

GETTING THE LIGHTS BACK ON

The U.S. Army Corps of Engineers Responds to Hurricane Maria, 2017-2018

Jonah Bea-Taylor



US Army Corps
of Engineers

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On the covers: Prime Power transmission and distribution specialists with the 249th Engineering Battalion, D Company, repaired power lines in Rio Grande, Puerto Rico, Oct. 19, 2017. U.S. Air Force photos by M. Sgt. Joshua L. DeMotts.

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FOREWORD

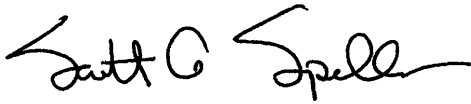
Hurricane Maria pummeled Puerto Rico on September 20, 2017, during an unprecedented season of overlapping natural disasters in the United States. Maria's catastrophic damage to Puerto Rico's electrical grid, and the lingering, island-wide power blackout that followed, created a truly daunting situation. The U S Army Corps of Engineers responded to these challenges with dedication and professionalism. When the nation called, the Corps stepped up.

Responding to the devastation in Puerto Rico, more than three thousand Corps personnel volunteered to assist their fellow Americans in need. They were part of a larger Unified Command supporting the Commonwealth of Puerto Rico, led by the Puerto Rico Electric Power Authority, the Federal Emergency Management Agency (FEMA), and representatives of the U S electric power industry. Together, the Corps and its partners delivered a world-class response to an extraordinary disaster.

Over the year following the storm, the Corps' persistent efforts to restore power in Puerto Rico included procuring more than 51 million replacement parts for the Unified Command - including 61,000 power poles and 8,400 miles of conductor wire. The Corps' mission included the installation of generators for temporary power at more than 1,200 critical facilities - four times more than in the aftermath of any previous storm. It also featured the Corps' first use of microgrids, which helped to turn the lights back on in nine isolated communities with 15,000 businesses and households. The Corps ruthlessly executed the mission of ensuring that even the most remote sites, across the island, were reconnected, often requiring the use of helicopter support to do so. At the height of the mission, the Corps was coordinating the work of more than four thousand contractors daily. FEMA allocated \$18 billion towards the Corps' work on grid repair alone.

Restoring the power in Puerto Rico required planning, logistical, engineering, contracting, and leadership capabilities unique to the Corps of Engineers. And although the

Corps assisted with recovery efforts in several ways, this book focuses on the story of the historic response to the electrical problems caused by Hurricane Maria in Puerto Rico. It describes the enormous challenges the Corps faced and how the talented and passionate people of the Corps always step up to engineer solutions to the nation's toughest challenges, especially in times of crisis. The innovation, hard work, and expertise of dedicated U.S. Army Corps of Engineers personnel was instrumental in turning the lights back on in Puerto Rico and for that I am immensely proud.

A handwritten signature in black ink, reading "Scott A. Spellmon". The signature is fluid and cursive, with the first name "Scott" and last name "Spellmon" clearly legible.

SCOTT A. SPELLMON

Lieutenant General, U.S. Army

Chief of Engineers

PREFACE

On September 20, 2017, Hurricane Maria roared across the island of Puerto Rico, causing catastrophic wind damage, flooding from torrential rainfall, and lasting power outages. Damage to the power grid was so widespread that almost the entire island was left without power. The resulting blackout would be the longest in U.S. history. It was impossible for many residents of rural areas to get to the remaining open medical facilities because of storm damage to mountain roads. Because of this enormous disruption to basic services and infrastructure, thousands of Americans would die over the next few months.¹ Maria exposed the vulnerability of many people who were living with very little and caused untold suffering in Puerto Rico. But the disaster also revealed the resourcefulness and resilience of Puerto Ricans and showcased the dedicated volunteerism of thousands of federal responders, power industry workers, and concerned individuals. The lights came back on all over Puerto Rico, community by community, month by month. A year after the storm, the island was still recovering, but the power was back on.

This book focuses on the role of the U.S. Army Corps of Engineers in the restoration of electric power. It highlights some of the challenges the agency faced and how it responded to those challenges. The Corps supported the efforts of the Puerto Rico Electric Power Authority to repair the vast majority of the island's electric transmission and distribution grid while maintaining electric service to those customers who had been reconnected. Despite being an unusual mission, one the agency had not attempted for more than a decade, it was an assignment the Corps eagerly received from the Federal Emergency Management Agency and the government of Puerto Rico. The Corps' vision is to engineer solutions to the nation's toughest challenges, and surely restoring power to millions of citizens in Puerto Rico was among those in 2017. This enthusiasm for helping fellow citizens, expressed by every volunteer and leader interviewed, is reflected in this account.

This book addresses only some elements of the larger response to Hurricane Maria in the U.S. territories in the Caribbean and only the first year of Puerto Rico's recovery, which as of 2020 is still far from complete. This narrative is compiled primarily from oral history interviews conducted by the Office of History, Headquarters, U.S. Army Corps of Engineers. It gives voice to some of the Corps personnel who were deeply involved in the response to Maria, but it is not comprehensive. Many dedicated Corps officers and employees could not be interviewed for this project.

Notes

¹ "Ascertainment of the Estimated Excess Mortality from Hurricane María in Puerto Rico," Milken Institute School of Public Health, the George Washington University, in collaboration with the University of Puerto Rico School of Public Health, 2018, 8-11, <https://publichealth.gwu.edu/sites/default/files/downloads/projects/PRstudy/Acertainment%20of%20the%20Estimated%20Excess%20Mortality%20from%20Hurricane%20Maria%20in%20Puerto%20Rico.pdf>

Timeline: Puerto Rico Power Restoration

2017

August	26 – Hurricane Harvey makes landfall in Texas.
September	6 – Hurricane Irma makes landfall in the U.S. Virgin Islands and Puerto Rico. 10 – Hurricane Irma makes landfall in the Florida keys. 20 – Hurricane Maria makes landfall in Puerto Rico. 30 – Official start of the U.S. Army Corps of Engineers power restoration mission.
October	1 – Approximately 5% of Puerto Rico Electric Power Authority (PREPA) normal peak electric load restored. 11 – Corps places first order for replacement parts on the bill of materials. 16-18 – Corps awards first grid repair contracts to Fluor and PowerSecure. 20 – One month post-landfall; 19% of normal peak load restored. 30 – Large gas turbine generators begin operating at Palo Seco power plant to stabilize power for the San Juan area. 31 – PREPA officially requests mutual assistance from other power companies.
November	7 – USNS <i>Brittin</i> arrives with critical equipment and some of the first order of parts on the bill of materials. 23-27 – Unified Command makes major reassessment of the parts needed to complete the bill of materials.
December	4-6 – Increase of initial grid repair contracts to \$461 million and award of additional contract to Fluor for \$495 million to dramatically increase capacity. 20 – Three months post-landfall; 65% of normal peak load restored.

2018

January	12-27 – The number of critical parts (poles, wire) available in Puerto Rico for installation on the grid doubles.
February	5-26 – Period of peak rate of power restoration; highest number of line crews (nearly 6,000 workers) and Corps personnel in Puerto Rico.
March	29 – Unified Command restores power to 95% of PREPA customers.
April	7 – Increase in PowerSecure contract to \$510.6 million to complete restoration in remote, mountainous areas.
May	18 – Corps' direct role in repairing power lines ends; power restored to 98.9% of PREPA customers.
June	Corps continues managing the bill of materials for PREPA, and Task Force Puerto Rico Recovery continues to assist with the lease, operation, and maintenance of two large generators at the Palo Seco power plant.
August	14 – 100% of eligible, pre-storm customers restored by PREPA and its contractors. Work rebuilding grid infrastructure continues.



On Sept. 19, 2017, Hurricane Maria approached Puerto Rico near maximum strength. Clouds obscure the Caribbean islands. (U.S. Naval Research Laboratory, Marine Meteorology Division)

INTRODUCTION

On September 20, 2017, Hurricane Maria made landfall on the southeast coast of Puerto Rico as the strongest storm to cross the island in more than eighty-five years.¹ With winds of 155 miles per hour, Maria ranked at the high end of Category 4 hurricanes, and the storm took a devastating path diagonally across the center of the whole island. While Puerto Rico has been brushed by many storms over the last century, only three major hurricanes (Category 3 or higher) followed a similar direct path across the commonwealth. For the Caribbean region as a whole, prior to Maria, the average rate of return for a Category 4 storm was almost twenty-five years, and for a Category 5 storm it was eighty-six years.² With more than \$90 billion in damages to Puerto Rico and the U.S. Virgin Islands, the National Oceanic and Atmospheric Administration lists Hurricane Maria as the third most expensive Atlantic storm in U.S. history after Hurricanes Katrina (2005) and Harvey (2017).³

Puerto Rico has a long history of devastating storms, and the last major storm to impact the island anywhere approaching the same extent was Hurricane Georges in 1998, which caused about \$6.4 billion in damages in the United States, including territories in the Caribbean.⁴ Before it struck Puerto Rico, Maria was the second Category 5 hurricane and the deadliest storm of the 2017 Atlantic hurricane season. At its peak in late September, Hurricane Maria caused catastrophic damage and numerous fatalities across the island nations and U.S. territories of the northeastern Caribbean, prolonging recovery efforts in the areas of the Leeward Islands that Hurricane Irma had struck weeks earlier.

The “hyperactive” 2017 hurricane season resulted in a series of disasters that would greatly stretch the resources that the U.S. Army Corps of Engineers (USACE) brings to emergency operations.⁵ Overall, it was the costliest year of weather-related disasters on record, with a total of \$306.2 billion in damages, almost \$100 billion greater than the damages wrought during 2005—the year of Hurricanes Katrina and Rita and previously



Geography of Puerto Rico

The main island of Puerto Rico is about 100 miles long by 35 miles wide at its farthest points—3,460 square miles of land in total—and about three times the size of Rhode Island.^a The Commonwealth of Puerto Rico also consists of over a hundred smaller islets, atolls, and cays, but only two—Vieques and Culebra—are populated. Puerto Rico is about one thousand miles from the U.S. mainland on the edge of the Caribbean Sea, about eighty miles east of the Dominican Republic and forty-five miles west of the U.S. Virgin Islands. Key ports include the capital San Juan, Ponce, Arecibo, and Mayagüez. The flight time between the closest mainland city, Miami, Florida, and San Juan is around two hours. After Hurricane Maria, almost all the non-containerized, bulk relief supplies arrived by barge to Puerto Rico, and ships took, at best, three days to travel the 1,121 nautical miles from Jacksonville, Florida, a key mainland barge port, to San Juan.^b

Puerto Rico has three main geographic regions: a mountainous interior, with the highest elevation at 4,390 feet; the coastal lowlands; and an area dominated by limestone rock erosion, called *karst*, in the northwest.^c The island has a marine tropical climate with rainfall on average eighteen days of the month and with a yearly mean temperature in the mid-80s during the day and mid-70s at night.^d The island boasts twelve hundred rivers and, surprisingly, no natural lakes, but twenty-one significant reservoirs provide water and hydroelectric power.^e Puerto Rico has almost 9,000 miles of roadways, divided into three networks, including about 250 miles of interstate highways that encircle the island and cross through the central mountains south of San Juan.^f

Puerto Rico is divided into seventy-eight municipalities, each governed by a mayor, a territorial type of organization that developed under Spanish colonial rule. Many municipalities include urban, suburban, and rural areas, although some are mostly rural with scattered small community centers. As a unit of local government, the municipality is equivalent to a county in the mainland United States.^g The Puerto Rico Electric Power Authority (PREPA) divides the island into seven power regions (further divided into twenty-six districts), with the number of clients in each region ranging from 140,000 to 300,000. PREPA counted 1.47 million clients before the storm.^h

Notes

a. U.S. Central Intelligence Agency, "Puerto Rico," *The World Factbook*, Last Updated January 23, 2019, <https://www.cia.gov/library/publications/resources/the-world-factbook/geos/rq.html>.

b. NOAA, *Distances Between United States Ports*, Office of Coast Survey, National Ocean Service, 13th ed., 2019, 10, <https://nauticalcharts.noaa.gov/publications/docs/distances.pdf>.

c. U.S. Geological Survey, "Elevations and Distances in the United States," 2001, Accessed January 29, 2019, <https://pubs.usgs.gov/gip/Elevations-Distances/elvadist.html>.

d. National Centers for Environmental Information, "Station Name: San Juan L M Marin International Airport," NOAA, Accessed January 29, 2019, <https://www.ncdc.noaa.gov/cdo-web/datasets/GHCND/stations/GHCND:RQW00011641/detail>.

e. Grupo Editorial EPRL, "Reservoirs of Puerto Rico," *Enciclopedia de Puerto Rico*, August 27, 2014, Accessed January 29, 2019, <https://enciclopediapr.org/en/encyclopedia/reservoirs-of-puerto-rico/>.

f. Autoridad de Carreteras y Transportación, "Guías para la Selección e Instalación de Rotulos de Orientación (Suplemento al MUTCD 2003)," Departamento de Transportación y Obras Públicas de Puerto Rico, December 22, 2004, 1, Archived from the original (PDF) on November 4, 2009.

g. Mercedes Casablanca, "About the Municipality: Past and Present," *Enciclopedia de Puerto Rico*, September 2, 2010, <https://enciclopediapr.org/en/encyclopedia/about-the-municipality-past-and-present/>.

h. Jeannine Anderson, "Incident management teams deploy in Puerto Rico, PREPA welcomes help," *American Public Power Association*, Disaster Response, <https://www.publicpower.org/periodical/article/incident-management-teams-deploy-puerto-rico-prepa-welcomes-help>; Puerto Rico Electric Power Authority (PREPA), "Resumen Regional (y por Distrito)," 20180403 REGIONAL MAP, April 3, 2018, Emergency Operations Collection, CEHO.

the most destructive.⁶ Within one month's time, the Federal Emergency Management Agency (FEMA) was responding to three major hurricanes, two of which hit the U.S. Virgin Islands and Puerto Rico within a two-week period. By the end of 2017, FEMA had registered more than 4.7 million survivors for individual assistance—more registrations than for Hurricanes Rita, Wilma, Katrina, and Sandy combined. The agency had also distributed more than \$2 billion in individual assistance to survivors, processed 133,000 flood insurance claims, and paid out more than \$6.3 billion to policyholders across the country.⁷ The cost of disasters in the United States was only increasing, and the federal government responded accordingly by increasing many forms of direct assistance.⁸

The last time the Corps had organized a response on any similar scale was five years previous when Hurricane Sandy churned up the mid-Atlantic coast in October 2012.⁹ In September 2017, Hurricanes Irma and Maria developed soon after Hurricane Harvey's historic rainfall had flooded the coast of southeast Texas. Irma impacted the Virgin Islands only twelve days after Harvey made landfall in Texas. Maria crossed Puerto Rico thirteen days later. This month-long period of three major hurricanes was followed by devastating wildfires in California only a couple of weeks later. It was this rapid sequence of overlapping disaster responses that challenged the Corps' contingency planning and ability to sustain the long recovery operations that followed. Of the federal disasters of late 2017, the Corps played an especially large role in the response to Hurricane Maria in terms of payments for goods and services related to the emergency operations.¹⁰

Maria devastated Puerto Rico, overwhelmed the commonwealth's emergency response capacities, and required the Corps to undertake many of its standard emergency support missions for FEMA, including temporary roofing, temporary emergency power, debris management, and critical infrastructure assessment.¹¹ Over the course of a year, the Corps made more than three thousand personnel assignments in support of missions in Puerto Rico. The majority of these personnel were civilians who had other, full-time job duties in their home districts that were set aside when they volunteered to deploy. The standard support rotation was one month, but some volunteers extended their tours to 60 or 90 days—with a few working for over 120 days. Others went to Puerto Rico more than once to support vital missions during the long recovery.¹² Both civilian volunteers and active-duty military personnel worked at least twelve hours a day, seven days a week. Some of the recovery missions were carried out on an unprecedented scale. For example, the more than thirteen hundred generators installed by the Corps by July 2018 to provide emergency power at critical facilities were more than had been needed for Hurricanes Katrina, Rita, and Sandy combined.¹³ Recognizing Puerto Rico's importance to the entire Corps of Engineers, Michael Ornella, Sr., a deputy district engineer for the Corps' Task Force Power Restoration, an ad hoc organization USACE established to execute repairs to the island's electrical grid, compared it to the "Super Bowl" of emergency responses. "I

always like that [comparison] because it really paints the picture of how big the emergency response in Puerto Rico was, in particular the response to restore the grid,” explained Ornella, who had already deployed to eleven disasters during his thirty-five-year career, “So if you do this type of work, you want to deploy to help people, to help your fellow Americans, why wouldn’t you want to be in the Super Bowl?”¹⁴

The island-wide power failure that followed the storm was the largest blackout in U.S. history.¹⁵ The damage to the island’s electrical system was so extensive it was challenging to even map which lines were still standing.¹⁶ Although it was several weeks after the storm before a large number of Corps personnel were actively involved in restoring power in Puerto Rico, the grid repair mission became the most intense focus of all the Corps’ Hurricane Maria recovery efforts by mid-October 2017.¹⁷ It took eight months for the Puerto Rico Electric Power Authority (PREPA), the Corps, their respective contractors, and mainland power companies to restore electricity to 98 percent of the commonwealth’s households and businesses, which numbered nearly 1.5 million before the storm. By mid-May 2018, when the Corps work directly repairing power lines came to an end, FEMA had allocated nearly \$2 billion to the power restoration program alone.¹⁸

In sheer numbers, grid repair and electric service restoration was a staggering mission. Puerto Rico has twenty-four hundred miles of transmission lines across the island and thirty thousand miles of distribution lines with three hundred sub-stations. PREPA estimated that 80 percent of the grid was affected by Hurricanes Irma and Maria.¹⁹ By late May 2018 when PREPA took over the work on the transmission and distribution lines from the Corps’ Task Force Power Restoration (commonly shortened to Task Force Power), the Corps had received more than thirty-five million pieces of material—parts, supplies, and equipment—to repair the grid. These included 52,427 power poles and 5,795 miles of conductor wire.²⁰ If they were lined up end-to-end, the new poles would stretch the length of the state of Florida, and the wire the Corps purchased was enough to connect Washington, D.C., to London.²¹ Almost all this material had to be shipped from mainland ports, and many components had to be manufactured from scratch.

Reflecting on the compounding urgency that defined the Corps’ response to Hurricane Maria, Brig. Gen . Diana M . Holland, commander of the Corps’ South Atlantic Division, explained that it was a disaster of failed infrastructure that unfolded over weeks and months, long after the hurricane season was over. “When you’re not there going through that, you’re thinking, well, the hurricane has passed, and now it’s just a response to the hurricane,” Holland emphasized. “No, every day is a new crisis, and every day that we can’t provide shelter or can’t put a roof over [someone], or can’t provide power generation, is a new crisis for people.... Every day you must make progress Every day you must find a solution, and every day we need supplies.”²²

Notes

¹ Richard J. Pasch, Andrew B. Penny, and Robbie Berg, “Tropical Cyclone Report: Hurricane Maria (AL152017),” National Hurricane Center, April 10, 2018, 4, https://www.nhc.noaa.gov/data/tcr/AL152017_Maria.pdf

² “FEMA Region II Hurricane Annex for Puerto Rico & US Virgin Islands,” Federal Emergency Management Agency, October 20, 2014, 34, <https://www.dhs.gov/sites/default/files/publications/FEMA%20Region%20II%20Hurricane%20Annex%20for%20Puerto%20Rico%20and%20US%20Virgin%20Islands-%20Oc.pdf>

³ Pasch, Penny, and Berg, “Tropical Cyclone Report: Hurricane Maria,” 1

⁴ John L. Guiney, “Preliminary Report Hurricane Georges: 15 September-01 October 1998,” National Hurricane Center, January 1999 (Updated September 2014), 7, https://www.nhc.noaa.gov/data/tcr/AL071998_Georges.pdf

⁵ Interview, Maj. Gen. Donald E. Jackson, Jr., Deputy Commanding General for Civil and Emergency Operations, HQUSACE, by Jonah Bea-Taylor and James Garber, HQUSACE, Washington, DC, December 20, 2017, 3, Oral History Collection, Office of History, HQUSACE, Alexandria, Virginia [Hereafter cited as CEHO]

⁶ “Hurricane Costs,” Office for Coastal Management, National Oceanic and Atmospheric Administration, Last Modified July 10, 2019, <https://coast.noaa.gov/states/fast-facts/hurricane-costs.html>

⁷ “Written testimony of FEMA Office of Response and Recovery Associate Administrator Jeff Byard for a House Committee on Energy and Commerce, Subcommittee on Oversight and Investigations hearing titled ‘Update on the Restoration of Puerto Rico’s Electric Infrastructure,’” April 11, 2018, Testimony, News, U.S. Department of Homeland Security, <https://www.dhs.gov/news/2018/04/11/written-testimony-fema-house-energy-and-commerce-subcommittee-oversight-and>

⁸ “2017 Hurricanes and Wildfires: Initial Observations on the Federal Response and Key Recovery Challenges,” Report GAO-18-472, U.S. Government Accountability Office (GAO), September 4, 2018, 2, <https://www.gao.gov/products/GAO-18-472>

⁹ “Hurricane Sandy C2 AAR,” Historian Notes, HQUSACE, January 28, 2013, Emergency Operations Collection, CEHO

¹⁰ “2017 Hurricanes and Wildfires,” 86. As of January 31, 2018, of the \$3.83 billion in federal funds obligated through contracts for the response to Hurricane Maria, the U.S. Army Corps of Engineers (Corps) was responsible for 50%. While the Corps’ role in the earlier 2017 storms, Hurricanes Harvey and Irma, was critical, it was not as significant in expenditures. The agency was responsible for procuring less than 5% of the goods and services in each of those cases.

¹¹ USACE Operations Center (UOC) Staff, “U.S. Army Corps of Engineers Contingency Ops Dashboard,” Hurricane Maria FEMA MA Log, September 21, 2017, 34, Emergency Operations Collection, CEHO

¹² Task Force Puerto Rico Recovery, “Puerto Rico Hurricane Response: One Year Later,” Infographic, Emergency Operations Collection, CEHO; South Atlantic Division Forward, “Deployment Tour Limits, Puerto Rico and U.S. Virgin Islands,” Memorandum, November 16, 2017, Emergency Operations Collection, CEHO

¹³ Jeff Hawk, “Pittsburgh District team deploys to Puerto Rico again,” News Releases, USACE Pittsburgh District, July 13, 2018, <https://www.lrp.usace.army.mil/Media/News-Releases/Article/1574649/pittsburgh-district-team-deploys-to-puerto-rico-again/>. By July 2018 many generators had been removed for maintenance while another was installed in that same location, leading to a total number of generators greater than the number of critical facilities that needed temporary power. The number of generators required was one of the unique challenges of Puerto Rico’s extended blackout that was unprecedented compared to earlier disasters in the mainland United States.

¹⁴ Interview, Michael Ornella, Sr., Deputy District Engineer, Task Force Power Restoration, by Jonah Bea-Taylor, by phone, June 27, 2018, 4, CEHO. According to Ornella, Franklin D. Ford, emergency planner and later Officer in Charge of Task Force Power’s Materials Section, was the first to call the Corps’ disaster response to Hurricane Maria the “Super Bowl” of emergency operations because of its scale and importance to the emergency management community.

¹⁵ Trevor Houser and Peter Marsters, “The World’s Second Largest Blackout,” Report, Rhodium Group, April 12, 2018, <https://rhg.com/research/puerto-rico-hurricane-maria-worlds-second-largest-blackout/>

¹⁶ Interview, José Sánchez, South Atlantic Division (SAD) Power Program Director, by James Garber and Jonah Bea-Taylor, HQUSACE, Part 1, April 9, 2018, 3, CEHO

¹⁷ Interview, Col. James DeLapp, Recovery Field Office (RFO) Commander, by Matthew Percy and James Garber, San Juan, Puerto Rico, October 18, 2017, 42, CEHO

¹⁸ FEMA and Task Force Power, “20180518 ESF Power Restoration SITREP,” Situation Report, May 18, 2018, 1, Emergency Operations Collection, CEHO; “Fact Sheet: Obligated Funding for Puerto Rico,” FEMA, September 10, 2018, <https://www.fema.gov/news-release/2018/09/10/fact-sheet-obligated-funding-puerto-rico>. FEMA also allocated an additional \$1.5 billion in direct assistance to PREPA, as an agency of the Puerto Rican government, for “emergency protective measures” to restore power.

¹⁹ Maria Gallucci, “Rebuilding Puerto Rico’s Power Grid: The Inside Story,” IEEE Spectrum, March 12, 2018, <https://spectrum.ieee.org/energy/policy/rebuilding-puerto-ricos-power-grid-the-inside-story>

²⁰ HQUSACE Public Affairs, “Talking Points for USACE Puerto Rico Power Grid Repair Mission,” May 18, 2018, Emergency Operations Collection, CEHO

²¹ Interview, Michael Ornella, Sr. (2018), 27-28

²² Interview, Brig. Gen. Diana Holland, Commander, USACE South Atlantic Division (SAD), by Matt Percy and James Garber, San Juan, Puerto Rico, October 19, 2017, 24-25, CEHO

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The flags of Puerto Rico and the United States flew at half staff at Puerto Rico National Cemetery in Bayamón, Oct. 27, 2017. (U.S. Navy)

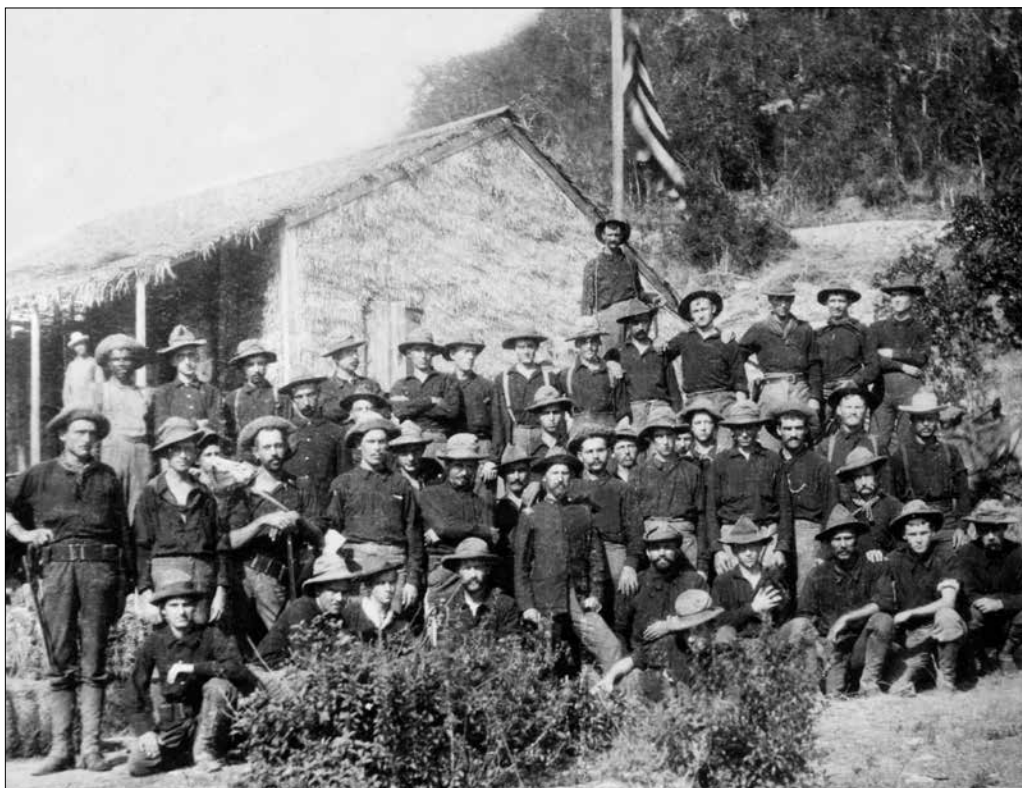
— CHAPTER 1 —

THE DISASTER IN HISTORICAL CONTEXT

When Hurricane Maria's powerful winds tore across Puerto Rico, they ripped apart electric transmission and distribution infrastructure that was especially vulnerable because years of basic maintenance had been deferred. The Puerto Rico Electric Power Authority (PREPA) had not carried out basic upkeep, such as clearing away encroaching tropical vegetation around lines and replacing corroded guy-wire anchors that stabilized transmission towers.¹ Because Hurricane Maria was nearly a Category 5 storm at landfall, it was bound to cause widespread damage in any environment. However, the island-wide blackout and months-long effort needed to repair the devastated electrical grid resulted from a worst-case confluence of unfortunate circumstances: the spiraling debt of the Puerto Rican government, an exodus of skilled utility workers from the island, and years of inadequate investment in infrastructure by PREPA. In 2016, the Puerto Rico Energy Commission commissioned an outside evaluation of PREPA to understand the state of its operations and finances. The experts' assessment was blunt: "We find that PREPA is in dire need of a capital infusion: monetary capital to pay for maintenance and ensure the system is operational; human capital to adequately staff generation and transmission equipment; and intellectual capital to strategically deploy PREPA's limited resources to break out of a cycle of disrepair and transition the fleet to a cleaner, more reliable system."²

Puerto Rico's Historic Relationship with the United States

Why would Puerto Rico's government-run electrical utility defer so many years of critical operations and maintenance investments in its power system? Part of the answer to that question lies in the history of the island's unusual relationship to the United States and the economic challenges the government of the Commonwealth of Puerto Rico faced beginning in the 1970s.



Company H, 1st Provisional Battalion of Engineers, near Guánica Bay, where U.S. forces landed on the southern shore of Puerto Rico, Jul. 1898. (Office of History, Headquarters, U.S. Army Corps of Engineers (CEHO), Gift of Reginald B. Looker)

Since the era of European colonization, Puerto Rico has never been fully independent as its own nation, nor has it ever been fully integrated into another one. Puerto Rico was one of Spain's first colonies in the New World, with the earliest European settlement taking place in 1493.³ It remained a Spanish colony for the next four hundred years, gaining some autonomy but never securing independence like most of Spain's possessions in Latin America did in the nineteenth century. Following the Spanish–American War, the 1898 Treaty of Paris ceded Spain's possession of Puerto Rico, Guam, and the Philippines to the United States.⁴ For eighteen months, Puerto Rico was under a U.S. military government. During the early months of American military occupation, the Corps of Engineers began its first projects on the island, including building roads from key ports into agricultural areas along the coast, clearing shipwrecks from San Juan harbor, and rebuilding fortifications.⁵ The Foraker Act of 1900 created a civilian government on the island, with a governor and executive council appointed by the U.S. president but with a locally-elected House of Representatives of thirty-five members and a resident commissioner who would have a non-voting seat in the U.S. Congress.⁶

Puerto Rico Becomes a Territory of the United States

When the United States ended military rule on the island, it was still unclear if Puerto Rico would become an American colony like the Philippines, a U.S. territory with a path to statehood like Hawaii, or something else entirely. In the 1901 case of *Downes v. Bidwell*—one of the “Insular Cases” that attempted to define the relationship between the United States and the islands it had seized from Spain—the Supreme Court confusingly categorized Puerto Rico as an “unincorporated territory.”⁷ It “belonged to” the United States, but critically, it was not “part of” the United States. For taxation purposes, Puerto Rico was treated like a foreign country. The Insular Cases created a unique legal status and prospective for Puerto Rico, one that differed from how U.S. territories had been established in the past, such as recently-annexed Hawaii, which would eventually become a state.

In 1917, after nearly two decades of American control, many young Puerto Ricans became U.S. citizens as a result of the Jones-Shafroth Act. The act, signed into law by President Woodrow Wilson, was largely responding to U.S. strategic interests in the Caribbean and manpower needs as the country entered World War I, but it only complicated the status of Puerto Rico.⁸ The Jones-Shafroth Act superseded the Foraker Act and granted U.S. citizenship to anyone born in Puerto Rico on or after April 25, 1898. It also created a popularly-elected Senate for Puerto Rico, expanded the territory’s House of Representatives, and established a bill of rights. The new law also mandated that Puerto Rican bonds be completely tax-exempt. Since no outside government could levy taxes on Puerto Rican debt, it created a precedent for a type of investment that would remain desirable, even when the island’s economy was struggling.⁹

After World War I, the Merchant Marine Act of 1920 mandated that goods transported by ship from one U.S. destination to another be carried on U.S.-flagged ships that were constructed in the United States, owned by American citizens, and crewed mostly by U.S. legal permanent residents and citizens.¹⁰ The purpose of the Merchant Marine Act was to make sure there was a viable U.S. merchant marine fleet should it be needed again in wartime. Despite the protections created by the act, the U.S. Merchant Marine fleet remains significantly smaller, in terms of ships and tonnage, and less competitive globally, than overseas shipping powerhouses such as Greece, Japan, China, and Germany.¹¹ The Merchant Marine Act (also called the Jones Act) has often been set aside in the wake of major disasters.¹² After Hurricane Maria, Department of Homeland Security (DHS) Acting Secretary Elaine Duke waived the Merchant Marine Act for Puerto Rico on September 28, 2017. The administration allowed that waiver to expire after ten days, on October 8.¹³

A Change of Status: The Commonwealth of Puerto Rico

After World War II, all Puerto Ricans were citizens of the United States, many of them veterans, but they still could not elect their own governor; and the territorial legislature’s

powers were very limited. The postwar world, however, saw widespread anticolonial movements, and American territories were not excluded from the popular drive for greater autonomy.¹⁴ In 1947 Congress moved to give Puerto Ricans a greater measure of self-governance and ended forty-seven years of territorial governors appointed by the president. The first democratically elected governor of Puerto Rico, Luis Muñoz Marín, took office in 1949. In July 1950 Congress approved and President Harry Truman signed Public Law 600 which allowed the island to adopt its own constitution as long as it did not change the rules governing its relationship with the United States.¹⁵ In particular, the U.S. Congress would remain in charge of areas such as “citizenship, immigration, coast-wise shipping, commercial treaties and foreign relations.”¹⁶ The new constitution, calling for an *Estado Libre Asociado*—“Associated Free State,” translated more commonly as the Commonwealth of Puerto Rico—was adopted in 1952.

The commonwealth status was an arrangement that Muñoz Marín had championed in the late 1940s as president of the Puerto Rican Senate.¹⁷ After 1952, Puerto Rico moved to reframe its relationship with the United States from that of a federally-controlled territory to a “compact” with a sovereign commonwealth. In practice, Congress remained in control of the island. Puerto Rico did not have the privileges and responsibilities of a U.S. state, but it did have self-governance in certain areas such as local elections and finance.¹⁸ While Puerto Rico’s autonomy remained limited, it could still benefit from business investment from the mainland United States by investors who took advantage of the unusual territorial status.

Economic Development and Operation Bootstrap

In Puerto Rico before World War II, economic development was minimal, and agriculture dominated the economy. Sugar had long been its top export, even as the island competed with other U.S. territories in that market. In the late 1940s, the Puerto Rican Administration of Economic Development designed a program of aid and tax incentives to the island, called *Operation Bootstrap*, to spur modernization.¹⁹ Governor Rexford Tugwell, an economist and former New Deal agricultural planner appointed by President Franklin Roosevelt, threw his weight behind the program. Under *Operation Bootstrap*, U.S. manufacturers could take advantage of lower labor costs on the island and pay no federal taxes on their profits. In practice this facilitated a shift on the island towards industrial jobs, which continued into the 1960s.

With both economic incentives and major federal expenditures for wartime facilities on the island, Puerto Rico experienced rapid economic growth during World War II. Federal expenditures in 1940 were only \$20.6 million, but by 1945 wartime government spending peaked at \$133 million (about \$1.8 billion in 2017 dollars).²⁰ During the 1950s, gross national product (GNP) growth on the island was slightly greater than 5 percent

annually, and in the early 1960s, it increased to 7 percent—significantly higher than the average annual increase in total U.S. gross domestic product during the same period, which was around 4.5 percent.²¹ Some of the postwar GNP growth translated into better wages for Puerto Rican workers in new manufacturing jobs.²²

Industrialization also disrupted traditional farming and craft production in the countryside. Many rural Puerto Ricans moved to cities such as San Juan and Ponce. They also migrated to the U.S. mainland in growing numbers. Migration levels peaked between 1950 and 1960, when 470,000 Puerto Ricans relocated to major U.S. cities such as New York and Chicago.²³ Similar levels of migration were reached again after 2010.²⁴ Hurricane Maria only exacerbated this trend.

Because of the growth of opportunities for Puerto Ricans both on the island and on the mainland, the semiautonomous, special “commonwealth” arrangement with the United States remained popular during this period. Governor Muñoz Marín remained in office until 1965, when he retired. In November 1968, Puerto Ricans elected Luis A. Ferré as governor. An engineer and industrialist representing the pro-statehood New Progressive Party, Ferré was only the third politician to be democratically elected to the governorship. The election was the first-ever defeat for the Popular Democratic Party that had been in power since 1940 and had worked to create and maintain the self-governing status arrangement between the United States and the island. Over the next fifty years, Puerto Rican politics would remain intensely divided between upholding the status quo territorial status of the commonwealth and trying to move towards full statehood.²⁵

Origins of the Debt Crisis: 1976–2016

By the late 1960s, the heady economic growth created by World War II and the shift away from agriculture towards industrial development had fizzled out. The basic challenge Puerto Rico faced after the end of *Operation Bootstrap* was generating enough revenue to adequately fund government services and infrastructure investments. The debt crisis that so eroded PREPA’s ability to maintain the island’s electrical grid has its origins in this gap between what the government raised and what it spent.

One effort to encourage continued investment in and industrialization of the island and to help the struggling economy was implementation of a business tax credit, essentially an evolution of *Operation Bootstrap*.²⁶ Enacted in 1976, section 936 of the U.S. tax code, known as the “Possession Credit,” exempted mainland companies from paying federal taxes on profits earned in Puerto Rico and other U.S. territories.²⁷ Section 936 did attract industry to the island, especially mainland pharmaceutical companies. Notably, however, it created an unfair playing field for companies actually based in Puerto Rico, which were not eligible for the credit. Writing in 2007 about the effects of these tax incentives, Brookings Institution economists Barry Bosworth and Susan Collins argued that “U.S. tax policy has

done a disservice to Puerto Rico by providing U.S. corporations incentives for investments with few or no employment or local linkages.”²⁸

Section 936 tax credits may have helped some segments of the island’s economy, but the overall results were not positive. By the early 1980s, Puerto Rico’s growth in GNP had fallen to just 2.1 percent and unemployment rose to 23.5 percent (the overall U.S. unemployment rate peaked at 10.8 percent in late 1982).²⁹ Federal aid to individuals in Puerto Rico increased dramatically. So did the number of employees working for Puerto Rico’s commonwealth government.³⁰ By 1990, almost 25 percent of the labor force was employed by the local and commonwealth governments (in the United States overall, about 13 percent of the nonfarm workforce was employed by local, state, and federal government during that period).³¹ Puerto Rico’s employment rate actually peaked in 2006, the year the tax credits fully expired, partly due to migration to the mainland. Meanwhile, during the 1990s, the commonwealth’s debt grew more quickly than GNP.³²

In 1996, the Bill Clinton administration began a process that would completely phase out the Section 936 tax credits over the next decade.³³ During that time, one-fourth of Puerto Rico’s manufacturing jobs disappeared.³⁴ The commonwealth government did not, however, do much to reduce its spending during this period. Similar to several U.S. states and cities during the same decade, such as Illinois and Detroit, Puerto Rico had massive public employee pension obligations. By 2004, there were \$11 billion in unfunded liabilities from the pension system alone.³⁵

Four years later the U.S. economy went into recession. After 2008 all types of mainland U.S. investment in the island rapidly declined, and Puerto Rico’s government revenues dried up. Again, as the island’s economy contracted more rapidly, the commonwealth government did not reduce the bulk of its spending. At first, the Puerto Rican government tried to make up for the shortfall by issuing bonds, especially to cover growing deficits in its operating budget.³⁶ The municipal bond market was particularly friendly to Puerto Rican government debt because the island’s bonds carried a slightly higher interest rate and they were tax-exempt. Adding Puerto Rican government debt to bond funds became a “money-making machine” for large banks in New York and on the island.³⁷

But selling more and more bonds could not make up for an economy in decline. As U.S. citizens, Puerto Ricans could move freely to the mainland to seek better jobs, and between 2000 and 2010, the island lost half a million residents. Puerto Rico’s total population decreased by almost eighty-three thousand to 3.7 million.³⁸ Between 2007 and 2017 Puerto Rico’s GNP fell by 14 percent, and in 2015, 46 percent of the population lived below the federal poverty line, compared to the U.S. national average of 15 percent. By 2013, it was clear that the island’s economy would not start growing again on its own, and if the government did not cut back on its spending, the commonwealth might default on its debt payments. Bond prices fell.

Along with massive pension obligations, a slowing economy, and migration, there were other factors unique to Puerto Rico that contributed to the commonwealth's fiscal crisis. Widespread tax evasion reduced the government's revenue and therefore its ability to finance operations. Unpaid taxes were estimated at nearly 30 percent of actual commonwealth income tax revenues in 1987 and nearly 25 percent of revenues in 1992. That percentage steadily declined during the 1990s as the government more aggressively collected taxes from sources other than payroll.³⁹

As a U.S. territory, Puerto Rico had to spend a disproportionate amount of its own revenues on health programs for low-income people compared to the fifty states.⁴⁰ A 1968 law set a 50 percent cap on how much the federal government could pay to territories for Medicaid. For Puerto Rico, that amounted to a \$20 million block grant. Even though that grant grew over the following decades, in 2015 it only amounted to \$329 million, or about 14 percent of Puerto Rico's total Medicaid costs that year.⁴¹ Starting in 2011, additional funding from the Affordable Care Act raised the overall federal contribution considerably—to about 64 percent of the total.⁴² While young, healthy people with higher incomes began to move in increasing numbers to the mainland, the remaining population remained dependent on federal programs. By 2015, almost half the island's residents—1.6 million people—depended on Medicaid.

As its debt grew and revenues shrank, Puerto Rico's fiscal crisis became acute. In February 2014, Standard & Poor's credit rating agency downgraded several of the commonwealth government's bonds below investment-grade to "junk-bond status" as concerns rose about the government's nearly \$70 billion of debt.⁴³ Over a matter of a few months, the market for Puerto Rico's debt began to dry up. Without a way to sell the bonds at reasonable interest rates in the municipal market, the commonwealth would run out of cash to cover its expenses. The government began using its savings to make payments on the debt, and it warned that those savings would soon run out. In August 2015, Puerto Rico defaulted on a major bond payment.⁴⁴

Using its power over U.S. territories, Congress intervened in June the following year, passing the Puerto Rico Oversight, Management, and Economic Stability Act (PROMESA) to restructure the island's debt, create an oversight board, and accelerate certain infrastructure projects.⁴⁵ PROMESA emphasized reducing the costs of electricity and diversifying the types of power generation used on the island.⁴⁶ Meanwhile, the federally appointed Financial Oversight and Management Board began to enforce austerity policies. The board pushed the commonwealth's government to increase revenues and reduce its expenses by raising taxes while curtailing public services and reducing workers' benefits. Those measures further compounded the crisis by provoking social distrust and unrest, which resulted in a series of protests across Puerto Rico beginning in May 2017.⁴⁷ That same month, the board moved the island towards a form of bankruptcy protection. With

nearly \$74 billion in bond debt and \$49 billion in unfunded pension obligations in 2017, the Commonwealth of Puerto Rico filed for a type of court-supervised debt restructuring process similar to those that cities such as Detroit, Michigan, and Stockton, California, had sought when they defaulted. It was the first time in U.S. history that an American state or territory had been forced to take such an extreme course of action.⁴⁸

PREPA Struggles to Maintain the Grid

The story of Puerto Rico's government debt overlaps with PREPA's failure to properly maintain the island's electrical grid. The power authority, a state-owned utility, was founded originally as an extension of mainland New Deal-era hydroelectric programs under Governor Rexford Tugwell. On May 2, 1941, the Puerto Rico legislature nationalized the island's private utilities and created the Puerto Rico Water Resources Authority, which became the Puerto Rico Electric Power Authority in 1979.⁴⁹ As a state monopoly, PREPA has provided free electricity to local governments and government-owned businesses for years.⁵⁰ In its power generation portfolio, PREPA mostly has relatively expensive and aging oil-fired power plants.⁵¹ In the first half of 2017, 47 percent of Puerto Rico's electricity came from petroleum, 34 percent from natural gas, 17 percent from coal, and only 2 percent from renewable energy. As of June 2018, average residential electricity prices on the island were significantly higher than every U.S. state except for Hawaii and Alaska: 21.24 cents/kWh compared to the U.S. average of 13.02 cents/kWh.⁵²

Operation Bootstrap and the tax incentives of the 1970s had attracted petrochemical plants and later pharmaceutical makers to Puerto Rico, and they developed factories near the south coast of the island. In the 1960s, PREPA built oil-fired power plants in that region to supply energy to these industries.⁵³ Even after a hoped-for petrochemical complex failed to materialize, some factories closed, and the tax incentives began to be phased out, PREPA continued to build power plants in the south of the island because land values were lower there than in the area surrounding the capital.⁵⁴ These investments, which continued into the 1990s, placed the bulk of generation capacity in the south, surrounded by declining industry that did not need it, while the majority of the population resided in the north in the San Juan area. The distance between the two coasts might be only thirty-five miles, but the terrain between is extremely rugged, with the transmission system suspended from hilltop to hilltop.

In more prosperous times, PREPA had designed its system to serve nearly four million people, including those key industrial areas along the south coast near the Port of Ponce and the densely populated areas in the north. In the 2000s, as Puerto Rico's population fell from 3.9 million to 3.5 million people and its economy continued to decline, PREPA did not roll back and reinforce the power system. It remained a sprawling, often redundant,

network with excess capacity that was able to suffer some degradation without permanently interrupting the service for the remaining customers.⁵⁵

PREPA not only deferred maintenance, it also issued its own bonds to finance basic operations. Like many state-owned enterprises in Puerto Rico, PREPA chose to “regularly capitalize maintenance expenditures and finance them through long-term public debt.” By 2004, state-owned enterprises on the island, which included PREPA, the Aqueducts and Sewers Authority (PRASA), the Highways and Transportation Authority (PRHTA), and several others, were collectively almost \$24 billion in debt.⁵⁶

Concerned about the utility’s high rates for customers, growing debt, and increasingly unreliable service, in 2014 the Puerto Rico Senate created the Puerto Rico Energy Commission to provide oversight for PREPA, which had previously regulated itself. The commission soon ordered the utility to conduct a public review of its rates and operations, which had not been done since the 1980s.⁵⁷ PREPA charged most customers significantly more than the average rate for electric power in the United States, but the utility provided highly subsidized—or even free—electricity to municipalities and state-run enterprises throughout the island. In early 2016 the Senate convened hearings to understand how PREPA had become so insolvent. The senators focused on a rash of issues including “secretive purchasing managers, elected officials who wasted money on natural gas pipelines that were scrapped, and an institutional hostility to wind and solar power that is hard to fathom on a breezy island where the sun shines most days.”⁵⁸

Because of its growing insolvency, PREPA had deferred years of operations and maintenance investments, which clearly affected the reliability of the system.⁵⁹ In September 2016, a fire at one of the power authority’s plants knocked out two transmission lines, resulting in a three-day, island-wide blackout.⁶⁰ “PREPA’s own records show that the number of service interruptions experienced by PREPA customers in the past few months of 2016 have been four to five times higher than the average U.S. customer,” noted the authors of the 2016 expert report to the Puerto Rico Energy Commission.⁶¹ Every part of the electric power system—from the power plants to the distribution wires—was aging and vulnerable to some degree. The median age of a PREPA power plant was forty-four years, compared to the industry average of eighteen years, and many of the most critical plants were not being serviced regularly.⁶² Generators experienced outages twelve times as often as the U.S. average.⁶³ In the five years before Hurricane Maria, PREPA had lost hundreds of employees. By July 2017, the utility was \$9 billion in debt and essentially filed for bankruptcy by asking for court protection while it tried to reduce its debts and continue current operations.⁶⁴

Comparing the Response to Hurricane Maria to Past Storms and Operations

The Corps of Engineers' involvement in Puerto Rico goes back to 1898, shortly after the end of the Spanish–American War. The Corps established a Puerto Rico District by 1907, which in 1929 became part of the North Atlantic Division.⁶⁵ During World War II, the Caribbean Division administered Corps activities in Puerto Rico, and in 1951 the Jacksonville District assumed responsibility for the territory.⁶⁶ In the early twentieth century, in addition to military construction projects, the Corps carried out civil works on the island, including harbor improvement, lighthouse construction, road development, and flood control.

