NEPR

Received:

Apr 11, 2021

8:09 PM

COMMONWEALTH OF PUERTO RICO
PUBLIC SERVICE REGULATORY BOARD
PUERTO RICO ENERGY BUREAU

IN RE: REVIEW OF THE PUERTO RICO ELECTRIC POWER AUTHORITY'S COMPREHENSIVE VEGETATION MANAGEMENT PLAN	**CASE NO. NEPR-MI-2019-0005** SUBJECT: LUMA's Vegetation Management Plan.

PETITION SUBMITTING LUMA'S VEGETATION MANAGEMENT PLAN

TO THE HONORABLE PUERTO RICO ENERGY BUREAU:

COME NOW LUMA Energy, LLC ("ManagementCo")[1], and **LUMA Energy ServCo, LLC** ("ServCo")[2], (jointly referred to as "LUMA"), and respectfully submit this Petition to the honorable Puerto Rico Energy Bureau ("Energy Bureau" and/or "Bureau"), through the undersigned counsel and submit LUMA's Vegetation Management Plan:

I. Introduction

LUMA entered into the Puerto Rico Transmission and Distribution System Operation and Maintenance Agreement dated as of June 22, 2020 (the "OMA"), with the Puerto Rico Electric Power Authority ("PREPA") and the Puerto Rico Public-Private Partnerships Authority ("P3 Authority") to (i) provide management, operation, maintenance, repair, restoration and replacement, and other related services for the transmission and distribution system ("T&D System"), in each case that are customary and appropriate for a utility transmission and distribution system service provider, and (ii) establish policies, programs and procedures with respect thereto

[1] Register No. 439372.
[2] Register No. 439373.

([(i) and (ii), collectively], the "O&M Services") . . . ." *See* OMA Section 5.1.[3] The O&M Services are to be provided in accordance with the "Contract Standards,"[4] requiring compliance with Applicable Law[5], Prudent Utility Practice[6], and other standards, terms, conditions and requirements specified in the OMA. Contract Standards necessarily require acting consistently with policy mandates and directives in Act 57-2014, as amended, known as the "Puerto Rico Energy Transformation and RELIEF Act" ("Act 57-2014"), Act 120-2018, as amended, known as the "Electric Power System Transformation Act" ("Act 120-2018") and Act 17-2019, known as the "Puerto Rico Energy Public Policy Act" ("Act 17-2019"), among others.

The O&M Services are to commence on a date referred to as the "Service Commencement Date," or the "Interim Period Service Commencement Date" if PREPA remains in Title III bankruptcy proceeding, and certain conditions precedent specified under the OMA are satisfied or

[3] The OMA further provides that, except for those rights and responsibilities reserved for PREPA and the P3 Authority or otherwise expressly provided in the OMA, LUMA "shall (A) be entitled to exercise all of the rights and perform the responsibilities of [PREPA] in providing the O&M Services, and (B) have the autonomy and responsibility to operate and maintain the T&D System and establish the related plans, policies, procedures and programs with respect thereto as provided in [the OMA]." *Id*. Moreover, the OMA provides that LUMA shall function as agent of [PREPA] and PREPA "irrevocably authorizes [LUMA] to (i) represent [PREPA] before [the Energy Bureau] with respect to any matter related to the performance of any O&M Services provided by [LUMA] under [the OMA]" and "(ii) prepare all related filings and other submissions before [the Energy Bureau]" among other functions. OMA, Section 5.6.

[4] The OMA defines "Contract Standards" as "the terms, conditions, methods, techniques, practices and standards imposed or required by: (i) Applicable Law; (ii) Prudent Utility Practice; (iii) applicable equipment manufacturer's specifications and reasonable recommendations; (iv) applicable insurance requirements under any insurance procured pursuant to this Agreement; (v) the Procurement Manuals, as applicable, and (vi) any other standard, term, condition or requirement specifically contracted in this Agreement to be observed by [LUMA]." *Id.* Section 1.1 at page 9.

[5] This term includes "any foreign, national, federal, state, Commonwealth, municipal or local law, constitution, treaty, convention, statute, ordinance, code, rule, regulation, common law, case law or other similar requirement enacted, adopted, promulgated or applied by any [governmental body][…]" in each case applicable to the parties to the OMA. *Id.,* Section 1.1 at page 3.

[6] "Prudent Utility Practice" is defined, in pertinent part, as "…at any particular time, the practices, methods, techniques, conduct and acts that, at the time they are employed, are generally recognized and accepted by companies operating in the United States electric transmission and distribution business as such practices, methods, techniques, conduct and acts appropriate to the operation, maintenance, repair and replacement of assets, facilities and properties of the type covered by the [OMA] . . . ." *Id.* at page 26.

waived (collectively, for purposes of this Petition, the "Commencement Date").[7] *See Id.*, Sections 4.5 and 4.7(b). Beginning on the Effective Date (that is, June 22, 2020) and until Commencement Date[8] (this period, the "Front-End Transition Period"), LUMA is required to provide "Front-End Transition Services"[9] which are "intended to ensure an orderly transition of the responsibility for the management, operation, maintenance, repairs, restoration and replacement of the T&D System to [LUMA] by the . . . [Commencement Date], without disruption of customer service and business continuity . . . ." *Id.*, Sections 1.1 at page 15 and Section 4.1(a).[10]

During the Front-End Transition Period LUMA "shall develop and provide Administrator and PREB, for their information, . . . [a] plan[] of action meeting Contract Standards that outline[s] the procedures and actions necessary for maintaining . . . (iii) a comprehensive vegetation management program (the "Vegetation Management Plan"). . . ." *Id.* Section 4.2(h); *see also id.* Annex II at pages II-26, II-40.

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[7]LUMA is assuming that PREPA will not exit the Title III Bankruptcy proceeding before June 1, 2021. Consistent with statements from the Executive Director of Financial Oversight and Management Board (FOMB) and PREPA Certified Fiscal Plan for FY2021, certified on June 29, 2020, the Initial Budgets assume that PREPA will exit Title III at December 31, 2021. *See e.g., "*Natalie Jaresko: "we are going to emerge from bankruptcy in 2021", PR Headline News, https://www.puertoricoheadlinenews.com/natalie-jaresko-we-are-going-to-emerge-from-bankruptcy-in-2021/ (last visited February 22, 2021). Consequently, LUMA anticipates providing the O&M Services during the Interim Period pursuant to the Supplemental Terms Agreement agreed between the OMA parties precisely for this contingency. If PREPA exits the Title III bankruptcy proceeding contemporaneously with all other conditions precedent to Service Commencement Date, then LUMA will begin providing O&M Services without the need for an "interim period." Mentions in this document (and in all other OMA required submittals to the Energy Bureau), to "beginning of O&M Services," "start of operations," "start of operations and maintenance services," and other allusions of similar import, shall be understood to refer to the end of the Front-End Transition Period and LUMA's commencement of O&M Services regardless of whether it is in under an "interim period" or after full "Service Commencement Date."

[8] *See Id.*

[9] The Front-End Transition Services are defined in the OMA as services to "complete the transition and handover to [LUMA] of the operation, management and other rights and responsibilities with respect to the T&D System pursuant to [the OMA], including the services contemplated by the Front-End Transition Plan; provided that the Front-End Transition Services shall not be O&M Services." [9] *Id.*, Section 1.1 at page 16.

[10] Although both ManagementCo and ServCo constitute the Operator under the OMA, after the Commencement Date, ServCo will provide the vast majority of the O&M Services while ManagementCo's role will be mainly providing oversight and management of ServCo.

Upon Service Commencement and as part of the O&M Services, LUMA is responsible for, among others, "managing and maintaining all assets of the T&D System including machinery, equipment, structures, improvements and condition assessment of the electrical system components, in accordance with the Contract Standards, including . . . (10) vegetation management in accordance with Prudent Utility Practice and Applicable Law . . . ." *Id.* Annex I, Section IIA, at page I-4.

During the Front-End Transition Period, LUMA engaged a team of industry-leading subject matter experts (SMEs) to use available data (e.g., LIDAR, publicly available imagery, system maps, employee and contractor knowledge, and existing outage data) and review available information, to prepare LUMA's proposed Vegetation Management Plan, which is submitted as Exhibit 1 to this Petition. *See* Exhibit 1, Section 1.0.[11] LUMA also reviewed PREPA's existing vegetation management plan, practices, and other aspects of vegetation management carried out by PREPA. *See id.*

Additionally, LUMA completed a gap assessment that identifies several deficiencies in PREPA's Vegetation Management Plan and Vegetation Management activities that need to be corrected for LUMA to meet the requirements of the OMA as well as to comply with applicable legal requirements. *Id.* Sections 1.0 and 11.1. The gaps that were identified include: (1) absence of a centralized organization to maintain and manage vegetation-related processes across the T&D System; (2) deferred vegetation management with work predominantly being reactive or corrective maintenance (a.k.a., "hot spotting"); (3) ineffective current pruning practices; and (4) equipment that is used by in-house personnel is in poor repair, with a scarcity of any specialized vegetation management equipment. *Id.* Section 11.1. As explained in Exhibit 1, deferral and lack of

[11] Pursuant to OMA Section 4.2(h), concurrently with this filing, LUMA will send the Vegetation Management Plan to the P3 Authority for information purposes.

vegetation maintenance are significant contributors to the poor system reliability, especially in extreme weather events such as hurricanes. *Id.*, Section 11.1.

The Vegetation Management Plan that is submitted herewith as Exhibit 1, establishes the basis to transform PREPA's current practices to an effective and efficient Vegetation Management Program and provides guidance for its management and organization. Implementation of LUMA's Vegetation Management Plan will require initial investments. *Id.* Section 1.0. It also requires continuous improvement through refinements and adjustments over the course of time to accommodate changing objectives and conditions. *See Id; See also Id.,* Section 8.0.

To address the gaps identified in PREPA's Vegetation Management and Maintenance Program, LUMA's Vegetation Management Plan identifies actions to remediate risks that include: (1) a centralized vegetation management team staffed by professionals; (2) re-establishing maintainable tree-conductor clearances on the T&D System, including reactive maintenance response initiatives and reclamation of rights of ways ("ROWs"). *See Id.,* Section 11.2. The work to abate or mitigate immediate vegetation risk in the most critical locations, along with an ongoing program to clear and re-establish ROWs to standard widths under the Vegetation Management Program are also part of LUMA's System Remediation Plan ("SRP") that was submitted to this Energy Bureau on February 24, 2021, Case No. NEPR-MI-2020-0019, *see* Section 6.6, Enabling Portfolio at pages 185-89. To reach the goals of the Vegetation Management Plan and in compliance with Act 17-2019, LUMA has allocated specific funds within the Operational Budget to implement the Vegetation Management Plan. *See Id.* Section 14.0; *see also* Initial Budgets filed on February 24, 2021, Case No. NEPR-MI-2021-0004, Schedule 5.2 at page 66 of LUMA's Initial Budgets.

The Vegetation Management Plan is based on the well-established utility industry principle of Integrated Vegetation Management ("IVM"). IVM is a structured decision-making process that emphasizes continuous improvement resulting in refinements and/or adjustments to monitor and adapt processes and practice to meet current and new objectives and conditions. *See Id.*, Sections 4.0 and 8.0. LUMA will employ the process of IVM to ensure that tall growing trees and woody shrubs incompatible with the use of the site do not interfere with overhead transmission and distribution circuits. *Id.; See also Id.*, Section 4.2.

The Vegetation Management Program will be based on recognizing the dynamics of tropical vegetation and include strategies to manage the response to maintenance rather than to simply attempt to control a problem. *See Id.,* Section 8.0. LUMA will establish management objectives using tolerance levels and action thresholds, based on internal and external factors including reliability, regulatory compliance, site sensitivity or location, stakeholder considerations, and budgets. *Id.* Section 8.0. Implementation of the Vegetation Management Plan will help ensure that incompatible tall growing trees and woody plants do not interfere with critically important power facilities, thereby reducing the risk that an incompatible tree or plant species will adversely affect system operations. *Id.* The intent is to work with nature to establish relatively stable steady-state conditions to provide a sustainable basis of managing tree related risks over time. The expectation is that implementation of the Vegetation Management Plan, over time, will reduce the cost and intensity of the Vegetation Management work required while at the same time improving system reliability and safety. *Id.*

The Vegetation Management Plan employs utility vegetation management industry standards and practices, including: the National Electric Safety Code, Rule 218 (2017); America National Standards ("ANSI") A300 Tree, Shrub and other Woody Plant Management-Standard

Practices, Part 1 (2014), Part 7 (2019), and Part 9 (2017); ANSI Z133 Safety Requirements for Arboricultural Operations (2017); the International Society of Arboriculture (ISA) Best Management Practices; the Right of Way Stewardship Counsel Technical Requirements (2016); and clearance requirements set forth by the North American Electric Reliability Corporation (NERC), NERC FAC-003.4. *See Id.*, Sections 3.2 and 7.0.

As will be explained in the body of this Petition, the Vegetation Management Plan meets Act 17's public policy objective to create a vegetation management program, to provide safe, efficient, stable and reliable power services in Puerto Rico in compliance with environmental laws, and to provide a better quality of life for Puerto Ricans. **Important goals of the Vegetation Management Plan include minimizing system interruptions and customer outages caused by trees and vegetation and reducing tree-conductor conflict and tree-initiated faults that pose safety risks to workers and the public and loss of electric services.**

LUMA respectfully requests that this honorable Energy Bureau **receive and review** the proposed Vegetation Management Plan submitted as Exhibit 1 to this Petition and consider the same in executing the role to oversee the Plan's implementation.

II. Energy Bureau's Authority

As the main entity in charge of ensuring compliance with energy public policy and to carry out energy policy mandates, this honorable Bureau has authority to review this Petition pursuant to Act 57-2014 and Act 17-2019.

Act 57-2014 gives the Energy Bureau authority and regulatory oversight over electric services and electric power service companies[12], such as PREPA and LUMA. *See* Act 57-2014,

[12]Section 1.2 of Act 17-2019, defines "electric power service company" as:

> any natural or juridical person or entity, including energy cooperatives, engaged in

Sections 6.3 and 6.4, 22 LPRA §§ 1054b and 1054c. Among other powers, the Energy Bureau may establish public policy standards with respect to electric power service companies, establish rates, regulate any transaction, action or omission in connection with the electric power grid and the electric power infrastructure, exercise jurisdiction over certified electric power companies, review controversies of electricity bills sent to customers, and exercise general jurisdiction over persons connected to the grid or receiving energy services and persons that exercise control over the provision of electric power services. *See Id.*

Of particular relevance to this Petition for Approval of LUMA's Vegetation Management Plan, Section 5.3(ww) of Act 57-2014, as amended by Act 17-2019, gives this Energy Bureau authority to "[o]versee compliance with vegetation management programs to be implemented by the Authority or its successor, or the transmission and distribution network Contractor, in accordance with the best practices of the industry to protect the network." Section 5.3(ww) of Act 57-2014, as amended, (official translation), 22 LPRA §1054b. (codifying Act 17-2019 in Spanish). Relatedly, Article 1.16 of Act 17-2019 endows the Bureau with authority to "oversee that the comprehensive vegetation management program," that PREPA or the transmission and distribution network Contractor [LUMA per the OMA], shall submit to the Energy Bureau, "meets the standards of the industry and the enforcement thereof." Article 1.16, Act 17-2019 (official translation); 22 LPRA §1141o (codifying Act 17-2019 in Spanish).

> the rendering of energy generation, transmission, and distribution services, billing, wheeling, grid services, energy storage, the resale of electric power, as well as any other electric power service as defined by the Bureau. For purposes of this Act, the Electric Power Authority or its successor, as well as any electric power transmission and distribution network operator, shall be deemed to be an Electric Power Service Company.

22 LPRA §1141a(c).

III. Act 17's Requirements on Vegetation Management

Implementation of the Vegetation Management Plan is one of the public policy priorities for maintenance of the Electric System infrastructure in Puerto Rico. *See* Act 17-2019, Section 1.6 (5) (official translation); 22 LPRA §1141e (5) (codifying Act 17-2019 in Spanish). In furtherance of said public policy mandate, Section 1.16 of Act 17-2019 provides that the comprehensive vegetation management plan shall direct, among other things, the following:

> (a) Maintaining a distance of at least ten (10) feet between trees and the easements for the transmission lines in accordance with the National Electrical Safety Code Standard (NESC);
>
> (b) Regularly patrolling and trimming any vegetation or materials that are next to the power lines;
>
> (c) Adopting the tree pruning recommendations established by accepted industry standards, such as the American National Standard Institute (ANSI);
>
> (d) Drafting of periodic and detailed reports on the compliance with the vegetation program; and
>
> (e) Establishing an appropriate and independent fund for the vegetation management program.

Id.

IV. Bureau Resolution of December 31, 2020

Pursuant to its authority under Acts 57-2014 and 17-2019, on December 31, 2020, this honorable Energy Bureau issued a Resolution and Order that initiated the captioned proceeding to evaluate the Comprehensive Vegetation Management Plan that LUMA shall develop pursuant to Section 4.2(h) of the OMA ("December 31st Resolution and Order"). The December 31st Resolution and Order references Section 1.16 of Act 17-2019 and the provisions of Section 4.2(h) of the OMA. *See* December 31st Resolution and Order at pages. 1-2.

In the December 31st Resolution and Order, this honorable Bureau stated that LUMA's Vegetation Management Plan "shall be aligned with [five] principles beneficial to the public

interests, including but not limited to . . .": (1) Advance the Earlier Compliance with Public Policy; (2) Further Efficiencies and Savings; (3) Impact to Areas with Significant Issues; (4) Synergies; and (5) Benefits for the Public Interest. *Id* at page 3. This honorable Bureau further directed that LUMA's Vegetation Management Plan should be aligned with Section 1.16 of Act 17-2019. *Id.* Finally, in the December 31st Resolution and Order this Bureau ordered that the Vegetation Management Plan "should show and discuss how it will take advantage of vegetation [sic] undertaken by PREPA after Act 17 entered into effect . . .[,]" and ensure that duplicity of efforts, which result in imprudent costs, is avoided." *Id.* at pages 3-4.

As per the requirements of the December 31st Resolution and Order, on January 15, 2021, LUMA attended a Pre-Filing Technical Conference held via videoconference during which LUMA provided a presentation discussing its approach in preparing the Vegetation Management Plan and received input from this honorable Energy Bureau regarding the filing and contents of the same.[13]

V. Hallmarks of LUMA's Vegetation Management Plan

LUMA's Vegetation Management Plan presents two perspectives: vegetation management and vegetation maintenance. *See* Exhibit 1, Sections 1.0, 4.0, 8.0 and 9.0. Vegetation management includes a strategic framework that describes the elements and functions of the Vegetation Management Plan. *Id.,* Section 1.0. In turn, vegetation maintenance provides the tactical aspects of the Vegetation Management Plan, including the control methods and practices required to execute the Plan. *Id.*

LUMA seeks to provide safe and effective management of vegetation while maintaining harmonious relationships with adjoining land users and the environment. *Id.* Section 4.1. LUMA

[13] LUMA filed with this Energy Bureau a copy of its presentation. *See* LUMA's "Motion in Compliance with Order Submitting LUMA's Presentation Given on January 15, 2021, at the Pre-Filing Technical Conference" dated January 15, 2021 in the referenced case.

will implement Integrated Vegetation Management principles to support the safe and reliable transmission and distribution of electric power in a safe, economically, ecologically, and environmentally sound manner. *Id.*, Section 4.2. Vegetation maintenance will be conducted in accordance with safe and sound environmental stewardship. *Id.*

Through the Integrated Vegetation Management approach and operating model, LUMA will ensure that incompatible tall growing trees and woody plants do not interfere with critically important power facilities. *Id.* Section 8.0.

The goals of the Vegetation Management Plan are to:

1. Provide **Reliable Electric Service** by minimizing system interruptions and customer outages caused by trees and other vegetation;

2. Provide **Safe Electric Service** by reducing tree-conductor conflict and tree-initiated faults that pose safety risks to workers and the public and loss of electric services;

3. Ensure **Worker Safety** by requiring employees to perform activities and functions in a manner that results in an accident and illness-free workplace and requiring contract providers to establish company safety polices and guidelines;

4. Afford **Cost-Effective Service** by employing qualified line clearance arborist and vegetation maintenance workers to perform the necessary work and managing crews, equipment, and workload to achieve a high level of productivity, quality, and safety;

5. **Support Development of On-Island Capabilities** by seeking long-term, continuous job opportunities for vegetation management program staff and the vegetation maintenance workforce provided by contract service providers, emphasizing recruitment and development of qualified individuals, support skills and knowledge-based training, and conducting competitive contracting for vegetation maintenance services; and

6. **Form a Local Chapter of the International Society of Arboriculture (ISA)** to benefit from a worldwide network of tree care professionals, offering personal and professional development opportunities to the arboriculture

> industry, and supporting local and regional arborist with networking and professional development opportunities.

Id., Section 4.2.

The Vegetation Management Plan provides for a centralized Vegetation Management Organization staffed by professionals that includes: (1) Senior Leadership led by a Director of vegetation management who assures a safe and high level of vegetation management performance across the system; (2) a Vegetation Management Program Team charged with executing the Vegetation Management Plan and staffed by SMEs with functional responsibility for vegetation maintenance work being performed in the field; and (3) a Vegetation Maintenance Operations Team, responsible for managing vegetation maintenance contracts and the operations performed by external Service Providers, focusing on the efficiency and effectiveness of the field forces. *See Id.*, Section 6.

The Vegetation Management Plan is data driven, includes vegetation assessments and inventories and relevant spatial analysis and mapping. *Id.*, Section 8.0. This information will be used to support the development of annual work plans and individual project plans, intended to: (1) selectively eliminate and suppress regrowth of incompatible, tall growing plant species; (2) encourage and promote a relatively stable and diversified compatible plant community consisting of various low growing species such as shrubs, herbs, grasses, forbs, and ferns; (3) enhance wildlife habitat conditions on the ROWs; and (4) encourage the use of utilities compatible in urban and developed landscapes. *Id.*

Vegetation management work will vary by zones associated with ROWs on the distribution system and the proximity of trees and branches to the overhead distribution lines (Removal/Reduction Zone, Edge Zone and Strike Zone). *Id.*, Section 8.3, Figure 8-1. Similarly, three transmission vegetation maintenance zones associated with ROWs on the transmission

system (Wire Zone, Border Zone and Strike Zone) will be created to perform vegetation management work. *Id.*, Section 8.3, Figure 8-2.

Section 9.0 of the Vegetation Management Plan describes the governing processes. It includes, among others, the key elements of vegetation maintenance. *Id.* Section 9.0. The general categories of vegetation maintenance work include: (1) **preventive work** that can be specifically planned for and prioritized, scheduled, and managed on a project basis and represents the largest portion of the projected budget for vegetation management; (2) **corrective work** that is difficult to plan for but that, once identified, can be efficiently scheduled and is generated by customer requests; and (3) **reactive work** that cannot be planned or scheduled but requires immediate attention and that is typically related to service interruptions and outages. *Id.* Sections 9.1-9.4.

LUMA will employ several control methods depending on the project. These methods include biological, physical and chemical controls. *Id.*, Section 10.0. Biological controls are at the core of the Vegetation Management Program and will reduce human intervention in vegetation maintenance in the future. *Id.*, Section 10.1. Physical control methods mainly include pruning or removal of tall growing trees and vines that are in the proximity of distribution facilities and along transmission corridors. *Id.* Section 10.2. Finally, chemical control methods include the use of herbicides, elimination of incompatible stems from a site, encouraging compatible plant covers and suppressing growth of incompatible species. *Id.* Section 10.3.

LUMA will establish a prioritization scheme to rapidly improve system reliability through vegetation management and maintenance as efficiently and effectively as possible and doing so in a way that leads to sustainable improvement over the long-term. *See Id.* Section 12.0 and 14.1. As described in Sections 12.0 of the Vegetation Management Plan, specific actions within this prioritized phased approach during the first year of the program will include:

1. **Rapid Reactive Response**: LUMA will initiate a reactive response intended to identify the "worst of the worst" condition on the T&D that presents risk to safety, reliability, and constrains system capacity. Conditions will be assessed using a full range of methods including remote sensing technology, "boots on the ground" inspection, and PREPA's experience and local knowledge of trouble spots. This phase will be conducted over an initial 6-month period, concurrent with the reclamation of ROWs that is described below and more fully in Section 12.0 of the Vegetation Management Plan,
2. **Reclamation of ROWs**: Reclamation work to reestablish cleared corridors to PREPA standard widths and maintain tree-conductor clearances. This activity will reclaim the ROWs and reestablish conditions that are reasonably maintainable by the systematic application of preventive maintenance practices, and
3. **Preventive Vegetation Maintenance**: Work performed once ROWs are reclaimed and is intended to control incompatible vegetation that poses risks to safety, reliability, and system capacity.

See Id. Section 12.0; *see also Id.*, Figure 12-2.

The Vegetation Management Plan recognizes that events will occur where well-planned preventive vegetation maintenance will not suffice, and either corrective or reactive maintenance will be required. *Id.* However, a measure of success of the Vegetation Management Program is a steady decline of corrective and reactive maintenance. *Id.* The expectation is that, over time, corrective vegetation maintenance will be performed as necessary when a site-specific need for vegetation maintenance is identified by LUMA or in response to customer requests. *Id.* Also,

reactive vegetation maintenance will occur in response to tree-initiated faults, interruptions, and outages. *Id.*

VI. LUMA's Vegetation Management Plan Complies with Statutory and Regulatory Requirements

A. Compliance with Section 1.16 of Act 17-2019

a. Distance between Trees and Easements (ROWs)

As explained in Figures 7-4 and 7-5 of the Vegetation Management Plan, the standard widths for transmission ROWs range between 25 and 100 feet, depending on the line type and whether they are located at Urban or Rural Sites. *See Id.* Section 7.1. In compliance with Act 17-2019, the implementation of the Vegetation Management Plan includes mitigation efforts within the ROWs to remove vegetation and trees in accordance with NESC and other applicable standards. Sufficient clearance will be achieved to provide reliable service between scheduled maintenance. Maintenance actions within transmission vegetation maintenance zones will include the wire zone (area below and adjacent to the alignment of transmission conductors); the border zone (area that extends from the outer edges of the wire zone to the edge of the clear corridor), and the strike zone (area beyond the edge of the maintained corridor in the ROW of the Transmission System). *See Id.,* Section 8.3, Table 8-2. Maintenance work in the strike zone will include pruning or removal of trees where there is a probable likelihood of failure or impact to conductors under normal weather conditions within the vegetation maintenance framework. *See Id.* These actions comply with Act 17's requirement that industry standards are followed to maintain safety clearances in the ROWs to avoid and minimize interruptions caused by trees interfering with the lines.

The Vegetation Management Plan establishes proposed minimum clearances in accordance with NERC requirements, NERC FAC-003.4. *See* Exhibit 1, Section 7.2, Figure 7-7. Maintenance work will prevent incompatible tree populations from breaching the minimum vegetation clearance

distances between preventive maintenance treatments. *Id.*, Section 7.2. This is consistent with industry practices, the intent and purpose of Act 17, and is aligned with PREPA's Easement Regulation, Regulation Number 7282 of February 24, 2007, that establishes the need to maintain safety clearances. *See* PREPA Regulation No. 7282, Section II F and W.

b. Regularly Patrolling and Trimming Vegetation or Materials Next to Power Lines

Employment of Integrated Vegetation Management processes will further compliance with Act 17's requirement of ongoing patrolling and trimming of vegetation and materials next to power lines. LUMA's Integrated Vegetation Management approach systematically ensures that tall growing trees and woody shrubs incompatible with the use of the site do not interfere with overhead transmission and distribution circuits. *See* Exhibit 1, Sections 4.2 and 8.0. LUMA will use spatial analysis, project-specific vegetation maintenance prescriptions, annual work plans, and condition assessment inspections, to provide a framework for meeting tree-conductor clearance requirements. *Id.* Through Integrated Vegetation Management, LUMA will gain the necessary understanding of the dynamics around incompatible species and the ecosystem to set management objectives and define vegetation maintenance treatment methods that include trimming, among others. *See Id.*

One of the cornerstones of LUMA's Vegetation Management Plan is preventive vegetation management through proactive and systematic inspection processes. *See Id.*, Section 9.2. LUMA will employ a condition-based approach to identify needs for preventive maintenance and schedule and perform these activities in a systematic basis. *Id.* As explained in Section 9.0 of the Vegetation Management Plan, preventive, corrective and reactive vegetation management processes allow LUMA to consistently remove vegetation and materials next to power lines all to ensure that incompatible tall growing trees and woody plants do not interfere with critically important power

facilities. Vegetation management practices will include trimming vegetation systematically among other control methods specified at Section 10.0 of the Vegetation Management Plan.

