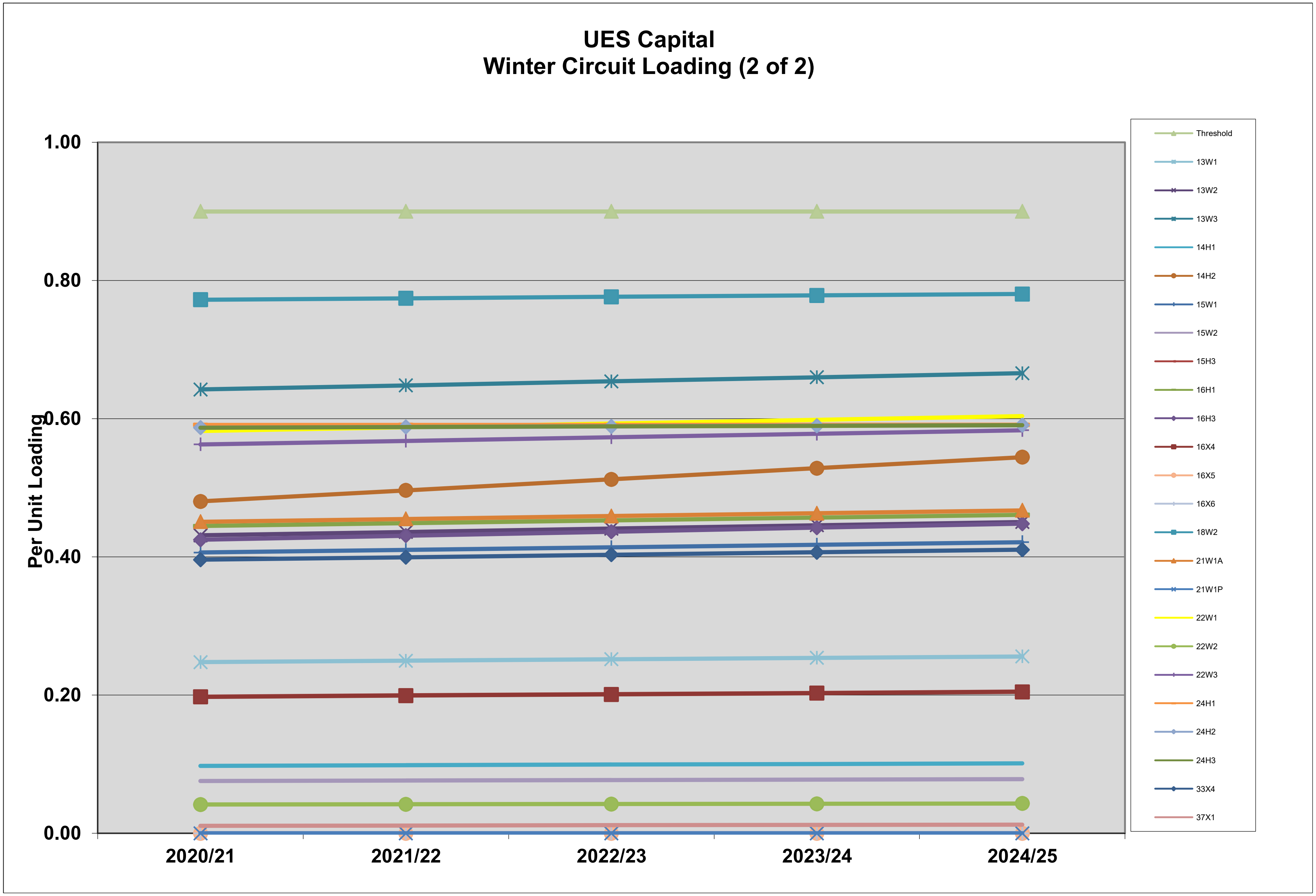
Appendix D

Circuit Loading Charts
(In Per Unit)


UES Capital
Summer Circuit Loading (1 of 2)
Per Unit Loading
1
0.8
0.6
0.4
0.2
0
2020
2021
2022
2023
2024
Threshold
1H1
1H2
1H3
1H4
1H5
1H6
1X7P
1X7A
2H1
2H2
2H4
3H1
3H2
3H3
4X1
4W3
4W4
6X3
7W3
7W4
8H1
8H2
8X3
8X5


UES Capital
Summer Circuit Loading (2 of 2)
Per Unit Loading
1
0.8
0.6
0.4
0.2
0
2020
2021
2022
2023
2024
Threshold
13W1
13W2
13W3
14H1
14H2
15W1
15W2
15H3
16H1
16H3
16X4
16X5
16X6
18W2
21W1A
21W1P
22W1
22W2
22W3
24H1
24H3
33X4
37X1


UES Capital
Winter Circuit Loading (1 of 2)
Per Unit Loading
1.00
0.80
0.60
0.40
0.20
0.00
2020/21
2021/22
2022/23
2023/24
2024/25
Threshold
1H1
1H2
1H3
1H4
1H5
1H6
1X7P
1X7A
2H1
2H2
2H4
3H1
3H2
3H3
4X1
4W3
4W4
6X3
7W3
7W4
8H1
8H2
8X3
8X5


UES Capital
Winter Circuit Loading (2 of 2)
Per Unit Loading
1.00
0.80
0.60
0.40
0.20
0.00
2020/21
2021/22
2022/23
2023/24
2024/25
Threshold
13W1
13W2
13W3
14H1
14H2
15W1
15W2
15H3
16H1
16H3
16X4
16X5
16X6
18W2
21W1A
21W1P
22W1
22W2
22W3
24H1
24H2
24H3
33X4
37X1

Appendix E

Circuit Tie Analysis

Circuit Tie	Restoring Circuit	Restored Circuit	Limit of Restoration during Summer Peak	Accepted Planning Violations	Limiting Element w/ Summer Normal Rating	% Peak Loading & Max Per-Phase Amps at S/S when Tie is Usable to Restore Entire Circuit	Accepted Planning Violations
7W3J7W4	7W3	7W4	Open @ P.90 South St	S/S Regulators @ 90% rating - 393A	S/S Regulator Rating - 393A	90% Peak, 391A Per Phase on Circuit	S/S Regulators @ 100% loading
	7W4	7W3	No Limit	None	N/A	N/A	None
7W3J18W2	7W3	18W2	Open @ P.1 Dunbarton Center Rd and P.150-X Woodhill Rd	Solids @ 91% rating - 300A	P.1 Robinson Rd Fuse - 130A	70% Peak, 122A Per Phase on Circuit	Fuse @ 94% loading
	18W2	7W3	Cannot carry at Peak	None	Bow Bog XFMR - 139A	35% Peak, 136A Per Phase on Circuit	XFMR @ 98% loading
7W3J22W3	7W3	22W3	Open @ P.1 Albin Rd	S/S Regulators @ 98% rating - 393A	S/S Regulator Rating - 393A	65% Peak, 331A Per Phase on Circuit	114V on Primary
	22W3	7W3	Open @ P.1 Carriage Rd	Iron Works Rd 1/0 ACSR @ 90% rating - 247A	Iron Works Rd 1/0 ACSR - 247A	56% Peak, 217A Per Phase on Circuit	114V on Primary
7W4J22W1	7W4	22W1	No Limit	Solids @ 95% rating - 300A	P.7 Storrs St Solids - 300A	100% Peak, 301A Per Phase on Circuit	Solids @ 95% loading
	22W1	7W4	Open @ P.23 South St	None	S/S Regulator Rating - 240A	80% Peak, 237A Per Phase on Circuit	2/0 ACSR @ 99% loading
7W4J22W2	7W4	22W2	No Limit	None	N/A	N/A	None
	22W2	7W4	No Limit	None	N/A	N/A	None
18W2J22W3	18W2	22W3	Cannot carry at Peak	None	S/S XFMR - 139A	42% Peak, 136A Per Phase on Circuit	XFMR @ 98% loading
	22W3	18W2	Cannot carry at Peak	None	Iron Works Rd 1/0 ACSR - 247A	70% Peak, 233A Per Phase on Circuit	1/0 ACSR @ 94% loading, 114V on Bow Center Rd
22W1J22W2-1	22W1	22W2	No Limit	None	N/A	N/A	None
	22W2	22W1	No Limit	None	N/A	N/A	None
22W1J22W3-2	22W1	22W3	Open @ P.1 Albin Rd and P.93 Clinton St	None	S/S Regulator Rating - 240A	65% Peak, 238A Per Phase on Circuit	S/S Regulators @ 98% loading
	22W3	22W1	Open @ P.23 Clinton St	Iron Works Rd 1/0 ACSR @ 98% rating - 247A	Iron Works Rd 1/0 ACSR - 247A	69% Peak, 245A Per Phase on Circuit	Trip Limit @ 98% loading
22W2J22W3	22W2	22W3	No Limit	None	N/A	N/A	None
	22W3	22W2	No Limit	Iron Works Rd 1/0 ACSR @ 91% rating - 247A	Iron Works Rd 1/0 ACSR - 247A	100% Peak, 225A Per Phase on Circuit	1/0 ACSR @ 91% loading
8H1J24H1	8H1	24H1	Cannot carry at Peak	None	Hollis 250 CU_UG - 320A	96% Peak, 306A Per Phase on Circuit	250 CU_UG @ 96% loading
	24H1	8H1	Cannot carry at Peak	None	Hazen Dr 1/0 ACSR - 247A	63% Peak, 242A Per Phase on Circuit	1/0 ACSR @ 98% loading, 115V on Primary
8H1J8H2-1	8H1	8H2	Open @ P.34 Pembroke Rd	Hollis 250 CU_UG @ 96% rating - 320A	Hollis 250 CU_UG - 320A	95% Peak, 311A Per Phase on Circuit	250 CU_UG @ 98% loading
	8H2	8H1	Open @ P.43-X Loudon Rd	None	Hollis 250 CU_UG - 320A	95% Peak, 311A Per Phase on Circuit	251 CU_UG @ 98% loading
8H1J8H2-2	8H1	8H2	Open @ P.34 Pembroke Rd	Hollis 250 CU_UG @ 96% rating - 320A	Hollis 250 CU_UG - 320A	95% Peak, 311A Per Phase on Circuit	250 CU_UG @ 98% loading
	8H2	8H1	Open @ P.43-X Loudon Rd	None	Hollis 250 CU_UG - 320A	95% Peak, 311A Per Phase on Circuit	250 CU_UG @ 98% loading
8H2J24H2	8H2	24H2	Cannot carry at Peak	None	Sullivan St 1/0 Al_UG - 165A	50% Peak, 205A Per Phase on Circuit	114V on Primary
	24H2	8H2	Cannot carry at Peak	None	S/S Regulator Rating - 331A	83% Peak, 328A Per Phase on Circuit	S/S Regulators @ 99% loading
16H1J16H3	16H1	16H3	Open @ P.2 Terrill Park Dr	Terrill Park Dr 3/0 AAC @ 97% - 340A	Terrill Park Dr 3/0 AAC - 340A	70% Peak, 271A Per Phase on Circuit	114.5V on Primary
	16H3	16H1	Open @ P.1 Airport Rd	Airport Rd Fuse @ 96% rating - 190A	Airport Rd 125N Fuse - 190A	93% Peak, 361A Per Phase on Circuit	125N Fuse @ 99% loading
16H1J24H2	16H1	24H2	Open @ P.12 and P.13 Loudon Rd	Low Voltage on Loudon Rd - 115.8V	Airport Rd 1/0 ACSR - 247A	42% Peak, 181A Per Phase on Circuit	114V on Primary
	24H2	16H1	Open @ P.1 Airport Rd	None	S/S Regulator Rating - 331A	79% Peak, 329A Per Phase on Circuit	S/S Regulators @ 99% loading
24H301A	24H1	24H3	No Limit	None	N/A	N/A	None
	24H3	24H1	No Limit	None	N/A	N/A	None
24H301B	24H2	24H3	No Limit	None	N/A	N/A	None
	24H3	24H2	No Limit	None	N/A	N/A	None

Appendix F

Master Plan Map


HAZEN DR
EAST SIDE DR
SHEEP DAVIS RD NORTH
ORMOND ST
CANTERBURY RD
BRANCH TPKE
LOUDON RD
PEMBROKE RD
CHENNEL DR
SHEEP DAVIS RD SOUTH
REGIONAL DR
AIRPORT RD
TERRILL PARK S/S
TERRILL PARK DR
OLD TURNPIKE RD
RUMFORD ST
STICKNEY AVE
MONTGOMERY ST S/S
STORRS ST S/S
CENTER ST
LOUDON RD
WASHINGTON ST
N SPRING ST
S STATE ST
STORRS ST
PINE ST
WARREN ST
PLEASANT ST
THEATRE ST
THOMPSON ST
S SPRING ST
THORNDIKE ST
13.8kV Mainline
13.8kV Mainline - Future
13.8kV Downtown UG
34.5kV Mainline
34.5kV Mainline - Future
34.5kV Sub-T

APPENDIX M

UES-SEACOAST 2020-2024 DISTRIBUTION SYSTEM PLANNING STUDY

Unitil Energy Systems – Seacoast

Distribution System Planning Study 2020-2024

Prepared By:

Jake Dusling
Unitil Service Corp.
October 25, 2019

TABLE OF CONTENTS

1. Executive Summary

This study is an evaluation of the Unitil Energy Systems – Seacoast (UES–Seacoast) electric distribution system. 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 prepare plans for the most cost-effective system improvements. The timeframe of this study is the summer peak load period over the next five years, from the summer of 2020 through the summer of 2024.

Projects currently under construction or that are expected to be completed in 2019 are assumed to be in service for the beginning year of this study.

The following items may require action within the 5-year study period. All cost estimates provided in this report are without general construction overheads.

Year	Project Description	Justification	Cost
2020	Timberlane S/S 13W2 Recloser – Replace Relay	Loading 93%	$17,500
2020	Circuit 23X1 – Install Regulator Wild Pasture Road	Voltage 115.5V	$30,000
2020	Circuit 23X1 – Install Regulator Amesbury Road	Voltage 115.9V	$30,000
2020	Circuit 13X3 – Install Regulators Old County Road	Voltage 115.9V	$70,000
2020	Circuit 22X1 – Install Regulator Colby Road	Voltage 116.5V	$30,000
2020	Circuit 19H1 – Transfer Load to 27X1	Voltage 116.6V Condition	$150,000
2020	Circuit 54X1 – Install Regulator Main Street	Voltage 116.9V	$30,000
2022	20T1 Transformer – Transfer Load to 28X1	Loading 91%	$225,000
2023	Circuit 19X3 – Replace cutouts with Switch	Loading 91%	$25,000
2024	Circuit 23X1 – Convert Portion of South Road	Loading 90%	$150,000
2024	Circuit 5X3 – Install Regulator Smith Corner Road	Voltage 116.9V	$30,000

2. System Configuration

The UES–Seacoast distribution system is comprised of 43 distribution circuits operating at primary voltages of 4.16, 13.8 and 34.5 kV. The majority of these circuits originate from 15 distribution substations supplied off the UES–Seacoast 34.5 kV subtransmission system, while 14 circuits are tapped directly off subtransmission lines. Additionally, there is one customer-owned subtransmission line tap supplied off the 34.5 kV subtransmission system and a few other distribution taps off the subtransmission lines to serve single customers.

The UES–Seacoast subtransmission system consist of 18 lines and is presently supplied from Eversource Energy's 345 kV and 115 kV transmission systems via three Eversource Energy substations, Timber Swamp, Peaslee, and Great Bay.

Timber Swamp substation, located in northwest Hampton, presently consists of a 345 kV high-side ring bus, two 345–34.5 kV, 75/100/125/140 MVA transformers, and two 34.5 kV low-side buses separated by a normally open bus tie breaker. Presently, one 34.5 kV bus supplies two line terminals feeding the UES-Seacoast 3360 and 3371 lines and second 34.5 kV bus supplies three line terminals feeding Eversource load. The 3360 and 3371 34.5 kV subtransmission lines transfer power from Timber Swamp substation to Guinea switching station serving loads in several UES-Seacoast service territory towns.

Peaslee substation, located in central Kingston is a 5 terminal 115 kV switching station with two outgoing 115 kV lines that supply the UES–Seacoast Kingston substation. Kingston substation consists of two 115-34.5 kV, 60 MVA transformers, supplying six UES–Seacoast 34.5 kV lines. Two of these lines supply five distribution substations to the southwest, two lines provide support to the northeast, and two line serves distribution load throughout Kingston and Danville.

Great Bay substation is located in southern Stratham. Great Bay consists of a 115 kV high-side bus, a single 115–34.5 kV, 24/32/40/44.8 MVA transformer, and a 34.5 kV low-side bus. Two 34.5 kV subtransmission lines exit Great Bay Substation and supply eight distribution substations and taps which serve loads in the Stratham and Exeter areas.

3. Study Focus

This study is primarily focused on the 34.5, 13.8 and 4.16 kV distribution substations and circuits. System modifications are based upon general distribution planning criteria. An evaluation of the 34.5 kV subtransmission system is made under a separate electric system planning study.

The first objective of this distribution planning study is to identify and propose solutions to correct specific conditions that do not meet design or operating criteria. The second objective is to develop and communicate a master plan for the development of a robust and efficient distribution system to accommodate long-term improvement and expansion throughout and beyond the study years. Recommendations are based on system adequacy, reliability and economy among available alternatives.