The 2017 hurricane season was not the first time the federal government assisted the territorial governments of Puerto Rico and the U.S. Virgin Islands after a natural disaster. Hurricanes have consistently been a force in Puerto Rico's history and economy.⁶⁷ The 1928 San Felipe II Hurricane killed more than three hundred people and left half a million Puerto Ricans homeless, almost one-third of the island's population at the time. Prior to Maria, San Felipe II was the most destructive storm to strike the island. Property damage was estimated at \$85 million (about \$1.2 billion in 2017 dollars).⁶⁸ That storm also wiped out Puerto Rico's significant coffee and citrus production, which never recovered.⁶⁹ The U.S. War Department assisted the American Red Cross in recovery efforts, sending supplies and medical personnel to the island. Four years later, another major hurricane, following a similar path to Hurricane Maria, again caused enormous damage in Puerto Rico. The 1932 San Ciprián Hurricane killed more than 250 people and caused \$35 million in damages (about \$600 million in 2017 dollars).⁷⁰ This time, Puerto Rico was struggling with the economic impacts of the Great Depression, and President Roosevelt supported the creation of the first New Deal agency on the island, the Puerto Rican Emergency Relief Administration. Through its Engineering Division, the agency completed many civil works projects, including building roads, repairing and improving buildings on Army posts, adding water systems at the Culebra Naval Station, and constructing numerous public schools, hospitals, and clinics.⁷¹

In 1992, the Corps' Jacksonville District organized an Antilles Office to better reflect its expanding role in both Puerto Rico and the U.S. Virgin Islands.⁷² The Antilles Office focused on flood risk reduction, improving navigation, and environmental restoration. In 2013 the office completed construction on a major flood risk management project on the Portugués and Bucana Rivers in the foothills above the city of Ponce.⁷³ The project originally consisted of three multipurpose units for both flood control and water supply: Portugués Dam and Reservoir, Cerrillos Dam and Reservoir, and channel improvements at Ponce.⁷⁴ The series of dams in the mountains had been under study and construction since the 1970s, and the completion of the Portugués and Bucana Rivers project represented the culmination of a sustained American commitment to well-built civil works in the



Aerial view of the inauguration of the Portugueses Dam in Ponce, Puerto Rico, Feb. 5, 2014. The dam was inaugurated by the governor of Puerto Rico, Alejandro Garcia Padilla, and Honorable Jo-Ellen Darcy, Assistant Secretary of the Army for Civil Works. (Puerto Rico National Guard photo by S. Sgt. Joseph Rivera Rebolledo, Public Affairs)

commonwealth despite suffering a number of significant delays. All Corps dams in Puerto Rico survived Hurricane Maria without any significant damage.⁷⁵

Hurricane Hugo (1989)

Hurricane Hugo caused catastrophic damage in the Virgin Islands and in the Puerto Rican islands of Vieques and Culebra, and it also resulted in significant wind damage on the main island of Puerto Rico before turning northwest to South Carolina.⁷⁶ Water and power outages were widespread. At the request of Puerto Rico's governor, Jacksonville District responded by providing generators to power three water filtration plants and tanker trucks to supply drinking water in the San Juan area. PREPA restored power to Puerto Rico in about four months.⁷⁷

While Puerto Rico recovered from Hugo quickly, St. Croix's infrastructure was entirely destroyed. The response to Hugo in St. Croix was a miniature version of what the Corps would accomplish in Puerto Rico nearly thirty years later. Between late September 1989 and early February 1990, Jacksonville District restored St. Croix's electrical grid and water supply.⁷⁸ This assistance to the government-owned U.S. Virgin Islands Water and Power Authority (WAPA) involved 375 people, 12 contractor firms, 105 utility trucks



U.S. Navy SeaBees from Bravo Company of the Naval Mobile Construction Battalion worked on power lines in the military housing area of Naval Station Roosevelt Roads, Puerto Rico, Sept. 30, 1998. The fierce winds of Hurricane Georges downed the lines. (DoD photo by Sr. Amn. Jerome Suson, U.S. Air Force)

and trailers, 12,000 poles, 2,800 transformers, and over 4 million feet of wire.⁷⁹

Hurricane Georges (1998)

Hurricane Georges was a powerful storm, and it caused significant damage in Puerto Rico, but the situation in 1998 was very different from when Maria hit nearly two decades later. After Georges, PREPA was able to restore power to the island in three months.⁸⁰ The commonwealth and its power authority took the lead in that restoration effort. In its response to Georges, the Corps struggled with numerous logistical difficulties, including moving supplies and equipment by barge, language barriers, and glitches in the structure of FEMA response funding.⁸¹ Despite these challenges, the response to Georges remained one of the only models for the Corps' emergency operations

in Puerto Rico.⁸² This held true especially with regard to the mission to provide generators to supply temporary emergency power, since the Corps had not typically been involved with electrical grid restoration (a recent and notable exception being the work on Iraqi infrastructure following the U.S. invasion of Iraq in 2003).

Georges proved the most disastrous of several 1998 storms.⁸³ Forming off the coast of Africa on September 13, the storm reached hurricane strength by September 17. After striking the Lesser Antilles as a Category 4 storm and causing extensive damage in Antigua, Barbuda, St. Kitts and Nevis, Georges plowed into Puerto Rico on September 21. Puerto Rico took the brunt of the storm and suffered severe destruction: Georges damaged seventy-two thousand homes, made thirty-six thousand people homeless, cut off power and water to a million people, created five million tons of debris, and destroyed 95 percent of banana and 75 percent of coffee crops. All seventy-eight municipalities requested aid.

Planning and Response Teams

Planning and Response Teams (PRTs) became a key part of the Corps' efforts in the 1990s and beyond to reform the agency's readiness and disaster response posture and to improve coordination with FEMA. First launched in 1998, PRTs consisted of a core group of about twenty civilian personnel who specialized in getting a particular type of disaster-response mission under way. Because the PRT concept was new in 1998, that year Jacksonville District established functionally based mission teams that were to be supplemented by other districts as needed. The PRT program would soon become the primary way the Corps leveraged its national strengths to respond to disasters in specific regions. By 1999, the PRTs included forty-two Emergency Support Function (ESF)-3 teams in support of debris removal, emergency road clearance, and the provision of ice, water, emergency power, temporary housing, and temporary roofing, as well

as supporting teams focused on public affairs, resource management, logistics, safety, and real estate. Each of the seven divisions maintained at least one of each type of team using trained volunteers. USACE headquarters would attach these teams to districts responding to emergencies. Each team included an action officer, contract specialist, district coordinator, quality assurance expert, and several mission managers. The Corps then arranged with FEMA to provide pre-declaration funding to allow the deployment of the teams as quickly as possible. As with many other elements of the federal emergency response program, the Corps' PRT program expanded significantly after the September 11, 2001, terrorist attacks.^a

Notes

a. Damon Manders, "The Emergency Management Partnership: U.S. Army Engineer Disaster Relief Operations, 1979 to Present" (Unpublished Manuscript, March 5, 2019), 193-94, Office of History, HQUSACE, Alexandria, Virginia.

The Corps sent an advance team to Puerto Rico on September 19, 1998, including a detachment from the 249th Engineer Battalion, a versatile battalion assigned to the U.S. Army Corps of Engineers that specializes in assessing the power needs of critical facilities and installing generators.⁸⁴ President Bill Clinton signed an emergency declaration shortly after the storm's landfall on September 21, and major disaster declarations followed on September 24 for Puerto Rico and from September 28 to October 1 for states along the Gulf of Mexico. Using pre-disaster declaration funding from FEMA, the Corps sent its newly-designated Planning and Response Teams (PRTs) for ice, water, and power to Puerto Rico before the storm, and some teams remained in Florida in case Georges would also make landfall there.

Because the majority of damage was in Puerto Rico, the Corps stood up the Georges Emergency Recovery Office in San Juan on September 21, 1998, which moved to permanent headquarters on October 5.⁸⁵ Headed by the deputy commander of the Corps' South Atlantic Division, Col. Dean Kershaw, the office boasted a peak staff of 544 Corps employees and 240 National Guardsmen and Reservists, in addition to 70 personnel from the 249th Engineer Battalion. The Corps handled more than eighty-five FEMA mission

assignments at a cost of \$840 million (about \$1.2 billion in 2017). In Puerto Rico, teams delivered 8.5 million gallons of water and 18 million pounds of ice from 7 distribution centers, conducted 415 power assessments and installed 285 generators, put on more than 60,000 temporary roofs, and removed 2 million cubic yards of debris by August 1, 1999.

Responsibility for repairing the electrical grid remained with PREPA. Two days after the storm, on September 23, 1998, PREPA reported that 100 percent of the island was without power.⁸⁶ The first week after the storm, the power authority estimated that it would take seven months to fully restore power to all its 1.3 million business and residential customers. A month later, on October 20, they had successfully restored 1.1 million customers, or 82 percent of the total.⁸⁷ Power was completely restored to all customers after six months. PREPA repaired the grid faster than expected after Hurricane Georges because the path of the storm across the southern half of the island was far less catastrophic than Maria would be, the electrical grid was in better repair at that time nearly twenty years earlier, and the utility made good use of alliances with mainland power companies.⁸⁸ Three hundred electric utility workers arrived from three East Coast power companies—Northeast Utilities, Niagara Mohawk Power, and Long Island Power Authority—to carry out repairs in sixty-nine crews. The companies also brought equipment and materials to assist PREPA in expediting the power restoration process in Puerto Rico. It was this kind of power industry support that would also accelerate the work of turning the lights back on after Hurricane Maria, two decades later.

Task Force Restore Iraqi Electricity (2003-2005)

The last time prior to Maria that the Corps had been tasked with restoring a power grid on the scale of Puerto Rico's was about six months after the 2003 U.S. invasion of Iraq. In September 2003, the Corps of Engineers stood up Task Force Restore Iraqi Electricity (TF RIE) to accept responsibility for twenty-six power generation and transmission projects that would restore service and add additional capacity to Iraq's electrical grid.⁸⁹ The task force completed about half of those projects within three months, and the rest were finished by June 2004, but a growing insurgency, political instability, and rising demand prevented the reliable supply of electricity across the country.⁹⁰ Although the terrain in Iraq is largely flatter and clearer than that in Puerto Rico, the Corps had struggled with widespread looting and insurgent attacks that actively sabotaged generation and transmission facilities around the country. The future Chief of Engineers, Lt. Gen. Todd T. Semonite, had been a colonel at the time in a key role as deputy commander of TF RIE. He had been constantly concerned about both the security of the Corps' international contractors as well as getting enough funds to pay them.⁹¹ In contrast, Puerto Rico was a far more permissive environment where funding was not a barrier and security issues rarely slowed work.



The Corps' last mission to repair a large electrical grid followed the 2003 invasion of Iraq. Col. Todd T. Semonite, Deputy Commander of Task Force Restore Iraqi Electricity (left-center), visited a work site on the Baiji transmission line in March 2004. To communicate, Semonite spoke in English to one interpreter who translated for the Korean contractors and to another who translated for the Iraqi subcontractors. (USACE)

But there were also important similarities about these critical missions fourteen years apart. Both the Iraqi and Puerto Rican electrical systems had suffered from years of neglect, and both were made up of obsolete, non-standard components that created endless logistical difficulties in obtaining replacement parts. Both systems had to be restored incrementally, with blackouts common even as more generation was brought back online.⁹² Fluor International, one of the Corps' main contractors for rebuilding power generation facilities in Iraq, was again chosen to help rebuild the grid in Puerto Rico.⁹³ In the years following the mission in Iraq, Semonite served in a number of leadership positions with the Corps, including as South Atlantic Division commander.⁹⁴ By the fall of 2017, there were very few people left in the Corps who had worked on TF RIE, but Semonite, by then chief of engineers, was in a unique position to make sure Puerto Rico's grid was restored successfully.⁹⁵

Notes

¹ U.S. Government Accountability Office, "Federal Support for Electricity Grid Restoration in the U.S. Virgin Islands and Puerto Rico," Report GAO 19-296, April 2019, Highlights Section, <https://www.gao.gov/products/GAO-19-296>. "Energy Resilience Solutions for the Puerto Rico Grid," Final Report, Office of Electricity, U.S. Department of Energy, June 2018, 20, <https://www.energy.gov/oe/articles/>

[office-electricity-releases-energy-resilience-solutions-puerto-rico-grid-report](https://www.energy.gov/oe/articles/office-electricity-releases-energy-resilience-solutions-puerto-rico-grid-report).

² Jeremy Fisher and Ariel Horowitz (Synapse Energy Associates), "Expert Report: State of PREPA's system, load forecast, capital budget, fuel budget, purchased power budget, operations expense budget," Puerto Rico Energy Commission, November 23, 2016, 14, <http://energia.pr.gov/>

wp-content/uploads/2016/11/Expert-Report-Revenue-Requirements-Fisher-and-Horowitz-Revised-20161123.pdf. In August 2018, the commonwealth's legislative assembly consolidated the Energy Commission (renamed the Puerto Rico Energy Bureau) and several other regulatory agencies within the Public Service Regulatory Board.

³ Nancy Morris, *Puerto Rico: Culture, Politics, and Identity* (Westport, CT: Praeger Publishers, 1995), 21.

⁴ "The Spanish-American War, 1898," Milestones in the History of U.S. Foreign Relations, Office of the Historian, U.S. Department of State, 2016, <https://history.state.gov/milestones/1866-1898/spanish-american-war>.

⁵ U.S. Army Corps of Engineers, *Annual Report of the Chief of Engineers*, 1901, 88.

⁶ Morris, *Puerto Rico: Culture, Politics, and Identity*, 26.

⁷ U.S. Reports: *Downes v. Bidwell*, 182 U.S. 244 (1901), online at Library of Congress, <https://www.loc.gov/item/usrep182244/>.

⁸ "Puerto Rico," Exhibitions and Publications; History, Art and Archives; U.S. House of Representatives, January 31, 2019, <https://history.house.gov/Exhibitions-and-Publications/HAIC/Historical-Essays/Foreign-Domestic/Puerto-Rico/>.

⁹ "Puerto Rico's Economic Crisis—Timeline," Education, Center for Puerto Rican Studies, CUNY Hunter College, 2, <https://centropri.hunter.cuny.edu/education/puerto-rico-crisis-timeline>.

¹⁰ Matt Pearce, "What is the Jones Act, and why does Puerto Rico want it gone?" *Los Angeles Times*, September 27, 2017, Accessed January 31, 2019, <https://www.latimes.com/nation/la-na-jones-act-20170927-story.html>. The Merchant Marine Act of 1920 is also called the "Jones Act" after its sponsor, Sen. Wesley Jones of Washington. It should not be confused with the 1917 Jones-Shafroth Act, which was introduced multiple times, starting in 1912, by Virginia Rep. William A. Jones.

¹¹ "Merchant Fleets," Economic and Financial Indicators, *The Economist*, October 17, 2015, <https://www.economist.com/economic-and-financial-indicators/2015/10/17/merchant-fleets>.

¹² Matthew Yglesias, "The Jones Act, the obscure 1920 shipping regulation strangling Puerto Rico, explained," *Vox*, October 9, 2017, <https://www.vox.com/policy-and-politics/2017/9/27/16373484/jones-act-puerto-rico>. "The executive branch has the authority to waive the act in special circumstances, as it has done in the past whenever the downside of making it excessively expensive to ship American goods from one place in America to another becomes a high-profile issue," Matthew Yglesias wrote in *Vox*. "The Bush administration issued Jones Act waivers after Hurricanes Katrina and [Rita] to speed the shipment of fuel to the Gulf Coast. The Obama administration issued a more limited waiver after Hurricane Sandy, again to speed the shipment of fuel. On September 8, the Trump administration issued Jones Act waivers for areas impacted by Hurricane Harvey."

¹³ Niraj Chokshi, "Trump Waives Jones Act for Puerto Rico, Easing Hurricane Aid Shipments," *New York Times*, September 28, 2017, <https://www.nytimes.com/2017/09/28/us/jones-act-waived.html>; Melanie Zanona, "White House lets Jones Act waiver expire for Puerto Rico," *The Hill*, October 9, 2017, <http://thehill.com/latino/354561-white-house-lets-jones-act-waiver-expire-for-puerto-rico>.

¹⁴ Ramon Grosfoguel, *Colonial Subjects: Puerto Ricans in a Global Perspective* (Berkeley: University of California Press, 2003), 66-67.

¹⁵ César J. Ayala and Rafael Bernabe, *Puerto Rico in the American Century: a history since 1898* (Chapel Hill, NC: University of North Carolina Press, 2007), 163.

¹⁶ Ayala and Bernabe, *Puerto Rico in the American Century*, 163.

¹⁷ Ayala and Bernabe, *Puerto Rico in the American Century*, 164.

¹⁸ Katie Zezima, "Puerto Rico pushes for statehood, calling it a civil rights issue," *Washington Post*, June 27, 2018, https://www.washingtonpost.com/national/puerto-rico-pushes-for-statehood-calling-it-a-civil-rights-issue/2018/06/27/717c5092-7a43-11e8-93cc-6d3bec-cdd7a3_story.html.

¹⁹ James L. Dietz, *Economic History of Puerto Rico: Institutional Change and Capitalist Development* (Princeton, NJ: Princeton University Press, 1986), 184; "Company Overview," PRIDCO, January 2019, <http://www.pridco.com/who-we-are/Pages/Company-Overview.aspx>. The Puerto Rican Administration of Economic Development is today called the Puerto Rico Industrial Development Company (PRIDCO). 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 the transformation from a traditional industrial economy to knowledge-based economy."

²⁰ Dietz, *Economic History of Puerto Rico*, 206.

²¹ Maria Elena Carrión, "Operation Bootstrap (1947)," *Enciclopedia de Puerto Rico*, September 15, 2014, <https://enciclopedia.pr.org/en/encyclopedia/operation-bootstrap-1947/>. Economic historians see growth in gross national product as a better measure than gross domestic product to show the island's own economic expansion, as distinguished from profits that would end up in the U.S. mainland.

²² Ayala and Bernabe, *Puerto Rico in the American Century*, 181. Between 1953 and 1963, the average weekly salary in manufacturing more than doubled for men, from \$18 in 1953 to \$44 in 1963. For women, many of whom began working manufacturing jobs for the first time, the average weekly salary tripled, from \$12 in 1953 to \$37 in 1963.

²³ Ayala and Bernabe, *Puerto Rico in the American Century*, 196. It may seem fairly obvious, but it is important to remember that restrictions on immigration did not affect

Puerto Ricans, who as U.S. citizens could simply move to any state and establish residency.

²⁴ D'Vera Cohn, Eileen Patten, and Mark Hugo Lopez, "Puerto Rican Population Declines on Island, Grows on U.S. Mainland," *Hispanic Trends*, Pew Research Center, August 11, 2014, <http://www.pewhispanic.org/2014/08/11/puerto-rican-population-declines-on-island-grows-on-u-s-mainland/>.

²⁵ Ayala and Bernabe, *Puerto Rico in the American Century*, 224; "Puerto Ricans say 'no' to statehood," *Americas Storypage*, CNN, December 14, 1998, Internet Archive, Retrieved June 18, 2006, <https://web.archive.org/web/20060618211803/http://www.cnn.com/WORLD/americas/9812/14/puerto.rico.01/>. There have been several non-binding plebiscites on various options for the status arrangement between Puerto Rico and the federal government. In 1967, the commonwealth arrangement received 60% of the vote while the statehood option got 39%. Political parties supporting a third option—Puerto Rican independence—boycotted the vote, as they have done several times since. In December 1998, after a century of U.S. rule and while the island was still recovering from Hurricane Georges, 46.5% of Puerto Rican voters supported statehood, but 50.2% of voters chose "none of the above," which essentially meant no change to the status quo. In June 2017, as Puerto Rico was under debt crisis management, 97% of voters supported statehood, but opposition parties boycotted the plebiscite and turnout was low, throwing the results into question.

²⁶ Rick Young, "Blackout in Puerto Rico," *Frontline*, Season 36, Episode 10, PBS, June 27, 2018, <https://www.pbs.org/wgbh/frontline/film/blackout-in-puerto-rico/>.

²⁷ Center for Puerto Rican Studies, "Puerto Rico's Economic Crisis," 3.

²⁸ Susan M. Collins, Barry P. Bosworth, and Miguel A. Soto-Class, "Introduction and Summary," in *The Economy of Puerto Rico: Restoring Growth*, ed. Susan M. Collins, Barry P. Bosworth, and Miguel A. Soto-Class (Washington, DC: Brookings Institution Press, 2006), 3.

²⁹ Richard C. Auxier, "Reagan's Recession," Pew Research Center, December 14, 2010, <https://www.pewresearch.org/2010/12/14/reagans-recession/>.

³⁰ Ayala and Bernabe, *Puerto Rico in the American Century*, 267, 292.

³¹ "Current Employment Statistics Survey: 100 years of employment, hours, and earnings," Monthly Labor Review, U.S. Bureau of Labor Statistics, August 2016, <https://www.bls.gov/opub/mlr/2016/article/current-employment-statistics-survey-100-years-of-employment-hours-and-earnings.htm>.

³² James Alm, "Assessing Puerto Rico's Fiscal Policies," in *The Economy of Puerto Rico: Restoring Growth*, 321. Between 1990 and 2004, GNP grew at an average yearly rate of 6.4%, while all forms of public debt—including commonwealth, municipal, and state-owned enterprises (such as PREPA)—grew at a yearly rate of 7.4%.

³³ John W. Schoen, "Here's how an obscure tax change sank Puerto Rico's economy," *U.S. Economy*, CNBC, September 26, 2017, <https://www.cnbc.com/2017/09/26/>

heres-how-an-obscure-tax-change-sank-puerto-ricos-economy.html.

³⁴ Schoen, "Obscure Tax Change."

³⁵ Alm, "Assessing Puerto Rico's Fiscal Policies," 323.

³⁶ Alm, "Assessing Puerto Rico's Fiscal Policies," 378.

³⁷ Young, "Blackout in Puerto Rico."

³⁸ Paul Mackun and Steven Wilson, "Population Distribution and Change: 2000 to 2010," 2010 Census Briefs, U.S. Census Bureau, March 2011, <https://www.census.gov/prod/cen2010/briefs/c2010br-01.pdf>.

³⁹ Alm, "Assessing Puerto Rico's Fiscal Policies," 353.

⁴⁰ Sarah Varney and Carmen Heredia Rodriguez, "Puerto Rico's Wounded Medicaid Program Faces Even Deeper Cuts," *Shots Health News*, NPR, August 1, 2018, <https://www.npr.org/sections/health-shots/2018/08/01/632804633/puerto-ricos-wounded-medicaid-program-faces-even-deeper-cuts>. "In February [2018], Congress approved \$4.8 billion in additional funds to help pay the island's Medicaid bills. But the additional payments are widely viewed as a stopgap measure; health economists say that extra money is likely to run out in September 2019, a grim estimate shared by the territory's fiscal oversight board."

⁴¹ Vann R. Newkirk II, "The Historical Exclusion Behind the Puerto Rico Bankruptcy Crisis," *The Atlantic*, May 2, 2017, <https://www.theatlantic.com/politics/archive/2017/05/medicaid-funding-cap-puerto-rico/524973/>.

⁴² "Medicaid Financing and Spending in Puerto Rico," Medicaid and CHIP Payment and Access Commission, August 2017, 5, <https://www.macpac.gov/wp-content/uploads/2017/09/Medicaid-Financing-and-Spending-in-Puerto-Rico.pdf>.

⁴³ "S&P downgrades Puerto Rico debt to junk status," *Business News*, Reuters, February 4, 2014, <https://www.reuters.com/article/us-munis-puertorico/sp-downgrades-puerto-rico-debt-to-junk-status-idUSBREA131M720140204>.

⁴⁴ Mary Williams Walsh, "Puerto Rico Defaults on Bond Payment," *New York Times*, August 3, 2015, <https://www.nytimes.com/2015/08/04/business/dealbook/puerto-rico-decides-to-skip-bond-payment.html>.

⁴⁵ Puerto Rico Oversight, Management, and Economic Stability Act, Pub. L. No. 114-187, 130 Stat. 549 § 101 (June 30, 2016), <https://www.gpo.gov/fdsys/pkg/PLAW-114publ187/pdf/PLAW-114publ187.pdf>. The acronym "PROMESA" means "promise" in Spanish, and the law is widely known in Puerto Rico by this title. Locally, the Financial Oversight and Management Board is called "La Junta" ("the board," in English).

⁴⁶ PROMESA § 503.

⁴⁷ Young, "Blackout in Puerto Rico"; Frances Robles, "Puerto Rico's University Is Paralyzed by Protests and Facing Huge Cuts," *New York Times*, May 25, 2017, <https://>

www.nytimes.com/2017/05/25/us/puerto-ricos-university-is-paralyzed-by-protests-and-facing-huge-cuts.html; Danica Coro, “Hundreds of Puerto Ricans protest, decry austerity measures,” *AP News*, Associated Press, August 30, 2017, <https://apnews.com/12eb8c98c46b4ce7b86fac9141ba44df>. Protests broke out again in early May 2018 as the Financial Oversight and Management Board approved a new fiscal plan for Puerto Rico that would reduce funding for public institutions and cut public-sector retirement benefits. The board still views these austerity measures, along with the privatization of PREPA and infrastructure investments, as the best way to relieve Puerto Rico’s government debts. In addition to protests, austerity led to litigation in 2018 between Governor Rosselló and the board, the latter having accused the former of failing to implement its policies. See Vann R. Newkirk II, “Puerto Rico Enters a New Age of Austerity,” *The Atlantic*, May 5, 2018, <https://www.theatlantic.com/politics/archive/2018/05/puerto-rico-enters-a-new-age-of-austerity/559565/>.

⁴⁸ Andrew Scurria, “What is Title III and Why is Puerto Rico in It?” *Wall Street Journal*, May 3, 2017, <https://www.wsj.com/articles/five-things-to-know-about-title-iii-and-puerto-rico-1493847673>; Mary Williams Walsh, “Puerto Rico Declares a Form of Bankruptcy,” *New York Times*, May 3, 2017, <https://www.nytimes.com/2017/05/03/business/dealbook/puerto-rico-debt.html>.

⁴⁹ “Pinceladas de Nuestra Historia,” Autoridad de Energía Eléctrica, 2019, <https://aepr.com/es-pr/qui%C3%A9nes-somos/historia>. In Spanish, the power authority was originally named *Autoridad de las Fuentes Fluviales* and is now called *Autoridad de Energía Eléctrica*, abbreviated AEE.

⁵⁰ Mary Williams Walsh, “How Free Electricity Helped Dig \$9 Billion Hole in Puerto Rico,” *New York Times*, February 1, 2016, <https://www.nytimes.com/2016/02/02/business/dealbook/puerto-rico-power-authoritys-debt-is-rooted-in-free-electricity.html>.

⁵¹ Nick Brown and Jessica Resnick-Ault, “Puerto Rico utility sale sets up fight with creditors,” *Business News*, Reuters, January 24, 2018, <https://www.reuters.com/article/us-puertorico-debt-prepa-analysis/puerto-rico-utility-sale-sets-up-fight-with-creditors-idUSKBN1FD0FP>.

⁵² “Puerto Rico Territory Energy Profile,” U.S. Energy Information Administration (U.S. EIA), July 19, 2018, <https://www.eia.gov/state/?sid=RQ>. Petroleum is an expensive, but easily-transportable, fuel source for electric power generation on both Hawaii and Puerto Rico. EIA reports that “Hawaii’s dependence on imported petroleum combined with isolated island grids results in the nation’s highest electricity prices.” <https://www.eia.gov/state/analysis.php?sid=HI>

⁵³ Ayala and Bernabe, *Puerto Rico in the American Century*, 192.

⁵⁴ Interview, José Sánchez, South Atlantic Division (SAD) Power Program Director, by James Garber and Jonah Beatty-Taylor, HQUSACE, Part 2, April 16, 2018, 8, Oral History Collection, Office of History, HQUSACE, Alexandria, Virginia [Hereafter cited as CEHO].

⁵⁵ Interview, José Sánchez, Part 2 (2018), 3.

⁵⁶ Alm, “Assessing Puerto Rico’s Fiscal Policies,” 323

⁵⁷ “Ordenan a la AEE comenzar proceso de revisión de tarifas,” *El Nuevo Día*, February 13, 2015, <https://www.elnuevodia.com/noticias/locales/nota/ordenana-laaecomenzarprocesoderevisiondetarifas-2007569/>.

⁵⁸ Walsh, “Free Electricity.”

⁵⁹ Interview, José Sánchez, South Atlantic Division (SAD) Power Program Director, by James Garber and Jonah Beatty-Taylor, HQUSACE, Part 1, April 9, 2018, 25, CEHO.

⁶⁰ Associated Press, “Puerto Rico electricity flickers back on after island-wide power outage,” *The Guardian*, September 23, 2016, Accessed January 31, 2019, <https://www.theguardian.com/world/2016/sep/23/puerto-rico-electricity-returns-outage>.

⁶¹ Fisher and Horowitz, “State of PREPA’s system,” 13.

⁶² “For example, PREPA did not identify any capital dollars spent on maintenance at Palo Seco 1 & 2 over the last six years despite the significant use of these units.” Note that bringing Palo Seco back online was one of the Corps’ first tasks after Hurricane Maria to restore some reliability to the grid. Fisher and Horowitz, “State of PREPA’s system,” 17. See also Task Force Power, “Task Force Power Operational Concept,” Governor’s Info Brief, October 23, 2017, Emergency Operations Collection, 10, CEHO.

⁶³ “Puerto Rico Territory Energy Profile,” U.S. EIA.

⁶⁴ Mary Williams Walsh, “Puerto Rico’s Power Authority Effectively Files for Bankruptcy,” *New York Times*, July 2, 2017, <https://www.nytimes.com/2017/07/02/business/puerto-ricos-electric-power-authority-effectively-files-for-bankruptcy.html>.

⁶⁵ “Corps of Engineers Statistical History, 1917-1980” (unpublished manuscript, 1985), Section 9: “Field Offices,” Typescript, General Files, Research Collection, CEHO.

⁶⁶ George E. Buker, *Sun, Sand and Water: A History of the Jacksonville District U.S. Army Corps of Engineers, 1821-1975* (Washington, DC: U.S. Government Printing Office, 1981), 150.

⁶⁷ Luis Caldera Ortiz, *Historia de los ciclones y huracanes tropicales en Puerto Rico* (Coamo, Puerto Rico: Editorial El Jagüey, 2017). According to the National Hurricane Center, “for several hundred years many hurricanes in the West Indies were named after the particular saint’s day on which the hurricane occurred. Ivan R. Tannehill describes in his book ‘Hurricanes’ the major tropical storms of recorded history and mentions many hurricanes named after saints. For example, there was ‘Hurricane Santa Ana’ which struck Puerto Rico with exceptional violence on July 26, 1825, and ‘San Felipe (the first)’ and ‘San Felipe (the second)’ which hit Puerto Rico on September 13 in both 1876 and 1928.” “Tropical Cyclone Naming History and Retired Names,” National Hurricane Center, 2018, https://www.nhc.noaa.gov/aboutnames_history.shtml.

⁶⁸ Pedro Caban, “Maria will fundamentally change U.S. policy toward Puerto Rico,” *The Conversation*, November 6, 2017, <http://theconversation.com/maria-will-fundamentally-change-us-policy-toward-puerto-rico-86038>.

⁶⁹ Stuart B. Schwartz, "Differential Disasters: The 1928 Hurricane and the Shaping of the Circum-Caribbean Region." *ReVista: Harvard Review of Latin America*, The David Rockefeller Center for Latin American Studies, Harvard University, 2007, <https://revista.drclas.harvard.edu/book/differential-disasters>.

⁷⁰ Center for Puerto Rican Studies, "Puerto Rico's Economic Crisis," 2.

⁷¹ Puerto Rican Emergency Relief Administration, *Second Report of the Puerto Rican Emergency Relief Administration from September 1, 1934, to September 30, 1935* (Washington, DC: U.S. G.P.O., 1939; Accessed through the HathiTrust), 13-17.

⁷² George E. Buker, *Environment—the Third E: A History of the Jacksonville District, U.S. Army Corps of Engineers, 1975-1998* (Jacksonville, FL: Jacksonville District, USACE, 1998), 177; Brig. Gen. Diana M. Holland, "Responding to the Perfect Storm: The U.S. Army Corps of Engineers and Disaster Response in Puerto Rico, 2017," *Military Review* (May-June 2019): 11-25, <https://www.armyupress.army.mil/journals/military-review/english-edition-archives/may-june-2019/holland-perfect-storm/>.

⁷³ "Portugues Dam," Civil Works Mission, USACE Jacksonville District, 2019, <https://www.saj.usace.army.mil/Missions/Civil-Works/Flood-Risk-Management/Portugues-Dam/>.

⁷⁴ Buker, *Environment*, 176.

⁷⁵ USACE Operations Center (UOC) Staff, "U.S. Army Corps of Engineering Contingency Ops Dashboard," HQUSACE, October 6, 2017, 16, Emergency Operations Collection, CEHO.

⁷⁶ Buker, *Environment*, 199.

⁷⁷ David Koenig and Stan Choe, "Puerto Rico remains dark as damage assessments begin," *AP News*, Associated Press, September 25, 2017, <https://www.apnews.com/3e2a-1b45a30f41f59aa6c81f03750bc0>. As quoted in an AP story, "Public Affairs Secretary Ramon Rosario said 80 percent of the island's transmission and distribution lines were knocked down. He noted that it took four months to restore power to the entire island after Hurricane Hugo in 1989 and six months after Hurricane Georges in 1998."

⁷⁸ Buker, *Environment*, 199.

⁷⁹ Buker, *Environment*, 202.

⁸⁰ Interview, José Sánchez, Part 1 (2018), 25.

⁸¹ Damon Manders, "The Emergency Management Partnership: U.S. Army Engineer Disaster Relief Operations, 1979 to Present" (unpublished manuscript draft, March 5, 2019), 201-202, Microsoft Word file, CEHO.

⁸² Interview, Col. Richard P. Pannell, Deputy Commander, Mississippi Valley Division (MVD), by Jonah Bea-Taylor, Matthew Percy, and Brian Rentfro, MVD Headquarters, Vicksburg, MS, January 9, 2018, 22, CEHO.

⁸³ Manders, *The Emergency Management Partnership*, 199.

⁸⁴ South Atlantic Division, "Hurricane Georges After Action Report: Alabama, Florida, Mississippi, Puerto Rico and U.S. Virgin Islands," 1999, 2-1, Historian's Files, Emergency Operations Collection, CEHO; "249th Engineer Battalion History," HQUSACE, n.d., Accessed January, 31, 2019, <https://www.usace.army.mil/249th-Engineer-Battalion/249th-Engineer-Battalion-History/>.

⁸⁵ Manders, *The Emergency Management Partnership*, 200-201; South Atlantic Division, "Hurricane Georges: Georges Emergency Recovery Office (GERO), Division Forward After Action Report," 3-12, Atlanta Federal Records Center, RG 77, Acc. 077-2011-0283, Box 25, File Georges Misc.

⁸⁶ South Atlantic Division, "Hurricane Georges: GERO After Action Report," 3-6.

⁸⁷ South Atlantic Division, "Hurricane Georges: GERO After Action Report," 3-47.

⁸⁸ "Vice President Gore Announces \$10.4 Million for Georges Emergency Power Restoration," Press Release HQ-99-179, Federal Emergency Management Agency, August 12, 1999, <https://www.fema.gov/news-release/1999/08/12/vice-president-gore-announces-104-million-georges-emergency-power>.

⁸⁹ USACE Transatlantic Programs Center, Memorandum for the Record, "Lessons Learned of Restore Iraqi Electricity (RIE) Directorate Projects and Processes," October 11, 2004, 8, Operation Iraqi Freedom Collection, CEHO.

⁹⁰ Robert Grathwol, "Task Force RIE Draft History" (unpublished manuscript, October 2007), 73, 86-92, Microsoft Word file, Operation Iraqi Freedom Collection, CEHO.

⁹¹ Grathwol, "Task Force RIE," 15, 30.

⁹² Grathwol, "Task Force RIE," 26-29.

⁹³ Grathwol, "Task Force RIE," 34; "Fluor Awarded \$154 Million in Iraqi Power Restoration Projects," Fluor Newsroom, February 17, 2004, <https://newsroom.fluor.com/press-release/archive/fluor-awarded-154-million-iraqi-power-restoration-projects>; "USACE Puerto Rico Power Restoration," Fluor Projects, 2018, <https://www.fluor.com/projects/puerto-rico-power-restoration>.

⁹⁴ "Lieutenant General Todd T. Semonite," Leadership, HQUSACE, June 5, 2018, <https://www.usace.army.mil/About/Leadership/Bio-Article-View/Article/776561/lieutenant-general-todd-t-semonite/>.

⁹⁵ Maj. Gen. Donald E. Jackson, Jr., to John Lonnquest, Email, September 27, 2017, Historian's Files, Emergency Operations Collection, CEHO. A week after Maria's landfall, SAD and HQUSACE leadership requested information about the history of Task Force RIE, and some of the lessons learned from repairing the Iraqi grid, from the Corps' Office of History.



Soldiers of the Puerto Rico National Guard along with members of the Puerto Rico State Guard worked together to clear roads in Punta Santiago, Humacao, Sept. 27, 2017. (National Guard photo by Spec. Hamiel Irizarry)

— CHAPTER 2 —

THE STORM

On September 20, 2017, while Hurricane Maria was slicing across Puerto Rico, President Donald Trump issued major disaster declarations for the Commonwealth of Puerto Rico and the U.S. Virgin Islands.¹ Recognizing the commonwealth’s limited resources, the Federal Emergency Management Agency (FEMA) committed the federal government to cover all disaster-relief costs for a period of eight months.² But both federal and local first responders were inadequately prepared for a disaster on the scale of back-to-back Hurricanes Irma and Maria in the U.S. territories in the Caribbean.³ To understand why, it is important to outline the process by which FEMA typically coordinates disaster response and how the U.S. Army Corps of Engineers usually works with FEMA during emergencies. Under the 1988 Stafford Act, the president makes a major disaster declaration at the request of a state or territorial governor, with the advice of FEMA. A major disaster declaration enables access to special funding from Congress to help both local governments and individuals recover.⁴ At least in principle, disaster response in the United States is from the “bottom up”—local governments take the lead, and the federal government supplements those efforts. When state and territorial resources are inadequate to the demands created by the emergency, FEMA brings in additional federal resources and coordinates how they are deployed.⁵

The Corps of Engineers supports FEMA’s response in what it terms “Emergency Support Function 3” (ESF-3), which covers a broad area designated as Public Works and Engineering.⁶ Other federal agencies have different emergency support functions, such as the U.S. Department of Energy in ESF-12, the function concerned with energy systems and system components.⁷ Within ESF-3, Public Works and Engineering, the Corps undertakes well-defined missions such as debris removal, temporary roofing, temporary emergency power, and emergency repair of damaged infrastructure and critical facilities.

FEMA first assigned the public works and engineering coordinating role to the Corps in its 2004 National Response Plan (later changed to National Response Framework), although the Corps has a much longer history in providing flood-fighting and construction support after disasters.⁸ Since 1941, the Corps has had its own statutory authorization under Public Law 84-99 to prepare for and respond to floods and other coastal emergencies.⁹

In 2014 FEMA updated its plans for the federal and local response to a major hurricane in Puerto Rico and the U.S. Virgin Islands. FEMA included a “Hurricane Annex” in its 2014 Concept of Operations to address a range of possible emergencies and to provide details about what resources would be available in Puerto Rico following a hurricane. The Hurricane Annex was informed by the federal responses to previous hurricanes, such as Hugo and Georges. The 2014 plans noted that “mitigation projects and advances in technology have postured the islands to be much more resilient” but also critically remarked that “although a tremendous amount of work has been accomplished, we must still prepare for the inevitable ‘big one’ that will test local, commonwealth, territorial, and Federal capabilities.” The scenario of the “big one” described a range of catastrophic impacts that could affect the response, including the possibility of having a 100 percent communications failure.¹⁰

In order to get relief under way quickly, many federal disaster response missions are well-defined, “pre-scripted” assignments that federal agencies have performed previously in support of FEMA.¹¹ These mission assignments can be activated and adapted as required. In addition, many contracts can be pre-awarded prior to a storm.¹² Under normal conditions, pre-scripted mission assignments and contracts in place enable the Corps to get contractors working more quickly on their “standard” post-disaster missions, such as temporary roofing, generators for emergency power, and debris removal. But other than some early plans that Corps planners briefly developed for the Virgin Islands after Irma, there was no Corps template for repairing an electrical grid.¹³

In fact, FEMA’s 2014 Concept of Operations indicated that providing temporary power was the only manner in which the U.S. Army Corps of Engineers (USACE) was supposed to respond to a blackout. “It is important to note that due to laws and regulations assistance is limited to facilitating restoration, not directly restoring or permanently repairing infrastructure,” the plan stated. “USACE can provide temporary power generation but they cannot fix transmission lines; fixing transmission lines is the responsibility of the owners. FEMA can mission assign the transportation of power crews to assist in restoration but the work of the power crews is under the authority of the companies they work for.”¹⁴

USACE Preparation for Maria’s Arrival

The Corps’ own planning for hurricane season started in the spring of 2017. In June it updated its Operation Plan 2017-11 (its plan to respond to any kind of hazardous event) and reiterated the Corps’ emergency response role under the National Response Framework,

which FEMA had updated the previous year. Under Operation Plan 2017-11, the Corps was prepared “to provide domestic and international technical engineering support to disaster response operations, military contingencies and stability operations through the use of forward deployed personnel, teams and units with reach back capabilities.”¹⁵ Corps planners also included specific scenarios as hypothetical exercises, such as major earthquakes in southern California and Alaska, but not one based on a major hurricane directly impacting American territory in the Caribbean.

The plan called for hurricane modeling to be carried out by South Atlantic Division’s Readiness Support Center and for multiple districts to provide teams to carry out the standard Corps missions that often followed a storm, such as debris management, temporary roofing, and infrastructure assessment. The plan specifically tasked Pittsburgh District with leading the initial mobilization of all temporary emergency power missions that FEMA assigned.¹⁶ Pittsburgh’s role would be crucial in the responses to both Hurricanes Irma and Maria, where installing generators at critical facilities was one of the most urgent needs in the Virgin Islands and Puerto Rico.

In August 2017, South Atlantic Division (SAD) leadership, along with emergency managers from several of the Corps’ southeastern districts, participated in an exercise that simulated how each district would react to a hurricane and how the division would balance resources to support the impacted districts. At the end of the month, Hurricane Harvey caused devastating flooding in a large section of the Texas coast. While the Southwestern Division (SWD) coordinated the response to Harvey, Brig. Gen. Diana Holland of the neighboring South Atlantic Division observed the Corps’ response in Texas closely. Prior to taking command of SAD in July 2017, Holland had been commandant of cadets at West Point and deputy commanding general of the 10th Mountain Division, and she had led several combat engineering and construction units, but this was her first assignment with the Corps of Engineers.¹⁷ “So for me,” said Holland, “number one being new to USACE, and number two being new to this level of disaster response... I watched Colonel [Paul] Owen and SWD very closely just to see the types of things that he was doing, how he was responding. I talked to him as well about what it was he would have done differently if he could start all over again.”¹⁸ Very soon she would be putting those observations to use.

Maria’s Impacts

Hurricane Maria developed from a tropical wave off the west coast of Africa on September 12, 2017. For the next several days, the National Hurricane Center tracked the storm across the Atlantic Ocean as it strengthened from a tropical depression into Tropical Storm Maria about 665 miles east of Barbados on September 16.¹⁹ Over the next two days a lack of wind shear coupled with warm ocean temperatures caused Maria to intensify rapidly as it approached the Leeward Islands. Maria became a major hurricane,

reaching Category 5 strength on September 18 just before making a catastrophic landfall on Dominica, becoming the strongest storm on record to strike that island.²⁰ After weakening slightly as it blasted Dominica, Maria achieved its peak intensity over the eastern Caribbean with maximum sustained winds of 172 mph.

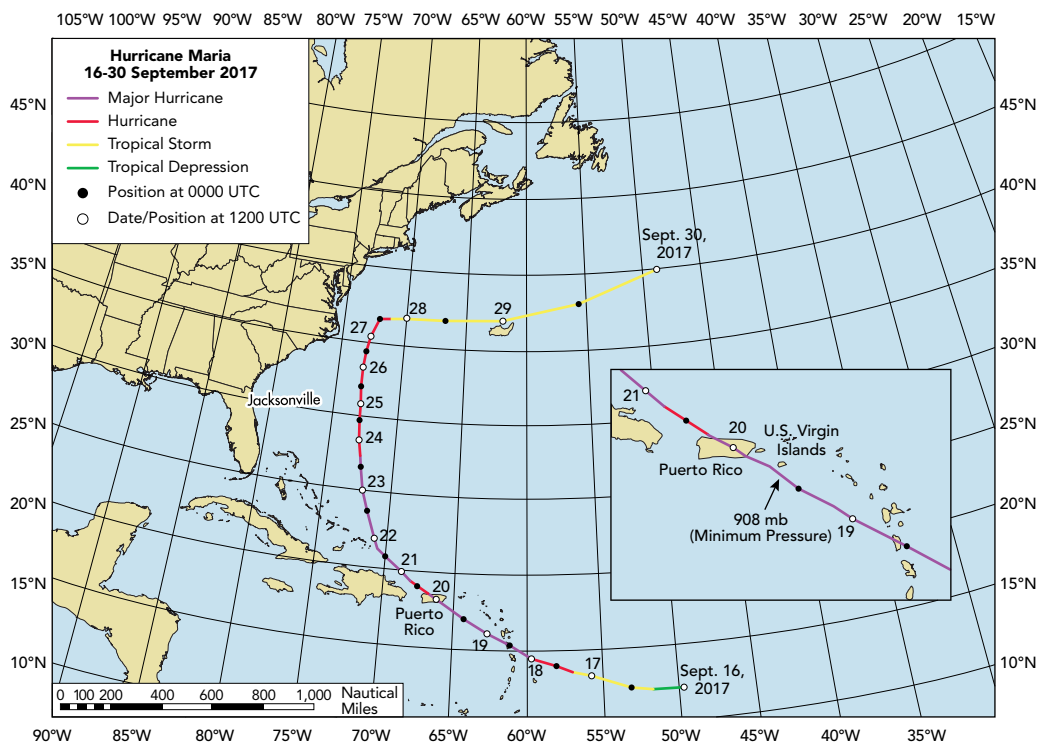
Prior to and during the formation of Hurricane Maria, Corps personnel deployed to the Caribbean to support Hurricane Irma response efforts as part of Task Force VIPR (Virgin Islands and Puerto Rico). On September 6, 2017, Irma had made landfall in the British Virgin Islands as a Category 5 storm, with incredibly destructive 178 mph winds. In the nearby U.S. Virgin Islands, Irma boasted wind gusts as high as 135 mph and also caused extensive damage there.²¹ Less than two weeks later, on September 17, as Hurricane Maria quickly intensified and moved towards the eastern Caribbean, officials suspended Hurricane Irma response efforts. Shipments of generators from Puerto Rico, temporary roofing material, and fuel trucks were paused. The Corps deferred the deployment of any additional responders from the mainland for ninety-six hours.²² The next day, September 18, FEMA requested that all non-essential personnel evacuate from the Virgin Islands. The 127 Corps employees remaining—78 in the Virgin Islands and 49 in Puerto Rico—sheltered in place at locations such as the Task Force VIPR Recovery Field Office (RFO) at the Lionel Jackson Readiness Center in St. Croix.

By September 19, the day before Maria's arrival in Puerto Rico, the Puerto Rican government had opened five hundred schools and other buildings as shelters. The *New York Times* reported that 2,756 people had relocated to a shelter. Although PREPA had restored power to 98 percent of the island after Hurricane Irma, there remained about sixty thousand customers without power. Maria would greatly extend the length of the blackout those survivors of two hurricanes faced.