Relatedly, the Vegetation Management Plan outlines the factors that will be considered in assessing conditions and determining the need to schedule preventive maintenance projects. *See Id., See also Id.,* Figure 9-2. The Vegetation Management Plan seeks to shift from a reactive methodology to a steady state of ongoing vegetation maintenance practices. *See Id.*, Section 11.2. These practices will allow LUMA to comply with the directives of Act 17-2019 regarding ongoing patrolling and removal of vegetation.

It bears noting that, to the extent possible, incompatible plants will be eliminated while preserving and enhancing low-growing compatible plant communities. *See Id.,* Section 8.0. Once ROWs reclamation is completed, LUMA's Integrated Vegetation Management approach will emphasize the selective use of herbicides to completely remove all tall growing incompatible species of vegetation from the ROWs environs, while simultaneously preserving, to the extent feasible, all other low growing desirable vegetation. *Id.* These measures, among others, will reduce the need to rely on constant trimming to address the risk of vegetation interference with power lines.

c. Adoption of Tree Pruning Recommendations by Accepted Industry Standards, such as ANSI.

The Vegetation Management Plan incorporates industry standards and best practices, including ANSI's standard practices on Tree, Shrub, and other Woody Plant Management, ANSI A 300, Part 1, Pruning (2014), and the Best Management Practices of the International Society of Arboriculture, including Tree Pruning (2019) and Utility Pruning of Trees (2004). *See Id.*, Section 2.3, S*ee also Id.,* Figure 7-7.

The use of proper pruning practices is a variant of biological control. *Id.* Section 10.1. The placement of pruning can reduce regrowth response, directing it away from conductors. *Id.,* Section 10.1. Line clearance tree pruning, a physical control method, represents a major component of LUMA's Vegetation Management Program, particularly on the distribution system in the more developed areas. *Id.* Pruning of limbs and branches will be conducted using arboricultural techniques, based on current industry standards and completed by skilled line clearance arborist. *See Id.*, Section 10.2; s*ee also Id.,* Figure 10-1.

d. Drafting of Periodic and Detailed Reports on the Compliance with the Vegetation Program

LUMA will establish and implement an ongoing program to monitor and assess compliance and performance. *See* Sections 4.2, 8 and 13. As explained in Section 13.0, LUMA will implement a performance management system that includes an easily accessible dashboard to facilitate the presentation of Key Performance Indicators/ Metrics regarding the efficiency and effectiveness of the Vegetation Management Program. *See Id.,* Section 13.0. This process will track and report on a set of clearly defined metrics that are routinely used in best-in-class utility vegetation management programs. Other metrics pertinent to the unique challenges LUMA faces in reclaiming the T&D System, will be identified near Commencement Date. *See Id.* The performance management system is currently envisioned to include five general categories of metrics (1) productivity; (2) effectiveness; (3) time utilization; (4) timeliness; and (5) results. *Id.* LUMA plans to acquire an application to house and analyze data and produce user-friendly reports. *See Id.*

e. Independent Fund for the Vegetation Management Program

As fully explained in LUMA's Initial Budgets filed before this Energy Bureau on February 24, 2021, Case No. NEPR-MI-2021-0004, LUMA has allocated funds within the Operational

Budget for vegetation management ($51, 301,000.00). *See* Schedule 5.2 at page 66 of LUMA's Initial Budgets. Also, the Enabling Portfolio, included at Section D.6 of the Initial Budgets allocates funds for the Vegetation Management Program. *Id.* at page 263. The Vegetation Management Program Brief at pages 267 through 271, provides the details of the program and includes the Program Funding and Timeline. *Id; see also* SRP at pages 185-89. Additionally, Section 14.0 of the Vegetation Management Plan discusses LUMA's approach to prioritizing spending for vegetation management and maintenance activities and provides the basis for the projections of LUMA's three-year operating budget.

It is respectfully submitted that this independent allocation of funds in LUMA's Initial Budgets complies with Act 17's requirement of an independent fund for the Vegetation Management Program.

B. Consideration of PREPA's Vegetation Management Plan and Avoidance of Duplication

As explained in Section 1 of this Petition, *supra*, LUMA conducted a gap assessment to ascertain the current state of PREPA's related processes, practices and performance. Based on knowledge of the industry and in consideration of applicable laws and regulation, LUMA looked to leverage PREPA's current plans and practices, while concurrently identifying areas representing significant improvement opportunities ("Major Gaps"). In performing this work, LUMA personnel and SMEs attended several workshops, conducted a series of interviews with a cross-section of PREPA's staff, reviewed information and data including ongoing contracts with external service providers, visited a representative sample of facilities and observed activities in the field. LUMA also conducted a comprehensive survey of field conditions that supports an assessment of vegetation maintenance workload. This process revealed several deficiencies in PREPA's execution of its Vegetation Management and Maintenance Programs, namely:

1. There is no centralized organization with the responsibility and authority for maintaining vegetation and managing vegetation-related processes across the T&D system,

2. Current pruning practices are not effective, resulting in excessive re-growth and wounding of trees that increase the likelihood tree-conductor conflicts and structural failures resulting in tree strikes,

3. There is no significant use of herbicides, and what limited use there is inconsistent with proper use,

4. Vegetation Maintenance has largely been deferred,

5. The equipment that is used by in-house personnel is in poor repair, with a scarcity of any specialized vegetation management equipment. The lack of appropriate tools and equipment contributes to low productivity of in-house personnel, and

6. The deferral and lack of vegetation maintenance is a significant contributor to the poor system reliability, especially in extreme weather events such as hurricanes. This also creates a public safety hazard: directly in the form of fallen wires or children climbing trees too close to energized lines, and indirectly in the form of power outages.

These findings are consistent with information found in PREPA's 2020 Fiscal Plan, Certified by the Financial Oversight and Management Board on June 29, 2020, which documents PREPA's underspending on vegetation management and specifies that in Fiscal Year 2019, PREPA did not spend any portion of the budget allocated for vegetation management.[14] As PREPA's 2020 Fiscal Plan states "[s]ince at least 2015, PREPA has failed in efforts to execute a vegetation management program, leaving the grid vulnerable to natural disaster.[15]" Said

[14] *See* PREPA 2020 Fiscal Plan at pages 14, 17-18, 23, 66, available at https://noticiasmicrojuris.files.wordpress.com/2020/06/2020-prepa-fiscal-plan-as-certified-by-fomb-on-june-29-2020.pdf (last visited April 10, 2021).
[15] *Id.* at page 66.

significant underspending on vegetation management has also left the T&D system vulnerable to other system disturbances.[16]

The aforementioned information indicates that under PREPA's current Vegetation Management Program, LUMA would not be in a position to meet Contract Standards and applicable legal requirements and policies. PREPA's Vegetation Management Program is not aligned with the OMA requirements that drive LUMA's activities at Service Commencement. After considering PREPA's recent trimming activities, LUMA designed its own Vegetation Management Plan. LUMA's Vegetation Management Plan is aligned with the main objectives of PREPA's Plan: safety, reliability and resiliency. To avoid duplication LUMA has leveraged PREPA's experience and expertise in preparing the Vegetation Management Plan.

C. Principles Beneficial to the Public Interest outlined in the December 31st Resolution and Order

The Vegetation Management Plan is aligned with the following "principles beneficial to the public interest" listed in the Bureau's December 31st Resolution and Order:

1. Advance the Earlier Compliance with Public Policy

Public policy objectives of Act 17-2019, relevant to vegetation management, in addition to the bedrock requirement of establishing a Vegetation Management Program, include:

- Compliance with "applicable environmental law and regulation in order to preserve the ecosystems of Puerto Rico and improve the quality of life of all Puerto Ricans." Act, 17-2019, Section 1.6(a),

[16] *Id.* at page 58.

- "To maintain the electric power infrastructure in optimal conditions to ensure reliability, resilience, and safety of the electric power service […]" *Id.,* Section 1.5(9)(e),
- "To ensure continuous improvements for the electric power grid in order to promote its resilience and diversification […]" *Id.,* Section 1.5(9)(f), and
- "To guarantee every customer's right to receive a reliable, stable, and excellent power service at a cost that is accessible, just, and reasonable […]" *Id.,* Section 1.5(10)(a).

22 LPRA §1141d (codifying Act 17-2019 in Spanish).

In furtherance of the aforementioned public policy mandates, LUMA's Vegetation Management Program is designed to support the safe and reliable transmission and distribution of electric power in an economically, ecologically, and environmentally sound manner. *See* Exhibit 1, Section 4.2. Through Integrated Vegetation Management processes, LUMA will revitalize and correctly position the overall vegetation management and maintenance process to support excellent and long-term sustainable reliability for Puerto Rico. *See Id.,* Section 1.0. **The goals of the Vegetation Management Plan to provide reliable and safe electric services that are cost-effective, are aligned with energy public policy.**

Responsible management of Puerto Rico's environmental and cultural resources, stewardship and sustainability, are important aspects of the Vegetation Management Plan that further public policy interests to preserve the ecosystem and improve quality of life in Puerto Rico. *See Id.,* Sections 2.8, 4.2. As explained throughout the Vegetation Management Plan, LUMA will comply with applicable laws, including environmental laws, all in furtherance of public policy. *See Id. e.g.,* Sections 3.0, 4.2 and 8.0.

LUMA will also further public policy goals by engaging proactively with citizens and landowners providing summaries of planned vegetation management activities while actively listening to citizens' concerns and answering questions. *See* Exhibit 1, Section 2.8.

Early and prompt compliance with public policy goals will be achieved through strategic and planned processes rooted in an understanding of the current state of the system and of the dynamics of the ecosystem, and through significant investments and allocations of funds for vegetation management. Establishment of a centralized vegetation management team comprised of SMEs who can establish and oversee implementation of procedures and practices to eliminate public dangers, along with implementation of Integrated Vegetation Management processes and use of technical specifications and methods based on industry standards, will assist LUMA in achieving prompt compliance with the public policy goals of addressing threats to reliable, stable and excellent power services.

Importantly, LUMA's prioritization of vegetation management is aimed at improving system reliability as efficiently and effectively as possible through rapid reactive response to identify the "worst of the worst" conditions on the T&D System that presents risk to safety, reliability, and constrain system capacity; reclamation of ROWs to reestablish conditions that are reasonably maintainable by the systematic application of preventive maintenance practices; and preventive vegetation maintenance work to control incompatible vegetation that poses risks to safety, reliability, and system capacity. *See Id.,* Section 14.1. Once these priorities are met within the first year of implementation of the Vegetation Management Plan, LUMA may achieve long-term compliance with public policy and vegetation management goals to apply corrective and reactive vegetation management as needed.

LUMA's data-driven approach to vegetation management that includes vegetation assessments and inventories and relevant spatial analysis / mapping to support the development of annual work plans and individual project plans, will set the stage for efficient and swift implementation of the Vegetation Management Plan in compliance with public policies. Additionally, implementation of a performance management system to track and report performance guided by a set of clearly defined metrics that are routinely used in best-in-class utility vegetation management programs, will allow LUMA to monitor its progress to promptly meet public policy goals related to vegetation management. *See Id.,* Section 13.0.

2. Further Efficiencies and Savings

Considered and planned employment of qualified line clearance arborists and vegetation maintenance workers to perform necessary work, as well as management of crews, equipment, and workload, will help LUMA achieve a high level of productivity, quality, and safety in a cost-efficient manner. The planned focus on long-term and continuous job opportunities for vegetation management program staff and the vegetation maintenance workforce, including support for development of on-island capabilities, are also designed to favor efficiencies and savings in the long-term.

Systematic implementation of preventive vegetation management to efficiently reduce risks posed by trees to the T&D System, coupled with deployment of a condition-based approach to identify the need for and scheduling of preventive maintenance rather than apply a rigid fixed interval maintenance, are aimed at providing efficient and cost-effective services. Performance of preventive maintenance activities in a systematic and scheduled basis will optimize, over time, the trade-off between the frequency of inspections and subsequent maintenance/total cost. *See Id.,* Section 9.2.

Efficiencies and savings are also to be achieved through implementation of LUMA's prioritization of spending programs that envisions a steady decline for the need to perform corrective and reactive vegetation maintenance works. *See Id.,* Section 12.0. Biological control methods will also improve efficiencies by promoting the growth of compatible trees / plants and decreasing the growth of incompatible plants, thereby reducing the need for pruning and chemical control methods and the amount of human intervention. *See Id.*, Sections 8.0, 10.0 and 10.1. The expectation is that implementation of the Vegetation Management Plan, over time, will reduce the cost and intensity of the vegetation management work while at the same time system reliability and safety will be enhanced. *Id.,* Section 8.0.

3. Impact to areas with significant issues

As explained in Section 11.2 of the Vegetation Management Plan, LUMA will address and remediate current gaps and risks through: (1) employment of a centralized vegetation management team staffed by professionals; (2) re-establishing maintainable tree-conductor clearances on the T&D System, including a reactive maintenance response initiative that **targets specific locations that pose the greatest risk to public safety, reliability, and system capacity, and reclamation of the ROWs, involving heavy clearing of existing vegetation**; and (3) shifting to steady ongoing vegetation maintenance practices. This framework is specifically tailored to tackle areas with significant issues and that pose the greatest risks to the T&D System.

LUMA's Vegetation Management Plan, which references the current state of PREPA's Vegetation Management Program, is designed to achieve a level of continued improvement by addressing the worst conditions to the T&D System, reestablishing conditions in ROWs that are reasonably maintainable, and controlling incompatible vegetation that poses risks to safety,

reliability, and system capacity. *See Id.*, Section 12.0. By impacting these key areas to vegetation management, LUMA will address key areas to reduce safety risks and service interruptions.

4. Synergies

Implementation of Integrated Vegetation Management decision-making processes and LUMA's data driven approach will allow LUMA to develop annual and individual work plans to efficiently employ manpower resources with cost-effective results. *See Id.*, Section 8.0. Mapping of vegetation maintenance work through defined vegetation management zones will also assist LUMA in conducting vegetation management and maintenance within efficient timelines. *See Id.*, Section 8.3.

Efficient work timelines will also be established through planning of preventive maintenance projects that consider risks, loads, vegetation conditions, cultural and environmental impacts, and action thresholds, and are executed by field technicians familiar with tree species, tree growth, and the risks trees pose to overhead T&D lines. *See Id.*, Section 9.2. Relatedly, corrective maintenance work conducted in accordance with priorities that will follow specified criteria is also designed to implement efficient work timelines. *Id.*, Section 9.3, Table9-3.

LUMA's vegetation management organization that includes: (1) senior leadership; (2) a vegetation management program team; and (3) a vegetation maintenance operations team, will allow LUMA to efficiently and effectively deploy manpower and resources to implement the Vegetation Management Plan.

5. Benefits for the Public Interest

As discussed in Section VI (A) and (C)(1) *supra*, the Vegetation Management Plan furthers important public policy mandates under Act 17-2019, including reliability, resiliency and safety, all to benefit the public interest. *See Id.*, Section 4.2. LUMA will revitalize and correctly position

the overall vegetation management and maintenance process to support excellent and long-term sustainable reliability for Puerto Rico which is a clear benefit to public interest and ratepayers. *See Id.,* Section 1.0. By reducing safety risks and service interruptions, LUMA's Vegetation Management Program will provide benefits to all Puerto Ricans and deliver the safe and reliable service that public policy requires and that is key for societal well-being and economic development.

Responsible care and management of Puerto Rico's environmental and cultural resources, stewardship and sustainability are also in the public interest as they will improve quality of life in Puerto Rico. *See Id.,* Sections 2.8, 4.2. Through proactive engagement with citizens and landowners providing summaries of planned vegetation management activities, listening to citizens' concerns, answering questions and making information available to assists landowners and other stakeholders in understanding the purpose of the Vegetation Management Program and the methods that have been chosen, will also benefit the public and ratepayers. *See Id.,* Section 2.8. LUMA's proposed engagement of stakeholders and consideration of their concerns and any societal impacts of planned vegetation management activities is also in the public interest. *See Id., See also Id.,* Section 2.0.

WHEREFORE, LUMA respectfully requests that the Energy Bureau **consider and accept** the Vegetation Management Plan included as Exhibit 1 to this Petition.

RESPECTFULLY SUBMITTED.

In San Juan, Puerto Rico, this 11th day of April 2021.

I hereby certify that I filed this Petition using the electronic filing system of this Energy Bureau and that I will send an electronic copy of this **Petition to the attorneys for PREPA**,

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Exhibit 1, LUMA's *Vegetation Management Plan*

Vegetation Management Plan

April 11, 2021

Vegetation Management Plan

Contents

Tables & Figures

1.0 Introduction

Effective management of vegetation in and near electric utility infrastructure is critical for the safety of electrical workers and the public and for the reliable and resilient delivery of electric service. Consistent with this statement, and pursuant to the laws, regulations, and industry standards presented in Section 3.0, Section 4.2(h), Annex I, Section II(A)(10), and Table 2-Handover Checklist in Annex II, Front-End Transition Plan of the Puerto Rico Transmission and Distribution System Operations and Maintenance Agreement dated June 22, 2020 ("O&M Agreement" or "OMA") calls for a plan to identify and establish the personnel, equipment, functions, processes, and procedures necessary for an effective vegetation management process. As part of LUMA's work prior to submitting the bid in November 2020 and during the Front-End Transition (FET), LUMA developed this Vegetation Management Plan. This required engaging a team of industry-leading subject matter experts (SMEs) to first, assess current state, using all available data (e.g., LIDAR, publicly available imagery, system maps, employee and contractor knowledge, and existing outage data), and the information collected during the Front-End Transition Period (e.g., vegetative cover, land use, access, and slopes and resources required to effectively manage the system's ROWs). As part of this work LUMA reviewed PREPA's current vegetation management plan and efforts, including work that PREPA self-performs as well as procurement, contracting and administration of third-party vendors. With this accomplished, LUMA then compared current state with other Vegetation Management programs exemplifying industry leading practices, and in so doing, identified major gaps, thus informing this Vegetation Management Plan (VMP), for the expressed purpose of:

- Establishing the basis for LUMA's Vegetation Management Plan, and in so doing,
- Providing guidance for the management of the plan and organization.

Serving as the overarching management tool for planning and executing all vegetation management activities across the 2,300 miles of transmission lines, nearly 12,000 miles of distribution feeders, and 364 facilities (e.g., substations and yards requiring bare ground weed control) that serve PREPA's customers, this plan acknowledges (1) the critical role that electricity plays in assuring a Nation's security, safety, economy, and welfare, (2) the requirements specified by state and federal agencies that PREPA provide safe, reliable electric service to its customers, and (3) the major role that tree-conductor conflicts have played in causing faults and interruptions on the system and subsequent outages to these customers.

Two perspectives are presented in this plan:

- Vegetation Management, strategic in nature, used to describe the elements and functions in LUMA's Vegetation Program moving forward, and
- Vegetation Maintenance, providing the tactical context and describing the control methods and practices required to execute the Vegetation Management strategy.

This Plan, consists of the following 14 Sections:

1. Introduction
2. Stakeholder Management
3. Applicable Laws, Regulations, and Industry Standards
4. Vegetation Management Vision, Values and Strategic Objectives
5. Critical Success Factors
6. Vegetation Management Organization

7. Physical Considerations
8. Integrated Vegetation Management
9. Vegetation Management Processes
10. Vegetation Maintenance Practices
11. Risk Management
12. Vegetation Management Improvement Plan
13. Performance Management
14. Investments and Expenditures

Further, this plan provides the roadmap for PREPA's (soon to be LUMA's) transformation to an effective and efficient Vegetation Management and Maintenance Program:

- The path will require significant initial investments (Business Process Re-engineering, Organizational Redesign, Change Management, IT / OT Application Installation, Training, reclaiming ROWs and performing reactive vegetation maintenance).
- The goal is to revitalize and correctly position the overall Vegetation Management and Maintenance process to support excellent and long-term sustainable reliability for Puerto Rico.

As currently constructed, this document reflects LUMA's understanding of the current situation. The Vegetation Management Plan will be periodically revised based on new information as LUMA assumes responsibility for vegetation maintenance on the T&D System. The dynamic nature of this plan will be indicative of LUMA's commitment to continuous improvement.

2.0 Stakeholder Management

Management of the relationship between LUMA's Vegetation Management Plan and key stakeholders is a critical success factor to capturing the benefits inherent in this Vegetation Management Plan. Implementation of the various actions and initiatives stated or inferred in the following sections require careful balancing of attention to the seemingly separate, yet sometimes competing perspectives of these stakeholders, and to the extent possible, LUMA will incorporate them into its strategic and annual plans. Specific areas addressed in this plan are:

- Federal Agencies
- Puerto Rican Commonwealth Agencies
- Puerto Rico Environmental Non-Profits
- Local Municipalities
- Professional Associations or "Green Industry" Trade Groups
- Private Sector Stakeholders
- Academic Institutions
- Customer and Public Relations
- Puerto Rico's Environmental and Cultural Resources
- Commitment to Public Interaction, Demonstration of Stewardship and Vegetation Management Plan Sustainability
- Recognition Programs

2.1 Federal Agencies

Five Federal Agencies need to be considered in implementing an effective Vegetation Management and Maintenance Plan:

1. USDA FOREST SERVICE

The Forest Service has three distinct natural resource mission areas with differing objectives and all three are of relevance to LUMA: National Forest System, Research and Development, and State and Private Forestry:

The National Forest System

The El Yunque National Forest (previously named Caribbean National Forest) is in northeastern Puerto Rico and is the only tropical rain forest in the National Forest System. It includes approximately 29,000 acres and El Yunque Peak which is 3,540' above sea level is one of the highest peaks in Puerto Rico. The communication tower constructed on El Yunque Peak in 1981 is of paramount importance to all emergency responders and is therefore, a high priority for access and power restoration following an outage. The Forest is noted for its biodiversity including 150 fern species and 240 tree species (88 of which are endemic or rare and 23 found exclusively in this forest). While it has no large wildlife species, it has hundreds of smaller animals, many of which exist nowhere else on the planet. Thirty-five percent of the Forest is designated as a wilderness area with an area bounded by the Rio Mameyes, Rio de la Mina and Rio Icacos rivers as components on the National Wild and Scenic Rivers System. Vegetation maintenance in this area will require proactive engagement with the El Yunque National Forest staff. The designated boundaries average one-quarter mile on either bank and water quality is protected by the Wild and Scenic Rivers Act. Other factors that negatively and positively impact Vegetation Management and Maintenance activities in this forest include:

- Negative Impact
  - Highway 191 through the forest was closed in 1970 due to a major landslide. After 22 years of continuous efforts to reopen this highway, the Forest Service concluded that the soils are highly unstable and withdrew any support to reopen it. A transmission line follows this corridor.
- Positive Impact:
  - The Final Rule to modify procedures for operating plans and agreements for vegetation management within and along the powerline rights-of-way was published in the Federal Register in July of 2020. The intent of the revised Rule is to promote the reliability of the United States' electrical grid and reduce the threat of damage to powerline facilities, natural resources, and nearby communities. It accomplishes this by streamlining the approval for routine and emergency vegetation management to remove or prune hazard trees on national forest lands within the linear boundary of a special use authorization for a powerline facility and on abutting national forest lands.

Research and Development:

There are two areas of particular importance to LUMA's Vegetation Management Plan:

- Luquillo Experimental Forest / El Verde Field Station, USDA Forest Service, Rio Grande, Puerto Rico: The El Verde research station was founded in 1940 and the Luquillo Experimental Forest was designated as a UNESCO Biosphere Reserve in 1976. With over 2,500 research studies having been performed here, the research scientists and administrators are resistant to any development or disturbance that fragments the forest ecosystem.

- International Institute of Tropical Forestry (IITF), USDA Forest Service, Rio Piedras Puerto Rico: IITF R&D includes a body of research scientists that conduct research and collaborate with other research scientists around the world in tropical forestry. There is a vast body of information that will be of value to LUMA's Vegetation Management Plan including trees, vines, ground cover, soils, hydrology, climate change, wildlife, ecology, forest products and wood utilization.

In both instances, there will be opportunities to collaborate with research scientists on the efficacy of vegetation management techniques employed both within the boundaries of the Experimental Forest and elsewhere on the island.

State and Private Forestry

International Institute of Tropical Forestry (IITF), USDA Forest Service, Rio Piedras Puerto Rico, State and Private Forestry (S&PF): S&PF includes a portfolio of programs that provide technical and financial assistance to the Puerto Rico Department of Natural and Environmental Resources, universities, and non-profit organizations throughout Puerto Rico. Through targeted technical knowledge and financial assistance and conservation education, federal resources have been leveraged to protect and support sustainable management of the islands' forests and ecosystems to produce goods and services that are important to many communities. A partnership with the urban forestry, forest stewardship and nursery (Reforestation, Nursery and Genetic Resources) programs could result in enhanced environmental urban and rural reforestation, habit development, creation of "green" jobs and income, and conservation education.

Because the missions of El Yunque National Forest and the International Institute of Tropical Forestry are different, the LUMA Vegetation Management Plan will need to meet with the management teams of each organization to discuss mutual areas of concern and identify opportunities for collaboration.

2. USDA NATURAL RESOURCE CONSERVATION SERVICE (NRCS)

NRCS offers financial and technical assistance to agricultural producers in making and maintaining improvements on their land through conservation practices, activities, and other enhancements. They offer two programs that offer partnership opportunities for LUMA's Vegetation Management Plan:

- The Environmental Quality Incentives Program (EQIP) provides financial and technical assistance to agricultural producers, addressing natural resource concerns and delivering environmental benefits (e.g., improved water and air quality, conserved ground and surface water, increased soil health and reduced soil erosion, and sedimentation, and improved / created wildlife habitat).
- The Healthy Forests Reserve Program (HFRP) assists landowners in restoring, enhancing, and protecting forestland resources on private and tribal lands through provision of easements and financial assistance. Through HRFP, landowners promote the recovery of endangered or threatened species, improve plant and animal biodiversity, and enhance carbon sequestration.

The NRCS will be a partner that can support the development of a strategy for vegetation maintenance work in areas of agriculture land use, as they work directly with farmers and can help inform decisions based on and understanding of their needs.

3. US FISH AND WILDLIFE SERVICE (USFWS)

The mission of the USFWS is to support the conservation, protection and enhancement of fish, wildlife and plants and their habitats for the continuing benefit of the American people. The portfolio of programs and conservation issues they manage are diverse and have relevance to LUMA. This includes but is not

limited to agriculture, aquatic habitat connectivity, climate resiliency, energy security, landscape conservation design, state wildlife action plans, urban conservation, and endangered species. The USFWS plays a pivotal role in implementing the Endangered Species Act (ESA) (16 USC 1536) in collaboration with states, private landowners, nongovernmental organizations, and other federal agencies, thus conserving endangered and threatened species of fish, wildlife, and plants, an act with which LUMA will comply.

In Puerto Rico, the Caribbean Ecological Services Field Office is in Boqueron and the Puerto Rican parrot aviary (a sub-office) is located within El Yunque National Forest. Formal research efforts to save the endangered Puerto Rican parrot by the USFWS, USDA Forest Service and the Commonwealth began in 1968. This field office emphasizes an ecosystem approach through partnerships and there will be opportunities for LUMA to partner with staff in the field office.

Because of the USFWS role in implementing the Endangered Species Act (ESA), LUMA will consult with its staff to evaluate and address concerns regarding potential impacts of vegetation management on wildlife. The survival of the Puerto Rican parrot is a national priority and there are other threatened and endangered species throughout Puerto Rico. USFWS staff will be able to advise LUMA regarding activities that could be undertaken in partnership with communities of concerned citizens.