4. Load Projections

A five year history of summer and winter peak demands for each individual circuit were developed from monthly peak demand readings. A linear regression analysis was performed on the historical loads to forecast future peak demands for substation transformers, circuits and other major devices. Attempts were made to take into account known significant load additions, shifts in load between circuits, etc. In some instances, the peak loads did not present a confident trend over the historical period, so estimates were made using the best available information and knowledge of the circuit. In general, one standard deviation was added to these forecasts to account for differences from year to year in the severity of summer heat and other varying factors.

This methodology does not directly forecast future DG interconnections or other DER projects/initiatives such as energy efficiency programs. Rather the impact of DG and other DER programs are inherent in the historical regression analysis by offsetting most recent peak loads thereby reducing projected growth rates at the circuit level. It is recognized that the reduction in circuit growth rates will lag DG interconnections and other DER projects implemented in a given year. However, since load forecasts are completed annually, the timing of projects identified in the planning process is continually reviewed and updated.

Summer and winter peak load projections of all circuits and substation transformers for the five year study period are listed in Appendix A.

The following table shows the five circuits with the highest annual growth rates.

Ranking	**Circuit**	**Average Annual Load Growth**	**Total Load Growth 2019-2023 (kVA)**
1	19X3	3.0%	1,954
2	23X1	2.2%	327
3	19X2	2.1%	447
4	2X3	2.0%	470
5	2X2	1.7%	693

The projection analysis can be referenced in Appendix A.

5. Rating Analysis

A detailed review of the limiting factors associated with each circuit was completed. The limiting factors include current transformers (CT), switches, circuit exit conductors, regulators, power transformers and protective device settings. Overall circuit ratings are based upon the most restrictive of these limiting elements. The distribution system circuit limitations can be referenced in Appendix B. These circuit ratings were compared to summer and winter peak load projections found in Appendix A.

Projected loads reaching certain thresholds prompted a closer assessment of the conditions. Shading, as shown below, has been added to the projection analysis to provide a visual representation of potential problem areas. The analysis of circuits and transformers reaching 90% or higher of their normal ratings are described in the following section 6.

In the five-year period of this study, 16 of the 44 circuits studied and 9 of the 14 UES-Seacoast transformers are projected to be loaded over 50% of the normal limit. There is 1 distribution substation transformer and 1 distribution circuit projected to be loaded over 90% of the normal limit during the study period.

Legend
loading < 50% of Normal Limit
50% ≤ loading ≤ 90% of Normal Limit
90% < loading ≤ 100% of Normal Limit
100% of Normal Limit < loading

6. Transformer and Circuit Loading Analysis

Transformer and circuit loadings have been compared to the respective ratings. The monthly per phase transformer load readings are added together and then converted to kVA. In order to maintain some conservatism, those transformers and circuits which have reached 90% of the limiting factor have been highlighted and will be discussed later in the section. The threshold of 90% was taken to account for phase loading imbalance.

This section details the findings resulting from the analysis described in Section 5 as well as an analysis of stepdown transformer loadings and a review of circuit load phase imbalance. Individual project descriptions, justification, predicted benefits and associated cost estimates intended to address each of the identified issues are included in Section 8.

6.1. Distribution Substation Transformer Loadings

Distribution substation transformers where the projected load reaches 90% or more of their seasonal rating are listed here. Charts displaying the summer and winter loading of transformers, in per unit, are included in Appendix C.

Dow’s Hill 4.16 kV Substation Transformer
Peak demand loading for the Dow’s Hill 20T1 transformer is projected to reach as much as 1,689 kVA, 91% of its summer normal rating in 2022. It is projected to reach 1,726 kVA, 93% of its summer normal rating by the summer of 2024.

6.2. Distribution Substation Equipment Loadings

Circuit elements where the projected load will reach 90% or more of their normal rating are listed below. Summer and winter circuit loading graphs are included in Appendix D.

Timberlane – Circuit 13W2
Peak demand loading for Circuit 13W2 out of Timberlane S/S is projected to reach as much as 4,604 kVA (93% of phase overcurrent minimum pick-up flag) by the summer of 2020, and increase to as much as 4,896 kVA (99% of phase overcurrent minimum pick-up flag) by the summer of 2024.

6.3. Distribution Stepdown Transformer Loadings

The Summer Normal Limit used for distribution stepdown transformer loading analysis is 120% of the nameplate rating. This is based upon the “Normal Life Expectancy Curve” in ANSI/IEEE C57.91-latest. The ambient temperature assumed is 30°C (86°F).

The following table summarizes the distribution stepdown transformers that are projected to exceed their Summer Normal limit during the study period. Shading has been added to the projections to provide a visual representation of potential overloads.

Legend

loading < 90% of Limit
90% < loading ≤ 100% of Limit
100% of Limit < loading

CIRCUIT / LOCATION	TOWN	POLE #	Year Expected to Exceed 90%/100% of Rating	TRANSFORMER SIZE (kVA)			2020 Projected % Loading of Summer Limit			
				A	B	C	A	B	C	BANK
43X1 – South Road	Kensington	32/83	2021/2024	333			88%			88%

6.4. Phase Imbalances

All of the circuits within the UES-Seacoast service territory were reviewed for phase balance. The per phase loading for each circuit was averaged over a timeframe of January 2018 through December 2018. Circuits and substation transformers were ranked based upon the worst average phase imbalances (greatest deviation from the average).

In general, the goal for phase balancing is 10%. Circuits, where the imbalance is greater than 20% (which is considered severe) are reviewed in more detail to determine the severity of the problem. There are no circuits on the UES-Seacoast system that will require projects in 2020 to address phase imbalance.

7. Circuit Analysis Results

Detailed circuit analysis is completed for the UES-Seacoast distribution system on a three year rotating cycle, where each circuit is reviewed once every three years. Milsoft Windmil software is used to model the system impedances and loads to identify potential problems areas. The circuit analysis performed includes voltage drop, load flow, and protection analysis. All identified problems should be followed up with verification from field measurements. Solutions to the deficiencies noted below are detailed in Section 8.

The following is a list of the circuits analyzed in 2019. All other UES-Seacoast circuits not shown on this listing were reviewed for planning purposes. However, models for those circuits were not re-created and analyzed to the level of detail as the circuits listed.

Substation	Circuit	Substation	Circuit
Plaistow S/S	5X3	Kingston S/S	22X1
Timberlane S/S	13W1		22X2
	13W2	Winnicutt Road Tap	51X1
	13X3	New Boston Road Tap	54X1
Westville S/S	21W1		54X2
	21W2	Hunt Road Tap	56X1
Guinea Road Tap	47X1	Dorre Road Tap	56X2

Additionally, two UES-Seacoast circuits (19X3 and 13X3) met the threshold, more than 500KW or 15% of circuit peak load of aggregate DG, to analyze the circuits for unacceptable voltage conditions due to DG penetration. No violations were identified on these circuit due to existing DG.

7.1. Voltage Concerns

Voltage drop analysis is performed to identify areas where the primary voltage on the circuit may be outside of a pre-determined acceptable range. The acceptable primary voltage range used for this analysis is 117-125 V on a 120 V base in order to maintain service voltage within the required ANSI range. This allows for a three-volt drop to the meter in the forward direction and a one-volt drop in the reverse direction to accommodate DG back feed. The following table summarize the areas where primary voltage is expected to be outside of this range. The table is sorted by circuit and year.

Circuit	Year	Voltage	Location
23X1	2020	115.5V	Wild Pasture Road, Kensington
	2020	115.9V	Old Amesbury Road, South Hampton
13X3	2020	115.9V	Old County Road, Plaistow
22X1	2020	116.5V	Cheney Lane, Danville
19H1	2020	116.6V	Oak Ridge Road, Exeter
54X1	2020	116.9V	Industrial Way, East Kingston
5X3	2024	116.9V	Kristie Lane, Plaistow

7.2. Overload Conditions

The following summarizes distribution equipment which is expected to be loaded above 90% of normal ratings during the five year study period. The table is sorted by circuit and year.

Circuit	Year	Percent Loading	Distribution Equipment (summer normal limit)	Location
19X3	2023	91%	Cutout with Solid Blades (300 Amps)	Pole 349/2, Pine Street, Exeter
23X1	2024	92% Continuous / 67% Minimum Melt	175QA (175 Amps Continuous / 240 Amps Minimum Melt)	Pole 32/84, South Road, Kensington (low-side stepdown fusing)

7.3. Protection Concerns

Analysis was performed on the circuits to identify protective devices that violate Unitil's distribution protection sensitivity and coordination criteria. This analysis resulted in the nine locations in the below table requiring protection modifications. EWRs will be issued in 2019 to address the concerns identified.

Circuit	Street	Pole	Old Fuse Size	New Fuse Size
20H1	E&H Trailer Park	2	20QA	50QA
13X3	Old County Road	11	175QA	200QA
22X2	Route 125	74	60QA	100QA
	Old Coach Road	1-A	100QA	150QA
6W2	North Shore Road	9	10QA	30QA
43X1	Washington Way	5	15QA	25QA
58X1	Chandler Avenue	14	30QA	60QA
	North Avenue	1	75QA	125QA
15X1	Pine Crest Shores	2	50QA	75QA

8. Detailed Recommendations

The following sections detail proposed system improvement projects to address the deficiencies listed in the previous sections. All cost estimates provided in this report are without general construction overheads.

All proposed traditional options were evaluated per Unitil's Project Evaluation Procedure and none of the proposed traditional options met the thresholds to require non-wires alternative projects to be reviewed.

8.1. Timberlane S/S 13W2 Recloser: Replace Relay and Increase Trip Setting – (2020)

Distribution load projections indicated that the trip setting of the 13W2 recloser at Timberlane substation is expected to exceed 93% of the phase overcurrent pick-up flag during summer conditions in 2020.

Increase the trip setting of circuit 13W2 to achieve a rating of at least 400 amps. This setting change will require the existing Form 3A recloser control to be replaced with a microprocessor based control.

Once this project is complete loading on 13W2 circuit position is expected to remain below planning criteria throughout the scope of this study.

Total Project Cost: $17,500

8.2. Circuit 23X1: Install Voltage Regulator Wild Pasture Road – (2020)

Circuit analysis has identified that the primary voltage along Wild Pasture Road in Kensington is expected to be as low as 115.5V in the summer of 2020 and as low as 114.5V in the summer of 2024.

An AMI voltage recording meter recorded an average minimum service voltage of 111V at customer along Wild Pasture Road during previous summer peak conditions.

Installing a voltage regulator along Wild Pasture Road is expected to resolve the identified voltage concern throughout the study period.

Total Project Cost: $30,000

8.3. Circuit 23X1: Install Voltage Regulator Amesbury Road – (2020)

Circuit analysis has identified that the primary voltage along Old Amesbury Road in South Hampton is expected to be as low as 115.9V in the summer of 2020 and as low as 115.3V in the summer of 2024.

An EWR has been issued to install an AMI voltage recording meter at a customer residences along Locust Street to verify model results.

Installing a voltage regulator along Amesbury Road is expected to resolve the identified voltage concern throughout the study period.

Total Project Cost: $30,000

8.4. Circuit 13X3: Install Voltage Regulators Old County Road – (2020)

Circuit analysis has identified that the primary voltage along Old County Road in Plaistow is expected to be as low as 115.9V in the summer of 2020 and as low as 115.3V in the summer of 2024.

An EWR has been issued to install an AMI voltage recording meter at a customer residences along Kingston Road to verify model results.

Installing a three voltage regulators along Old County Road is expected to resolve the identified voltage concern throughout the study period.

Total Project Cost: $70,000

8.5. Circuit 22X1: Install Regulator Colby Road – (2020)

Circuit analysis has identified that the primary voltage along Cheney Road in Danville is expected to be as low as 116.5V in the summer of 2020 and as low as 116.1V in the summer of 2024.

An AMI voltage recording meter recorded an average minimum service voltage of 112V at customer along Wild Pasture Road during previous summer peak conditions.

Installing a 2nd voltage regulator along Colby Road on phase C is expected to resolve the identified voltage concern throughout the study period.

Total Project Cost: $30,000

8.6. Circuit 19H1: Transfer Load to 27X1 – (2020)

Circuit analysis has identified that the primary voltage along Oak Ridge Road in Kensington is expected to be as low as 116.6V in the summer of 2020 and as low as 116.1V in the summer of 2024.

Additionally, the capacitor bank on 19H1 along Drinkwater Road creates AMI metering reading problems when it is switched into service and there are condition concerns associated with the aging 19H1 equipment at Gilman Lane substation.

Transfer circuit 19H1 to circuit 27X1 and decommission the 19H1 circuit position at Gilman Lane substation. A bank of 500 kVA stepdown transformers and three voltage regulators will be installed along Drinkwater Road to accommodate the load transfer.

This project is expected to address the identified voltage concern throughout the study period.

Total Project Cost: $150,000

8.7. Circuit 54X1: Install Voltage Regulator Main Street – (2020)

Circuit analysis has identified that the primary voltage along Industrial Way in East Kingston is expected to be as low as 116.9V in the summer of 2020 and as low as 116.7V in the summer of 2024.

An EWR has been issued to install an AMI voltage recording meter at a customer residences along Haverhill Road to verify model results.

Installing a voltage regulator along Main Street is expected to resolve the identified voltage concern throughout the study period.

Total Project Cost: $30,000

8.8. 20T1 Transformer: Transfer Load to 28X1 – (2022)

Distribution load projection indicate that the 20T1 transformer at Dow's Hill S/S is expected to be loaded to 91% of its normal ratings during summer conditions in 2022.

Rebuild Exeter Road from Pole 12/124 to pole 93/37 to 35 kV and convert to 34.5 kV operations. Pole 12/143 to Pole 93/37 will be reconductored with 336 spacer cable (Pole 12/124 to Pole 12/143 was previously rebuilt with 35kV spacer cable).

A bank of stepdown transformers will be installed in the vicinity of Ashbrook Road pole 8/21 and the new open point between 28X1 and 20H1 will be at Hampton Road pole 92/42.

This project is expected to address the identified transformer loading concern throughout the study period. Additionally, this projects works towards the master plan for the area.

Total Project Cost: $225,000

8.9. Circuit 19X3: Replace Cutouts with Switch – (2023)

Circuit analysis has identified that the cutouts with solid blades along Pine Street are expected to exceed 91% of their normal limits during summer conditions in 2023.

Replacing the existing cutouts with a gang-operated loadbreak switch will resolve this identified loading constraint throughout the study period.

Total Project Cost: $25,000

8.10. Circuit 23X1: Convert Portion of South Road – (2024)

Circuit analysis has identified that the 333 kVA stepdown transformer and 175QA low-side stepdown fuse is expected to exceed 90% of their normal limits during summer conditions in 2024.

Option 1 (Proposed):
Rebuild South Road from pole 32/84 to the vicinity of pole 32/59 to 35kV single-phase construction and convert to 34.5 kV operation. A new 333 kVA stepdown transformer will be installed in the vicinity of pole 32/59 South Road.

Total Project Cost: $150,000

Option 2:
Rebuild South Road from Amesbury Road pole 1/142 to South Road pole 32/59 to 35 kV spacer cable construction. Two additional 333 kVA stepdowns will be install at pole 32/83 South Road.

Total Project Cost: $250,000

Both options described above are expected to resolve the identified planning constraints through 2024 and beyond.

8.11. Circuit 5X3: Install Voltage Regulator Smith Corner Road – (2024)

Circuit analysis has identified that the primary voltage along Kristie Lane in Plaistow is expected to be as low as 116.9V in the summer of 2024.

An EWR has been issued to install an AMI voltage recording meter at a customer residences along Kristie Lane to verify model results.

Installing a voltage regulators along Smith Corner Road is expected to resolve the identified voltage concern throughout the study period.

Total Project Cost: $30,000

9. Circuit Tie Analysis

A detailed analysis was performed on all mainline distribution circuit ties in the UES-Seacoast system. The circuit ties were evaluated using 2020 projected summer peak loads and were assessed for loading and voltage violations. It is understood that marginal low voltage and protection coordination/sensitivity concerns may exist while circuits are tied. For the purposes of this review all elements were allowed to be operated up to their long term emergency ratings while circuits are tied.

Detail results of this analysis can be found in Appendix E.

10. Master Plan

This section describes a long range master plan for the UES–Seacoast system. The purpose of this plan is to provide strategic direction for the development of the electric distribution system as a whole. It does not, in and of itself, represent a cost-benefit justification for major system investments. Instead, it is intended to guide design decisions for various individual projects incrementally working towards broader system objectives. The concepts detailed below should be considered in all future designs of the system. It is expected that this Master Plan will be modified, adjusted, and refined as system challenges and opportunities evolve.

This master plan has been separated into two different parts. The first part of the plan consists of an overview map of the Seacoast distribution system. The second part of the master plan consists of more detailed future considerations. At this time some of these future considerations are not detailed.

10.1. Master Plan Map

The map in Appendix F identifies existing and future main line backbones at 34.5 kV, 13.8 kV and 4.16 kV as well as existing and future mainline equipment and a vision for self-healing". The map should be used as a tool when designing system improvement projects. Sections of conductor which have been identified as backbones will be constructed to 336.4 AA open wire conductor or equivalent and the appropriate insulation should be used, even if conditions do not require it at the time of construction.

10.1.1 Portsmouth Ave., Stratham

Portsmouth Ave. in its entirety will be converted to 34.5 kV three-phase main line construction creating ties to between circuits 47X1 and 51X1 and 11X1.