Before making landfall in Puerto Rico on September 20, Maria weakened slightly to a very high Category 4 hurricane, but its destructive area grew in size.²³ The storm hit the coast near Yabucoa on the southeastern side of the island around six o'clock in the morning local time with winds of 155 mph—the most intense storm to strike the island in eighty-nine years. The center of the hurricane raged across Puerto Rico, roughly diagonally from southeast to northwest, for several hours and re-entered the Atlantic around two o'clock in the afternoon. The storm's interaction with the island's landmass below it further weakened the hurricane, though it later regained some strength as it moved northeast of the Bahamas. Moving slowly to the north, Maria gradually degraded and weakened to a tropical storm on September 28. Maria then accelerated towards the east and later east-northeast over the open Atlantic, becoming extra-tropical on September 30 and dissipating by October 3. The Outer Banks of North Carolina experienced tropical-storm-force winds on September 26, but otherwise the storm did not impact the continental United States.

Figure 2.1: Tracking Hurricane Maria

Best and final track positions for Hurricane Maria, Sept. 16–30, 2017. Redrawn from data from the National Oceanic and Atmospheric Administration.



Maria's greatest damage to the United States was in Puerto Rico, and consequently the focus of the Corps' response to Maria was in the commonwealth. The entire island experienced major hurricane winds. "It was as if a 50- to 60-mile-wide tornado raged across Puerto Rico, like a buzz saw," said Jeff Weber, a meteorologist with the National Center for Atmospheric Research. "It's almost as strong as a hurricane can get in a direct hit."²⁴ The commander of the Corps' South Atlantic Division, General Holland, gave a similar description: "If you were to start at the southeast end of the island, it looks like a fireball hit that coast and just made a run right through the middle of the island...and it rolled right through their rainforest that is known for being bright green. It just looked like it stripped the life out of the vegetation on that path.... It's the same with the homes that are in that path. I mean roofs were completely removed. Appliances were out in the fields...."²⁵

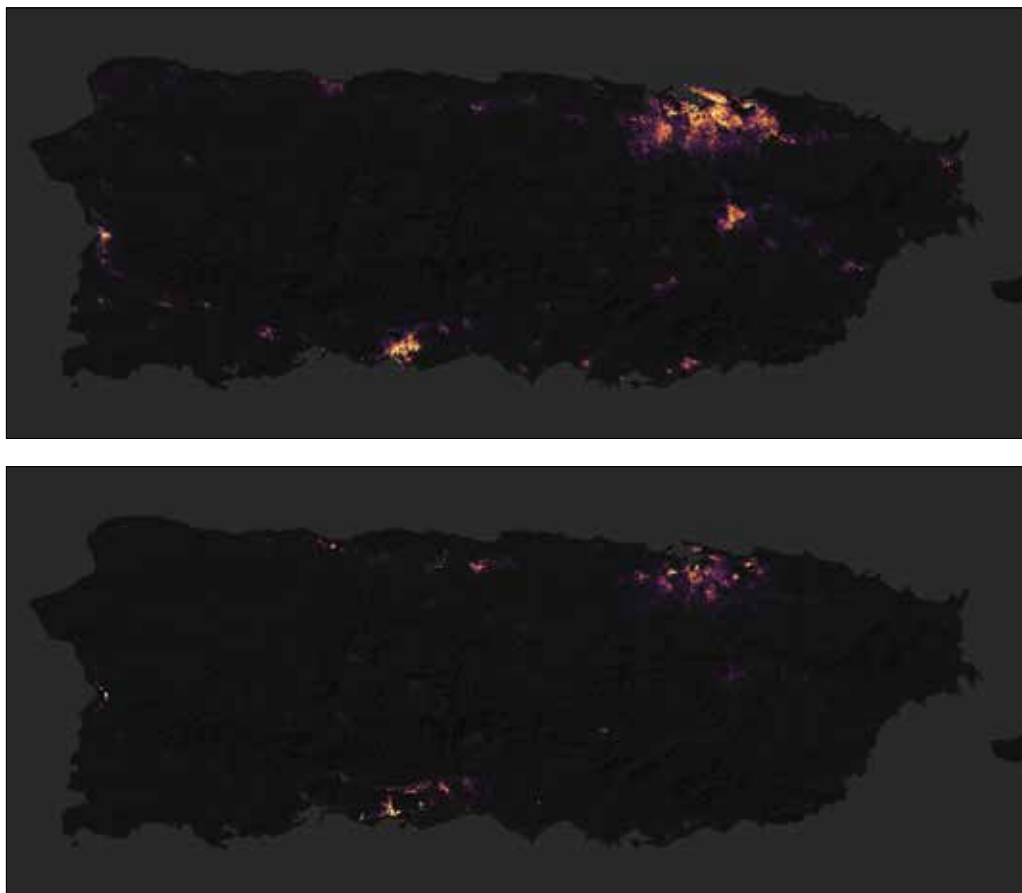
The United States Geological Survey measured high water marks of 5.1 feet above ground level inside structures at Punta Santiago in the municipality of Humacao near the area where Maria made landfall.²⁶ Local reports estimated nearby storm surges as high as nine feet above ground level and at least several feet of storm surge around most of the rest of the island. Instruments recorded wind gusts of 109 mph at Yabucoa Harbor



Flooded streets in Canóvanas Municipality. Governor Ricardo Rosselló visited areas affected by Hurricane Maria in the municipalities of Loiza and Canóvanas and the surrounding areas, Sept. 21, 2017. Personnel from the Federal Emergency Management Agency took part in this visit to survey the damage left in the aftermath of the hurricane. (National Guard photo by Spec. Hamiel Irizarry)

and 118 mph at Camp Santiago shortly after landfall and before many of the gauges were destroyed. In addition to wind, the storm brought very heavy rains across the entire commonwealth, with rainfall peaking at 37.9 inches in Caguas. Much of the island received more than twenty inches of rain. Flooding from rainfall and storm surge affected the capital, San Juan, with waist-deep water in some areas. Coastal neighborhoods were heavily damaged. Numerous structures lost their roofs.

The *New York Times* reported that the entire island was without power and the town of Toa Baja near San Juan was inundated by the La Plata River as well as water released by the Puerto Rico Aqueduct and Sewer Authority from La Plata Lake Dam in Toa Alta to prevent damage to the structure. By Friday, September 22, rescuers had saved more than 2,000 people from the second stories of homes around Toa Baja. At least eight people died from the flooding, and many others were likely not accounted for in the chaotic aftermath of the flood.²⁷ Initial estimates of the overall death toll from the storm were unrealistically low because communication was cut off and remote municipalities could not assess the storm's impacts. Even two weeks after landfall only 34 deaths were officially attributed to the storm.²⁸



Before and after processed images of Puerto Rico's nighttime lights. The upper image is a baseline from before Hurricane Maria; the lower image is a composite from Sept. 27-28, 2017. (NASA Earth Observatory images by Joshua Stevens, using data courtesy of Miguel Román, NASA GSFC, and Andrew Molthan, NASA MSFC)

During the storm, thousands of homes suffered varying degrees of damage while large swaths of vegetation were shredded by the hurricane's violent winds. According to *New York Times* reporting, Hurricane Maria ruined approximately 80 percent of the commonwealth's crop value, a loss estimated at \$780 million.²⁹ Most important, the island's electrical grid was catastrophically damaged—PREPA's estimate was that 80 percent of the transmission and distribution system was lost—leaving most of Puerto Rico's 3.4 million residents without electricity.³⁰ In terms of the total hours of service lost by the number of customers (households and businesses), Maria caused the largest power outage in American history.³¹

Despite having coped with frequent smaller storms in the Caribbean for years, Puerto Rico was poorly prepared for this worst-case, island-wide storm disaster. Maria left few undamaged areas to stage support to the rest of the island. "It passed over and affected the

entire island,” said Miguel Román, a member of NASA’s disasters response team, comparing the scale of destruction to the mainland United States. “Imagine if a hurricane started in Florida and ended up in Washington State. That’s what we’re dealing with here.”³² Every airport and seaport on the island closed to commercial traffic for the first several days after the storm. Generators powering critical facilities had not been tested to run for long periods of time, damage to roads slowed emergency services, and without power, water supply systems failed. With food and water distribution limited, a humanitarian crisis was looming. Although the relief effort initially was hampered by communications challenges, the eventual scale of the federal response to Maria reflected the growing recognition of a dire situation in Puerto Rico and the limited resources the commonwealth had available.³³ In July 2018, FEMA released a hurricane season after action report that called the 2017–2018 government relief response “the longest sustained air mission of food and water delivery in FEMA history.”³⁴

The storm’s profound impacts lingered throughout Puerto Rico for weeks. On September 26, nearly a week after the storm, *USA Today* reported 95 percent of the island was without power, less than half the population had tap water, and 95 percent of the cell towers on the island were still out of service. A week later the *New York Times* noted that 89 percent of residents still had no power, 44 percent had no water service, and 58 percent had no cell service. A month after the storm, the commonwealth government’s emergency response website, *Status.pr*, which it had set up to provide more accurate information during the long recovery, reported only 18.5 percent of the island had electricity, 49.1 percent of cell towers were working, and 69.5 percent of customers had running water, with restoration occurring more slowly in the north.³⁵ Sixty-six hospitals were open, but only forty-five of those were running on electric power from the grid. Ports and commercial flights were back to normal operations, but nearly 8 percent of U.S. post office locations, 12 percent of supermarkets, and 21 percent of gas stations were still closed. More than forty-two hundred people were still living in emergency shelters. Although many basic services would be completely restored by the end of the year, damage to housing, persistent power failures, and the continuing lack of jobs motivated many citizens to leave Puerto Rico. Over the next six months, more than one hundred thousand survivors would relocate to the U.S. mainland.³⁶

The economic impact of Hurricane Maria was severe and widespread, and scholars continue to analyze it three years later. More than a week after the hurricane struck, many residents waited in long lines at ATMs to withdraw cash. Tourism was heavily impacted, even with the return of some cruise lines in late October. In June 2018, the board established by the Puerto Rico Oversight, Management, and Economic Stability Act released a report that estimated that Maria would reduce Puerto Rico’s GNP by 9 percent over pre-storm levels.³⁷ Forty percent of the island’s population was still living below the poverty

Revising Maria's Death Toll

The number of deaths in Puerto Rico that can be attributed to Hurricane Maria was a contentious and evolving issue in the months following the storm. The official count of deaths resulting directly from the storm remained quite low for nearly a year. The earliest statistic for confirmed deaths related to Hurricane Maria in Puerto Rico was only sixteen. On October 3, 2017, Governor Ricardo Rosselló told reporters at a news conference in San Juan that the death toll related to Hurricane Maria had risen to thirty-four. In December Puerto Rico's Department of Public Safety announced that the official count was sixty-four.

Several studies soon suggested the number of deaths could be much higher than that. A December 2017 review by the *New York Times* of daily mortality data from Puerto Rico's vital statistics bureau indicated a significantly higher death toll from the hurricane than the commonwealth government acknowledged. The *Times*' analysis found that in the forty-two days after Hurricane Maria made landfall on September 20 as a Category 4 storm, 1,052 more people than usual died across the island.^a Other investigations found that the government of Puerto Rico did not follow federal guidelines to certify deaths in the month after the storm.^b

In late May 2018, a Harvard University team of researchers published a study in the *New England Journal of Medicine* estimating a wide range of deaths that could be attributed to the storm—from 793 to 8,498.^c *CNN* reported that the study's midpoint estimate of 4,645 deaths became a rallying cry for activists in June who were upset by what they saw as "a lack of accountability for the scale of the catastrophe by officials in Puerto Rico

and the United States."^d A research letter published in early August in the journal of the American Medical Association, *JAMA*, from researchers at the Pennsylvania State University also used a method of counting excess deaths based on Puerto Rican government data.^e The Penn State study concluded that there were likely 1,139 deaths related to Maria.

In February 2018, Puerto Rico Governor Rosselló called for an independent review of the commonwealth's official count. The Milken Institute School of Public Health at the George Washington University (GWU) conducted that independent review, and their study concluded that there were far more deaths that could be attributed to the aftermath of the storm than the official count. The researchers calculated that there were nearly 3,000 "excess" deaths, compared with average mortality rates and factoring in migration from the island, in the six months after Maria made landfall, between September 2017 and February 2018.^f The GWU study also noted higher risks of death after the storm in certain municipalities and among specific demographic groups.

"The risk of death was 45% higher and persistent until the end of the study period for populations living in low socioeconomic development municipalities, and older males (65+) experienced continuous elevated risk of death through February," the GWU researchers found. "40% of municipalities saw significant increases in mortality during the study period than in the comparable period of the previous two years."^g On the same day the GWU report was released publicly, August 28, 2018, Governor Rosselló increased the commonwealth's official death toll from Hurricane Maria from 64 to 2,975.^h

Notes

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line, and 10 percent of small businesses—eight thousand in total—had not reopened. A year after the storm, the Puerto Rico Planning Board, which is part of the governor's office, estimated that the impact of Hurricane Maria on the island's economy was a loss of at least \$43 billion. This figure included calculations for the positive impacts of federal recovery funding and insurance payouts.³⁸

Over fifty pharmaceutical companies halted their manufacturing on the island right after the hurricane. The manufacturing of medical devices and pharmaceuticals had made up 30 percent of Puerto Rico's economy. In 2016, Puerto Rican pharmaceuticals represented 72 percent of the island's exports—including "exports" to the U.S. mainland—with a value of \$14.5 billion, and the Puerto Rican sector accounted for 25 percent of all U.S. pharmaceutical exports.³⁹ The halt in pharmaceutical manufacturing on the island caused a one-month-long shortage in medical supplies throughout the United States, especially of IV bags, forcing health care providers to scramble behind the scenes for alternative methods to administer drugs to their patients.⁴⁰

Initial Limited Recovery Efforts

The large federal relief operation in response to Hurricane Maria built on capabilities already in place from the response to Hurricane Irma. With the Virgin Islands severely damaged by Irma, the closest places to stage personnel were on Puerto Rico and nearby islands and ships in the Caribbean. As Maria approached two weeks later, FEMA's National Response Coordination Center in Washington remained fully activated with all emergency

support functions operational, including liaisons to the Department of Defense (DoD).⁴¹ The Corps maintained its own liaisons at two of FEMA's regional offices: Region IV in Atlanta that was already responding to Irma in Florida and Region II in New York that would lead the response to Maria in the Caribbean.⁴² On the ground in the Virgin Islands, pre-positioned FEMA personnel already responding to Irma included federal coordinating officers, Incident Management Assistance Teams, and staff from the agency's Caribbean Area Division.

Maj. Gen. Donald E. Jackson, Jr., Deputy Commanding General for Civil and Emergency Operations at Corps of Engineers headquarters, kept the National Security Council and Congress informed of the Corps' relief activities. The Corps also participated in daily meetings with personnel from FEMA, DoD, and the Department of Homeland Security (DHS).⁴³ The Office of the Secretary of Defense was very involved in the FEMA-led relief effort, and the U.S. Army Northern Command deployed regular Army forces in addition to the National Guard as part of its contribution to the relief effort.

The U.S. Navy had previously established and deployed Combined Task Force 189—composed of the ships USS *Kearsarge*, USS *Wasp*, and USS *Oak Hill* with about forty-five hundred sailors and marines and multiple helicopter squadrons—to provide hurricane relief to the Virgin Islands following Irma.⁴⁴ As Hurricane Maria approached, the Navy used two landing craft to transport relief workers, support personnel, and equipment from St. Thomas, St. John, and St. Croix to the *Kearsarge*. Many responders thus rode out the storm onboard the *Kearsarge* south of Puerto Rico so as to be in place to continue their operations as soon as the storm passed. Forty USACE personnel sheltered on St. Croix and thirty-eight remained on St. Thomas during Hurricane Maria.⁴⁵

In a press release on September 20, while Maria was still tearing across the island, DoD officials outlined additional storm preparations involving various National Guard units. The Puerto Rico National Guard was calling up about 500 of its members, and 820 National Guard soldiers from the Virgin Islands and other states were sheltering in place in the islands. The Kentucky and Tennessee Army National Guard positioned six UH-60 medevac Black Hawk helicopters in Puerto Rico. In addition, the National Guard moved three of its Hercules C-130 transport planes from San Juan to Florida so they could be ready to assist with the response starting on September 21.⁴⁶

The first requirement after the storm began to move off the island was re-opening San Juan's international airport to military flights. Within hours of Hurricane Maria's winds dropping to safe speeds, U.S. Air Force aircraft landed at San Juan under night vision conditions and Air Force personnel set up infrared beacons and established minimal power supplies to allow subsequent aircraft to land safely. In the first two days after the storm, Army National Guard contingency response and special tactics teams reopened six airfields in Puerto Rico and the Virgin Islands.⁴⁷ According to FEMA's 2014 response



Sailors aboard the amphibious assault ship USS *Kearsarge* processed service members evacuated from St. Thomas, U.S. Virgin Islands, in anticipation of Hurricane Maria, Sept. 17, 2017. (U.S. Navy photo by PO3 Ryre Arciaga)

plan, the military had to establish an “air/sea bridge” as soon as possible in order to send relief supplies and personnel to Puerto Rico and its outlying islands. Limited capacity on the ground caused by weakened and destroyed facilities encumbered this effort in 2017, but responders improvised. For example, Roosevelt Roads Naval Air Station, a major alternate airfield to San Juan, had been closed in 2004, but during the recovery efforts several units flew into the abandoned base and set up relief efforts there anyway. FEMA continued coordinating federal efforts to reopen more of Puerto Rico’s air and seaports and bring in essential relief supplies.⁴⁸ In the initial three weeks after Maria made landfall, the Joint Force Land Component Command flew more than fourteen hundred sorties in support of relief efforts, and by December that number would increase to twenty-two hundred.⁴⁹

In addition to flights involved in the relief effort, extremely limited commercial traffic also resumed at San Juan’s international airport in late September.⁵⁰ By September 26, a dozen commercial flights were operating daily, and by October 3, there were thirty-nine commercial flights per day from all Puerto Rican airports, about a quarter of the normal number.⁵¹ Normal commercial airport operations resumed later that week, but it remained

difficult for many travelers to get a seat on a flight off the island as a growing number of Puerto Ricans chose to temporarily relocate to the mainland.

The widespread destruction of power and communications infrastructure in Puerto Rico challenged the usual federal disaster response process because it meant that the commonwealth's government could not adequately assess what support it required, and it initially failed to request aid for some of its most dire needs, such as electrical grid repair. Even the Puerto Rico Emergency Management Agency's offices were heavily damaged.⁵² This lack of guidance was an unexpected challenge for federal agencies, who usually expect to address the needs identified by the state. "When the coast of Florida or Texas is hit by a storm, given their size, un-impacted regions of the state can lend assistance to the response effort," explained General Jackson. "When a storm hits Puerto Rico or the U.S. Virgin Islands, the whole territory is impacted. Many of the initial challenges came from a lack of command and control and situational awareness. Because the federal government relies on the authorization and direction of the state or territory in responding to emergency situations, it adds a new layer of complexity when calamity strikes a location that renders the government incapable of quickly assessing or communicating their need."⁵³

Early reporting indicated that the confusion left by the storm led to a delay in the arrival of responders from both federal agencies and voluntary organizations.⁵⁴ Another partial reason why the initial relief effort was limited is because resources and personnel were already allocated elsewhere to respond to the consecutive disasters of Hurricane Harvey and Hurricane Irma in August and September 2017.⁵⁵ But by Friday, September 22, more than seven thousand federal civilian and military personnel—including 280 FEMA staff and 1,600 National Guard soldiers—were on the ground in Puerto Rico and the U.S. Virgin Islands to support response and recovery operations in the wake of Hurricanes Irma and Maria.⁵⁶

The initial relief effort following Hurricane Maria was also impeded to a lesser degree by the Jones Act, also known as the Merchant Marine Act, which prohibits foreign-built and operated ships from transporting cargo between U.S. ports. This restriction meant that only U.S. carriers could bring supplies to Puerto Rico without paying fees and tariffs. In 2016 U.S. carriers represented less than 1 percent of the global merchant marine fleet.⁵⁷ In the aftermath of Hurricane Irma, DHS Acting Secretary Duke approved a waiver of the Jones Act which lasted until September 22. That meant that during the week following Maria's landfall in Puerto Rico, the Jones Act was back in force and only U.S. ships could deliver aid to the island. On September 28, DHS temporarily waived the act again to benefit relief operations for Maria, partly at the recommendation of Defense and Homeland Security officials.⁵⁸

More federal aid arrived on September 24 when major ports reopened. Eleven cargo ships carrying 1.6 million gallons of water, 23,000 cots, food, and dozens of generators



U.S. Coast Guard crewmembers and partner agencies unloaded food and water from a Marine Corps Expeditionary Unit UH-1 helicopter in Utuado, Puerto Rico, Sept. 29, 2017. (U.S. Coast Guard photo by PO2 Meredith Manning)

arrived in San Juan.⁵⁹ Corps of Engineers and National Oceanic and Atmospheric Administration (NOAA) surveying crews, with support from the U.S. Coast Guard, had made the reopening of ports their first priority after the storm, and many key commercial shipping companies were able to resume operations within the week.⁶⁰

The most significant barrier to delivering aid turned out to be getting relief supplies out of the port. Although ships had delivered thousands of containers of supplies to the Port of San Juan, very few of those basic necessities, such as drinking water, food, and medical supplies, were immediately distributed across the island. Many roads were still too full of debris for trucks to pass. Some roads and bridges were completely washed away. Diesel also remained in short supply, limiting the number of trucks available to make shipments. Meanwhile, as goods piled up at the Port of San Juan, very little storage space remained to accept additional shipments.⁶¹ It was another month until an Army Rapid Port Opening Element and a Navy Expeditionary Port Unit, working together as part of the U.S. Transportation Command's Joint Task Force Port Opening, started operating a large receiving area for recovery supplies at the Port of Ponce on the south coast of the island.⁶² The Port of Ponce would later serve as the primary receiving site for the heavy equipment and millions of parts the Corps would order to repair the power grid.

Water, fuel, and medicine remained critical areas of need. A week after landfall, an estimated 44 percent of the population of Puerto Rico remained without drinking water, and with growing recognition of the extent of the humanitarian crisis on the island, DoD adjusted its concept of operations from “a short term, sea-based response to a predominantly land-based effort designed to provide robust, longer term support,” with fuel delivery a top priority.⁶³ At the time, there were miles-long lines for gasoline for vehicles and diesel for personal generator fuel.⁶⁴ A joint Army National Guard and Marine Expeditionary Unit team established an Installation Staging Base at the former Roosevelt Roads Naval Air Station; they transported Department of Health and Human Services assessment teams via helicopter to hospitals across Puerto Rico to determine medical requirements.

On September 28, U.S. Army Lt. Gen. Jeffery S. Buchanan arrived in Puerto Rico to coordinate the joint forces land-based hurricane relief efforts on the island and to act as the Department of Defense’s primary liaison to FEMA.⁶⁵ General Buchanan, Commander of U.S. Army North, was sent by U.S. Northern Command—the Department of Defense organization responsible for military support of civil authorities after a disaster—as the response efforts transitioned from a sea-based to a land-based operation. While Northern Command, working for FEMA, had been involved with both the responses to Harvey and Irma previously, this forward-deployed role for General Buchanan in Puerto Rico was special. Puerto Rico was different from Florida and Texas, which both had robust emergency management agencies and large numbers of National Guard available to respond to disasters. Puerto Rico, in terms of its capabilities compared to the scale and ferocity of the storm, was overwhelmed. Buchanan’s presence on the ground with a significant headquarters, Joint Forces Land Component Command, was necessary to coordinate a larger federal response than had followed Harvey and Irma.⁶⁶

The urgent need was to distribute the thousands of containers of supplies that were stuck in port receiving facilities.⁶⁷ Since local government was still struggling to pull its resources together, federal responders had to move the supplies. U.S. military forces had to provide more helicopters to shuttle supplies to remote areas while roads were still impassible, and Marines, National Guard, and the Corps of Engineers all had to focus on clearing those roads. On September 29, Buchanan announced that there were efforts under way to bring in more troops. “For example, on the military side, we’re bringing in both Air Force, Navy and Army medical capabilities in addition to aircraft, more helicopters,” said Buchanan. “[But] it’s not enough, and we’re bringing more in.”⁶⁸

The same day, the 250-bed hospital ship USNS *Comfort* left port at Norfolk, Virginia, arriving in San Juan on October 3. A couple of days later, *Comfort* departed on an around-the-island tour to assist storm victims. The ship remained a dozen miles offshore, and patients were brought to it by helicopter or boat tender after being referred by Puerto Rico’s Department of Health. However, most of the state-of-the-art floating hospital went

Funding Disaster Relief

Because the major natural disasters of 2017 followed one after another, creating overlapping and compounding needs that became clearer over time, Congress responded with multiple packages of relief funding.^a In total, Congress had authorized about \$136 billion as of July 2018 across several different federal programs. The first round of funding was a response to the severe wind damage and vast areas of flooding produced by Hurricane Harvey in southeast Texas in late August 2017. On September 1, the Trump administration requested \$7.8 billion in supplemental funding for relief operations in response to Hurricane Harvey. On September 6, the House quickly passed the relief package requested by the administration as an amendment to H.R. 601, the Continuing Appropriations Act for the following fiscal year, 2018. The final bill passed by both houses of Congress on September 8—just as Hurricane Irma was threatening the state of Florida—also included \$7.4 billion for disaster relief through the Department of Housing and Urban Development's Community Development Fund. That same day President Trump signed it into law as Public Law 115-56, which authorized a total of \$15.3 billion in funding.^b

Hurricane Irma made landfall in Florida two days later, but it did not produce as much damage across the peninsula as anticipated. The storm did, however, cause widespread destruction in the U.S. Virgin Islands and the Florida Keys.^c Hurricane Maria followed less than two weeks later. Combined, the major hurricanes of 2017 caused over \$250 billion in damages.^d Given the growing awareness of the magnitude of relief needs, on October 4 the Trump administration requested an additional \$12.7 billion for the Disaster Relief Fund—an appropriation that

Federal Emergency Management Agency (FEMA) uses to fund relief efforts. On October 12, the House passed another supplemental appropriation (H. R. 2266) that included the president's request and added \$18.7 billion for the Disaster Relief Fund. The House bill also allowed some of that funding to be transferred to other programs. For example, \$4.9 billion would go to FEMA's Disaster Assistance Direct Loan Program account, which the government of Puerto Rico could use to pay salaries and other expenses to avoid a local government shutdown.^e The bill subsequently became Public Law 115-72 on October 26, 2017, authorizing a total of \$36.5 billion in funding.^f

Major wildfires broke out in northern California in October and only added to the nationwide need for disaster relief. Over the next couple of months, damages across the state of California would reach nearly \$12 billion.^g The Trump administration made a third supplemental appropriations request for disaster relief and recovery funding on November 17, 2017, seeking roughly \$44 billion in additional funding. Unlike the previous two requests, congressional action was delayed by an intense political showdown over the budget and immigration policy that lasted into January 2018.^h Not until February 7 did the Senate take up H.R. 1892, which became known as the "Bipartisan Budget Act of 2018" (BBA). An amendment to the budget act included more than \$84 billion in additional disaster assistance funding, and FEMA received an additional \$23.5 billion in funding authority for the Disaster Relief Fund from that amount. The House passed the amended bill and President Trump signed it into law as Public Law 115-123 on February 9, 2018.ⁱ

The BBA also waived requirements of the 1988 Stafford Act that had limited FEMA funding only to emergency repairs of the electrical systems in Puerto Rico and the Virgin Islands.^j Subsequently FEMA could use BBA funds to help the Puerto Rico Electric Power Authority (PREPA) rebuild sections of the grid to current mainland utility standards. Finally, the BBA provided more than \$15 billion in construction funding in hopes of beginning a process for rehabilitating and eventually improving Puerto Rico's federal infrastructure. All repairs to Corps projects damaged in Puerto Rico and the Virgin Islands were completely federally funded from this amount.^k The same fund pays for the study, design, and construction of ongoing Corps projects in Puerto Rico, without any cost-sharing requirements for the commonwealth.

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unused, even though island clinics and hospitals were overburdened, because there were too few referrals. Governor Rosselló explained on October 17 that the "disconnect...was in the communications flow," and added that he had asked "for a complete revision of that so that we can now start sending more patients over there."⁶⁹ After remaining offshore for three weeks, the *Comfort* docked in San Juan on October 27, briefly departing only once to restock at sea from a naval resupply ship. By November 8, *Comfort's* staff had treated 1,476 patients, to include performing 147 surgeries and assisting with two births.

A little more than two weeks after the storm, U.S. Northern Command continued to distribute commodities by ground and air in support of FEMA's ongoing relief efforts in Puerto Rico. The Defense Logistics Agency was planning to distribute up to 2.5 million gallons of water in Puerto Rico. By October 6, DoD supplied more than 162,000 gallons

of water in bulk, 44,000 gallons of fuel, 1.5 million meals, and 2.99 million bottles of water to regional support areas; additionally, it delivered 106,000 meals and 244,000 bottles of water directly to municipalities on the island.⁷⁰

One lasting criticism of the initial federal relief effort was that it could have been much larger. In 2010, when a magnitude 7 earthquake struck Haiti, a massive military and civilian response followed. The first U.S. troops arrived two days after the quake, and within two weeks more than twenty-two thousand troops were assisting with the recovery.⁷¹ In contrast, after Hurricane Maria, only about nine thousand military personnel, including four thousand National Guard, deployed to conduct recovery operations within two weeks of the hurricane's landfall.⁷² Nearly a month after the storm, in mid-October, the number of troops had increased to 14,300, and the number of military helicopters had more than doubled to 68. "We're getting a lot done, but we have a long way to go," said General Buchanan in an interview with Department of Defense News.⁷³ At that point, most of the troops in Puerto Rico were logisticians, medical specialists, and aviation specialists, according to Buchanan. Military personnel were still delivering food, water, and fuel to the people who needed it. "We bring supplies in [to the major ports] and we distribute to regional staging areas with FEMA," he said. "The Puerto Rican National Guard pushes it out from there."

Although both are Caribbean islands, Puerto Rico is a territory of the United States, and therefore the legalities of the relief efforts in Haiti differed from those in Puerto Rico.⁷⁴ For an operation on U.S. soil, a different set of rules for engagement of military forces applies. The laws that govern these issues, such as the Posse Comitatus Act of 1878, date back to the end of Reconstruction and limit how the Army can be used within the United States. Amended several times over the last 150 years, these laws essentially serve as guidance for the military role in domestic disaster relief.⁷⁵ The Puerto Rican government was supposed to be in the lead, and FEMA was supporting the commonwealth. The Defense Department, in turn, was supporting FEMA. In principle, only when civilian resources were inadequate to respond would a larger military response be appropriate. For there to be greater military involvement, both the commonwealth and FEMA would have to request that support.

Research by the Harvard Humanitarian Initiative indicated that coordination between civilian and military agencies eventually was successful in Maria's aftermath, but the federal government initially failed to understand the full scale of the disaster. Researchers reported that: "Puerto Rico's government was completely overwhelmed, making it very difficult for FEMA and the U.S. military to get a clear picture of what was most urgently required—and where—in the first days after the storm. The island's total power outage, in particular, hobbled emergency aid. Troops and FEMA staff deployed across the island could not communicate with affected communities."⁷⁶ Communications failures and weaknesses would remain an issue throughout much of the early recovery efforts.

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Structural engineers Christopher Bamberg and Ariel Marrero Irizarry spoke with elementary school principal Eduardo Hernandez on Oct. 20, 2017. The school lost a special needs classroom to Hurricane Maria. Over the first month after the storm, the Corps and its partners assessed more than 250 schools between San Juan and Mayagüez for damages. (USACE photo by Brigida Sanchez)

— CHAPTER 3 —

THE CORPS RESPONDS TO MARIA, SEPTEMBER-DECEMBER 2017

In the first weeks after the storm, several major challenges arose that were atypical of the Corps' more routine disaster response operations. The day before landfall, September 19, 2017, the Federal Emergency Management Agency (FEMA) had issued almost all of the Corps' standard ESF-3 missions (Public Works and Engineering), which included setting up a Recovery Field Office (RFO), conducting infrastructure assessments, removing storm debris, providing generators for emergency power, and installing temporary roofing materials. The Puerto Rico Electric Power Authority (PREPA) was struggling to make the most essential repairs to the grid, but the mission to restore power would not become the Corps' primary and defining effort in Puerto Rico until October.

When Maria made landfall in Puerto Rico on September 20, 127 Corps personnel were already in the U.S. Virgin Islands and Puerto Rico.¹ It was those Corps employees—especially the staff of the Antilles Area Office, who had developed relationships with local agencies over years—who first helped the Corps assess the situation on Puerto Rico after the storm.² Recovery efforts in response to Hurricane Irma were continuing across Florida, which was spared a second hit from Maria. At the time, the Corps' Jacksonville District was leading those missions in Florida, but it had handed off its FEMA mission assignments in the Virgin Islands and Puerto Rico to Wilmington District.³ Wilmington's recovery efforts in the islands following Irma were then delayed and degraded by the passage of Maria.⁴

Within a couple of days following the storm's landfall, the Corps, with U.S. Coast Guard and National Oceanic and Atmospheric Administration (NOAA) support, was surveying ports and navigation routes throughout the Virgin Islands and Puerto Rico. The Corps and NOAA survey crews had weathered the storm at Guantánamo, Cuba, and

boarded a Coast Guard cutter for San Juan early on September 21.⁵ The Corps' goal for this rapid response was to reestablish navigation and reopen ports to commercial shipping, with the first priority being delivery of critical relief supplies. The Port of San Juan reopened on September 23 under daylight-only restrictions. Using a Jacksonville District vessel stored at Fort Buchanan near San Juan, channel survey crews completed their assessments of San Juan Harbor the next day and then moved west to the Port of Arecibo. Daylight restrictions in San Juan remained in place until September 27, when the port was fully reopened to commercial shipping day and night. Surveys around the island continued, and all major Puerto Rican ports reopened, albeit some with restrictions, by October 1.⁶ It was another three weeks before many other private and smaller public ports around the island fully reopened.

For the Corps' South Atlantic Division (SAD), the initial emergency response to Hurricane Maria overlapped with the response to Hurricane Irma in several areas. The commander of the Jacksonville District, Col. Jason Kirk, compared the situation to having to respond to an enemy's "most dangerous course of action."⁷ Over a two-week period, large storms twice impacted the U.S. Virgin Islands and Puerto Rico. It was clear to SAD's commander, Brig. Gen. Diana M. Holland, that the multiple storms affecting the entirety of Jacksonville's area of responsibility meant that the division would have to send reinforcements for the district. Wilmington District, under the command of Col. Robert Clark, would handle ESF-3 FEMA mission assignments in the Virgin Islands while Mobile District, under Col. James DeLapp, would lead the initial response in Puerto Rico.⁸ The catastrophic impact of the storms was soon brought home by two reports that made it clear the Corps' response was going to be anything but by the book—first, that almost all power was out on the island, and second, that a major dam at Lake Guajataca was in danger of failing because of torrential rain and high water levels.

Setting up a Recovery Field Office

On Sunday, September 24, 2017, an advance team of thirteen Corps personnel, led by DeLapp, arrived in San Juan to establish a Recovery Field Office (RFO). DeLapp had assumed command of Mobile District in June 2016. He had previously been commander of the Nashville District and had spent two years at U.S. Central Command in Tampa, Florida, helping stand up the Joint Interagency Task Force to counter the Islamic State in Iraq and Syria. He had also been one of the writers of the Corps' after action report that focused on lessons learned from Hurricane Sandy in 2012.⁹ In Puerto Rico, the RFO would manage both the Corps' immediate response and the long-term recovery missions for FEMA. When USACE establishes an RFO, it's an indication that the Corps of Engineers recognizes the significant support needs following a major disaster and it demonstrates a commitment to scaling up and coordinating the Corps' work in the field for a significant period of time.



An advance team from Mobile District arrived in San Juan on Sept. 24, 2017. (USACE South Atlantic Division)

The Mobile District advance team was the first Corps of Engineers team from the mainland that deployed specifically to respond to Maria. It arrived via government aircraft belonging to the Mississippi Valley Division because commercial flights were still extremely limited and FEMA flights could not accommodate all the Corps' needs.¹⁰ In addition to the challenge of transporting the emergency responders, the Corps was dealing with a number of other unexpected complications during the first week after the storm: limited communications, seaports that were mostly shut down, few resources pre-positioned on the island, numerous storm-damaged roads blocked by debris, and their own emergency response infrastructure that was already stretched thin managing the response to two other major hurricanes.

In just one example of how these accessibility issues forced the Corps to modify its usual approach to emergency operations, it took until September 25 to get a mobile communications vehicle into Puerto Rico.¹¹ Normally, communications vehicles and larger emergency command and control vehicles are pre-positioned so they are ready to provide a tactical operations and communications platform in disaster areas as soon as conditions are safe for their deployment. These vehicles are vans and larger trucks modified to incorporate



Emergency Command and Control Vehicle deployed to the Port of Ponce, Oct. 22, 2017. (CEHO photo by Matthew Pearcy)

satellite communications, on-board generators, and some highly efficient office space. Following a disaster, these vehicles become part of a deployable tactical operations system used by the Corps to begin assessing the situation immediately and lay the groundwork for more personnel to arrive. In more practical terms, they provide internet and phone service to response teams in an area where communications are highly degraded. After Hurricane Irma, one mobile communications vehicle was already occupied in the Virgin Islands. The combination of Maria's uncertain path and the limited capacity on cargo flights meant that two other vehicles and their crews had to wait at Tyndall Air Force Base in Florida for eight days before the Air Force could airlift them to Puerto Rico.¹²

The urgent situation at Guajataca Dam (discussed below) and the growing awareness of catastrophic damage to the island's power grid made the situation even more unpredictable. "It was very dynamic," remembered Colonel DeLapp. "Those first, I'd say, ten days were probably some of the busiest I've had in all my time... because of the fast-moving pace, a lot of political pressure, and the limited resources that we had here on the ground."¹³ At first, Mobile District set up a temporary RFO at the Puerto Rico Convention Center in San Juan, where FEMA and other federal and local emergency management agencies had already established a Joint Field Office (JFO).¹⁴ Other responders continued to arrive.



Joint Field Office at the Puerto Rico Convention Center in San Juan where hundreds of FEMA staff and teams from other federal and commonwealth agencies worked together to support Hurricane Maria recovery, Oct. 3, 2017. (USACE South Atlantic Division)

A specialized infrastructure assessment Planning and Response Team (PRT) deployed from the Corps of Engineers' Charleston District on September 30. In Puerto Rico, the team was tasked with inspecting a wide range of damaged public buildings and facilities to determine if they were safe for use. Over the next couple of months, the team inspected 4 airports, 9 port facilities, 205 police stations, 1,131 schools, 260 sewer facilities, a bridge, a potential FEMA office, and a potential field hospital location. It also provided geotechnical assistance for specific mudslide locations on the island.¹⁵ Another team dedicated to managing the contracts awarded for repair of many of these critical public facilities to return them to full use operated in Puerto Rico over the next year, making thousands of safety inspections and repairs to 119 buildings at an estimated cost of \$15.3 million.¹⁶ Most of these repairs were to leaky roofs and to the interiors of buildings that had been damaged by water leaks from those roofs.¹⁷

During his first week in Puerto Rico responding to the emergency at Guajataca Dam, dealing with the arrival of multiple PRTs, standing up the RFO in San Juan, and seeing early indications that the Corps might be involved in repairing the electrical grid, Colonel

DeLapp realized clearly that the multiple rapidly-expanding missions in Puerto Rico and the U.S. Virgin Islands would require the Corps to establish a larger, multifaceted organization led by a general officer. The problem, and the Corps' response to it, was turning out to be similar in scale to the Corps' effort to repair Iraq's power grid after the fighting, sabotage, and looting in 2003. During a September 28 conference call with General Holland and Lt. Gen. Todd Semonite, Chief of Engineers, DeLapp described the need for a larger operation, comparing the current situation to some of the Corps' early projects in Iraq. "I knew about the Task Force RIE (Restore Iraqi Electricity), how it was organized, what level people were running that, plus Task Force RIO, Restore Iraqi Oil, so I was pretty intimately familiar with that and knew that there was a general officer, an SES [Senior Executive Service], helping run just those programs, and that this wasn't just a normal RFO mission."¹⁸

As the scale of the power restoration mission became clearer, and with multiple districts within South Atlantic Division fully occupied with responding to Irma and Maria, General Holland requested support from outside the division. Working with the Great Lakes and Ohio River Division, General Semonite chose Pittsburgh District, under the command of Col. John Lloyd, to lead the forthcoming grid restoration mission. Colonel Lloyd had previously been deployed to the Virgin Islands after Hurricane Irma—one among a number of Corps leaders who had supported the South Atlantic Division while it was so widely impacted by the storm—and Pittsburgh District had already been tasked with leading the initial temporary emergency power mobilization.

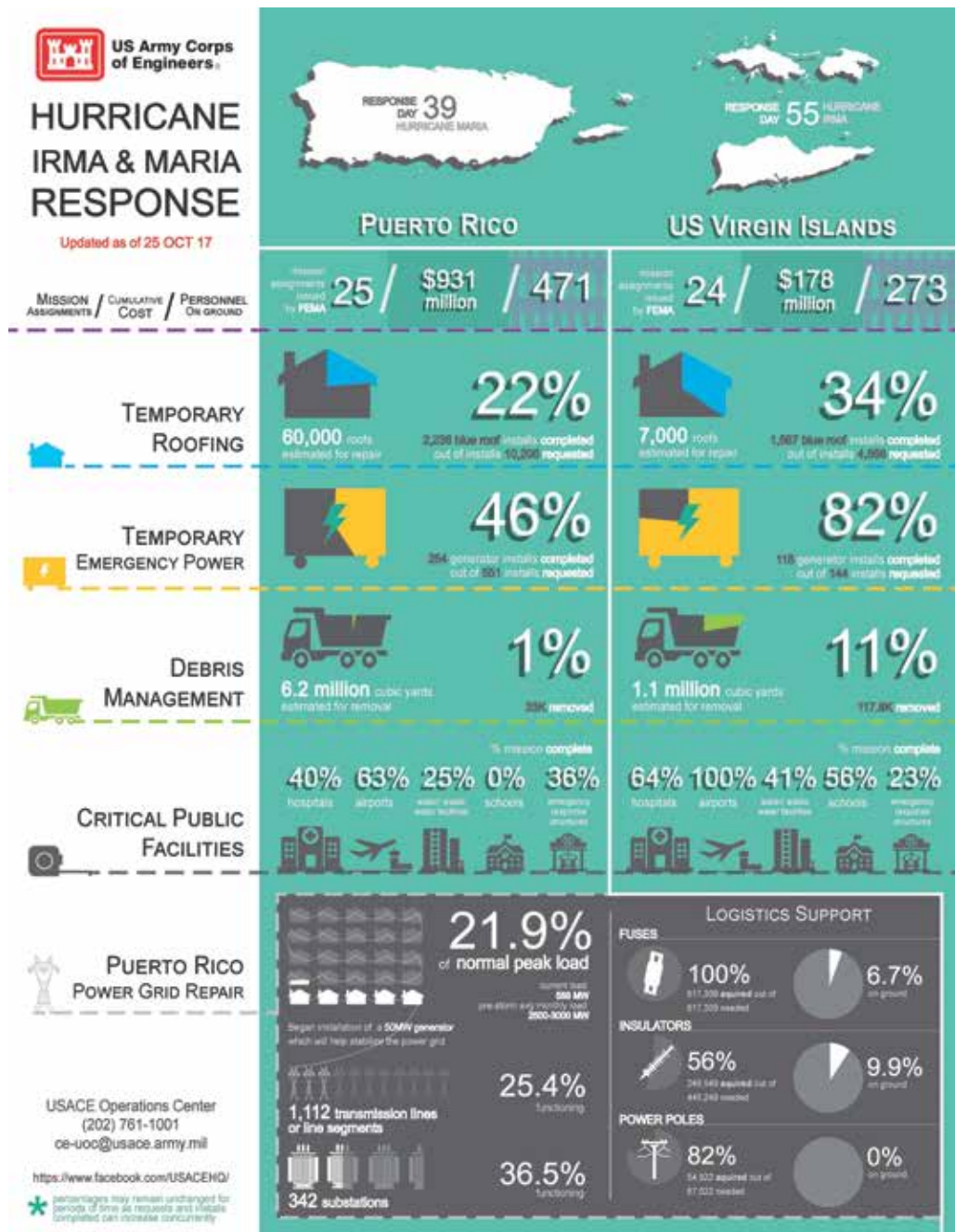
But with a new and larger power mission on the horizon, the complexity of the Corps' role in the federal response to Hurricane Maria was about to evolve substantially, and Holland felt that she needed to be on site to help coordinate and sustain projects in both Puerto Rico and the Virgin Islands. "On the way to Puerto Rico with the chief on 29 September," said Holland, "was when I recommended to the chief that, 'Now there are three districts on the islands. If we're going to have Pittsburgh, Mobile, and Wilmington, it's time to do something from a regional perspective to help manage all this, certainly in the chaos, the crisis period,...so that the colonels could concentrate on getting organized and executing the mission.'"¹⁹ As a result, General Holland remained in Puerto Rico and set up a forward command node for South Atlantic Division near the convention center in San Juan, just as the scale of the response in the islands began to escalate rapidly.

Public Affairs

The catastrophic situation in Puerto Rico seemed to grab the entire world's attention during the first month after the storm. Evolving crises brought about by the hurricane's thrashing, such as an eroding spillway at Guajataca Dam and the all-consuming black-out, kept the Corps' work in Puerto Rico in the global news. However, there was only

Fig. 3.1. USACE Hurricane Response Infographic

Early “infographic” showing the status of the Corps’ complex response to Hurricanes Irma and Maria in the Caribbean, Oct. 25, 2017. The Public Affairs Office and the Operations Center at Corps headquarters jointly produced these graphics several times per week until June 2018 to convey a lot of information to the public in an accessible, visual format. The Corps had used similar infographics previously following Hurricane Harvey in August 2017. (CEHO, Emergency Operations Collection)



one Corps public affairs officer in Puerto Rico for the first ten days after the storm.²⁰ Lisa Hunter, the chief of public affairs for Mobile District, arrived with the advance team on September 24, though she had been fielding media requests even before she deployed. With no public affairs support on the island, many requests in the immediate aftermath of the storm had to be handled by Corps personnel with other duties who had originally deployed for Irma and had ridden out Maria in San Juan. Hunter explained the early state of affairs:

Usually when you come in to an event like this you actually pitch to the media and tell them you're here and what you're doing and such as that.... [In this case] the media had gotten hold of us even before I left Mobile. We had requests from Vox Media, the Weather Channel, Univision, Telemundo, CNN New Day. So even before I left Mobile I was coordinating interviews and providing talking points for the personnel who were already on the ground, including the 249th [Engineer Battalion] chief warrant officers, and then, of course, Lt. Col. [Roberto] Solorzano who was representing Mobile District here.... So I was doing talking points and prepping them for interviews by phone in advance of their interviews.²¹

Fortunately Hunter was soon to receive some assistance.

A week later, Brigida Sanchez, a public affairs specialist from Walla Walla District who had been deployed to South Atlantic Division headquarters to provide public affairs support there, arrived in San Juan to help Hunter.²² Located at the temporary RFO at the Joint Field Office, the two public affairs officers worked with FEMA public affairs representatives, South Atlantic Division personnel, and staff of the public affairs office at Corps headquarters in Washington, D.C., to produce talking points and update a wide array of media outlets—local, national, and international—about the Corps' evolving missions in Puerto Rico.

Along with external requests for information, there were overwhelming demands for updates on the operations from within the Corps and from other federal agencies. "You can just imagine the number of questions we were getting from all angles," explained General Holland in mid-October. "USACE was briefing Congress. USACE was briefing the president. USACE was briefing the FEMA administrator. The task to inform people is unrelenting, particularly with this grid mission."²³

In the second week of October, two additional public affairs officers deployed to Puerto Rico as the Corps' organization and activities there became more complex. Jeff Hawk from Pittsburgh District came to work for Task Force Power Restoration, the Corps' district-like organization formed to restore the electrical grid, and Maj. Catalina Carrasco took a leadership role in communications at the division's forward-deployed headquarters in San Juan

under General Holland. Major Carrasco was particularly suited to the task; she brought military public affairs experience with the Indiana National Guard and fluent Spanish language skills to the highest level of the Corps' engagement with local officials. Initially, the public affairs team in Puerto Rico had tried translating news releases into Spanish, the first language of the commonwealth, but quickly realized it was not an effective means of sharing critical information, at least not without skilled interpreters.²⁴ It took several weeks to bring in the Spanish-language capacity, both locally and at the division level, through recruiting Corps employees who were fluent in Spanish and by hiring local contractors. Maintaining that linguistic capacity remained a challenge throughout the mission.