4. ENVIRONMENTAL PROTECTION AGENCY (EPA)

The mission of the EPA is to protect human health and the environment, as they are the lead agency with statutory authority to implement the major federal environmental laws, including the Clean Water Act and the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). EPA regulates various provisions of the Clean Water Act, including Section 402 which regulates storm water discharges associated with industrial activities under the National Pollutant Discharge Elimination System (NPDES) which applies to certain activities that disturb land in excess of specified thresholds to control discharges into waters of the U.S. Although these provisions will not apply to the vast majority of LUMA's activities under this Vegetation Management Plan, LUMA will meet the requirements under these provisions when applicable. EPA also regulates the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA covering the manufacture, sale and use of all pesticides, and gathers health, safety, and exposure data regarding toxic substances. LUMA's herbicide specifications, prescribed right-of-way treatments and supervision of vegetation management operations will ensure that all such operations are performed in compliance with FIFRA.

5. US DEPARTMENT OF LABOR

The Department of Labor administers federal labor laws to guarantee workers' rights to fair, safe, and healthy working conditions. Relevant to LUMA's Vegetation Management Plan is the Occupational Safety and Health Administration (OSHA) that was created to assure safe and healthy working conditions for working men and women by establishing and enforcing standards and providing training, outreach, education, and assistance. There are OSHA directives relating to vegetation management that are codified in OSHA 1910.269 (Electric Power Generation, Transmission and Distribution) and clarified in ANSI Z133 and which LUMA will meet. Similarly, OSHA 1910. 331-335 establish Minimum Approach Distances (MAD) for incidental work by qualified and nonqualified arborist that will also be met by LUMA.

In Puerto Rico, the Puerto Rico Occupational Safety and Health Administration (PROSHA) is the local counterpart to OSHA.

2.2 Puerto Rican Commonwealth Agencies

There are seven agencies within the Commonwealth with whom LUMA Vegetation Management plans to establish relationships.

1. PUERTO RICO DEPARTMENT OF AGRICULTURE, AGROLOGY AND AGRICULTURAL MATERIALS LABORATORY

The Department of Agriculture is the agency that administers FIFRA requirements as authorized by the Pesticide Act of Puerto Rico. This agency is responsible for the registering pesticides for use in Puerto Rico, licensing applicators, establishing record keeping requirements, and enforcement. LUMA's specifications, prescribed right-of-way treatments and supervision of vegetation management operations will ensure that all such operations are performed in compliance with these regulations.

2. DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES (DNER)

The Puerto Rico Department of Natural and Environmental Resources is the executive department of the government of Puerto Rico tasked with protecting, conserving, developing, and managing the natural and environmental resources in the U.S. Commonwealth of Puerto Rico. In the DNER organization, there are four areas that are of significance to LUMA's Vegetation Management Plan: Forest Service, Wildlife Division, Environmental Quality Board, and the Division of Forest Reserves and Refuges. Three of the four functional areas have a federal counterpart:

- The Commonwealth Forest Service is a partner of the USDA Forest Service,
- The Wildlife Division is a Commonwealth partner to the USFWS, and
- The Environmental Quality Board is the local partner for the EPA.

To receive federal funds for local program implementation, a Puerto Rico Forest Action Plan (USDA Forest Service) and a Puerto Rico State Wildlife Action Plan (USFWS) is required.

3. DNER FOREST SERVICE

Two programs administered by the DNER in cooperation with the USDA Forest Service are the Urban and Community Forestry (U&CF) and the Forest Stewardship Programs.

- The purpose of the U&CF Program is to provide technical and financial assistance to communities, public and private entities, and municipalities on the management of urban forest resources. Engagement with DNER on this program will provide an opportunity as in many cases the trees posing unacceptable risk to the T&D system are in developed areas and are part of Puerto Rico's urban forests.
- The purpose of the Forest Stewardship program is to provide technical assistance to private forest landowners to encourage and enable active long-term, multiple resource forest management.

The link to the Forest Action Plan is http://drna.pr.gov/wp-content/uploads/2016/12/SAP-2016-FINAL-9-15-2016-rev-ETI.compressed.pdf.

4. DNER WILDLIFE DIVISION

The Wildlife Division includes the Natural Heritage Program which has authority for habitat acquisition and a mandate to maintain a conservation data center for wildlife species of concern or critical elements. The conservation data center maintains maps of species distribution and provides technical assistance for using the data bank. Critical elements are not limited to federally or locally listed species. Some

species, important to Puerto Rican heritage and culture, although abundant, are considered critical elements for this unit. This program is also in charge of identifying lands for conservation throughout the Island. The link to the Wildlife Action Plan is http://drna.pr.gov/wp-content/uploads/2015/10/PRSWAP-2015.pdf.

The Safe Harbor Program is a USFWS conservation strategy implemented by the DNER Wildlife Division to monitor and manage species of concern on private or non-federal lands. A Safe Harbor Agreement is a voluntary agreement involving private or other non-federal property owners whose actions contribute to the recovery of species listed as endangered or threatened under the Endangered Species Act.

5. DNER ENVIRONMENTAL QUALITY BOARD (EQB)

As the Commonwealth's counterpart to the Environmental Protection Agency, the EQB will be concerned with any utility vegetation management activities that impact stormwater runoff or otherwise may affect the environment.

6. DNER DIVISION OF FOREST RESERVES AND REFUGES

This Division provides management and oversight for Commonwealth nature preserves, parks, and forests. Any utility vegetation management within any of the areas or designated corridors between some of these protected areas will require consultation.

Engaging in discussion with the Secretary of the Department of Natural and Environmental Resources and key staff will foster development of effective working relationships with the Division heads within this Agency. It will be important for LUMA to work with DNER staff on matters of concern and including each Division head during the initial planning phases of LUMA's Vegetation Management Plan to identify opportunities for possible collaboration.

7. PUERTO RICO INDUSTRIAL DEVELOPMENT COMPANY (PRIDCO)

The Puerto Rico Industrial Development Company (PRIDCO) is a government-owned corporation dedicated to promoting Puerto Rico as an investment destination for companies and industries worldwide. Since its establishment in 1942, PRIDCO has been a catalyst for Puerto Rico's economic development, leading its transformation from a traditional industrial economy to a knowledge-based economy. Their mission is to foster economic development by attracting investment and creating jobs within, among others, manufacturing, life sciences, information technology, aerospace, and export services.

There may be an opportunity for LUMA to partner with PRIDCO to develop an incubator that utilizes wood waste from line clearing operations to create value added products, jobs, and income opportunities in both urban and rural settings. LUMA is also interested in exploring possibilities to collaborate with PRIDCO in the development of the green industry, a forest products industry, and a local industry to utilize the waste stream of woody debris removed from site clearing, and the creation of an infrastructure to pursue the global market of high value tropical hardwoods.

2.3 Puerto Rico Environmental Non-Profit Organizations

LUMA Vegetation Management will engage in discussion with nonprofit groups, starting with an open dialogue regarding any issues, concerns, or questions they might have. Areas of mutual interest and opportunities to collaborate will arise and be factored into the overall Stakeholder Management strategy. Among the key groups that LUMA expects to engage are the following.

Vegetation Management Plan

1. PARA LA NATURALEZA ("FOR NATURE" - PART OF THE PUERTO RICO CONSERVATION TRUST)

The Puerto Rico Conservation Trust is a private non-profit organization that currently manages 14 reserves (~13,000 acres) across the island. This entity monitors habitat as it relates to native habitat preservation and restoration and educates the public on the conservation of natural resources.

2. THE NATURE CONSERVANCY (TNC) – CARIBBEAN DIVISION

The Nature Conservancy strives to create a sustainable future for Puerto Rico, where communities and nature can thrive together. The TNC works closely with local government and stakeholders using innovative tools and technologies to restore and preserve the vital ecosystems Puerto Ricans rely upon every day and helps create a more resilient, secure future for nature and people. The TNC partners with the Puerto Rico Conservation Trust who ultimately holds any easements that are acquired.

3. CENTER FOR THE CONSERVATION OF THE LANDSCAPE (CENTRO PARA LA CONSERVACION DEL PAISAJE)

This entity develops projects to protect, conserve, restore and positively transform the forest landscape with responsible management strategies for natural resources.

4. CAFIESENCIA PUERTO RICO

Cafi-Cultura Puertoriquena, Inc is a private educational non-profit organization incorporated in 2008 that provides rural communities of Puerto Rico opportunities to improve their quality of life and achieve social and economic justice through sustainable economic development of agriculture, tourism, historic and natural preservation, and education. They have a volunteer base comprised of a team of professionals in agronomy, horticulture, economic development, conservation, GIS, and biology. This group will be an asset in changing the mindset regarding a new vision for a sustainable future for Puerto Rico.

5. ORGANIZACION PRO AMBIENTE SUSTENABLE

Organización Pro Ambiente Sustentable Inc. is a non-profit corporation founded in San Juan, Puerto Rico. Since 2005 it has administered international programs and certifications aimed at education towards sustainability and environmental protection in search of transforming Puerto Rico into a sustainable island. They provide certification of eco schools and develop specific activities to educate and promote behavioral changes within their communities. Their mission is to integrate initiatives aimed towards creating a sustainable Puerto Rico and increasing awareness among its citizens through environmental action programs that achieve a sustainable island. LUMA will consider opportunities to partner with this organization to advance the Arbor Day Foundation Tree Campus K-12 program at schools across the island.

6. CIUDADANOS DEL CARSO ("CITIZENS OF THE KARST")

Ciudadanos del Carso is a private non-profit organization whose mission is the acquisition of land, particularly in the karst region of Puerto Rico, for protection and conservation. This organization monitors habitat as it relates to native habitat preservation and restoration. Ciudadanos del Carso also educates the public on the conservation of natural resources and collaborates with other environmental organizations and government agencies on projects and studies related to the conservation of the karst region. This well-established stakeholder group that will have interest in LUMA's activities in the karst region. When appropriate, LUMA will engage in discussions on topics of mutual interest to explore opportunities to achieve mutually aspired goals.

2.4 Local Municipalities

There are 78 municipios, or municipalities in Puerto Rico with an elected mayor. For many of these cities, entry into the Arbor Day Foundation Tree City USA program is the first step towards having an urban forestry program. The municipio of Caguas has been a Tree City USA for the past 10 years, and though neither municipios of Ponce nor Carolina are certified as a Tree City USA, they both have an agronomist with responsibility for urban trees on staff. Frequently a limiting factor for municipalities to become a Tree City USA is meeting the standard of $2 per capita on tree maintenance. With the systematic approach to line clearance employed by LUMA, there may be a significant opportunity for LUMA to partner with the municipios and the Puerto Rico DNER to obtain Tree City USA status.

2.5 Professional Associations or "Green Industry" Trade Groups

At this writing LUMA is unaware of professional associations or trade groups with direct relevance to the Vegetation Management Plan currently operating in Puerto Rico, though the Puerto Rico Forest Action Plan does refer to the Association of Professional Arborists. This apparent void represents an opportunity for LUMA's Vegetation Management Plan, recognizing the need for professional networks and opportunity to work in cooperation with the International Society of Arboriculture (ISA). See section 4.0 of this plan for more information on ISA.

2.6 Private Sector Stakeholders

The Private Sector offers unique opportunities to effect positive change in Puerto Rico's economy, and establish good will between LUMA and local businesses.

1. COMMERCIAL ARBORISTS

LUMA plans to engage with commercial arborists to foster the profession and support safe work practices in proximity to energized lines, thereby making a positive change within the arboriculture industry in Puerto Rico. One such opportunity is presented by the Tree Care Industry Association TCIA). It has been advancing tree care since 1938, providing tree care professionals with tools for everyday use to increase profits, lower training costs, retain quality employees, and remain a step ahead of continually evolving regulatory issues. There may be TCIA member companies operating in Puerto Rico, particularly since private tree care companies do operate on the Island.

2. CURRENT LINE CLEARANCE TREE SERVICES

Four firms currently provide vegetation maintenance services to PREPA. They are assigned to complete line clearance work on preventive maintenance projects under contract with the utility:

- DRC Emergency
- Xpert LLC,
- Master Link
- Perfect Clearing.

3. PUERTO RICO HARDWOODS

This organization is dedicated to bringing the finest hardwoods in the world from Puerto Rico to the market. Following the Hurricanes of 2017, Puerto Rico Hardwoods was a major player along with the USFS IITF in developing a plan for the management of waste wood and vegetative debris. Its goal is to salvage downed wood for economic development, build long term capacity and expertise for managing and market logs and processing materials, and prevent waste from going into landfills.

LUMA sees the potential to establish partnerships with Puerto Rico Hardwoods, IITF and possibly PRIDCO. The reclamation phase of this plan is likely to generate a significant volume of logs and other woody debris. We believe there may be opportunities for demonstrations related to milling and drying wood and creating other products like woodchips, compost, and biochar.

4. NURSERY SECTOR

There are a small number of commercial growers that have the potential to propagate landscape trees suitable for planting in proximity to and below overhead distribution lines.

- Pennock Growers
- Martex Farms
- Tropigardens
- Agrotroppics
- Los Islenos
- Green Good
- Landesigns

“Utility friendly” trees suitable for planting in proximity to overhead lines are going to be required for the long-term success of vegetation maintenance in urban areas. The possibility to contract grown nursery stock for urban reforestation should not be overlooked.

2.7 Academic Institutions

There are several educational organizations with courses and specializations in topics relevant to LUMA’s Vegetation Management Plan. LUMA’s new plan will create demand for qualified personnel. The need to train this workforce is a major initial concern for LUMA as we assume responsibility for vegetation maintenance work on the T&D system. This creates opportunities for mutually beneficial partnerships between LUMA, the Arbor Day Foundation and colleges and universities across Puerto Rico.

1. UNIVERSITY OF PUERTO RICO, MAYAGUEZ

The university includes the College of Agriculture Science and the School of Horticulture which teaches classes in urban forestry and arboriculture. This university also hosts the Future Farmers of America, a body of environmental management students. Because of its academic role in providing urban forestry education, UPR Mayaguez should not only be a certified Tree Campus USA but should also lead the way for all other academic institutions of higher learning.

2. UNIVERSITY OF PUERTO RICO, RIO PIEDRAS

This university includes the Department of Planning. A partnership with this department could develop plans for the utility corridors to function as more than just a utility corridor. It also represents an opportunity for LUMA to provide an educational opportunity for the next generation of urban professionals.

3. UNIVERSIDAD ANA G MENDEZ, TURABO CAMPUS

This campus is certified with the Arbor Day Foundation as a Tree Campus USA. In partnership with LUMA and the Arbor Day Foundation, the Universidad Ana G Mendez, Turabo Campus could be held up as an example of local environmental stewardship.

4. INTERAMERICANA UNIVERSITY

This campus is certified with the Arbor Day Foundation as a Tree Campus USA.

5. UNIVERSIDAD POLITECNIA

This university includes the School of Architecture and Landscape Architecture. A partnership between LUMA's Vegetation Management Plan and the Landscape Architecture program's design studios could develop conceptual designs for the utility corridors to function as linear elements for recreation, wildlife, and other functional and aesthetic uses. It is also an important opportunity for LUMA to provide an educational opportunity for the next generation of environmental leaders.

6. OTHER TRAINING INSTITUTIONS

LUMA will continue to support training and development opportunities to enhance the capabilities of its utility arborist. For example, a comprehensive curriculum and training program has been developed by Butte College in CA. This program, sponsored by a utility, was developed in response to a dramatic increase in demand for line clearance tree crews in response to wildfires. The training program (including supporting training materials) is being translated into Spanish and has been offered to LUMA, who in turn, plans to offer this program through the LUMA Technical Institute. Two members of LUMA's Vegetation Management team are currently supporting a similar effort by Butte College in developing a training program for field technicians.

2.8 Customer and Public Relations

As part of LUMA's commitment to a sustainable approach to Integrated Vegetation Management (IVM), (refer to Section 4.0), the principles underlying IVM will be shared with the public. Proactive engagement with the people of Puerto Rico will include providing summaries of planned vegetation management activities while actively listening to citizens' concerns and answering questions. This approach addresses four key elements:

1. PUBLIC TRANSPARENCY

LUMA will make its annual Vegetation Maintenance Plan available to the public to inform communities of plans for routine maintenance in their respective area. LUMA will seek support of IVM principles in the public arena by informing stakeholders of the benefits of vegetation maintenance activities. LUMA will be responsive to stakeholders' concerns, actively engaging them regarding their input, while stressing the societal and community benefits to be realized.

2. LANDOWNER NOTIFICATION

LUMA is responsible for the safe and reliable delivery of energy and acknowledges its responsibility to maintain vegetation consistent with easements or other existing landowner agreements.

- Though we do not ask for permission to perform routine work, we do communicate with and notify landowners regarding planned vegetation management activities and consider any stated requests or concerns.
- In some cases, LUMA may initially seek the permission of property owners when it is necessary to remove significant landscape trees on developed sites in proximity to distribution lines.
- While permission is not required for removal of these trees in the wire zone of transmission ROW, a courtesy contact with property owners will be made.

In most cases any initial contact with underlying property owners will have to be completed during the project development phase and is reflected in the vegetation maintenance prescription. Vegetation maintenance crews should provide property owners/customers that may be impacted by field operations with a courtesy notice of pending work. This notice should occur within two weeks of crews arriving on the site. Notification may be provided through use of a door hanger approved by LUMA.

3. ENGAGEMENT OF STAKEHOLDERS

LUMA values the input of stakeholders and will consider their concerns and any societal impacts of planned vegetation management activities. To the extent possible, LUMA will incorporate these perspectives into its strategic and annual planning process.

4. COMMITMENT TO PUBLIC INTERACTION, DEMONSTRATION OF STEWARDSHIP AND VM PROGRAM SUSTAINABILITY

This commitment is not just to communicate regarding planned maintenance activities, but to make information available that assists landowners and other stakeholders in understanding the purpose of the program, the methods that have been chosen, and how these methods are consistent with our goals for safety, reliability, and stewardship. LUMA will provide access to its strategic and annual work plans and develop materials that educate internal and external stakeholders on the benefits of IVM.

2.9 Puerto Rico's Environmental and Cultural Resources

Responsible care for and management of Puerto Rico's environmental and cultural resources is a critically important aspect of any vegetation management plan. This stewardship represents a shared responsibility between LUMA and all the stakeholders and customers that LUMA serves.

CULTURAL RESOURCES

Puerto Rico's cultural resources are rich and diverse, providing tangible remains of past human activities. These include buildings; structures; historic or prehistoric objects; rock inscriptions; earthworks, canals, or landscapes, often older than 50 years in age. In fact, Puerto Rico is 500 years older than St. Augustine, FL which is the oldest known city in the United States. There is a tree in Ponce to which Christopher Columbus is said to have tied his boat. From the masonry walls that fully encircled the city of San Juan by 1783, including the El Morro and Castillo San Cristobal fortresses to the Cabo San Juan Lighthouse in Fajardo to the Taino Rock carvings or petroglyphs that can be found throughout the island, Puerto Rico has a wealth of cultural resources. LUMAs Vegetation Management Plan will be sensitive to these facts and take measures to avoid adversely impacting protected cultural resources in accordance with applicable laws and regulations governing the protection and management of these resources.

AESTHETICS OF VEGETATION MANAGEMENT

Puerto Rico is largely composed of mountainous and hilly terrain, with nearly one-fourth of the island covered by steep slopes. The island is approximately 100 miles wide between the eastern and western points, and the distance between the Atlantic Ocean and Caribbean Sea is approximately 30 miles measured in a straight line. With the island's highest mountain range trending east west and exceeding 3,000 feet above sea level, views of both the Atlantic and the Caribbean Sea are possible from many locations. Care will be taken to apply methods, appropriate for controlling vegetation in visually sensitive areas, including manual, mechanical, biological (for noxious weeds), and herbicide (spot and localized applications):

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- The reclamation phase of LUMA's Vegetation Management Plan will have a significant visual impact as overgrown ROW corridors are cleared on incompatible vegetation. This is a necessary first step in a process to reestablish conditions that can subsequently be managed using practices that reduce the visual impact of vegetation maintenance operations.
- LUMA will generally use broadcast foliar application of herbicide as a follow-up to heavy mastication and mowing of incompatible vegetation. These applications have the potential to create areas of browned vegetation. This application method will have only limited use beyond the reclamation phase of the program.
- LUMA can retain temporary visual buffers at road crossings, highways/visual overlooks, leave sufficient vegetation, where possible, to screen the view of the right-of-way during the reclamation phase of the project. These visual buffers will be less significant once reasonably maintainable conditions are restored and the steady stated preventive maintenance phase of the project begins.
- The use of management zones within T&D ROW's include provisions that create a transition of plant forms, effectively softening the visual impact of a hard, straight-line ROW edge.

THREATENED OR ENDANGERED PLANT OR ANIMAL SPECIES

For threatened or endangered (T&E) plant or animal species, LUMA will:

- Control vegetation in locations with known populations of sensitive or threatened and endangered (T&E) species by prescribing appropriate, biological, physical, and chemical control methods that minimize the potential for adverse effects. LUMA will also consider practices that achieve our objectives and enhance the quality of critical habitat. These activities will be conducted in consultation with the USFWS, when applicable (see below).
- Consult with the USFWS staff at the Caribbean Field Office or the DNER Wildlife Division to determine whether any T&E species or designated T&E critical habitats are present in the project area.
- If T&E species or designated critical habitats are present in the project area, determine whether they are likely to be affected. If the project is likely to impact an area, but not adversely affect T&E species, obtain concurrence from the USFWS, or the DNER Wildlife Division as appropriate.
- If it is determined that the project is likely to adversely affect T&E species or their designated critical habitats, initiate formal consultation with the USFWS and follow measures developed to mitigate any such impacts.
- Apply mitigation measures (such as timing restrictions, or specific method use) resulting from the above consultations.
- LUMA will comply with any other applicable provisions of federal and Puerto Rico laws and regulations governing these protected species.

STEEP OR UNSTABLE SLOPES TOPOGRAPHY

The topography of the main island of Puerto Rico is divided into three major regions: the mountainous region, the coastal plains and the northern karst region. The Cordillera Central mountain range extends through the entire island trending east west, dividing it into the northern and southern region. The mountain region accounts for approximately 60 percent of the land area. The average elevation of the Cordillera Central mountain range is above 3,400' which results in steep slopes down to the coastal plains.

The ecological diversity of Puerto Rico is reflected in the diversity of its soils. Ten of the 12 soil orders established by Soil Taxonomy, the official system of soil classification of the United States National Cooperative Soil Survey, are present in Puerto Rico.

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For steep or unstable slopes, the following mitigation measures may be considered.

- Limit use of methods that result in significant soil disturbance.
- Not using ground-disturbing mechanical equipment to clear slopes over 20 percent.
- Perform mechanical clearing when the ground is dry enough to sustain heavy equipment.
- Reseed or replant seedlings on slopes with potential erosion problems and/or take other erosion control measures, as necessary.
- All activities will be designed considering and in compliance with applicable laws and regulations governing the specific geographical area and natural resource present.

SPANNED CANYONS

Incompatible vegetation within long transmission line spans from ridge to ridge where conductor clearance is sufficient to assure no violation of Tolerance Levels nor exceeding Action Thresholds (as these terms are defined in Section 8.1 of this plan) will be retained.

WATER RESOURCES

Puerto Rico has lakes (none of them natural) and more than 50 rivers. Most of these rivers are born in the Cordillera Central, Puerto Rico's principal mountain range located across the center of the island. The rivers in the northern part of the island are longer, with higher flow capacity than those in the south. The south is therefore drier and hotter than the north. These rivers make up 60 watersheds across the island, where over 95 percent of the runoff returns to the sea. Water resources include wetlands, springs, rivers above ground and in caves below ground, lakes, and lagoons.

The following considerations will inform development of site-specific vegetation maintenance prescriptions.

- Using selective methods within riparian zones that minimize disturbance.
- Using selective control methods that preserve non-target compatible vegetation.
- Retaining the physical structure of incompatible vegetation using control methods that eliminate incompatible trees biologically yet allowing them to remain standing.
- Recognize that any discharge of material (displaced soils, and in certain circumstances, vegetation debris) within a water of the U.S. may be subject to Corps regulations or EPA regulations under the Clean Water Act as well as DNER regulations, which LUMA will meet, as applicable.
- Notify appropriate government officials of any amount of herbicide spill in or near water.
- Consider climate, geology, and soil types in selecting the herbicide/adjuvant with lowest relative risk of migrating to water resources.
- When using herbicides/adjuvants, apply appropriate buffer zones to preclude the possibility of herbicide movement from the application site to adjoining water bodies.

INVASIVE PLANT SPECIES

Plant species can be identified as either native, endemic, exotic, naturalized or invasive. Invasive species are those that grow or spread aggressively in its new environment and cause environmental and/or economic harm. LUMA vegetation activities will focus on mitigating the spread of these invasive plant seeds, with treatment prescriptions seeking to minimize ground disturbances. While natural regeneration of native or naturalized species may often be appropriate, introducing seed stock of plant materials known to support pollinators and other wildlife may be preferred.

There is a body of scientific literature published by the Forest Service's International Institute of Tropical Forestry and the academic institutions of Puerto Rico that will provide site specific information.

2.10 Recognition Programs

LUMA's Vegetation Management Plan, designed to achieve industry best performance, is both complex and challenging, requiring the support and participation of several internal and external stakeholder groups. A series of recognition programs, two of which are presented herein, provide opportunities to assess and periodically guide refinements through engagement of these important stakeholders:

- **Tree Line USA**, a program sponsored by the Arbor Day Foundation, recognizes best practices in public and private utility arboriculture, demonstrating how trees and utilities can co-exist for the benefit of the communities they serve. It encourages compliance with five core standards: quality tree care, annual worker training, tree planting and public education, tree-based energy conservation program, and Arbor Day celebration and participation.
- **Right-of-Way Steward Accreditation**, a program offered by the Rights-of-way Stewardship Council, establishes standards for responsible right-of-way vegetation management along corridors. Its requirements, developed by a diverse group of stakeholders, reflect the highest standards for an integrated vegetation management and is available to support self-assessments and third-party audits.

3.0 Applicable Laws, Regulations, and Industry Standards

The legal requirement to prepare this Vegetation Management Plan arises from Section 1.16 of the Puerto Rico Energy Public Policy Act, Act No. 17-2019, as amended ("Act 17-2019") which requires the operator of the transmission and distribution grid to prepare and present to the Puerto Rico Energy Bureau ("PREB") a comprehensive Vegetation Management Plan in accordance with best industry practices to protect the integrity of the grid, and that such Plan meet the requirements set forth in that section. Section 1.06(5) of Act 17-2019 also declares as an initial objective of Act 17-2019 to establish priorities for the maintenance of infrastructure of the electric system and create vegetation management plans. In addition, Article 6.3 of the Puerto Rico Energy Transformation and RELIEF Act, Act 57-2014, as amended, provides that PREB will oversee the compliance of T&D Operator with a vegetation management plan in accordance with best practices in the industry to protect the grid.

LUMA is committed to compliance with all laws and regulations, and adherence to industry standards and best practices. The following subsections discuss the principal Federal and Puerto Rico laws and regulations that may apply or have relevance to LUMA's Vegetation Management Program. This list is not meant to encompass all laws and regulations that could possibly apply to all activities under this Vegetation Management Plan, but rather highlight the principal laws and regulations that may apply to these types of activities. LUMA will comply with these and all other laws and regulations that are applicable to the activities under this Vegetation Management Plan as determined on a case-by-case basis.

3.1 Federal Agencies and Puerto Rico Agencies

Federal Agencies and their Puerto Rico counterparts and the laws and regulations they implement and may impact the Vegetation Management Program in Puerto Rico include:

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1. USDA FOREST SERVICE AND PUERTO RICO DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES (DNER) FOREST SERVICE

The following Forest Service laws and regulations apply to LUMA's Vegetation Management Plan because transmission and distribution lines cross the El Yunque National Forest. It will have to be determined if any of these powerlines cross the wilderness portion of the Forest as defined by the following three rivers: Rio Mameyes, Rio de la Mina and Rio Icacos.