10.1.2 Kingston, East Kingston, Kensington, and Hampton Falls

The Shaw's Hill 34.5 kV distribution tap is comprised of 2 circuit positions (27X1 and 27X2). Portions of circuits 19X3, 23X1 and 19H1 will be transferred to these circuits over time. This will provide various circuit ties amongst circuits 27X1, 27X2, 23X1, 19X3, 19X2, 28X1 and 43X1.

Exeter Switching circuit 19H1 will be converted to 34.5 kV. This will involve the conversion of Drinkwater Road to the south and will a create tie between circuits 27X1, 19X2.

Dow's Hill S/S and circuit 20H1 will be converted to 34.5 kV. This will involve the conversion of Route 27 and Route 88 and will create ties with circuits 18X1, 47X1 and 28X1.

Route 125 in Kingston will be converted to 34.5 kV. This will include converting portions of circuits 54X1, 22X1, 56X1 and 56X2 to allow the creation of circuit ties.

10.1.3 Hampton and Hampton Beach

Drinkwater road will be converted to 34.5 kV, creating a circuit tie between 2X3 and 28X1.

Winnacunnet Road Tap and the western portion of circuit 46X1 and the 2X2 portion of Winnacunnet Road will be convert to 34.5 kV operation, allowing portions of 2X2 to be transferred to 46X1.

10.1.4 Atkinson, Plaistow and Newton

The 34.5 kV circuit(s) emanating from Plaistow substation will be extended to create future circuit ties with circuits 58X1 and 56X1 and provide a future distribution backup to the radial 3358 line.

11. Conclusion

The projects identified in this study attempt to address all of the system constraints that have been identified. The future of the UES–Seacoast system will rely predominantly on where load enters the system and growth occurs. In the future, projects will continue to focus on improving system voltages, increasing capacity and creating additional distribution circuit ties that will improve overall system reliability. Implementation of the master plan will enable the system to grow towards one common vision in a direct and cost effective manner. It is recognized that this study is a living document and it will be continually updated as the system's needs change or new system deficiencies are identified.

Appendix A

Summer and Winter Load Forecasts

UES-Seacoast
5-Year Load Forecast
2020-2024

	Summer Peak Loads (three-phase kVA)				
	Projected				
Distribution Element	**2020**	**2021**	**2022**	**2023**	**2024**
Cemetery Lane 15X1	7,689	7,799	7,908	8,017	8,127
Dorre Road Tap 56X2	1,885	1,906	1,927	1,948	1,969
Dow's Hill 20T1	1,652	1,670	1,689	1,707	1,726
20H1	1,652	1,670	1,689	1,707	1,726
East Kingston 6T1	5,707	5,771	5,834	5,898	5,961
6W1	2,721	2,751	2,781	2,811	2,842
6W2	3,545	3,585	3,624	3,663	3,703
Exeter 1T1	2,991	3,024	3,057	3,090	3,124
Exeter 1T2	2,991	3,024	3,057	3,090	3,124
1H3	1,486	1,502	1,519	1,535	1,552
1H4	1,505	1,522	1,539	1,555	1,572
Gilman Lane 19T1	641	649	656	663	670
19H1	641	649	656	663	670
Gilman Lane 19X2	5,235	5,347	5,459	5,570	5,682
Gilman Lane 19X3	15,750	16,239	16,727	17,216	17,705
Guinea Road Tap 47X1	5,253	5,290	5,328	5,366	5,404
Guinea Switching 18X1	11,559	11,699	11,838	11,977	12,117
Hampton 2T1	1,193	1,206	1,219	1,233	1,246
2H1	1,193	1,206	1,219	1,233	1,246
Hampton 2X2	9,852	10,025	10,198	10,371	10,545
Hampton 2X3	5,819	5,936	6,054	6,171	6,289
Hampton Beach 3T3	9,444	9,552	9,659	9,767	9,874
3W1	4,710	4,768	4,826	4,883	4,941
3W4	4,734	4,784	4,834	4,883	4,933
High Street 17T1	6,041	6,115	6,189	6,263	6,337
17W1	4,088	4,136	4,184	4,232	4,280
17W2	1,953	1,979	2,005	2,031	2,057
Hunt Rd Tap 56X1	2,299	2,325	2,351	2,377	2,403
Kingston 22X1	3,791	3,834	3,876	3,918	3,960
Kingston 22X2	659	666	674	681	688
Mill Lane Tap 23X1	3,602	3,683	3,765	3,847	3,929
Munt Hill 28X1	1,604	1,624	1,644	1,664	1,684
New Boston Rd. Tap	5,812	5,876	5,941	6,006	6,070
54X1	2,927	2,959	2,992	3,024	3,057
54X2	2,885	2,917	2,949	2,981	3,014
Plaistow 5X3	4,347	4,360	4,372	4,385	4,397
Portsmouth Ave. Substation	12,895	13,193	13,492	13,790	14,089
11X1	4,904	4,947	4,989	5,032	5,075
11X2	7,294	7,375	7,456	7,538	7,619
Seabrook 7T1	4,294	4,342	4,390	4,437	4,485
7W1	4,294	4,342	4,390	4,437	4,485
Seabrook 7X2	6,079	6,146	6,214	6,281	6,349
Shaw's Hill Tap	3,420	3,458	3,496	3,534	3,572
27X1	2,123	2,084	2,107	2,129	2,152
27X2	1,072	1,083	1,095	1,107	1,119
Stard Road Tap 59X1	8,057	8,146	8,236	8,325	8,415
Timberlane 13T1	7,381	7,467	7,553	7,639	7,725
13W1	4,105	4,151	4,196	4,242	4,287
13W2	4,604	4,677	4,750	4,823	4,896

UES-Seacoast
5-Year Load Forecast
2020-2024

	Summer Peak Loads (three-phase kVA)				
	Projected				
Distribution Element	**2020**	**2021**	**2022**	**2023**	**2024**
Timberlane 13X3	1,393	1,416	1,440	1,463	1,486
Westville 21T1	6,249	6,332	6,415	6,498	6,581
21W1	6,249	6,332	6,415	6,498	6,581
Westville 21T2	5,097	5,169	5,241	5,312	5,384
21W2	5,097	5,169	5,241	5,312	5,384
Westville Tap 58X1	11,973	12,106	12,240	12,373	12,506
58X1E	5,276	5,335	5,393	5,452	5,511
58X1W	6,697	6,772	6,846	6,921	6,995
Willow Road Tap 43X1	6,407	6,478	6,549	6,620	6,692
Winnacunnet Road Tap 46X1	1,423	1,440	1,457	1,473	1,490
Winnicutt Road Tap 51X1	5,548	5,605	5,663	5,721	5,778

Legend

loading < 50% of Normal Limit
50% ≤ loading ≤ 90% of Normal Limit
90% < loading ≤ 100% of Normal Limit
100% of Normal Limit < loading

	Winter Peak Loads (three-phase kVA)				
	Projected				
Distribution Element	**2019/20**	**2020/21**	**2021/22**	**2022/23**	**2023/24**
Cemetery Lane 15X1	5,781	5,891	6,000	6,110	6,219
Dorre Road Tap 56X2	1,362	1,377	1,392	1,407	1,422
Dow's Hill 20T1	1,366	1,381	1,396	1,411	1,426
20H1	1,366	1,381	1,396	1,411	1,426
East Kingston 6T1	4,921	4,976	5,031	5,085	5,140
6W1	2,127	2,151	2,174	2,198	2,222
6W2	2,794	2,825	2,856	2,887	2,918
Exeter 1T1	1,252	1,266	1,280	1,294	1,308
Exeter 1T2	1,180	1,193	1,207	1,220	1,233
1H3	1,252	1,266	1,280	1,294	1,308
1H4	1,180	1,193	1,207	1,220	1,233
Gilman Lane 19T1	549	563	578	592	607
19H1	549	563	578	592	607
Gilman Lane	3,333	3,455	3,577	3,699	3,821
Gilman Lane 19X3	10,935	11,200	11,465	11,730	11,995
Guinea Road Tap 47X1	3,793	3,821	3,848	3,875	3,903
Guinea Switching 18X1	8,348	8,448	8,549	8,650	8,750
Hampton 2T1	993	1,004	1,015	1,026	1,037
2H1	993	1,004	1,015	1,026	1,037
Hampton 2X2	7,114	7,240	7,365	7,490	7,615
Hampton 2X3	4,501	4,576	4,652	4,728	4,803
Hampton Beach 3T3	6,820	6,898	6,975	7,053	7,131
3W1	3,401	3,443	3,485	3,527	3,568
3W4	3,419	3,455	3,491	3,527	3,562
High Street 17T1	4,750	4,821	4,891	4,962	5,032
17W1	3,050	3,084	3,118	3,151	3,185
17W2	1,700	1,737	1,774	1,810	1,847
Hunt Rd Tap 56X1	1,660	1,679	1,698	1,716	1,735
Kingston 22X1	2,803	2,834	2,865	2,896	2,927
Kingston 22X2	476	481	486	492	497
Mill Lane Tap 23X1	2,684	2,710	2,736	2,761	2,787
Munt Hill 28X1	1,158	1,173	1,187	1,201	1,216
New Boston Rd. 54X1	4,846	4,951	5,056	5,161	5,266
54X1	2,558	2,638	2,718	2,798	2,877
54X2	2,287	2,313	2,338	2,364	2,389
Plaistow 5X3	3,139	3,148	3,157	3,166	3,175
Portsmouth Ave. Substation	9,533	9,639	9,745	9,851	9,957
11X1	4,265	4,313	4,360	4,407	4,455
11X2	5,268	5,326	5,385	5,443	5,502
Seabrook 7T1	3,101	3,136	3,170	3,205	3,239
7W1	3,101	3,136	3,170	3,205	3,239
Seabrook 7X2	4,327	4,405	4,482	4,560	4,637
Shaw's Hill Tap	2,378	2,409	2,440	2,471	2,502
27X1	1,671	1,691	1,711	1,731	1,751
27X2	818	850	882	915	947
Stard Road Tap 59X1	5,818	5,883	5,948	6,012	6,077
Timberlane 13T1	6,399	6,574	6,749	6,924	7,099
13W1	2,754	2,818	2,883	2,948	3,012
13W2	3,646	3,756	3,866	3,976	4,087

UES-Seacoast
5-Year Load Forecast
2019/20-2023/24

	Winter Peak Loads (three-phase kVA)				
	Projected				
Distribution Element	**2019/20**	**2020/21**	**2021/22**	**2022/23**	**2023/24**
Timberlane 13X3	1,138	1,170	1,202	1,234	1,266
Westville 21T1	4,450	4,500	4,549	4,599	4,648
21W1	4,450	4,500	4,549	4,599	4,648
Westville 21T2	3,237	3,343	3,449	3,556	3,662
21W2	3,237	3,343	3,449	3,556	3,662
Westville Tap 58X1	7,997	8,063	8,129	8,194	8,260
58X1E	3,161	3,172	3,184	3,196	3,208
58X1W	4,837	4,890	4,944	4,998	5,052
Willow Road Tap 43X1	4,780	4,834	4,887	4,940	4,993
Winnacunnet Road Tap 46X1	1,028	1,040	1,052	1,064	1,076
Winnicutt Road Tap 51X1	4,007	4,048	4,090	4,131	4,173

Legend

loading < 50% of Normal Limit
50% ≤ loading ≤ 90% of Normal Limit
90% < loading ≤ 100% of Normal Limit
100% of Normal Limit < loading

Appendix B

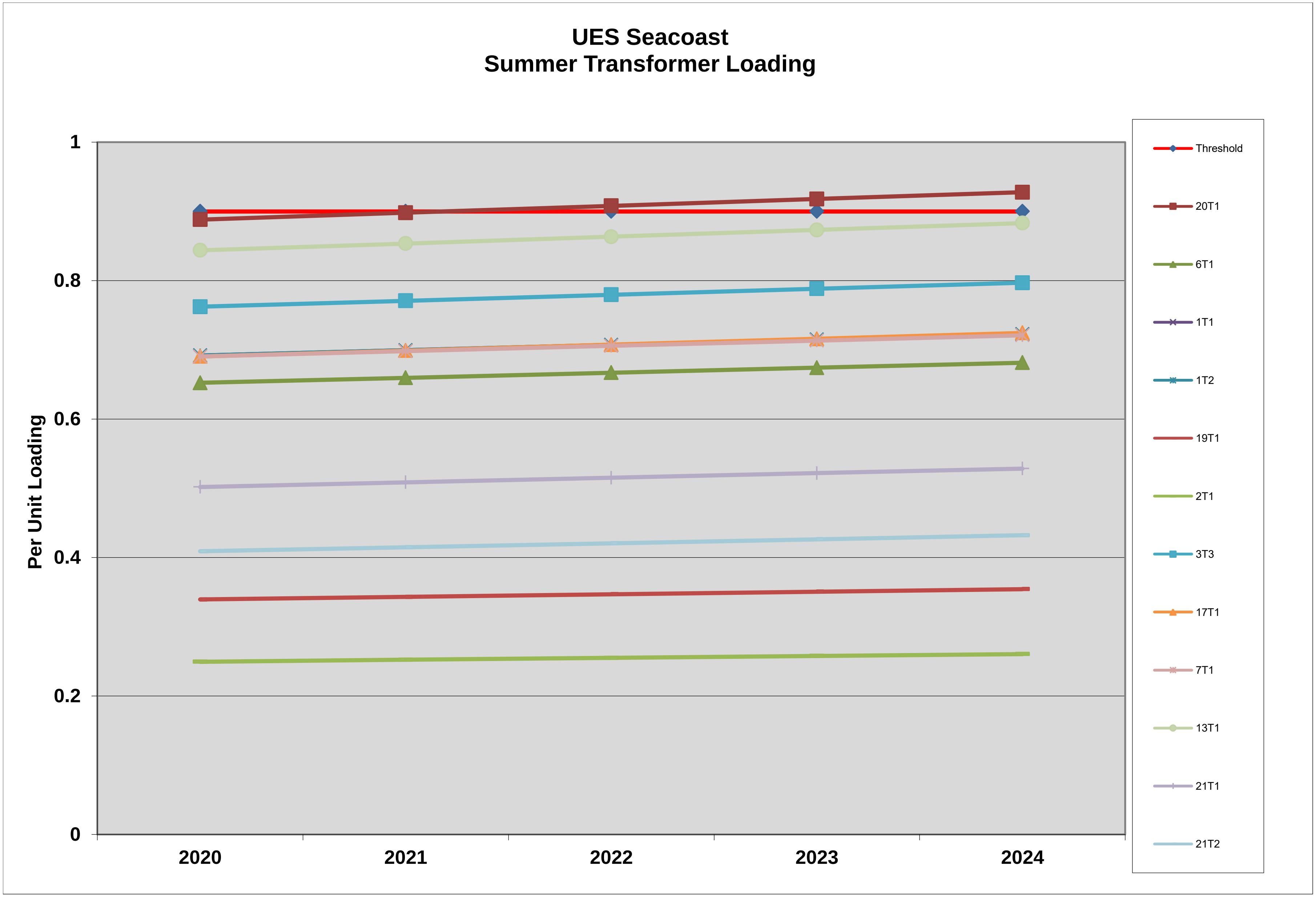
Distribution Circuit Ratings and Limitations