The Corps also benefitted early on from having an Army press camp deployed to visually document the overall Department of Defense response to the hurricane. Soldiers serving with an Army press camp are trained to deploy as a media operations center and serve as a source of information for civilian media covering a disaster. Nineteen soldiers from the 24th Press Camp Headquarters at Fort Bliss were joined by thirty other troops trained in public affairs from the Marines, Navy, Air Force, and National Guard. These servicemembers documented a number of Corps missions and were especially valuable in producing high-quality images and video of the spillway stabilization efforts at Guajataca Dam in the first two weeks after the storm. They then made these photos and the motion picture footage available to journalists and the public through the Defense Visual Information Distribution Service website. "They have incredible young soldiers here who have so much enthusiasm and really want to get out of the JFO and see what's going on and capture that," Hunter said in October. "In the Army they call it a combat multiplier. They've been able to multiply the products that we've been able to do, so we've been able to focus on a more strategic communications type of goals."²⁵

Communicating about the Power Mission

On September 30, 2017, ten days after landfall, the Corps officially started work related to what would become its defining mission in Puerto Rico: repairing the island's heavily damaged power grid. Normally after a major storm, utilities work together to repair electrical infrastructure, but the damage in Puerto Rico was so profound, and the local power authority was so slow in its initial response, that FEMA designated the Corps of Engineers as the lead federal agency to coordinate power restoration. Initially the media posed a number of questions about the Corps' plans for repairing the grid that public affairs specialists could not answer. "In the beginning of this it was hard for us to be able to give them solid answers, in the sense of this is the date when everything's going to start moving," remembered Major Carrasco. "Because one, there were contracts being worked out. We still were being coordinated as far as the way ahead. So it was really hard for the media to understand why we wouldn't provide them a time line, or why we couldn't provide them a date."²⁶



Chief of Engineers Lt. Gen. Todd Semonite spoke with Fox News at the Puerto Rico Convention Center in San Juan on Sept. 30, 2017, the official start of the Corps' power restoration mission. (USACE South Atlantic Division)

In the first week of October, the key communications message from USACE headquarters was still about the temporary roofing program because that mission remained a critical part of the Corps' response to both Hurricanes Irma and Maria in Puerto Rico, the Virgin Islands, and Florida. By the second week of October, however, as the deadline for submitting a request for temporary roofing assessments passed in Florida, and the power mission in Puerto Rico became the Corps' primary focus, the status of the island's grid also became a top priority of USACE communications specialists.²⁷

Local media in Puerto Rico were in some ways more aggressive towards, and more used to getting frustratingly little information from, local officials than were their counterparts on the mainland. Major Carrasco remembered several long, disorganized press conferences that were very different from the ones she had experienced as a public affairs officer with the National Guard. "Some of them were like two hours long. And the media there, you know, they wouldn't get the right answers so they kept sometimes attacking," said Carrasco. But she also noted that local media treated the Corps differently. "They were very fair to the Corps of Engineers, I can tell you that," she said.²⁸

Once FEMA had officially tasked USACE with a power restoration mission, the Corps sent senior executive José Sánchez, the acting director of contingency operations at the Corps' headquarters in Washington, to lead the grid repair program for the South Atlantic Division. Sánchez had grown up on the island and attended the University of Puerto Rico. He was quickly recognized by local officials and media as a trusted authority within the federal power restoration program, and he brought enormous credibility to the Corps' efforts. The demands for his time—to appear live and answer questions from local media and explain what the Corps was doing—were relentless.²⁹ In any case, his presence and ability to speak Spanish were helpful because local Spanish-language media, such as radio, was often a more effective means of getting news to remote communities who were still waiting to get their power back.

Early media attention also focused on the contract PREPA had given to Montana-based Whitefish Energy to repair the grid in the first week after the storm. Journalists had numerous questions about the origins of that contract, its terms, and how it differed from the arrangements the Corps was making. Jeff Hawk remembered having to defer most of those inquiries to PREPA, while also clarifying what the Corps' role would be. "We had to keep explaining—look, we're the federal government, we have federal contractors, we are in charge of those contracts, nobody else is," recalled Hawk. "Not industry, not the government of Puerto Rico, we are responsible for ensuring the quality of the work and the fulfillment of the contract, contractual terms, and no one else."³⁰

Early on the media had pressed the Corps to present a realistic assessment of how long it would take to reach the goal of restoring power to 95 percent of the island's customers. Part of that challenge in formulating an answer was getting the data to make an accurate assessment of how many repairs would be needed and even how many customers were offline. Another aspect of the challenge was working around unrealistic promises made by local politicians about when most of the power would be restored. "The media, again, would try to pit us against one another," recalled Carrasco. "Well, the governor is saying this, now you're saying this. And so it was always trying to find a balance of we understand where he's coming from, you know, obviously we want the power as soon as possible. But these are the challenges.... Based on the devastation and based on what we knew and the number of poles and the number of wire that needed to be installed, it just was not a realistic expectation."³¹

As the year 2017 came to an end, and it was clear that full restoration of power would take months longer, the Corps developed a strategic communications plan with key partners in the Unified Command Group, which included FEMA, PREPA, and members of the mainland power industry. By this time, with multiple organizations working to restore power on the island, the various agencies felt they needed to be better coordinated in terms of communications so as to create a unified message concerning progress towards



Task Force Power program director José Sánchez was interviewed by Giovanni Brignoni on Facebook Live, Dec. 20, 2017. Three months after landfall, Puerto Ricans were increasingly turning to social media for credible answers about how quickly power would be restored in different parts of the island. Brignoni, a helicopter pilot with state police agency Fuerzas Unidas de Rapida Acción, had become something of a local hero for the rescues he performed after the storm. He also took on a personal mission to bring unvarnished information about the federal response directly to the people of Puerto Rico via Facebook. (Giovanni Brignoni on Facebook)

storm, Task Force Power also was challenged to include team members who had Spanish-language capabilities. Many Puerto Rican officials were more comfortable speaking Spanish, especially those in rural areas of the island. The use of Spanish was also essential for building public trust and confidence. Contractor and power industry partner crews often had very few fluent Spanish-speakers, and they also needed language support, so the Corps let additional contracts for interpreters to go out with the crews. Power program director José Sánchez continued to be interviewed frequently on Spanish-language television and radio programs on the island. Many Puerto Ricans could still receive radio broadcasts, even without power in their homes. Sánchez recalled talking to the mayor of Culebra, a small, outlying island where the Corps installed the first large, multi-generator “microgrid” to provide power while workers repaired the primary grid. “When I went in to discuss the microgrid on this island... he said to me, ‘I may understand some English, but I want this in Spanish,’” said Sánchez. “I want to talk to you.”³⁶

restoration of the commonwealth’s electrical grid.³² In addition to informing Puerto Ricans, the Corps wanted to sustain the momentum in the restoration efforts by conveying a sense of urgency.³³ The Corps also wanted to be transparent about how and where the funding for grid repair was being spent.

The primary goal of the strategic communications plan was to build trust.³⁴ It was important to inform survivors who were waiting to get their power back, along with local officials throughout the island, about the progress of the mission—how many customers had their power back, where repair work was occurring, and how many personnel were involved—using one voice.³⁵ Working with the Unified Command Group also made it clear that the Corps was going to stay to see the mission completed and that it had the resources to do so. “It codified our approach and it morphed into something much better,” remembered Hawk.

Much as was the case with the Corps’ initial public affairs presence in Puerto Rico after the

Social Media

Making it clear where the Corps was working, and how many people they had working, became more important in October, and increasingly USACE used social media outlets to get that word out to the public.. Looking back on the questions the administration and Congress were asking, Deputy Commanding General for Civil and Emergency Operations, Maj. Gen. Donald E. Jackson, remembered: “I think about mid-October we got more aggressive, because we needed to explain why it had been several weeks and there was not a lot of line repair work ongoing. In mid-October, we turned to social media to begin a more aggressive approach. Most people now get their news from social media, not from press releases posted on Corps websites. As an organization, we really learned a lot about the power of social media in getting messages out to a broad audience.”³⁷

Mapping where people were sharing stories or posting about the Corps’ work helped public affairs staff recognize when a local story had become an event of national concern. According to Evan Dyson, the social media program manager in the Office of Public Affairs at USACE headquarters, social media provides an opportunity for the Corps to be a direct source of credible information during an emergency.³⁸ That credibility has brought a wide and growing audience to the agency’s social media feeds. For example, there were around 167,000 views of Corps’ posts on Twitter in July 2017. By October, after hurricanes Harvey, Irma, and Maria, there were more than two million views a month on average.

One example of an effective use of social media was the Corps’ response to questions about the impact of Lt. Gen. Jeffrey Buchanan’s departure in mid-November and the winding down of the active military mission in support of FEMA. “People online were assuming that that meant the Corps of Engineers was leaving,” said Dyson. “A lot of them were responding negatively like, ‘How dare you leave. We’re nowhere near done.’ We picked up on that very quickly, because we monitor for chatter and things like that.... So working with the public affairs people on the ground in Puerto Rico, they were comfortable with us saying essentially, ‘The Corps of Engineers, in support of FEMA, will stay in Puerto Rico and the U.S. Virgin Islands until our job is done.’ That little talking point put a lot of people’s minds at ease.”³⁹

The impact of social media is measured not just by how many people see a post on Twitter or Facebook but on the sentiment expressed in response to those posts. “Social media has a great potential to reach stakeholders of all levels, not just in the case of disasters but in everyday life,” said Dyson. “It is another mechanism that we as communicators can use to connect with audiences who care about the work that we do.... It has a very promising potential during disasters to alleviate concerns. I think what we’ve seen is that the public is appreciative of that.”⁴⁰ The result of this kind of consistent engagement was that public opinion of the Corps’ work in Puerto Rico generally remained neutral to positive.



Brig. Gen. Diana Holland (center), USACE South Atlantic Division commander, surveyed emergency repair work at Guajataca Dam with Lt. Col. Roberto Solorzano (left) from Mobile District, Oct. 23, 2017. Flexible tubes connected to pumps above the dam site helped lower the level of the lake and bypass the spillway damaged by Hurricane Maria. (U.S. Air Force photo by A1C Nicholas Dutton)

In Puerto Rico, the Corps focused on communicating accurate information about the status of the grid restoration mission as widely as possible. In an environment where getting a clear picture of what was happening was challenging at all levels, this transparent, accessible approach was critical to building confidence in the federal government’s response to Hurricane Maria. “It wasn’t about talking about the Corps,” remembered General Holland, “it was more about a way to bring people together and say, ‘Okay, let’s inform the island of when PREPA is going to be here next and when we’re going to be there next.’ Making sure the word got out to instill confidence is something that I think [gave us] a level of credibility, and we were able to do that in a thoughtful and calm way.”⁴¹

Guajataca Dam

The Puerto Rico Electric Power Authority (PREPA) operates one of the largest dams on the island at Lake Guajataca. The multipurpose, compacted-earth dam is 984 feet long and 120 feet tall and is located in the steep, forested hills at the intersection of three municipalities: Quebradillas, San Sebastián, and Isabela.⁴² Lake Guajataca serves to alleviate the risk of flooding in the area and provides hydroelectric power and drinking water to more than 250,000 residents of the island’s northwest coast. Over thirty-six hours on September

20–21, 2017, Hurricane Maria dumped more than twenty inches of rain on the surrounding watershed, and the reservoir rose as much as six feet, sending cascades of water down the dam's emergency spillway.⁴³ The spillover effectively began lowering the water level in Lake Guajataca to reduce stress on the dam itself, but the roaring overflow caused severe damage to the rock-filled channel at the base of the spillway that eventually leads into the Guajataca River. As water continued to flow down the spillway into the shattered channel, the earthen material underneath the spillway's concrete slabs started to erode in the direction of the dam. If the process continued unchecked, the dam itself could fail.⁴⁴

Media reports at first raised fears that the dam was in danger of imminent failure.⁴⁵ In response, on September 22 the National Weather Service issued a flash flood emergency for parts of the area. With communications down, there was widespread confusion about how likely the dam was to fail. Officials initially ordered thousands of people to evacuate the area and considered about seventy thousand to be at risk in the event of a failure, but they quickly reduced those numbers to around five hundred evacuees as more information became available about the damaged spillway. The flash flood warning expired on September 24.⁴⁶

That day, FEMA requested that the Corps provide technical assistance in evaluating the condition of the dam and proposing measures to stabilize it.⁴⁷ Although the Corps of Engineers was responsible for several water resources projects on the island, it had not built nor did it maintain Lake Guajataca Dam.⁴⁸ PREPA operated the dam, and PREPA personnel initially tried to handle the emergency situation, but they did not have the resources in place to stop the increasingly-dangerous erosion. As General Jackson explained, the Corps has a great deal of domestic and international experience in dam safety, and the American public has an expectation that at moments of crisis with these structures, the Corps should be involved. In fact, General Semonite had advocated that the Corps should offer this technical expertise during recent high-risk events, such as the February 2017 crisis at the state-owned Oroville Dam in California, a situation that had a number of similarities to Guajataca Dam after Hurricane Maria. "In reality, elements of the dam were failing, very similar to the Oroville Dam, where an improperly designed and built spillway failed under extreme conditions. Guajataca Dam was the same," said Jackson. "It doesn't matter who owns a dam or levee project, the American public see the USACE as the lead agency and expect us to be part of the solution."⁴⁹

Immediately after arriving in San Juan with the advance team from Mobile District on September 24, Colonel DeLapp went by helicopter to assess the damage to the spillway at Guajataca Dam. Roads to the dam site at Lake Guajataca were impassible because of storm debris and bridges destroyed by flooding. After initially making an aerial assessment, DeLapp and the other officials landed. DeLapp recalled:



An MH-53E Sea Dragon lifted jersey barriers to use in the stabilization of the Guajataca Dam spillway, Oct. 8, 2017. The emergency repairs to the dam were an interagency effort to mitigate damages caused by the heavy rains and inflows from Hurricane Maria. (U.S. Air Force photo by Capt. David J. Murphy)

They were just going to fly us around, but having done this type of stuff around the world before, I knew we could land on the crest of the dam, on the roadway. We walked across the crest of the dam down the embankment and observed just the magnitude of the destruction below the spillway...the lower half had been washed away. Then the undermining that was happening below the spillway was significant, and it had very heavy flows still at that time coming over the spillway. We had noticed, obviously, that the connections for the water treatment plant and water supply connections had all been cut, so we knew that that was an issue and the access, just [getting] in and out. The bridge downstream had been essentially washed out. So the big thing was to...really figure out what we needed to do to get the lake level down and start to stabilize the spillway.⁵⁰

Right away the Corps brought in dam safety experts to find solutions to stop the erosion. Dennis Zeveney, the chief of the Geotechnical Branch at Jacksonville District, had been at that first inspection with Colonel DeLapp. Dan Blaydes, Jacksonville's lead engineer for dams and levees, arrived two weeks later. "When [the Corps] arrived on site it was four days after the hurricane and approximately 50 percent of the spillway channel was eroded



A CH-47 Chinook helicopter from the Puerto Rico Army National Guard placed a large sand bag on the spillway of the 89-year-old Guajataca Dam in Isabela, Oct. 9, 2017. (U.S. Army photo by Pvt. Alleea Oliver)

and gone, with two feet of water flowing through the spillway,” remembered Blaydes. “Most of it happened very quickly after the hurricane [when] the flows were super high.”⁵¹

On September 30 additional dam safety experts arrived from Mobile, Jacksonville, and New England Districts, and on October 2, at the direction of FEMA, the Corps and the Department of Defense, along with PREPA, took the first steps towards slowing the erosion underneath the damaged emergency spillway.⁵² As Colonel DeLapp described, the team had discussed options with FEMA and PREPA engineers that first evening after touring the dam site: “There was a small group of military and civilian engineers that came up with this plan to stabilize and put some pressure against the bottom of this [remaining spillway] and then create, using super sacks [sandbags], a kind of check dam below.... So we had a plan, but at that point, it was just kind of, ‘Stop the bleeding.’”⁵³

Consequently, as part of a joint operation with the 26th Marine Expeditionary Unit, CH-53 Sea Stallion and V-22 Osprey aircraft from the USS *Kearsarge* dropped five-ton concrete blocks and highway “jersey barriers” to mitigate the erosion to the damaged spillway. Corps engineers directed the placement of more than five hundred barriers against the broken edge of the spillway. Next, Army National Guard units from Pennsylvania and Georgia used their helicopters to drop more than thirteen hundred large, three-thousand-pound



A USACE dam safety expert documented the damage to the spillway at Guajataca Dam, Oct. 23, 2017. (U.S. Air Force photo by A1C Nicholas Dutton)

“super sack” sandbags into the spillway below the pile of barriers and rubble to create a “check dam.”⁵⁴ This temporary barrier of sandbags essentially created a new plunge pool, which greatly slowed the velocity of water falling from the bottom of the eroded spillway, thus minimizing the under-cutting of the dirt slope beneath the spillway’s concrete slabs. Once nearby roads were repaired, soldiers from the Puerto Rico National Guard hauled in one hundred tons of rock per day from a nearby quarry to further stabilize the spillway. These emergency measures to mitigate damage to the spillway were completed by November 14.⁵⁵

Meanwhile, the Corps also took actions to lower the level of Lake Guajataca below flood stage to prevent water from flowing over the damaged spillway in the first place. During the overflow, water cascading into the emergency spillway channel had essentially caused a mudslide that clogged the dam’s ninety-six-inch conduit outlet into the Guajataca River. The Corps had to remove material blocking that main outlet to help restore the usual flow out of the reservoir—up to five hundred cubic feet per second. Mobile District and PREPA cleared the main outlet on September 30, 2017.⁵⁶ Another smaller, fifty-four-inch outlet pipe led to a seventeen-mile-long water-supply canal. This secondary outlet was severed by the damage to the spillway, and drinking water supplies to the canal were cut off.

In order to lower the lake level, repair the spillway, and resupply the canal, the Corps installed diesel-powered water pumps on the lake’s embankment.⁵⁷ These pumps would

send water down long tubes into the canal, bypassing the spillway and the damaged outlets. Jacksonville District quickly awarded an emergency contract to have ten high-capacity eighteen-inch pumps transported to and set up at the dam. The Air Force brought in the first two pumps in a C-130 Hercules cargo plane from North Carolina, and the rest later arrived by barge from mainland ports. As the lake level slowly decreased, the flow of water over the spillway eventually stopped. The emergency action proved successful, and the Corps planned to provide a more permanent fix in the future.⁵⁸

With the pumps running and the reservoir drawn down, the spillway was temporarily stabilized on November 15, 2017, although another 10 percent of the spillway channel had been lost during the two weeks that it took crews with the Corps and DoD to stabilize the dam.⁵⁹ After stabilization, Jacksonville District began working with FEMA and PREPA to plan for a second phase of the dam remediation program which would involve a set of interim risk reduction measures to provide initially one-hundred-year flood level protection and eventually up to one-thousand-year level protection for the spillway and channel. Some of the second phase measures included repairing the high-pressure gate controls, reinforcing the spillway, and stabilizing slopes near the inlet tower. Construction work started on this phase on March 21, 2018, and was completed by November 2019.⁶⁰ A year after Maria, FEMA estimated that the total costs of dam stabilization had reached \$65 million.⁶¹

Temporary Roofing

The Corps of Engineers has a long history of making different kinds of temporary housing repairs after disasters, and FEMA first gave the Corps the mission of covering damaged, leaking sections of roofs with strong blue plastic tarps after Hurricane Andrew in 1992. This mission eventually became known as *Operation Blue Roof*. By far the largest number of blue roofs installed by Corps' contractors was 193,000 across the southeastern United States during the devastating 2005 hurricane season of Katrina, Rita, and Wilma.⁶² There had not been a blue roof mission in the nine years following Hurricane Ike (2008), but after Hurricane Irma in 2017, the Corps installed 13,370 temporary roofs across Florida in about eight weeks.⁶³ In Puerto Rico after Hurricane Maria, FEMA allocated \$185 million to the temporary roofing mission, and the Corps assisted with 59,469 repairs.⁶⁴ This was almost exactly the same number of temporary repairs that had been made after Hurricane Georges nineteen years earlier.⁶⁵

The intention of the blue roof mission is to provide homeowners in disaster areas with fiber-reinforced sheeting to cover damaged roofs, to make sure that that material is professionally installed, and thus to protect homes from further deterioration caused by wind or rain until the owners can make arrangements for more permanent repairs.⁶⁶ Depending on the needs of local governments, the Corps' mission can range from simply providing technical assistance to contracting for and managing the installation of blue roofs on damaged



Aerial view of temporary roofing installed in communities near Ponce, Dec. 21, 2017. By December Operation Blue Roof had completed nearly 26,000 installations. More than 1,200 contractors, nearly 100 U.S. Army Corps of Engineers quality assurance personnel, and dozens of others processed more than 73,000 rights of entry, inspections, and assessments. (USACE photo by Patrick Loch)

homes and sometimes larger public buildings, as was the case after Hurricane Maria. FEMA normally arranges for the procurement and shipment of the blue plastic sheeting, and in some cases furring strips and nails, to pre-designated staging areas.

In practice, however, providing temporary roofing in Puerto Rico presented several unexpected challenges that slowed the rate of installations and altered the protocol for how the blue roof program was run. First, very little of the blue plastic sheeting was pre-positioned on the island, ready for a disaster. In fact, FEMA had sent much of the material that had been warehoused on Puerto Rico to the Virgin Islands to help begin the recovery after Hurricane Irma.⁶⁷ In Puerto Rico, the Corps had warehouses in San Juan and Ponce where FEMA delivered plastic roofing material directly from shipping containers arriving at the nearby ports. The Corps then distributed that blue roof material to contractors working in different parts of the island who brought their own equipment and other supplies.

But the availability of blue roof material was not the limiting factor at the start of the mission; getting the temporary roofing Planning and Response Team (PRT) on the ground to begin the assessment process was the more difficult challenge. Due to limited commercial flights, the expert team from St. Louis District was delayed, despite their concerted efforts to get seats. Three members of the team had deployed earlier to respond

to Hurricane Irma, and they remained in San Juan assessing how many roofs would be needed.⁶⁸ Additional team members managed to arrive the following week, but it wasn't until October 4, two weeks after landfall, that the full twenty-five-member PRT was in place on the island.⁶⁹ That same day, crews installed the first blue roof on a critical facility, a physical rehabilitation hospital in San Juan.⁷⁰ "The people are the biggest thing that we need for this mission to really succeed," explained temporary roofing program manager Josh Marx. "We've got to have the people on the ground doing the assessments to make this thing work. So that the contractor can do the work. That was the biggest challenge."⁷¹ At the height of the mission in January 2018, 280 Corps personnel were deployed to support the mission, along with 200 local, Spanish-speaking quality assurance (QA) contractors.⁷²

The housing situation in Puerto Rico was very different from that in the southeastern United States where the blue roof mission was first developed for the standard, asphalt-shingled roof.⁷³ In Puerto Rico, most homes have flat concrete roofs that can withstand hurricane-strength winds.⁷⁴ But thousands of other homes have gently sloping metal roofs that blew away entirely in the storm, leaving only a few damaged rafters behind. Most of these homes had no underlying plywood or similar material to which to attach the tarp-like blue roof. Josh Marx explained:

The key here is that these are metal type roofs. There's no decking to it. Once the wind gets underneath it, there's no hurricane clips. This is an economically challenged portion of the island that we're dealing with, or they're concrete structures where they put an addition on their home and they put the addition on top of the concrete and they put the metal roof up there.... [The hurricane wind] didn't necessarily always have to rip the metal all the way off. Sometimes [it] could just pick it up a little bit and pop the seam and all of a sudden they were leaking. So [it was] very challenging to determine what the extent of the damages are and who was going to qualify for a roof.⁷⁵

The result was that portions of many of the homes in the hardest-hit areas were open to the sky and weather as survivors waited to see if they would qualify for a temporary roof.

More than one hundred public shelters housed 11,375 survivors on September 29, but by early November 75 percent of that shelter population had returned to lightly damaged homes or found somewhere else to stay.⁷⁶ Unfortunately, many survivors did not have anywhere else to go. Some returned to heavily damaged homes and lived in them, often in very uncomfortable or even dangerous conditions, and in some cases for a few months, waiting for a blue roof to be installed.⁷⁷ On the mainland, FEMA might have been able to provide temporary housing support by paying for hotel stays or by bringing in thousands of mobile homes, as they had done after Hurricanes Katrina and Rita in Texas, Louisiana, and Mississippi.⁷⁸ While FEMA did eventually pay for nineteen thousand Puerto Rican



Temporary roofing team members Axel Montalvo-Bartolomei and Richard Dabal spoke with a local resident of Ponce, Puerto Rico, to assess his home to see if it qualified for a Blue Roof, Oct. 30, 2017. (U.S. Air Force photo by A1C Nicholas Dutton)

survivors to stay in hotels on the mainland, on the island itself, there were few hotels with power and rooms available.⁷⁹ Although the Corps had anticipated undertaking a large temporary housing mission, FEMA didn't assign it one in Puerto Rico.⁸⁰

Recognizing this frustrating situation, the Corps worked with FEMA to adapt the eligibility rules of the blue roof program so that more homes could qualify for temporary roofing. For a home to qualify in Puerto Rico, it needed to be structurally sound and have 50 percent of its rafters intact.⁸¹ Given the amount of time and money it would take to rebuild roofs more permanently, a contractor proposed a cost-effective solution that had been used in Puerto Rico after Hurricane Georges, something called the “shower cap” approach. Essentially, the contractor made sure the remaining rafters on the home could support a tarp, installed additional rafters if necessary, and then placed the blue roof directly over those rafters like a tent. Workers would then securely tack down the material around the edges.⁸²

Because of the unique features of improvised home construction in Puerto Rico, the Corps found it hard to estimate how many homes would need temporary roofs. The roofing team was not able to conduct aerial reconnaissance until October 19—nearly a month after the storm hit—but those survey flights were needed to improve the estimates of how many blue roofs would be needed and the condition of the surviving homes. Early models, largely



Corps contractors installed a temporary roof on a home in Las Casas, near San Juan, Oct. 20, 2017. (CEHO photo by James Garber)

based on Geographic Information System (GIS) data and previous storms, had predicted only about thirty thousand roofs would be eligible.⁸³ After analyzing the views from the reconnaissance flights, the team doubled the estimates to sixty thousand, which was about how many roofs were actually installed. When the application period for the blue roof program ended on January 10, 2018, survivors had submitted more than seventy-six thousand Right of Entry (ROE) forms as part of their requests for temporary roofing for their damaged properties, and about sixty-eight thousand of those properties were assessed and found eligible for the program. By the time the temporary roofing program was complete in late March, about ninety-five hundred of the remaining submissions had been canceled because homeowners had likely found other ways to make repairs or had abandoned the property.⁸⁴

Another notable difference between temporary roofing missions on the mainland and the situation in Puerto Rico involved securing those Right of Entry forms. In order to be considered for the temporary roofing program, a homeowner or landlord must have legally agreed to allow the Corps' contractors access to the property by signing an ROE form. While on the mainland the Corps often opened ROE sign-up centers at central locations such as at a major home supply store, using this model proved to be challenging in an environment with poor communications and damaged roads still blocked by storm debris. It was hard for many people in Puerto Rico to travel to sign-up locations or even to learn about the program. Recognizing this situation, local Corps contractors went door-to-door

collecting paper ROEs in neighborhoods across the island.⁸⁵ Spanish-speaking Puerto Rican QA contractors were especially helpful reaching out to local communities and answering survivors' questions about the program.

The need to find and train Spanish-speaking personnel bedeviled every mission the Corps undertook for FEMA. In order to conquer the language barrier in the temporary roofing arena, FEMA recruited bilingual Puerto Rican volunteers to help residents complete the ROE paperwork, the Corps reached out to local officials to help coordinate the door-to-door collection of ROEs, and the Corps sought out its own personnel from across the entire agency who had grown up on the island to act as supervisors.⁸⁶ The Corps also awarded a contract through Jacksonville District to bring in and train local, bilingual QA specialists who could help collect ROEs, perform initial assessments of properties to see if they would qualify for a blue roof, and determine the kind of work that would be needed on a particular home.⁸⁷

The Corps also needed to track the various properties through the process—from obtaining the ROEs, to making an assessment of the property, and finally to installing a blue roof.⁸⁸ Corps personnel used electronic data collection systems, essentially networked tablet devices with GIS software adapted to the mission. Initially these systems were useless because of poor connectivity, forcing the team to rely on paper records, but as cellular service returned, the use of these networked devices helped the Corps teams manage the mission more effectively.⁸⁹

Perhaps the most important lesson the Corps took away from the temporary roofing program in Puerto Rico was the downside of depending on just one roofing contractor for a disaster of this scale.⁹⁰ After Hurricane Georges in 1998, the Corps had hired four local contractors a week after landfall, and the number of contractors eventually increased to forty-six. The 777 crews those contractors hired ended up installing a similar number of roofs as would be installed after Maria.⁹¹ In 2017, the Corps made use of its Advanced Contracting Initiative (ACI), a program developed and implemented for emergency and disaster scenarios, so that a specific contractor was on alert and ready to mobilize even before Maria made landfall. In this case, Ceres Environmental was responsible for installing the blue roofs after the Corps' temporary roofing team had made initial estimates of how many properties would need one. Again, logistical difficulties in getting contractors and materials to the right places on the island to begin work made for a slow start to the operation. Compare the 4,536 blue roofs installed in Florida a month after Hurricane Irma swept through the state with only 802 installed in Puerto Rico a month after Maria.⁹²

Although Ceres Environmental increased its rate of blue roof installations to three hundred per day within ten days of receiving the order to begin work—a pace of production that met the requirements of the ACI contract—more contractors working on the island earlier would likely have shortened the wait time for many residents with damaged roofs.⁹³



Contracted dump trucks loaded with storm debris to haul to a collection site, Oct. 21, 2017. Corps contractors consolidated woody debris from this area at Campanilla in Toa Baja Municipality. (CEHO photo by James Garber)

The Corps ultimately awarded three additional roofing contracts. At the height of the temporary roofing program in January 2018, the Corps, through its four contractors, was installing twelve hundred roofs per day. Corps employees also served as quality assurance officers to verify that the blue roof installations were completed correctly by the contractor. Typically 10 to 25 percent of the final inspections involved actually visiting the survivor's house, whereas the remaining inspections relied on photos submitted by the contractor.⁹⁴ The Corps completed its blue roof temporary housing mission on March 22, 2018.⁹⁵

Debris Management

The Corps of Engineers' typical debris mission following natural disasters involves removing vegetation brought down by storms and final disposal of marine debris, construction and demolition materials, and household appliances such as refrigerators and washing machines. The various federal emergency management agencies have tasked USACE to remove debris after hurricanes since the mid-1950s, but the Corps has a much longer history, going back to the turn of the twentieth century, of assisting local and state governments



Mounds of woody, vegetative debris were collected and sorted by Corps contractors across Puerto Rico, Jan. 22, 2018. (USACE photo by Andrew Kornacki)

with debris removal after river flooding.⁹⁶ As with the other missions that the Corps was handling for FEMA, the post-hurricane situation in Puerto Rico challenged expectations and standard procedures within the debris management arena. It took the New Orleans-based debris removal Planning and Response Team (PRT) a week to get its managers on a flight to Puerto Rico. The multiple disasters of 2017 had required more PRTs than usual to deploy, and debris teams from other districts had already rotated through earlier missions in Texas and Florida. The New Orleans District team, which had been first organized in 2012, was finally getting its first on-the-ground experience.⁹⁷

The first task for the debris team was activating their local ACI contractor to clear roads blocked by fallen rocks and vegetation—an essential task (one that National Guard units had begun earlier) and a crucial first step to bringing relief to the island. The process of deciding which routes to clear was chaotic at first. Normally the commonwealth’s transportation department and emergency managers would have directed the effort, but local communications were so degraded that FEMA was assigning areas to clear on an ad hoc basis. “Basically we would have a debris task force meeting that was actually run by FEMA, and we’d look at a map and say ‘all right, you take this, I take this, and you take this,’ and we’d go out,” remembered Christopher Gilmore, a member of the New Orleans debris PRT. “Then we’d come back in that afternoon and say ‘how much did you get cleared?’”⁹⁸

The next step was staffing the PRT and surveying local governments around the island to assess how large the debris mission was going to be. Early estimates put the total volume of debris to be collected in the aftermath of both storms at 6.2 million cubic yards. FEMA tasked the Corps with collecting 3.9 million cubic yards of this total, while municipalities and the commonwealth government would handle the rest.⁹⁹ According to the program’s

design, municipalities would consolidate debris locally and then Corps contractors would haul it to a larger collection site in the area. At this temporary disposal and reduction site, workers separated the debris by type and contractors used large wood chippers to mulch the vegetative material so that some of it could be reused and to minimize how much material was going into landfills with limited space.

By mid-October, only thirty-one of Puerto Rico's seventy-eight municipalities had requested assistance from FEMA to remove their local debris. Some mayors had trouble understanding the Right of Entry form that would grant Corps contractors access to collection sites. As local leaders learned more about the debris management program and got a better sense of just how much material there was to process, the mission grew substantially. As with the temporary roofing effort, Spanish-speaking Corps personnel and local government liaisons eventually helped build confidence in the federal program. Although personnel found it difficult to locate appropriate sites to stage and process debris, by January 2018 there were more than seventy collection sites on the island.¹⁰⁰

As the effort expanded as more and more remote areas became fully accessible, contractors working for the Corps deployed some thirteen hundred trucks to collect and haul vegetative, construction, and demolition debris, nearly forty thousand cubic yards daily, from fifty-five municipalities.¹⁰¹ By February 9, the Corps had removed 3 million cubic yards of debris, and by the end of April, the mission was 94 percent complete with almost 3.9 million cubic yards of material removed. In the spring of 2018, FEMA extended the mission, more than once, as some parts of the island continued to struggle to handle the volume of dense, hardwood debris from large fallen trees. A year after the storm's landfall, contractors had hauled away and processed 4.4 million cubic yards. At that time, FEMA funding allocations for debris removal in Puerto Rico had reached \$211 million.¹⁰²

Temporary Emergency Power

While restoring an electric grid is an unusual project for the Corps of Engineers, providing temporary generator power to specific sites is a standard emergency response mission that the Corps often carries out for FEMA after hurricanes. As with installing temporary roofing, assessing and repairing critical facilities, and clearing away debris, setting up, fueling, and servicing large generators has become one of the Corps' areas of expertise. The Corps first installed diesel generators in the late 1970s as part of hurricane disaster responses in the Caribbean and Pacific.¹⁰³ After more recent powerful hurricanes, such as Katrina (2005) and Sandy (2012), the Corps assisted FEMA by providing temporary power to critical facilities, such as hospitals, police stations, and water treatment plants. Many of these generators were tractor-trailer sized and generated 1.8 megawatts (MW) of power. In the case of Puerto Rico, with its entire electrical grid offline, backup generators at hospitals

inadequate for extended operation, and water treatment plants not functioning, providing temporary power was quite literally a life-saving measure.¹⁰⁴

Because the blackout in Puerto Rico was so lengthy, USACE established Task Force Temporary Emergency Power (TF TEP) to coordinate the sourcing, installation, and servicing of a record-shattering number of large generators on the island.¹⁰⁵ Before Maria, the largest number of emergency response generators the Corps had installed at critical facilities had been in the year after Hurricane Katrina; in Louisiana and Mississippi the Corps installed 310 generators after the storm, and after Hurricane Rita followed in September 2005, the Corps installed 238 generators in Texas.¹⁰⁶

Hurricane Maria was not the first disaster in 2017 to which the Corps had responded with a mission to install temporary power. The Corps deployed Planning and Response Teams (PRTs) to install generators after Hurricane Harvey in Texas and Hurricane Irma in Florida and the U.S. Virgin Islands.¹⁰⁷ As Irma threatened the eastern Caribbean in the first week of September, an advance team of fourteen temporary power experts deployed to San Juan. The team included six soldiers from the 249th Engineer Battalion, a versatile unit of soldiers assigned to the Corps that provides commercial-level power to military units and federal relief organizations during disaster response operations.¹⁰⁸

After Irma knocked out power in the Virgin Islands, FEMA began to stage generators in Puerto Rico with plans to transport them by barge to St. Thomas, a relatively short distance compared to shipping from the mainland. But Puerto Rico also had temporary power needs after Irma, and the island did not have very many FEMA generators on-hand to begin with; only twenty-five FEMA generators were available on the island on September 19.¹⁰⁹ Ten members of the Memphis District temporary power PRT who deployed originally after Hurricane Irma would ride out Maria in San Juan, and they would stay on to assist with the much larger response to that second storm.¹¹⁰

As with the other emergency support missions for FEMA, additional responders with an expertise in temporary power were delayed by the lack of commercial flights to the island. For example, the first five managers of a specialized Albuquerque District PRT for temporary power were deployed from New Mexico two days after Hurricane Maria made landfall in Puerto Rico, but they ended up waiting in Atlanta for three days for a flight to San Juan.¹¹¹ At that time, the main international airport on the island was handling only a few emergency flights per day. After the team arrived in San Juan on September 25, they stayed on FEMA cots at the Puerto Rico Convention Center for the first few nights. Fifteen more members of the Albuquerque temporary power PRT arrived the next day on a military aircraft from Savannah, Georgia.¹¹²

It became clear to the Albuquerque PRT that their assumptions about the state of the communications infrastructure in Puerto Rico were incorrect. Many of the plans they intended to use were based on experience from a mainland U.S. disaster, such as Hurricane

Sandy in 2012 in the New York and New Jersey area where mobile communications had been somewhat degraded but were still widely available. In Puerto Rico, internet connection was by satellite only, and it was very sporadic. The team's mobile phones did not work on what remained of the Puerto Rican cellular network, and no one had brought satellite phones. Even a lack of printer cartridges hampered early efforts to get organized.¹¹³

In addition to the difficulty of getting people to the island, delivering the necessary equipment was also troublesome. Because the generators were so large, the most effective way of transporting them was by sea. On September 23, a barge with generators from the Defense Logistics Agency (DLA) arrived in San Juan after having been delayed by port closures and the storm itself. Some of these generators were destined for the Virgin Islands, but in Puerto Rico there were now fifty-five federal generators available to be installed with twenty-nine more on the way.¹¹⁴ A week after Maria's landfall, critical facilities in Puerto Rico had requested thirty-one temporary power assessments from FEMA, and two companies of the 249th Engineer Battalion completed eleven of those assessments in the first week. At that point, crews had installed only two generators.¹¹⁵

The Corps again made use of the Advanced Contracting Initiative (ACI) to bring in more personnel and equipment for the large-scale temporary power mission. Louis Berger Group (LBG) was the experienced ACI contractor initially activated after Hurricane Irma to provide temporary power in the Virgin Islands and Puerto Rico. On September 19, the day before Maria's landfall, LBG had already deployed sixty-nine personnel to San Juan. Many of these personnel were supposed to support the response in the Virgin Islands, but there was no lodging for them, so they waited out Maria's passage at the Army's Fort Buchanan in the San Juan area.¹¹⁶ After the storm, forty-two LBG staff remained in Puerto Rico to jump-start the renewed temporary power mission there.¹¹⁷

Adding to the constraints caused by limited availability of generators and delayed arrival of contractor crews was a lag in identifying and assessing the power needs of critical facilities. Even with enough people, equipment, and generators, TF TEP still needed a priority list of where to establish temporary power sources. Normally, that guidance would come from the commonwealth government through FEMA, but overwhelmed Puerto Rican officials were slow to start making priority lists.¹¹⁸ Since many facilities had their own backup generators, it was also not clear who would need federal assistance immediately. LBG had the capacity, but they had only fifty-five generators and not much guidance to work with. A week after the storm, there were eighty-two LBG personnel in San Juan, waiting for the mission to progress.

During the first week, FEMA and the Corps, with limited input from the Puerto Rico Emergency Management Agency (PREMA), prioritized assessments and installations at San Juan's largest hospital, Centro Médico, a hospital in suburban Bayamón, and the Mayagüez Medical Center on the western side of the island.¹¹⁹ "That was enough to get



A 249th Engineer Battalion Prime Power team assessed the power house of the Centro Medico hospital complex in San Juan before installing two FEMA generators and a transformer on Oct. 22, 2017, to maintain reliable backup power at the island's most critical medical center. (USACE photo by Brigida Sanchez)

us started, knock the kinks out of our processes, and so on, so it started slowly,” recalled Reginald Bourgeois, a mission manager with the Albuquerque PRT, but with urgent requests for more reliable temporary power coming in from across the island, the frustration was palpable “Probably in the first two weeks, I think we had four generators installed, and folks were screaming,” said Bourgeois. Although few in number, these were large generators installed at critical facilities, and they made a significant life-sustaining difference in those communities.¹²⁰

In principle, the priorities of the Corps’ temporary power program were first to save life and then to sustain life.¹²¹ Scattered across the island were many clinics, water treatment facilities, first responder stations, and other facilities that fell into these essential categories. To decide where first to expend the limited resources, PREMA coordinated its list of highest-priority sites with FEMA, and FEMA approved those facilities. Working with the Bravo Company of the 249th Engineer Battalion, the temporary power team assessed facilities’ power needs and selected appropriate generators for those sites.¹²²

In the second week after the storm, the commonwealth and FEMA began to include water pumping and filtration systems among their top priorities for temporary power, along with hospitals where local backup systems had begun to fail. Remote communities depended on water pumping stations that had been connected to the grid, and the lack

Facility-Owned Generators

The need to provide reliable supplemental power during the extended blackout in Puerto Rico was so persistent, and the stock of generators available on the mainland so depleted, that the Federal Emergency Management Agency (FEMA) assigned the Corps of Engineers a mission it had never before undertaken: Maintenance of generators owned by critical public facilities to keep those hospitals, police stations, schools, and water pumping facilities operating. Many large public services buildings on the island had their own gas- or diesel-powered electric generators, but many of those units were aging and poorly maintained, and they did not necessarily run reliably during the long power outage caused by Hurricane Maria.^a Although the situation in Puerto Rico severely tested the longevity of many of these generators owned by public and private agencies, maintenance issues are not uncommon even under normal circumstances. Given the early delays in the arrival of large numbers of federally provided generators, facilities with their own operational generators found it prudent simply to keep their own local capacity in place. The Corps estimated about \$42 million of FEMA funding would apply to this maintenance program.^b

As Reggie Bourgeois, a mission manager with the Albuquerque District Temporary Power Planning and Response Team (PRT) described, in reality the mission to repair and maintain facility-owned generators supplemented the standard generator supply mission: "What happened was we got here in Puerto Rico, and we would run out to do an assessment of, perhaps, a hospital. We'd get to the hospital, and there were three generators sitting there, because they had emergency power, but they don't run. So now, you had this



Geoff Lee, a Corps temporary emergency power quality assurance representative, worked on a generator at the Institute of Puerto Rican Culture located in Old San Juan, Oct. 27, 2017. (USACE photo by Edward Rivera)

decision, 'Do I put another generator here, or do I fix those three so that we can use the original generator somewhere else?'"^c

Darin Aihara, a civil engineer with the Honolulu District Temporary Emergency Power PRT, explained that the program originated as a way to provide power to some of the largest critical facilities while they waited for an assessment of their needs for a federally supplied generator: "So when the main crew comes in, instead of doing assessments, we can say, 'Bam, bam, bam. Here, contractor, fix this generator. Fix this generator. Service this generator.' Right now, the game plan is to try to get a leg up on the assessments and hopefully do small minor repairs to keep the generators running."^d

The Honolulu PRT arrived in Puerto Rico on October 5 to launch the facility-owned generator maintenance and repair mission. At that point, some facilities had been running their own generators for two weeks straight, and issues developed that the facility managers had not seen before.

Those managers, with a little outside expertise to diagnose why their equipment was not working, could themselves obtain replacement parts and make repairs on their own. Also during the first week of the program, the U.S. Navy provided a Power Assessment Team, a group of mechanics and electricians from the USS *Wasp*, to diagnose generator problems. As the program developed and as temporary power contractors also arrived, technicians could assess and then make repair recommendations on the spot. In some situations, contract specialists with Task Force Temporary Emergency Power in Pittsburgh were able to authorize contracted technicians to make minor repairs, as long as they cost less than \$3,000.^e

By late November, FEMA had allocated \$35 million to the non-federal generator operations and maintenance mission.^f By the end of December, teams from Honolulu and Savannah Districts, along with contractors from Louis Berger Group, had assessed more than four hundred generators already in place and made repairs to more than one hundred of those engines.^g Although early on the team members focused on hospitals, later the teams mostly addressed the generators in support of water supply, sewage treatment, and flood control facilities, those owned by the Puerto Rico Aqueduct and Sewer Authority. In some

cases their aging generators had been flooded during the hurricane or had sucked in debris that was stirred up by the storm. By early May 2018, the temporary emergency power task force had repaired more than 250 non-federal generators and had performed generator maintenance more than 430 times.^h

Notes

- a. Interview, Reginald Bourgeois, Mission Manager, Temporary Emergency Power, by Matthew Percy, RFO, San Juan, Puerto Rico, October 18, 2017, 11, Oral History Collection, Office of History, HQUSACE, Alexandria, Virginia [Hereafter cited as CEHO].
- b. Federal Emergency Management Agency, "Fact Sheet: Obligated Funding for Puerto Rico," September 10, 2018, <https://www.fema.gov/news-release/2018/09/10/fact-sheet-obligated-funding-puerto-rico>.
- c. Interview, Reginald Bourgeois (2017), 11.
- d. Interview, Darin Aihara, Temporary Power Planning and Response Team, Honolulu District, by Matthew Percy, San Juan, Puerto Rico, October 18, 2017, 14, CEHO.
- e. Interview, Darin Aihara (2017), 16-18.
- f. "Puerto Rico Maintenance and Services of Non-FED Generators COP," TFTEP COP Slides, November 28, 2017, 4, Emergency Operations Collection, CEHO.
- g. Cody Kozacek, "Non-Federal Generator Operation and Maintenance Mission helps power critical water infrastructure in Puerto Rico," USACE Mobile District, News, December 29, 2017, <https://www.sam.usace.army.mil/Media/News-Stories/Article/1406119/non-federal-generator-operation-and-maintenance-mission-helps-power-critical-wa/>.
- h. "USACE Temporary Emergency Power Mission," Temporary Power Talking Points, May 5, 2018, 2, Emergency Operations Collection, CEHO.

of water was a more pressing issue in many places than was being in the dark. In the early weeks of the mission, officials found it hard to make simplistic calculations about where the needs were greatest, with so many parts of the island in crisis. "It saves lives," said Bourgeois in mid-October 2017, referring to the supply of electrical power to sites without it. "We have one [generator] at a community with only twelve hundred people. It's Adjuntas [municipality]. It's a mountain community. They have spent fifteen days gathering water from rainwater to be able to drink. They had a water pump and a well. I mean what's that worth? How do you put value on twelve hundred people not having drinking water? So we started doing that."¹²³

It is nearly certain that power disruptions at critical facilities cost lives, based on continuing analyses of the storm's indirect impacts.¹²⁴ For example, multiple hospitals on the island reported operating for weeks after the storm without air conditioning, with temperatures in the 90s, as their generators were used for life-saving equipment.¹²⁵ Sanitary conditions deteriorated. Doctors postponed surgeries. Even the island's largest and most important medical facility, the Centro Médico in San Juan, experienced significantly degraded service, with only two out of three of its backup generators running. Centro Médico is the only trauma center in the Caribbean basin. Even when grid power was restored, service remained unreliable, and the Corps installed a third high-capacity generator at the hospital on October 22.¹²⁶

Although the Corps was not responsible for decisions prioritizing which facilities would get generators first there was no avoiding the incredible urgency of the situation. The temporary power team received calls every day from facility administrators and local government officials who were waiting for generators.¹²⁷ Sometimes waiting was not an option, and temporary power Quality Assurance (QA) specialists would visit a service site only to discover that the generator had been moved by the local agency to another site. In turn, the Corps' temporary power managers used GPS-based tracking devices to monitor the whereabouts of the various generators and to account for their unannounced relocations.