- Federal Lands Policy and Management Act of 1976 https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd488457.pdf
- Wild and Scenic Rivers Act https://www.nps.gov/parkhistory/online_books/anps/anps_6f.htm
- Special Uses Permit regarding Procedures for Operating Plans and Agreements for Powerline Facility Maintenance and Vegetation Management Within and Abutting the Linear Boundary of a Special Use Authorization for a Powerline Facility https://www.federalregister.gov/documents/2020/07/10/2020-13999/land-uses-special-uses-procedures-for-operating-plans-and-agreements-for-powerline-facility
- PREPA in fact has a use permit from the US Forest Service in connection with the transmission and distribution lines that pass through El Yunque National Forest and other structures associated with PREPA's operations which includes an Operating Plan governing the maintenance activities.

The DNER's Forest Service is a partner of the USDA Forest Service. The DNER's Forest Service also oversees the implementation of laws and regulations governing Puerto Rico State Forests, including Puerto Rico Forests Act, Act No. 133 of July 1, 1975, as amended, which establishes the public policy of Puerto Rico to protect, expand and conserve the forest resources of Puerto Rico and creates the Forest Service within the DNER and its implementing regulations.

LUMA will meet the requirements under these US Forest Service and DNER regulations and permits, as applicable to its activities under this Vegetation Management Plan, as well as any other laws and regulations governing activities in forest areas that may be applicable to the activities under the Vegetation Management Plan.

2. US FISH AND WILDLIFE SERVICE (FWS) AND PUERTO RICO DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES (DNER) WILDLIFE DIVISION

The purpose of the Endangered Species Act (ESA) is to protect and recover imperiled species and the ecosystems upon which they depend. It is administered primarily by the U.S. Fish and Wildlife Service (see https://www.fws.gov/endangered/esa-library/pdf/ESAall.pdf). The Commonwealth partner for the FWS is the DNER Wildlife Division. Endangered Species Act regulations are codified at 50 CFR Part 402. The DNER has a local counterpart- the DNER Regulation to govern vulnerable species and species in danger of extinction in the Commonwealth, DNER Regulation Number 6766. LUMA will comply with these regulations in implementing this Vegetation Management Plan, as applicable.

3. ENVIRONMENTAL PROTECTION AGENCY (EPA), PUERTO RICO DEPARTMENT OF AGRICULTURE AND PUERTO RICO DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES (DNER) ENVIRONMENTAL QUALITY DIVISION

EPA is the federal agency that administers the major federal environmental laws, including the Clean Water Act and the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), which regulates the manufacture, sale and use of all pesticides and governs the application of herbicides. All herbicide applications performed by LUMA and/or its contractors will comply with FIFRA and LUMA's specification, prescribed right-of-way treatments and supervision of vegetation management operations will ensure that

all such operations are performed in compliance with FIFRA. The Commonwealth partner for the EPA regarding pesticides is Puerto Rico Department of Agriculture, Agrology and Agricultural Materials Laboratory.

Under the Clean Water Act, some of the following provisions could be relevant to some activities under LUMA's Vegetation Management Plan:

- Section 401 of the Clean Water Act regulating discharges into navigable waters.
- Section 402 of the Clean Water Act regulating storm water discharges associated with industrial activities under the National Pollutant Discharge Elimination System (NPDES).
- Section 404 of the Clean Water Act regulating discharges of dredged or fill material into waters of the U.S. (primarily regulated by the U.S. Army Corps of Engineers).

The DNER's Puerto Rico Water Quality Standards Regulation establishes water quality standards to sustain the designated uses of water bodies in Puerto Rico and establish means for achieving and the quality of the waters of Puerto Rico, among other things. A water quality certificate may be required as part of the permits required under the Clean Water Act provisions listed above.

LUMA will meet the requirements under these Clean Water Act provisions and the Puerto Rico Water Quality Standards Regulation when applicable to its activities under this Vegetation Management Plan.

4. US DEPARTMENT OF LABOR, OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) AND PUERTO RICO DEPARTMENT OF LABOR, PUERTO RICO OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (PROSHA)

OSHA 1910.269 is directly applicable to utility line clearance tree work including establishing Minimum Approach Distances (MAD) for qualified utility arborist and trainees. Similarly, OSHA 1910. 331-335 establish MAD for incidental work by qualified and nonqualified arborist. LUMA will comply with these and other applicable requirements as may be promulgated by OSHA and PROSHA.

5. NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION (NERC) AND FEDERAL ENERGY REGULATORY AGENCY (FERC)

The North American Electric Reliability Corporation (NERC) is a non-profit organization that works to assure the effective and efficient reduction of risks to the reliability and security of the electrical grid. To that end, NERC has developed Reliability Standards and FAC-003-4, specific to Transmission Vegetation Management. FERC has adopted this standard for application to the high voltage grid across North America, and though PREPA's transmission system is not connected to that grid (i.e., FAC-003.4 is not a regulatory requirement), LUMA's Vegetation Management Plan for PREPA's 230kV and 115 kV system will generally be aligned with the NERC standard.

The intent of FAC-003-4 is to maintain a reliable electric transmission system by using a defense- in-depth strategy in managing vegetation located on transmission rights of way (ROW) and minimize encroachments from vegetation located adjacent to the ROW, thus preventing the risk of vegetation-related outages that could lead to cascading outages.

6. THE PUERTO RICO OFFICE OF PERMITS MANAGEMENT (OGPE, BY ITS ACRONYM IN SPANISH)

The Planning Board Joint Regulation for the Evaluation and Issuance of Permits Related to Development, Land Use and Business Operations, Regulation 9233, contains requirements related to land use and development and including requirements governing the cutting, trimming, uprooting, transplanting or planting of trees as well as certain earth disturbance activities that may be incidental to public works, among other things, which in some cases require permits from OGPE. Exemptions are provided for the following activities: cutting, trimming and disengaging conducted by PREPA as authorized by law.

7. OTHER PUERTO RICO LAWS AND REGULATIONS

There are other laws and regulations specific to Puerto Rico, not specifically listed above, that are related to the protection or management of natural resources, or the environment which could potentially apply to activities under this Vegetation Management Plan depending on the nature of the activities, geographic area and natural resources present at the area of the activities. LUMA will comply with all requirements under these laws and regulations as determined applicable to specific activities undertaken on a case-by-case basis.

3.2 Industry Standards and Best Practices

LUMA's Vegetation Management Plan seeks to incorporate the following industry standards and best practices:

- National Electric Safety Code, Rule 218 (2017)
- ANSI Z133 Safety Requirements for Arboricultural Operations (2017)
- ANSI A300 Tree, Shrub, and other Woody Plant Management- Standard Practices:
  - Part 1 Pruning (2014)
  - Part 7 Integrated Vegetation Management (2019)
  - Part 9 Tree Risk Assessment (2017)
- International Society of Arboriculture Best Management Practices
  - Tree Pruning (2019)
  - Utility Pruning of Trees (2004)
  - Tree Risk Assessment (2017)
  - Utility Tree Risk Assessment (2020)
  - Integrated Vegetation Management (2014)
  - Closed Chain of Custody for Herbicides in the Utility Vegetation Management Industry (2011)
- Right-of-Way Stewardship Council
  - ROW Steward Technical Requirements (2016)

3.3 Right to Perform Work

EASEMENTS

PREPA's Regulation for Easements of the Electric Power Authority, Regulation 7282, sets forth the process for the acquisition, establishment, constitution, and cancellation of easements for the transmission and distribution lines, equipment, structures and other objects, the minimum requirements applicable to these easements, and PREPA's rights with respect to these easements, among other things. This regulation includes requirements governing the type of vegetation that may be planted within these easements and some activities and rights of PREPA related to vegetation management. Most of the Transmission and Distribution assets owned by PREPA are located within these easements, reflecting

established standard easement widths that grant the right of occupancy and the right to perform vegetation maintenance work within the easement.

In some cases, LUMA may identify the need to widen the cleared corridor associated with segments of the transmission system. LUMA provide timely communication with affected owners and stakeholders and will seek to carry out necessary vegetation management activities with the consent of the fee owner. LUMA will follow applicable law and Regulation 7282 in working with affected owners and stakeholders.

Where formal recorded easements do not exist, the right to perform vegetation maintenance is acquired by prescriptive rights after the line has been in service for twenty years.

US FOREST SERVICE SPECIAL USE PERMITS

Special Use Permits establish the right of occupancy and the right to perform vegetation maintenance work on Transmission and Distribution lines on federal national forests, in this case, the El Yunque National Forest. As mentioned, PREPA has a special use permit for PREPA transmission and distribution lines and other PREPA structures within this forest. LUMA will comply with the requirements of that permit as applicable to transmission and distribution structures. A new (revised) Rule was adopted by the Forest Service in 2020 to streamline the approval for routine and emergency vegetation management on NFS lands within the linear boundary of a special use authorization for a powerline facility and on abutting NFS lands to remove or prune hazard trees as defined in the final rule. The intent of the revised Rule is to promote the reliability of the United States' electrical grid and reduce the threat of damage to powerline facilities, natural resources, and nearby communities. LUMA will meet the applicable requirements under this rule and any laws and regulations affecting national forests.

4.0 Vegetation Management Vision, Policy, and Goals

4.1 Vision

LUMA's vision is to provide safe and effective management of vegetation while maintaining harmonious relationships with adjoining land users and the environment. We will apply methods that are site sensitive, based on the best practices and scientific tree care research information available. In so doing, we seek to minimize impact to sensitive wildlife and plants, cultural resources, and other natural resources as much as possible, while ensuring the safe and reliable operation of the electric system.

4.2 Policy

The policy of the LUMA Vegetation Management Plan is to support the reliable transmission and distribution of electric power in a safe, economically, ecologically, and environmentally sound manner. Stewardship and sustainability will be achieved through use of Integrated Vegetation Management:

STEWARDSHIP AND SUSTAINABILITY

LUMA seeks to conduct all vegetation maintenance and management operations in a manner that exemplifies safety and sound environmental stewardship. LUMA's Vegetation Management Plan recognizes the inherent risk of working on or in trees and related vegetation that could be electrified due to their proximity to power lines, and that achieving sustainability requires the balancing of the economics, environmental, and social aspects of LUMA's Vegetation Management Plan:

- The safety of every employee, contractor, and customer defines a LUMA core value. LUMA VM staff and VM service provider employees will adopt a proactive approach towards accident prevention and work to establish and sustain a culture of safety first in the workplace.
- LUMA's Vegetation Management Plan will comply with all applicable environmental laws and regulations. All employees, from the officer level to the front line, are responsible and accountable for compliance and have an obligation to raise issues and concerns for resolution.
- All LUMA management, contractors and employees are accountable for implementing, maintaining, measuring, and finding opportunities for continuous improvement of LUMA's safety and environmental programs.
- The Plan will may go beyond regulatory requirements when such action benefits the environment and stakeholders, and we will support and participate in the design, development and establishment of sound public policy and educational initiatives that protect human health and the environment. We will work with governments and other entities in creating responsible laws, regulations, and standards to safeguard the community and environment.
- Customers, suppliers, and other stakeholders will be engaged in a constructive dialogue on environmental matters to achieve a healthy and safe environment for all.
- Reports on environmental performance will be transparent.
- An ongoing program to monitor and assess compliance and performance will be established and implemented.

INTEGRATED VEGETATION MANAGEMENT (IVM)

LUMA will employ the process of IVM to ensure that tall growing trees and woody shrubs incompatible with the use of the site do not interfere with overhead transmission and distribution circuits. In doing so, we will balance the use of cultural, biological, physical, and chemical based methods for controlling incompatible tall growing woody species while at the same time promoting the establishment and growth of compatible low growing plant communities on the ROW. This will entail use of spatial analysis, project-specific vegetation maintenance prescriptions, annual work plans, and condition assessment inspections to provide a framework for meeting tree-conductor clearance expectations.

4.3 Goals

In achieving this vision and executing this policy, the following goals define the framework under which LUMA's Vegetation Management Program will operate:

RELIABLE ELECTRIC SERVICE

Vegetation interference with energized conductors is one of the most common causes of electrical outages on distribution systems and has been a primary source of transmission grid failures resulting in widespread, lengthy blackouts. LUMA's goal is to minimize system interruptions and customer outages caused by trees and other vegetation.

SAFE ELECTRIC SERVICE

Tree initiated faults can in and of themselves present a hazard to workers and the public, and loss of electric service to vital facilities and systems can adversely affect public safety. Vegetation growing in conflict with energy delivery infrastructure requires periodic maintenance to provide safety to the public and workers, and impedes access for inspection, repair, and maintenance of facilities. Our goal is to reduce tree-conductor conflict and assure safe electric service.

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WORKER SAFETY

LUMA recognizes that maintaining employees' health and safety is an integral part of all business activities and our goal to achieve an accident-free workplace. All employees are required to perform activities and functions in a manner that results in an accident and illness-free workplace. Each employee is responsible for his/her own safety and shall be thoroughly familiar with, and observe the practices set forth in the company's safety and health programs. Each employee shall perform his/her duties in such a manner as to always ensure safety to themselves, their fellow employees, and the public.

All contract providers of vegetation maintenance services are required to establish their own company safety policies and guidelines. Safety policies, practices, and safety-related documentation will be reviewed and considered in the contractor qualifications process and monitored as work is completed.

COST-EFFECTIVE SERVICE

LUMA's goal is to perform work as efficiently and effectively as possible. LUMA employs qualified line clearance arborist and vegetation maintenance workers to perform the necessary work. Crews, equipment, and workload are managed to achieve a high level of productivity, quality, and safety.

SUPPORT DEVELOPMENT OF ON-ISLAND CAPABILITIES

LUMA's Vegetation Management Plan relies on industry standards and best practices, and places emphasis on quality, efficiency, and effectiveness of work (i.e., productivity). To achieve this, we seek long-term, continuous job opportunities for vegetation management program staff and the vegetation maintenance workforce provided by contract service providers. We emphasize the recruitment and development of qualified individuals, support skills and knowledge-based training, operate a robust QA/QC program, and conduct competitive contracting for vegetation maintenance services.

FORM LOCAL CHAPTER OF THE INTERNATIONAL SOCIETY OF ARBORICULTURE (ISA))

The ISA provides a worldwide network of tree care professionals, offering personal and professional development opportunities to the arboriculture industry, and supporting local and regional arborist with networking and professional development opportunities relevant to specific locale. There are three levels of membership available:

- Professional Membership, open to all individuals actively engaged in the arboriculture field and anyone interested in planting or preserving trees.
- Student Membership, free when they join their local chapter.
- Associate Membership offered at a reduced membership fee to individuals whose country/province of residence does not use English as the official language.

Of particular interest is the ISA Certification (credentialing) Program which confirms, through review of education training, industry experience, and successful passing of an exam, that individuals have the necessary knowledge and skills to properly care for trees, as well as portray a high level of dedication to the profession and the community that they serve. Specific certifications include:

- Certified Arborist
- Certified Arborist Utility Specialist
- Certified Arborist Municipal Specialist
- Certified Tree Worker Climber Specialist

- Certified Tree Worker Aerial Lift Specialist
- Certified Master Arborist

The umbrella ISA organization includes the Arborist Research and Education Academy, Society of Commercial Arboriculture, Society of Municipal Arboriculture, and Utility Arborist Association.

5.0 Critical Success Factors

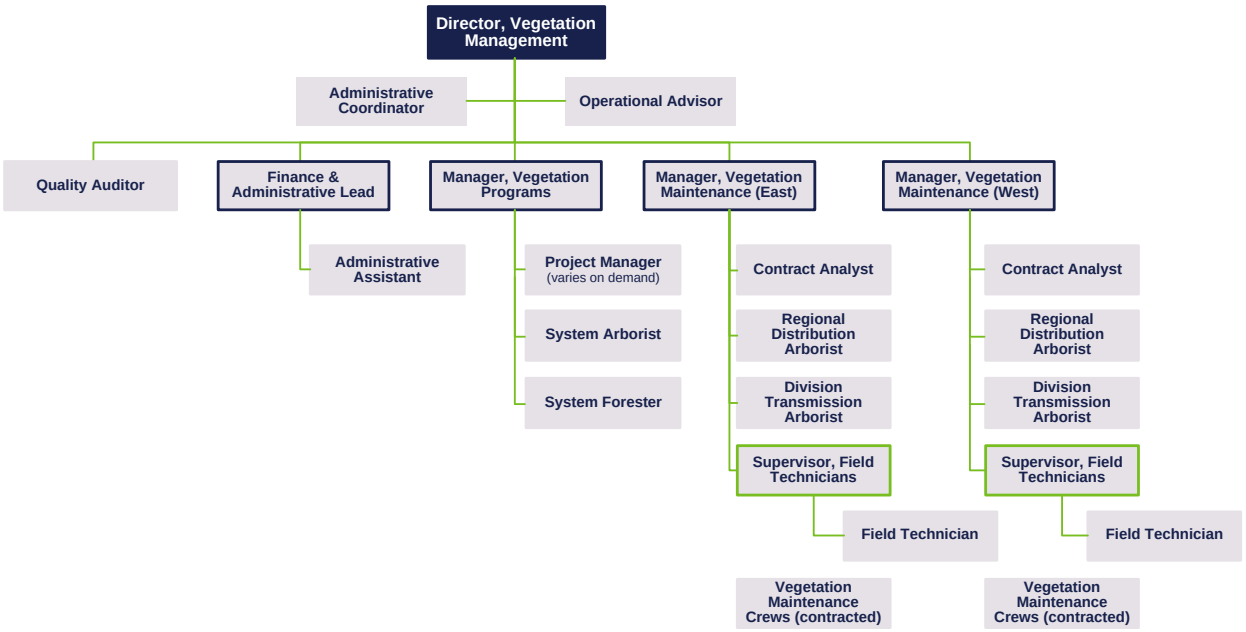
Key factors in achieving the vision and strategic objectives for Vegetation Management include:

- Forming a centralized vegetation management team, staffed by professionals who can rapidly establish procedures and practices aimed at eliminating public endangerment and supporting a safe and efficient work environment.
- Receiving adequate funding to re-establish maintainable tree-conductor clearances on the T&D system (i.e., perform reactive maintenance and reclaim the ROWs) within the first three years.
- As appropriate tree-conductor clearances are re-established, shifting from a reactive and reclamation mode of operation to steady-state integrated vegetation management, adhering to the processes and practices described in Sections 9.0 and 10.0 of this Plan.
- Fully deploying the principles of Integrated Vegetation Management (refer to Section 8.0) to provide sustainable management of vegetation over the long term rather than simply controlling vegetation currently in conflict with overhead lines.
- Using technical specifications based on industry standards ad best management practices to establish vegetation maintenance work expectations
- Using formally established process flows to define standard approaches to efficiently manage and measure the performance of the various types of vegetation maintenance work.
- Implementing a field enabled IT tool to manage vegetation maintenance work, including planning, scheduling, executing, and evaluating the effectiveness of vegetation maintenance activities. The data collected using this tool will support calculation of resource requirements and budgets, based on quantitative estimates of the vegetation maintenance workload to be completed.

6.0 Vegetation Management Organization

The following chart (Figure 6-1) and expanded discussions provide an overview of the structure and functioning of LUMA's Vegetation Management Organization.

Figure 6-1: High-Level Post-Commencement Vegetation Management Organization



6.1 Senior Leadership

LUMA's Vegetation Management Program is led by the Director, Vegetation Management who assures a safe and high level of vegetation management performance across the system, to the benefit of the customers and communities it serves. Reporting to the Director are the following functions:

- **Quality Auditor** supports Quality Control (QC) activities performed by LUMA and service provider personnel, conducting independent Quality Assurance (QA) studies of processes and practices across the vegetation management organization.
- **Finance and Administrative Lead** is responsible for maintaining the performance management, budgeting, and accounting systems for the vegetation management organization.
- **Managers** of the Vegetation Management Program and Vegetation Maintenance positions also report to the Director. Their roles are described below.

6.2 Vegetation Management Program Team

The Vegetation Management Program Team, charged with executing the Vegetation Management Plan, is staffed by Subject Matter Experts with functional responsibility for vegetation maintenance work being performed in the field. Responsible for vegetation maintenance contracts, technical specifications, and contract negotiations, this Group is led by the **Manager, Vegetation Management Program**, who provides technical guidance regarding all Vegetation Management processes and maintenance practices, assuring a safe, efficient, and effective operation. This manager is supported by:

- **System Arborists** who provide technical expertise for the utility arboricultural practices, tree risk assessments, urban forestry, and the use of tree growth regulators. They provide support to:
  - Other LUMA departments in presenting LUMA's Vegetation Management Program to customers, public, and other stakeholder parties,
  - Their Utility Arborists counterparts in LUMA's distribution vegetation maintenance services and contact service provider field operations,

  - Development and refinement of the Vegetation Management Plan, and
  - Monitor and evaluate new developments (regulations, standards, best practices, technology) related to IVM.
- **System Foresters** who guide matters related to IVM including the use of chemical (herbicides) and physical (mowing, mastication) control methods. They provide support to:
  - Their Utility Forester counterparts in LUMA's transmission vegetation maintenance services and contact service provider field operations,
  - Development and refinement of the Vegetation Management Plan, and
  - Monitor and evaluate new developments (regulations, standards, best practices, technology) related to IVM.
- **Vegetation Project Managers**, who support implementation of LUMA's new Vegetation Management Program and will be assigned to major capital construction projects that require vegetation management-related support.

6.3 Vegetation Maintenance Operations Team

This group is responsible for managing vegetation maintenance contracts and the operations performed by external Service Providers, focusing on the efficiency and effectiveness of the field forces. Led by a **Manager, Vegetation Maintenance,** in each LUMA operating Division, these individuals have direct line authority and responsibility for vegetation maintenance operations on the Transmission and Distribution systems within their respective divisions. Each is responsible to foster an appropriate culture of safety within in-house and external Service Provider operations. They are supported by:

- **Utility Distribution Arborists**, each with responsibility for vegetation maintenance work on distribution projects within their respective regions. These individuals assign and monitor projects, generally involving line clearance tree pruning and removal work, to external service providers, and represent LUMA's Vegetation Management Program to customers, municipalities, and other stake holders within the region.
- **Utility Transmission Arborist**, one in each Division, responsible for transmission vegetation management projects within their respective Division. This work generally involves heavy clearing and the use of various IVM control methods including the use herbicides and heavy machinery to physically clear the transmission ROW.
- **Supervisor, Field Technicians**, supervise field technicians who perform condition assessments, interact with property owners, and develop vegetation maintenance prescriptions. These supervisors plan, schedule and assign field technicians to perform these functions for individual distribution and transmission circuits.

7.0 Physical Considerations

In considering the approaches, processes, and practices to invoke in LUMA's Vegetation Management Plan, there are several physical aspects to consider. This section expands upon three of them:

- Transmission and Distribution System,
- Tree Conductor Clearances, and
- Right Tree / Right Place.

7.1 Transmission and Distribution System

The PREPA Transmission and Distribution system includes 11,000 miles of overhead primary electric distribution lines and nearly 2700 transmission lines along with approximately 300 substations. LUMA has been assigned responsibility for all Vegetation Management and Maintenance activities performed on this system.

OVERHEAD DISTRIBUTION SYSTEM MILES

Vegetation maintenance work on the distribution system involves pruning and removal of individual trees. For the purpose of this discussion, the distribution system can be viewed as consisting of two voltage classes, based on their susceptibility to tree initiated short circuit faults (higher voltages being more susceptible).

Table 7-1. Miles of Overhead Distribution Line by Voltage

Voltage	15 kV Class	5 kV Class			
	7.62/13.20 kV	4.80/8.32 kV	4.16/7.20 kV	2.77/4.80 kV	2.40/4.16 kV
Miles	5,089	3,709	422	17	6,652

The PREPA distribution system also includes approximately 12,000 miles of low voltage secondary supply, individual service, and streetlighting lines.

TRANSMISSION SYSTEM MILES

Vegetation maintenance work on the transmission system on circuits energized at 230kV and 115kV involves removal and control of incompatible species and management of compatible plant communities within the ROW. Circuits energized at 38kV also include a significant amount of line clearance tree pruning.

Table 7-2. Miles of Transmission Lines by Voltage

Voltage	230 kV	115 kV	38 kV
Miles	423	680	1,464

SUBSTATION AND POLE YARDS

There are approximately 300 substation sites with an estimated area of 54 acres requiring bare ground weed control. There are also 34 individual yards where equipment and materials are stored that will require bare grounds weed control.

STANDARD RIGHTS-OF-WAY WIDTHS

PREPA is the owner of energy delivery system infrastructure. LUMA is responsible for vegetation maintenance on the PREPA ROW. Rights to maintain vegetation in proximity to the T&D system are established by easement.

Standard Widths: Distribution ROW

The standard width for primary voltage distribution line ROW does not vary by the intensity of land use, number of phases, or type of construction. These ROW widths on multi-phase distribution lines where conductors are on cross arms are narrow as compared to the Utility Vegetation Management (UVM) industry, resulting in limited tree-conductor clearances for outer phases on cross arm construction.

Table 7-3. PREPA Standard Widths for Distribution ROW, Rural and Residential Sites

Line Type	Voltage Class	Standard ROW Width Edge to Edge (from Centerline)
Single Phase (1Ø)	7.6/13.2kV	10' (5')
Multi-phase (2-3Ø)	7.6/13.2kV	10' (5')
Double circuit 3Ø	7.6/13.2kV	10' (5')
Aerial Spacer Cable	7.6/13.2kV	10' (5')
Single Phase (1Ø)	≤4.8/8.3kV	10' (5')
Multi-phase (2-3Ø)	≤4.8/8.3kV	10' (5')
Low voltage Secondary	120/240V	10' (5')
Services	120/240V	none

Standard Widths: Transmission ROW

The standard width for Transmission line ROW in urbanized/developed areas varies by voltage and type of construction. These ROW widths are significantly narrower than those typically found in the industry, resulting in significant limitations to tree-conductor clearances to outer phases.

Table 7-4. Standard Widths for Transmission ROW, Urban / Developed Sites

Line Type	Voltage Class	Standard ROW Width Edge to Edge (from Centerline)
Double Circuit Structure	230 kV	60' (30')
Two lines common ROW	230 kV	100' (50')
Single Circuit	115 kV	30' (15')
Double Circuit Structure	115 kV	40' (20')
Two lines common ROW	115 kV	100' (50')
Single Circuit	38 kV	25' (12.5')
Double Circuit Structure	38 kV	25' (12.5')
Two lines common ROW	38 kV	undefined

The standard width for Transmission line ROW in less developed rural area varies by voltage.

Table 7-5. Standard widths for Transmission ROW, Rural Undeveloped Sites

Line Type	Voltage Class	Standard ROW Width Edge to Edge (from Centerline)
Single Circuit	230 kV	100 (50)
Double Circuit Structure	230 kV	100 (50)

Line Type	Voltage Class	Standard ROW Width Edge to Edge (from Centerline)
Two lines common ROW	230 kV	100 (50)
Single Circuit	115 kV	100 (50)
Double Circuit Structure	115 kV	100 (50)
Two lines common ROW	115 kV	100 (50)
Single Circuit	38 kV	50 (25)
Double Circuit Structure	38 kV	50 (25)
Two lines common ROW	38 kV	50 (25)

7.2 Tree Conductor Clearances

Vegetation maintenance work is intended to reduce risk by addressing the potential for tree-conductor conflicts. Creating and maintaining clearance between energized conductors and trees, sufficient to provide reliability between scheduled preventive maintenance treatments is a focus of the work. The work is also intended to reduce the likelihood of a tree or branch part interfering with the line. This is a function of the stability of the tree part and its proximity to the line. Pruning and/or removal accomplish this by eliminating tree parts prone to failure and reducing the likelihood of a line strike by increasing separation from conductors.