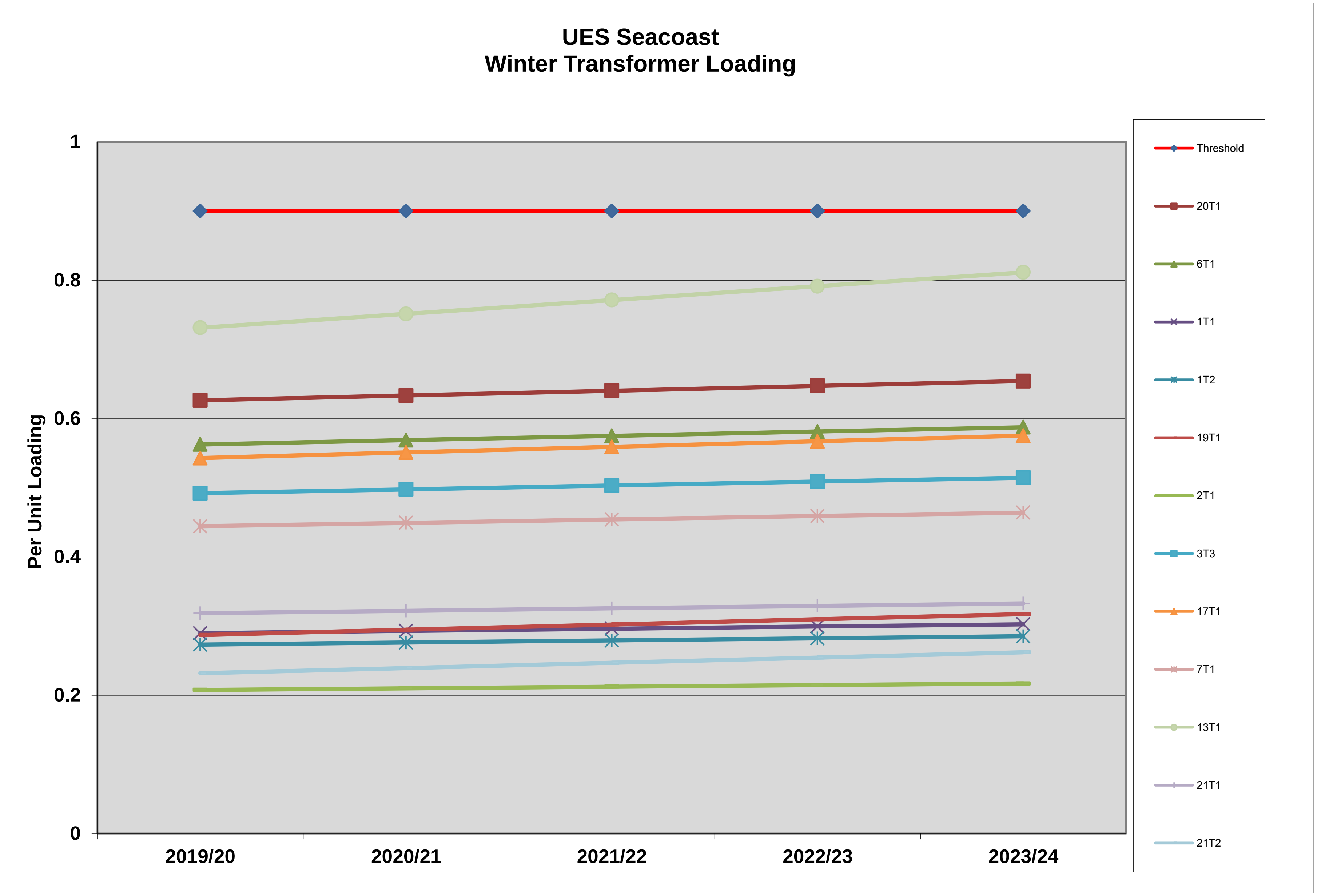
Distribution Element	Voltage Base	Breaker or Recloser Continuous Rating		Breaker or Recloser Trip Level		Breaker or Recloser Load Enchroachment		Current Transformer Present Tap Selection		Switch Continuous Rating		Fuse Limit		Regulator Limit		Conductor Rating		Transformer Rating		Overall Rating		Overall Rating		Limiting Element	
	(kV)	Normal (Amps)	LTE (Amps)	Normal (Amps)	LTE (Amps)	Normal (Amps)	LTE (Amps)	Normal (Amps)	LTE (Amps)	Normal (Amps)	LTE (Amps)	Normal (Amps)	LTE (Amps)	Normal (Amps)	LTE (Amps)	Normal (Amps)	LTE (Amps)	Normal (Amps)	LTE (Amps)	Normal (kVA)	LTE (kVA)	Normal (Amps)	LTE (Amps)	Normal	LTE
Cemetary Lane 15X1	34.5	800	800	333	360			600	600	900	900			450	525	531	645			19,899	21,512	333	360	Relay Set	Relay Set
Dorre Road Tap 56X2	34.5									600	600	113	113			247	294			6,723	6,723	113	113	Fuse	Fuse
Dow's Hill 20T1	4.16											597	597					258	268	1,860	1,930	258	268	Xfmr	Xfmr
20H1	4.16	600	600	355	384			600	600	600	600			480	560	531	645			2,559	2,767	355	384	Relay Set	Relay Set
East Kingston 6T1	13.8											412	412					521	530	9,842	9,842	412	412	Fuse	Fuse
6W1	13.8	800	800	296	320	468	468	600	600	600	600			589	687	531	645			11,186	11,186	468	468	Relay Set	Relay Set
6W2	13.8	800	800	296	320	468	468	600	600					589	687	531	645			11,186	11,186	468	468	Relay Set	Relay Set
Exeter 1T1	4.16							600	600	900	900	933	933					623	636	4,323	4,323	600	600	CT	CT
Exeter 1T2	4.16							600	600	900	900	933	933					623	636	4,323	4,323	600	600	CT	CT
1H3	4.16	800	800	414	448					900	900					500	620			2,986	3,228	414	448	Relay Set	Relay Set
1H4	4.16	800	800	414	448					900	900					500	620			2,986	3,228	414	448	Relay Set	Relay Set
Gilman Lane 19T1	4.16											299	299					262	271	1,890	1,950	262	271	Xfmr	Xfmr
19H1	4.16	560	560	296	320			600	600	400	400			480	560	340	411			2,133	2,306	296	320	Relay Set	Relay Set
Gilman Lane	34.5	400	400	444	480			600	600	600	600			450	525	500	620			23,902	23,902	400	400	Brkr/Rclsr	Brkr/Rclsr
Gilman Lane 19X3	34.5	800	800	370	400			600	600	600	600			450	525	531	645			22,110	23,902	370	400	Relay Set	Relay Set
Guinea Road Tap 47X1	34.5	560	560	414	448			200	200	300	300			240	280	531	645			11,951	11,951	200	200	CT	CT
Guinea Switching 18X1	34.5	600	600	414	448			600	600							531	645			24,763	26,771	414	448	Relay Set	Relay Set
Hampton 2T1	4.16	1200	1200									746	746					860	877	5,378	5,378	746	746	Fuse	Fuse
2H1	4.16	560	560	414	448			600	600	600	600			802	935	340	411			2,450	2,961	340	411	Wire	Wire
Hampton 2X2	34.5	800	800	311	336			600	600	400	400			450	525	531	645			18,572	20,078	311	336	Relay Set	Relay Set
Hampton 2X3	34.5	800	800	311	336			600	600	900	900			450	525	531	645			18,572	20,078	311	336	Relay Set	Relay Set
Hampton Beach 3T3	13.8	800	800					600	600									518	528	12,390	12,610	518	528	Xfmr	Xfmr
3W1	13.8	800	800					600	600	600	600			440	514	531	645			10,527	12,281	440	514	Reg	Reg
3W4	13.8	800	800	296	320			600	600	600	600			263	307	415	415			6,282	7,328	263	307	Reg	Reg
High Street 17T1	13.8											412	412					521	530	9,842	9,842	412	412	Fuse	Fuse
17W1	13.8	800	800	444	480			600	600	600	600			589	687	531	645			10,613	11,473	444	480	Relay Set	Relay Set
17W2	13.8	800	800	296	320			600	600	600	600			589	687	531	645			7,075	7,649	296	320	Relay Set	Relay Set
Hunt Rd Tap 56X1	34.5	800	800	278	300			600	600	600	600			270	315	531	645			16,134	17,927	270	300	Reg	Relay Set
Kingston 22X1	34.5	1200	1200	414	448			600	600	1200	1200					531	645			24,763	26,771	414	448	Relay Set	Relay Set
Kingston 22X2	34.5	1200	1200	414	448			600	600	1200	1200					531	645			24,763	26,771	414	448	Relay Set	Relay Set
Mill Lane Tap 23X1	34.5	400	400	296	320			200	200	600	600			240	280	531	645			11,951	11,951	200	200	CT	CT
Munt Hill Tap 28X1	34.5	800	800	192	208			600	600	600	600			450	525	531	645			11,497	12,429	192	208	Relay Set	Relay Set
New Boston Road	34.5	800	800	296	320			600	600	600	600			241	281	531	645			14,413	16,815	241	281	Reg	Reg
54X1	34.5	800	800	244	264			600	600	600	600					531	645			14,592	15,776	244	264	Relay Set	Relay Set
54X2	34.5	800	800	244	264			600	600	600	600					531	645			14,592	15,776	244	264	Relay Set	Relay Set
Plaistow 5X3	34.5	800	800	259	280					600	600			241	281	531	645			14,413	16,732	241	280	Reg	Relay Set
Portsmouth Ave Substation	34.5	800	800	348	376			400	400					450	525	531	645			20,783	22,468	348	376	Relay Set	Relay Set
Portsmouth Ave 11X1	34.5	800	800	237	256			600	600	600	600					531	645			14,150	15,297	237	256	Relay Set	Relay Set
Portsmouth Ave 11X2	34.5	800	800	237	256			600	600	600	600					531	645			14,150	15,297	237	256	Relay Set	Relay Set
Seabrook 7T1	13.8											1187	1187					260	265	6,220	6,330	260	265	Xfmr	Xfmr
7W1	13.8	800	800	592	640			600	600	900	900			263	307	531	645			6,282	7,328	263	307	Reg	Reg
Seabrook 7X2	34.5	800	800	192	208			600	600	900	900			200	234	531	645			11,497	12,429	192	208	Relay Set	Relay Set
Shaw's Hill Tap	34.5	800	800	266	288			600	600	600	600			450	525	531	645			15,919	17,210	266	288	Relay Set	Relay Set
27X1	34.5	800	800	237	256											531	645			14,150	15,297	237	256	Relay Set	Relay Set
27X2	34.5	800	800	237	256											531	645			14,150	15,297	237	256	Relay Set	Relay Set
Stard Road Tap 59X1	34.5	800	800	311	336					600	600			450	525	531	645			18,572	20,078	311	336	Relay Set	Relay Set
Timberlane 13T1	13.8							600	600			412	412					523	532	9,842	9,842	412	412	Fuse	Fuse
13W1	13.8	560	560	414	448			300	300	600	600			524	612	531	645			7,171	7,171	300	300	CT	CT
13W2	13.8	560	560	207	224			300	300	400	400			263	307	531	645			4,953	5,354	207	224	Relay Set	Relay Set
Timberlane 13X3	34.5	800	800	178	192					600	600			241	281	531	645			10,613	11,473	178	192	Relay Set	Relay Set
Westville 21T1	13.8							600	600									521	530	12,450	12,670	521	530	Xfmr	Xfmr
21W1	13.8	560	560	414	448			600	600	600	600			589	687	531	645			9,905	10,708	414	448	Relay Set	Relay Set
Westville 21T2	13.8							600	600									521	531	12,460	12,700	521	531	Xfmr	Xfmr
21W2	13.8	560	560	414	448			300	300	600	600			589	687	622	776			7,171	7,171	300	300	CT	CT
Westville Tap 58X1	34.5	560	560					400	400	300	300			241	281					14,413	16,815	241	281	Reg	Reg
58X1E	34.5	800	800	370	400											531	645			22,110	23,902	370	400	Relay Set	Relay Set
58X1W	34.5	800	800	148	160											663	808			8,844	9,561	148	160	Relay Set	Relay Set
Willow Road Tap 43X1	34.5	800	800	370	400									270	315	531	645			16,134	18,823	270	315	Reg	Reg
Winnacunnet Road Tap 46X1	34.5	560	560	67	72					72	72	135	135	270	315	531	645	60	60	3,600	3,600	60	60	Xfmr	Xfmr
Winnicutt Road Tap 51X1	34.5	800	800	414	448					900	900					531	645			24,763	26,771	414	448	Relay Set	Relay Set

Distribution Element	Voltage Base	Breaker or Recloser Continuous Rating		Breaker or Recloser Trip Level		Breaker or Recloser Load Enchroachment		Current Transformer Present Tap Selection		Switch Continuous Rating		Fuse Limit		Regulator Limit		Conductor Rating		Transformer Rating		Overall Rating		Overall Rating		Limiting Element	
	(kV)	Normal (Amps)	LTE (Amps)	Normal (Amps)	LTE (Amps)	Normal (Amps)	LTE (Amps)	Normal (Amps)	LTE (Amps)	Normal (Amps)	LTE (Amps)	Normal (Amps)	LTE (Amps)	Normal (Amps)	LTE (Amps)	Normal (Amps)	LTE (Amps)	Normal (Amps)	LTE (Amps)	Normal (kVA)	LTE (kVA)	Normal (Amps)	LTE (Amps)	Normal	LTE
Cemetary Lane 15X1	34.5	800	800	333	360			600	600	900	900			536	536	694	777			19,899	21,512	333	360	Relay Set	Relay Set
Dorre Road Tap 56X2	34.5									600	600	113	113			322	354			6,723	6,723	113	113	Fuse	Fuse
Dow's Hill 20T1	4.16											597	597					303	321	2,180	2,310	303	321	Xfmr	Xfmr
20H1	4.16	600	600	355	384			600	600	600	600			580	580	694	777			2,559	2,767	355	384	Relay Set	Relay Set
East Kingston 6T1	13.8											412	412					580	603	9,842	9,842	412	412	Fuse	Fuse
6W1	13.8	800	800	296	320	468	468	600	600	600	600			712	712	694	777			11,186	11,186	468	468	Relay Set	Relay Set
6W2	13.8	800	800	296	320	468	468	600	600					712	712	694	777			11,186	11,186	468	468	Relay Set	Relay Set
Exeter 1T1	4.16							600	600	900	900	933	933					704	747	4,323	4,323	600	600	CT	CT
Exeter 1T2	4.16							600	600	900	900	933	933					704	747	4,323	4,323	600	600	CT	CT
1H3	4.16	800	800	414	448					900	900					696	778			2,986	3,228	414	448	Relay Set	Relay Set
1H4	4.16	800	800	414	448					900	900					696	778			2,986	3,228	414	448	Relay Set	Relay Set
Gilman Lane 19T1	4.16											299	299					304	321	2,151	2,151	299	299	Fuse	Fuse
19H1	4.16	560	560	296	320			600	600	400	400			580	580	443	495			2,133	2,306	296	320	Relay Set	Relay Set
Gilman Lane	34.5	400	400	444	480			600	600	600	600			536	536	696	778			23,902	23,902	400	400	Brkr/Rclsr	Brkr/Rclsr
Gilman Lane 19X3	34.5	800	800	370	400			600	600	600	600			536	536	694	777			22,110	23,902	370	400	Relay Set	Relay Set
Guinea Road Tap 47X1	34.5	560	560	414	448			200	200	300	300			290	290	694	777			11,951	11,951	200	200	CT	CT
Guinea Switching 18X1	34.5	600	600	414	448			600	600							694	777			24,763	26,771	414	448	Relay Set	Relay Set
Hampton 2T1	4.16	1200	1200									746	746					969	1008	5,378	5,378	746	746	Fuse	Fuse
2H1	4.16	560	560	414	448			600	600	600	600			969	969	443	495			2,986	3,228	414	448	Relay Set	Relay Set
Hampton 2X2	34.5	800	800	311	336			600	600	400	400			536	536	694	777			18,572	20,078	311	336	Relay Set	Relay Set
Hampton 2X3	34.5	800	800	311	336			600	600	900	900			536	536	694	777			18,572	20,078	311	336	Relay Set	Relay Set
Hampton Beach 3T3	13.8	800	800					600	600									580	603	13,860	14,341	580	600	Xfmr	CT
3W1	13.8	800	800					600	600	600	600			532	532	694	777			12,720	12,720	532	532	Reg	Reg
3W4	13.8	800	800	296	320			600	600	600	600			318	318	415	415			7,075	7,590	296	318	Relay Set	Reg
High Street 17T1	13.8											412	412					584	613	9,842	9,842	412	412	Fuse	Fuse
17W1	13.8	800	800	444	480			600	600	600	600			712	712	694	777			10,613	11,473	444	480	Relay Set	Relay Set
17W2	13.8	800	800	296	320			600	600	600	600			712	712	694	777			7,075	7,649	296	320	Relay Set	Relay Set
Hunt Rd Tap 56X1	34.5	800	800	278	300			600	600	600	600			326	326	694	777			16,582	17,927	278	300	Relay Set	Relay Set
Kingston 22X1	34.5	1200	1200	414	448			600	600	1200	1200					694	777			24,763	26,771	414	448	Relay Set	Relay Set
Kingston 22X2	34.5	1200	1200	414	448			600	600	1200	1200					694	777			24,763	26,771	414	448	Relay Set	Relay Set
Mill Lane Tap 23X1	34.5	400	400	296	320			200	200	600	600			290	290	694	777			11,951	11,951	200	200	CT	CT
Munt Hill Tap 28X1	34.5	800	800	192	208			600	600	600	600			536	536	694	777			11,497	12,429	192	208	Relay Set	Relay Set
New Boston Road	34.5	800	800	296	320			600	600	600	600			291	291	694	777			17,416	17,416	291	291	Reg	Reg
54X1	34.5	800	800	244	264			600	600	600	600					694	777			14,592	15,776	244	264	Relay Set	Relay Set
54X2	34.5	800	800	244	264			600	600	600	600					694	777			14,592	15,776	244	264	Relay Set	Relay Set
Plaistow 5X3	34.5	800	800	259	280					600	600			291	291	694	777			15,477	16,732	259	280	Relay Set	Relay Set
Portsmouth Ave Substation	34.5	800	800	348	376			400	400					536	536	694	777			20,783	22,468	348	376	Relay Set	Relay Set
Portsmouth Ave 11X1	34.5	800	800	237	256			600	600	600	600					694	777			14,150	15,297	237	256	Relay Set	Relay Set
Portsmouth Ave 11X2	34.5	800	800	237	256			600	600	600	600					694	777			14,150	15,297	237	256	Relay Set	Relay Set
Seabrook 7T1	13.8											1187	1187					292	307	6,980	7,330	292	307	Xfmr	Xfmr
7W1	13.8	800	800	592	640			600	600	900	900			318	318	694	777			7,590	7,590	318	318	Reg	Reg
Seabrook 7X2	34.5	800	800	192	208			600	600	900	900			242	242	694	777			11,497	12,429	192	208	Relay Set	Relay Set
Shaw's Hill Tap	34.5	800	800	266	288			600	600	600	600			536	536	694	777			15,919	17,210	266	288	Relay Set	Relay Set
27X1	34.5	800	800	237	256											694	777			14,150	15,297	237	256	Relay Set	Relay Set
27X2	34.5	800	800	237	256											694	777			14,150	15,297	237	256	Relay Set	Relay Set
Stard Road Tap 59X1	34.5	800	800	311	336					600	600			536	536	694	777			18,572	20,078	311	336	Relay Set	Relay Set
Timberlane 13T1	13.8							600	600			412	412					589	618	9,842	9,842	412	412	Fuse	Fuse
13W1	13.8	560	560	414	448			300	300	600	600			634	634	694	777			7,171	7,171	300	300	CT	CT
13W2	13.8	560	560	207	224			300	300	400	400			318	318	694	777			4,953	5,354	207	224	Relay Set	Relay Set
Timberlane 13X3	34.5	800	800	178	192					600	600			291	291	694	777			10,613	11,473	178	192	Relay Set	Relay Set
Westville 21T1	13.8							600	600									584	612	13,970	14,341	584	600	Xfmr	CT
21W1	13.8	560	560	414	448			600	600	600	600			712	712	694	777			9,905	10,708	414	448	Relay Set	Relay Set
Westville 21T2	13.8							600	600									584	613	13,970	14,341	584	600	Xfmr	CT
21W2	13.8	560	560	414	448			300	300	600	600			712	712	873	976			7,171	7,171	300	300	CT	CT
Westville Tap 58X1	34.5	560	560					400	400	300	300			291	291					17,416	17,416	291	291	Reg	Reg
58X1E	34.5	800	800	370	400											694	777			22,110	23,902	370	400	Relay Set	Relay Set
58X1W	34.5	800	800	148	160											868	974			8,844	9,561	148	160	Relay Set	Relay Set
Willow Road Tap 43X1	34.5	800	800	370	400									326	326	694	777			19,495	19,495	326	326	Reg	Reg
Winnacunnet Road Tap 46X1	34.5	560	560	67	72					72	72	135	135	326	326	694	777	60	60	3,600	3,600	60	60	Xfmr	Xfmr
Winnicutt Road Tap 51X1	34.5	800	800	414	448					900	900					694	777			24,763	26,771	414	448	Relay Set	Relay Set