The Temporary Power Mission at Full Stride

Although the early stage of the temporary power program went slowly and was hampered by logistical challenges, only a month after the storm hit the island, the teams that made up Task Force Temporary Emergency Power (TF TEP) were much closer to meeting their goals. Two factors came together to accelerate the pace of installations: more people arrived to complete assessments at critical facilities in order to prioritize installations and more generators and accessory equipment became available to install. The temporary power teams also benefitted from the success of two weeks of road clearing so that more critical facilities were accessible across the island. By the end of the first week of October 2017, 265 facilities had requested assessments, TF TEP had completed 156 inspections, and the teams had installed thirty generators, with nine more installations in progress. There were 250 generators available to install on the island, and there were 214 temporary power personnel on the ground, based at two different sites, including 147 Louis Berger Group contractors.¹²⁸

Even as the capacity of TF TEP increased during that first month after the storm, it was still struggling to keep up with the demand for generator assessments. Local backup generators were stressed across the island, and more and more facilities realized they would need more reliable, or additional, power for the long run. By October 17, nearly 500 assessments had been requested at critical facilities, 376 inspections had been completed, and 127 generators had been installed—nearly 100 more than had been operational ten days earlier. TF TEP was trying to increase the rate of installations above 15 per day, and



Shelby Deal, a quality assurance specialist with the temporary emergency power mission, inspected a generator at a water pumping station near Jayuya, Puerto Rico, Jan. 4, 2018. Maintaining reliable water supplies across the island became a key mission for the temporary power team after life-saving needs were initially met. (USACE photo by Codi Kozacek)

priorities for new installations had largely shifted to water pumping stations.¹²⁹ By then there were almost 250 personnel on the island dedicated to the temporary power mission and 288 generators available to install. The greatest bottleneck at this point was that 214 of those generators were stuck in the Port of San Juan, and there were not enough personnel to unload and transport them for installation.¹³⁰

In early November, a PRT from Pittsburgh District arrived to take over management of the mission from Albuquerque. By that time, the teams had installed nearly five hundred generators on Puerto Rico—surpassing the previous record number following Hurricane Katrina.¹³¹ TF TEP had also reached an unprecedented rate of new installations: twenty-five generators a day. The pace continued to increase, and the number of daily installations peaked in late December. By then, eight hundred contractors were on the island. Many of these crews included local Puerto Rican workers subcontracted to LBG.¹³² With a mission that large, their local knowledge and skills were valuable to the teams. “They were doing everything from prepping generators to installing generators to refueling generators and doing routine maintenance and any repairs that were required,” said Al Coglio, an emergency management specialist from Pittsburgh District who deployed with the temporary power team. “Basically they were the hands-on. We were just the management of that team.”¹³³

The huge number of generators required by critical facilities—from clinics to water treatment plants to fire stations to community centers—as they waited week after week for grid power to be restored was unprecedented in the Corps’ history. FEMA’s inventory of commercial generators on the mainland was exhausted, and TF TEP was forced to work with DLA and LBG to lease generators from other suppliers. The support of DLA personnel in procuring generators and electrical components was essential for both the temporary power mission and the grid restoration effort.¹³⁴

Once again, the lack of Spanish speakers on the temporary power teams presented a challenge to the success of the mission. “We were put in a situation where we were attaching generators to facilities and most of the folks that worked in those facilities spoke Spanish, where the majority of our teams spoke English,” remembered Coglio. Especially in the interior of the island, facility managers who were in charge of making sure their buildings had backup power often did not speak fluent English. By November, TF TEP too set up a local contract to engage bilingual interpreters, and they were eventually able to staff a telephone hotline, essentially a help desk, to handle requests for servicing and repairing generators.¹³⁵

Around Christmas 2017, TF TEP installed the one thousandth generator in Puerto Rico.¹³⁶ By then, however, many generators had been running for an extended period of two months or more, far longer than after previous storms in other states. Some of these units began to have maintenance issues and needed to be replaced with another generator. Crews then serviced the malfunctioning unit and often re-installed it at another location, meaning that TF TEP also had to keep supplies of parts on hand for the mounting number of repairs.¹³⁷

The large generators that FEMA and DLA supplied for the Corps’ temporary emergency power program were not meant to power individual homes. However, smaller household generators were everywhere on the island. A story in *Wired* magazine described the profusion of temporary power sources. “Diesel and gas generators became the island’s constant, deafening background noise. Long orange extension cords slithered out of windows, connecting houses to one another, as neighbors shared the power their generators were producing.... During its busiest period after the storm, one store in San Juan was selling about 400 generators a day.”¹³⁸

In Puerto Rico the temporary power mission would outlast the Corps’ direct work on the electrical grid by several months. A year after Maria’s landfall, TF TEP had installed federally-owned or leased generators at 1,289 critical facilities, such as hospitals, wastewater treatment plants, water purification facilities, and fire and police stations. Additionally, TF TEP repaired and serviced hundreds of non-federal generators and set up and maintained nine microgrids, which provided temporary power to remote communities while primary grid power was being restored.¹³⁹ A little more than a year after the storm, on September 26, 2018, sixty-nine generators and three microgrids were still in operation.¹⁴⁰

At that point, FEMA had allocated \$706 million to these programs.¹⁴¹ Corps employees from Pittsburgh, Tulsa, Memphis, Walla Walla, Honolulu, Albuquerque, and Savannah Districts had deployed to Puerto Rico in forty-five-day rotations to help complete this effort, which was completely unprecedented in scale and duration.¹⁴²

Notes

¹ USACE Operations Center (UOC), "Hurricane Irma & Maria (SAD)-CONUS," Common Operating Picture, September 20, 2019 (0400), 2-3, Emergency Operations Collection, Office of History, HQUSACE, Alexandria, VA [Hereafter cited as CEHO].

² Brig. Gen. Diana M. Holland, "Responding to the Perfect Storm: The U.S. Army Corps of Engineers and Disaster Response in Puerto Rico, 2017," *Military Review* (May-June 2019): 11-25, <https://www.armyupress.army.mil/journals/military-review/english-edition-archives/may-june-2019/holland-perfect-storm/>; Andrew A. Kornacki, "Change of Command at USACE Recovery Field Office," *News, U.S. Army*, February 5, 2018, https://www.army.mil/article/200104/change_of_command_at_usace_recovery_field_office. Leading the Corps' initial response efforts was Lt. Col. Roberto Solorzano from Mobile District. Solorzano had been deployed after Irma and rode out Maria in San Juan. His knowledge of Spanish was particularly helpful for Mobile District's advance party, which arrived on September 24. Solorzano would return to Puerto Rico to take command of the RFO in San Juan at the end of January 2018.

³ UOC, "Hurricane Irma COP," September 15, 2017, 2, Emergency Operations Collection, CEHO.

⁴ UOC Staff, "UOC Contingency Ops Dashboard," HQUSACE, September 21, 2017, 21-22, Emergency Operations Collection, CEHO.

⁵ UOC Staff, "UOC Contingency Ops Dashboard," Hurricanes Irma & Maria: Navigation (VIPR), September 22, 2017, 44, Emergency Operations Collection, CEHO.

⁶ UOC Staff, "UOC Contingency Ops Dashboard," September 25, September 28, and October 2, 2017, Emergency Operations Collection, CEHO.

⁷ Interview, Col. Jason Kirk, Commander, Task Force Power, by Jonah Bea-Taylor and James Garber, by phone, May 24, 2018, 3, Oral History Collection, CEHO.

⁸ Interview, Brig. Gen. Diana Holland, Commander, USACE South Atlantic Division (SAD), by Matt Percy and James Garber, San Juan, Puerto Rico, October 19, 2017, 7-8, CEHO; Mobile District, "Recovery Field Office," After Action Report, Story 16-17, July 2018, Emergency Operations Collection, CEHO.

⁹ Interview, Col. James DeLapp, Recovery Field Office (RFO) Commander, by Matthew Percy and James Garber, San Juan, Puerto Rico, October 18, 2017, 6-8, CEHO; "Col. James A. DeLapp," Biography, USACE Mobile District, June 23, 2016, <https://www.sam.usace.army.mil/About/Leadership/Bio-Article-View/Article/808531/col-james-a-delapp/>.

¹⁰ Interview, Col. James DeLapp (2017), 17; Mobile District, "Recovery Field Office," 1; Pete Gitto, "South Atlantic Division Deployment Summary Response to Hurricane Maria," After Action Report, 2018, 1, Emergency Operations Collection, CEHO. According to the SAD after action report, "USACE deployment requirements had to compete with other Federal agencies for FEMA airlift and were bumped from scheduled FEMA flights by other Federal passengers with a higher priority established by FEMA. USACE Logistics personnel assigned to the FEMA National Response Coordination Center, Movement Control Group, fulfilled the continuous need to ensure USACE priorities were accurately projected throughout the FEMA movement prioritization and adjudication process." Despite these early challenges, by October 12, 2017, South Atlantic Division had deployed 832 personnel and 264 pieces of equipment to Puerto Rico using a combination of available places on FEMA, military, and commercial aircraft, along with Crowley Maritime barges from Jacksonville, Florida.

¹¹ Mobile District, "Hurricane MARIA and IRMA DTOS Mission," After Action Report, 2018, 2, Emergency Operations Collection, CEHO.

¹² Mobile District, "Hurricane MARIA and IRMA DTOS Mission." Carrying out the Deployable Tactical Operations System (DTOS) mission exemplified the creativity and learning that the challenges of disaster response in Puerto Rico required. Small mobile communications vehicles had been airlifted to disaster areas in the past, but for the first time ever, the Corps barged two large Emergency Command and Control Vehicles (ECCVs) to expand operations in Puerto Rico. According to Mobile District's after action report, at first "USACE logistics and USAF aerial delivery specialists determined that it would be nearly impossible to fly an ECCV due mostly to issues of loading and unloading. However, we provided specifications to USACE logistics and Crowley [a maritime logistics company] for a feasibility assessment to ship the ECCVs via barge. This had never been done before and this type of information on our equipment did not exist as it was never intended to be shipped. After much study of pictures and taking of measurements and discussion with logistics and Crowley, we moved forward and the ECCVs were shipped and arrived in PR by 16 Oct."

¹³ Interview, Col. James DeLapp (2017), 33.

¹⁴ Mobile District, "Recovery Field Office," 1. After about a month at the convention center, Mobile District found a long-term RFO location at Millennium Park Plaza, an office complex in suburban San Juan, close to Fort Buchanan where FEMA had staged an Incident Support Base since

Hurricane Irma. By that time, the RFO had grown to more than 600 Corps personnel.

¹⁵ Charleston District, "South Atlantic Charleston Submission for the IAPRT 2017 Year in Review," Memorandum for the Record, After Action Report, July 12, 2018, 1, Emergency Operations Collection, CEHO. Note that the inspections of hospitals and other medical facilities were carried out by the U.S. Public Health Service.

¹⁶ "Fact Sheet: Obligated Funding for Puerto Rico," News Release No. FS 049, Federal Emergency Management Agency (FEMA), September 10, 2018, <https://www.fema.gov/news-release/2018/09/10/fact-sheet-obligated-funding-puerto-rico>; Task Force Puerto Rico Recovery, "Puerto Rico Hurricane Response: One Year Later," Infographic, Emergency Operations Collection, CEHO.

¹⁷ Andrew Kornacki, "Critical Public Facility mission evolves as Puerto Rico recovery efforts continue," Public Affairs News Archive, HQUSACE, January 27, 2018, <https://www.usace.army.mil/Media/News-Archive/Story-Article-View/Article/1430217/critical-public-facility-mission-evolves-as-puerto-rico-recovery-efforts-contin/>. John Schreiner, USACE Critical Public Facilities Project Manager, shared one example of how important his team's work was in the early days of the Corps' response: "I remember walking into Centro Medico, San Juan, to conduct the site inspection. Technicians were working in the lab surrounded by buckets to catch the water from the leaking roof. In the weeks following award the roof has been sealed, ceiling tiles have been replaced, and the walls have been repaired. The temporary repairs have returned the medical center back to normal operation."

¹⁸ Interview, Col. James DeLapp (2017), 32-33.

¹⁹ Interview, Brig. Gen. Diana Holland (2017), 13-14.

²⁰ UOC Staff, "U.S. Army Corps of Engineers Operational Update," HQUSACE, October 1, 2017, 14, Emergency Operations Collection, CEHO.

²¹ Interview, Lisa Hunter, Public Affairs Chief, Mobile District, by Matthew Percy and James Garber, San Juan, Puerto Rico, October 18, 2017, 21-22, CEHO. Lisa Hunter's 2017 media campaign for Hurricane Maria Disaster Response later won first place in the U.S. Army's Maj. Gen. Keith L. Ware Communications Awards Competition. See <https://www.army.mil/klw/winners/index.html>.

²² Interview, Lisa Hunter (2017), 6-9. In addition to the two public affairs officers in San Juan, Tom O'Hara, Director of Public Affairs at Omaha District, served in a critical role as a liaison officer with FEMA, fielding numerous inquiries about the Corps' support for FEMA.

²³ Interview, Brig. Gen. Diana Holland (2017), 33.

²⁴ Interview, Lisa Hunter (2017), 43-45. Corps personnel stationed at the Jacksonville District's Antilles Area Office were for the large part from Puerto Rico, and they could communicate fluently in Spanish. But during the first week of the Corps' response, the need for quality assurance (QA) staff was so urgent that the area office staff were trained as QAs for the road-clearing mission.

²⁵ David Burge, "Press camp soldiers cover stories in Puerto Rico, help with relief effort," *El Paso Times*, November 16, 2017, <https://www.elpasotimes.com/story/news/military/ft-bliss/2017/11/16/press-camp-soldiers-cover-stories-puerto-rico-help-relief-effort/850742001/>; Interview, Lisa Hunter (2017), 24-25.

²⁶ Interview, Maj. Catalina Carrasco, Deputy Chief of Public Affairs, HQUSACE, by Jonah Bea-Taylor, HQUSACE, Washington, DC, June 15, 2018, 8, CEHO.

²⁷ UOC Staff, "UOC Contingency Ops Dashboard," Puerto Rico Communications Strategy, October 7 and 17, 2017, 8, Emergency Operations Collection, CEHO.

²⁸ Interview, Maj. Catalina Carrasco (2018), 10.

²⁹ Interview, Maj. Catalina Carrasco (2018), 11.

³⁰ Interview, Jeffrey Hawk, Public Affairs Officer, Pittsburgh District, by Jonah Bea-Taylor, by phone, June 12, 2018, 22, CEHO.

³¹ Interview, Maj. Catalina Carrasco (2018), 11-13.

³² Interview, Carlos Torres, Power Restoration Coordinator, Commonwealth of Puerto Rico, by Jonah Bea-Taylor, by phone, August 1, 2019, CEHO.

³³ Holland, "Responding to the Perfect Storm."

³⁴ "UNIFIED Communications Plan, Electric Grid Power Restoration, Puerto Rico," December 2017, 1, Emergency Operations Collection, CEHO.

³⁵ Interview, Jeffrey Hawk (2018), 37-38.

³⁶ Interview, José Sánchez, South Atlantic Division (SAD) Power Program Director, by James Garber and Jonah Bea-Taylor, HQUSACE, Part 2, April 16, 2018, 22, CEHO.

³⁷ Interview, Maj. Gen. Donald E. Jackson, Jr., Deputy Commanding General for Civil and Emergency Operations, HQUSACE, by Jonah Bea-Taylor and James Garber, HQUSACE, Washington, DC, December 20, 2017, 71-72, CEHO.

³⁸ Interview, Evan Dyson, Social Media Program Manager, HQUSACE, by Jonah Bea-Taylor and Matt Percy, HQUSACE, Washington, DC, November 16, 2017, 17, CEHO.

³⁹ Interview, Evan Dyson (2017), 18-19.

⁴⁰ Interview, Evan Dyson (2017), 30-31.

⁴¹ Interview, Brig. Gen. Diana Holland, Commander, South Atlantic Division, by Jonah Bea-Taylor, Atlanta, GA, December 14, 2018, 20, CEHO.

⁴² "Lago Guajataca at Damsite," Water Resources of the Caribbean, 50010800, U.S. Geological Survey, Internet Archive, Retrieved July 28, 2018, https://web.archive.org/web/20180728131326/https://pr.water.usgs.gov/public/rt/pr_lakes/lake_50010800.html.

⁴³ UOC, "UOC Contingency Ops Dashboard," October 6, 2017, 17, Emergency Operations Collection, CEHO. The USGS gauge at the dam site at Lake Guajataca broke during the hurricane. The water level may have risen higher than

six feet over 36 hours. The gauge was repaired on September 28, 2017.

⁴⁴ John MacPherson, "DoD provides unique and critical support to Puerto Rico," *Yankee Engineer*, USACE New England District, November 2017, 4-5, <https://www.sam.usace.army.mil/Portals/74/docs/YankeeEngineer/2017/YENovember2017.pdf?ver=2017-12-07-082224-083>.

⁴⁵ Gabe Gutierrez, "Lack of Communication Hinders Efforts Amid Dam Failure Fear in Puerto Rico," *U.S. News*, NBC, September 23, 2017, <https://www.nbcnews.com/news/us-news/lack-communication-amid-dam-failure-fears-hurricane-damaged-puerto-rico-n804236>.

⁴⁶ Frances Robles, "Cracks in a Puerto Rican Dam Send Neighbors a Message: Leave Now," *New York Times*, September 23, 2017, <https://www.nytimes.com/2017/09/23/us/guajataca-dam-puerto-rico.html>; Air National Guard, "24SEP17_AR_IAA_PR_GUAJATACA_DAM_UPDATE," USPERS Guajataca Dam, 7, Emergency Operations Collection, CEHO.

⁴⁷ UOC Staff, "Operational Update," HQUSACE, September 25, 2017, 44, Emergency Operations Collection, CEHO.

⁴⁸ *Report of the Commissioner of the Interior for Porto Rico for the Fiscal Year Ending June 30, 1926* (San Juan: Dept. of the Interior of Puerto Rico, 1927), 133-139, digital copy available on the Hathi Trust, <https://hdl.handle.net/2027/uc1.b3002135>. Funding for the Guajataca Dam was first authorized in 1919 by Act No. 59 of the Territorial Legislature of Puerto Rico, under which the U.S. Department of War, Bureau of Insular Affairs, was authorized to sell bonds for the account of the Insular Government of the island. Construction work was carried out by the Isabela Irrigation Service, Porto Rico [sic] Department of the Interior, between 1921 and 1928. Isabela initially hired local contractors for the dam construction, but they rescinded those contracts in 1926 and finished the dam themselves in 1927. An irrigation system for the surrounding region was completed in December 1928. Isabela also began selling electricity generated by the dam to nearby towns. In the 1940s, the hydroelectric facilities of many small producers were incorporated into what would eventually be called the *Autoridad de Energía Eléctrica* (PREPA), which put together an island-wide grid.

⁴⁹ Interview, Maj. Gen. Donald E. Jackson, Jr., (2017), 34-35.

⁵⁰ Interview, Col. James DeLapp (2017), 19-20.

⁵¹ Quoted in Luke Abaffy, "Feds Fight to Firm Up Puerto Rico Dam," *ENRSoutheast, Engineer News-Record*, February 26, 2018, <https://www.enr.com/articles/44047-feds-fight-to-firm-up-puerto-rico-dam>.

⁵² Lisa Hunter, "Army Corps, DoD, and local authorities work to stabilize Guajataca Dam," Press Release, HQUSACE, October 2, 2017, <https://www.usace.army.mil/Media/News-Releases/News-Release-Article-View/Article/1332840/army-corps-dod-and-local-authorities-work-to-stabilize-guajataca-dam/>.

⁵³ Interview, Col. James DeLapp (2017), 24-26.

⁵⁴ MacPherson, "DoD provides unique and critical support to Puerto Rico," 5.

⁵⁵ "Guajataca Dam Concept of Operations," April 2018, 2, Emergency Operations Collection, CEHO.

⁵⁶ "Guajataca Dam Concept of Operations."

⁵⁷ Interview, Col. James DeLapp (2017), 27.

⁵⁸ Hunter, "Army Corps, DoD, and local authorities work to stabilize Guajataca Dam."

⁵⁹ Abaffy, "Feds Fight to Firm Up Puerto Rico Dam."

⁶⁰ Daniel Blaydes, "18 July 2018—Site Observation Report—Guajataca Dam, Isabela, Puerto Rico," Memorandum for the Record, July 18, 2018, Emergency Operations Collection, CEHO; UOC Staff, "U.S. Army Corps of Engineers Operational Update," HQUSACE, November 6, 2019, 15, Emergency Operations Collection, CEHO.

⁶¹ UOC Staff, "U.S. Army Corps of Engineers Operational Update," HQUSACE, June 25, 2018, 20, Emergency Operations Collection, CEHO; "Fact Sheet: Obligated Funding for Puerto Rico."

⁶² HQUSACE, "Temporary Roofing Mission," Fact Sheet, USACE Mobile District, 2007, <http://www.sam.usace.army.mil/Portals/46/docs/pa/docs/071510-A-AQ963-022.pdf>.

⁶³ UOC Staff, "UOC Contingency Ops Dashboard," November 13, 2017, 24, Emergency Operations Collection, CEHO.

⁶⁴ "Summary of the 2017 Puerto Rico Temporary Roofing Mission," After Action Report, November 2018, Emergency Operations Collection, CEHO; Task Force Puerto Rico Recovery, "Puerto Rico Hurricane Response: One Year Later"; "Fact Sheet: Obligated Funding for Puerto Rico."

⁶⁵ Damon Manders, "The Emergency Management Partnership: U.S. Army Engineer Disaster Relief Operations, 1979 to Present" (unpublished manuscript draft, March 5, 2019), 201, Microsoft Word file, CEHO; South Atlantic Division, "Hurricane Georges: Georges Emergency Recovery Office (GERO), Division Forward After Action Report," 3-12, Atlanta Federal Records Center, RG 77, Acc. 077-2011-0283, Box 25, File Georges Misc.

⁶⁶ "Temporary Roofing," Fact Sheet, HQUSACE, December 15, 2011, <https://www.usace.army.mil/Media/Fact-Sheets/Fact-Sheet-Article-View/Article/475463/temporary-roofing/>.

⁶⁷ Rick Young, "Blackout in Puerto Rico," *Frontline*, Season 36, Episode 10, PBS, June 27, 2018, <https://www.pbs.org/wgbh/frontline/film/blackout-in-puerto-rico/>.

⁶⁸ Interview, Gregory E. Bertoglio, Temporary Roofing Subject Matter Expert, by James Garber, Joint Field Office, San Juan, Puerto Rico, October 19, 2017, 11, CEHO.

⁶⁹ "Summary of the 2017 Puerto Rico Temporary Roofing Mission," 1.

⁷⁰ “Corps of Engineers installs first Blue Roof in Puerto Rico,” News Release No. 17-051, HQUSACE, October 5, 2017, <https://www.usace.army.mil/Media/News-Releases/News-Release-Article-View/Article/1335052/corps-of-engineers-installs-first-blue-roof-in-puerto-rico/>.

⁷¹ Interview, Joshua Marx, Temporary Roofing Program Manager, by James Garber and Jonah Bea-Taylor, by phone, June 26, 2018, 12, CEHO.

⁷² “Summary of the 2017 Puerto Rico Temporary Roofing Mission,” 1. During an emergency response, Quality Assurance personnel make sure the contractor is performing the work as expected. They review contractor work in progress, checking that it is meeting specifications in the contract. They thus ensure that government interests in the quality of the final product are protected.

⁷³ “Summary of the 2017 Puerto Rico Temporary Roofing Mission,” 1.

⁷⁴ Interview, Joshua Marx (2018).

⁷⁵ Interview, Joshua Marx (2018), 15.

⁷⁶ FEMA, “Senior Leadership Briefing and Recovery Snapshots—Hurricanes Maria, Irma, and Harvey,” October 11, 2017, 3, Emergency Operations Collection, CEHO.

⁷⁷ John D. Sutter, “La Ruta De María: A journey along the path of the hurricane,” *CNN News*, CNN, February 1, 2018, <https://www.cnn.com/2018/01/12/us/sutter-maria-route-puerto-rico-invs/index.html>.

⁷⁸ Kimberly Kindy and Aaron C. Davis, “With thousands still in shelters, FEMA’s caution about temporary housing hinders hurricane recovery,” *Washington Post*, October 28, 2017, https://www.washingtonpost.com/investigations/with-thousands-still-in-shelters-femas-caution-about-temporary-housing-hinders-hurricane-recovery/2017/10/28/58bd2ae0-acdf-11e7-be94-fabb0f1e9ffb_story.html.

⁷⁹ “FEMA’s Transitional Sheltering Assistance Program Ends June 30,” News Release 193, FEMA, June 2, 2018, <https://www.fema.gov/news-release/2018/06/02/femas-transitional-sheltering-assistance-program-ends-june-30>.

⁸⁰ Maj. Gen. Donald E. Jackson to Maj. Gen. Michael C. Wehr, “29 Sep FEMA/HQDA Briefing Notes,” Email, September 29, 2017, Emergency Operations Collection, CEHO.

⁸¹ Interview, Joshua Marx (2018).

⁸² Interview, Joshua Marx (2018).

⁸³ Interview, Gregory Bertoglio (2017), 13, 30.

⁸⁴ Lynn Rose, “Operation Blue Roof Right of Entry application deadline ends in Puerto Rico,” Press Release, HQUSACE, January 13, 2018, <https://www.usace.army.mil/Media/News-Releases/News-Release-Article-View/Article/1420371/operation-blue-roof-right-of-entry-application-deadline-ends-in-puerto-rico/>; “Temporary Roofing—Cumulative Projection,” Graph, March 23, 2018,

Emergency Operations Collection, CEHO; “Temporary Roofing,” Roofing Slides Draft, March 22, 2018, Emergency Operations Collection, CEHO. Despite showing tremendous patience with the program, many survivors likely found other temporary or permanent solutions during the months they waited for a Blue Roof.

⁸⁵ Patrick Loch, “USACE Blue Roof mission in Puerto Rico is a family affair,” Public Affairs News Archive, HQUSACE, December 28, 2017, <https://www.usace.army.mil/Media/News-Archive/Story-Article-View/Article/1406701/usace-blue-roof-mission-in-puerto-rico-is-a-family-affair/>.

⁸⁶ Loch, “USACE Blue Roof mission.”

⁸⁷ Interview, Gregory Bertoglio (2017), 27.

⁸⁸ Interview, Gregory Bertoglio (2017), 17.

⁸⁹ “Summary of the 2017 Puerto Rico Temporary Roofing Mission,” 2.

⁹⁰ Interview, Joshua Marx (2018).

⁹¹ South Atlantic Division, “Hurricane Georges After Action Report,” 3-25, 5-34.

⁹² UOC Staff, “UOC Contingency Ops Dashboard,” October 11, 2017, 22; and October 20, 2017, 24; both Emergency Operations Collection, CEHO.

⁹³ Interview, Joshua Marx (2018), 29-30; “Summary of the 2017 Puerto Rico Temporary Roofing Mission,” 2.

⁹⁴ Joshua Marx, Email to author, June 25, 2019.

⁹⁵ Ed Loomis, “Corps Contractors Complete 50,000th Blue Roof Installation,” News, U.S. Army, January 24, 2018, https://www.army.mil/article/199472/corps_contractors_complete_50000th_blue_roof_installation; “Summary of the 2017 Puerto Rico Temporary Roofing Mission,” 2.

⁹⁶ Manders, “The Emergency Management Partnership,” 6-7; Leland R. Johnson, *Situation Desperate: U.S. Army Engineer Disaster Relief Operations, Origins to 1950* (Alexandria, VA: Office of History, Headquarters, U.S. Army Corps of Engineers, 2011), 62.

⁹⁷ Interview, Christopher Gilmore, Debris Action Officer, by Matthew Percy, San Juan, Puerto Rico, October 21, 2017, 6-9, Oral History Collection, CEHO.

⁹⁸ Interview, Christopher Gilmore (2017), 16-22; “Commercial Airline Service Resumes in San Juan,” News and Updates, Federal Aviation Administration, September 25, 2017, <https://www.faa.gov/news/updates/?newsId=88805>; “Update: U.S. Northern Command Continues Puerto Rican Relief Efforts,” Release No. 17-038, USNORTHCOM, October 10, 2017, <http://www.northcom.mil/Newsroom/Press-Releases/Article/1338436/update-us-northern-command-continues-puerto-rican-relief-efforts/>. Some routes were assigned to the Corps specifically to aid the entire federal response to the hurricane. These critical routes included the remote access road to the Federal Aviation Administration’s long-range radar station on one of the highest mountains in El Yunque National Park. Repairs to this station, and to

other, shorter-range facilities, would allow a higher volume of flights into Puerto Rico. Meanwhile, National Guard and Marine units cleared routes to access damaged mobile communications towers.

⁹⁹ Interview, Christopher Gilmore (2017), 26; Patrick Loch, "USACE emergency response missions include debris removal and temporary power generation in Puerto Rico," News Stories, USACE Mobile District, January 16, 2018, <https://www.sam.usace.army.mil/Media/News-Stories/Article/1415867/usace-emergency-response-missions-include-debris-removal-and-temporary-power-ge/>.

¹⁰⁰ Interview, Christopher Gilmore (2017), 37-38, 57; Loch, "USACE emergency response missions include debris removal."

¹⁰¹ Loch, "USACE emergency response missions include debris removal."

¹⁰² "Debris Mission," Talking Points, May 5, 2018, Emergency Operations Collection, CEHO; Task Force Puerto Rico Recovery, "Puerto Rico Hurricane Response: One Year Later"; "Fact Sheet: Obligated Funding for Puerto Rico."

¹⁰³ Manders, "The Emergency Management Partnership," 196.

¹⁰⁴ Ari Shapiro, "Hurricane Maria Leaves Hospital In Puerto Rico Running On Generator Power," *All Things Considered*, NPR, September 20, 2017, <https://www.npr.org/2017/09/20/552418215/hurricane-maria-leaves-hospital-in-puerto-rico-running-on-generator-power>; Alexa Liautaud, "Puerto Rican hospitals are still desperate for fuel, generators, and cash," *Vice News*, October 9, 2017, https://news.vice.com/en_us/article/evamjj/puerto-rican-hospitals-are-still-desperate-for-fuel-generators-and-cash; Frances Robles, "Puerto Rico's Health Care Is in Dire Condition, Three Weeks After Maria," *New York Times*, October 10, 2017, <https://www.nytimes.com/2017/10/10/us/puerto-rico-power-hospitals.html>; Kara Dapena, Daniela Hernandez, and Arian Campo-Flores, "Inside Puerto Rico's Struggle to Recover a Month After Hurricane," *Wall Street Journal*, October 20, 2017, <https://www.wsj.com/articles/inside-puerto-ricos-struggle-to-recover-a-month-after-hurricane-1508491811>.

¹⁰⁵ Jacqueline Tate, HQUSACE, "Corps installs 2000th power generator in Puerto Rico," News, Defense Visual Information Distribution Service (DVIDS), April 2, 2018, <https://www.dvidshub.net/news/271503/corps-installs-2000th-power-generator-puerto-rico>. The total number of critical facilities that received generators was 1,289, but some facilities got multiple generators, and many generators were installed, uninstalled for maintenance, and then re-installed again if power remained unreliable or the facility's own backup systems were not fully operational. Counting the total number of generator-related tasks produces a much higher total, about 2,200 installations and re-installations.

¹⁰⁶ 249th Engineer Battalion, "Hurricane Maria PR/USVI Temporary Emergency Power Mission Facts," ver. 1, November 28, 2017, Emergency Operations Collection, CEHO.

¹⁰⁷ Cheryl Moore, HQUSACE, "USACE Task Force Temporary Emergency Power team powers down in Texas," News, DVIDS, September 21, 2017, <https://www.dvidshub.net/news/249144/usace-task-force-temporary-emergency-power-team-powers-down-texas>; "'Temporary Power' team doing their part to return Florida to normalcy," News Releases, HQUSACE, September 22, 2017, <https://www.usace.army.mil/Media/News-Releases/News-Release-Article-View/Article/1322389/temporary-power-team-doing-their-part-to-return-florida-to-normalcy/>.

¹⁰⁸ "Hurricane Irma Contingency Operations Executive Summary," September 4, 2017, Emergency Operations Collection, CEHO.

¹⁰⁹ UOC Staff, "U.S. Army Corps of Engineers Operational Update," HQUSACE, September 20, 2017 Emergency Operations Collection, CEHO.

¹¹⁰ UOC Staff, "U.S. Army Corps of Engineers Operational Update," HQUSACE, September 18 and 25, 2017, 13, Emergency Operations Collection, CEHO. Transporting generators to the Caribbean was a challenge, both because of the length of time required to ship by barge and the concerns about their suitability to air transport. Florida, in sharp contrast, had 284 FEMA generators on-hand on September 18, eight days after Irma's landfall in the Keys. Some of those generators had been warehoused in the state, and others were trucked in.

¹¹¹ Interview, Reginald Bourgeois, Mission Manager, Temporary Emergency Power, by Matthew Pearcy, RFO, San Juan, Puerto Rico, October 18, 2017, 6-7, CEHO.

¹¹² Interview, Reginald Bourgeois (2017), 9.

¹¹³ Interview, Reginald Bourgeois (2017), 20.

¹¹⁴ "Hurricanes Irma & Maria: Common Operating Picture," September 24, 2017, 2, Emergency Operations Collection, CEHO.

¹¹⁵ "Hurricanes Irma & Maria: Common Operating Picture," September 27, 2017, 2, Emergency Operations Collection, CEHO; Patricia Fontanet Rodriguez, "Power mission in Puerto Rico set to be largest ever in US," News, U.S. Army, November 6, 2017, https://www.army.mil/article/196385/power_mission_in_puerto_rico_set_to_be_largest_ever_in_us.

¹¹⁶ UOC Staff, "U.S. Army Corps of Engineers Contingency Ops Dashboard," HQUSACE, September 19, 2017, 20, Emergency Operations Collection, CEHO.

¹¹⁷ UOC Staff, "U.S. Army Corps of Engineers Contingency Ops Dashboard," HQUSACE, September 25, 2017, 36, Emergency Operations Collection, CEHO.

¹¹⁸ Franklin Ford to José Sánchez, Email, September 26, 2017, Emergency Operations Collection, CEHO.

¹¹⁹ "Hurricanes Irma and Maria: Common Operating Picture," September 26, 2017, 2, Emergency Operations Collection, CEHO.

¹²⁰ Interview, Reginald Bourgeois (2017), 23.

¹²¹ Interview, Albert Coglio, Emergency Management Specialist, USACE Pittsburgh District, by Jonah Beatty, by phone, June 22, 2018, 19, CEHO.

¹²² Interview, Albert Coglio (2018), 28-29.

¹²³ Interview, Reginald Bourgeois (2017), 50-51.

¹²⁴ Nishant Kishore, Domingo Marqués, Ayesha Mahmud, et al., "Mortality in Puerto Rico after Hurricane Maria," *New England Journal of Medicine* (2018; 379:162-170), May 29, 2018, 4-5, <https://www.nejm.org/doi/10.1056/NEJMsa1803972>.

¹²⁵ Mattathias Schwartz, "Maria's Bodies," *Intelligencer*, *New York Magazine*, November 27, 2017, <http://nymag.com/daily/intelligencer/2017/12/hurricane-maria-man-made-disaster.html>.

¹²⁶ Brigida Sanchez, USACE South Atlantic Division, "The Tenacity of Prime Power & the Resolve of Puerto Rico," News, DVIDS, October 24, 2017, <https://www.dvidshub.net/image/3895583/tenacity-prime-power-resolve-puerto-rico>.

¹²⁷ Interview, Albert Coglio (2018), 6-7.

¹²⁸ UOC Staff, "U.S. Army Corps of Engineers Contingency Ops Dashboard," Hurricane Maria Power COP, October 6, 2017, 29, Emergency Operations Collection, CEHO. A significant number of facilities requested an assessment and then found that their own backup power was working, or they chose to purchase a generator privately, or in a few cases, these facilities got grid power back while waiting for an inspection. Other facilities were not eligible or were lower priority because they were not involved in life-saving or sustaining work. Thus there were more than 70 cancelled and closed assessments in the first two weeks of the mission alone.

¹²⁹ S. Sgt. Elizabeth Tarr, 24th Theater Public Affairs Support Element, "U.S. Army Corps of Engineers provide generators for critical facilities in Puerto Rico," News, DVIDS, October 8, 2017, <https://www.dvidshub.net/news/251006/us-army-corps-engineers-provide-generators-critical-facilities-puerto-rico>.

¹³⁰ UOC Staff, "U.S. Army Corps of Engineers Contingency Ops Dashboard," Task Force Temporary Emergency Power (TF TEP) Power COP, October 17, 2017, 24, Emergency Operations Collection, CEHO.

¹³¹ Edward Rivera, "Remote Puerto Rico community hospital gets 500th FEMA generator installed by USACE," News, U.S. Army, November 11, 2017, https://www.army.mil/article/196762/remote_puerto_rico_community_hospital_gets_500th_fema_generator_installed_by_usace.

¹³² Interview, Albert Coglio (2018), 4-5.

¹³³ Interview, Albert Coglio (2018), 9.

¹³⁴ Jason Kaneshiro, "Power Projection," DLA Troop Support, Defense Logistics Agency, March 8, 2018, <https://www.dla.mil/AboutDLA/News/NewsArticleView/Article/1466839/power-projection/>.

¹³⁵ Interview, Albert Coglio (2018), 7-8.

¹³⁶ UOC Staff, "USACE Contingency Operations Update," December 28, 2017, 3, Emergency Operations Collection, CEHO.

¹³⁷ Interview, Albert Coglio (2018), 16-18; Pam Radtke Russell, "Kris Caldwell: Getting Power Back to the People in Puerto Rico," *Engineering News-Record*, January 10, 2019, <https://www.enr.com/articles/46165-getting-power-back-to-the-people-in-puerto-rico>; Codi Kozacek, "Army Engineers Generate Electric Power in Puerto Rico," News, U.S. Department of Defense, January 16, 2018, <https://dod.defense.gov/News/Article/Article/1416130/army-engineers-generate-electric-power-in-puerto-rico/>.

¹³⁸ Daniel Alarcón, "What Happened in the Dark: Puerto Rico's Year of Fighting for Power," *Wired*, August 23, 2018, <https://www.wired.com/story/puerto-rico-hurricane-maria-recovery/>.

¹³⁹ "TF Power—Microgrid Update," Situation Report, March 8, 2018, 2, Emergency Operations Collection, CEHO. A total of 9 microgrids were actually installed and operated. FEMA approved an additional microgrid at Humacao, near where Maria made landfall on the southeast coast, but this system was never installed because grid power was restored to parts of the area in the meantime.

¹⁴⁰ UOC Staff, "U.S. Army Corps of Engineers Operational Update," HQUSACE, September 26, 2018, 28, Emergency Operations Collection, CEHO.

¹⁴¹ "Fact Sheet: Obligated Funding for Puerto Rico."

¹⁴² Andrew Kornacki, USACE Buffalo District, "A Day in the Life: Temporary Emergency Power QA in Puerto Rico," News, DVIDS, August 17, 2018, <https://www.dvidshub.net/news/289234/day-life-temporary-emergency-power-qa-puerto-rico>; Task Force Puerto Rico Recovery, "Puerto Rico Hurricane Response: One Year Later."



Prime Power transmission and distribution specialists with the 249th Engineering Battalion, D Company, set a concrete power pole in Rio Grande, Puerto Rico, Oct. 19, 2017. D Company comprised reservists with professional experience as lineworkers. (U.S. Air Force photo by M. Sgt. Joshua L. DeMotts)

— CHAPTER 4 —

THE BEGINNING OF THE GRID RESTORATION MISSION, SEPTEMBER 2017-JANUARY 2018

The most visible impact of Hurricane Maria on Puerto Rico was the complete blackout of the island. Two weeks after Hurricane Irma roared past the northern coast of the island, the Puerto Rico Electric Power Authority (PREPA) reported that power had been restored to 96 percent of its customers, meaning about sixty-one thousand were still in the dark when Maria destroyed transmission and distribution lines in every region of the commonwealth.¹ While Maria was not quite as powerful as Irma as it passed through the western Caribbean, its diagonal path across the center of Puerto Rico brought the storm's worst winds directly into the island's primary transmission infrastructure in the central highlands.² Any electrical system would have been extensively damaged by a strong Category 4 storm, but after years of widespread neglect by the struggling, deeply indebted power authority, Puerto Rico's grid was even more vulnerable to the second, far more direct hit.³

In terms of total customer-hours of electricity lost, Puerto Rico's blackout was likely the second worst in world history, falling just behind Typhoon Haiyan, which devastated the Philippines in 2013.⁴ The patience and fortitude of the people of Puerto Rico throughout this long ordeal cannot be overstated. Carlos Torres—a power industry veteran who led the Unified Command Group that included PREPA, the Federal Emergency Management Agency (FEMA), and the U.S. Army Corps of Engineers—explained to the House Energy and Commerce Committee in April 2018:

Having lived on the island now for more than five months, I can tell you that the people of Puerto Rico are the most resilient people I have ever met in my

life. Every single person on the island was impacted by Hurricane Maria, and many continue life today, dealing without power, without water. While their resiliency is admirable, nobody deserves to be without electricity for this long, and I and everyone involved in the restoration effort remain committed to working as one team, with one mission—providing power to our fellow citizens in Puerto Rico.⁵

Following most recent major natural disasters, such as Hurricane Sandy (2012), the Corps' response had been focused on providing temporary emergency power in the form of generators at critical facilities, such as police stations, airports, and hospitals. Generally, the federal government does not take responsibility for repairing electrical systems in the United States.⁶ After major storms that cause widespread power outages, American power companies help each other repair electrical grids. Power industry mutual aid (or assistance) agreements usually mean that various power companies can provide enough trucks and line workers to fix downed power lines and damaged poles and substations. For example, in 2017 these mutual aid agreements between local and regional utilities meant they would help each other restore power in Texas and Florida after hurricanes Harvey and Irma. Thousands of line workers from surrounding, undamaged areas essentially got in their utility trucks and converged on the impacted service areas. Local utilities supported these crews with basic food, lodging, and replacement parts.⁷

In Puerto Rico, however, PREPA waited more than a month before formally requesting mutual aid. Instead, in the chaotic devastation left by Hurricane Maria, the power authority contracted Whitefish Energy—a tiny, startup electrical services company—to hire subcontractors to repair transmission lines. The deal with Whitefish proved to be extremely controversial, especially as the scale of the damage to Puerto Rico's grid seemed so disproportionate to the capacity of a young company that listed only two permanent employees and \$1 million in revenue in 2017 in a database that tracks federal contractors.⁸ The situation in Puerto Rico was also obviously different from mainland states such as Florida and Texas because line workers could not simply drive from staging grounds in nearby, less-impacted areas.

When the federal government does play a role in the repair of electrical infrastructure, typically FEMA assigns it to the U.S. Department of Energy (DOE) under the National Response Framework's Emergency Support Function for energy (ESF-12).⁹ In practice, DOE provides technical assistance and some coordination as power companies in different states follow through on their mutual aid responsibilities after a disaster.¹⁰ Because of these mutual assistance agreements, and leadership at the state level, FEMA rarely asks a federal agency to directly lead a grid repair effort.

Soon after Hurricane Irma devastated the U.S. Virgin Islands on September 6, 2017, however, FEMA requested that the Corps begin making initial plans for just such an un-

usual power restoration mission.¹¹ The storm destroyed about 90 percent of the power grid on the island of St. John and about 80 percent on St. Thomas.¹² The Corps had received a temporary power mission for Puerto Rico and the Virgin Islands on September 2, a few days before Irma's landfall, and had begun deploying temporary power Planning and Response Teams (PRTs) to both locations.¹³ Six days after the storm, once ports in the Virgin Islands had reopened, the Defense Logistics Agency (DLA) barged thirty-one generators from Puerto Rico to St. Thomas at FEMA's direction. The Virgin Islands Water and Power Authority (WAPA) installed one industrial-sized, 800-kW generator (enough to power about five hundred average American households) at the Randolph Harvey Power Plant to help stabilize power generation on St. Thomas.¹⁴

Operations planners at the Corps headquarters produced a draft plan, consisting of three phases, for reconstituting the Virgin Islands' power distribution grid. First, the federal government would send its own line workers to make initial repairs. DOE's Western Area Power Administration (not to be confused with the Virgin Islands Water and Power Authority, or WAPA) would take the lead in providing materials and repairing generation and transmission infrastructure. During the first month of the response, the Corps would focus on clearing debris to make sure Western Area Power Administration crews had access to the downed poles and lines.¹⁵ Second, with mutual assistance agreements in place, additional crews from mainland power companies would begin working on the power distribution system. Finally, after the first month, with power restored to most critical facilities and a large number of generators providing emergency power across the islands, the Corps would transition to leading a more permanent rebuild of the power grid. To improve resiliency, but only if authorized by Congress, the Corps could consider rebuilding to better than pre-storm conditions, perhaps by erecting more concrete poles.¹⁶

Before the Corps could fully develop those plans, however, Hurricane Maria dramatically changed the picture of electrical repair needs in the Caribbean and the kind of leadership that would be needed in the region. In the Virgin Islands, WAPA did end up requesting mutual aid from mainland power companies. DOE took a strong lead in facilitating this effort for WAPA, going beyond its usual emergency advising and coordinating role for FEMA.¹⁷ In addition to the catastrophic impacts on Puerto Rico, Hurricane Maria heavily damaged parts of the Virgin Islands, especially the island of St. Croix, and as a result of both storms, more than fifty-five thousand WAPA customers lost power.

In the Virgin Islands, DOE's Western Area Power Administration, along with power industry partners, faced the same logistical challenges that the Corps would encounter on a much larger scale transporting workers, equipment, and parts to Puerto Rico.¹⁸ WAPA set a goal of restoring 90 percent of eligible customers to the power grid by Christmas, and they in fact achieved that goal. The remaining eligible customers, those with connection equipment still in a serviceable state, got their power back by mid-March 2018. More

than eight hundred linemen from the Western Area Power Administration and mainland power companies supported restoration operations on the islands.¹⁹ Although the Corps did not receive a power restoration mission in the Virgin Islands, the initial planning effort prepared the Corps for the response to Hurricane Maria in Puerto Rico.²⁰

How the Corps Assumed a Grid Restoration Mission

The official start of the Corps of Engineers' mission to repair Puerto Rico's electrical grid was September 30, 2017, ten days after Hurricane Maria completely knocked out power.²¹ The sequence of events that delayed both the start of the Corps' power restoration mission in Puerto Rico and the arrival of mutual aid from the mainland power industry began the day before Maria's landfall, September 19. Subsequent investigations by the U.S. House Committee on Natural Resources revealed that an email conversation had taken place that day between PREPA's supply chain chief, Ramón Caldas, and Whitefish Energy CEO Andy Techmanski.²² Caldas wanted to know the company's rates and how soon they could mobilize crews to the island. PREPA was particularly interested in Whitefish's experience, however limited, in using helicopters to make repairs in difficult terrain and their willingness to come to Puerto Rico without demanding payment guarantees.²³

But in the week immediately after landfall, and without waiting for Whitefish, PREPA started making repairs with its own crews on short sections of key transmission lines that connected power plants to nearby substations. Most of these immediate repairs were in the San Juan area. For example, the power authority repaired two lightly damaged 115-kilovolt (kV) lines running south from Palo Seco power plant five miles to a transmission center in Bayamón.²⁴ But the damage to many long-distance transmission lines was far more extensive; the storm knocked down or mangled every single tower holding up some lines.