DISTRIBUTION CLEARANCES

Table 7-6 below provides guidance on tree-conductor clearances within the Removal/Reduction and Edge Zones (pertaining to tree-conductor and overhang clearances) to be established at the time that vegetation maintenance work is performed. Trees and branches within and extending into the Removal/Reduction and Edge Zones are assessed and maintained. The intent is that sufficient clearance be achieved to provide reliability over the course of the interval between scheduled preventive maintenance (see Preventive Vegetation Maintenance Time Frame, within Section 9.2).

The risk trees pose to overhead distribution varies by factors such as nominal voltage, voltage gradient, conductor type (e.g., bare vs coated), and overcurrent protection scheme. These factors vary across the overhead distribution system, and as a result so too does exposure to risk. Required clearances are specified as part of the preventive maintenance prescriptions developed for each project. LUMA expects that clearances prescribed and achieved on circuits energized at lower primary voltages may, in some cases, be less than those at higher voltages. Similarly, clearances prescribed and achieved for coated conductor and aerial spacer cable systems may be less than for bare conductor.

The Utility Vegetation Management industry recognizes that in most jurisdictions incidental tree-conductor contact due to ingrowth will occur on a distribution circuit prior to scheduled preventive maintenance. The National Electric Safety code recognizes incidental contact as acceptable and does not create an expectation that utilities will maintain overhead distribution systems free of any tree contact. It focuses on contacts that have the potential to cause damage to conductors. As such LUMA's vegetation management strategy on the distribution system recognizes that incidental tree-conductor contact will occur. The object is not to achieve clearance sufficient to eliminate any contact with conductors. It is to achieve the clearances specified in the table below when vegetation maintenance is performed. Tree-conductor clearance is lost as trees respond to line clearance pruning.

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Table 7-6. Tree-Conductor Clearance Requirements, Reduction/Removal and Edge Zones

Line Type	Voltage Class	Overcurrent Protection	Tree-conductor clearances[1] to be established	Overhang Clearances (tree-conductor)
Three-phase (3Ø)	7.6/13.2kV	Substation Breaker	12’	Ground to sky
Multi-phase (2-3Ø)	7.6/13.2kV	Reclosure, line fuse	12’	15’
Single phase (1Ø)	7.6/13.2kV	Lateral fuses	12’	12’
Three-phase (3Ø)	≤4.8/8.3kV	Substation Breaker	12’	12’
Multi-phase (2-3Ø)	≤4.8/8.3kV	Reclosure, line fuse	12’	12’
Single phase (1Ø)	≤4.8/8.3kV	Lateral fuses	12’	12’
Open wire Secondary	120/240V	Transformer fuse	5’	5’
Tri-plex Secondary	120/240V	Transformer fuse	5’	5’
Open wire service	120/240V	Transformer fuse	No Hard Contact	No Hard Contact
Tri-plex service	120/240V	Transformer fuse	No Hard Contact	No Hard Contact

Vegetation maintenance work within the Removal/Reduction and Edge Zones considers the condition and structural integrity of each tree, site conditions that may increase the likelihood of tree failure and expected regrowth response rates.

LUMA seeks to eliminate hard contacts between low voltage service wires and trees. This requires only incidental pruning of the tree and is accomplished during routine scheduled work on the primary lines. Should property owners desire additional clearance, they are directed to the Operations Department, which may opt to temporarily drop the line so that a property owner can perform the desired work.

Vines climbing on structures and interfering with equipment also represent a significant risk to reliability and must also be maintained. Vines are cut and the stump is treated with herbicide.

TRANSMISSION CLEARANCES

Guidance on tree-conductor clearances within the Wire and Border Zones[2] will be established at the time that vegetation maintenance work is performed, consistent with the criteria presented in Table 7-7. The intent is that sufficient clearance be achieved to assure reliable service during the interval between scheduled preventive maintenance actions.

Clearance expectations on the transmission system are based on application of IVM concepts of Tolerance Levels (TL) and Action Thresholds (AT). While the PREPA transmission system is not subject to NERC requirements, LUMA is voluntarily adopting several elements of NERC FAC-003.4 Transmission Vegetation Management. The TL for a transmission circuit compliant with FAC-003.4 can be defined as the point that incompatible trees encroach on the Minimum Vegetation Clearance Distances (MVCD). In this context the AT is the clearance achieved to prevent incompatible tree populations from breaching the MVCD over the interval between preventive maintenance treatments.

[1] This is a value that PREPA has established and stated in their VM Plan documents. LUMA is using this as guidance, but not considering it a “not to violate” MVCD for the distribution system.

2 Wire Zone refers to the section of a utility transmission right-of-way directly under the wires and extending to a pre-established distance on each side, and Border Zone refers to the section of transmission right-of-way that extends a pre-established distance from the outside transmission wire.

Table 7-7. Tree-Conductor Clearance Requirements, Wire and Boarder Zones

Line Type	Voltage Class	Wire Zone Clearances	Edge Zone Clearances[3]	Overhang Clearances	FAC-003.4 MVCD[4]	ANSI Z133 MAD[5]
All types	230 kV	No Trees	20’	Ground to Sky	4.0-4.6’	7’ 0”
All types	115 kV	No Trees	15’	Ground to Sky	1.9-2.0’	3’ 11”
All types	38 kV	No Trees	12’	Ground to Sky	1’	2’ 11”

The TL and AT model can also be adapted for management of compatible species. Compatible species, by definition, do not grow to heights that will encroach on the MCVD, but they can grow to heights or densities that interfere with line-of-sight requirements for line inspection and in densities that impede access for repairs. Compatible plant communities will be assessed on a site-by-site basis and maintained to mitigate potential interference with critical maintenance functions.

Tolerance Levels and Action Thresholds can also be based on considerations such as economic optimization of treatments, access, aesthetics, safety, or other matters of concern to the vegetation manager.

VEGETATION AT SUBSTATIONS

For safety and security reasons, a fence surrounds each substation. Inside the fence, the land is graded flat and graveled. Outside the substation fence, there is a buffer of rock/gravel. Beyond the buffer, the substation property may range in size from less than an acre to several hundred acres, which may be forest, field, or landscaped shrubs.

A ground mat lies under the gravel within the fenced area of the substation. The ground mat is a metal grid buried under the soil to “ground” the electrical equipment of the substation and to create an equipotential plane. A plant growing up through the ground mat could provide another grounding path for electricity and would represent a safety hazard.

Gravel areas within the fenced area of the substation are maintained in a bare ground condition. A bare ground buffer along and outside the substation fence is also maintained. Tall growing trees outside the fenced area but capable of striking any substation equipment and fencing are reduced or removed.

VEGETATION AT STORAGE YARDS

A significant portion of the inventory of T&D materials and equipment is stored outside in gravel yards. Weed growth in these areas is a nuisance, potential safety hazard, and may contribute to the degradation of inventory assets. Gravel areas within storage yards are maintained in a bare ground condition.

ACCESS ROADS

The LUMA Vegetation Management Plan includes work to maintain vegetation that may impede access to Transmission and Distribution lines and equipment. Access roads are retired after use and maintained in a condition that assures access can be achieved by off-road capable all-wheel drive equipment within a

3 This is a value that PREPA has established and stated in their VM Plan documents. We are using this as guidance, but not considering it a “not to violate” MVCD

4 Minimum Vegetation Clearance Distance, per NERC FAC-003.4

5 Minimum Approach Distance for Qualified Line Clearance Arborists, per Table 2, ANSI Z-133

reasonable amount of time. Access roads are not maintained in a condition that provides continuously available access to over-the road vehicles.

Access roads are used by line crews, their machinery, and vehicles can safely travel over them to the electric facility for emergency and routine maintenance work. These access roads are generally unimproved dirt or gravel roads. They are kept clear of trees and brushy vegetation. Some are maintained by LUMA and some by the underlying landowner.

7.3 Right Tree / Right Place

The urban forest is an asset for communities and property owners. However, it often includes species of trees that are not suitable for sites that are near powerlines. If trees grow too close to the electric facilities, they can threaten LUMA's ability to provide safe and reliable electric service. This reality necessitates the pruning or removal of trees, an expensive proposition with often, sub-optimal results, particularly in the selection of replacement trees. The Arbor Day Foundation has developed a guide to help people select the right tree for the right place.

A healthy community forest begins with careful planning. With a little research and a simple layout, tree "owners" can produce a landscape that will cool their home in summer and tame the winter winds. A well-planned yard will contain trees that grow well in the soil and moisture of the neighborhood. These trees can be properly placed to avoid conflicts with power lines and buildings, and the aesthetics will increase property values.

A proper landscape plan takes each tree into consideration:

- **Height.** Will the tree bump into anything when it is fully grown?
- **Canopy Spread.** How wide will the tree grow?
- **Is the tree Deciduous or Evergreen?** (Will it lose leaves in the winter?)
- **Form or Shape.** A columnar tree will grow in less space. Round and V-Shaped species provide the most shade. [shape guide]
- **Growth Rate.** How long will it take for a specific tree to reach its full height? Slow growing species typically live longer than fast growing species.
- **Soil, Sun and Moisture** requirements.
- **Fruit.** No one wants messy droppings on busy sidewalks.
- **Hardiness Zone** indicates the temperature extremes in which a tree can be expected to grow. One can check with the community's tree board or forestry department or a local county cooperative extension agent for a list of trees suitable for planting in a specific hardiness zone (Arborday.org hardiness zones lookup).

LUMA encourages landowners and communities to plant trees for the many benefits they offer. However, it is essential that the right tree species be selected to avoid future conflicts with power lines. LUMA intends to work with Arbor Day Foundation supporting their programs and services delivered in Puerto Rico.

8.0 Integrated Vegetation Management (IVM)

IVM is a structured decision-making process that:

- Emphasizes continuous improvement resulting in

Vegetation Management Plan

- Refinements / adjustments over the course of time, because of the need to
- Monitor and adapt processes and practices to meet current and new objectives and conditions.

Vegetation maintenance actions begin with gaining an understanding of the dynamics around incompatible species and the ecosystem. Based on this knowledge, management objectives are set using tolerance levels and action thresholds. These objectives are based on internal and external factors including reliability, regulatory compliance, site sensitivity or location, stakeholder considerations, and budgets. Vegetation maintenance treatment methods are then defined, recognizing the economic and environmental effects of the work, after which specific activities are planned, prescribed, and implemented based on site and project specific conditions.

LUMA's Vegetation Management Plan applies this approach, thus ensuring that incompatible tall growing trees and woody plants do not interfere with critically important power facilities. Under an IVM operating model, the goal is to reduce the risk that an incompatible tree or plant species will adversely affect system operations. To the extent possible, incompatible plants are eliminated while preserving and enhancing low-growing compatible plant communities. These low-growing plant communities will compete with incompatible plants, providing a form of biological control. In the urban forest promoting planting of more compact forms in place of tall growing landscape trees is a similar strategy based in IVM. LUMA expects in applying IVM, the cost and intensity of the vegetation work required over time will reduce while improving system reliability and safety. This approach will also provide safety, environmental, and social benefits.

LUMA's Management Program will be data driven and include vegetation assessments and inventories and relevant spatial analysis / mapping. This information will be used to support the development of annual work plans and individual project plans, intended to:

- Selectively eliminate and discourage the development and growth of incompatible, tall growing plant species, while at the same time,
- Encourage and promote a relatively stable and diversified compatible plant community consisting of various low growing species such as shrubs, herbs, grasses, forbs, and ferns, and thereby
- Enhance wildlife habitat conditions on the right of way.
- Encourage and promote the concept of the "Right Tree/Right Place" in the urban forest and across developed landscape areas, favoring utility friendly vegetation in proximity to overhead T&D lines.

In implementing this process, LUMA's Vegetation Management Program will:

- Comply with all laws and regulations and will incorporate appropriate industry standards and best management practices.
- Comply with rights and uses established in PREPA's easement for T&D ROW.
- Engage, notify, and educate stakeholders. Consider their interests in the planning process.
- Ensure consistency between this Vegetation Management Plan and project-specific vegetation maintenance plans.
- Implement a continuous improvement process that applies experience gained to adjust and refine the Vegetation Management Program and vegetation maintenance practices.

Specific elements to be applied at both the program and project levels include:

- Establishing objectives.
- Evaluating the site.

- Defining tolerance levels and action thresholds.
- Evaluating and selecting control methods.
- Implementing control methods.
- Monitoring treatment and quality assurance activities.

Before presenting the Management Processes and Maintenance Practices that will drive LUMA's success in operationalizing this Vegetation Management plan, there are three areas to present that define the framework for applying and capturing the full benefits of IVM.

8.1 Tolerance Levels and Action Thresholds

Clearance requirements are based on two elements considered in IVM-based vegetation management programs:

- The Tolerance Level (TL) defines the maximum allowable incompatible-plant pressure, (e.g., species, density, height, location, or condition) that can occur without creating unacceptable consequences).
- The Action Threshold (AT) defines the level of incompatible plant pressure (e.g., species, density, height, location, or condition) where vegetation maintenance treatments should occur to prevent conditions reaching the tolerance levels.

If conditions reach the tolerance level, control methods shall be implemented. Vegetation maintenance work should be initiated when conditions reach action thresholds. Tolerance Levels and Action Thresholds are based on considerations such as economic optimization of treatments, access, aesthetics, safety, and other matters of concern to the vegetation manager.

8.2 Compatible and Incompatible Vegetation

The IVM strategy recognizes and emphasizes selectivity in applying vegetation maintenance treatments. The PREPA distribution and transmission systems are populated with millions of plants but only some have the condition, growth characteristics, and/or location that make them incompatible with safe and reliable energy delivery.

- Compatible species are those that are congruent with the intended use of the site, and include small trees, shrubs and herbaceous vegetation that will never grow into conflict with overhead conductors.
- Incompatible species are those that are not congruent with the intended use of the site and include tall growing trees and other plant forms (e.g., bamboo and palms) with the potential to conflict with overhead conductors.

An initial list of tree species based on characteristics that affect their compatibility with the transmission and distribution system are included in Appendix A. LUMA recognizes the diversity of species in topical ecosystems and intends to revise and expand such lists to generally characterize species using attributes relevant to our Vegetation Management Program.

The general strategy is to control incompatible species while encouraging the growth of compatible species. Compatible species may, on occasion, need control if their height or density impedes the necessary line of sight for inspection or access to perform maintenance. Project specific vegetation maintenance prescriptions address both incompatible and compatible species.

8.3 Vegetation Management Zones

Vegetation maintenance work varies by zone within and adjacent to the cleared corridor. There are three zones defined in terms of their location relative to energized conductors, based on ANSI A300 Part 7 (2019) and the companion ISA BMP on Integrated Vegetation Management

DISTRIBUTION VEGETATION MAINTENANCE ZONES

Trees and branches in proximity to overhead distribution lines exist in three zones (described below in Table 8-1). The risks trees pose, and the preventive maintenance requirements intended to mitigate or abate the risk vary by zone. As a result, so do the vegetation management objectives. Trees create risk to overhead distribution lines by deflecting or falling into contact with conductors. Tree growth that creates incidental contact with distributions lines is generally viewed as low risk.

Table 8-1. Vegetation Maintenances Zones Associated with ROW on the Distribution System

Distribution-VM Zone	Definition
Removal/Reduction Zone	▪ This zone includes trees below and adjacent to the alignment of distribution conductors and includes trees located within the PREPA standard ROW. ▪ In rural and undeveloped areas this zone is managed for the established of a low-growing compatible plant community dominated by herbaceous plants such as grasses, sedges, forbs, and limited low-growing woody shrubs. ▪ In residential and developed areas, the preference is to remove fast-growing trees directly below conductors. Larger and high value landscape trees are maintained using reduction, directional, and structural pruning.
Edge Zone	▪ This zone includes trees located beyond the PREPA standard ROW and within the clearance area. ▪ The edge clearance zone extends from the outer edges of the removal/reduction zone to the limit of the specified clearance area. ▪ Structurally sound trees are pruned to maintain clearance and reduce likelihood of failure and impact to utility targets, and to direct future growth away. ▪ Trees posing moderate to high risk to utility targets are pruned or removed to mitigate risk. ▪ Weakly attached branches likely to fail and impact conductors are removed. ▪ Overhanging branches are reduced or removed as necessary to reduce likelihood of failure and impact to utility targets.
Strike Zone	▪ This zone includes trees located along and beyond the edge of the maintained corridor. ▪ The width of the strike zone varies by factors such as voltage and land use and may not include all trees tall enough to strike the lie should they fail. ▪ Trees in this zone are not routinely pruned or removed unless there is probable likelihood of failure and impact to conductors under normal weather conditions within the vegetation maintenance time frame.

TRANSMISSION VEGETATION MAINTENANCE ZONES

Incompatible vegetation in proximity to transmission lines also exist in three zones (described below in Table 8-2). The risks trees pose, and the maintenance actions to mitigate or abate the risk vary by zone. As a result, so do the vegetation management objectives. Trees create risk to overhead transmission lines by deflecting, falling, and growing into contact with conductors.

Once ROW reclamation is completed, LUMA's IVM approach emphasizes the selective use of herbicides to completely remove all tall growing incompatible species of vegetation from the ROW environs, while simultaneously preserving, to the extent feasible, all other low growing desirable vegetation. LUMA will rely on individual plant treatments that consider species, height of the woody plants in question, their

growing location within the ROW, and the plant's position relative to the overhead conductors. The selective elimination of individual incompatible plants reduces disturbance and unintended damage to compatible plants.

Table 8-2. Vegetation Maintenances Zones Associated with ROW on the Transmission System

Transmission VM Zone	Definition
Wire Zone	▪ The wire zone is that area below and adjacent to the alignment of transmission conductors. It is managed for the established of low-growing compatible plant communities dominated by herbaceous plants such as grasses, sedges, forbs, and limited low-growing woody shrubs. ▪ Vegetation in the wire zone will also be maintained to preserve access and to provide for line-of-site visual inspections. ▪ The wire zone typically has the least ground clearance from conductors. ▪ When wire height is adequate, selected woody vegetation may be incorporated into the wire zone as facilities cross deep valleys, canyons, mountainsides, or other similar terrain. ▪ In some few cases tall growing incompatible species may be retained as buffers, visual screening, or for other specific purposes, provided adequate clearances are achieved and maintained.
Border Zone	▪ The border zone extends from the outer edges of the wire zone to the edge of the cleared corridor and is managed for a diverse community of compatible herbaceous and woody plants including shrubs and species of small trees. ▪ Branches extending into the border zone from trees along the edge of the maintained corridor require pruning to achieve and maintain adequate side clearance from energized conductors. ▪ In some cases, transmission ROW may be too narrow to recognize and manage for a discrete border zone reducing the opportunity to retain woody shrubs and small growing trees.
Strike Zone	▪ This zone includes trees located along and beyond the edge of the maintained corridor. ▪ The width of the strike zone varies by factors such as voltage and land use and may not include all trees tall enough to strike the line should they fail. ▪ Trees in this zone are not routinely pruned or removed unless there is probable likelihood of failure and impact to conductors under normal weather conditions within the vegetation maintenance time frame.

9.0 Vegetation Management Processes

9.1 Introduction

Vegetation maintenance represents a continuous and repetitive process. When trees are pruned, they re-grow, often with increased vigor, and when removed, others are recruited to fill the space created. This section briefly describes the governing processes, starting with the key elements of Vegetation Maintenance, and then addressing a myriad of post-vegetation maintenance activities.

Table 9-1. General Classification of Vegetation Maintenance Work

Vegetation Maintenance	General Characteristics
Preventive	Work that can be specifically planned for and prioritized, scheduled, and managed on a project basis. It represents the largest portion of the Vegetation Management O&M budget.

Vegetation Maintenance	General Characteristics
Corrective	Work that is difficult to plan for, but once identified can be efficiently scheduled. This work is generated by customer requests, LUMA Operations and / or VM program staff. With an effective Preventive Maintenance process in place, a goal to limit this work to <10 percent of maintenance expenditures is reasonable.
Reactive	Work that cannot be planned or scheduled but requires immediate attention. This work is typically related to service interruptions and outages.

Process flow diagrams for each process, consistent with those in use by leading Vegetation Management organizations, are included as an Appendix to this Plan. They are conceptual in nature, to be refined and expanded upon as we gain experience and a better understanding of the steps requiring amplification.

9.2 Preventive Maintenance

Preventive vegetation maintenance, to be implemented after Rapid Reactive Response and Reclamation of the ROW described in Section 12.0, represents the cornerstone of LUMA's of Vegetation Management Program. Vegetation managers will work within the natural biological system to create sustainable conditions that can efficiently reduce risks posed by trees to the T&D system, but not sufficient to reduce the need for a proactive and systematic inspection and maintenance process. LUMA will:

- Deploy a condition-based approach to identify the need for and scheduling of preventive maintenance rather than apply a rigid fixed interval maintenance cycle,
- Perform these activities in a systematic and scheduled basis. In so doing, optimize, over time, the trade-off between the frequency of inspections and subsequent maintenance / total cost, (i.e., shorter intervals can reduce immediate cost but increase total owned cost, and longer intervals can increase the costs of treatments but lower the total owned cost), and overall risk of tree-caused service interruptions / customer outages,
- Manage these activities as discrete projects, be they based on individual distribution feeders, transmission circuits or line segments between substations, or identified as individual initiatives.

Factors considered in assessing condition and determining the need for and scheduling of preventive maintenance projects are described in Table 9-2.

Table 9-2. Factors Considered in Determining the Need for Preventive Maintenance

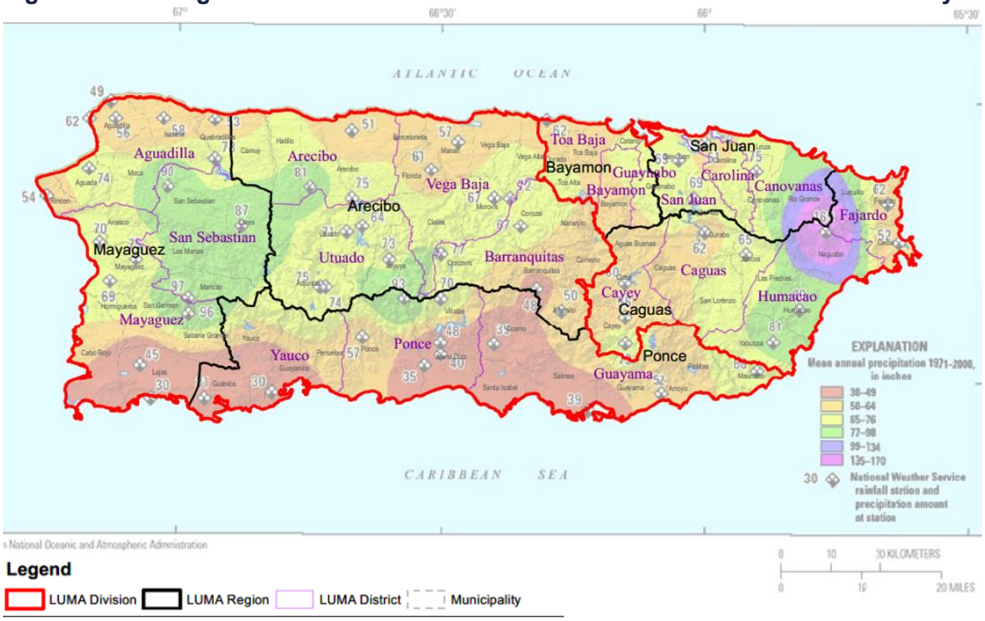
Factor	Description
History	Time since previous maintenance
Projection	Anticipated preventive maintenance time frame
Performance	frequency of tree-initiated faults, interruptions, and outages, and related KPI's (LUMA contract compensatory e.g., SAIFI and SAIDI)
Infrastructure	Voltage, phases, construction framing, conductor type
Conditions	Field assessment of conditions by VM staff and Service Providers
Internal input	Input from LUMA Operations, and other LUMA functional departments
External input	Customer and stakeholder concerns
Construction	Plans for Utility Transformation and major (FMEA) capital projects

Factor	Description
Criticality	Critical loads and customers, system stability, resilience, and redundancy

Projects, pre-planned considering risks, loads, vegetation conditions, cultural and environmental impacts, and action threshold, are executed by field technicians familiar with tree species, tree growth, and the risks trees pose to overhead T&D lines. Field technicians will work with stakeholders and develop specific preventive maintenance prescriptions for each project. Once planned, a project is assigned to a vegetation maintenance service provider to complete, with a job package and technical specifications to define specific work requirements. Once completed, the service provider will complete the required project documentation to be retained by LUMA for future use.

Precipitation, a profile of which is illustrated in Figure 9-3, is a primary variable to consider in anticipating the intervals between scheduled preventive maintenance actions.

Figure 9-1. Average Annual Rainfall on Puerto Rico across LUMA's Service Territory[6]



Notwithstanding the factors presented above, in general, the preventive maintenance time frames for distribution will range between one and three years (refer to Appendix D for anticipated time frames by District and Municipality), whereas transmission will likely require preventive maintenance every other year.

LUMA plans on adopting additional measures to improve the effectiveness of its Vegetation Preventive Maintenance process:

- **Enhanced Tree Risk Assessment** (refer to Figure C-2 in Appendix C for the Process Map): The industry is increasingly making use of focused inspections on the most critical elements of distribution circuits based on overcurrent protection zones and/or critical loads (e.g., hospitals). These initiatives typically require additional condition assessment inspections between the completed and next planned

[6] Though not shown on the map, Vieques and Culebra are included in the service territory.

preventive maintenance but reap the benefits of fewer critical service interruptions and customer outages.

- **Coordinated Aerial and Ground-Based Inspections**: While not a regulatory mandate LUMA's approach to managing tree related risk on the transmission system will include an annual inspection by a combination of aerial and ground-based methods.

Refer to Figure C-1 in Appendix C for an illustrative example of an Industry Best Practice Preventive Maintenance Process Map.

9.3 Corrective Maintenance

While the need to perform work to correct or respond to a condition is difficult to plan for in advance, it can be anticipated. LUMA recognizes this reality and, once the initial Rapid Reactive Response and Reclamation of the ROW described in Section 12.0 is completed, will manage this work to achieve an industry "rule of thumb" of limiting corrective maintenance to less than 10 percent of the vegetation maintenance expenditures.

Corrective maintenance requests can originate from external customers / other stakeholders, or from within LUMA. Regardless of the source, these requests will be screened / assessed for validity (either through the call center or qualified vegetation management / service provider personnel).

Once identified and assessed as valid, the request for work will be prioritized per the criteria presented in Table 9-3.

Table 9-3. Priority of Response for Corrective Maintenance

Priority	Characteristics
1	Conditions poses an immediate public safety hazard or reliability issue. If an imminent safety hazard, the representative that identified the issue remains on site until a crew arrives or the hazard is abated.
2	Conditions pose high potential risk. Once verified the work will be completed within 7 days of the initial identification.
3	Conditions pose moderate risk. Once verified work will be completed within 30 days of identification.
4	Condition poses low risk. Once verified work can be deferred and completed during regularly scheduled preventive maintenance.

Refer to Figure C-3 in Appendix C for an illustrative example of an Industry Best Practice Corrective Maintenance Process Map.

9.4 Reactive Maintenance

Reactive maintenance is performed in response to an immediate need, appropriately categorized as Priority 1 per Figure 9-3. The work is neither planned nor scheduled, as the requirement can occur on a specific localized basis or in response to a major weather event. Adding to the urgency, this work will, likely, be in support of LUMA's Line Operations crews.

Vegetation maintenance work in response to storm events includes clearing access and supporting line crews in their efforts to quickly restore service. It bypasses the normal protocol of notifying customers/property owner in advance and is limited to doing only what is necessary to clear the power lines and correct for any obvious hazardous conditions. Debris including downed trees and branches are left on site.

Refer to Figure C-4 in Appendix C for an illustrative example of an Industry Best Practice Reactive Maintenance Process Map.

9.5 Major Capital Construction Projects

LUMA anticipates the need to provide vegetation related services on capital construction projects (e.g., capital projects requiring access, new ROW clearing, and widening existing ROW). Conceptually, the process is like the preventive maintenance process. In situations involving construction work orders, the Planner or Pre-Inspector may be required to provide cost estimates for necessary tree pruning or removals required by the project and, in consultation with the project designer, obtain written permission to perform such work from affected property owners. Under no circumstances will the crews perform tree work associated with such projects in the absence of clear, written instructions.