Appendix C

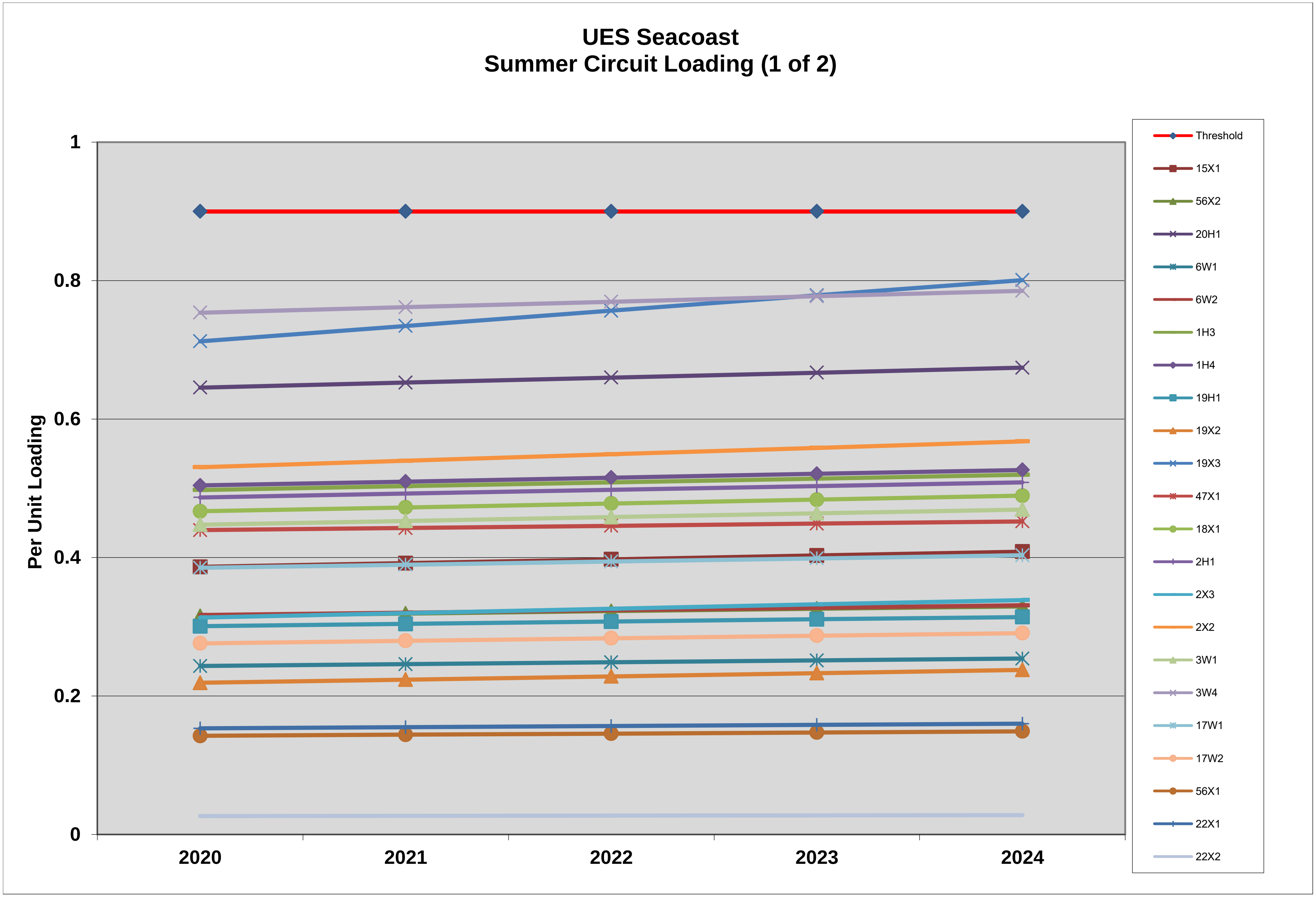
Transformer Loading Charts
(in Per Unit)

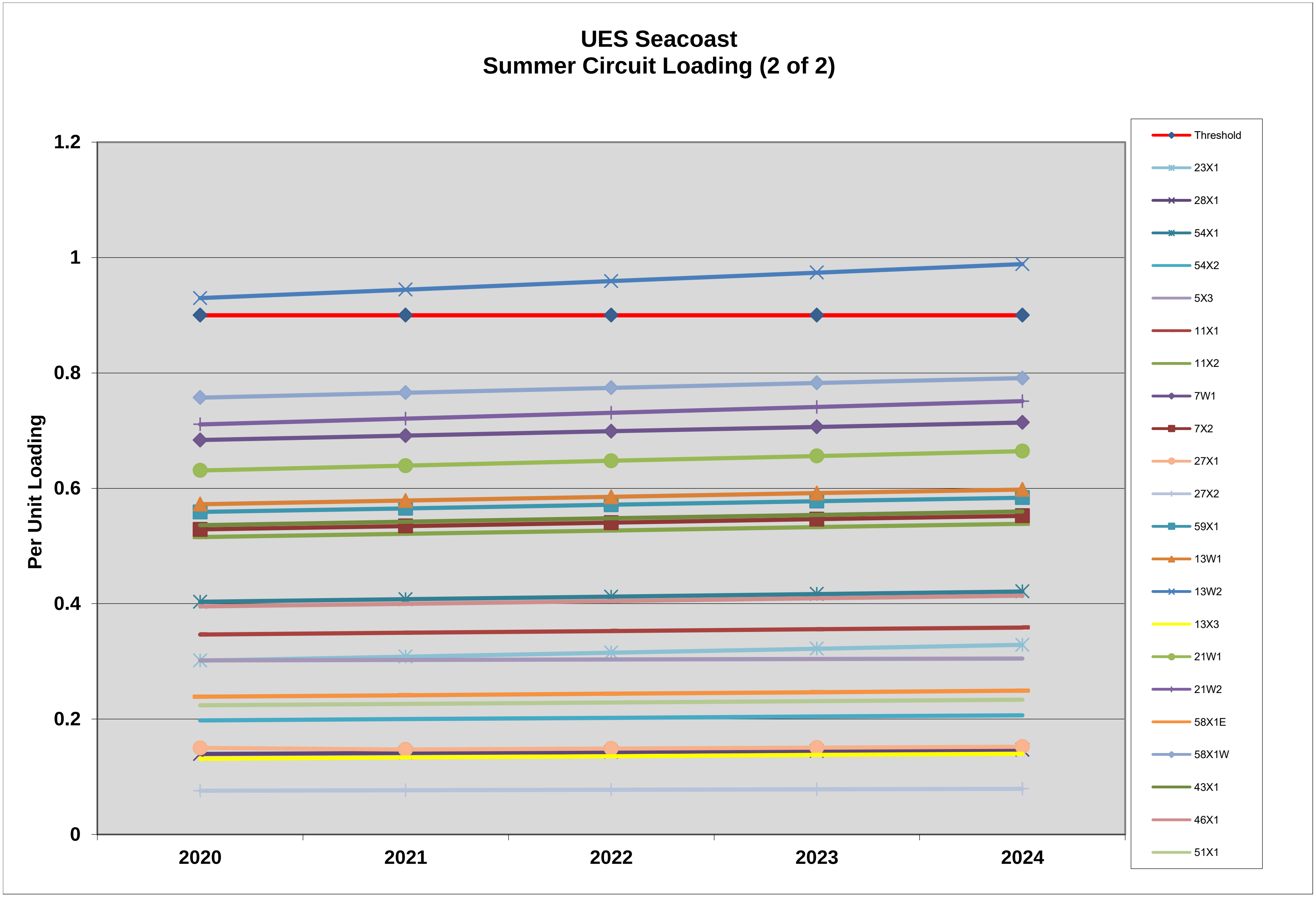

UES Seacoast
Summer Transformer Loading
Per Unit Loading
1
0.8
0.6
0.4
0.2
0
2020
2021
2022
2023
2024
Threshold
20T1
6T1
1T1
1T2
19T1
2T1
3T3
17T1
7T1
13T1
21T1
21T2

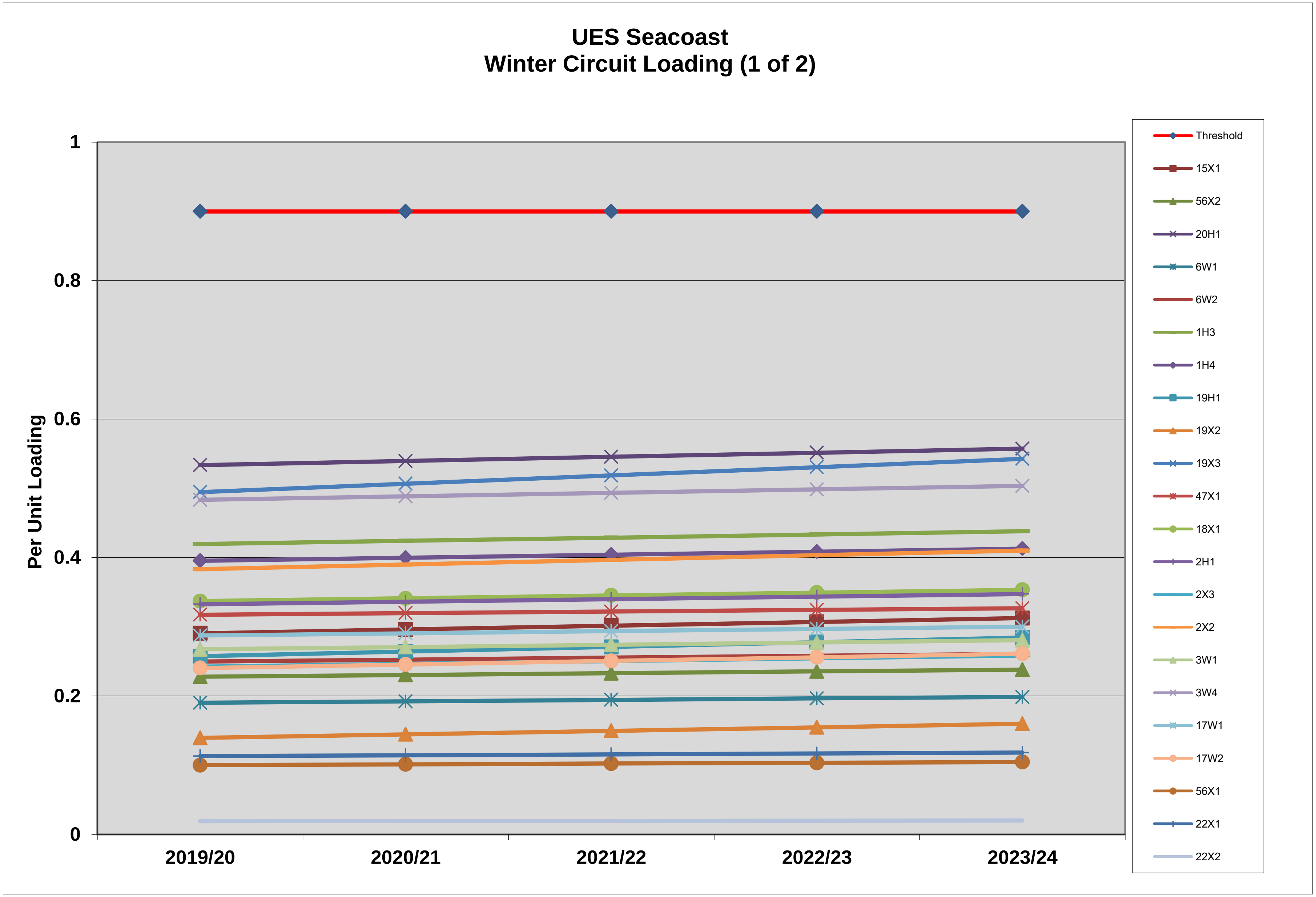

UES Seacoast
Winter Transformer Loading
Per Unit Loading
1
0.8
0.6
0.4
0.2
0
2019/20
2020/21
2021/22
2022/23
2023/24
Threshold
20T1
6T1
1T1
1T2
19T1
2T1
3T3
17T1
7T1
13T1
21T1
21T2

Appendix D

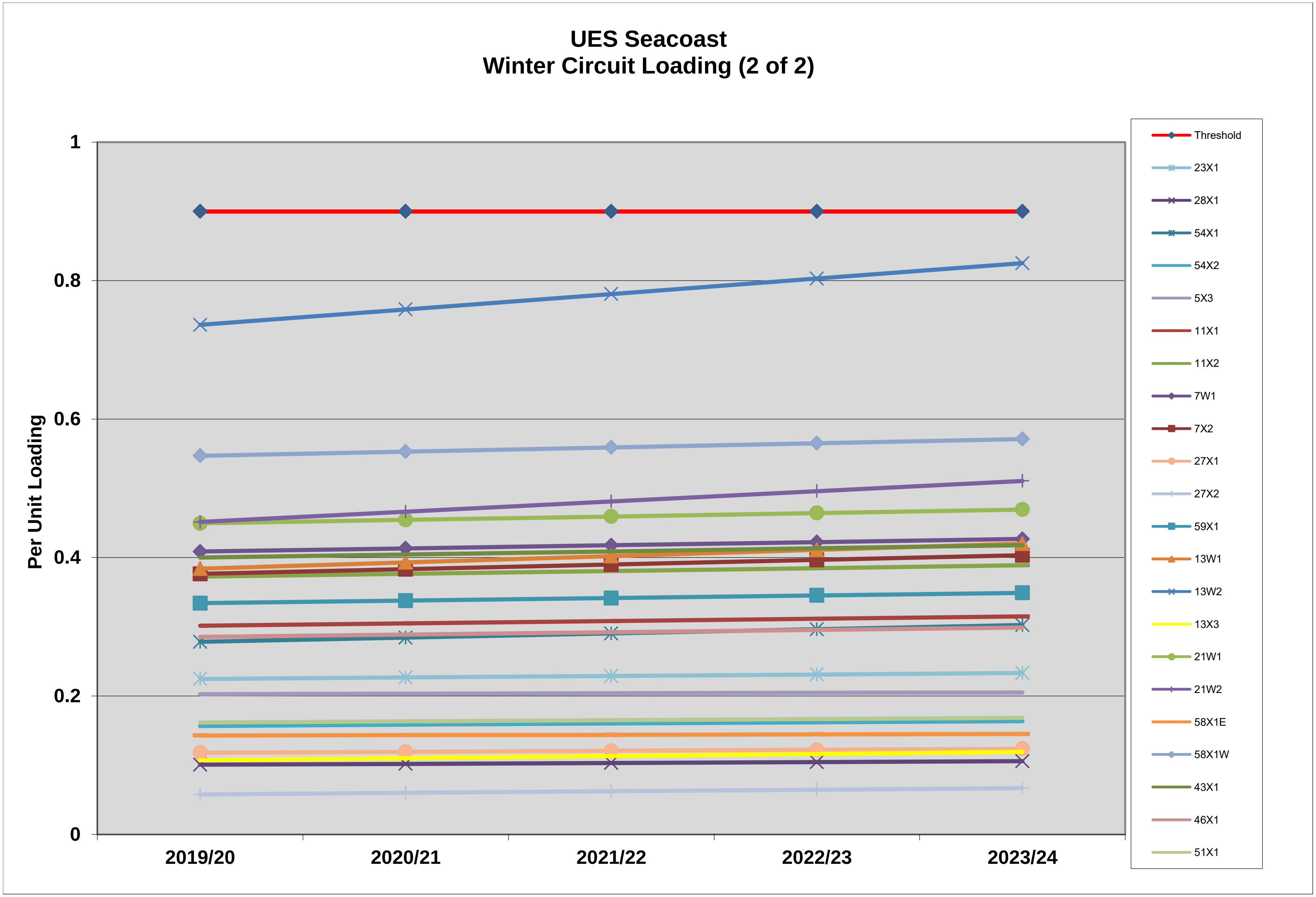
Circuit Loading Charts
(in Per Unit)