On September 26, PREPA awarded a contract to Whitefish Energy to repair some of the island's downed transmission lines. Whitefish's subcontracted workers started arriving soon after, but they had very little direction from the power authority about which lines to address first.²⁵ Whitefish was not the only organization to get frustrated by the lack of useful guidance from the power authority; the Corps would also face a similar situation in the early days of the federal grid restoration mission.²⁶

While PREPA struggled to get the support it needed for restoring power, the White House and FEMA began discussing a possible Corps role overseeing electrical system repair in Puerto Rico. According to Lt. Gen. Todd Semonite, Secretary of Energy Rick Perry, whose agency would normally lead grid repair work for FEMA, specifically asked the Corps of Engineers to take charge of the mission.²⁷ On September 27, during a press conference on the White House lawn about the federal response to Hurricane Maria, FEMA Administrator Brock Long named the Corps of Engineers the lead federal agency to oversee the power grid restoration process in Puerto Rico.²⁸ That same day, the Corps,

DOE, the American Public Power Association, and New York Power Authority (NYPA) held the first interagency conference call to begin joint planning for power restoration.²⁹ Meanwhile, Corps contingency planners who were deployed to San Juan (such as Frank Ford) met with PREPA officials (such as Ramón Caldas) about how the federal grid repair mission could satisfy PREPA's overwhelming needs.³⁰

On September 28, according to a detailed *New York Times* investigation, PREPA, mainland government officials at the state level, and power industry representatives held a conference call.³¹ During that call, officials with the power authority refused a direct, collective offer of mutual aid from the NYPA and other public utility leaders and instead reaffirmed their decision to continue relying primarily on Whitefish.

The next day, however, with the situation on the island becoming increasingly dire, and with Whitefish's attempts to begin grid repair with PREPA off to a slow start, Puerto Rico's government officially requested support from FEMA for power restoration.³² On Friday, September 29, the Corps received a verbal mission assignment for temporary repairs to the electrical grid from FEMA, and the power restoration mission officially began late the next day.³³ At that time, 95 percent of PREPA customers—nearly 1.5 million homes and businesses—were still without power.³⁴

At the end of the first week after landfall, FEMA had essentially tasked the Corps to lead a federal intervention in a local power restoration effort that was not moving quickly enough.³⁵ It was likely that other factors also influenced the assignment of the Puerto Rican grid repair mission to the Corps, including its robust temporary emergency power missions already underway, the Corps' ability to manage large federal construction contracts, and the agency's record of financial accountability over large projects. "I think because we're here already, and we're doing temporary power, and we do have [grid repair] in our history," explained the commander of the South Atlantic Division, Brig. Gen. Diana Holland, soon after the start of the power mission, "we could bridge the gap until the United States government decides what the long-term plan is for Puerto Rico."³⁶

On September 29, on his first post-storm visit to Puerto Rico, General Semonite brought José Sánchez with him from Washington to direct the power restoration effort.³⁷ Previously, Sánchez had been acting director of contingency operations at Corps headquarters, and he had been very involved in coordinating the Corps' response to Hurricanes Harvey and Irma with FEMA and other federal agencies. Originally from Puerto Rico, Sánchez spoke Spanish fluently and had earned a master's degree in civil engineering from the University of Puerto Rico. With the assignment to USACE of the grid repair mission, Sánchez worked under General Holland at the division's forward-deployed headquarters in San Juan as director of the division's power restoration program, which was a role similar to a civil works programs director at the regional level in the Corps.³⁸

Another key leader who helped build the crucial relationship between PREPA and the Corps was Sharon Garay Rodríguez. An electrical engineer, Garay Rodríguez had worked for PREPA in the 1990s—and had seen first-hand how the power authority responded to Hurricane Georges—before eventually becoming chief of the construction division at the Corps’ Fort Worth District.³⁹ As deputy director of Task Force Power, Garay Rodríguez was the subject matter expert on the Puerto Rican power system in support of José Sánchez and South Atlantic Division’s power restoration program. Corps personnel who spoke Spanish and were originally from Puerto Rico, such as Garay Rodríguez and Sánchez, helped enormously with the challenge of building positive working relationships with power authority executives and technical experts who best understood the island’s grid.⁴⁰

Prior experience working with PREPA did not necessarily make the situation any less overwhelming for Garay Rodríguez. After arriving late on September 29, her aim was to get a better picture of the damage to the island’s power grid. “We were just focusing on getting data, on meeting, discussing with PREPA, trying to embed within PREPA to have different individuals within our team talking to some counterparts,” said Garay Rodríguez. “So we have one point of contact trying to gather the data, because it became overwhelming. Everybody was coming to me, ‘who do we need to talk to? Sharon, do you know this? How does this operate? When do we know how many customers?’... It became overwhelming so we divided the work, and that’s how we started.”⁴¹

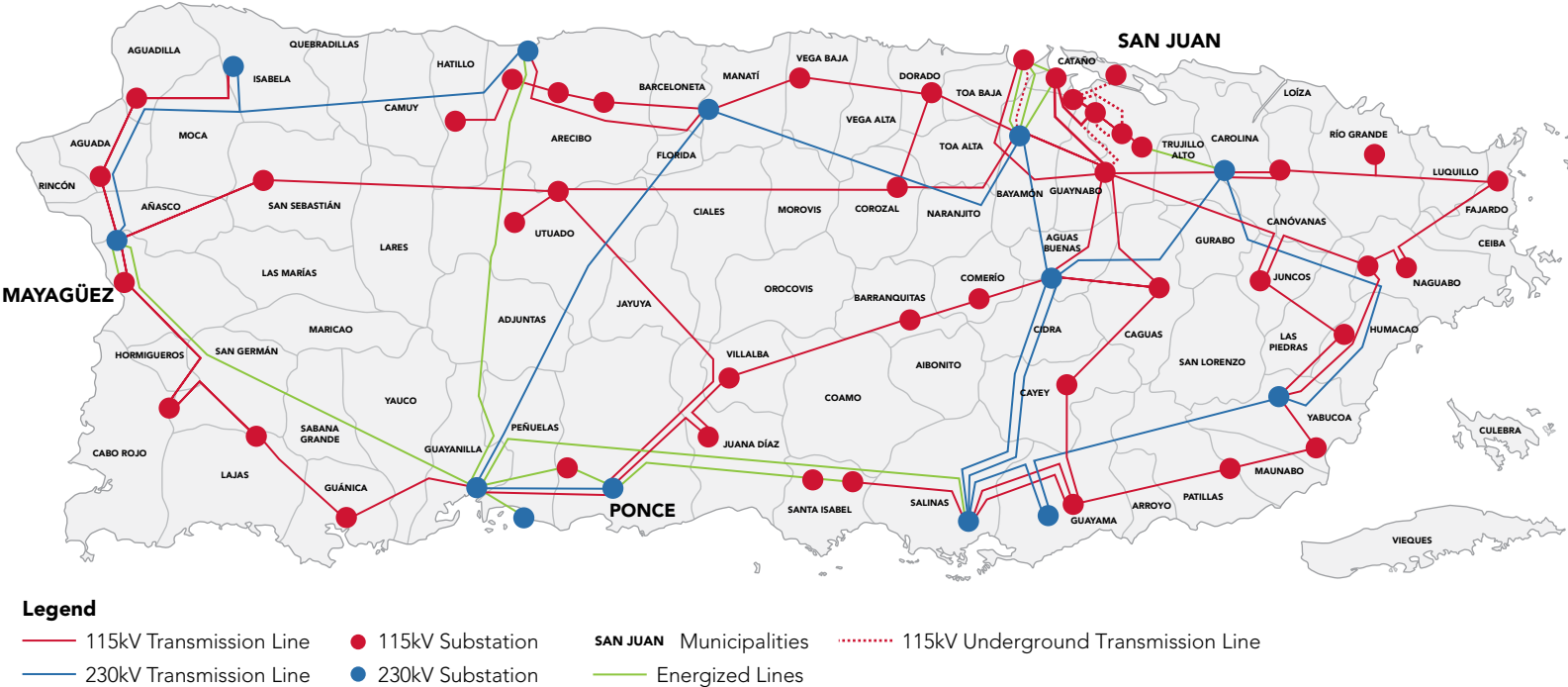
Capt. Brian Molloy, a project manager from Pittsburgh District, arrived on October 1 to serve at the Recovery Field Office (RFO) as an operations officer for Col. James DeLapp. He remembered the challenge of trying to understand how much of the grid was damaged after the Corps officially received the power restoration mission from FEMA:

Colonel DeLapp had had a meeting over at...PREPA headquarters, and he came back to the RFO in the convention center with a few photographs and maps that they had up on the wall that showed the major transmission lines on the island of Puerto Rico. He handed that over to me and basically said, “Brian, look, this is what we have right now. We need to be able to graphically show how many of these transmission lines are operational and which ones are not operational so that we can start to identify where we need assets and where we need resources....” So I started working that product for him that same day, and I put together, really, the first daily SITREP [Situation Report] that we could put forward that showed the status of the transmission lines. That was something that we could somewhat measure from that point forward.⁴²

For the next ten days after the official mission assignment on September 30, Colonel DeLapp and the Mobile District team at the RFO continued working with PREPA to get preliminary damage assessments so Task Force Power could make plans to repair the grid.⁴³

Figure 4.1: Puerto Rico's Power Grid

The status of PREPA transmission lines based on available data, Oct. 2, 2017. Lines highlighted green on the southwest side of the island and in the San Juan area were the only energized segments nearly two weeks after landfall. Redrawn from data in CEHO, Emergency Operations Collection.



The power team at the RFO divided the planning work into three areas: generation, transmission and distribution, and materials. The true extent of the damage to the interior of the island was still very difficult to measure. General Semonite remembered surveying damage from a helicopter during his visit to the island:.

I think what really impressed me was, way up on a remote mountain in the middle of nowhere, there might be five or six houses with a little tiny road, and then there would be a small power line on the side of a cliff climbing up that mountain to be able to feed those people. Even on the road to get to those houses, you could see the trees all fallen down all the way along there and the devastation of mainly the vegetation. Also, with a lot of the poles that were down, I knew that it was going to be a substantial rebuild.⁴⁴

Assessing the Damage

Organizationally, the Corps took the next step towards getting the lights back on by forming a special task force focused on restoring power. Col. John Lloyd, the Corps' Pittsburgh District commander, and his advance team arrived in Puerto Rico on October 11, 2017, to stand up Task Force Power Restoration. Colonel Lloyd had assumed command of Pittsburgh District in July 2016 and previously had been commander of the 19th Engineer Battalion, which he deployed to New York City to respond to Hurricane Sandy in 2012. Earlier in 2017, Lloyd had deployed to the Virgin Islands to stand up a Recovery Field Office as part of the Corps' response to Hurricane Irma.⁴⁵

In Puerto Rico, Lloyd took leadership of a task force that would focus primarily on repairing the electric grid, and it became essentially the second Corps office on the island equivalent to a district headquarters. Engineers arriving in San Juan to staff the task force were aware of the island's lack of power, but it was still unnerving to them to encounter a total blackout. Arriving on a rainy evening, members of the Pittsburgh team immediately noted the airport was hot and muggy with limited power for air conditioning.⁴⁶ It was challenging driving from the airport, even as part of a convoy, to the Joint Field Office (JFO) at the Puerto Rico Convention Center through darkened, partially-flooded streets with no working signals and few surviving road signs. Pumping systems that kept parts of San Juan dry did not have backup generators and therefore were idle. With only spotty cell phone connections, GPS data was unavailable, and the technology that many responders relied on for basic navigation was not working.

Setting up in temporary space at the convention center that was shared with South Atlantic Division Forward, working essentially to establish a new district-level organization to coordinate the huge project of power grid repair, Task Force Power was initially overwhelmed with demands. "It's kind of like when your house is on fire, what room do

The 249th Engineer Battalion Makes Early Repairs

In the first weeks of the Corps of Engineers' response to Hurricane Maria, Delta Company of the Army's 249th Engineer Battalion made some critical repairs to small sections of Puerto Rico's electrical grid, the first Corps unit to initiate grid repair work. Delta Company, comprised entirely of reserve soldiers with experience as electrical linemen, specialized in restoring overhead power distribution systems. The Corps' headquarters had initially considered deploying this unit to the Virgin Islands after Hurricane Irma, but that mission ultimately did not materialize.^a Delta Company arrived in Puerto Rico, however, on October 10, 2017, and from the start they applied their skills to the somewhat unusual electrical system in the commonwealth.^b By the first week of November, twenty-three personnel from Delta Company—the most ever to deploy for a single mission—were on the ground repairing distribution lines in the San Juan area in collaboration with the Puerto Rico Electric Power Authority (PREPA).

During those critical weeks of October, while Task Force Power was still getting contracts for grid repair in place, Delta Company's work helped prepare the capital's electrical system to be re-energized. The process began when Delta Company received new poles from PREPA, which the troops then firmly secured in place. Fallen distribution lines, usually tangled and covered in debris, were then "fished" from the ground and attached to the power pole, ready to be energized once the transmission lines came back online. Delta Compa-



Prime Power transmission and distribution specialists with the 249th Engineering Battalion, D Company, repaired power lines in Rio Grande, Puerto Rico, Oct. 19, 2017. (U.S. Air Force photo by M. Sgt. Joshua L. DeMotts)

ny restored an average of ten power poles per day, and by early November they had repaired more than twenty-seven thousand feet of distribution line. "I spent a lot of time with Delta Company," recalled Col. John Lloyd, the commander of Task Force Power. "They were great soldiers. They brought a great amount of experience because most of them are utility workers in their civilian jobs, so they know this business extremely well, and they were able to get out there and really accomplish a lot of the distribution restoration early on."^c

Notes

a. Interview, Col. John P. Lloyd, Commander, Task Force Power Restoration, by Jonah Bea-Taylor and James Garber, by phone, June 8, 2018, 18, Oral History Collection, Office of History, HQU SACE, Alexandria, Virginia.

b. San Luciano Vera, "Prime Power Soldiers recognized for service in Puerto Rico," HQU SACE News Archive, December 28, 2017, <https://www.usace.army.mil/Media/News-Archive/Story-Article-View/Article/1405770/prime-power-soldiers-recognized-for-service-in-puerto-rico/>.

c. Interview, John Lloyd (2018), 18.

you decide to put out first?" said Marc Glowczewski, a senior project manager on the task force. "I think initially it was kind of planning the restoration and figuring out how are we going to put out the fire. But that was shortly followed by how are you going to get enough manpower to do that?"⁴⁷



Col. John Lloyd led an update briefing with Task Force Power at the Puerto Rico Convention Center, San Juan, Oct. 27, 2017. (USACE Pittsburgh District photo by Jeff Hawk, Public Affairs)

A related challenge Task Force Power faced in October was setting realistic expectations about the timeline for power restoration. Soon after standing up the task force in mid-October, Colonel Lloyd and General Semonite briefed Puerto Rico Governor Ricardo Rosselló about their estimates for how long it would take to restore the grid.⁴⁸ The commitment to a specific timeline made at this key leadership briefing was understood differently by Governor Rosselló and Corps leadership. Task Force Power representatives who were at the meeting insisted that the Corps never estimated mission completion any earlier than the end of February or the beginning of March 2018.⁴⁹ Nevertheless, at a press conference on October 15, Governor Rosselló presented his own timeline, promising that the island's power generation would be at 95 percent of pre-storm levels by Christmas 2017.⁵⁰ He maintained that holiday goal of "getting about 90, 95 percent of the energy grid back up" into late November 2017.⁵¹ Planners for Task Force Power estimated that it would have taken double the 425 line repair crews present on the island at that point to meet that timeline.⁵²

The Corps recognized Rosselló's aspiration for 95 percent power restoration by late December while acknowledging that the resources were not likely going to be in place to meet that goal. At a press briefing on October 20 at the Pentagon, General Semonite explained, "The governor has made a milestone of trying to get 30 percent of the Puer-

to Rican load up by the end of October, and then 50 percent by the end of November. I personally think those are stretch goals, but we're very, very committed to trying to meet where the governor's at, and all of our guys are going all out with every single thing we can to meet the governor's goals. The challenge is going to be, how do you get past 50 percent? And I personally think that it's going to go into January and February to get the majority of them back up and running."⁵³

The First Plan: Operations Order 2017-54

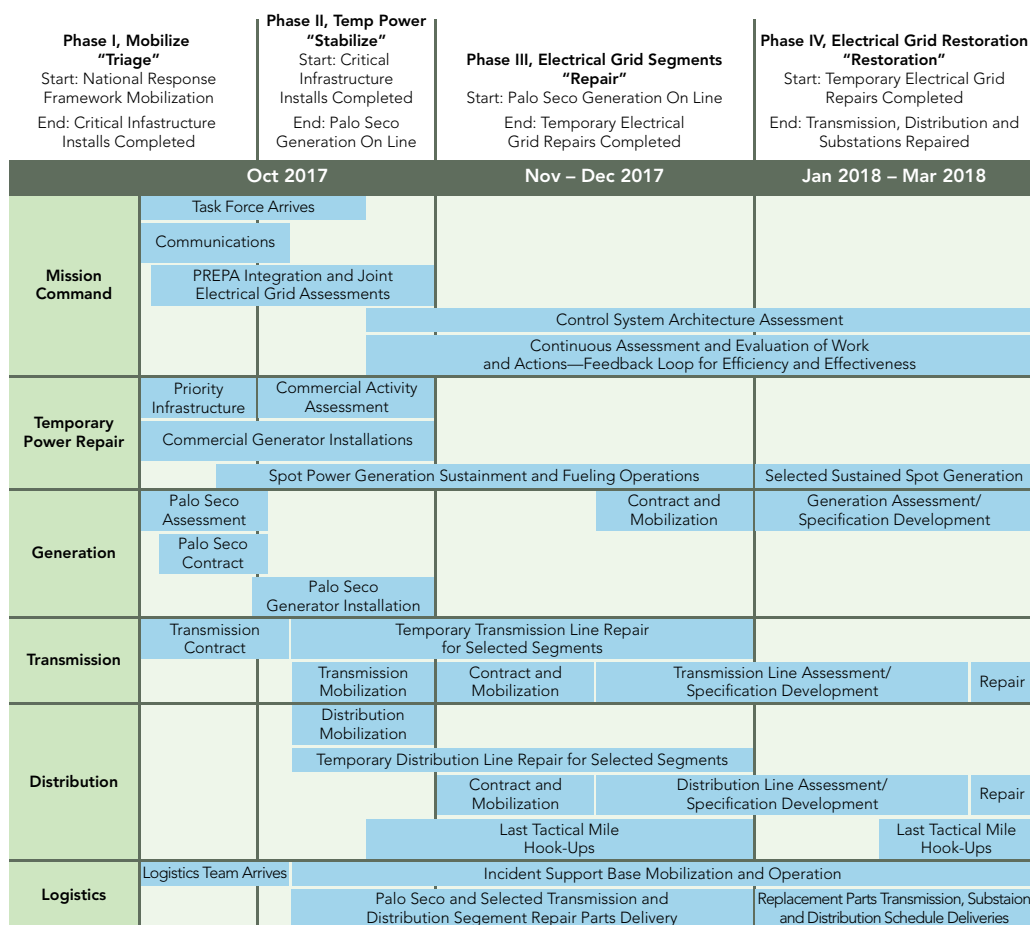
On October 11, 2017, the same day the Pittsburgh advance team arrived in Puerto Rico to stand up Task Force Power, the Corps headquarters published Operations Order (OPORD) 2017-54: "Restore Puerto Rico's Electrical Power."⁵⁴ As an Army command composed primarily of civilians, but led by professional military officers, the Corps of Engineers uses these kinds of formal orders to implement emergency response operations wherever needed. Headquarters officials largely based the order on the legwork that José Sánchez, Sharon Garay Rodríguez, Frank Ford, Capt. Brian Molloy, and other planners had undertaken over the previous ten days. The order outlined a plan for how the Corps would execute the power restoration program for FEMA. The objective was to repair Puerto Rico's power grid and distribution system to provide electricity to the citizens of the island and thus enable the commonwealth's economic recovery. The order included an estimated completion date that was based on the initial planning efforts at South Atlantic Division Forward: power to the island was to be completely restored no later than March 2018.⁵⁵ That timeline reflected the Corps' preliminary damage assessment up to that date; it would change after the task force completed more detailed assessments.

OPORD 2017-54 formally established Task Force Power Restoration as a partner with FEMA, DOE, and PREPA to repair all aspects of power generation, transmission, and distribution damaged by Hurricanes Irma and Maria and to fully restore electricity to the citizens of Puerto Rico.⁵⁶ Although FEMA assigned the task of grid restoration in Puerto Rico to the Corps, DOE also sent subject matter experts from their Office of Electricity Delivery and Energy Reliability to Puerto Rico.⁵⁷ They focused on providing technical advice to PREPA and its mainland utility partners on power generation and grid stability, though they also supported Task Force Power's grid restoration program.⁵⁸

To repair the entire island-wide grid, Task Force Power would have to build a logistics organization capable of acquiring, transporting, and distributing government and contractor equipment and a vast array of materials. If the Corps only focused on bringing in contractors, and those line workers had no spare parts to make repairs, power restoration could not proceed. The task force also had to develop a strategy to let contracts rapidly, both for manpower and for materials.

Figure 4.2: Planning Power Restoration

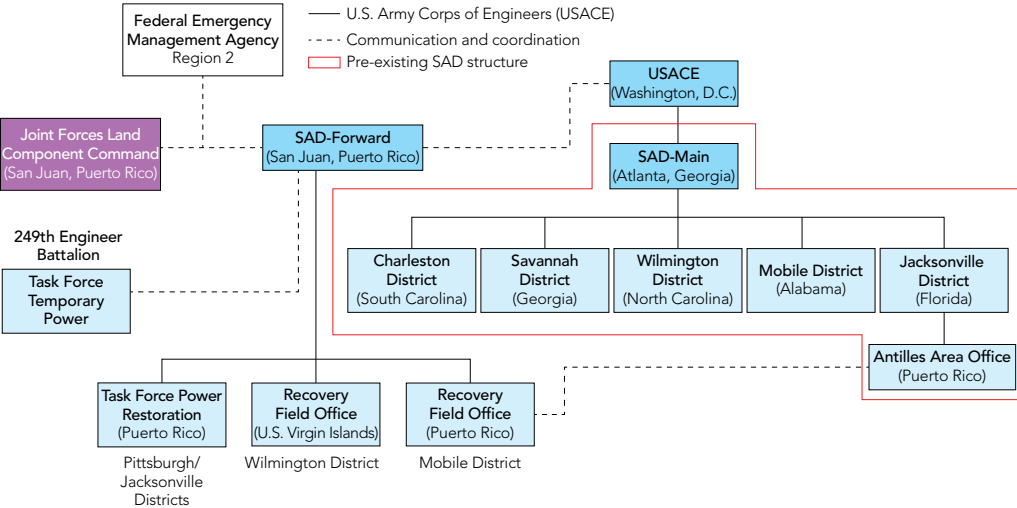
Some of the assignments that Task Force Power Restoration planned to complete concurrently in order to fully restore power to Puerto Rico by late March 2018. Redrawn from data in CEHO, Emergency Operations Collection.



Along with delineating the need to acquire replacement parts and to issue contracts with firms who could send repair crews, OPORD 2017-54 specified four main “lines of effort” to restore power fully to the island. The first was to provide even more temporary emergency power under ESF-3, the Corps’ traditional public works and engineering role in disaster recovery efforts. Increasing the availability of temporary power meant providing more generators and fueling and maintaining them in order to keep critical facilities running while the permanent power grid was being restored over the next few months, an unusually long period of service for temporary generators compared to past disasters. Because the need for temporary power was so great across Puerto Rico, FEMA also authorized the fueling and servicing of non-federal generators, an unprecedented expansion of this mission.⁵⁹

Figure 4.3: Hurricane Response Regional Task Organization

South Atlantic Division's (SAD) organizational chart for disaster response operations in the Caribbean in 2017-18. Brig. Gen. Diana Holland commanded a forward headquarters of the division in San Juan. Along with two Recovery Field Offices, Task Force Power Restoration in Puerto Rico under Col. John Lloyd was one of three district-level organizations helping the islands recover from Hurricanes Irma and Maria. Redrawn from original in Holland, Brig. Gen. Diana M. "Responding to the Perfect Storm: The U.S. Army Corps of Engineers and Disaster Response in Puerto Rico, 2017." *Military Review* (May-June 2019).



The second line of effort was to stabilize the permanent power supply. To do so, Task Force Power would have to lease and install two 25-MW generators on the grounds of the Palo Seco Power Plant in the vicinity of San Juan no later than October 25, 2017. The generators would provide load balancing capability in the greater San Juan area, and they would help stabilize the system locally so that power could be more quickly and reliably restored to the island's most densely populated area.

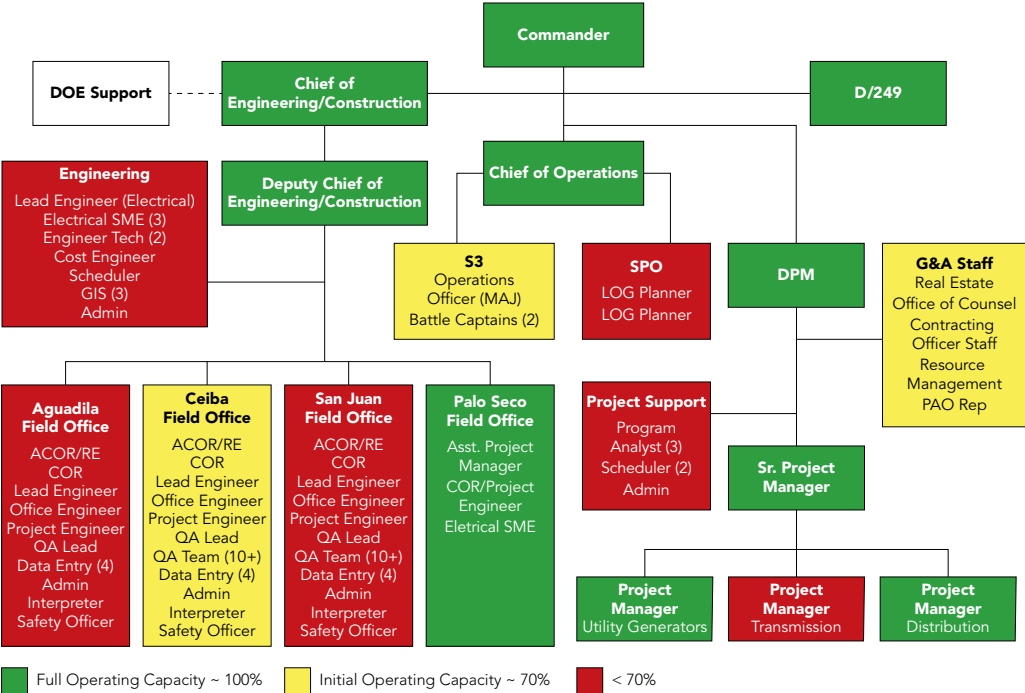
The third task was to create an interim power supply. Task Force Power would accomplish this goal by restoring selected transmission (voltages ranging from 230 kV to 115 kV), sub-transmission (38 kV), and distribution lines (4 kV to 13 kV) across the system to energize segments of the power grid. The work would be carried out simultaneously in three different regions, and resident offices had to be established in the vicinity of Aguadilla, on the far west coast of the island, Ceiba on the far east coast, and metropolitan San Juan. Finally, the last line of effort addressed the eventual repair of the commonwealth's entire power grid and future planning for a more resilient power system on the island.

How the Corps Organized and Executed the Mission

Organizationally, the Corps replicated its standard regional structure to execute the enormous grid restoration mission. General Holland was in command of the South Atlantic Division Forward headquarters in Puerto Rico and the Virgin Islands, which was stationed

Figure 4.4: Task Force Power Restoration Organization

Draft organizational chart for Task Force Power Restoration, Oct. 18, 2017. The colors indicate different functional operating capacity a week after the task force stood up in temporary offices at the Puerto Rico Convention Center. One of the first goals for Task Force Power was to increase its personnel strength. Redrawn from data in CEHO, Emergency Operations Collection.



Organizational abbreviations:

ACOR - Alternate Contracting Officer Representative
COR - Contracting Officer Representative
D/249 - 249th Engineer Battalion, Delta Company
DPM - Deputy for Project Management
G&A - General & Administrative
GIS - Geographic Information Systems
LOG - Logistics
PAO - Public Affairs Officer
QA - Quality Assurance
RE - Resident Engineer
S3 - Operations Staff (Active Duty Officers)
SME - Subject Matter Expert
SPO - Support Operations Officer

near the Puerto Rico Convention Center in San Juan. Below the division-level headquarters, Task Force Power became the equivalent of a second Corps of Engineers district. The Recovery Field Office (RFO), led by the Mobile District Commander, Col. James DeLapp, was the first district-type organization the Corps had deployed to Puerto Rico. The RFO—located near Fort Buchanan in San Juan—focused on the Corps’ standard emergency response missions: temporary emergency power, temporary roofing, debris management, and shoring up critical facilities. For grid restoration, Colonel Lloyd and his initial group of staff from Pittsburgh District essentially replicated the structure and staffing of a Corps’ district but with a focus on only one overarching mission. Captain Molloy recalled:

We essentially stood up a second district from scratch, which was fascinating to watch. When I first got there with Colonel DeLapp, there were probably 12, 13, 14 of us on the ground at the time. Colonel DeLapp and his entire RFO organization stood up to several hundred people, and then we deployed the whole second district. So we essentially built out two Corps of Engineers districts in less than a month and were executing hundreds of millions of dollars in contracts over that time.⁶⁰

As the deputy commander of South Atlantic Division Forward, Col. Richard Pannell, framed it, “You’ve heard the analogy of building an aircraft in flight. We were not only building the aircraft in flight, but we had paratroopers jumping out of that aircraft and building another aircraft down below so that they could accomplish the mission.”⁶¹

In October 2017, as Task Force Power continued to “set up camp” in temporary offices at the convention center and assess the enormous task ahead, their first mission-oriented challenge was trying to develop a basic understanding of the status of Puerto Rico’s power grid. It took several days just to produce a basic picture of which lines were the most damaged and to begin estimating how long it would take to complete repairs. PREPA had not provided a detailed, comprehensive schematic of the main transmission lines, power plants, and substations to the Corps. Ultimately, it would take weeks to gather enough data to make a realistic assessment of the damage.

The main reason for this high level of uncertainty was that the power authority was still gathering its own information about which lines were destroyed and which areas had sustained less severe damage.⁶² “We didn’t have the level of fidelity of saying on this street we need nine poles. That just didn’t exist and it wouldn’t exist a month later,” said Molloy. “So that coordination, that back and forth between us and PREPA was really important at the front end of things in order for us to even identify which direction we needed to go.”⁶³ PREPA itself was not immune to the effects of the blackout. Not only were their personnel dealing with storm-damaged homes, the inability to contact friends and family, and washed-out roads, but the utility’s data systems that monitored local power outages were down.⁶⁴

Communication between the power authority and the task force was also surprisingly difficult at first, as Corps planners required more specific information about exactly what equipment needed to be repaired. “Getting the data from them was kind of challenging, difficult, because they were not used to operat[ing] on an assessing, planning, executing type of mode,” explained Sharon Garay Rodríguez. “They were just putting out fires and trying to see what they could repair. That really affected the progress. But...the desperation was so [great] that they didn’t have the luxury to put their crews to start looking and assessing the system to develop a plan. They have to act.”⁶⁵

Aerial surveys of the high-voltage transmission lines across the island were a key part of Task Force Power’s first assessments.⁶⁶ As Colonel Lloyd recalled: “My initial sense was



Aerial view of a downed transmission tower in a remote location, Oct. 31, 2017. USACE aerial surveys helped to create a more accurate assessment of damage to the power grid. (Still from video by Sgt. David Wilkinson, 65th Press Camp Headquarters)

just based on typical restoration work that it would be fairly quick. But once I got down there and I actually did a fly-over of Puerto Rico and saw the devastation and started doing the coordination, I quickly realized that this was going to be a long-term mission and that my time down there was an unknown end date, which I was definitely fine with doing.”⁶⁷

While working with PREPA to get a clear picture of the damage to the transmission lines was daunting, the utility was able to provide valuable estimates of the status of the distribution system, the lines that actually connected homes and businesses across different regions. “One of the initial problems we had was trying to figure out exactly what was damaged and what wasn’t,” explained Marc Glowczewski, “so we had a coordination meeting with them where they basically brought in all their regional managers and said, ‘okay, I have about 60 percent of these lines are down, and 20 percent of these lines, and this is how much,’ and that was great because it allowed us to kind of verify a cost estimate, allowed us to verify the logistics order that we made...”⁶⁸

With the basic maps, visual assessments, and damage estimates in hand, the next challenge for Task Force Power was stabilizing the grid, which would lead to limited power restoration. Puerto Rico’s network of transmission towers and distribution lines had been severely damaged, but most of the island’s power plants continued to operate. This did not mean, however, that it was simply a matter of reconnecting the wires. With the existing plants generating a steady base load of electricity for the grid, if there was suddenly a significant increase in demand as powerless areas were reconnected, it would act like a huge breaker failing and the circuit would go dead.⁶⁹



USACE contractors deliver two 25-MW generators to the Palo Seco plant near San Juan, Oct. 17, 2017. (USACE South Atlantic Division)

In order for any part of the grid to be re-energized, there needed to be a reliable source of generation that could quickly be scaled up and down to meet the demand from areas of the capital that were coming back online. Soon after receiving FEMA's standard power restoration assignment, the Corps began developing a contract to lease two 25-MW generators to be installed at a key generation facility to provide a combined 50 MW of flexible, on-demand electrical power for the densely populated San Juan area. (Fifty MW is roughly the power required by thirty thousand American homes, but in this case rapid scalability was more important than total power output.) In the first week of October, the power authority identified the Palo Seco Power Plant across the bay from San Juan as the best location to install the two massive-capacity temporary generators that could provide this kind of rapid response.⁷⁰ PRE-PA had taken the Palo Seco plant offline in August 2017 due to concerns over safety and the condition of the plant, and possible storm damage did not improve the situation.⁷¹ Although Palo Seco was theoretically operable, its power output from oil-fueled generators could not be modulated rapidly to nearly the same extent as could the output from newer mobile gas turbine generators.⁷² The Corps awarded a \$35 million contract for the two generators to Weston Solutions, and the APR Energy generators composed of GE-brand gas turbines they selected arrived in Puerto Rico on October 13. It took two days to move them to the plant and another two weeks for technicians to fully set up and commission the generators, which started producing scalable power at Palo Seco on October 30.⁷³

A month after the Corps received the grid restoration mission from FEMA, the first line of effort of installing life-saving generator power remained paramount. The temporary emergency power mission continued to focus on providing generators to power critical infrastructure on the island. “As early as 9 October we knew that the first priority of things to really ramp up with, the normal mission accorded us anyway, was the temporary power,” explained Captain Molloy. “So we needed to get generators in place to bring up those critical things—the hospitals, the police stations, those really critical nodes for facilities that need to come up just for life support and public safety.”⁷⁴

At the same time, Task Force Power began repairing the grid itself, simultaneously focusing on areas that mirrored the path of electric service provision from the provider to the customers: power generation, long-distance transmission, and local distribution networks.⁷⁵ During the planning stages, six DOE subject matter experts in each of these areas coordinated with PREPA and helped the task force understand the kind of labor, equipment, and material that would be needed to make repairs in each of these systems.⁷⁶ DOE brought specific knowledge based on extensive experience with mainland power systems to help validate the assessments made by Corps planners. For example, DOE experts helped assess the status of transmission towers from aerial images and distribution wires from field surveys. Not every hanging wire had to be replaced—some could just be restrung—but it took a trained eye to recognize the difference.⁷⁷

Bringing in Contractors

Restoring power to the capital was going to be a large project, but for the truly daunting scale of island-wide grid repair, Task Force Power would have to contract with large engineering and construction firms. The expertise of the Corps in construction management—administering large contracts and assuring that the work is executed properly—has been part of how the Corps fulfills its emergency management function in support of FEMA since a construction management role was first established in the Department of Homeland Security’s 2004 all-hazards National Response Plan.⁷⁸

In order to efficiently hire the right contractors to repair the grid, Task Force Power needed to develop a “statement of work” that specified clearly detailed tasks and expectations.⁷⁹ But it was extremely difficult to define what exactly needed to be repaired, how many people would be required, and how much equipment those workers would need without better data about how many miles of power lines were damaged. Damage assessments that were as accurate as possible would help the Corps’ contracting officers write the statement of work and better assess how quickly the contractors could actually repair the grid. Because PREPA was struggling to get its own assessments in place, the Corps and others still relied on a lot of guesswork to create a realistic scope and timeline.

There were many other challenges to developing such large federal contracts so quickly. Normally, preparing a statement of work for such a complex project was a careful, deliberate process that would take at least six months to a year. Now Task Force Power would have to secure contracts in a matter of only a few weeks.⁸⁰ In those terms, government contracts in the tens of millions of dollars for utility-scale generators, and other contracts in the hundreds of millions of dollars to get workers started on repairing transmission lines, were completed at lightning speed. Still, it was nearly a month after the storm before contractors were actually on the ground.⁸¹ The delay was partly owed to the lack of a mechanism in place for emergency contracting for electrical infrastructure on this scale.⁸² The technical expertise in federal contracting, with all of its rigorous complexity, was also not available in Puerto Rico at the start of the power restoration mission. Contracting officers with significant experience and the warrants to authorize large funding amounts volunteered from multiple Corps districts and centers to complete these administrative tasks remotely.

The need to rectify the blackout situation on the island was urgent and pressing, and Task Force Power had to move forward with the first set of contracts even with limited data. It was not ideal to start such a large project on basic “time and materials” contracts because these had no built-in incentive for contractors to actually get the lines energized quickly, but at least they allowed the work to get started.⁸³ Sharon Garay Rodríguez summarized the conditions Puerto Ricans were facing and the urgency surrounding the start of the task force’s programs:

Obviously putting contracts in place takes a long time. We didn’t have that luxury. Because there was no power, there was no pumps allowing the storm drain water to be pumped, and that caused a flood almost every day in the San Juan area. Banks were shut down. The only way to buy something if there was a store available was to use cash, so the lines at the ATM machines were huge. The lines at the gas stations, because they were running out of gas. People would sleep overnight [in their cars waiting].... Hotels were shut down. So there was desperation, economic crisis starting to build up.⁸⁴

In early October, Capt. Brian Molloy and Marc Glowczewski from Pittsburgh District developed a work plan to restore power to the island in phases. “The general idea was that phase one would focus on grid stability,” explained Molloy, “and then phase two would be getting into adding more redundancy to the population centers and powering more population centers, and then phase three would be everything else. That kind of phase would fill in all the gaps.”⁸⁵

Among the expedited procurement methods that were available to the Corps, the Basic Ordering Agreement (BOA) proved to be particularly useful in getting work started on the transmission system.⁸⁶ The U.S. Army Engineering and Support Center, Huntsville, issued a request for proposals to nine companies that had already passed through a selection pro-



USACE contractors worked to restore the electrical grid in the Villa Alegria neighborhood of heavily damaged Caguas Municipality, Apr. 14, 2018. (USACE photo by Dave Palmer)

cess as part of the center's Resilient Power and Mechanical Systems program. Those nine pre-selected companies then submitted bids for transmission system repair work for the first phase of power restoration—bringing back some stability to the grid in key municipalities. After analyzing those bids, the Corps selected the proposal from Fluor, a very large, global energy and construction firm based in Texas.⁸⁷ The Corps awarded the first contract to Fluor for \$240 million on October 16, 2017, and Fluor's first subcontracted crews started assessing the grid that same day in the area around the capital.⁸⁸ Fluor soon continued its work by re-establishing electrical distribution in the densely populated regions on the northeast side of the island containing the adjacent municipalities of San Juan, Guaynabo, and Bayamón. The contractor would later expand into the mountainous southeast part of the island that had been heavily damaged.

Meanwhile, the Corps' Jacksonville District used a sole-source, targeted contract to select a second prime contractor. Task Force Power was looking for a company with demonstrated experience in electrical infrastructure to take the lead repairing the distribution system in areas that were less damaged. On October 18, 2017, the task force, in coordination with Jacksonville District, awarded a \$40 million contract to PowerSecure, a North Carolina-based firm that specialized in utility infrastructure.⁸⁹ The following day, PowerSecure crews started working on repairing the power distribution network in the

municipality of Mayagüez and surrounding areas on the western side of the island, which had suffered from the storm less than other areas. Later the Corps would expand PowerSecure's contract to include the region surrounding the critical Port of Ponce on the island's south coast.⁹⁰ "At the very beginning we were just awarding contracts because we knew we needed capacity," explained Molloy, "and at some point you needed to have somebody that took a more strategic look over the whole top of it and say, 'look, we need to identify the structure of how we employ all of these things.'"⁹¹

Nearly a month after Maria made landfall, more capacity was still needed urgently to make any significant progress repairing the grid. The first contract to Fluor for \$240 million would only be enough to get started on the first phase of power restoration.⁹² In fact, at the expenditure rate experienced in mid-October—calculated by multiplying the expected number of work crews by their day rate—Task Force Power expected the BOA to run out of funds in early November, thus disrupting the nascent repair efforts.⁹³ In response, FEMA quickly authorized an additional \$261 million, which Huntsville added to Fluor's original contract on December 4, 2017.

Even with this increase in funding, a pressing need for greater capacity remained. The Corps established a second BOA, and after receiving another set of bids, they again selected Fluor. The second contract to Fluor, awarded on December 6, 2017, was funded at \$495 million.⁹⁴ An even larger funding amount had been envisioned but was reduced in light of bid protests from other companies who had competed for the contract.

Because the western side of the island where PowerSecure was working was in better shape, their crews made fast progress. But as was the case with the BOA for Fluor, the work repairing the grid was so extensive and required so much time and effort that PowerSecure's contracts also had to be increased multiple times over the next few months. Supplemental agreements increased funding of that contract to nearly \$200 million in mid-December, and it was increased again in February 2018 to \$370 million.⁹⁵ As the repair work extended into more remote areas, with significant access challenges, FEMA made more funding available and the PowerSecure contract was increased to \$510 million in early April.⁹⁶

Fluor and PowerSecure achieved certain rates of progress repairing the grid depending on numerous factors, including the terrain, the degree of damage in the areas in which they were assigned, whether the work was primarily transmission or distribution, how many customers were connected to each circuit, and the contractor's previous experience with electrical infrastructure. "It was an interesting paradigm and dynamic," explained Glowczewski. "You had Fluor and PowerSecure. One of them is a power contractor and one of them is not. So the information that one needed wasn't as great as the other.... You want the mission to be successful, how do you make it successful and get people the information they need? It was a struggle a little bit, trying to figure out how to coordinate between the two different types of contractors."



An early coordination meeting among PREPA, USACE, and PowerSecure at Aguadilla, Nov. 1, 2017. (USACE)

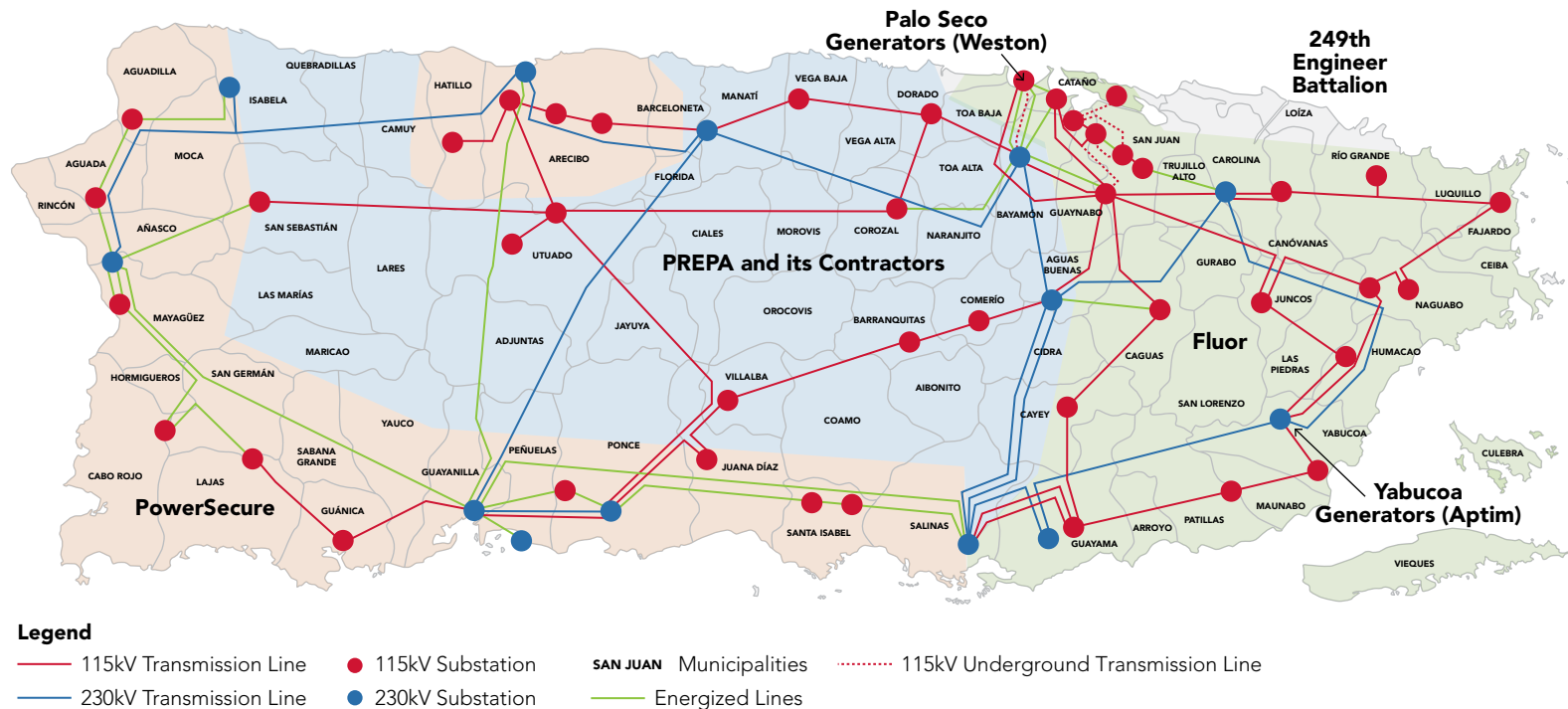
Greater cooperation from regional PREPA administrators could also facilitate the repair process. Sharon Garay Rodríguez elaborated on the key role of the regional PREPA administrator in the west, in the less-damaged Mayagüez region, where PowerSecure made relatively rapid progress restoring power:

The integration of that office, the PREPA office, with our staff and the contractor was a really good one. That administrator, he was doing things right and people were getting power. Then the other contractor we got was Fluor. And they were mostly on the metro and east side of the country, and that's where there was more devastation. And that's where the system is a little bit more complex. And that's where you have the heart of the politics. So the work became very challenging.⁹⁷

Molloy also remembered: "It was probably the busiest I've ever been in my professional life. We were working 18-hour days almost every day the whole month I was there, and it was just a constant reevaluation over and over and over again of what do we know, what are the unknowns, what are the knowns, how do we fill the gaps, what does the plan look like now that we know this additional information?"⁹⁸

Figure 4.5: Planned Contractor Assignments

Contractor work areas for Phase 1 of the USACE power restoration plan, Oct. 26, 2017. Redrawn from data in CEHO, Emergency Operations Collection.



The Power Industry Arrives

During the first two weeks of October when Task Force Power was setting up its temporary camp at the convention center and getting the initial Corps contracts for grid repair in place, Whitefish Energy continued working for PREPA. The mainland power industry had offered aid, but the power authority did not request that public utilities come to the island under the conditions of mutual aid. In its role supporting the power authority, the government of Puerto Rico, and FEMA, the Corps was open to the possibility of continuing to work with the contractor PREPA had chosen that was already on the island. Initially, the Corps assumed that Whitefish was going to be the third primary contractor repairing the transmission grid, in addition to Fluor and PowerSecure.⁹⁹ Mobile District started looking into possibilities of integrating Whitefish's existing contract with the Corps' grid repair plans.¹⁰⁰

Speaking from her own experience coordinating repair work with PREPA, Sharon Garay Rodríguez explained this willingness on the part of federal authorities to work with Whitefish: "You had a contractor that was doing productive work, that already had a system developed with the people from PREPA, the coordination, their planning efforts, and they were moving, and as anywhere, once you bring new people in, there's another learning curve."¹⁰¹ However, when the Corps awarded the contract to PowerSecure in late October, which brought in a second firm with deep electrical grid infrastructure experience, it became less important for the Corps to work with Whitefish.