Development of Process Map is pending receipt of information related to the magnitude and types of capital projects that will be funded post-commencement.

9.6 Post-Incident Investigations

Consistent with industry best practices, LUMA's Vegetation Management Program staff will investigate a portion of significant tree caused incidents with two objectives in mind:

- Record observations and findings from the event into a tree failure database and use findings to develop risk and tree failure profiles, and otherwise inform development and refinement of technical specifications and maintenance prescriptions.
- Gain real-time insight into how trees are creating problems on the overhead T&D system.

In determining which events to investigate, criteria such as the size and/or duration (e.g., ≥500 customers, ≥1 hour) of an outage and / or the interruptions to critical circuits and outages affecting critical loads will be established. The specific criteria will be firmed up as operational experience is gained, and the specific thresholds will change as overall reliability improves.

Refer to Figure C-5 in Appendix C for an illustrative example of an Industry Best Practice Post Incident Investigations Process Map.

9.7 Customer Refusals

While the right to perform vegetation maintenance work on the T&D ROW is established by easement, LUMA anticipates that in some cases these rights will be challenged. This will likely occur during the reclamation phase of the project, less so during preventive maintenance projects, and much less likely during corrective and reactive maintenance work. Vegetation maintenance processes include work by field technicians preparing maintenance prescriptions which includes notifying stakeholders of planned work as a matter of courtesy. Technical specifications for vegetation maintenance work will also include a notification in advance of starting work. In some cases, the permission of the owner may be acquired in advance of removal of high value landscape trees. Each of these touchpoints has the potential for a property owner of customer to initially refuse to allow the necessary work. We also anticipate the possibility that vegetation maintenance crews will be challenged when work is in progress.

The customer refusal process includes several escalating steps that LUMA will use to reach agreement. In the end, the work necessary to assure safety and that reliability-related risk will be abated or mitigated and performed.

Refer to Figure C-6 in Appendix C for an illustrative example of an Industry Best Practice Customer Refusals Process Map.

9.8 Customer Complaints

LUMA recognizes that the magnitude of change and aesthetic impact of the reclamation phase of the project has the potential to result in adverse reactions from customers. The use of project-specific maintenance prescription that include consideration of stakeholders will reduce the level concern. We also recognize that things will not always go as planned. The customer complaint process includes several escalating steps that LUMA will use to resolve customer concerns. We expect customer complaints will be reduced following the reclamation phase of the project.

Refer to Figure C-7 in Appendix C for an illustrative example of an Industry Best Practice Customer Complaint Process Map.

9.9 Customer Damage Claims

LUMA anticipates that unintended damage to private property will occur and is committed to assuring reasonable repairs and achieving an equitable resolution of damage claims. For physical damage caused by vegetation maintenance work on a site, the provider of vegetation maintenance services will play a major role in resolving damage claims. LUMA's responsibility will be to assure that any claims of damage are resolved.

Refer to Figure C-8 in Appendix C for an illustrative example of an Industry Best Practice Customer Damage Claims Process Map.

10.0 Vegetation Maintenance Practices

LUMA's Vegetation maintenance practices support a long-term strategy to establish and maintain sustainable conditions on the Transmission and Distribution system. This is a fundamental concept central to IVM that recognizes that the response of natural systems to change is predictable. Thus, the response of individual trees and plant communities to any vegetation maintenance intervention can be anticipated and managed in a way that reduces conflicts and costs. By deploying natural processes, the intensity and amount of input (vegetation maintenance) required will, in time, be reduced resulting in more sustainable conditions that can be efficiently maintained.

The specific requirements for each control method are defined in LUMA's technical specification, methods (of which there are three) that are prescribed specifically for each project:

- **Biological Control Methods**, reflected in both physical and chemical controls, reducing the amount of human intervention in future years.
- **Physical Control Methods**, addressing the pruning or removal of tall growing trees and vines in proximity of distribution facilities and along transmission corridors deemed incompatible with the safe and reliable operation of the power system.
- **Chemical Control Methods**, applying registered herbicides, eliminating incompatible stems from a site, encouraging the establishment and expansion of compatible plant cover, and thus suppressing the growth of incompatible species.

After which the practices regarding the disposal of debris are presented.

10.1 Biological Control Methods

Biological control is at the core of LUMA's program. Biological controls include managing the level of competition exerted by compatible plant communities, inhibiting reinvasion, and suppressing the growth of incompatible trees.

Though its direct application may appear limited, it has direct application in the urban forest. Aligned with the Right Tree / Right Place Program presented in Section 7.3, this method involves introducing, promoting, and establishing openings for compatible species and cultivars of trees, previously occupied by incompatible tall growing trees. The use of proper pruning practices is also a variant of biological control. Trees respond to pruning in predictable ways. The placement of pruning can reduce re-growth response, direct it away from conductors, and reduce the likelihood of decay associated with the pruning wound, subsequently reducing the risk of structural failure and line strike.

LUMA will also evaluate opportunities to apply biological controls by direct seeding of compatible herbaceous cover within the wire zone on highly disturbed sites.

10.2 Physical Control Methods

Physical control methods prescribed vary based on several factors related to the condition and make up of ROW vegetation. They also vary based on the type and voltage of the affected facility. Vegetation maintenance work on:

- Overhead distribution lines consist predominantly of pruning or removing trees that can grow into or fall on the facilities,

- Higher voltage 230 kV and 115 kV transmission lines are less reliant on tree pruning and focus more on the removal of incompatible trees within the cleared ROW corridor, 38 kV transmission includes both pruning and removal of tree species within the ROW, and
- Trees outside the cleared corridors are assessed and maintained by physical methods (removal, reduction) as deemed appropriate for the specific situation.

Table 10-1 (below) describes each Physical Control Vegetation Management Practice and its primary use.

Table 10-1. IVM Physical Control Methods

Vegetation Management Practice	Primary Use
Tree Pruning: Pruning limbs and branches using property arboricultural techniques. This work is completed by skilled line clearance arborist working aloft.	Height reduction and side pruning on distribution lines. Limited side pruning on 230kv and 115kV transmission lines, more frequent use on 38kV lines.
Tree Removal: Felling of incompatible trees**.** This work is completed by skilled line clearance arborist working at ground level and in some cases aloft.	Reduction/removal zone on distribution lines. Wire and border zone on transmission lines. Reclamation and Steady State preventive maintenance phases.
Severing of Vines: Cutting vines to create a gap between root system and above ground portion interfering with T&D infrastructure.	Predominantly on Distribution lines. Reclamation and Steady State preventive maintenance phases.
Manual Cutting: Individual small diameter incompatible plants are cut by chain saw or other means of severing the above ground portion of the plant.	T&D ROW, Reclamation and Steady State preventive maintenance phases.
Mechanical Reduction: The mechanized cutting / removal of branches in the crowns of trees.	T&D ROW, Reclamation and Steady State preventive maintenance phases.
Mechanical Mastication: The mechanized cutting and shredding of the above ground portion of woody vegetation.	Medium to high density, larger diameter incompatible stems. Transmission ROW, undeveloped sites. Reclamation phase, ROW widening, and clearing new ROW.
Mechanical Mowing: The mechanized cutting and shredding of the above ground portion of herbaceous and small diameter woody vegetation.	Medium or lower density, smaller diameter incompatible stems. T&D ROW, undeveloped sites. Reclamation phase, ROW widening, and clearing new ROW

These physical control vegetation maintenance practices are expanded upon below.

TREE PRUNING

Line clearance tree pruning, carried out by qualified line clearance arborists working from an aerial platform or while climbing within a crown of trees, represents a major component of LUMA's Vegetation Management Plan, particularly on the distribution system in the more developed areas. All pruning work wounds a tree. Done poorly it can result in an exaggerated regrowth response by weakly attached "suckers", adversely alter tree architecture, and increase exposure to decay organisms that can weaken the tree. Each of these adverse consequences increases the likelihood of tree-initiated faults causing system interruptions and customer outages. In short, improper pruning increases the risk it is intended to address. Consequently, LUMA emphasizes the use of proper arboriculture techniques, based on current industry standards and best vegetation management practices, as outlined in its technical specifications for line clearance pruning.

TREE REMOVAL

Tree removal, performed by qualified line clearance crews working at ground level (some aerial work to reduce the tree is often performed), is often preferred to tree pruning. The stumps of trees that have been removed are typically treated with an herbicide to permanently eliminate the tree from the site, thereby reducing future workload. This is a predominant maintenance practice for the transmission system, and important practice for the distribution system.

Though small trees can often be removed at a cost comparable to or less than the cost of pruning, the removal of large trees can be prohibitively expensive. In many cases the present value cost of repeated pruning may be less than the cost to remove a large tree on a difficult site.

SEVERING OF VINES

Vines on guy wires, poles, and equipment represent a significant risk to reliability. They are severed at the base with an airgap created between the root system and portion of vine climbing on the structure. The stumps of vines that have been removed are typically treated with an herbicide to permanently eliminate them.

Vines are severed and treated by a qualified worker using a machete or chain at ground level. The upper portion of the vine remains attached and is not removed by vegetation maintenance crew personnel.

MANUAL CUTTING

Manual cutting typically involves the removal of small diameter incompatible species of tree. Freshly cut stumps are treated with an herbicide to permanently eliminate the tree from the site, thereby reducing future workload.

MECHANICAL REDUCTION

LUMA anticipates the use of mechanized equipment to reduce branches and crowns of trees encroaching on conductors. This may include ground-based boom mounted saws and saws suspended from helicopters. We anticipate that these methods will have limited use during the reclamation phase of the project and may be more suitable once cleared corridors have been established.

MECHANICAL MASTICATION

Mastication work involves heavy clearing of trees using heavy equipment fitted with a variety of cutting heads capable of reducing standing trees to woody debris. This will prove to be an important method during ROW reclamation, widening, and / or clearing new ROW.

MECHANICAL MOWING

Mowing work and the required equipment is like that performed / used in mechanical mastication but involves the clearing of small diameter woody stems and herbaceous plant materials. It is typically used to clear standing vegetation and is also used to reduce debris generated by pruning, hand cutting, and tree removal. It is an important method for the distribution system, used during the steady state preventive maintenance phase once reclamation has been completed.

10.3 Chemical Control Methods

As previously stated, chemical control methods eliminate incompatible stems from a site, encouraging the establishment and expansion of compatible plant cover capable of suppressing the reestablishment and

growth of incompatible species. In accomplishing this, LUMA will use chemical control methods that are commonly used across the industry, and as defined in LUMA's technical specifications. Table 10-2 describes each of these Chemical Control Vegetation Management Practices and their primary use.

Table 10-2. Common IVM Chemical Control Herbicide Application Methods

Vegetation Management Practice	Primary Use
Low Volume Foliar: The herbicide mixture is applied selectively to individual incompatible plants by an applicator with backpack sprayer or small spray rig.	Steady State preventive maintenance. Medium or lower incompatible stem density and heights < 10 ft.
Selective Hydraulic Foliar (a.k.a. "High Volume Foliar"): The herbicide mixture is applied selectively to incompatible plants by an applicator using a spray rig with tank, pump, hose, and spray gun.	Transitional from reclamation to steady state phase. Medium to high incompatible stem density and heights < 10 ft.
Hand Cut and Treat: The herbicide mixture is applied selectively to the freshly cut stumps of incompatible plants by an applicator with backpack sprayer or small hand sprayer.	Reclamation and Steady State preventive maintenance phases. Whenever incompatible stems are cut.
Frill (a.k.a. "hack & squirt"): The herbicide mixture is applied to fresh frill cuts on an incompatible stem by an applicator using a small hand sprayer or spray bottle.	Specialized needs, incidental use; sensitive sites and inaccessible sites.
Broadcast Foliar: Nonselective application made by calibrated spray nozzles or a gun applied at a fixed rate to an area of ROW.	Follow-up treatment to mastication and mowing. Treatment applied when incompatible stems have re-sprouted. Also used for controlling weeds in substations and yards.

LUMA will apply herbicides that are commonly used in contemporary utility vegetation management programs, most of which are currently registered for use in Puerto Rico and others that are in the process of being registered. LUMA will conduct efficacy trials and establish a limited number of standard mixtures for use on the T&D system. Tables 10-3 and 10-4 list those commercially available herbicides used in IVM and registered for use in Puerto Rico, and typical range in volumes of mixtures.

Table 10-3. Commercially Available Herbicides Used in IVM / Registered for Use in Puerto Rico

Product	Producer	Active Ingredients
Arsenal Habitat	BASF	Imazapyr
Arsenal Powerline	BASF	Imazapyr
Overdrive	BASF	Dicamba
Esplanade 200 SC	Bayer	Indaziflam 19.05%
Esplanade EZ	Bayer	Glyphosate-isopropylammonium 20.46%, Diquat dibromide .89%, Indaziflam .089%
METHOD® 240SL HERBICIDE	Bayer	Aminocyclopyrachlor-potassium 25%
METHOD® 50SG HERBICIDE	Bayer	Aminocyclopyrachlor 50%
STREAMLINE® HERBICIDE	Bayer	Aminocyclopyrachlor 39.5%, Metsulfuron 12.6%
CIMARRON® PLUS HERBICIDE	Bayer	Metsulfuron 48%, Chlorsulfuron 15%
VELPAR® L VU HERBICIDE	Bayer	Hexazinone 25%
VIEWPOINT® HERBICIDE	Bayer	Imazapyr 31.6%, Aminocyclopyrachlor 22.8%, Metsulfuron-methyl 7.3%

Product	Producer	Active Ingredients
Ranger PRO Herbicide	Bayer	Glyphosate
Roundup Custom	Bayer	Glyphosate
Roundup PRO Concentrate	Bayer	Glyphosate
Garlon 4 Ultra	Corteva	Triclopyr
Rodeo	Corteva	Glyphosate
Graslan L	Corteva	Picloram + 2, 4-D
Milestone	Corteva	Aminopyralid

Table 10-4. Typical Range in Volumes of Herbicide Mixtures Applied by IVM Chemical Control Methods

IVM Chemical Control Method	Typical Application Volumes
Hydraulic Foliar applications	50-100 GPA selective,
Low Volume Foliar application	5-15 GPA, often <5 GPA
Low Volume Basal and Cut Stump applications	1-3 GPA basal, < 1 GPA stump
Cut Surface and Frill applications	<1 GPA, often much less
Broadcast Foliar applications	±30 GPA
Broadcast Cut Stubble applications	±25 GPA

These chemical control vegetation maintenance practices are expanded upon below:

LOW VOLUME FOLIAR

Low volume foliar application is the dominant IVM chemical control method used in the utility vegetation management industry today. Planned for use once the ROW is reclaimed, it will assist in maintaining incompatible vegetation on most of the ROW miles and acres. Low volume foliar applications are typically made by an applicator with backpack walking the ROW, with the herbicide mixture being applied to the foliage of individual target plants. It is particularly well-suited for lower densities and heights of incompatible stems. The herbicide mixture used in the low volume foliar application method are water-based and include higher concentrations of active ingredients as compared to those used in hydraulic foliar applications. LUMA expects that the herbicide mixtures to be used in Puerto Rico will include triclopyr, picloram and metsulfuron methyl.

SELECTIVE HYDRAULIC FOLIAR

Hydraulic foliar applications (a.k.a. high volume foliar) are used to maintain medium and high density stands of incompatible vegetation. This application method is typically made by an applicator with spray gun and hose walking the ROW. A spray rig with tank and pump are often mounted on an ATV, pickup truck, or other prime mover. The herbicide mixture is applied selectively over the leafy foliage of individual target plants or groups of incompatible species.

The greatest volume though lowest concentrations of herbicide mixtures are applied in this IVM chemical control method. The mixture, though water-based, can result in damage to compatible plant communities. LUMA expects that the herbicide mixtures used in Puerto Rico will include triclopyr, picloram and metsulfuron methyl.

HAND CUT AND TREAT

Cut surface application are paired with work to physically control the above ground portion of incompatible species including trees, bamboos, and vines. While physical methods remove the immediate risk, cut vegetation will re-sprout and grow vigorously. Application of an herbicide eliminates the plant by killing the root system. Cut stump applications involve treating the cut face of the stump, remaining bark to ground line and the surface of any exposed roots. This application is made using a backpack or small hand sprayer.

The herbicide mixtures used in cut stump applications are not water-based. The active ingredient is diluted in a viscous basal oil carrier. LUMA expects that the herbicide mixtures used in Puerto Rico will include triclopyr and imazapyr.

FRILL

Frill applications have limited but important use in LUMA's Vegetation Management Program. They are highly selective and do not require specialized equipment. Frill applications are typically made on sensitive sites such as riparian zones. Because the method is easily transportable, it is also effective for vegetation maintenance work where access is difficult such as for mountain top structures.

Frill applications are typically made by an applicator walking the ROW. A frill cut is made by machete or hatchet and a small quantity of herbicide is applied to the fresh cut. A common name for this method is "hack and squirt" which aptly describes the process. The herbicide mixtures used are water-based.

LUMA expects that the herbicide mixtures used in Puerto Rico will include triclopyr, imazapyr, and glyphosate.

BROADCAST FOLIAR

Broadcast foliar applications are not selectively applied and are most suitably used following initial clearing and ROW reclamation work, typically following physical control of incompatible vegetation. While the application method is non-selective, the herbicides used are generally selective, targeting broadleaf plants with limited to no effect on grass.

Application is made by calibrated spray nozzles or a gun. Herbicide mixtures used in broadcast foliar applications are applied at a fixed rate to an area of ROW that does not vary with stocking. Broadcast foliar applications are made to the foliage of re-sprouted growth following physical control by mastication. The application is made after the re-growth has developed enough foliar surface to intercept and translocate the herbicide through the above- and below-ground portions of the targeted species.

LUMA expects that the herbicide mixtures used in Puerto Rico will include triclopyr, picloram, and methsulfuron methyl.

TREE GROWTH REGULATORS

In addition to those chemical control methods summarized in Table 10-2, LUMA expects to make limited use of Tree Growth Regulators (TGR) to reduce the rate of stem elongation following pruning. In reducing pruned trees' regrowth response, TGRs extend the preventive maintenance intervals, an intervention particularly useful in areas where tree-conductor clearance is constrained. Performed by specialized crews, TGR applications:

- Are generally limited to high value landscape/amenity trees on urban and developed sites,
- Can be made following pruning,
- The dose applied varies by tree size and species
- Paclobutrazol is expected to be the TGR used in Puerto Rico,
- Are injected into the soil root plate around the base of the tree, and
- Will be based on research and experience in tropical urban forests in Hawaii and Australia and refined through further development and demonstration work in Puerto Rico.

TOTAL VEGETATION CONTROL

The intent of herbicide applications in substations and material storage yards is total vegetation control. The objective to create and maintain gravel areas free of vegetation:

- Bare ground weed control is accomplished by nonselective broadcast foliar applications (not selectively applied) using a non-selective herbicide.
- Application is made by calibrated spray nozzles or a gun. Herbicide mixtures used in broadcast foliar applications are applied at a fixed rate to an area of gravel. The herbicide mixtures are also non-selective and are intended to control all forms of plants. They have residual soil activity intended to inhibit germination and establishment of weed within a growing season.
- LUMA expects that the herbicide mixtures used in Puerto Rico will include Imazapyr, Aminocyclopyrachlor, Indaziflam, Sulfometuron-methyl and glyphosate.

10.4 Debris Disposal

The reclamation phase of the project is expected to generate substantial volumes of woody debris that must be disposed, and lesser volumes of debris will continue to be generated during the steady state preventive maintenance phase of the project.

Debris generated by physical control methods is commonly referred to as “slash” and is handled in a variety of manners, based on site type and volume of debris generated. Slash disposal requirements are included in site and project-specific vegetation maintenance prescriptions, consistent with the relevant portions of LUMA’s technical specifications for vegetation maintenance.

Table 10-5. Types of Disposal Methods

Type of Disposal	Description	Where Used
Chip and Haul	Limbs & branches chipped, chips blow into truck, off-site disposal	Developed urban and residential sites, maintained landscapes
Chip and Blow	Limbs & branches chipped, chips blow on-site	Accessible undeveloped sites and natural landscapes.
Pile, Windrow	Limbs & branches collected into piles or “windrows” along ROW edge.	Inaccessible undeveloped sites and natural landscapes.
Lop and Scatter	Limbs & branches cut in sections and left to lay close to ground	Undeveloped sites and natural landscapes.
Mulching	Limbs & branches reduced on-site to mulch by mastication/mowing equipment.	Undeveloped sites and natural landscapes.

The Debris Disposal methods are expanded upon below:

Vegetation Management Plan

CHIP AND HAUL

Debris generated during pruning and tree removal work will be reduced by mechanical chipping:

- Drum and disk chippers reduce slash into chips 4 inches or less in diameter. The chips are blown into a truck and hauled off site for disposal.
- Trunks and branches too large to be handled by the chipper are limbed and the limbs are then chipped.
- Larger Trunks are placed in rows along the edge of the right-of-way or scattered, as the situation requires.
- The chips and trunks left on the right-of-way are left to decompose naturally.

CHIP AND BLOW

This method is like that used in Chip and Haul, but the chips are blown on site:

- Chips are spread evenly across the site.
- Larger diameter material is placed in rows along the edge of the right-of-way or scattered, as the situation requires.
- The chips and trunks left on the right-of-way are left to decompose naturally.

PILE, WINDOW

Debris generated during pruning and tree removal work is collected in piles and/or windrows along the edge of the ROW. Piles are limited to waist height and will be left on the right-of-way to decompose naturally.

LOP AND SCATTER

Debris generated during pruning and tree removal work is cut into small pieces and left to lay close to the ground. The material is cut (lopped) by ax or chainsaw and the cut branches and trunks are scattered on the ground and left to decompose.

MULCHING

Mechanized mastication and mowing machinery are used to reduce slash on-site to mulch. Debris remains within the ROW and left to decompose.

LUMA expects that a significant quantity of logs will be generated as whole trees are removed during the reclamation phase the project and during ROW widening work. Logs will be left on site, piled within and along the edge of the cleared ROW, with the intention of facilitating using and repurposing logs as lumber when feasible.

11.0 Risk Management

This plan is a blend of "take-over," risk remediation, and "business-as-usual" plans. Therefore, there is a certain amount of embedded risk attributable to the:

- Pure magnitude of the Vegetation Management practices / processes shortcomings (i.e., gaps) between PREPA's current state and that of representative of industry norms, and
- The extremely poor reliability with SAIFI and SAIDI values buried in the fourth quartile, half of which is estimated to be attributed to tree-caused outages.

The recently submitted System Remediation Plan included programs to address both aspects, seeks to abate or mitigate immediate vegetation management-related risk in the most critical locations, along with an ongoing program to clear and re-establish rights-of-way (ROW) to standard widths. Along with reclaiming rights-of-way corridors, the remediation element of this plan calls for a field enabled IT tool to manage the program, along with ongoing line clearance, pruning, tree removal, the use of herbicides, etc. and vegetation management training.

11.1 Current State

The recently completed Gap Assessment revealed several deficiencies in PREPA's execution of its Vegetation Management and Maintenance Programs. Until corrected, these items will compromise LUMA's ability to meet the contract requirements specified in the OMA:

- There is no centralized organization with the responsibility and authority for maintaining vegetation and managing vegetation-related processes across the existing Transmission and Distribution (T&D) system, and thus there is no regular focused vegetation management plan in place. In-house employees and contractors do not operate using the most up-to-date utility vegetation management industry standards and best management practices.
- Vegetation maintenance has largely been deferred, with the vegetation maintenance work being performed by in-house personnel conducting predominantly reactive or corrective maintenance (a.k.a., "hot spotting"). Some preventive vegetation maintenance work is being performed by service providers under contracts with PREPA's Project Management Office (PMO).
- Current pruning practices are not effective, resulting in excessive re-growth and wounding of trees that increase the likelihood tree-conductor conflicts and structural failures resulting in tree strikes (refer to Appendix B for species prone to structural failure).
- The equipment that is used by in-house personnel is in poor repair, with a scarcity of any specialized vegetation management equipment. There is little use of herbicides and no use of tree growth regulators. The lack of appropriate tools and equipment contributes to low productivity of in-house personnel.
- The deferral and lack of vegetation maintenance is a significant contributor to the poor system reliability, especially in extreme weather events such as hurricanes. This also creates a public safety hazard: directly in the form of fallen wires or children climbing trees too close to energized lines, and indirectly in the form of power outages.
- These findings indicate possible failure to meet applicable legal requirements, policies or standards, the OMA requirements that drive LUMA's activities at commencement, or any semblance of Prudent Utility Standards, such as:
  - The OMA requires LUMA to implement a Vegetation Management Plan in accordance with Prudent Utility Practice and Applicable Law. OMA, Annex I, Section II(A)(10).

- Act 57-2014, as amended, provides that PREB will oversee the compliance of LUMA with a Vegetation Management Plan in accordance with best practices in the industry to protect the grid. Art. 6.3.
- Act 17-2019, as amended requires: As an initial objective of the law to establish priorities for the maintenance of infrastructure of the electric system and create vegetation management plans and requires the transmission and distribution system operator to prepare a Vegetation Management Plan meeting the requirements set forth in the law. Sections1.6(5) and 1.16.

11.2 Actions to Remediate Risk

As stipulated in the OMA, the recently submitted System Remediation Plan limits LUMA's contractual liability until certain elements of this plan are in place, namely:

- A centralized vegetation management team is created and staffed by professionals who establish procedures and practices aimed at mitigating and abating risks trees pose to the T&D system, eliminating public endangerment and promoting a safe and efficient work environment.
- The process of re-establishing maintainable tree-conductor clearances on the T&D system is initiated, including a:
  - Reactive maintenance response initiative that targets specific locations that pose the greatest risk to public safety, reliability, and system capacity, and
  - Reclamation of the ROWs, involving heavy clearing of existing vegetation, and, in some cases, requiring widening of existing ROWs.
- Effect the shift from a reactive methodology to steady state ongoing vegetation maintenance practices, as individual circuits are reclaimed (consistent with the principles of Integrated Vegetation Management).

However, risk remediation per the OMA does not connote a well-defined and operable Vegetation Management and Maintenance process. Rather, it means that the essential elements are in place to realize steady improvement, and over an extended period, reach a desired state.

11.3 Desired State

The desired state reflects alignment and compliance with the policies, procedures, and practices outlined in this Vegetation Management Plan. Summarizing, the following description, extracted from the Program Brief the defined the System Remediation Plan, applies:

- Vegetation-related functions will be centrally managed by a dedicated vegetation management (VM) team composed of utility vegetation management industry subject matter experts (SMEs) with the responsibility and authority to complete the work in a timely and effective manner. The program will be guided by this plan based on current industry standards and best management practices. LUMA's Vegetation Management Plan will be based on the principles of integrated vegetation management, which is an approach for sustainable management of vegetation over the long term rather than simply controlling vegetation currently in conflict with overhead lines.
- Technical specifications will establish vegetation maintenance work expectations, and process flows will be used to define standard approaches to efficiently manage the various types of maintenance work. Performance measurement and quality systems will be used to manage this work, with the full range of specialized vegetation maintenance services in effect.

Achieving this state will require continuance of actions to remediate the highest risk items until LUMA reclaims the existing rights-of-way, transitions to long-term preventive maintenance individual circuits as

they are reclaimed, and fully operationalizing a program of rapid reactive response to address the most critical locations.

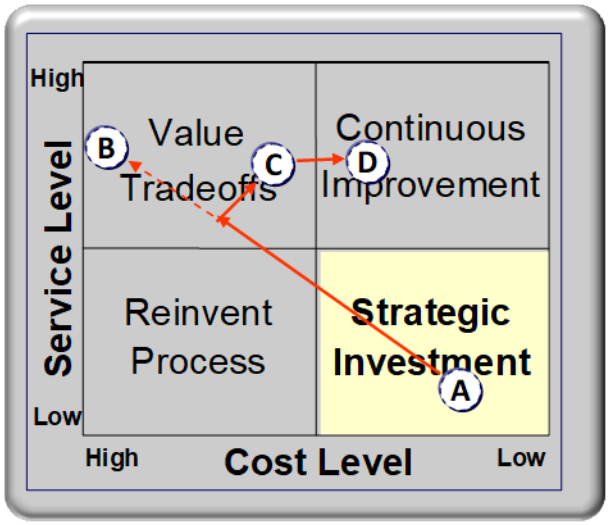
Additionally, LUMA will need to implement a field enabled IT tool to manage vegetation maintenance work, including planning, scheduling, executing, and evaluating the effectiveness of vegetation maintenance activities. The data collected using this tool will support calculation of resource requirements and budgets, based on quantitative estimates of the vegetation maintenance workload to be completed.