UES Seacoast
Summer Circuit Loading (1 of 2)
Per Unit Loading
1
0.8
0.6
0.4
0.2
0
2020
2021
2022
2023
2024
Threshold
15X1
56X2
20H1
6W1
6W2
1H3
1H4
19H1
19X2
19X3
47X1
18X1
2H1
2X3
2X2
3W1
3W4
17W1
17W2
56X1
22X1
22X2


UES Seacoast
Summer Circuit Loading (2 of 2)
Per Unit Loading
1.2
1
0.8
0.6
0.4
0.2
0
2020
2021
2022
2023
2024
Threshold
23X1
28X1
54X1
54X2
5X3
11X1
11X2
7W1
7X2
27X1
27X2
59X1
13W1
13W2
13X3
21W1
21W2
58X1E
58X1W
43X1
46X1
51X1



UES Seacoast
Winter Circuit Loading (1 of 2)
Per Unit Loading
1
0.8
0.6
0.4
0.2
0
2019/20
2020/21
2021/22
2022/23
2023/24
Threshold
15X1
56X2
20H1
6W1
6W2
1H3
1H4
19H1
19X2
19X3
47X1
18X1
2H1
2X3
2X2
3W1
3W4
17W1
17W2
56X1
22X1
22X2



UES Seacoast
Winter Circuit Loading (2 of 2)
Per Unit Loading
1
0.8
0.6
0.4
0.2
0
2019/20
2020/21
2021/22
2022/23
2023/24
Threshold
23X1
28X1
54X1
54X2
5X3
11X1
11X2
7W1
7X2
27X1
27X2
59X1
13W1
13W2
13X3
21W1
21W2
58X1E
58X1W
43X1
46X1
51X1

Appendix E

Circuit Tie Analysis Results

Circuit Tie	Restoring Circuit	Restored Circuit	Limit of Restoration during Summer Peak	Accepted Planning Violations	Limiting Element w/ Summer Normal Rating	% Peak Loading & Max Per-Phase Amps at S/S when Tie is Usable to Restore Entire Circuit	Accepted Planning Violations
1H3J1H4 River St	1H3	1H4	Entire Circuit	None	N/A	N/A	N/A
	1H4	1H3	Entire Circuit	None	N/A	N/A	N/A
1H3/1H4 Main St Pole 125/15	1H3	1H4	Up to Solids on Front Street Pole 70/27	None	300A Solids Main Street Pole 12/1	85% of Peak, 380A	114V on Primary
	1H4	1H3	Up to Solids on Main Street Pole 125/1	None	247A 1/0ACSR Lincoln Street	70% of peak, 320A	114V on Primary
6W1J6W2	6W1	6W2	Entire Circuit	None	N/A	N/A	N/A
	6W2	6W1	Entire Circuit	None	N/A	N/A	N/A
19X2J11X2	19X2	11X2	Entire Circuit	None	N/A	N/A	N/A
	19X2	11X2 and 11X1	Both Circuits	None	N/A	N/A	N/A
	11X2	19X2	Entire Circuit	None	N/A	N/A	N/A
19X2J19X3 River St	19X2	19X3	Entire Circuit	98% of 19X2 Recloser and Phase pickup	400A 19X2 Recloser	100% of peak, 392A	98% of 19X2 Recloser and Phase pickup
	19X3	19X2	Entire Circuit	90% of 19X3 Phase Pickup	500A 19X3 Phase Pickup 450A 19X3 Regulators	100% of Peak, 398A	90% of 19X3 Phase Pickup
19X3J43X1	19X3	43X1	Up to Solids on Kingston Road Pole 219/47	100% of Solids Pine Street Pole 149/2	300A Solids Pine Street Pole 149/2	75% of Peak, 350A	100% of Solids Pine Street Pole 149/2
	43X1	19X3	Up to Cutout Mounted Sectionalizer on Epping Road Pole 61/15 (need to replace 150QA Kingston Road Pole 219/39 with solids)	None	270A 43X1 Regulators (need to replace 150QA Kingston Road Pole 219/39 with solids)	70% of Peak, 305A	112% of 43X1 Regulators

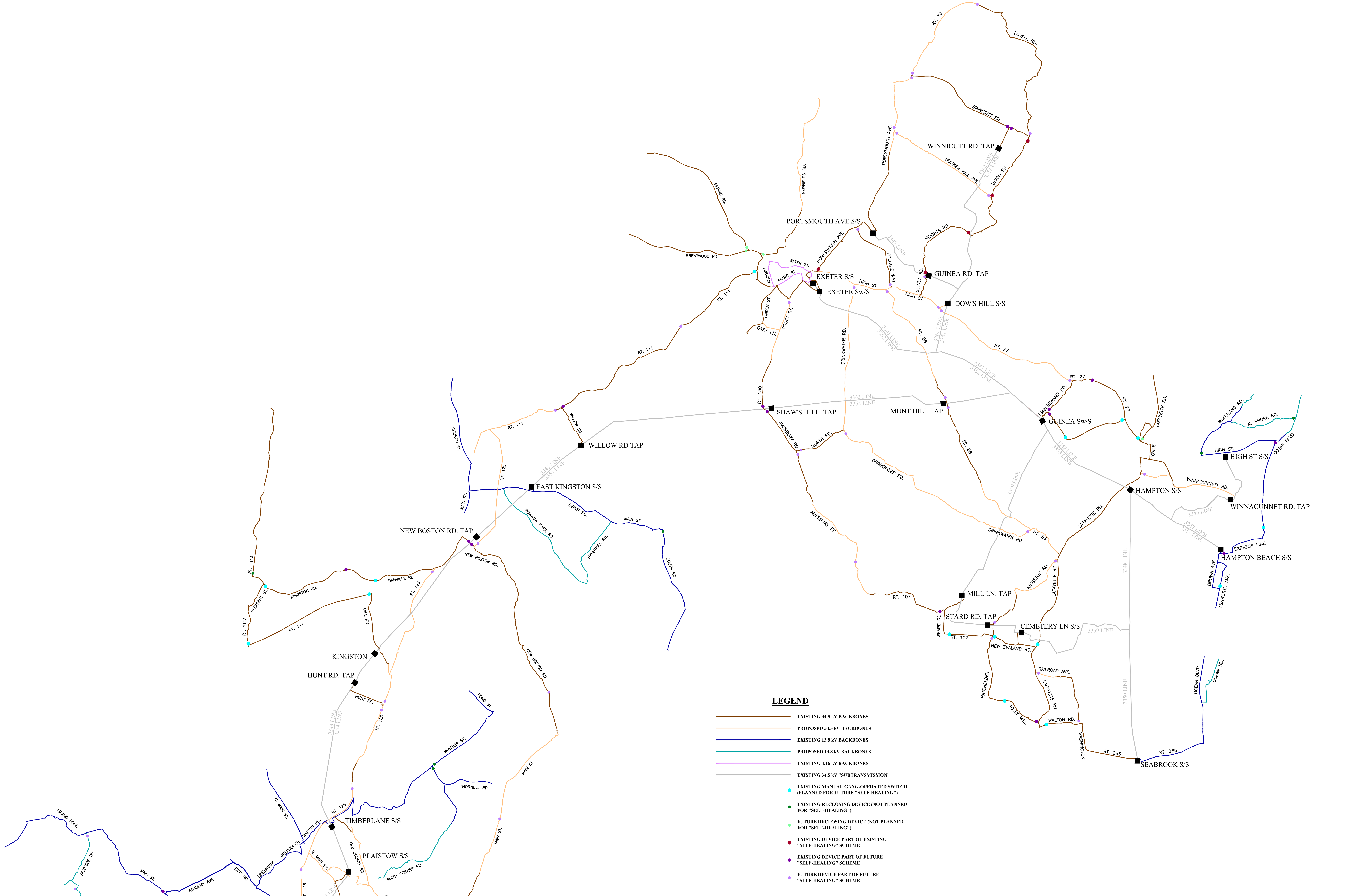
Circuit Tie	Restoring Circuit	Restored Circuit	Limit of Restoration during Summer Peak	Accepted Planning Violations	Limiting Element w/ Summer Normal Rating	% Peak Loading & Max Per-Phase Amps at S/S when Tie is Usable to Restore Entire Circuit	Accepted Planning Violations
5X3J58X1	5X3	58X1	Up to 58X1E Recloser	None	240A 5X3 Regulators	90% of Peak, 265A	110% of 5X3 Regulators
	58X1	5X3	Up to 5X3R1 Recloser	108% of 58X1 Regulators	240A 58X1 Regulators	90% of Peak, 270A	110% of 58X1 Regulators
13W1J13W2	13W1	13W2	Up to solids at Whittier Street Pole 35/1	100% on 13W1 300A CT Tap	300A 13W1 CT Tap	80% of Peak, 300A	100% on 13W1 300A CT Tap
	13W2	13W1	Up to Solids on Walton Road Pole 104/4	None	280A 13W2 Phase Pickup 262A 13W2 Regulators	65% of Peak, 240A	88% of 13W2 Pickup 92% of 13W2 Regulators
13W1J21W1	13W1	21W1	Up to Switch East Road Pole 21/16	93% of 13T1 Fuses Continuous Current Rating	457A 13T1 Fuses Continuous Current Rating 300A 13W1 CT Tap	65% of Peak, 295A	98% of 13W1 CT Tap 91% of 13T1 Fuses Continuous Current Rating
	21W1	13W1	Entire Circuit	82% of 21W1 Phase Pickup	520A 21T1 Transformer 560A 21W1 Phase Pickup 560A 21W1 Recloser	100% of Peak, 460A	82% of 21W1 Phase Pickup
21W1J21W2	21W1	21W2	Up to 21W2A Recloser	115V on Primary	331A 3/0 AA along Academy Ave	80% of Peak, 410A	115V on Primary
	21W2	21W1	Cannot be used under Peak	Cannot be used under Peak	300A 21W2 CT Tap	60% of Peak, 300A	100% of 21W2 CT Tap 114V on Primary
21W1/21W2 Solids at S/S	21W1	21W2	Entire Circuit	97% of 21T1 Transformer 90% of 21W1 Phase Pickup	520A 21T1 Transformer 560A 21W1 Phase Pickup 560A 21W1 Recloser	100% of Peak, 500A	97% of 21T1 Transformer 90% of 21W1 Phase Pickup
	21W2	21W1	Cannot be used under Peak	Cannot be used under Peak	300A 21W2 CT Tap	60% of Peak, 300A	100% of 21W2 CT Tap
22X1J22X2	22X1	22X2	Entire Circuit	None	N/A	N/A	N/A
	22X2	22X1	Entire Circuit	None	N/A	N/A	N/A
22X1J54X2	22X1	54X2	Entire Circuit	None	N/A	N/A	N/A
	54X2	22X1	Entire Circuit	None	N/A	N/A	N/A

Circuit Tie	Restoring Circuit	Restored Circuit	Limit of Restoration during Summer Peak	Accepted Planning Violations	Limiting Element w/ Summer Normal Rating	% Peak Loading & Max Per-Phase Amps at S/S when Tie is Usable to Restore Entire Circuit	Accepted Planning Violations
47X1J51X1	47X1	51X1	Entire Circuit	100% of 47X1 200A CT Tap	200A 47X1 TDA CT Tap	100% of Peak, 200A	100% of 47X1 200A CT Tap
47X1J51X1	51X1	47X1	Entire Circuit	None	N/A	N/A	N/A
2X2J2X3	2X2	2X3	Entire Circuit	None	N/A	N/A	N/A
2X2J2X3	2X3	2X2	Entire Circuit	None	N/A	N/A	N/A
2X2J18X1	2X2	18X1	Up to 18X1R1 with 18X1J3 Open	None	269A #1 Cu along Winnacunnet Road 300A Solids Pole 290/1 Winnacunnet Road	85% of Peak, 310A	110% of #1 Cu Winnacunnet Rd 98% of Solids Winnacunnet Pole 290/1
2X2J18X1	18X1	2X2	Entire Circuit	None	N/A	N/A	116V on Primary
2X3J15X1	2X3	15X1	Entire Circuit	None	N/A	N/A	N/A
2X3J15X1	15X1	2X3	Entire Circuit	None	N/A	N/A	N/A
18X1J3	18X1R3	18X1R2	Entire Circuit	None	N/A	N/A	N/A
18X1J3	18X1R2	18X1R3	Entire Circuit	None	N/A	N/A	N/A
7X2J15X1	7X2	15X1	Cannot be used under Peak	Cannot be used under Peak	260A 7X2 Phase Pickup 200A 7X2 Regulators	85% of Peak, 225A	87% of 7X2 Pickup 112% of 7X2 Regulators
7X2J15X1	15X1	7X2 and 7W1	Entire Circuits of 7X2 and 7W1	None	N/A	N/A	N/A
15X1J59X1-1	15X1	59X1	Entire Circuit	86% of Continuous and 63% of Minimum Melt of 175QA Old New Zealand Road Pole 61/13	175A (240A MM) 175QA Old New Zealand Road Pole 61/13	100% of Peak, 275A	86% of Continuous and 63% of Minimum Melt of 175QA Old New Zealand Road Pole 61/13
15X1J59X1-1	59X1	15X1	Entire Circuit	None	N/A	N/A	N/A

Circuit Tie	Restoring Circuit	Restored Circuit	Limit of Restoration during Summer Peak	Accepted Planning Violations	Limiting Element w/ Summer Normal Rating	% Peak Loading & Max Per-Phase Amps at S/S when Tie is Usable to Restore Entire Circuit	Accepted Planning Violations
15X1J59X1-2	15X1	59X1	Entire Circuit	None	N/A	N/A	N/A
	59X1	15X1	Entire Circuit	None	N/A	N/A	N/A
23X1J59X1	23X1	59X1	Up to Solids on Amesbury Road Pole 1/140	100% of 23X1 200A CT Tap	200A 23X1 TDA CT Tap	90% of Peak, 195A	98% of 23X1 200A CT Tap
	59X1	23X1	Entire Circuit	None	N/A	N/A	N/A
17W1J17W2	17W1	17W2	Entire Circuit	None	N/A	N/A	N/A
	17W2	17W1	Entire Circuit	None	N/A	N/A	N/A
3W1J17W1	3W1	17W1	Up to 17W1R1 Recloser	92% of 3T3 Transformer	518A 3T3 Transformer	90% of Peak, 350A	99%of 3T3 Transformer
	17W1	3W1	Entire Circuit	90% of 3T3 Fuse Continuous Current Rating	457A 13T3 Fuses Continuous Current Rating	100% of Peak, 340A	90% of 3T3 Fuse Continuous Current Rating
3W1J3W4	3W1	3W4	Entire Circuit	None	N/A	N/A	N/A
	3W4	3W1	Up to 3W1R1	115% of 3W4 Regulators	263A 3W4 Regulators	100% of Peak, 300A	115% of 3W4 Regulators
3W1J3W5	3W1	3W4	Entire Circuit	None	N/A	N/A	N/A
	3W4	3W1	Up to 3W1R1	115% of 3W4 Regulators	263A 3W4 Regulators	100% of Peak, 300A	115% of 3W4 Regulators

Appendix F

Master Plan Map



REV.	DESCRIPTION	BY	DATE	CHK	APR
E	UPDATED FOR 2020-2024 PLANNING STUDY		6/17/19		
D	UPDATED FOR 2018-2022 PLANNING STUDY		1/23/17		
C	UPDATED FOR 2017-2021 PLANNING STUDY		12/21/15		
B	UPDATED FOR 2016-2020 PLANNING STUDY		8/7/15		
A	UPDATED FOR 2014-2018 PLANNING STUDY		4/30/13		

REVISIONS

DRAWN

CHECKED

APPROVED

Unitil

MASTER PLAN MAP
UES–SEACOAST
DISTRIBUTION PLANNING STUDY

SCALE	DATE	SHEET	DRAWING NO.
N/A	10/24/12	1 OF 1	UES–S MP

APPENDIX O

37 LINE / 4X1 NON-WIRES ALTERNATIVES FOR LOAD RELIEF REQUEST FOR INFORMATION EVALUATION

37 Line / 4X1 Non-Wires Alternatives for Load Relief Request for Information Evaluation

September 18, 2019

1 Introduction

In early 2019 as part of the UES-Capital system planning process Unitil identified the possible overload of the 37 line from Penacook to MacCoy Street tap in 2020 following the switching to restore all load for the contingent loss of the circuit 4X1 supply with all generation off-line[1].

The proposed traditional option to resolve this constraint is to reconductor the 37 line from Penacook to the MacCoy Street tap in 2020. The estimated cost to reconductor the 37 line is $750,000 without overheads. Additional information regarding the constraint and options considered can be found in the UES-Capital 2020-2029 Electric System Planning Study.

This project was evaluated per Unitil's Project Evaluation Procedure. Per the procedure non-wires alternatives (NWA) were not required to be evaluated, because the implementation date of the proposed traditional option is less than three years in the future. However, it was determined that Unitil would obtain information regarding NWA projects to defer this project.