With hindsight, the power authority's choice to depend so heavily on Whitefish and to refuse early offers of mutual aid from the mainland power industry appears perplexing. At a U.S. Senate Committee on Energy and Natural Resources hearing in November 2017, Ricardo Ramos, PREPA's executive director, explained that the power authority was "unable to meet the requirements" for mutual assistance, and that was why he did not make the request. Those requirements included providing basic housing and food for workers from partner power companies, and the power authority had been too paralyzed in the days after the storm to build basecamps. Ramos' explanation did not address the facts that workers from the New York Power Authority had performed assessments on the island without asking for any support from PREPA, FEMA had guaranteed repayment of most of the costs of emergency grid repair, and the Department of Defense had built two large basecamps on the island for federal responders two weeks after landfall.¹⁰² Meanwhile, Whitefish's subcontracted line workers—many of whom worked for mainland utilities—continued to arrive in Puerto Rico, and they continued to wait for their trucks and equipment to arrive by barge. Although Whitefish did make some significant repairs to transmission lines near the capital, for the most part their crews did not get the directions or the parts they needed from the power authority.¹⁰³

By the end of October, with pointed questions coming from a variety of media outlets and congressional committees, it was clear that the dubious circumstances surrounding the award of the contract to Whitefish meant that politically it could not continue. On October 19, PREPA awarded a new \$200 million contract to Cobra Acquisitions, a subsidiary of Oklahoma-based Mammoth Energy Services.¹⁰⁴ With this new contractor coming into the picture, and with the Corps'



Jacksonville Electric Authority crews replaced broken poles along Puerto Rico Highway 1, Oct. 20, 2017. (JEA, Puerto Rico Power Diary)

efforts well under way, on October 29 Governor Rosselló announced that he had asked the power authority's board to cancel the contract with Whitefish, two days after FEMA issued a statement criticizing the deal.¹⁰⁵ Based on its initial review of the contract, FEMA had "significant concerns" with how PREPA procured Whitefish's services and whether the prices it was charging the power authority were "reasonable."¹⁰⁶

With the cancellation of the Whitefish contract at the end of October, Task Force Power had to modify its earlier work plans to take into account which contractors would be available in November. "Obviously any time you had something with so many unknowns, things are going to change," said Captain Molloy. "One of the major changes that happened is in that first plan we had, we expected to have a third major contractor and that obviously fell through. So we ended up with the two contracts. The one to PowerSecure and the one to Fluor."¹⁰⁷

PREPA finally made a formal request for mutual aid from mainland utilities on October 31, two days after the governor demanded that the power authority cancel its contract with Whitefish. Executive Director Ramos sent a letter to power industry trade groups requesting assistance from public and private utilities.¹⁰⁸ By the second week of November, hundreds of workers and equipment from New York power companies—including NYPA, Con Edison, and its subsidiary Orange and Rockland Utilities—began arriving in Puerto Rico.¹⁰⁹ Florida's biggest power company, FPL, was still completing the largest power restoration effort in its history owing to Hurricane Irma, but smaller Florida utilities, such as Jacksonville Electric Authority, Kissimmee Utility Authority, Orlando Utilities Commission, and Lakeland Electric, sent personnel in November, some of these still working under the remaining capacity of PREPA's canceled contract with Whitefish.¹¹⁰



Trucks and equipment from Florida Power & Light Company en route to Puerto Rico, Jan. 2, 2018. (Photo courtesy of Edison Electric Institute)

With the arrival of mutual aid by mid-November, substantial electrical repair work was under way in several parts of Puerto Rico although not yet at a scale appropriate for restoring power across the island. The Corps' contractors were also making significant repairs on a daily basis. "You're beginning to see bolts being turned, lines being pulled up and poles being put up," said José Sánchez. "Then it was a matter of how do we ramp that up? How do we accelerate that restoration effort?... It really wasn't until the middle of November that we were actually sure of the contracts that we have, that we are comfortable with the capacity that we have at that point. Knowing exactly all the effort that's required, because we didn't have a full assessment."¹¹¹

Over the next few months more than twenty local and regional power companies, ranging from Sacramento Municipal Utility District to FPL, supported PREPA under mutual aid agreements. These crews helped greatly to accelerate the work being performed by the power authority and its contractors on the nearly thirty thousand miles of lines in the island's distribution system, 80 percent of which had been damaged or destroyed.¹¹² Mainland utilities also worked on the 2,400-mile transmission system that was the focus of the Corps and its contractors in November and December. Overall, approximately three thousand industry line workers and support personnel were involved in the restoration effort on the island.¹¹³

Still, these numbers were much smaller than the power industry mutual aid response to Hurricanes Harvey and Irma earlier in 2017. After Harvey, ten thousand power industry workers were repairing damaged lines in coastal Texas, and Irma was one of the largest mutual aid responses in industry history. More than sixty thousand workers responded in Florida and Georgia alone.¹¹⁴ In that case, with easy access by highway to the disaster area, power companies could pre-position thousands of workers and their trucks as well as logistics staff to sustain those crews over the following weeks. In Puerto Rico, most workers flew in on charter flights and their trucks arrived by barge from mainland ports all over the southeast. Given the conditions of its damaged infrastructure—roads, water supply, and housing—there was a limit on how many workers the island could support.¹¹⁵ The number of transmission and distribution line workers—from both the power industry and government contractors—reached a peak of nearly six thousand in late February 2018.¹¹⁶

Once crews from the power industry arrived, coordination became even more critical. Already there were challenges trying to ensure an efficient division of the work between the contractors who were working for the Corps and the ones brought in by the power authority. Captain Molloy recalled:

One of the hardest parts about planning this thing is that we weren't the only people there doing the work. So we were trying to identify where we need the resources, where we expect to work first, trying to identify various transmission lines and distribution regions that we'll work on. But at the same time we have another organization that's also doing that, and that's PREPA. So they're bringing contractors to the island, we're bringing contractors to the island. And we had a number of meetings with them, trying to work out sort of the roles and responsibilities and the different lines that we would assign to our contractors versus their contractors.¹¹⁷

A key turning point in the coordination effort occurred on November 22, 2017, when Governor Rosselló appointed a representative to act as the single point of contact for grid repair. This move followed a meeting Rosselló had with the governors of Florida and New York, the states that had been providing the most power industry support to Puerto Rico's grid restoration project.¹¹⁸ Rosselló selected Carlos Torres to be the Puerto Rico Power Restoration Coordinator. Torres was a consultant for Edison Electric Institute who had retired from a thirty-year career with New York's Con Edison, where he had led emergency response efforts after Hurricane Sandy in 2012.¹¹⁹

Torres was already in Puerto Rico prior to assuming his role as power restoration coordinator. He had arrived there soon after PREPA officially requested mutual aid at the end of October 2017. In early November Torres and Manny Miranda, FPL's senior vice president of power delivery, prepared a man-hour construction plan based on the scattered



Maj. Gen. Donald E. Jackson, Jr. (left at corner), USACE Deputy Commanding General for Civil and Emergency Operations, visited Task Force Power leaders and spoke at the Unified Command Group's daily coordination meeting, Jan. 4, 2018. (USACE photo by Jay Field)

information then available about the damage to the island's electric grid. The construction plan was to help the mainland power industry figure out what support PREPA needed and how to supplement the efforts already under way.¹²⁰

Torres also made aerial surveys as part of the assessments the power industry needed. He was shocked by the extent of the damage he witnessed—the denuded vegetation and demolished homes, transmission towers twisted beyond recognition, and four PREPA power substations completely destroyed. “The damage caused by Hurricane Maria is unlike anything any of us in the industry has ever seen on the mainland United States,” Torres testified to the U.S. House Committee on Energy and Commerce in April 2018. “Without question, this power restoration mission has been the most challenging of my career.”¹²¹

For the rest of the mission, the Unified Command Group—guided by Carlos Torres, as the governor's representative, and including leadership from the Corps, FEMA, the mainland power industry, and PREPA—coordinated power restoration efforts on a daily basis, seven days a week, with the goal to restore power as effectively and as soon as possible.¹²² Agency leaders at the daily meetings of the Unified Command Group often included Colonel Lloyd for Task Force Power, FEMA Power Sector Chief Dr. Ahsha Tribble, and PREPA Interim Director Justo González. The daily coordination meetings also usually included a number of stakeholders from across the island. These sessions were often long

and contentious because participants had to make urgent decisions about where to allocate resources in an environment where information about the status of the grid was consistently lagging. The coordination meeting was followed by briefings that focused on transmission and distribution tasks specifically.¹²³ “Under the Unified Command,” said Lloyd, “it was really having alignment between myself, Dr. Tribble, and Mr. Torres so that we were speaking with one voice and making decisions as one body, and that one entity wasn’t doing something counter to another entity. Not that we always agreed on everything or a way ahead, and sometimes there was tension amongst the group, but at least trying to maintain that alignment was pretty important for us to do.”¹²⁴

One tool the Unified Command Group used to organize its emergency response was an Incident Management Team (IMT).¹²⁵ In Puerto Rico, a Central IMT worked with power authority leadership at PREPA headquarters in San Juan to plan an effective sequence in which to restore transmission and then to link that work with refurbishing local distribution systems.¹²⁶ Beginning in December 2017, the group formed regional IMTs comprising experienced industry professionals to coordinate with local PREPA officials to better understand what was needed in different parts of the island. Once IMTs were involved and up to speed in January 2018, they were able to greatly enhance coordination with local officials and thus to prioritize the most-needed line work. Importantly, they also helped to clarify what replacement parts the Corps needed to order. With parts ordered and lines prioritized, the Corps and PREPA assigned contractors to a geographic area, and then the IMT assigned individual line segments to each of those contractors in coordination with power industry crews.¹²⁷

At the local level, the regional IMTs were composed of about ten experts from major electric utilities who managed and repaired power grids as part of their jobs every day. Each team included several operations managers, a logistician, a planner, a transmission specialist, and a couple of distribution specialists. “And what was great about that was they knew each other,” said Frank Ford, the officer in charge of Task Force Power’s Materials Section. “Not only did everybody at FPL [Florida Power & Light] know each other, but FPL knew Oncor [Electric Delivery] because they worked with each other in these storms. The power of that move can’t be underestimated because what that did was that put technical professionals in each of the regions.”¹²⁸ As Colonel Lloyd described it, “We were sending contractors in to try to work with PREPA to develop priorities on what lines had to be restored, and they were really just kind of struggling with that. So the Incident Management Teams came in and helped fill some of the roles that PREPA was short on and developed those priorities.”¹²⁹ The interaction on the ground between the IMTs and PREPA’s regional staff made the task force’s plans for grid restoration truly executable at the scale of the whole island.

Stabilizing the Central Grid

Grid restoration generally involved three interrelated components—stabilizing power generation, repairing key high-voltage transmission lines that send power across the island to population centers, and repairing the far more numerous lower-voltage distribution lines that bring power to homes and businesses. Phase one of the power restoration plan, which had officially begun with the mission assignment from FEMA on September 30, had focused on providing generators to critical facilities and stabilizing the grid in the San Juan area by installing two 25-MW mega-generators at Palo Seco to provide load balancing capability.¹³⁰

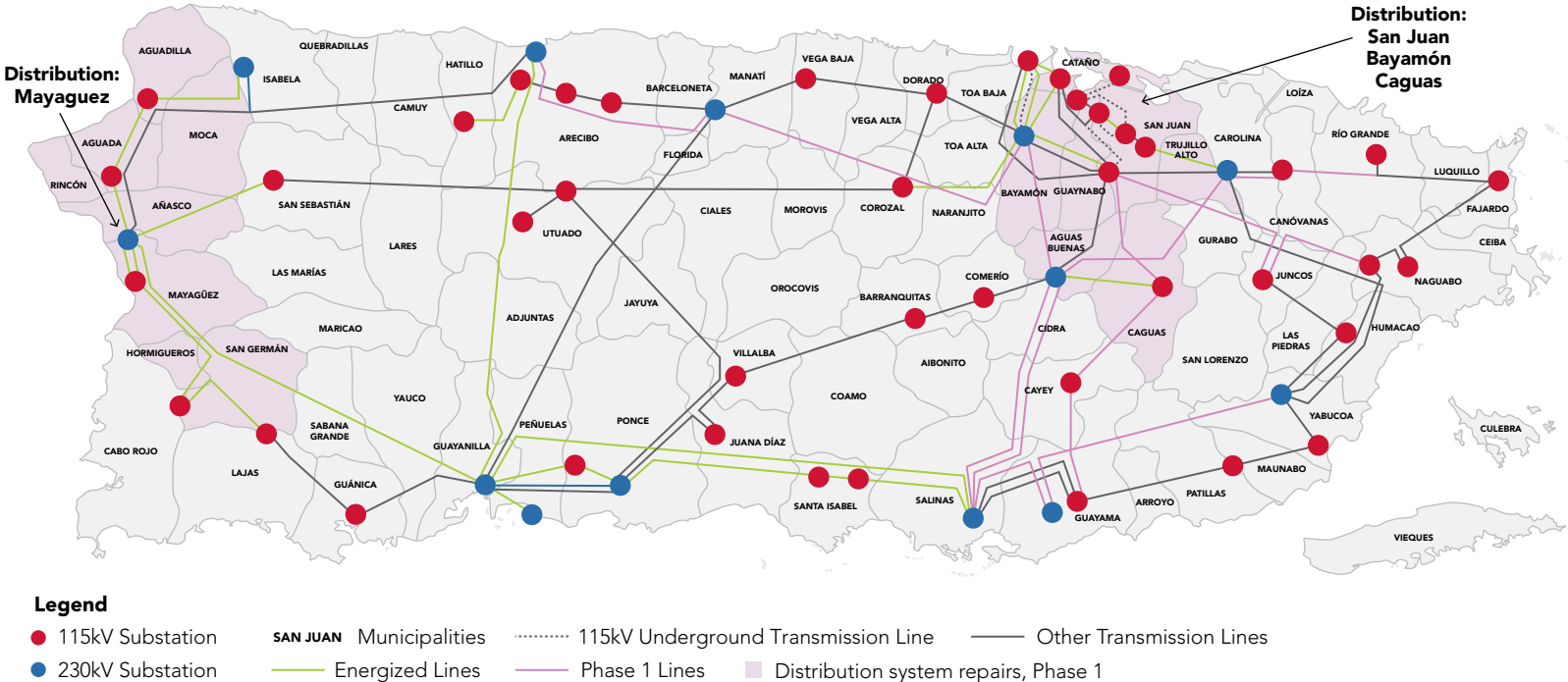
As mentioned earlier, the Palo Seco plant had been a key generator for the San Juan area, but the reliability and efficiency of its service had degraded over time. Even before the storm, parts of the plant were shut down, and it was not designed to quickly ramp generation up and down to meet the rapidly changing demand for electricity as power was restored to areas of the capital.¹³¹ The power authority estimated that the load balancing capability of the Corps-contracted, utility-scale generators installed at Palo Seco combined with the electricity produced at the three other plants near San Juan would be sufficient to support the capital's immediate power requirements.

Phase one of the Corps' power restoration plan also provided grid stability and reliability through the restoration of the central Puerto Rican transmission loop. Maria had knocked out crucial transmission lines linking power generation hubs on the south coast with the key demand center for that electricity in the San Juan area on the north coast. For example, 230 kV and 115 kV transmission lines running north through two corridors across the mountains, via Aguas Buenas and Caguas, connected metro San Juan to the massive 1,500-MW power complex at Aguirre, with multiple oil-fired steam plants, and a 454-MW coal-fired plant in Guayama. While these generation facilities were still producing power, and 230 kV transmission lines looping farther west towards Ponce and then north across the island to Arecibo were still energized, the critical San Juan area, with the island's largest population and key government facilities, was essentially cut off from its primary sources of power.¹³² Additionally, phase one included repairs to the distribution system in the San Juan area and the relatively unscathed Mayagüez region in the west. Phase one would be considered complete when the San Juan area had access to reliable grid power.¹³³

The second goal for Task Force Power was to bring stable electrical service back to some of the island's largest population centers. Cities such as San Juan and its suburbs such as Bayamón, as well as other key population centers, such as Ponce and Caguas, were designated as priorities by FEMA, which considered both population size and economic needs in its assessment.¹³⁴ By mid-October, small parts of San Juan did have intermittent power, but recurring blackouts were frequent.¹³⁵ To support island-wide relief efforts, more capital-area residents and businesses needed their power restored, and that power needed to be more reliable.

Figure 4.6: First Phase Power Restoration Plan, Grid Stability and Reliability

Phase 1 of the USACE power restoration plan, Oct. 26, 2017. Redrawn from data in CEHO, Emergency Operations Collection.



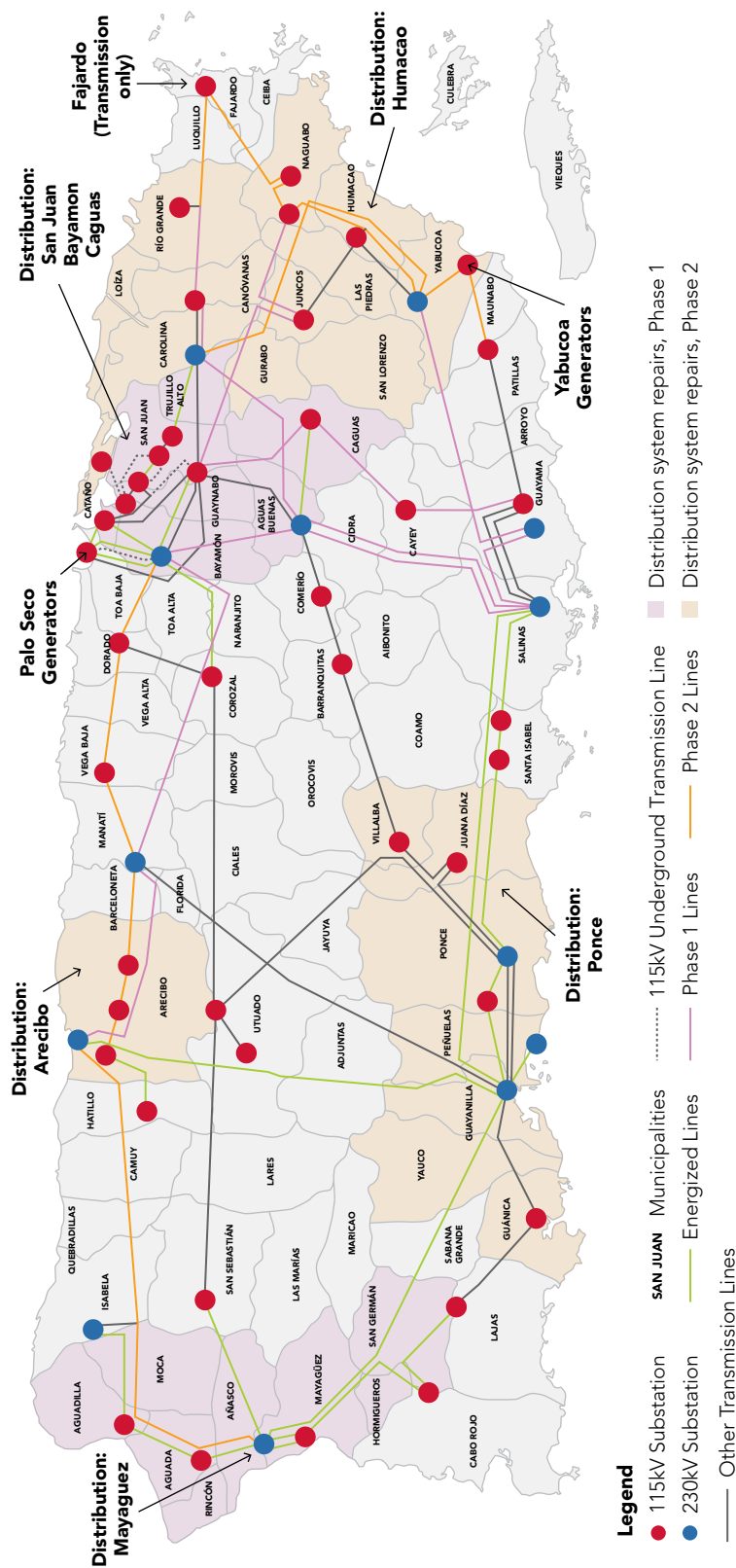
The phases of Task Force Power's restoration plan attempted to align with most of FEMA's priorities. For example, in phase one, the task force also included some of the municipalities that are part of greater San Juan, such as densely-populated Bayamón and Caguas, where key transmission lines passed through valleys in the hills. Other populous areas near the capital, such as Carolina, were designated for phase two. Meanwhile, left out of phase one were a couple of FEMA's highest priority population centers, such as the municipality of Ponce, a large seaport and industrial site. Many of these prioritization decisions had to consider FEMA's assessment, the level of damage to the grid's local distribution systems, and how power was actually generated and transmitted across the mountainous interior of the island.¹³⁶

Importantly, however, the Corps decided to begin work on phase two long before phase one was complete. Several repair operations ran in parallel. Task Force Power's planning for the mission in early October was really focused on where and how to get started. "We tried to identify general geographic regions that we could focus contractors to so that they could mobilize and set up their basecamps in the right places and come with the right mix of equipment," said Molloy. "It's a different mix of equipment if you're going to be doing transmissions lines versus distribution lines versus substations. So we needed to get them that idea of what you'll be doing—25 percent transmission, 75 percent distribution, and you're going to be working in these areas. That's sort of the general plan that came together around the 15th [of October]."¹³⁷

Ultimately, both the Corps and FEMA were supporting PREPA, and that meant that the power authority made guided decisions by setting the priority for each high voltage transmission line, down through lower voltage sub-transmission and local distribution on the regional level, and consequently what areas would get power back first. To set these priorities, PREPA developed a detailed master plan for the reestablishment of the electrical system. The earliest version of this plan was started in early October 2017 for long distance transmission, but it was revised frequently after that time and became more localized. The Central IMT, led by industry professionals experienced in power restoration, helped develop the Transmission Reestablishment Plan beginning in November.¹³⁸ Meanwhile, to prioritize the sub-transmission and local distribution system repairs in its master plan, the power authority considered many factors, such as how much damage needed to be repaired, redundancy in the system, and what lines had already been energized, how much of the damage had already been assessed, and how many customers that line served.¹³⁹

In November, Task Force Power endeavored to better synchronize their efforts with PREPA. To do so, the task force's command personnel moved out of the Joint Field Office in the convention center and into the nearby PREPA headquarters offices in San Juan.¹⁴⁰ The move allowed for closer alignment of the efforts under way by Corps and PREPA contractors and the power industry mutual assistance crews. Relocating also gave Task Force

Figure 4.7: Second Phase Power Restoration Plan, System Redundancy and Population Centers
Phase 2 of the USACE power restoration plan, Oct. 26, 2017. Redrawn from data in CEHO, Emergency Operations Collection.



Power a chance to step back and carefully consider the strategy going forward. “There’s a lot of energy in the JFO,” explained Marc Glowczewski. “There’s an island’s worth of response going on. You continue to feed off of that energy. Moving to PREPA headquarters kind of let us take a tactical pause a little bit and catch our breath and say, ‘Is this what we want to do? Are we making sense here?’ It kind of allowed us to have some room to think, which was good.”¹⁴¹

Also in early November, the Corps contracted with Aptim Federal Services for \$19 million to lease a third utility-size generator to stabilize the grid in a new region.¹⁴² Aptim sent its generator to the southeast side of the island, to PREPA’s Yabucoa Power Plant, to provide scalable, reliable power to and to accelerate power restoration in a heavily-damaged region critical to the pharmaceutical industry. The municipalities of Yabucoa and nearby Humacao had been “ground zero,” where the storm had made landfall and inflicted the greatest destruction.¹⁴³ Contractors had the 25-MW generator at the Yabucoa Power Plant operational by December 9, 2017, and it helped restore power to, among other things, the large Praxair oxygen plant that had previously supplied oxygen to 80 percent of Puerto Rico’s hospitals.¹⁴⁴

Task Force Power had also been growing—from a handful of Corps employees at the RFO in early October 2017 to over 150 civilian and military by the end of the month, located in the task force headquarters and three field offices.¹⁴⁵ At the height of the mission in mid-February 2018, the number of civilian and military Corps personnel assigned to the task force reached more than 250. By that time, the Corps also had more than 4,000 contractors working to repair the grid.¹⁴⁶

In contrast to February, the early weeks of the power restoration mission had been like a “house on fire.” Similar to other major disaster responses that involved the rapid establishment of what was essentially a temporary Corps district office, building the organization while moving forward with the mission made for chaos and urgency. The team needed to bring in people quickly to accomplish the mission. As power restoration program director José Sánchez noted, “There was a portion of the information gathering that’s happening at the same time we’re building the team. We had to. We just didn’t have time. And within the first two weeks we had the team, we had a pretty good plan, [and] we had some information, but...to be honest it took months to gather all of the information in the system.”¹⁴⁷

While the Corps did not embrace Governor Rosselló’s assertion that power would be fully restored across the island in time for Christmas that year, Task Force Power’s early plans still proved optimistic. Two of the biggest assumptions that the task force made were that 80 percent of the island’s grid would need repair and that line repair crews would be able to work at a certain rate of progress, one that was based on flat terrain estimates.¹⁴⁸ The task force made both of those assumptions based on incomplete data about the condition of the grid, the area of mountainous terrain on the island, and the logistical challenges



A bird's-eye view of bucket trucks being unloaded from a barge at the Port of Ponce, Puerto Rico, Jan. 16, 2018. (Photo courtesy of Edison Electric Institute)

of procuring enough towers, transformers, and miles of wire from the U.S. mainland. “I actually calculated one of the first completion dates that we put out publicly,” explained Captain Molloy, “and I did it on an Excel spreadsheet based on: These are the contracts that we know are going to come in. These are how many line crews we think are going to come in with them. This is the expected production rate of each crew. And based on the 10 percent of damage reports that we’ve gotten, we can extrapolate that data out. We can identify how much time it’s going to take to do each of that work, and then come up with an end date.”¹⁴⁹

As more damage reports came in from PREPA, power company crews, and contractors, Task Force Power revised those estimates with the help of the logistics team and cost engineers at Pittsburgh District.¹⁵⁰ But the need to wait for replacement parts to be manufactured and the challenging terrain in the hard-hit southeast of the island meant that it would take months longer than expected to get power back to the final small percentage of customers still without. “I think they were generally fairly accurate,” reflected Marc Glowczewski, looking back on the early estimates. “We did some manpower calculations with the crews and crew makeups, but when you run the numbers, you’re like you don’t need crews, you need materials. It’s really the materials and the poles and the lines that you’re going to need. I think ultimately that ended up being kind of a limiting factor. It’s like how fast can you get materials there versus crews? You can bring in a thousand crews but if they’re just sitting there, you have a thousand crews that aren’t doing anything.”¹⁵¹

Materials were thus a persistent challenge for grid repair. In its first two months, Task Force Power had planned for the restoration of electric service across Puerto Rico, it had

secured critical generating capacity at the Palo Seco Power Plant, it had staffed up field offices, and it had brought in contractors capable of actually repairing key transmission and distribution lines. But even by December, the task force was still lacking a steady supply of parts to make repairs. To scale up grid restoration the Corps would have to acquire millions of parts over the next few months.

Notes

¹ “Hurricane Irma & Hurricane Harvey: September 19 Event Summary,” Report No. 38, Infrastructure Security and Energy Restoration, U.S. Department of Energy (DOE), September 19, 2017, 5, https://www.energy.gov/sites/prod/files/2017/10/f37/Hurricanes%20Irma%20and%20Harvey%20Event%20Summary%20September%2019_0.pdf.

² Office of Electricity Delivery and Energy Reliability, DOE, “Puerto Rico Electric Power Authority,” Fact Sheet, July 2014, 7, Emergency Operations Collection, Office of History, HQUSACE, Alexandria, Virginia [Hereafter cited as CEHO].

³ Rick Young, “Blackout in Puerto Rico,” *Frontline*, Season 36, Episode 10, PBS, June 27, 2018, <https://www.pbs.org/wgbh/frontline/film/blackout-in-puerto-rico/>.

⁴ Trevor Houser and Peter Marsters, “The World’s Second Largest Blackout,” Report, Rhodium Group, April 12, 2018, <https://rhg.com/research/puerto-rico-hurricane-maria-worlds-second-largest-blackout/>. According to the Rhodium Group’s analysis of utility data, while Hurricane Maria caused the largest blackout in U.S. history, the second largest was also in Puerto Rico following Hurricane Georges in 1998.

⁵ *Hearing: Update on the Restoration of Puerto Rico’s Electric Infrastructure, Before the House Subcommittee on Oversight and Investigations, Committee on Energy and Commerce, 115th Cong. (April 11, 2018)* (statement of Carlos D. Torres, Consultant, Edison Electric Institute, and Power Restoration Coordinator, Puerto Rico), 4, <https://docs.house.gov/meetings/IF/IF02/20180411/106913/HHRG-115-IF02-Wstate-TorresC-20180411.pdf>.

⁶ Jen Stutsman, “Energy Department and Federal Efforts to Support Utility Power Restoration Efforts,” Public Affairs, DOE, October 31, 2012, <https://www.energy.gov/articles/energy-department-and-federal-efforts-support-utility-power-restoration-efforts>.

⁷ “Final Hurricane Irma Update: 95 Percent of Customers Restored Since Storm’s Peak,” Issues and Policy, Edison Electric Institute, September 18, 2017, <http://www.eei.org/issuesandpolicy/electricreliability/mutualassistance/Pages/Hurricane%20Irma.aspx>.

⁸ Nicky Ouellet, “Tiny Montana Firm Gets \$300 Million Contract To Help Restore Power In Puerto Rico,” *The Two-Way*, NPR, October 24, 2017, <https://www.npr.org/sections/thetwo-way/2017/10/24/559864118/tiny-montana-firm-gets-300-million-contract-to-help-restore-power-in-puerto-rico>.

⁹ “Emergency Support Function #1–Energy Annex,” DOE, May 2013, 1, https://www.energy.gov/sites/prod/files/2013/06/f1/ESF12_Energy_2013.pdf.

¹⁰ Interview, José Sánchez, South Atlantic Division (SAD) Power Program Director, by James Garber and Jonah Bea-Taylor, HQUSACE, Washington, DC, Part 1, April 9, 2018, 10, Oral History Collection, CEHO.

¹¹ Interview, Maj. Gen. Donald E. Jackson, Jr., Deputy Commanding General for Civil and Emergency Operations, HQUSACE, by Jonah Bea-Taylor and James Garber, HQUSACE, Washington, DC, December 20, 2017, 40, CEHO.

¹² *Field Hearing: The Historic 2017 Hurricane Season: Impacts on the U.S. Virgin Islands, Before the House Subcommittee on Interior, Energy, and Environment, Committee on Oversight and Government Reform, 115th Cong. (March 12, 2018)* (written testimony of Myron D. Jackson, Senate President, U.S. Virgin Islands Legislature, 12-13), <https://docs.house.gov/meetings/GO/GO28/20180312/107980/HHRG-115-GO28-Wstate-JacksonM-20180312.pdf>.

¹³ USACE Operations Center (UOC), “Hurricane Irma Dashboard,” September 6, 2017, 13, Emergency Operations Collection, CEHO.

¹⁴ Lt. Gen. Todd Semonite to Brig. Gen. Diana Holland and Col. John Lloyd, Email, September 12, 2017; Maj. Gen. Ed Jackson to Lt. Col. Karl Jansen, Email, September 12, 2017; both Emergency Operations Collection, CEHO.

¹⁵ USACE G3, “US Virgin Islands Power Distribution Reconstitution,” Hurricane Irma, September 18, 2017, 3-6, Emergency Operations Collection, CEHO.

¹⁶ Maj. Gen. Donald Jackson to Lt. Gen. Todd Semonite, “PLANNING UPDATE: USACE Role in USVI Power Restoration,” Email, September 17, 2017, Emergency Operations Collection, CEHO.

¹⁷ “Power line workers return from hurricane-ravaged U.S. Virgin Islands,” News Releases, DOE Western Area Power Administration, November 30, 2017, <https://www.wapa.gov/newsroom/NewsReleases/2017/Pages/Team-returns-from-hurricane-damaged-USVI.aspx>.

¹⁸ Jackson, (written testimony), 13; “Maria and Irma Recovery,” DOE Western Area Power Administration, Last Updated July 25, 2018, <https://www.wapa.gov/Pages/irma-recovery.aspx>. Founded in 1977 as part of the DOE, the Western Area Power Administration is a federal agency that sells wholesale hydroelectric power to retail electric utilities across 15 western states.

¹⁹ “U.S. Virgin Islands Will Have a Much Stronger Power Grid,” News Release 114, Federal Emergency Management Agency (FEMA), April 2, 2018, <https://www.fema.gov/news-release/2018/04/02/us-virgin-islands-will-have-much-stronger-power-grid>.

²⁰ Interview, Maj. Gen. Donald E. Jackson, Jr., (2017), 41.

²¹ USACE Operations Center to Commander’s Critical Information Requirements, “Receipt of Mission Assignment to Execute Electrical Power Grid,” Email, September 30, 2017, Emergency Operations Collection, CEHO.

²² Ramón Caldas to Andy Techmanski, “RE: Power Line Storm Restoration,” Email, September 19, 2017, Exhibit 1, Released November 13, 2017, by the U.S. House Committee on Natural Resources, , Historian’s Files, CEHO.

²³ Ouellet, “Tiny Montana Firm.”

²⁴ Puerto Rico Electric Power Authority (PREPA), “Electric System Reestablishment Plan—Transmission Lines,” November 22, 2017, Emergency Operations Collection, CEHO.

²⁵ Steven Mufson, Jack Gillum, Aaron C. Davis, and Arelis R. Hernández, “Small Montana firm lands Puerto Rico’s biggest contract to get the power back on,” *Washington Post*, October 23, 2017, https://www.washingtonpost.com/national/small-montana-firm-lands-puerto-ricos-biggest-contract-to-get-the-power-back-on/2017/10/23/31ccc3e-b4d6-11e7-9e58-e6288544af98_story.html; Alexia Fernández Campbell and Umair Irfan, “Puerto Rico’s deal with Whitefish was shady as hell, new records show,” *Vox*, November 15, 2017, <https://www.vox.com/policy-and-politics/2017/11/15/16648924/puerto-rico-whitefish-contract-congress-investigation>.

²⁶ Interview, Sharon Garay Rodriguez, Deputy Director, Task Force Power Restoration, by Jonah Bea-Taylor, by phone, May 14, 2018, 26, CEHO.

²⁷ Lt. Gen. Todd T. Semonite to Hon. Ryan McCarthy, Acting Secretary of the Army, “USACE CDR SENDS SPOTREPORT—POTUS assigned new mission to USACE to restore POWER GRID in the Puerto Rico,” Email, September 27, 2017, Emergency Operations Collection, CEHO; Interview, Lt. Gen. Todd T. Semonite, Chief of Engineers, by John Lonquest, HQUSACE, Washington, DC, December 14, 2018, 3, CEHO. One of the critical, early questions from the administration about the Corps’ role in rebuilding the grid was about financial accountability. Given the commonwealth’s overwhelming debt and PREPA’s bankruptcy, it was important to Office of Management and Budget that FEMA funds go to an agency with a history of easy auditability and transparency in its spending.

²⁸ “TIMELINE—The long power restoration process in Puerto Rico,” *Market News*, Reuters, October 30, 2017, <https://www.reuters.com/article/usa-puertorico-power-timeline/timeline-the-long-power-restoration-process-in-puerto-rico-idUSL2N1N51KV>.

²⁹ UOC Staff, “U.S. Army Corps of Engineers Contingency Ops Dashboard,” HQUSACE, September 28, 2017, 35, Emergency Operations Collection, CEHO; Jeannine Anderson, “New York flies emergency team, drones, supplies

to Puerto Rico,” American Public Power Association, September 22, 2017, <https://www.publicpower.org/periodical/article/new-york-flies-emergency-team-drones-supplies-puerto-rico>. NYPA made its commitment to Puerto Rico’s recovery clear from the start. It had already sent one of the earliest emergency response teams, led by New York Governor Andrew Cuomo, on September 22.

³⁰ Interview, Rhonda Mustafaa, Chief of Plans and Operations, Directorate of Logistics, HQUSACE, and Franklin Ford, Officer in Charge, Task Force Power, Materials Section, by Jonah Bea-Taylor and Lt. Col. David McGuire, HQUSACE, Washington, DC, July 12, 2018, 21, CEHO.

³¹ James Glanz and Frances Robles, “How Storms, Misssteps and an Ailing Grid Left Puerto Rico in the Dark,” *New York Times*, May 6, 2018, <https://www.nytimes.com/interactive/2018/05/06/us/puerto-rico-power-grid-hurricanes.html>.

³² Interview, Maj. Gen. Donald E. Jackson, Jr., (2017), 38.

³³ HQUSACE, “WARNORD 2017-54 (Restore Puerto Rico’s Electrical Power),” October 3, 2017, 6, Emergency Operations Collection, CEHO; FEMA, “Mission Assignment Number 4339DR-PR-COE-SAD-16,” September 29, 2017, Emergency Operations Collection, CEHO. Although the terms “restoration” and “repair” were used interchangeably by multiple local and federal officials in Puerto Rico, the Corps was not rebuilding the Puerto Rican electrical system. The Corps was technically only authorized to “execute temporary repairs to the segments [of the] electrical grid to allow interim restoration of system segments as directed by FEMA until the full electrical grid restoration can be implemented.” The Corps carried out *temporary repairs* because the USACE ESF-3 role supporting FEMA involves repairing public works and restoring them to their pre-storm condition, not rebuilding them better than they were before. The 1988 Robert T. Stafford Disaster Relief and Emergency Assistance Act (Public Law 100-707) prevents the Corps from improving public works as part of the disaster response; ordinarily Congress must appropriate funds for such improvements.

³⁴ “Hurricanes Maria, Irma, and Harvey: September 29 Event Summary,” Report No. 50, Infrastructure Security and Energy Restoration, DOE, September 29, 2017, 2, <https://www.energy.gov/sites/prod/files/2017/09/f37/Hurricanes%20Maria%2C%20Irma%20and%20Harvey%20Event%20Summary%20September%2029%2C%202017.pdf>.

³⁵ Interview, Maj. Gen. Donald E. Jackson, Jr., (2017), 38-39. The Corps’ Deputy Commanding General for Civil and Emergency Operations, Maj. Gen. Donald E. Jackson, summarized the story of how the Corps ended up leading power restoration efforts in Puerto Rico: “When Maria hit, the governor made the decision that he was not going to activate Mutual Assistance Agreements. He chose to send out a solicitation directly to private industry after Irma hit, once the Puerto Rico Electric Power Authority felt that the repair mission was beyond what they could do themselves. Whitefish was the low bidder, and [they] soon came in and started working for PREPA as a sole source contractor to begin the grid restoration. FEMA turned to the Corps of Engineers and asked us if we could initiate similar planning as we had done for the U.S. Virgin Islands, but for Puerto

Rico, which we did. On the 29th of September, General Semonite went to Puerto Rico to talk with the governor, and on the 30th, we received a FEMA Mission Assignment to do the grid restoration.”

³⁶ Interview, Brig. Gen. Diana Holland, Commander, USACE South Atlantic Division (SAD), by Matt Percy and James Garber, San Juan, Puerto Rico, October 19, 2017, 22, CEHO.

³⁷ Interview, José Sánchez, Part 1 (2018), 8.

³⁸ Interview, José Sánchez, Part 1 (2018), 15.

³⁹ Interview, Sharon Garay Rodriguez (2018), 8-10.

⁴⁰ Brig. Gen. Diana M. Holland, “Responding to the Perfect Storm: The U.S. Army Corps of Engineers and Disaster Response in Puerto Rico, 2017,” *Military Review* (May-June 2019): 11-25, <https://www.armyupress.army.mil/journals/military-review/english-edition-archives/may-june-2019/holland-perfect-storm/>.

⁴¹ Interview, Sharon Garay Rodriguez (2018), 11.

⁴² Interview, Capt. Brian Molloy, Operations Officer, Task Force Power Restoration, by Jonah Bea-Taylor, by phone, May 14, 2018, 10-11, CEHO.

⁴³ Interview, Col. James DeLapp, Recovery Field Office (RFO) Commander, by Matthew Percy and James Garber, San Juan, Puerto Rico, October 18, 2017, 52, CEHO.

⁴⁴ Interview, Lt. Gen. Todd T. Semonite, Chief of Engineers, by John Lonquest, Office of the Chief of Engineers, the Pentagon, Arlington, VA, December 11, 2017, 23, CEHO.

⁴⁵ Interview, Lt. Gen. Todd T. Semonite (2017), 2-4; “Colonel John P. Lloyd, Commander, Pittsburgh District,” Leadership, USACE Pittsburgh District, August 2, 2016, <https://www.lrp.usace.army.mil/Portals/72/docs/About/Lloyd,%20COL%20John%20P%20Bio.pdf?ver=2016-08-02-115841-150>.

⁴⁶ Interview, Marc Glowczewski, Senior Project Manager, Task Force Power Restoration, by Jonah Bea-Taylor, by phone, May 17, 2018, 4, CEHO.

⁴⁷ Interview, Marc Glowczewski (2018), 9.

⁴⁸ Interview, Capt. Brian Molloy (2018).

⁴⁹ Interview, José Sánchez, Part 1 (2018).

⁵⁰ Cynthia López Cabán, “95% with electricity before Christmas,” *El Nuevo Día*, October 15, 2017, <https://www.elnuevodia.com/english/english/nota/95withelectricitybeforechristmas-2366195/>.

⁵¹ Interview, Ricardo Rossello, by Rachel Martin, Transcript, “Puerto Rico Governor on the Island’s Recovery,” *Morning Edition*, NPR, November 22, 2017, <https://www.npr.org/2017/11/22/565881168/puerto-rico-governor-on-the-islands-recovery>; Interview, Maj. Gen. Donald E. Jackson, Jr., (2017), 66-70. As the initial response shifted to longer-term recovery, Governor Rosselló was focused on making sure Puerto Rico’s many needs were visible in the media and the federal government committed as many re-

sources as possible to the island. Sometimes this persistence meant that the governor was critical of the Corps’ timeline to restore power.

⁵² Task Force Power, “Task Force Power Restoration Operational Concept,” Information Brief, October 19, 2017, 12, Emergency Operations Collection, CEHO.

⁵³ “Department of Defense Press Briefing by Army Corps of Engineers Commander Lt. Gen. Todd T. Semonite in the Pentagon Briefing Room on Relief Efforts in Florida, Puerto Rico and the Virgin Islands,” Transcript, October 20, 2017, <https://www.defense.gov/Newsroom/Transcripts/Transcript/Article/1349928/departement-of-defense-press-briefing-by-army-corps-of-engineers-commander-lt-ge/>.

⁵⁴ HQUSACE, “Operations Order 2017-54 (Restore Puerto Rico’s Electrical Power),” October 11, 2017, Emergency Operations Collection, CEHO.

⁵⁵ HQUSACE, “Operations Order 2017-54,” 3.

⁵⁶ HQUSACE, “Operations Order 2017-54,” 3.

⁵⁷ *Hearing: Full Committee Hearing to Examine Puerto Rico’s Electric Grid, Before the Senate Committee on Energy and Natural Resources*, 115th Cong. (May 8, 2018) (written testimony of Assistant Secretary Bruce J. Walker, Office of Electricity Delivery and Energy Reliability, U.S. Department of Energy, 1), <https://www.energy.senate.gov/public/index.cfm/2018/5/full-committee-hearing-to-examine-puerto-rico-s-electric-grid>.

⁵⁸ Interview, Col. John P. Lloyd, Commander, Task Force Power Restoration, by Jonah Bea-Taylor and James Garber, by phone, June 8, 2018, 7, CEHO.

⁵⁹ Edward Rivera, “Engineering Solutions for the Nation’s Toughest Problems: USACE tackles Puerto Rico’s power grid,” News, U.S. Army, March 24, 2018, https://www.army.mil/article/202684/engineering_solutions_for_the_nations_toughest_problems_usace_tackles_puerto_ricos_power_grid.

⁶⁰ Interview, Capt. Brian Molloy (2018), 39-40.

⁶¹ Interview, Col. Richard P. Pannell, Deputy Commander, Mississippi Valley Division (MVD), by Jonah Bea-Taylor, Matthew Percy, and Brian Rentfro, MVD Headquarters, Vicksburg, MS, January 9, 2018, 61, CEHO.

⁶² Interview, Capt. Brian Molloy (2018), 12.

⁶³ Interview, Capt. Brian Molloy (2018), 14.

⁶⁴ Interview, Col. John Lloyd (2018).

⁶⁵ Interview, Sharon Garay Rodriguez (2018), 15.

⁶⁶ Interview, Col. John Lloyd (2018), 9, 12.

⁶⁷ Interview, Col. John Lloyd (2018), 31.

⁶⁸ Interview, Marc Glowczewski (2018), 28.

⁶⁹ Interview, José Sánchez, South Atlantic Division (SAD) Power Program Director, by James Garber and Jonah Bea-Taylor, HQUSACE, Washington, DC, Part 2, April 16, 2018, 5, CEHO.

⁷⁰ HQUSACE, “Operations Order 2017-54,” 5.

⁷¹ Génesis Ibarra, “Puerto Rico power utility director: Palo Seco plant won’t run ‘under any circumstance,’” *Caribbean Business*, October 31, 2019, <https://caribbean-business.com/puerto-rico-power-utility-director-palo-seco-plant-wont-run-under-any-circumstance/>.

⁷² “Puerto Rico: U.S. Army Corps of Engineers 85MW,” Case Study, APR Energy, n.d., <https://www.aprenergy.com/case-study/puerto-rico/>.

⁷³ “TF Power Restoration SITREP,” Situation Reports, October 15, 17, and 27, 2017, Emergency Operations Collection, CEHO; FEMA, “Fact Sheet: Obligated Funding for Puerto Rico,” September 10, 2018, <https://www.fema.gov/news-release/2018/09/10/fact-sheet-obligated-funding-puerto-rico>. The turbines continued to run at Palo Seco into 2019. A year after Maria, FEMA estimated that funding for this scalable generation capacity had increased to \$134.3 million. “Generators supplying power to Palo Seco to stabilize grid,” News Release No. 17-111, HQUSACE, October 30, 2017, <https://www.usace.army.mil/Media/News-Releases/News-Release-Article-View/Article/1357799/generators-supplying-power-to-palo-seco-to-stabilize-grid/>.

⁷⁴ Interview, Capt. Brian Molloy (2018), 14-15.

⁷⁵ Interview, Capt. Brian Molloy (2018), 15.

⁷⁶ Interview, Col. John Lloyd (2018), 7.

⁷⁷ Interview, Marc Glowczewski (2018), 29-31.

⁷⁸ Damon Manders, David Tajkowski, and Michael Dace, *Rebuilding Hope: A History of the Response to Hurricanes Katrina and Rita* (St. Louis, MO: Ordnance and Technical Services Branch, Engineering and Construction Division, St. Louis District, USACE, 2011), 84.

⁷⁹ Interview, Capt. Brian Molloy (2018).

⁸⁰ Interview, José Sánchez, Part 1 (2018), 22.

⁸¹ Interview, Capt. Brian Molloy (2018).

⁸² U.S. Government Accountability Office, “Federal Support for Electricity Grid Restoration in the U.S. Virgin Islands and Puerto Rico,” Report GAO-19-296, April 2019, 19-20, <https://www.gao.gov/products/GAO-19-296>. While options for very large emergency contracts may have been limited, the Corps did have Advanced Contracting Initiative (ACI) firms ready to go for its most common post-hurricane missions—debris removal, temporary roofing, and generators. There were no ACI contracts for grid repair, but the Corps did use a number of different contract vehicles to speed up the process of getting utility workers on the ground in Puerto Rico.

⁸³ U.S. Army Engineering and Support Center, Huntsville, “Award for Contract W912DY-18-F-0003,” Section B: Supplies or Services and Prices, October 15, 2017, 3, Emergency Operations Collection, CEHO; U.S. Department of Defense Inspector General, “Audit of U.S. Army Corps of Engineers Oversight on Contracts for Repair and Restoration of the Electric Power Grid in Puerto Rico,” Report No. DODIG-2019-128, September 30, 2019, i-iii,

<https://media.defense.gov/2019/Oct/03/2002189874/-1/-1/1/DODIG-2019-128.PDF>. The expediency of a time-and-materials contract did end up making it harder for the Corps to verify the contractors’ performance. A 2019 audit of the Corps’ time-and-materials contracts concluded that both the U.S. Army Engineering and Support Center at Huntsville and the USACE Jacksonville District “did not adequately monitor contractor labor hours worked or accurately review invoices to ensure contractor invoices corresponded to actual work performed....” The DoD Inspector General’s analysis of labor costs indicated that at least \$50.1 million paid by the Corps on invoices valued at \$320.2 million (about 15.6%) was “unsupported and potentially unallowable.” These invoices represented only a sixth of the total amount authorized by FEMA for power restoration. General Semonite responded to the report, saying that “in this case, life, health, and safety considerations dictated expediency at the expense of established processes.” The Corps agreed to follow up on the Inspector General’s recommendations for improving the quality assurance process for time-and-materials contracts.