Last, the VM team will be staffed with SMEs who will act as mentors, assisting in developing SME level of knowledge, skills, and capabilities of the requisite vegetation maintenance field force.

12.0 Vegetation Management Improvement Plan

Figure 12-1 illustrates the current state of PREPA's (soon to be LUMA's) Vegetation Management Program, indicating its position in Quadrant IV (often referred to as "Strategic Investment" quadrant as organizations / programs so categorized often require an infusion of dollars to realize any substantial and sustainable improvement), the result of severe underinvestment and subsequent poor service level performance.

Figure 12-1. Performance Improvement Process



As we identify improvement opportunities, it is important to note that the journey to Quadrant I (where "Continuous Improvement" becomes the focus) requires three steps:

- Establish performance improvement initiatives (typically in the form of "short-term" and / or one-time investments) to close the service level performance gaps as quickly as possible ("A" towards "B"),
- Offset a portion of any upfront increases in spending and / or investment with the reductions related to initial improvements in organizational or practices efficiencies ("A" towards "B" but diverted to "C"), and
- As Service Level Performance shows improvement, remove any residual non-value-added activities and / or functions that remain ("C" to "D").

Vegetation Management Plan

The previous Risk Management section outlines the actions required to achieve the initial level of remediation (the point at which some foundational elements are in place) and defines the desired state and specific actions to achieve a modicum of sustainable performance in our Vegetation Management practices. Assuming an understanding of the need for some well-targeted investments at commencement, we have outlined a three-phased approach to implementation, adhering to the following sequencing of actions representing a profile of how work may proceed:

Figure 12-2. Key to Color codes used In Figure 12-3

Rapid Reactive Response	ROW Reclamation	Steady State Preventive Maintenance

Figure 12-3. Conceptual Schedule for 3-Phased VM Plan Implementation

		Yr. 1	Yr. 1	Yr. 1	Yr. 1	Yr. 2	Yr. 2	Yr. 2	Yr. 2	Yr. 3	Yr. 3	Yr. 3	Yr. 3	Yr. 4	Yr. 4	Yr. 4	Yr. 4	Yr. 5	Yr. 5	Yr. 5	Yr. 5
line type	miles	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
230kV	398																				
230kV	398	Existing URBAN ROW will require acquisition of additional widening																			
115kV	546																				
115kV	546		Existing URBAN ROW will require acquisition of additional widening																		
115kV	546																				
38kV	1172			Existing URBAN ROW will require acquisition of additional widening																	
15kV 3Ø	2355		Will involve "pushing" ROW edge out but not to the extent that additional width be formally established by easement.																		
15kV 1Ø	3048																				
5kV 3Ø	2455		Will involve "pushing" ROW cleared corridor edge out.																		
5kV 1Ø	4760		Will involve "pushing" ROW cleared corridor edge out.																		

The key elements of this plan include the following.

RAPID REACTIVE RESPONSE

LUMA will initiate a reactive response intended to identify the “worst of the worst” condition on the Transmission and Distribution system that presents risk to safety, reliability, and constrains system capacity. Conditions will be assessed using a full range of methods including remote sensing technology, “boots on the ground” inspection, and PREPA’s experience and local knowledge of trouble spots. This phase of the engagement will be conducted over an initial 6-month period, concurrent with the Reclamation Phase of the engagement

RECLAMATION OF ROW

Reclamation work will be performed to reestablish cleared corridors to PREPA standard widths and maintainable tree-conductor clearances. Deferral of preventive maintenance has resulted in severely overgrown ROWs. Therefore, the intent of this phase is to reclaim the ROW and reestablish conditions that are reasonably maintainable by the systematic application of preventive maintenance practices.

PREVENTIVE VEGETATION MAINTENANCE

Preventive vegetation maintenance work, performed once the ROW is reclaimed, is intended to control incompatible vegetation that poses risks to safety, reliability, and system capacity. The previously described IVM-based approach is intended to manage tree and plant community response in a manner that reduces, over time, the intensity of preventive maintenance work.

The following acknowledges that events will occur where well-planned preventive vegetation maintenance will not suffice, and either corrective or reactive maintenance will be required. That said, a measure of

success in executing this plan is a steady decline in these two categories until the amount of corrective and reactive maintenance is, indeed, manageable.

CORRECTIVE VEGETATION MAINTENANCE

Corrective vegetation maintenance (a.k.a. “hot spotting”) will be performed as necessary when a site-specific need for vegetation maintenance is identified by LUMA or in response to customer requests. LUMA will manage demand for corrective maintenance as a discreet body of work rather than continually disrupt production on preventive maintenance projects.

REACTIVE VEGETATION MAINTENANCE

This body of work occurs in response to tree-initiated faults, interruptions, and outages. Tree crews can be an important resource to Line Operations in their effort to respond, restore, and repair tree-related damage to energy delivery infrastructure.

In adopting this phased approach to implementation, we aspire to achieve the following short-term goals, deemed critical to realizing the vision and goals outlined in Section 4.0:

PRIORITIZE SAFETY

Addressing the backlog of untrimmed trees that will mitigate public safety risks due to power outages, fallen wires and people climbing onto energized lines,

IMPROVE CUSTOMER SATISFACTION

Reducing outages and system interruptions caused by vegetation-caused electrical faults and potentially shortening their duration (i.e., cleared ROWs allow easier access to fault locations), thus improving the customer experience

ACHIEVE OPERATIONAL EXCELLENCE

Applying vegetation management practices, focused on reactive and corrective work (i.e., addressing problems after they arise). A well-functioning program will trim vegetation systematically, increasing the efficiency of the workforce and the reliability of the system.

13.0 Performance Management

LUMA’s Vegetation Management organization will implement a performance management system that includes an easily accessible dashboard to facilitate the presentation of Key Performance Indicators / Metrics regarding the efficiency and effectiveness of its Vegetation Management Program. Managed by the Finance and Administrative Lead, this process will track and report on a set of clearly defined metrics that are routinely used in best-in-class utility vegetation management programs. Other metrics pertinent to the unique challenges LUMA faces in reclaiming the T&D will be identified as we near commencement. We anticipate that new performance metrics will be developed, and existing metrics will be revised as the program matures. That said, there are five general categories of metrics to consider in developing this performance dashboard.

PRODUCTIVITY

Focused on the cost of performing work, the anticipated use of “cost plus” contracts, renders this metric critical to managing and controlling contractor costs. Through a competitive bidding process, hourly billing rates will be established for labor and equipment (with materials likely passed through at cost with a relatively small markup). The extent to which work units are established for the more typical vegetation management activities (e.g., tree pruning, tree removal, and cost per acres of various IVM activities), and adjusted based on experience, will determine LUMA’s ability to control these costs. The objective will be to transition to unit cost and other forms of contracting once a solid baseline is established.

EFFECTIVENESS

These metrics focus on optimizing the work being completed, by computing various cost and production ratios (e.g., prune vs. removal where removals, more costly, remove future workloads; or corrective vs. preventive maintenance expenditures to benchmark against industry norms).

TIME UTILIZATION

These metrics describe how effective a function is in focusing on an assigned task. An example would be a comparison of productive (e.g., pruning trees) to non-productive time (e.g., travel time). Another compares controllable non-productive time (e.g., travel) to time assigned to other tasks unrelated to producing an output (e.g., training).

TIMELINESS

These metrics focus on the ability to meet schedule-related commitments. They are useful at several levels including the rollout of programs and initiatives, individual projects, and individual transactions such as responding to the need for corrective maintenance (e.g., customer request for “hot spotting”).

RESULTS

The primary driver for the increased emphasis on Vegetation Management is PREPA’s poor reliability, in particular the frequency of tree-caused customer outages during and in the absence of major events. Therefore, the performance dashboard should provide transparency regarding the average frequency and duration of customer outages caused by vegetation. This will assist in informing decisions around the focus and periodicity of vegetation maintenance.

A key assumption underlying the rollout of an effective performance management process is the purchase / development of an IT application to house and analyze data and produce user-friendly reports. Vegetation Management software is available in the commercial marketplace, ranging from full-blown enterprise solutions to more simple applications. Initial indications are that LUMA will opt for a “middle-of-the-road” solution that can be quickly deployed and will be compatible with a developing work planning and performance measurement solution.

14.0 Investments and Expenditures

The Vegetation Management Investments and Expenditures initially address those systemic deficiencies that preclude LUMA from being able to meet the standards of performance required under the OMA. Presented as part of LUMA’s System Remediation Plan, these initiatives / projects define most of the spending contemplated for FY2022 through FY2025, acknowledging that remediation will occur over time, and circumstances will arise that will cause variations from this plan as (e.g., major storms and unexpected power outages). Annual spending levels (mostly O&M) will reach (and could easily exceed)

$60.0 million until LUMA (1) reaches the remediated state, and (2) gains experiential knowledge (supported by accurate cost and performance data) of the effort required to effectively manage and maintain vegetation within its service territory.

The following discussion first presents our approach to prioritizing O&M spending (vegetation management and maintenance activities are, as a rule, expensed as O&M), after which we present the bases for and subsequent projection of a three-year operating budget.

14.1 Prioritization of Spending Programs

Per the proposed Vegetation Management Improvement Plan summarized in Section 12.0, a three-step prioritization scheme will be invoked, aimed at rapidly improving system reliability as efficiently and effectively as possible, and doing so in a way that leads to sustainable improvement over the long haul:

1. Rapid Reactive Response: Targeting the first six months for completion, LUMA will initiate a reactive response intended to identify the “worst of the worst” condition on the Transmission and Distribution system that presents risk to safety, reliability, and constrains system capacity.
2. Reclamation of ROW: Concurrent with the Rapid Reactive Response, reclamation work will be performed to reestablish cleared corridors to PREPA standard widths and maintainable tree-conductor clearances. The intent of this phase is to reclaim the ROW and reestablish conditions that are reasonably maintainable by the systematic application of preventive maintenance practices.
3. Preventive Vegetation Maintenance: With the ROW reclaimed, preventive vegetation maintenance work will be performed to control incompatible vegetation that poses risks to safety, reliability, and system capacity.

Once LUMA establishes an effective and efficient preventive Vegetation Maintenance process, it will be poised to respond to requirements to apply corrective and reactive vegetation management as needed.

The initial budget establishes five projects, focused on initial remediation of risk (refer to Section 12.0):

- Reactive Response
- Reclamation of the T&D System ROW
- Steady state preventive maintenance
- VM Information Technology
- VM Advanced Technology[7]

The long-term O&M investment and spending plans will presume “business as usual” as the system reaches a remediated state.

14.2 Vegetation Management Workload

The remediation efforts addressed in Section 11.0 and outlined in the five projects submitted in the initial budget request define most of the workload for the first three years following commencement. However, a description of these activities alone, do not convey the amount of work required during this timeframe, be

[7] Not explicitly discussed elsewhere in the document, this project Item Is for the assessment and potential adoption of A.I., "big data", high-res remote sensing, etc. Not planned for immediate implementation, this Is an area that is seeing rapid development In the UVM Industry, driven by the CA wildfires.

it associated with remediation or routine day-to-day management and maintenance. To bridge this gap, LUMA deployed a combination of remote sensing spatial analyses, photo interpretation, and “boots on the ground” condition assessments to provide a basis for an estimate of vegetation maintenance workload for PREPA’s Transmission and Distribution system.

An initial assessment used data sets that are available in the public domain including CCAP land classes (2m2 resolution), Google Earth images and general databases that provided topographic and geographic details. This information was linked to PREPA’s asset management data, including line location, type, and voltage. Once the system was described in general terms, LUMA acquired high resolution (5cm2) near real time satellite imagery for twenty individual 25km2 areas located across the PREPA system. Individual line segments within each area were randomly selected and provided to an experienced vegetation maintenance SME who then defined the work and crew type and estimated the amount of time each transect would require. This was done for 300 transects. Finally, two experienced SME’s conducted field assessments of 60 individual transects to validate these estimates. The resulting estimate has a statistical accuracy for workload on the distribution system of ±11 percent at the 90 percent confidence interval.

TREE EXPOSURE ON THE DISTRIBUTION SYSTEM

LUMA used C-CAP[8] data that identifies land covers on the PREPA Transmission and Distribution system where vegetation maintenance work will be required. The land covers are grouped based on the expected intensity of vegetation maintenance work. For example:

- Forest covers made up of incompatible trees require the most intensive work,
- Shrub cover types may have scattered trees and require significantly less maintenance,
- Open land in agricultural uses as well as open land in more intensively developed landscapes may include some scattered individual landscape trees, and
- A fourth groups of land covers absent of trees require no vegetation maintenance work.

Table 14-1. Caption

Significant VM Work	Some VM Work	Incidental VM Work	No VM Work
Upland Forest	Scrub Shrub	Cultivated Crops	Bare Land
Palustrine Forested Wetland	Palustrine Scrub Shrub Wetland	Pasture Hay	Background
Estuarine Forested Wetland	Estuarine Scrub Shrub Wetland	Grassland	Impervious Surface
		Developed Open Space	Palustrine Emergent Wetland
		Cultivated Crops	Estuarine Emergent Wetland
			Unconsolidated Shore
			Open Water
			Palustrine Aquatic Bed
			Estuarine Aquatic Bed

[8] NOAA Coastal Change Analysis Program (2016)

Vegetation Management Plan

In describing the forest land of Puerto Rico, the Forest Action Plan of 2016 states that succession is a natural ecological process in which one plant community replaces another over an extended period. Secondary succession is the re-establishment of the same or a different plant community in an area where a (natural or man- made) disturbance has occurred. The term “secondary forest” is derived from this concept of succession. Information on stocking, and canopy closure in Puerto Rico shows a predominance of secondary forests with early and mid- successional tree species that are not stocked to their full potential (Brandeis et al. 2007). An estimated 68 percent of Puerto Rico is in young secondary forest, 12 percent is in mature forest; and land reverting to forest accounts for 18 percent of total forest cover.

The National Urban and Community Forestry Advisory Council defines the urban and community forest as broadly including urban parks, street trees, landscaped boulevards, public gardens, river and coastal promenades, greenways, river corridors, wetlands, nature preserves, natural areas, shelter belts of trees and trees at industrial sites. In the Puerto Rico Forest Action Plan, the urban forests are described as a forested ecosystem characterized by a high concentration of human influences. This plan defines urban classification schemes and states that depending on the classification, between 11 and 50 percent of Puerto Rico could be called urban. LUMA’s vegetation maintenance workload assessment stratifies the workload on the T&D system by intensity of land use. It goes on to say that developed lands in urban areas form green infrastructure in the same way that roads, water mains, electric lines, and sewers form grey infrastructure. For example, a forest patch can provide habitat for feeding and nesting birds, while a green corridor can ease dispersal if populations become too large or recruitment if they are too small. Connecting open spaces in urban settings creates value. Green infrastructure connects forest and other vegetated land in settings such as wetlands, parks, farms, shorelines, cemeteries, and utility corridors.

The results of this analysis demonstrate differences in the exposure of the overhead distribution system to trees. LUMA is using the UVM industry convention in describing the distribution system in terms of miles.

Table 14-2. Portion of Distribution System Requiring Vegetation Maintenance

Primary Distribution Voltage Class	Total Miles	Miles with VM Requirements	Percent of Total to be Managed
5 kV	9,729	4,017	70%
15 kV	2,207	504	30%
TOTAL	**11,937**	**4,521**	**61%**

Distribution system VM workload can be further stratified by intensity of infrastructure (single Ø/multi Ø), land use (urban/residential), accessibility, and slope difficulty.

TREE EXPOSURE ON THE TRANSMISSION SYSTEM

LUMA used NOAA C-CAP data to assess the workload on the transmission system. The land cover classes presented in Figure 14-1 are also relevant to the transmission system. However, workload on the transmission system is presented in acres, as is commonly the case in the UVM industry.

Table 14-3. Portion of Transmission System Requiring Vegetation Maintenance

Voltage	Total Acres	Acres with VM Requirements	Percent of Total to be Managed
38 kV	8,010	3,255	41%

Voltage	Total Acres	Acres with VM Requirements	Percent of Total to be Managed
115 kV	7,169	4,197	59%
230 kV	4,968	3,521	71%
TOTAL	**20,148**	**10,973**	**54%**

Workload on the transmission system can be further stratified by land use (urban/residential), accessibility, and slope difficulty. LUMA also developed a preliminary estimate of the potential need to widen the transmission ROW. The actual determination to widen any transmission corridors will be based on performance requirements, criticality of a circuit, and site conditions.

Table 14-4. Projection of Transmission ROW Widening Requirements

Voltage	Total Miles	Miles of Widening	Acres of Widening
38kV Widening	1,464	628	897
115kV Widening	680	403	373
230kV Widening	423	301	152

14.3 Vegetation Management O&M Spending Forecast

The projected O&M spending forecast assumes the reclamation phase will be completed within the first three years. Once a site is reclaimed the focus will shift to steady state preventive vegetation maintenance, the interval for which will vary from project to project.

Appendix A: Tree Species Incompatible with Powerlines

The following table provides a list of tree species generally incompatible with power lines because of their tendency to exhibit fast and extensive regrowth.

Common Name (Spanish)	Common Name (English)	Latin Name (genus, species)
siris tree	Lebbeck tree	Albizia lebbeck
albizia	tall albizia	Albizia procera
achiotillo		Alchornea latifolia
bambu	bamboo	Bambusa vulgaris
almacigo	gumbo-limbo	Bursera simaruba
canafitula	golden shower tree	Cassia fistula
caucho	rubber tree	Castilla elastica
pino	Australian pine	Casuarina equisetifolia
yagrumo hembra	trumpet tree	Cecropia schreberiana
cape prieto	Spanish elm	Cordia alliodora
guancaste	earpod	Enterolobium cyclocarpum
eucalipto	rainbow eucalyptus	Eucalyptus deglupta
eucalipto de alcanfor	swamp mahogany	Eucalyptus robusta
palo de goma	India rubber	Ficus elastica
guacima	“Bastard” cedar	Guazuma ulmifolia
emajugua	sea hibiscus	Hibiscus tiliaceus
molinillo	sandbox tree	Hura crepitans
guama americano	Manila tamarind	Pithecellobium dulce
saman	rain tree	Samanea saman
cheflera	umbrella tree	Schefflera actinophylla
cassia amarilla	Siamese cassia	Senna siamea
meaito	African tulip	Spathodea campanulata
citara	golden apple	Spondias dulcis
pomarroasa	rose-apple	Syzygium jambos
teca	teak	Tectona grandis
almendra	Indian almond	Terminalia catappa
cenzio	prickly ash	Zanthoxylum martinicense

Appendix B: Species Prone to Structural Failure

The following table provides a list of tree species prone to structural failure.

Common Name (Spanish)	Common Name (English)	Latin Name (genus, species)
siris tree		Albizia lebbeck
albizia	tall albizia	Albizia procera
almacigo	gumbo-limbo	Bursera simaruba
yagrumo hembra	trumpet tree	Cecropia schreberiana
cape prieto	Spanish elm	Cordia alliodora
eucalipto	rainbow eucalyptus	Eucalyptus deglupta
molinillo	sandbox tree	Hura crepitans
flamboyan azul	jacaranda	Jacaranda mimosifolia
corcho	balsa	Ochroma pyramidale
palo de mato	peronia, horse-eye bean	Ormosia krugii
cheflera	umbrella tree	Schefflera actinophylla
meaito	african tulip	Spathodea campanulata
citara	golden apple	Spondias dulcis
anacaguita	Panama tree	Sterculia apetala
cenzio	prickly ash	Zanthoxylum martinicense

Appendix C: Vegetation Management Process Maps

The following Figures map out the processes presented in Section 9.0 They are general in nature, illustrative of Industry Best Practices, and will be tailored to ensure alignment to and compliance with applicable Laws and Regulations.

Figure C-1: Preventive Maintenance Process Map (Section 9.2)

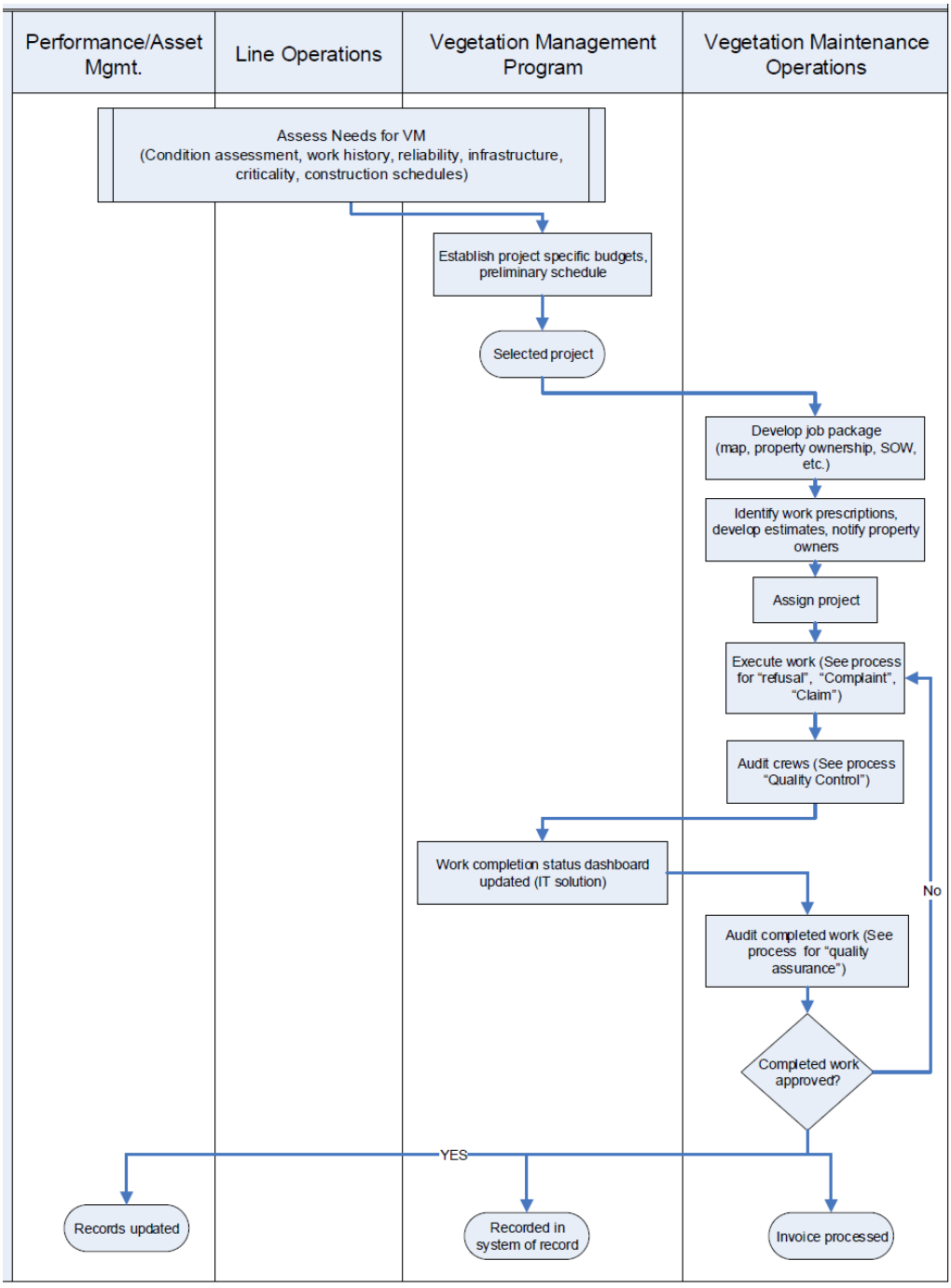
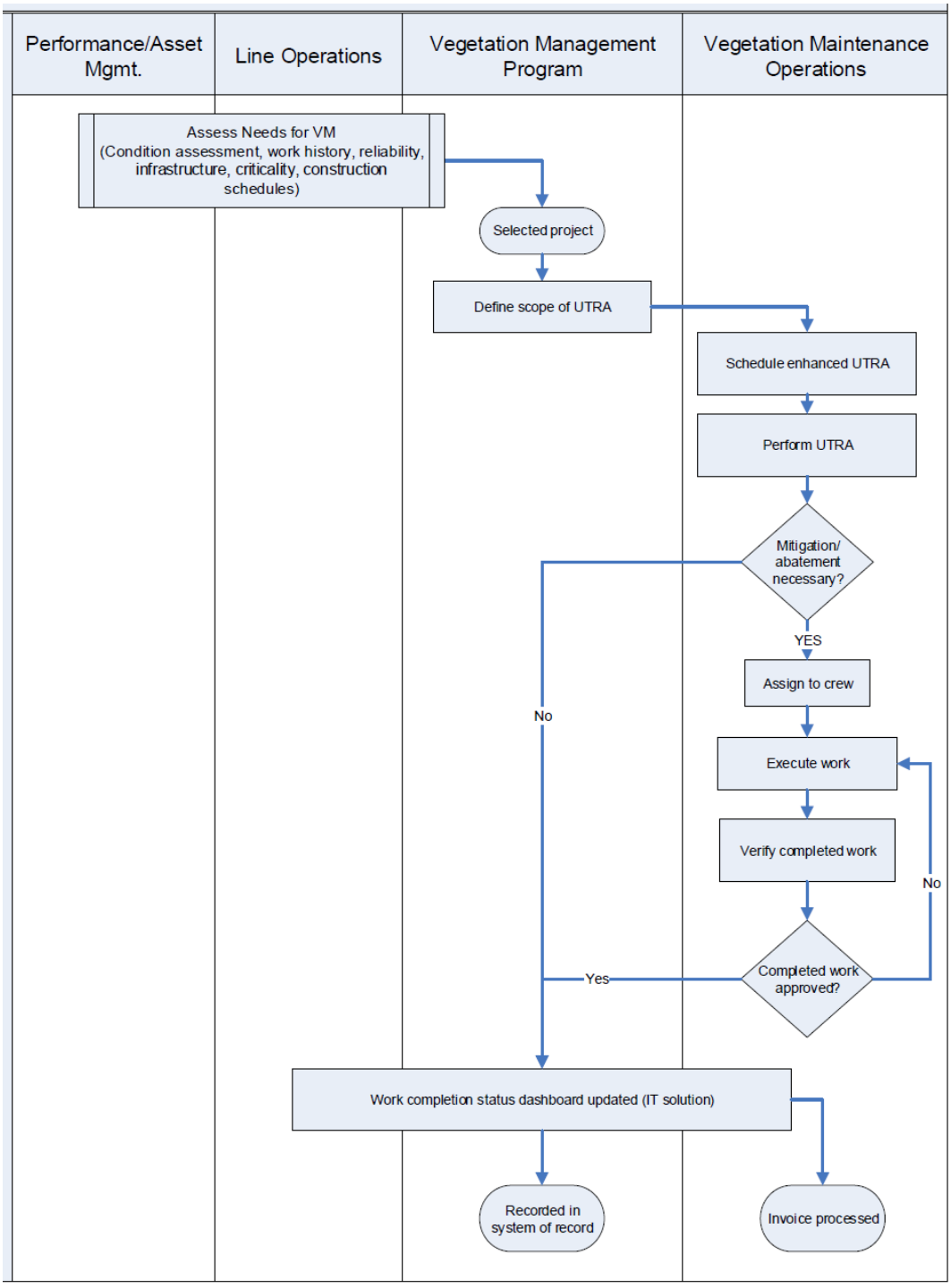


Figure C-2: Enhanced Tree Risk Assessment (Section 9.2)



Note: UTRA is an abbreviation for Utility Tree Risk Assessment.