In order for the NWA project/portfolio of projects to be considered the project(s) must reduce load in the area by approximately 3.5 MW by 2022 and 0.3 MW per year from 2023 to 2029 at the time of peak.

Unitil's Project Evaluation Procedure workflow for this constraint can be found in appendix A.

2 NWA Request for Information (RFI) Process

On March 29th, 2019 an RFI was released to the following vendors.

Vergent Power Solutions	EEI Services
Josh Hotvet	Clean Energy NH
Con Edison	Leidos
Solar Power Financial	Revision Energy
Barrington Power LLC	E.ON Climate and Renewables
WEG/BESS	Tangent Energy Solutions
OED Granite Apollo	CVE
New England Battery Storage	Pellet Heat
TRC	KW Management
Primary Lines/ABB	

Of the nineteen vendors that received the RFI eleven expressed interest in participating in the RFI process.

[1] Wheelabrator/SES is the largest generator in the area and is modelled offline per planning criteria. All three hydroelectric generators are modelled offline because they are typically offline during summer conditions due to low river flow.

Unitil received and responded to twenty-two clarifying questions and after the clarifying question and answer process four of the eleven remaining participants notified Unitil that they would not be submitting a response to the RFI.

Unitil received submittals from the four participants below with the others electing not submit information.

Barrington Power LLC	New England Battery Storage
WEG/BESS	Primary Lines/ABB

All four of the responses were for the installation of energy storage with one response paring the energy storage with a photovoltaic (PV) facility. The energy storage capacities proposed ranged from 3.5MW/7.0MWh to 5MW/20MWh and the proposed PV facility had a peak output rating of 3MW.

The pricing structure of three of the submittals had Unitil owning the infrastructure with one submittal having the vendor owning the infrastructure with Unitil paying and annual fee. The cost of the proposals ranged from $6.7 million to $11.5 million over a ten year period.

Additionally, two of the submittals called for a one time installation and two if the submittals proposed an initial installation to meet near term requirements with smaller installations/upgrades to accommodate future load growth.

3 Evaluation Process

A financial model was created to quantifiably capture some of the additional benefits of DER and perform a net present value analysis against the traditional option.

Results of that analysis are below with a negative result indicating that the NWA is more costly and a positive result indicating that the NWA is less costly than the traditional option.

Primary Lines/ABB Submittal

NPV - 5 Year	-$2,522,119
NPV - 10 Year	-$2,271,491
NPV - 20 Year	-$3,801,938

Barrington Power LLC

NPV - 5 Year	-$7,097,539
NPV - 10 Year	-$5,053,594
NPV - 20 Year	-$2,495,755

September 18, 2019

New England Battery Storage

NPV - 5 Year	-$1,630,371
NPV - 10 Year	-$2,881,063
NPV - 20 Year	-$4,070,362

WEG/BESS

NPV - 5 Year	-$3,653,377
NPV - 10 Year	-$3,435,701
NPV - 20 Year	-$1,853,750

The financial calculations used for this analysis can be found in appendix B.

Using the financial analysis the detailed cost/benefit analysis detailed in Unitil's Project Evaluation Procedure was performed. For this analysis the projects were condensed into three options: 1. Reconductor the 37 Line – Traditional Option; 2. Energy Storage – NWA; 3. Energy Storage/PV – NWA. Below is a summary of the results.

		Ranked Score (N Best, 1 Worst, N= # of Options)			
Evaluation Criteria	Weight Factor	Option 1	Option 2	Option 3	[redacted]
Functionality *(See Below)*	15%	3	2	1	
Environmental *(See Below)*	10%	2	3	1	
Reliability *(See Below)*	15%	3	2	2	
Feasibility *(See Below)*	25%	3	2	1	
Unitil Cost	30%	3	2	1	
Value Added Benefit of DG	5%	1	2	3	
Totals	100%	**2.8**	**2.1**	**1.25**	

Overall Rankings	**1**	2	3	[redacted]

Unitil's Project Evaluation Procedure detailed cost/benefit analysis can be found in the appendix C.

4 Conclusion

Based on the financial analysis and the cost benefit analysis the proposed project to address the identified 37 line constraint is to reconductor the 37 line from Penacook to the MacCoy Street tap.

Additionally, based on the information obtained as part of the NWA RFI process it is recommended that the traditional project cost to trigger an NWA review remain at $250,000 without overheads. However, it is also recommended that the review of NWA projects be triggered when equipment is expected to exceed 80% of its normal rating during the first five years of the study period and exceed 90% of its normal rating in year five of the study period under basecase/normal configuration conditions. Under planned contingency configurations it is recommended that NWA project reviews be triggered when equipment is expected to exceed 90% of its normal rating during the first five years of the study period and exceed 100% or its normal rating in year five of the study period.

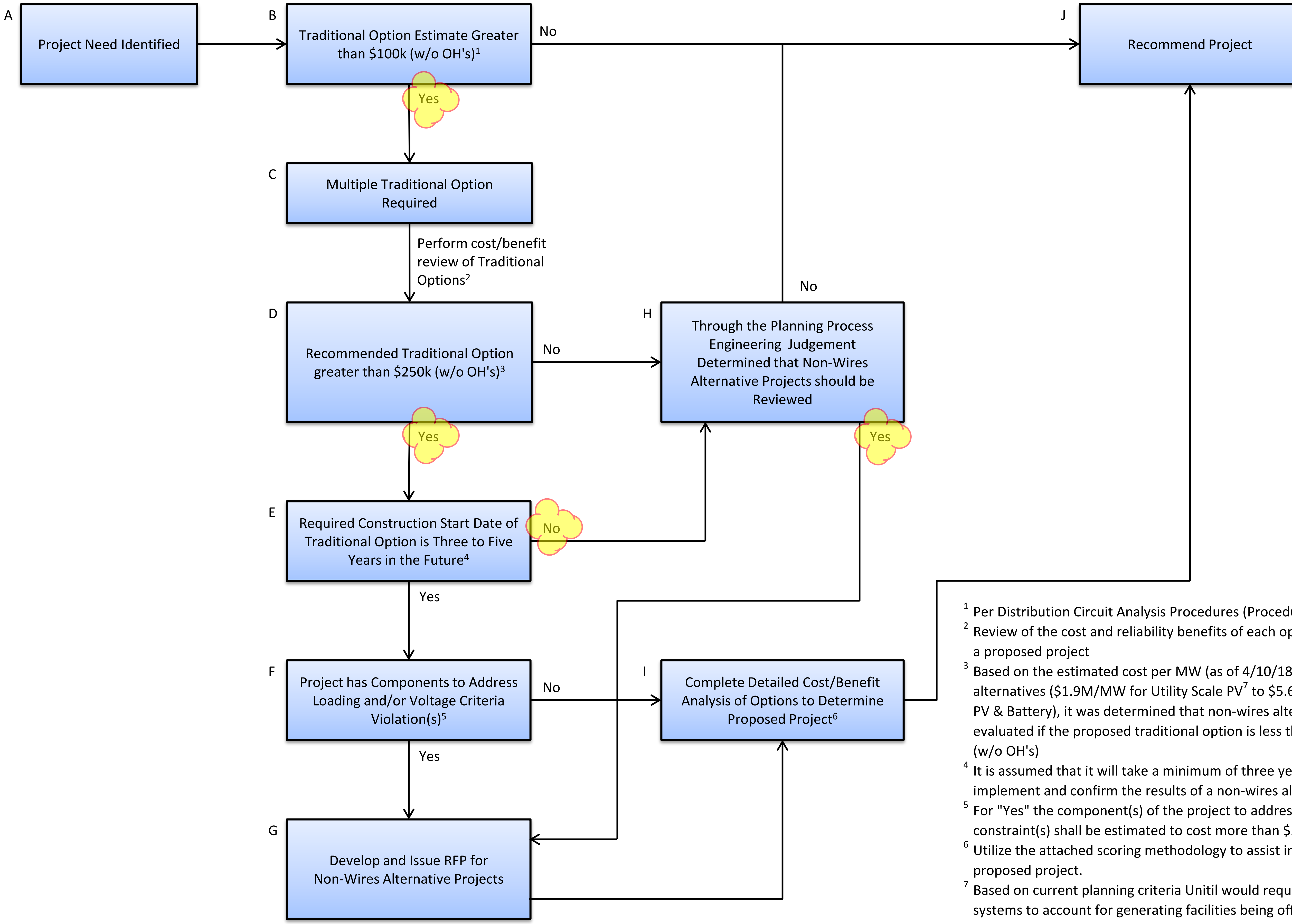
The intent of these loading thresholds is to review and possibly implement NWA projects to defer planning violations opposed to using NWA projects to resolve planning violations.

Appendix A

Project Evaluation Procedure Workflow

Project Evaluation Workflow

37 Line Loading Violation
7/15/2019



[1] Per Distribution Circuit Analysis Procedures (Procedure No. PR-DT-DS-03).

[2] Review of the cost and reliability benefits of each option to determine a proposed project

[3] Based on the estimated cost per MW (as of 4/10/18) to implement non-wires alternatives ($1.9M/MW for Utility Scale PV[7] to $5.6M/MW for Roof Top PV & Battery), it was determined that non-wires alternatives would not be evaluated if the proposed traditional option is less than $0.25M (w/o OH's)

[4] It is assumed that it will take a minimum of three years to evaluate, implement and confirm the results of a non-wires alternative project.

[5] For "Yes" the component(s) of the project to address loading and/or voltage constraint(s) shall be estimated to cost more than $250k (w/o OH's).

[6] Utilize the attached scoring methodology to assist in selecting a proposed project.

[7] Based on current planning criteria Unitil would require multiple utility scale systems to account for generating facilities being off-line.

Appendix B

RFI Evaluation Financial Calculators

NEBS

Income Tax Rate	27.34%	Frequency Credit ($/MW/yr)	$6,956	Reduction in MWh System Consumption ($/MWh)	$110
Property Tax Rate	2.70%	Capacity Credit ($/MW/yr)	$55,560	REC ($/MWh)	$25
Cost of Capital	8.00%	RNS Trans Cost Reduction ($/MWh/yr)	$113,712	MWh generated/yr/MW	1275
		RNS Trans Cost Reduction (hours/day)	6		

Assumptions are highlighted in blue

	Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
NWA Installation Construction Installed in Given Year																						
Battery Cost Installed in Given Year			$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000
Battery Size (MW) Installed in Given Year		5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Battery Size (MWh) Installed in Given Year		20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Battery Expected Life (yrs)	10																					
PV Cost Installed in Given Year																						
PV Size (MW) Installed in Given Year																						
PV Generation (MWh/yr) Installed in Given Year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PV Expected Line (yrs)	20																					
O&M NWA			$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000	$ 20,000
Traditional Alternative Cost					$ (750,000)																	

NPV - 5 Year	*($1,630,371.16)*
NPV - 10 Year	*($2,881,063.57)*
NPV - 20 Year	*($4,070,362.20)*

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Net Plant	$0	$1,080,000	$2,052,000	$2,916,000	$3,672,000	$4,320,000	$4,860,000	$5,292,000	$5,616,000	$5,832,000	$5,940,000	$5,940,000	$5,940,000	$5,940,000	$5,940,000	$5,940,000	$5,940,000	$5,940,000	$5,940,000	$5,940,000	$5,940,000
Merchant Regulation (Frequency)		$34,780	$34,780	$34,780	$34,780	$34,780	$34,780	$34,780	$34,780	$34,780	$34,780	$34,780	$34,780	$34,780	$34,780	$34,780	$34,780	$34,780	$34,780	$34,780	$34,780
Capacity Credit		$277,800	$277,800	$277,800	$277,800	$277,800	$277,800	$277,800	$277,800	$277,800	$277,800	$277,800	$277,800	$277,800	$277,800	$277,800	$277,800	$277,800	$277,800	$277,800	$277,800
RNS Trans. Cost Reduction (Savings)		$379,040	$379,040	$379,040	$379,040	$379,040	$379,040	$379,040	$379,040	$379,040	$379,040	$379,040	$379,040	$379,040	$379,040	$379,040	$379,040	$379,040	$379,040	$379,040	$379,040
Energy Consumption Reduction		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
REC		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Revenues		$691,620	$691,620	$691,620	$691,620	$691,620	$691,620	$691,620	$691,620	$691,620	$691,620	$691,620	$691,620	$691,620	$691,620	$691,620	$691,620	$691,620	$691,620	$691,620	$691,620
Property Tax		$29,160	$55,404	$78,732	$99,144	$116,640	$131,220	$142,884	$151,632	$157,464	$160,380	$160,380	$160,380	$160,380	$160,380	$160,380	$160,380	$160,380	$160,380	$160,380	$160,380
O&M		$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000
Depreciation - Installation		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Depreciation - Battery		$0	$108,000	$216,000	$324,000	$432,000	$540,000	$648,000	$756,000	$864,000	$972,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000
Depreciation - PV		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Taxable Income	-	$642,460	$508,216	$376,888	$248,476	$122,980	$400	($119,264)	($236,012)	($349,844)	($460,760)	($568,760)	($568,760)	($568,760)	($568,760)	($568,760)	($568,760)	($568,760)	($568,760)	($568,760)	($568,760)
Income Tax	-	$175,649	$138,946	$103,041	$67,933	$33,623	$109	($32,607)	($64,526)	($95,647)	($125,972)	($155,499)	($155,499)	($155,499)	($155,499)	($155,499)	($155,499)	($155,499)	($155,499)	($155,499)	($155,499)
Cashflow From Operations	-	$466,811	$477,270	$489,847	$504,543	$521,357	$540,291	$561,343	$584,514	$609,803	$637,212	$666,739	$666,739	$666,739	$666,739	$666,739	$666,739	$666,739	$666,739	$666,739	$666,739
Investment Activity:																					
Installation Construction	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Battery Investment	$0	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000
PV Investment	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Deferred Traditional Alternative Cost	$0	$0	$0	($750,000)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Cashflow From Investments	$0	$1,080,000	$1,080,000	$330,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000	$1,080,000
Cashflow	$0	($613,189)	($602,730)	$159,847	($575,457)	($558,643)	($539,709)	($518,657)	($495,486)	($470,197)	($442,788)	($413,261)	($413,261)	($413,261)	($413,261)	($413,261)	($413,261)	($413,261)	($413,261)	($413,261)	($413,261)

Barrington

Income Tax Rate	27.34%	Frequency Credit ($/MW/yr)	$6,956	Reduction in MWh System Consumption ($/MWh)	$110	Assumptions are highlighted in blue
Property Tax Rate	2.70%	Capacity Credit ($/MW/yr)	$55,560	REC ($/MWh)	$25	
Cost of Capital	8.00%	RNS Trans Cost Reduction ($/MWh/yr)	$113,712	MWh generated/yr/MW	1275	
		RNS Trans Cost Reduction (hours/day)	6			

Year		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
NWA Installation Construction Installed in Given Year		$11,063,278																				
Battery Cost Installed in Given Year	Included in above																					
Battery Size (MW) Installed in Given Year			6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Battery Size (MWh) Installed in Given Year			12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
Battery Expected Life (yrs)	20																					
PV Cost Installed in Given Year	included in above																					
PV Size (MW) Installed in Given Year			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
PV Generation (MWh/yr) Installed in Given Year			3825	3825	3825	3825	3825	3825	3825	3825	3825	3825	3825	3825	3825	3825	3825	3825	3825	3825	3825	3825
PV Expected Line (yrs)	20																					
O&M NWA			$ 27,500	$ 27,500	$ 27,500	$ 27,500	$ 27,500	$ 27,500	$ 27,500	$ 27,500	$ 27,500	$ 27,500	$ 27,500	$ 27,500	$ 27,500	$ 27,500	$ 27,500	$ 27,500	$ 27,500	$ 27,500	$ 27,500	$ 27,500
Traditional Alternative Cost					$ (750,000)																	

NPV - 5 Year	*($7,097,539.68)*
NPV - 10 Year	*($5,053,594.30)*
NPV - 20 Year	*($2,495,755.04)*

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Net Plant	$11,063,278	$10,510,114	$9,956,950	$9,403,786	$8,850,622	$8,297,459	$7,744,295	$7,191,131	$6,637,967	$6,084,803	$5,531,639	$4,978,475	$4,425,311	$3,872,147	$3,318,983	$2,765,820	$2,212,656	$1,659,492	$1,106,328	$553,164	($0)
Merchant Regulation (Frequency)		$41,736	$41,736	$41,736	$41,736	$41,736	$41,736	$41,736	$41,736	$41,736	$41,736	$41,736	$41,736	$41,736	$41,736	$41,736	$41,736	$41,736	$41,736	$41,736	$41,736
Capacity Credit		$0	$333,360	$333,360	$333,360	$333,360	$333,360	$333,360	$333,360	$333,360	$333,360	$333,360	$333,360	$333,360	$333,360	$333,360	$333,360	$333,360	$333,360	$333,360	$333,360
RNS Trans. Cost Reduction (Savings)		$227,424	$227,424	$227,424	$227,424	$227,424	$227,424	$227,424	$227,424	$227,424	$227,424	$227,424	$227,424	$227,424	$227,424	$227,424	$227,424	$227,424	$227,424	$227,424	$227,424
Energy Consumption Reduction		$420,750	$420,750	$420,750	$420,750	$420,750	$420,750	$420,750	$420,750	$420,750	$420,750	$420,750	$420,750	$420,750	$420,750	$420,750	$420,750	$420,750	$420,750	$420,750	$420,750
REC		$95,625	$95,625	$95,625	$95,625	$95,625	$95,625	$95,625	$95,625	$95,625	$95,625	$95,625	$95,625	$95,625	$95,625	$95,625	$95,625	$95,625	$95,625	$95,625	$95,625
Total Revenues		$785,535	$1,118,895	$1,118,895	$1,118,895	$1,118,895	$1,118,895	$1,118,895	$1,118,895	$1,118,895	$1,118,895	$1,118,895	$1,118,895	$1,118,895	$1,118,895	$1,118,895	$1,118,895	$1,118,895	$1,118,895	$1,118,895	$1,118,895
Property Tax		$283,773	$268,838	$253,902	$238,967	$224,031	$209,096	$194,161	$179,225	$164,290	$149,354	$134,419	$119,483	$104,548	$89,613	$74,677	$59,742	$44,806	$29,871	$14,935	($0)
O&M		$27,500	$27,500	$27,500	$27,500	$27,500	$27,500	$27,500	$27,500	$27,500	$27,500	$27,500	$27,500	$27,500	$27,500	$27,500	$27,500	$27,500	$27,500	$27,500	$27,500
Depreciation - Installation		$553,164	$553,164	$553,164	$553,164	$553,164	$553,164	$553,164	$553,164	$553,164	$553,164	$553,164	$553,164	$553,164	$553,164	$553,164	$553,164	$553,164	$553,164	$553,164	$553,164
Depreciation - Battery		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Depreciation - PV		$0	$0	$0	$0	$0	$0	$0	$0	$1	$0	$1,913	$2,104	$2,295	$0	$0	$0	$0	$0	$0	$0
Taxable Income	-	($78,902)	$269,393	$284,329	$299,264	$314,200	$329,135	$344,071	$359,006	$373,940	$388,877	$401,900	$416,644	$431,388	$448,619	$463,554	$478,489	$493,425	$508,360	$523,296	$538,231
Income Tax	-	($21,572)	$73,652	$77,736	$81,819	$85,902	$89,986	$94,069	$98,152	$102,235	$106,319	$109,879	$113,910	$117,942	$122,652	$126,736	$130,819	$134,902	$138,986	$143,069	$147,152
Cashflow From Operations	-	$495,834	$748,905	$759,757	$770,609	$781,461	$792,313	$803,166	$814,018	$824,870	$835,722	$847,097	$858,001	$868,906	$879,130	$889,982	$900,834	$911,686	$922,538	$933,391	$944,243
Investment Activity:																					
Installation Construction	$11,063,278	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Battery Investment	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
PV Investment	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Deferred Traditional Alternative Cost	$0	$0	$0	($750,000)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Cashflow From Investments	$11,063,278	$0	$0	($750,000)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Cashflow	($11,063,278)	$495,834	$748,905	$1,509,757	$770,609	$781,461	$792,313	$803,166	$814,018	$824,870	$835,722	$847,097	$858,001	$868,906	$879,130	$889,982	$900,834	$911,686	$922,538	$933,391	$944,243

ABB

Income Tax Rate	27.34%	Frequency Credit ($/MW/yr)	$6,956	Reduction in MWh System Consumption ($/MWh)	$110
Property Tax Rate	2.70%	Capacity Credit ($/MW/yr)	$55,560	REC ($/MWh)	$25
Cost of Capital	8.00%	RNS Trans Cost Reduction ($/MWh/yr)	$113,712	MWh generated/yr/MW	1275
		RNS Trans Cost Reduction (hours/day)	6		

Assumptions are highlighted in blue

	Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
NWA Installation Construction Installed in Given Year																						
Battery Cost Installed in Given Year		$3,670,000			$380,000	$380,000	$380,000	$380,000	$380,000	$380,000	$380,000	$380,000	$4,050,000	$760,000	$760,000	$760,000	$760,000	$760,000	$760,000	$760,000	$760,000	$760,000
Battery Size (MW) Installed in Given Year		3.5	3.5	3.5	3.9	4.3	4.6	5.0	5.4	5.8	6.2	6.5	6.9	7.3	7.7	8.1	8.4	8.8	9.2	9.6	10.0	10.3
Battery Size (MWh) Installed in Given Year		7.0	7.0	7.0	7.8	8.5	9.3	10.0	10.8	11.6	12.3	13.1	13.8	14.6	15.4	16.1	16.9	17.6	18.4	19.2	19.9	20.7
Battery Expected Life (yrs)	10																					
PV Cost Installed in Given Year																						
PV Size (MW) Installed in Given Year																						
PV Generation (MWh/yr) Installed in Given Year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PV Expected Line (yrs)	20																					
O&M NWA			$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000
Traditional Alternative Cost					$ (750,000)																	

NPV - 5 Year	*($2,522,119.29)*
NPV - 10 Year	*($2,271,491.10)*
NPV - 20 Year	*($3,801,938.47)*

	Year 0	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**
Net Plant	$3,670,000	$3,303,000	$2,936,000	$2,949,000	$2,924,000	$2,861,000	$2,760,000	$2,621,000	$2,444,000	$2,229,000	$1,976,000
Merchant Regulation (Frequency)		$24,346	$24,346	$26,989	$29,633	$32,276	$34,919	$37,562	$40,206	$42,849	$45,492
Capacity Credit		$194,460	$194,460	$194,460	$215,573	$236,686	$257,798	$278,911	$300,024	$321,137	$342,250
RNS Trans. Cost Reduction (Savings)		$132,664	$132,664	$147,068	$161,471	$175,875	$190,278	$204,682	$219,085	$233,489	$247,892
Energy Consumption Reduction		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
REC		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Revenues		$351,470	$351,470	$368,517	$406,676	$444,836	$482,996	$521,155	$559,315	$597,474	$635,634
Property Tax		$89,181	$79,272	$79,623	$78,948	$77,247	$74,520	$70,767	$65,988	$60,183	$53,352
O&M		$35,000	$35,000	$35,000	$35,000	$35,000	$35,000	$35,000	$35,000	$35,000	$35,000
Depreciation - Installation		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Depreciation - Battery		$367,000	$367,000	$367,000	$405,000	$443,000	$481,000	$519,000	$557,000	$595,000	$633,000
Depreciation - PV		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Taxable Income	-	($139,711)	($129,802)	($113,106)	($112,272)	($110,411)	($107,524)	($103,612)	($98,673)	($92,709)	($85,718)
Income Tax	-	($38,197)	($35,488)	($30,923)	($30,695)	($30,186)	($29,397)	($28,327)	($26,977)	($25,347)	($23,435)
Cashflow From Operations	-	$265,486	$272,686	$284,817	$323,423	$362,775	$402,873	$443,716	$485,304	$527,638	$570,717
Investment Activity:											
Installation Construction	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Battery Investment	$3,670,000	$0	$0	$380,000	$380,000	$380,000	$380,000	$380,000	$380,000	$380,000	$380,000
PV Investment	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Deferred Traditional Alternative Cost	$0	$0	$0	($750,000)	$0	$0	$0	$0	$0	$0	$0
Cashflow From Investments	$3,670,000	$0	$0	($370,000)	$380,000	$380,000	$380,000	$380,000	$380,000	$380,000	$380,000
Cashflow	($3,670,000)	$265,486	$272,686	$654,817	($56,577)	($17,225)	$22,873	$63,716	$105,304	$147,638	$190,717

	Year 11	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
Net Plant	$5,722,000	$5,773,000	$5,748,000	$5,685,000	$5,584,000	$5,445,000	$5,268,000	$5,053,000	$4,800,000	$4,509,000
Merchant Regulation (Frequency)	$48,136	$50,779	$53,422	$56,065	$58,709	$61,352	$63,995	$66,638	$69,282	$71,925
Capacity Credit	$363,362	$384,475	$405,588	$426,701	$447,814	$468,926	$490,039	$511,152	$532,265	$553,378
RNS Trans. Cost Reduction (Savings)	$262,296	$276,699	$291,103	$305,506	$319,910	$334,313	$348,717	$363,120	$377,524	$391,927
Energy Consumption Reduction	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
REC	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Revenues	$673,794	$711,953	$750,113	$788,272	$826,432	$864,592	$902,751	$940,911	$979,070	$1,017,230
Property Tax	$154,494	$155,871	$155,196	$153,495	$150,768	$147,015	$142,236	$136,431	$129,600	$121,743
O&M	$35,000	$35,000	$35,000	$35,000	$35,000	$35,000	$35,000	$35,000	$35,000	$35,000
Depreciation - Installation	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Depreciation - Battery	$304,000	$709,000	$785,000	$823,000	$861,000	$899,000	$937,000	$975,000	$1,013,000	$1,051,000
Depreciation - PV	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Taxable Income	$180,300	($187,918)	($225,083)	($223,223)	($220,336)	($216,423)	($211,485)	($205,520)	($198,530)	($190,513)
Income Tax	$49,294	($51,377)	($61,538)	($61,029)	($60,240)	($59,170)	($57,820)	($56,189)	($54,278)	($52,086)
Cashflow From Operations	$435,006	$572,459	$621,455	$660,806	$700,904	$741,747	$783,335	$825,669	$868,748	$912,573
Investment Activity:										
Installation Construction	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Battery Investment	$4,050,000	$760,000	$760,000	$760,000	$760,000	$760,000	$760,000	$760,000	$760,000	$760,000
PV Investment	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Deferred Traditional Alternative Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Cashflow From Investments	$4,050,000	$760,000	$760,000	$760,000	$760,000	$760,000	$760,000	$760,000	$760,000	$760,000
Cashflow	($3,614,994)	($187,541)	($138,545)	($99,194)	($59,096)	($18,253)	$23,335	$65,669	$108,748	$152,573

WEG

Income Tax Rate	27.34%	Frequency Credit ($/MW/yr)	$6,956	Reduction in MWh System Consumption ($/MWh)	$110
Property Tax Rate	2.70%	Capacity Credit ($/MW/yr)	$55,560	REC ($/MWh)	$25
Cost of Capital	8.00%	RNS Trans Cost Reduction ($/MWh/yr)	$113,712	MWh generated/yr/MW	1275
		RNS Trans Cost Reduction (hours/day)	6		

Assumptions are highlighted in blue

	Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
NWA Installation Construction Installed in Given Year		$6,040,165								$1,824,400												
Battery Cost Installed in Given Year																						
Battery Size (MW) Installed in Given Year		4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4
Battery Size (MWh) Installed in Given Year		14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2
Battery Expected Life (yrs)	10																					
PV Cost Installed in Given Year																						
PV Size (MW) Installed in Given Year																						
PV Generation (MWh/yr) Installed in Given Year			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PV Expected Line (yrs)	20																					
O&M NWA			$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000	$ 30,000
Traditional Alternative Cost					$ (750,000)																	

NPV - 5 Year	*($3,653,377.14)*
NPV - 10 Year	*($3,435,701.87)*
NPV - 20 Year	*($1,853,750.02)*

	Year 0	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Year 11**	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**
Net Plant	$6,040,165	$5,738,157	$5,436,149	$5,134,140	$4,832,132	$4,530,124	$4,228,116	$3,926,107	$5,448,499	$5,146,491	$4,844,483	$4,542,474	$4,240,466	$3,938,458	$3,636,450	$3,334,441	$3,032,433	$2,730,425	$2,428,417	$2,126,408	$1,824,400
Merchant Regulation (Frequency)		$33,389	$33,389	$33,389	$33,389	$33,389	$33,389	$33,389	$44,518	$44,518	$44,518	$44,518	$44,518	$44,518	$44,518	$44,518	$44,518	$44,518	$44,518	$44,518	$44,518
Capacity Credit		$266,688	$266,688	$266,688	$266,688	$266,688	$266,688	$266,688	$266,688	$355,584	$355,584	$355,584	$355,584	$355,584	$355,584	$355,584	$355,584	$355,584	$355,584	$355,584	$355,584
RNS Trans. Cost Reduction (Savings)		$272,909	$272,909	$272,909	$272,909	$272,909	$272,909	$272,909	$363,878	$363,878	$363,878	$363,878	$363,878	$363,878	$363,878	$363,878	$363,878	$363,878	$363,878	$363,878	$363,878
Energy Consumption Reduction		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
REC		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Revenues		$572,986	$572,986	$572,986	$572,986	$572,986	$572,986	$572,986	$675,085	$763,981	$763,981	$763,981	$763,981	$763,981	$763,981	$763,981	$763,981	$763,981	$763,981	$763,981	$763,981
Property Tax		$154,930	$146,776	$138,622	$130,468	$122,313	$114,159	$106,005	$147,109	$138,955	$130,801	$122,647	$114,493	$106,338	$98,184	$90,030	$81,876	$73,721	$65,567	$57,413	$49,259
O&M		$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000
Depreciation - Installation		$302,008	$302,008	$302,008	$302,008	$302,008	$302,008	$302,008	$302,008	$302,008	$302,008	$302,008	$302,008	$302,008	$302,008	$302,008	$302,008	$302,008	$302,008	$302,008	$302,008
Depreciation - Battery		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Depreciation - PV		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Taxable Income	-	$86,047	$94,201	$102,356	$110,510	$118,664	$126,818	$134,972	$195,967	$293,017	$301,172	$309,326	$317,480	$325,634	$333,788	$341,943	$350,097	$358,251	$366,405	$374,560	$382,714
Income Tax	-	$23,525	$25,755	$27,984	$30,213	$32,443	$34,672	$36,901	$53,577	$80,111	$82,340	$84,570	$86,799	$89,028	$91,258	$93,487	$95,716	$97,946	$100,175	$102,405	$104,634
Cashflow From Operations	-	$364,530	$370,455	$376,380	$382,305	$388,230	$394,154	$400,079	$444,398	$514,915	$520,839	$526,764	$532,689	$538,614	$544,539	$550,464	$556,389	$562,313	$568,238	$574,163	$580,088
Investment Activity:																					
Installation Construction	$6,040,165	$0	$0	$0	$0	$0	$0	$0	$1,824,400	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Battery Investment	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
PV Investment	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Deferred Traditional Alternative Cost	$0	$0	$0	($750,000)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Cashflow From Investments	$6,040,165	$0	$0	($750,000)	$0	$0	$0	$0	$1,824,400	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Cashflow	($6,040,165)	$364,530	$370,455	$1,126,380	$382,305	$388,230	$394,154	$400,079	($1,380,002)	$514,915	$520,839	$526,764	$532,689	$538,614	$544,539	$550,464	$556,389	$562,313	$568,238	$574,163	$580,088

Appendix C

Project Evaluation Procedure
Detailed Cost/Benefit Analysis

Constraint / Need for Project: 37 Line Loading Violation

Project Need Year: 2020
Date Evaluation Performed: 6/18/2019
Traditional Alternative Construction Start Year: 2020

	Project Scope
Option 1	Reconductor 37 Line - Traditional Option
Option 2	Energy Storage - NWA
Option 3	Energy Storage/PV - NWA

Number of Alternatives **3**

User Input (cell will turn white once value is enetered)

Evaluation Criteria	Weight Factor	**Ranked Score (N Best, 1 Worst, N= # of Options)** Option 1	Option 2	Option 3
Functionality *(See Below)*	15%	3	2	1
Environemental *(See Below)*	10%	2	3	1
Reliability *(See Below)*	15%	3	2	2
Feasibility *(See Below)*	25%	3	2	1
Unitil Cost	30%	3	2	1
Value Added Benefit of DG	5%	1	2	3
Totals	100%	**2.8**	**2.1**	**1.25**

Overall Rankings	1	2	3

Functionality Evaluation Criteria	Weight Factor	**Ranked Score (N Best, 1 Worst, N= # of Options)** Option 1	Option 2	Option 3
Operating Flexibility	15%	3	1	2
Availability	30%	3	2	1
Maintenance	10%	3	2	1
Load Servicing Capacity	20%	3	3	1
DG Interconnect Capacity	10%	3	2	1
System Master Plan	15%	3	2	2
Totals	100%	**3**	**2.05**	**1.3**
	Rankings	1	2	3

Environmental Evaluation Criteria	Weight Factor	**Ranked Score (N Best, 1 Worst, N= # of Options)** Option 1	Option 2	Option 3	
Wetland Impact	25%	1	3	2	[redacted]
Tree Clearing	25%	3	3	1	
Residential Area Impacts	25%	2	3	1	
Municipal Considerations	25%	2	3	1	
Totals	100%	**2**	**3**	**1.25**	
	Rankings	2	1	3	

Reliability Evaluation Criteria	Weight Factor	**Ranked Score (N Best, 1 Worst, N= # of Options)** Option 1	Option 2	Option 3	
Customer Exposure	30%	3	1	2	[redacted]
Miles / Equipment Exposure	30%	2	2	1	
Automatic Restoration	20%	1	1	1	
Power Quality	20%	1	3	3	
Totals	100%	**1.9**	**1.7**	**1.7**	
	Rankings	1	2	2	

Feasibility Evaluation Criteria	Weight Factor	**Ranked Score (N Best, 1 Worst, N= # of Options)** Option 1	Option 2	Option 3	
Likelihood of Completion	50%	3	2	1	[redacted]
Long Term Solution	25%	3	2	2	
Life Span	20%	3	2	2	
Design Standards	5%	3	2	2	
Totals	100%	**3**	**2**	**1.5**	
	Rankings	1	2	3	

Note: Weight factors and evaluation criteria shall be adjusted as needed