Figure C-3: Corrective Action Process Map (Section 9.3)

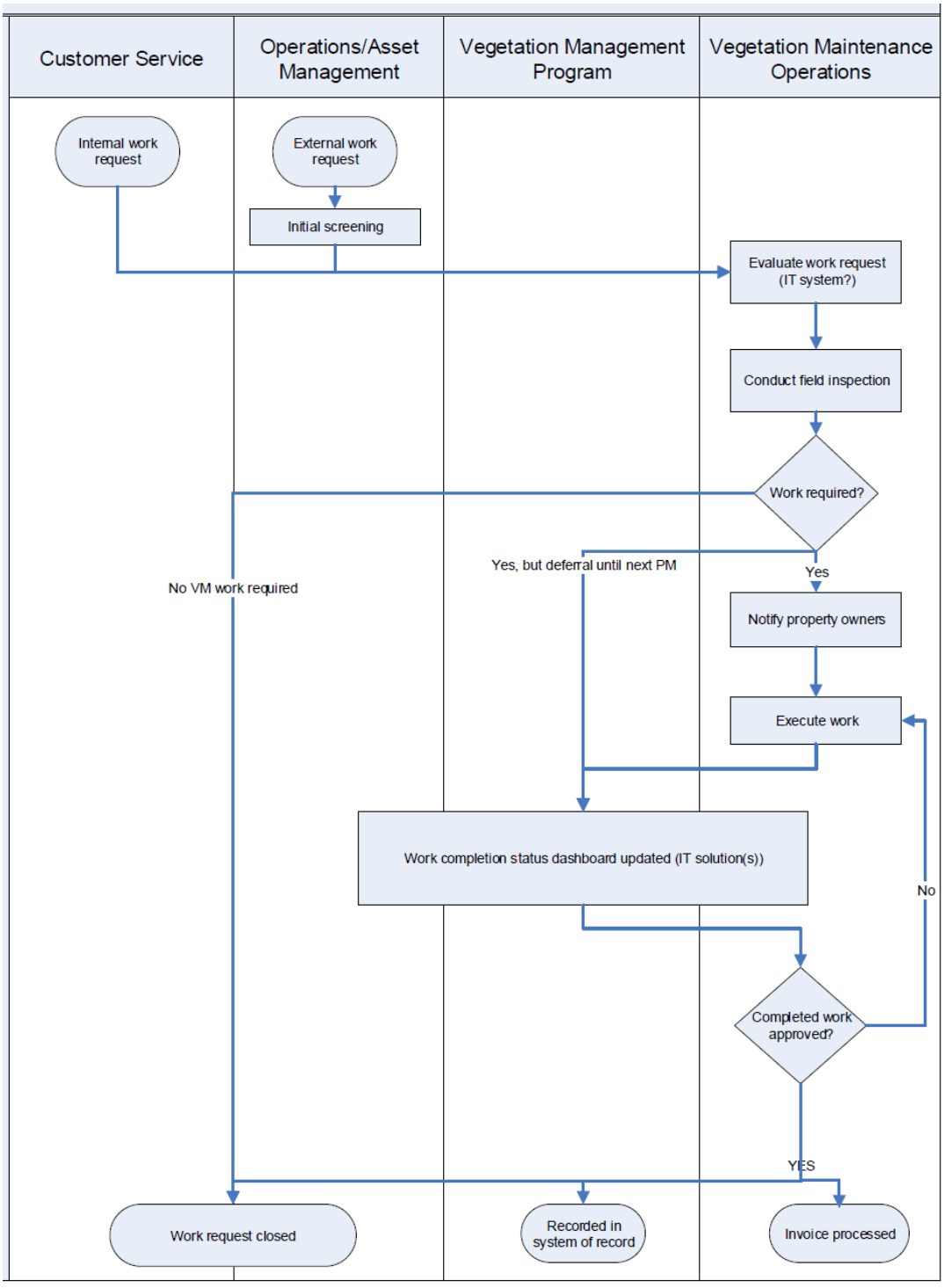


Figure C-4: Reactive Maintenance (Section 9.4)

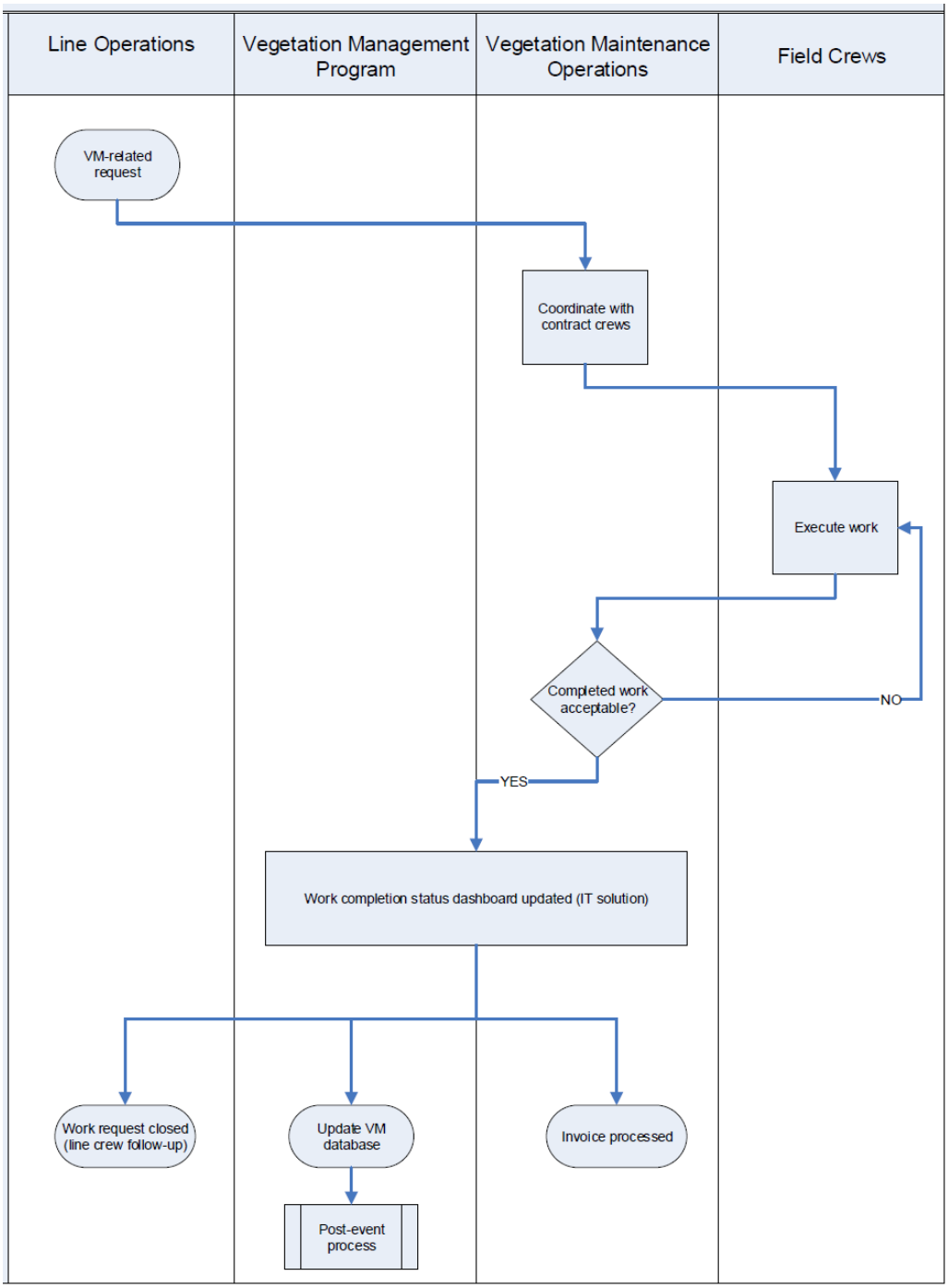


Figure C-5: Post Incident Investigations (Section 9.6)

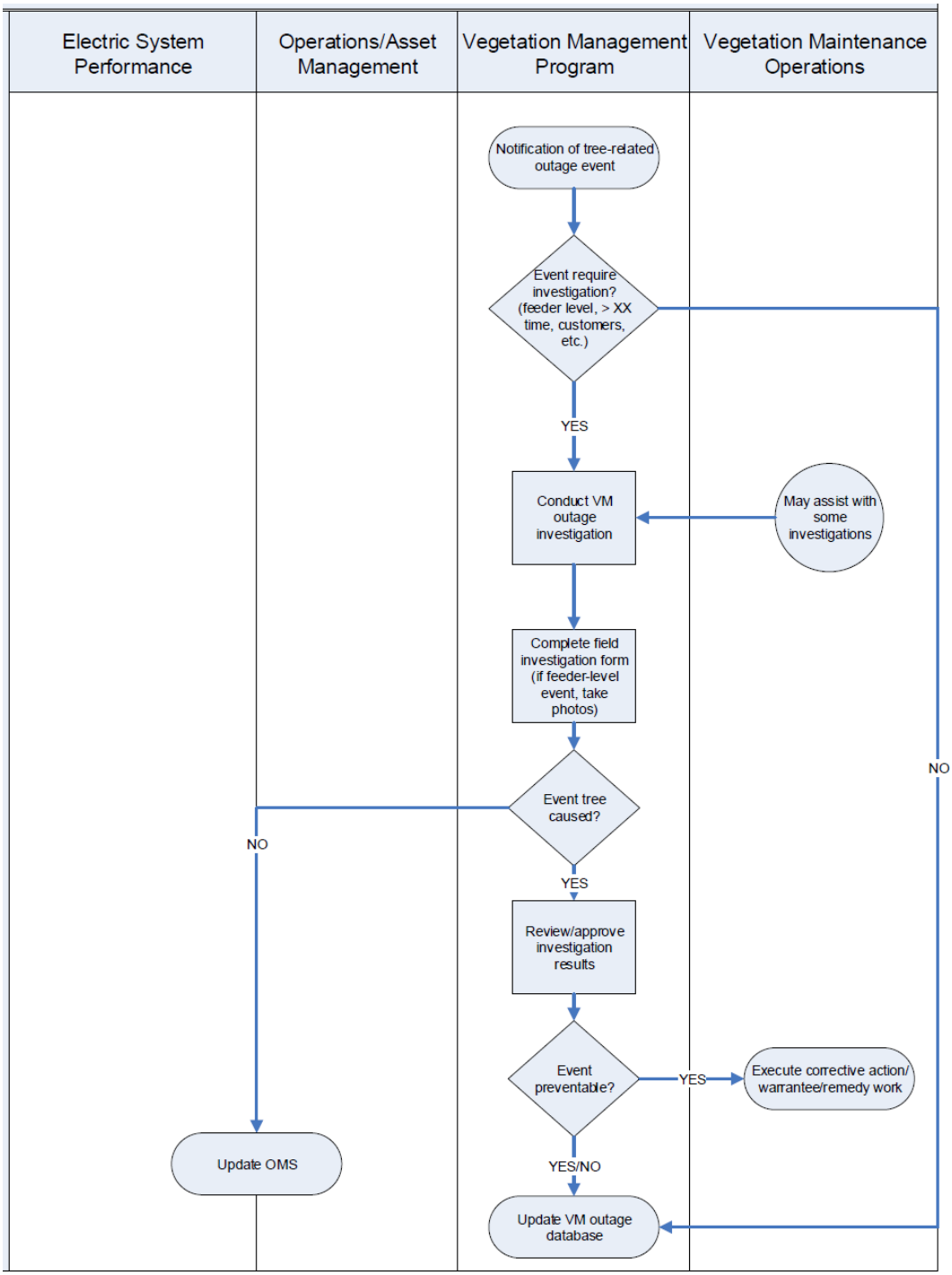


Figure C-6: Customer Refusals (Section 9.7)

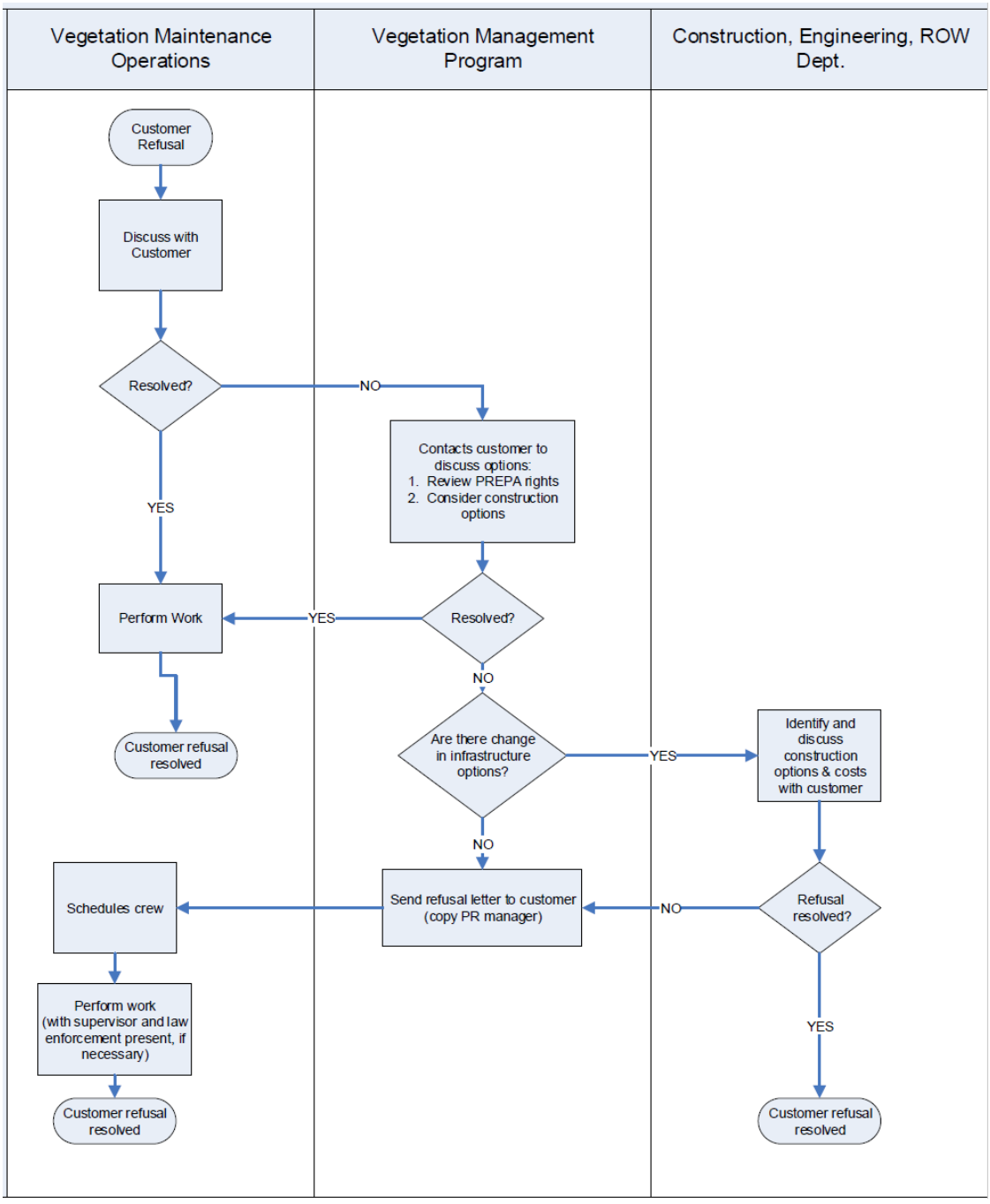


Figure C-7: Customer Complaints (Section 9.8)

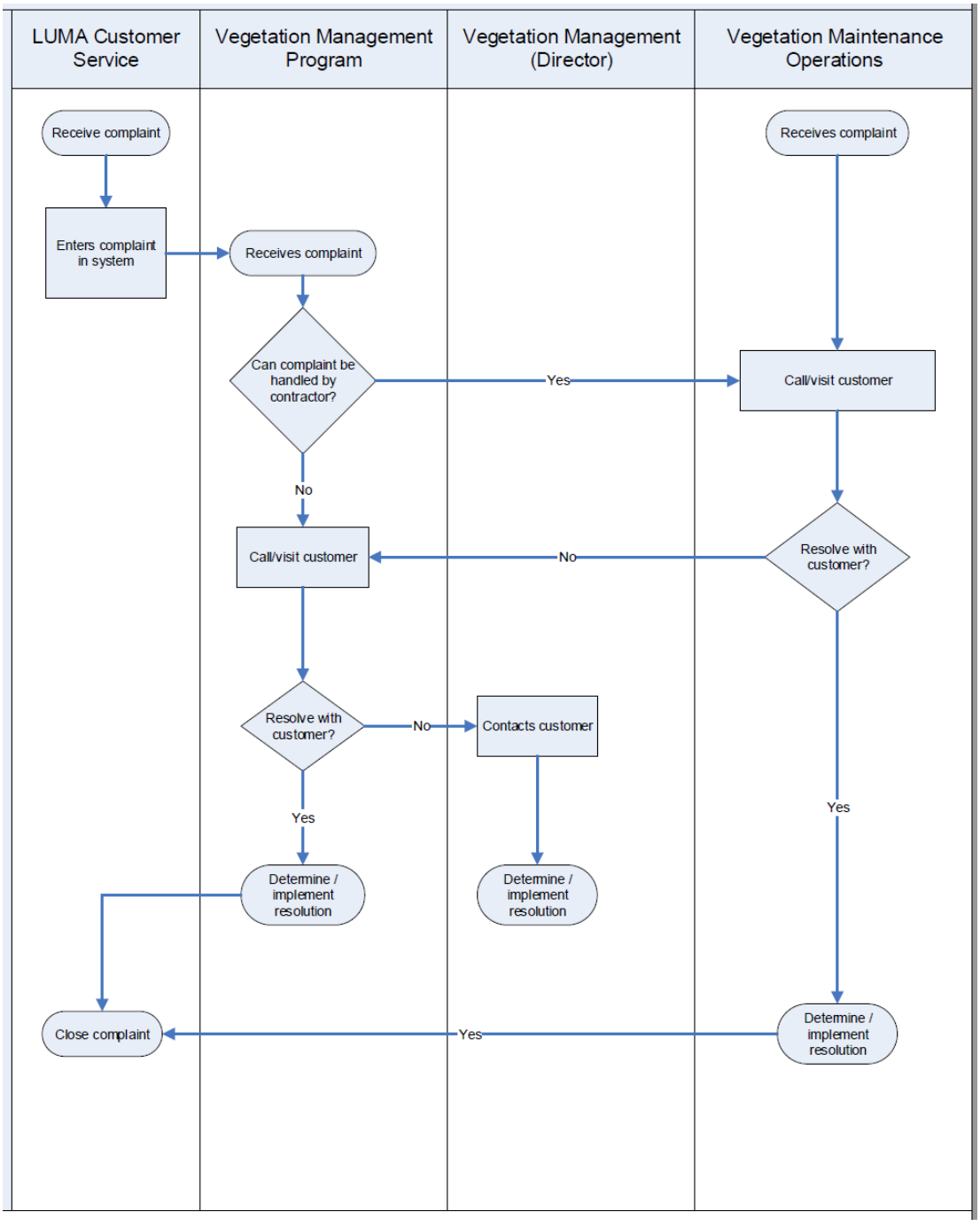
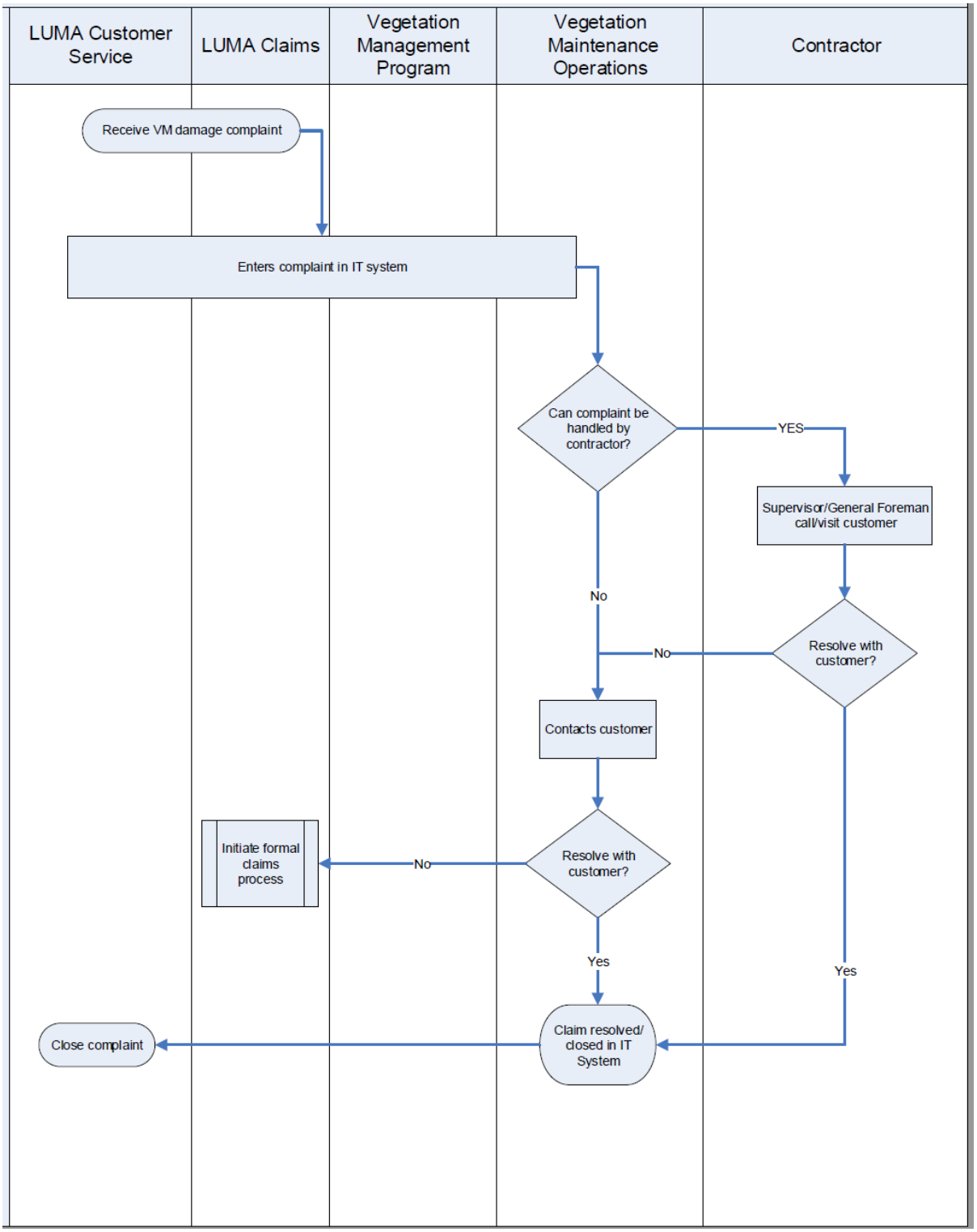


Figure C-8: Customer Damage Claims (Section 9.9)

Vegetation Management Plan



Appendix D: Distribution PM Timeframes

The following table provides the estimated timeframe / frequency for performing Preventive Vegetation Maintenance on the Distribution System (by Division, Region, District and Municipality) which will undergo refinement during implementation.

Division	Region	District	Municipio	Timeframe (yrs)
Isla	Arecibo	Utuado	Adjuntas	1
Isla	Mayaguez	Aguadilla	Aguada	1
Isa	Mayaguez	Mayaguez	Anasco	1
Metro	San Juan	Canovanas	Canovanas	1
Metro	Bayamon	Toa Baja	Catano	1
Isla	Arecibo	Vega Baja	Ciales	1
Isla	Arecibo	Barranquitas	Corozal	1
Metro	Bayamon	Guaynabo	Guaynabo	1
Isla	Arecibo	Arecibo	Hatillo	1
Isla	Mayaguez	Mayaguez	Hormigueros	1
Metro	Caguas	Humacao	Humacao	1
Isla	Arecibo	Utuado	Jayuya	1
Isla	Mayaguez	San Sebastian	Lares	1
Isla	Mayaguez	San Sebastian	Las Marias	1
Metro	Caguas	Humacao	Las Piedras	1
Metro	San Juan	Canovanas	Loiza	1
Metro	Caguas	Fajardo	Luquillo	1
Isla	Mayaguez	San Sebastian	Maricao	1
Isla	Mayaguez	Mayaguez	Mayaguez	1
Isla	Mayaguez	Aguadilla	Moca	1
Isla	Arecibo	Barranquitas	Morovis	1
Metro	Caguas	Humacao	Naguabo	1
Isla	Arecibo	Barranquitas	Orocovis	1
Metro	San Juan	Canovanas	Rio Grande	1
Metro	San Juan	San Jaun	San Juan	1
Isla	Mayaguez	San Sebastian	San Sebastian	1
Metro	San Juan	San Juan	Trujillo Alto	1
Isla	Arecibo	Utuado	Utuado	1
Metro	Caguas	Humacao	Yabucoa	1
Isla	Mayaguez	Aguadilla	Aguadilla	2
Metro	Caguas	Caguas	Aguas Buenas	2

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Division	Region	District	Municipio	Timeframe (yrs)
Isla	Arecibo	Barranquitas	Aibonito	2
Isla	Arecibo	Arecibo	Arecibo	2
Isla	Ponce	Guayama	Arroyo	2
Isla	Arecibo	Arecibo	Barceloneta	2
Isla	Arecibo	Barranquitas	Barranquitas	2
Metro	Bayamon	Bayamon	Bayamon	1,2
Metro	Caguas	Caguas	Caguas	2
Isla	Arecibo	Arecibo	Camuy	2
Metro	San Juan	Carolina	Carolina	2
Isla	Ponce	Cayey	Cayey	1,2
Metro	Caguas	Fajardo	Ceiba	2
Isla	Ponce	Cayey	Cidra	2
Isla	Arecibo	Barranquitas	Comerio	2
Metro	Bayamon	Toa Baja	Dorado	2
Metro	Caguas	Fajardo	Fajardo	2
Isla	Arecibo	Arecibo	Florida	2
Isla	Ponce	Guayama	Guayama	2
Metro	Caguas	Caguas	Gurabo	2
Isla	Arecibo	Arecibo	Isabela	1,2
Metro	Caguas	Caguas	Juncos	1,2
Isla	Arecibo	Vega Baja	Manati	2
Isla	Ponce	Guayama	Maunabo	1,2
Isla	Arecibo	Barranquitas	Naranjito	2
Isla	Ponce	Ponce	Ponce	2
Isla	Arecibo	Arecibo	Quebradillas	1,2
Isla	Mayaguez	Aguadilla	Rincon	2
Isla	Mayaguez	Mayaguez	Sabana Grande	1,2
Isla	Mayaguez	Mayaguez	San German	1,2
Metro	Caguas	Caguas	San Lorenzo	2
Metro	Bayamon	Toa Baja	Toa Alta	2
Metro	Bayamon	Toa Baja	Toa Baja	2
Isla	Arecibo	Vega Baja	Vega Alta	1,2
Isla	Arecibo	Vega Baja	Vega Baja	1,2
Isla	Ponce	Ponce	Villalba	2,3
Isla	Mayaguez	Yauco	Yauco	1,2,3
Isla	Mayaguez	Mayaguez	Cabo Rojo	3

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Division	Region	District	Municipio	Timeframe (yrs)
Isla	Ponce	Guayama	Coamo	3
Isla	Mayaguez	Yauco	Guanica	3
Isla	Mayaguez	Yauco	Guayanilla	3
Isla	Ponce	Ponce	Juana Diaz	3
Isla	Mayaguez	Mayaguez	Lajas	3
Isla	Ponce	Guaynabo	Patillas	3
Isla	Mayaguez	Yauco	Penuelas	3
Isla	Ponce	Guayama	Salinas	3
Isla	Ponce	Guayama	Santa Isabel	3
Metro	Caguas	Fajardo	Culebra	3
Metro	Caguas	Fajardo	Vieques	3