⁸⁴ Interview, Sharon Garay Rodriguez (2018), 12.

⁸⁵ Interview, Capt. Brian Molloy (2018), 20.

⁸⁶ According to the Federal Acquisition Regulation, a basic ordering agreement is “a written instrument of understanding between the government and a contractor that contains (1) terms and clauses for future contracts (orders) between the parties during its term; (2) a description, as specific as possible, of supplies or services to be provided; and (3) methods for pricing, issuing, and delivering future orders under the agreement. A basic ordering agreement is not a contract but is used to expedite contracting for supplies or services when specific items, quantities, and prices are not known but a substantial number of requirements are anticipated.” See <https://www.acquisition.gov/content/16703-basic-ordering-agreements>.

⁸⁷ Interview, José Sánchez, Part 2 (2018), 23-26.

⁸⁸ Interview, Capt. Brian Molloy (2018); Jeff Hawk, “USACE awards \$831 million contract to Fluor Corp. for power grid repair in Puerto Rico,” News, U.S. Army, December 2, 2017, https://www.army.mil/article/197645/usace_awards_831_million_contract_to_fluor_corp_for_power_grid_repair_in_puerto_rico. Fluor had been a key contractor in rebuilding Iraq’s generation capacity after the 2003 U.S. invasion. See Robert Grathwol, “Task Force RIE Draft History” (unpublished manuscript, October 2007), 34, Microsoft Word file, Operation Iraqi Freedom Collection, CEHO.

⁸⁹ “PowerSecure signs contract with the U.S. Army Corps of Engineers (USACE) to help restore Puerto Rico electric grid,” Community Articles, Southern Company, October 10, 2017, <https://www.southerncompany.com/corporate-responsibility/corporate-responsibility-newsroom/community-articles/powersecure-signs-contract.html>; FEMA, “Fact Sheet: Obligated Funding for Puerto Rico.”

⁹⁰ Maj. Catalina Carrasco, “USACE awards additional \$140.5 million for power grid restoration efforts in Puerto Rico,” Release No. 1804-07, News, DVIDS, April 7, 2018, <https://www.dvidshub.net/news/272157/usace-awards-ad>

ditional-1405-million-power-grid-restoration-efforts-puerto-rico.

⁹¹ Interview, Capt. Brian Molloy (2018), 17.

⁹² FEMA, “Fact Sheet: Obligated Funding for Puerto Rico.” Fluor was awarded two separate contracts with authorization to execute work up to \$753.7 million. As of Sept. 6, 2018, USACE had processed invoices totaling \$515.7 million.

⁹³ “Task Force Power Restoration Operational Concept,” October 19, 2017, 13.

⁹⁴ “Fluor Awarded Second U.S. Army Corps of Engineers Contract to Support Power Grid Repair in Puerto Rico,” Newsroom, Fluor, December 6, 2017, <https://newsroom.fluor.com/news-releases/news-details/2017/Fluor-Awarded-Second-US-Army-Corps-of-Engineers-Contract-to-Support-Power-Grid-Repair-in-Puerto-Rico/default.aspx>.

⁹⁵ “Definitive Contract W912EP18C0003,” Federal Contract Award, GovTribe, Updated March 21, 2019, <https://govtribe.com/contract/award/w912ep18c0003>. The contract was awarded to PowerSecure on October 18, 2017.

⁹⁶ Carrasco, “USACE awards additional \$140.5 million.”

⁹⁷ Interview, Sharon Garay Rodriguez (2018), 25.

⁹⁸ Interview, Capt. Brian Molloy (2018), 23.

⁹⁹ Interview, Col. John Lloyd (2018); Interview, José Sánchez, Part 1 (2018).

¹⁰⁰ Interview, Marc Glowczewski (2018), 16.

¹⁰¹ Interview, Sharon Garay Rodriguez (2018), 28.

¹⁰² Maria Gallucci, “Rebuilding Puerto Rico’s Power Grid: The Inside Story,” *IEEE Spectrum*, March 12, 2018, <https://spectrum.ieee.org/energy/policy/rebuilding-puerto-ricos-power-grid-the-inside-story>; Anderson, “New York flies emergency team, drones, supplies to Puerto Rico.”

¹⁰³ Glanz and Robles, “How Storms, Missteps and an Ailing Grid Left Puerto Rico in the Dark.”

¹⁰⁴ Andrew Scurria, “Puerto Rico Contract Spending Accelerates With Army Corps Exit,” *Wall Street Journal*, March 2, 2018, <https://www.wsj.com/articles/puerto-rico-contract-spending-accelerates-with-army-corps-exit-1519948452>; Pam Radtke Russell, Louise Poirier, and Jim Parsons, “Why Another Hurricane Can Devastate Puerto Rico and Texas—Again,” *Engineering News-Record*, June 6, 2018, <https://www.enr.com/articles/44633-why-another-hurricane-can-devastate-puerto-rico-and-texasagain>; U.S. Attorney’s Office, District of Puerto Rico, “FEMA Deputy Regional Administrator, Former President Of Cobra Acquisitions, LLC, And Another Former FEMA Employee Indicted For Conspiracy To Commit Bribery, Honest Services Wire Fraud, Disaster Fraud, Among Other Charges,” News Release, U.S. Department of Justice, September 10, 2019, <https://www.justice.gov/usao-pr/pr/fema-deputy-regional-administrator-former-president-cobra-acquisitions-llc-and-another>. Over the next few months, PREPA increased Cobra’s contract to \$945 million. After the USACE grid repair mission ended, PREPA signed

another \$900 million contract with Cobra as a part of a larger grid restoration program. Beginning in late 2018, the Department of Homeland Security (DHS) Office of Inspector General began conducting an investigation into allegations bribery and fraud surrounding the awarding of these contracts by PREPA to Cobra with FEMA officials’ approval.

¹⁰⁵ Frances Robles and Deborah Acosta, “Puerto Rico Cancels Whitefish Energy Contract to Rebuild Power Lines,” *New York Times*, October 29, 2017, <https://www.nytimes.com/2017/10/29/us/whitefish-cancel-puerto-rico.html>.

¹⁰⁶ “UPDATED: FEMA Statement on Puerto Rico Electric Power Authority’s Contract with Whitefish,” News Release, FEMA, October 27, 2017, <https://www.fema.gov/news-release/2017/10/27/updated-fema-statement-puerto-ri-co-electric-power-authoritys-contract>.

¹⁰⁷ Interview, Capt. Brian Molloy (2018), 20-21.

¹⁰⁸ Scott DiSavino and Roberta Rampton, “Puerto Rico calls on U.S. utilities to help restore power,” *U.S. Headlines*, Reuters, October 31, 2017, <https://www.reuters.com/article/us-usa-puertorico-power-new-york/puerto-rico-calls-on-u-s-utilities-to-help-restore-power-idUSKBN1D02FJ>.

¹⁰⁹ “Governor Cuomo Announces 160 Utility Personnel Arrive in Puerto Rico to Assist with Power Grid Recovery,” News, Office of Governor Andrew M. Cuomo, November 13, 2017, <https://www.governor.ny.gov/news/governor-cuomo-announces-160-utility-personnel-arrive-puerto-rico-assist-power-grid-recovery>.

¹¹⁰ Susan Salisbury, “Logistics hinder Florida firms in restoring Puerto Rico’s power,” *Palm Beach Post*, November 3, 2017, Internet Archive, Retrieved November 8, 2017, <https://web.archive.org/web/20171108160140/https://www.mypalmbeachpost.com/business/logistics-hinder-florida-firms-restoring-puerto-rico-power/xf9J7FkEhFfc-miX0IIWmAJ/>; Frances Robles, “Contractor for Puerto Rico Power Suspends Work, Citing Unpaid Bills,” *New York Times*, November 21, 2017, <https://www.nytimes.com/2017/11/21/us/whitefish-puerto-rico-power.html>.

¹¹¹ Interview, José Sánchez, Part 1 (2018), 19.

¹¹² Interview, Col. Jason Kirk (2018), 10.

¹¹³ “Puerto Rico Power Restoration Effort,” Edison Electric Institute, August 2018, <http://www.eei.org/ma/Pages/default.aspx?e=Maria>.

¹¹⁴ “Irma: Electric Power Industry Responding in Force, Nearly 90 Percent of Customers Restored,” Talking Points, Edison Electric Institute, September 16, 2017, https://www.eei.org/ma/Documents/Irma_Talking_Points.pdf.

¹¹⁵ David Ferris, “How Puerto Rico became the worst grid disaster,” *Energywire, E&E News*, April 19, 2018, <https://www.eenews.net/stories/1060079499>.

¹¹⁶ Interview, Col. Jason Kirk (2018), 10.

¹¹⁷ Interview, Capt. Brian Molloy (2018), 21.

¹¹⁸ Interview, Col. John Lloyd (2018), 20.

- ¹¹⁹ “Governor of Puerto Rico appoints coordinator for energy system restoration effort,” La Fortaleza, Oficina de la Gobernadora, November 27, 2017, <https://www.fortaleza.pr.gov/content/governor-puerto-rico-appoints-coordinator-energy-system-restoration-effort>.
- ¹²⁰ Interview, Carlos Torres, Power Restoration Coordinator, Commonwealth of Puerto Rico, by Jonah Bea-Taylor, by phone, August 1, 2019, CEHO; Jason Singer, “Gaining a Unified Command of the Situation After Hurricane Maria,” *T&D World*, August 19, 2019, <https://www.tdworld.com/test-and-measurement/gaining-unified-command-situation-after-hurricane-maria>.
- ¹²¹ *Hearing: Update on the Restoration of Puerto Rico’s Electric Infrastructure*, Torres statement, 1.
- ¹²² The Unified Command Group is one of the organizational structures specified under the Incident Command System (ICS) used by emergency managers at all levels of government in the United States. These protocols are laid out in the National Incident Management System (NIMS) developed by the Department of Homeland Security in 2004. A Unified Command allows all agencies with responsibility for responding to the incident to participate in the decision-making process. For more background on the origins of ICS and NIMS, see Kimberly S. Stambler and Joseph A. Barbera, “Engineering the Incident Command and Multiagency Coordination Systems,” *Journal of Homeland Security and Emergency Management* 8, Iss. 1 (2010): Article 43.
- ¹²³ Interview, Carlos Torres (2019), 17.
- ¹²⁴ Interview, Col. John Lloyd (2018), 34.
- ¹²⁵ Interview, Col. John Lloyd (2018), 22-23; Jeannine Anderson, “Incident management teams deploy in Puerto Rico, PREPA welcomes help,” American Public Power Association, December 12, 2017, <https://www.publicpower.org/periodical/article/incident-management-teams-deploy-puerto-rico-prepa-welcomes-help>.
- ¹²⁶ Interview, Carlos Torres (2019), 19-20.
- ¹²⁷ Interview, Michael Ornella, Sr., Deputy District Engineer, Task Force Power Restoration, by Jonah Bea-Taylor, by phone, June 27, 2018, 19, CEHO.
- ¹²⁸ Interview, Rhonda Mustafaa and Franklin Ford (2018), 56.
- ¹²⁹ Interview, Col. John Lloyd (2018), 23.
- ¹³⁰ Jeff Hawk, “Generators supplying power to Palo Seco to stabilize grid,” News, U.S. Army, October 30, 2017, https://www.army.mil/article/196170/generators_supplying_power_to_palo_seco_to_stabilize_grid.
- ¹³¹ Interview, Col. John Lloyd (2018), 16.
- ¹³² “Task Force Power Restoration Operational Concept,” October 19, 2017, 8; DOE Office of Electricity, “Puerto Rico Electric Power Authority,” 7. There were three high-voltage (230kV and 138kV) transmission loops in Puerto Rico. The eastern and western loops had been completed in the early 2000s. The central loop was significantly older, dating from the 1970s, and was composed primarily of 230kV lines, and it was the focus of Phase 1 of the Corps’ plan. The central loop was also crucial to restoring power fully in San Juan. The western loop was in far better shape than the central or eastern loop. Fluor’s work on transmission lines for the Corps concentrated primarily on the heavily damaged eastern loop, which had taken the full force of Maria’s winds. Additional, redundant 138kV transmission lines crossed the center of the island, and some of those were never repaired.
- ¹³³ “Task Force Power Restoration Operational Concept,” October 19, 2017, 7.
- ¹³⁴ Capt. Brian Molloy to author, “RE: Follow up question on Puerto Rico regions,” Email, July 5, 2018, Historian’s Files, CEHO.
- ¹³⁵ Deborah Acosta and Frances Robles, “Puerto Ricans Ask: When Will the Lights Come Back On?” *New York Times*, October 19, 2017, <https://www.nytimes.com/2017/10/19/us/puerto-rico-electricity-power.html>.
- ¹³⁶ “Task Force Power Restoration Operational Concept,” October 19, 2017, 5-7.
- ¹³⁷ Interview, Capt. Brian Molloy (2018), 19.
- ¹³⁸ Interview, Carlos Torres (2019), 21-23.
- ¹³⁹ Puerto Rico Electric Power Authority (PREPA), “Electric System Reestablishment Plan—Subtransmission and Distribution Lines,” Master Plan, December 26, 2017, Emergency Operations Collection, CEHO.
- ¹⁴⁰ Interview, Col. John Lloyd (2018), 30.
- ¹⁴¹ Interview, Marc Glowczewski (2018), 8.
- ¹⁴² “Generators supplying power to Palo Seco to stabilize grid,” News Release 17-111, HQUSACE, October 30, 2017, <https://www.usace.army.mil/Media/News-Releases/News-Release-Article-View/Article/1357799/generators-supplying-power-to-palo-seco-to-stabilize-grid/>; Alex Figueroa Cancel, “Corps of Engineers will remove generators from power plants,” *El Nuevo Día*, July 10, 2018, <https://www.elnuevodia.com/english/english/nota/corpsengineerswillremovegeneratorsfrompowerplants-2434091/>; “Fact Sheet: Obligated Funding for Puerto Rico.” The mega-generator at Yabucoa ran until July 2018. A year after the storm, FEMA estimated total costs for this emergency power source for hard-hit southeastern Puerto Rico had increased to \$57 million.
- ¹⁴³ Rick Jervis, “‘This city has been ignored’: Yabucoa, ground zero for Hurricane Maria in Puerto Rico, still reeling,” *USA Today*, March 11, 2018, <https://www.usatoday.com/story/news/2018/03/11/yabucoa-puerto-rico-ground-zero-hurricane-maria-long-road-ahead-recovery/393118002/>; Sarah Almukhtar, Matthew Bloch, Ford Fessenden, and Jugal K. Patel, “Maps: Hurricane Maria’s Path Across Puerto Rico,” *New York Times*, September 26, 2017, <https://www.nytimes.com/interactive/2017/09/18/world/americas/hurricane-maria-tracking-map.html>.
- ¹⁴⁴ Marga Parés Arroyo, “Oxygen supplies in hospitals at risk,” *El Nuevo Día*, October 19, 2017, <https://www.elnuevodia.com/english/english/nota/oxygensuppliesinhospital-satrisk-2367348/>; “Hurricanes Irma & Maria,” Common

Operating Picture, November 2, 2017, 2, Emergency Operations Collection, CEHO.

¹⁴⁵ Interview, Marc Glowczewski (2018), 7; “TF Power Restoration SITREP,” Situation Report, October 30, 2017, Emergency Operations Collection, CEHO.

¹⁴⁶ Task Force Power, “TF Power Restoration Update,” Daily Update, February 10, 2018, 2, Emergency Operations Collection, CEHO; UOC Staff, “U.S. Army Corps of Engineers Operational Update,” Puerto Rico Power Grid Restoration, February 16 2018, 26, Emergency Operations Collection, CEHO.

¹⁴⁷ Interview, José Sánchez, Part 1 (2018), 18.

¹⁴⁸ Interview, Capt. Brian Molloy (2018), 35.

¹⁴⁹ Interview, Capt. Brian Molloy (2018), 26-27.

¹⁵⁰ Interview, Capt. Brian Molloy (2018), 32.

¹⁵¹ Interview, Marc Glowczewski (2018), 33-34.

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Military Sealift Command's USNS *Brittin* entered the Port of Ponce, Puerto Rico, carrying 53-foot-long generator trailers and other supplies, Nov. 3, 2017. Personnel of the 597th Transportation Brigade, U.S. Navy Cargo Handling Battalion One, and staff from FEMA and other agencies together loaded the *Brittin* in Charleston, South Carolina, with equipment critical to the restoration efforts. (U.S. Air Force photo by S. Sgt. Teresa J. Cleveland)

— CHAPTER 5 —

PROCURING REPLACEMENT PARTS, OCTOBER 2017–JANUARY 2018

As Task Force Power learned in late 2017, the key to repairing Puerto Rico’s grid was acquiring the necessary replacement electrical parts. It was also the Corps of Engineers’ greatest challenge.¹ Although the Corps had dealt with complex logistical problems and the need to procure out-of-the-ordinary replacement parts when it made repairs to the Iraqi grid in 2003-2005, that mission was unique and therefore it had not resulted in the Corps developing a lasting, specialized capacity to assume power restoration missions.² When Task Force Power began planning to undertake grid repair in late September, it was unclear exactly what parts, and in what quantity, would be needed to fully restore Puerto Rico’s electric power. Team members were also uncertain if they would be able to rapidly procure, ship, and distribute millions of parts, including many types of poles, non-standard wire, transformers, insulators, and hundreds of other smaller components that were needed in Puerto Rico. The agency urgently had to learn and develop new capabilities. “First, we must improve in non-standard logistics planning and execution. It was in this area that we learned and grew the most,” explained the Corps’ Deputy Commanding General for Civil and Emergency Operations, Maj. Gen. Donald E. Jackson. “How do you scale logistics operations beyond the routine? How do you take advantage of other agencies to extend USACE operational reach?”³

The logistics team within Task Force Power took on this daunting task and worked with staff at headquarters to develop the Corps’ first interagency logistics task force.⁴ Although the first couple of months were incredibly challenging, the logistics team learned so much and eventually became so adept at managing the complex orders, partnerships, and supply chains that the indispensable “Bill of Materials” mission they were focused on outlasted the Corps’ role in actually repairing the power lines. In fact, while the Corps and its contractors

did not directly repair a majority of the island's transmission and distribution lines, the Corps did lead the effort to acquire all of the replacement parts. A year after Maria's landfall, in late September 2018, the "BOM Squad"—or the unified materials team led by the Corps in conjunction with the Federal Emergency Management Agency (FEMA), the Puerto Rico Electric Power Authority (PREPA), and power industry and Department of Defense (DoD) partners—had acquired, transported, and distributed 51.5 million pieces of material costing \$420 million, including more than 61,000 poles and 8,400 miles of wire.⁵

The Bill of Materials (BOM) —the sum of orders for replacement electrical parts needed to repair the grid completely—was the most critical, and thorny, planning challenge throughout the power restoration mission because there was a constant need to align the number of contracted repair personnel with the materials they would need to do those repairs.⁶ Even with the right number of line workers on the island to make repairs, there was only so much those workers could do with what was there already. Everyone who worked on the grid—from 249th Engineer Battalion soldiers to Corps contractors to PREPA and power company crews—were incredibly resourceful in reusing wire, standing up intact poles that had fallen, and salvaging other materials that could be used on the grid.⁷ But they still needed an enormous number of parts to replace the components of the grid that had been completely destroyed by the storm.

On September 30, 2017, as South Atlantic Division Forward was first learning about the grid mission from FEMA, Frank Ford, a headquarters planner assigned as an operations officer with Task Force Power, faced the challenge of building a logistics organization that could catalog, procure, transport, and distribute the millions of needed electrical parts. Normally, the knowledge required to undertake such a specialized task was limited to those in the power industry, so for the first couple of months, the Corps was forced to build its own expertise. Rhonda Mustafaa, Chief of Plans and Operations for the Directorate of Logistics at Corps headquarters, provided support and coordination with federal partners in the Washington area. Mustafaa was the task force's key liaison with FEMA and the Defense Logistics Agency (DLA) in the early days of the mission—a role for which she was honored as the Corps' Civilian of the Year in 2018. She also deployed to Puerto Rico in January 2018 after Ford temporarily rotated out.⁸

In late September 2017, PREPA's online inventory system was still not functioning, and most of their warehouses on the island were damaged by water and wind from the storm, so the utility could not access much of its remaining supplies.⁹ Furthermore, much of the power authority's own stock of parts had been depleted as it repaired the grid after Irma grazed the island and knocked out power to 65 percent of customers.¹⁰ When Maria rolled in less than two weeks later, PREPA simply did not have the supplies on-hand to make island-wide repairs. Worse still, there were very few parts left in warehouses in the mainland United States.

Utilities in Texas and Florida had already reduced those inventories following the thousands of repairs made after Hurricanes Harvey in Texas and Irma in Florida.¹¹

The critical lack of parts meant that Hurricane Maria came close to being a truly “catastrophic” national disaster because it caused such extensive damage in Puerto Rico and there were so few materials available anywhere in the country to start patching the system back together. “We still had bandwidth remaining that we could respond,” explained Ford. “A catastrophic event brings you to your knees, no bandwidth remaining, all around expired. And I would tell you for the federal responder, for Puerto Rico it almost brought us to that point.”¹²

Without large inventories of appropriate parts available to Task Force Power to repair Puerto Rico’s grid, many components would have to be manufactured on the mainland. Manufacturers would then have to send those new parts to Port Canaveral or Jacksonville in Florida to be shipped out on barges. Once in Puerto Rico three to four days later, the supplies would have to be inventoried, stored in warehouses, and finally distributed across the island to the crews who needed those parts the most. All of these steps required a capacity for expeditionary, “overseas” logistical coordination—to track and maintain the flow of parts from the manufacturer to a port to a barge to a warehouse to the grid—which the Corps had not previously developed, at least independently of large military operations. In the language of military doctrine, the Corps had not developed an operational-level sustainment capability of its own.¹³

The Corps’ national-level logistics activity also struggled at first to develop a concept of operations that would adequately describe what capabilities—partnerships, personnel, data, and processes—were required to meet the needs of the grid restoration mission. There was very little existing guidance for the kind of program that would have to be built over the next two months to acquire sufficient parts.¹⁴ As Mustafaa explained, “For us, in this particular mission set, the requirement was to procure or acquire electrical materials. So when I think about the requirement to procure or acquire these electrical materials, I’m looking at wow, who has that? First of all, who has an inventory for those materials? And oh by the way, we’re also still in the recovery response stage of Harvey and Irma.”¹⁵

In addition, the personnel available for contingency operations—in terms of the number of subject matter experts with sufficient training—within the Corps of Engineers’ logistics community had atrophied over the years.¹⁶ The Corps was not the only agency facing staffing challenges. FEMA also struggled with the logistical and personnel demands of the huge response in the U.S territories in the Caribbean.¹⁷ On October 1, in an interview on Fox News, FEMA Administrator Brock Long described the Puerto Rico recovery as “the most logistically challenging event the United States has ever seen.” The comment was criticized for being historically inaccurate, but the recognition that multiple U.S. relief agencies were challenged by the overseas nature of the logistics component of the recovery mission was very timely.¹⁸



M. Sgt. Tatshee L. Simmons, Illinois Army National Guard, looked for the manufacturer information on a special wire, unique to Puerto Rico, Jan. 16, 2018, at the Port of Ponce laydown yard, operated by Task Force Power Restoration. Simmons, a member of TF Power's Bill of Materials team, or "BOM Squad," managed the site's stock control, inventory, and distribution. "Puerto Rican Special" was a type of wire unique to high voltage transmission because of its mostly aluminum composition. (U.S. Army photo by Gerald Rogers)

Task Force Power closed the gaps in the Corps' logistical capabilities by reaching out to DoD partners, especially the DLA, U.S. Transportation Command (USTRANSCOM), and U.S. Army Sustainment Command.¹⁹ DLA supply chains were useful in getting Corps orders fulfilled by manufacturers of electrical parts. USTRANSCOM was able to expediently move both equipment and parts to ports for shipment to Puerto Rico. Army Sustainment deployed personnel under the Army's Logistics Civil Augmentation Program to receive, inventory, and distribute the vast array of parts to staging areas and finally to the line work crews actually repairing the grid.²⁰ "I will say that if it were not for our federal partners," recalled Mustafaa, "we would not have been successful. We would not have been able to execute our logistics mission in the expeditious manner in which we executed during this response. That is a fact."²¹

Although DLA managed a robust construction supply chain that incorporated electrical equipment suppliers, the vendors were challenged by the need for unique parts and the general lack of electrical replacement parts in power industry inventories around the country after multiple grid repair efforts that year. Industry partners, such as the Edison Electric Institute, thus also played a key role as a broker in obtaining parts from mainland manufacturers.²²

Similar to the difficulty in learning what lines actually needed to be repaired, it was hard to know which parts were needed, and how many, before the status of the grid was fully assessed. Yet the long lead-time required to obtain parts from manufacturers meant that some kind of order needed to be placed, along with a contract to fund it, as soon as possible. There was no time to wait for a complete list of needed parts for the entire grid. Even with industry experts advising, the power restoration logistics team needed to develop their own technical knowledge of a vast array of grid components, many of them unique to Puerto Rico's system, as rapidly as possible. For example, the "Puerto Rican Special," a unique type of electrical transmission cable used by PREPA and found only on the island, had to be manufactured from scratch on the mainland using old blueprints.²³ Another example was transformers. As Col. John Lloyd, commander of the task force, recalled, "I understand from industry that on the mainland, generally, there's only probably about five or six different size transformers. In Puerto Rico we were dealing with fifty or more different sizes, and different types of transformer requirements there as well."²⁴

Generating the First Bill of Materials

On October 6, 2017, before the leadership of Task Force Power had even arrived, the Corps' logistics team met with PREPA's supply chain chief, Ramón Caldas, and received the first list of more than a hundred items the utility thought it needed to make urgent repairs. "That Bill of Materials, he gave us what he thought the cost would be based on what they paid for material," explained Frank Ford. "It was estimated at being about \$150 million worth of material. I think it had like 135 lines on it."²⁵

At that point, South Atlantic Division had already concluded they did not have a contract in place that would allow them to procure the amount of electrical parts that would be needed in Puerto Rico, and the logistics team had already contacted the Defense Logistics Agency for acquisition support. Through their global connections with vendors and manufacturers in the construction community, DLA's Troop Support Branch had a supply chain and contract vehicles in place to meet the early needs for equipment in Puerto Rico. The Construction and Equipment Supply Chain at DLA became the main source of parts for the grid repair Bill of Materials.²⁶

On October 6, when Ford got that first long list of parts from Caldas, he knew it would take too long to order all of it at once. They would have to implement some kind of priority system. "So we sat down with Mr. Caldas at PREPA and said, what are your top priority items? The things you must have today," remembered Ford. "We grabbed a red highlighter and we marked off those items in red, and that became the infamous Red BOM. The Red Bill of Materials." Next he asked Caldas what he needed that was less of a priority and could wait possibly seven to ten days. Caldas identified those items, and Ford marked them with a yellow highlighter, creating a Yellow BOM. Ford recalled



A digger derrick drove off the Military Sealift Command's USNS *Brittin* in Ponce, Nov. 3, 2017. The Bob Hope-class roll-on/roll-off ship carried 300 mobile generators, 43 bucket trucks, 33 digger derricks, 1 UH-60 Black Hawk helicopter, and additional supplies on a four-day voyage to Ponce from the Naval Weapons Station at Joint Base Charleston, S.C. (FEMA photo by Steven L. Shepard, External Affairs)

that everything else on the list became the White BOM, “because I ran out of highlighters. White BOM was those things nice to have, didn’t have to have. Like PPE [personal protective equipment], chainsaws. Things we knew we would need, but didn’t have to have it immediately.”²⁷ That informal prioritization of the BOM into red, yellow, and white lists was critical to placement of the first large orders of parts.

With the power authority’s computer system down, the Corps logistics team was poring through filing cabinets with PREPA staff looking for paper records with technical specifications so as to make sure the right parts were going to be on that first critical order.²⁸ The team took a couple of days to find those specifications, while DLA was checking with vendors, and on October 8 DLA provided the vendors’ best prices and delivery times. Then PREPA engineers had to ensure that the order was technically acceptable. On October 10, the Corps approved DLA’s pricing and delivery times. On the 11th, the contract to order the first \$46 million of the total Bill of Materials, the Red BOM, was finally in place.²⁹

The first order for the highest-priority items, the Red BOM, aimed to get 50 percent of the materials PREPA initially thought it needed. Later orders would fill in the missing pieces once power industry experts and contractors on the ground had made more

accurate technical assessments of what was really needed.³⁰ But even ordering only half of what PREPA was likely to need to repair the grid was a huge commitment for the task force without knowing for sure what the damage was and what materials exactly would be required to repair it. “Right off the bat, even at that 50 percent level, we were looking at the material requirement being extensive,” said Colonel Lloyd. “We were talking at that time already about fifty thousand various poles just to replace the poles that we knew were either down, destroyed or damaged. And those included concrete, steel and wood poles.”³¹

The first equipment— three hundred mobile generators, forty-three bucket trucks, thirty-three digger derricks, and one UH-60 Black Hawk helicopter, as well as some actual replacement parts—started arriving November 3 on the first Maria-related roundtrip sailing of the USNS *Brittin* from Charleston, South Carolina. The *Brittin* was one of the U.S. Navy Military Sealift Command’s large roll-on, roll-off ships, and it would make several more “turns” over the coming months.³² Material for grid repair also started arriving by barge that same week from Jacksonville, Florida, but because so many parts needed to be manufactured, it took forty-five days for a substantial amount of the Red BOM to arrive on the island.

By early November, most Puerto Ricans had been without electricity for at least seven weeks, and significant power restoration efforts were only just beginning. In recognition of the grim situation, the Corps pushed for faster delivery times, even if that meant costs were higher. “We had to do some arm wrestling and some professional poking and jabbing with DLA to convince them that we could substantiate paying a higher price for faster delivery,” noted Ford. “And it took some time. It wasn’t easy. They have to protect their warrants and they have to do what’s right by the American people. But we think, and I still believe in my heart, that we made the right decision by saying time was more important than cost.”³³

Completing the Orders

Task Force Power placed two more orders from that first Bill of Materials, closing out the Yellow BOM in late October and the White BOM in early November. But that list was just the first estimate as to what parts, and how many, would be needed to fully repair the grid. The task force expanded and drastically revised the BOM as crews on the ground assessed in detail additional areas of the grid. Before the task force placed additional orders against the expanded BOM, its ongoing assessments of what parts were needed were first validated by PREPA engineers, followed by a board of power industry experts through the regional Incident Management Teams (IMTs) reporting to the Unified Command Group.³⁴ Then DLA worked with key vendors in its supply chains to produce best and final quotes for costs, and finally the task force contracted its order of parts with DLA.³⁵

In addition to being able to take advantage of DLA’s well-developed links with industrial suppliers, the Corps used DLA as its primary broker to acquire components for

two other reasons. The first was simply to have a single purchaser for all the contractors doing grid repair work on the island.³⁶ If both PREPA and the various contractors—the remaining Whitefish subcontractors, Cobra, PowerSecure, and Fluor—all started trying to purchase a million feet of cable, suppliers would likely respond to that demand with higher prices. From a private-sector, industry perspective, however, DLA was not the most efficient choice because of the numerous regulations they had to comply with as a federal agency.³⁷

DLA's purchasing speed may have been slow by industry standards, but the federal government has one additional advantage during emergencies. The second reason to rely on DLA was its ability to invoke the Defense Production Act. Congress enacted this legislation in 1950 at the start of the Korean War, and it gave the president broad authority to demand that manufacturers give priority to defense production and to requisition materials and property.³⁸ Since that time the act has become critical to a wider definition of "national defense," a term which now includes support to Department of Homeland Security programs for the protection and restoration of critical infrastructure.³⁹ In practice, the heads of certain federal agencies can invoke the Defense Production Act during national emergencies, and businesses then have to give preferential scheduling to "rated," or priority, contracts and orders placed by those agencies.⁴⁰

Despite its power on paper, the Defense Production Act did not actually expedite the manufacture or procurement of badly needed replacement parts for the grid in Puerto Rico. On October 8, DLA reported to Task Force Power that the best delivery times in industry could provide for some components were in the range of three to five months. Frank Ford remembered being completely shocked:

What I quickly learned was that even though we can invoke the Defense Production Act, that means squadoosh to industry. Why is that? I had it explained to me by Eric Silagy. He's the CEO of Florida Power & Light.... He says, "Frank, you think you're a big deal. You're buying \$250 million worth of stuff. You're buying \$50 million worth of poles. You're buying \$150 million worth of insulators and bolts and nuts and sundries and \$50 million worth of transformers and conductors.... Every year FPL buys \$100 million worth of poles. Every year.

Ford recalled Silagy finished by making the point that the government's huge repair project in Puerto Rico was still small compared to annual power industry purchasing: "I'm buying \$100 million in poles every year for the last twenty years and for the next twenty years. Who gets priority? You or me?"⁴¹

As mentioned, in late November, as Task Force Power, the Central IMT, and PREPA got a better sense of what damage had actually occurred to the grid, and what really would be needed to repair it, Frank Ford, Carlos Torres, and a unified materials team revised and expanded the BOM. The team worked through Thanksgiving Day to get its next set of



Employees of Power Precast Products, Corp., Rio Grande, Puerto Rico, poured cement into a mold to produce a utility pole, Jan. 11, 2018. Soon after Hurricane Maria passed through the island and damage assessments began, FEMA authorized a contract with Power Precast to manufacture 45-, 55-, and 65-foot-long cement utility poles and self-supporting bases for them. (USACE photo by Gerald Rogers)

orders correct and to make sure power crews arriving in Puerto Rico would have the parts they needed to rapidly scale up grid repair efforts across the island.⁴² “We’re ordering a lot in November and early December,” remembered Ford. “It’s becoming apparent we need more of this and more of that. All of a sudden in December, in January, we got a slug of requirements and we basically were back in October again.”⁴³ FEMA funding for repair parts increased from about \$155 million in late October to more than \$240 million by the end of 2017.⁴⁴

As the BOM expanded, it became clear that many of the parts needed to fill the next orders would have to be manufactured from scratch. In some cases, power industry leaders were able to appeal to their suppliers to put the needs of grid repair in Puerto Rico ahead of their own resupply.⁴⁵ This kind of intervention from the CEOs of large power companies was highly unusual, but it demonstrated a national, industrial commitment to respond to the longest blackout in U.S. history that went beyond ordinary mutual assistance.

Frank Ford gave an example of how Task Force Power came to depend on manufacturers producing new parts for the grid just in time. “In November we were putting insulators up Thanksgiving Day, [and] we had insulators that had been built on 12 November,” said Ford. “Think about that. Manufactured on 12 November, installed in Puerto Rico, after a five or six-day barge, on a pole on Thanksgiving Day. That’s how tight manufacture and supply was and probably still is.”⁴⁶

Some of the larger items took considerably longer to manufacture. “We didn’t know what magnitude that was until we began the process of trying to acquire materials,” said Corps power program director José Sánchez. “That’s when we realized this is going to take even longer. For example, a steel pole of let’s say one hundred feet in length can take twenty-one days from the moment you order it to the moment it comes out of the factory. Concrete poles have to be cured. So if you order concrete poles you have to have a time from the moment they’re actually constructed to the moment you can actually use them.”⁴⁷

Another challenge was shipping those items to Puerto Rico. Initially FEMA had a small contract with Jacksonville-based Crowley Maritime Corporation. That FEMA contract grew quickly as the need to bring relief supplies to Puerto Rico became so pressing, but by December the Corps’ orders of parts and equipment for grid repair had become large enough to exhaust the contract’s additional capacity.⁴⁸ For transportation, the logistics team depended on the contracts and arrangements managed and made by the Corps’ federal partners. The fact that the *Brittin* was making multiple return trips was one of those helpful early arrangements, but the Corps was not setting its schedule. “We had a strategic transportation network that we were using, and none of it belonged to us,” remembered Mustafaa. “None of the contracts belonged to us. None of the assets belonged to us. It was put together based on relationships and professional courtesies.”⁴⁹

In order to have more control over the scheduling of shipments, more barge space, and more responsiveness, Task Force Power reached out to USTRANSCOM in early December. Parts had started to arrive, but not nearly fast enough or in enough quantity to fully meet the capacity of contracted and mutual assistance line workers. The Corps did not hire its own barge, but through USTRANSCOM the logistics team was able to establish a contract for dedicated delivery service for critical items.⁵⁰

Accelerating the Mission

It took about a month to put the transportation arrangements in place, and by the second week of January, the Corps’ ability to expedite electrical components to Puerto Rico greatly increased. Starting January 13, Task Force Power was able to distribute more than two hundred thousand parts to crews repairing the grid across the island; this was double the number of items that had been acquired since the mission began.⁵¹ The long-awaited increase in available material then had to be matched by a greater labor capacity in order for the repair mission to accelerate. The Corps’ two primary contractors brought in one thousand more workers in January. That same month an additional fifteen hundred repair workers and support personnel from across the American electric power industry arrived in Puerto Rico through the mutual assistance program. Barges hired by power companies to carry their vehicles and equipment had been arriving in several waves in Ponce since the end of December.⁵²



Newly manufactured poles at the Task Force Power Restoration laydown yard at the Port of Ponce, Feb. 4, 2018. (USACE photo by Robert DeDeaux)

The results of the mid-January acceleration were significant. From January 12 to 27, the number of power poles that had arrived in Puerto Rico nearly doubled from 13,070 to 25,770. The length of conductor wire received similarly increased from 1,128 to 2,102 miles. The number of transformers increased by a factor of four, from 449 to 1,994, and there were almost eight times as many insulators, with an increase from 8,000 to 62,895. Most of the totals for parts actually on site represented more than half of the amount that had been ordered up to that point.⁵³

This leap forward in the execution of the Bill of Materials for the power mission would not have been possible without logistics personnel embedded with the task force at every level—from the district office in San Juan to the largest materials warehouse at the Port of Ponce to area offices and staging areas across Puerto Rico. DLA also deployed experienced liaison officers to work with Task Force Power directly in order to expedite the purchasing process.⁵⁴ In addition to these experts in DLA's supply chains and capabilities, much of the BOM Squad's work was carried out by a rotating team of around thirty National Guard soldiers and Army Reservists. These soldiers, and others who led daily operations, became known as the "battle desk" at the Task Force. "We had active duty soldiers that came from



Logistics team with Task Force Power commander Col. Jason Kirk (third from right) at the Port of Ponce, Feb. 17, 2018. (Photo courtesy of Jason Kirk)

our districts,” said Michael Ornella, Deputy District Engineer of Task Force Power. “They were usually captains, some of them lieutenants.... We had some reservists that were called up from a whole bunch of different places that were there and working alongside the civilian work force. And we had guardsmen. We had guardsmen from Florida, from Washington, D.C., from Indiana, from Louisiana. Every one of these people were absolutely phenomenal at what they did.”⁵⁵

Frank Ford expanded on this Corps-wide appreciation for the dedication of so many committed public servants, volunteers, and citizen-soldiers. “We had Title 32 [National Guard], we had Title 10 Reservists, we had active duty, we had Army, U.S. Army Corps of Engineers, we had DLA, we had industry experts, we had federal DOE experts,” said Ford. “That was the team built. An unbelievable team. Unbelievable effort, working eighteen hours a day, seven days a week, every day. Just knocking it out. I can’t say enough about what they did.”⁵⁶

Notes

¹ U.S. Government Accountability Office, “Federal Support for Electricity Grid Restoration in the U.S. Virgin Islands and Puerto Rico,” Report GAO 19-296, April 2019, 18-19, <https://www.gao.gov/products/GAO-19-296>.

² Robert Grathwol, “Task Force RIE Draft History” (unpublished manuscript, October 2007), 87, 101, Microsoft Word file, Operation Iraqi Freedom Collection, Office of History, HQU SACE, Alexandria, Virginia [Hereafter cited as CEHO].

³ Interview, Maj. Gen. Donald E. Jackson, Jr., Deputy Commanding General for Civil and Emergency Operations, HQUSACE, by Jonah Bea-Taylor and James Garber, HQUSACE, Washington, DC, December 20, 2017, 81, Oral History Collection, CEHO.

⁴ Interview, Rhonda Mustafaa, Chief of Plans and Operations, Directorate of Logistics, HQUSACE, and Franklin Ford, Officer in Charge, Task Force Power, Materials Section, by Jonah Bea-Taylor and Lt. Col. David McGuire, HQUSACE, Washington, DC, July 12, 2018, 53, CEHO.

⁵ Task Force Puerto Rico Recovery, “Puerto Rico Hurricane Response: One Year Later,” Infographic, Emergency Operations Collection, CEHO. The BOM mission was estimated to be completed at the end of April 2019, but on January 24, FEMA directed the Corps to stop procuring parts for the BOM, and the purchasing authority was transferred to PREPA. Because of long manufacturing lead times, and continued repairs to the grid, the Corps would continue to receive shipments from earlier orders and transfer them to PREPA even after all eligible customers were reconnected. The Corps stopped procuring parts for PREPA by the end of January 2019 and the last shipment arrived in April that year. After that time, PREPA was entirely responsible for its own procurement, although questions about how the grid should be rebuilt and funded in the long run remained. See USACE Operations Center (UOC) Staff, “U.S. Army Corps of Engineers Operational Update,” HQUSACE, February 6, 2019, 13, Emergency Operations Collection, CEHO.

⁶ Interview, Capt. Brian Molloy, Operations Officer, Task Force Power Restoration, by Jonah Bea-Taylor, by phone, May 14, 2018, CEHO.

⁷ Interview, Col. John P. Lloyd, Commander, Task Force Power Restoration, by Jonah Bea-Taylor and James Garber, by phone, June 8, 2018, 19, CEHO.

⁸ Interview, Rhonda Mustafaa and Franklin Ford (2018), 5.

⁹ Interview, Rhonda Mustafaa and Franklin Ford (2018), 22; Some of the gaps in PREPA’s inventory system would become particularly controversial. The power authority inaccurately believed most of their spare parts were used making repairs to the grid after Irma. PREPA later discovered at least one large cache of parts in a warehouse in San Juan that they had not disclosed to the Corps. PREPA officials blamed communication issues after FEMA seized the parts for the grid repair mission in January 2018. See Adrian Florido and Marisa Peñaloza, “Puerto Rico Governor Asks DOJ to Investigate Island’s Public Power Utility,” *News*, NPR, January 11, 2018, <https://www.npr.org/2018/01/11/577439244/puerto-rico-governor-asks-doj-to-investigate-island-s-public-power-utility>.

¹⁰ Jim Wyss, “Puerto Rico assessing Hurricane Irma damage amid widespread power outage,” *Miami Herald*, September 8, 2017, <https://www.miamiherald.com/news/weather/hurricane/article172023172.html>.

¹¹ Gerald Rogers, “BOM Squad scours two continents to acquire critical power grid materials for Puerto Rico recovery,” *News*, U.S. Army, January

13, 2018, https://www.army.mil/article/199079/bom_squad_scours_two_continents_to_acquire_critical_power_grid_materials_for_puerto_rico_recovery.

¹² Interview, Rhonda Mustafaa and Franklin Ford (2018), 44.

¹³ Interview, Rhonda Mustafaa and Franklin Ford (2018), 14; Chairman of the Joint Chiefs of Staff, *Joint Logistics*, Joint Publication 4-0, October 16, 2013, I-1. According to *Joint Logistics* doctrine, “Sustainment is the provision of logistics and personnel services necessary to maintain and prolong operations until mission accomplishment and redeployment of the force. Joint logistics supports sustained readiness for joint forces.” The JCS updated and changed the October 2013 version in 2019 and it is no longer available online. The May 8, 2019, version is available at https://www.jcs.mil/Portals/36/Documents/Doctrine/pubs/jp4_0ch1.pdf?ver=2019-05-10120259-860.

¹⁴ Ronald E. Richards, “Puerto Rico Lessons Learned,” Section: SAD (FWD) G-4 (Logistics), After Action Report, July 2018, Emergency Operations Collection, CEHO.

¹⁵ Interview, Rhonda Mustafaa and Franklin Ford (2018), 9.

¹⁶ Interview, Rhonda Mustafaa and Franklin Ford (2018), 7.

¹⁷ Interview, Rhonda Mustafaa and Franklin Ford (2018), 6; “2017 Hurricane Season: FEMA After-Action Report,” Federal Emergency Management Agency (FEMA), July 12, 2018, vi-vii, <https://www.fema.gov/media-library/assets/documents/167249>.

¹⁸ Kevin Lui, “FEMA Chief Slammed for Calling Puerto Rico Relief Efforts the ‘Most Logistically Challenging Event,’” *Time*, October 2, 2017, <http://time.com/4964574/hurricane-maria-fema-brock-long-puerto-rico-logistics/>.

¹⁹ Interview, Maj. Gen. Donald E. Jackson, Jr. (2017), 45-46.

²⁰ “Concept of Logistics Support,” LOG Draft Plan v2, October 8, 2017, Emergency Operations Collection, CEHO, 1-9; Jon Micheal Connor, “LOGCAP supports Puerto Rican relief efforts with ongoing help,” *News*, U.S. Army, March 28, 2018, https://www.army.mil/article/202845/logcap_supports_puerto_rican_relief_efforts_with_ongoing_help; “LOGCAP Builds Base Camps in Puerto Rico after Hurricane,” Inside DI, DynCorp International, December 20, 2017, <http://www.di-atworknow.com/announcements/di-puerto-rico>. In early October 2017, DynCorp International, the LOGCAP contractor, initially supported U.S. Northern Command and FEMA by building two basecamps for 1,000 soldiers and FEMA first responders at Aguadilla Airfield and on the grounds of the former Naval Air Station at Roosevelt Roads. As the initial response shifted to recovery, and Army and National Guard units rotated home, DynCorp continued providing a number of logistical support services to Task Force Power. The management (by LOGCAP personnel and contractors) of the inventory of parts at the bill of materials laydown yard and warehouse in Ponce was critical to the grid restoration mission.

²¹ Interview, Rhonda Mustafaa and Franklin Ford (2018), 6.

²² Interview, Rhonda Mustafaa and Franklin Ford (2018), 9.

- ²³ Interview, Rhonda Mustafaa and Franklin Ford (2018), 11; Interview, José Sánchez, South Atlantic Division (SAD) Power Program Director, by James Garber and Jonah Bea-Taylor, HQUSACE, Washington, DC, Part 2, April 16, 2018, 13-14, CEHO. "Puerto Rican Special" is unique to high voltage transmission because of its mostly all-aluminum construction. This design reduces the overall weight on the transmission line structure and allows maximum current to run through the aluminum conductor.
- ²⁴ Interview, Col. John Lloyd (2018), 27.
- ²⁵ Interview, Rhonda Mustafaa and Franklin Ford (2018), 22-23. The estimate for the total cost to procure and transport that first bill of materials quickly increased to \$250 million, and FEMA responded right away by increasing the funding for the mission assignment accordingly. By June 2018, more than \$323 million would be allocated by USACE for the BOM.
- ²⁶ Jason Kaneshiro, "Puerto Rico power grid re-energizes with DLA-provided materials," DLA Troop Support Public Affairs, Defense Logistics Agency, May 18, 2018, <http://www.dla.mil/AboutDLA/News/NewsArticleView/Article/1525421/puerto-rico-power-grid-re-energizes-with-dla-provided-materials/>.
- ²⁷ Interview, Rhonda Mustafaa and Franklin Ford (2018), 24-25.
- ²⁸ Interview, Rhonda Mustafaa and Franklin Ford (2018), 26.
- ²⁹ Katherine Chambers, "Task Force Power Decision Log," Milestones Spreadsheet, December 27, 2017, Emergency Operations Collection, CEHO.
- ³⁰ Interview, Rhonda Mustafaa and Franklin Ford (2018), 49.
- ³¹ Interview, Col. John Lloyd (2018), 10.
- ³² S. Sgt. Teresa J. Cleveland, "JBLE unit partners with FEMA in Puerto Rico humanitarian mission," News, U.S. Army, November 7, 2017, <https://www.army.mil/article/196543>.
- ³³ Interview, Rhonda Mustafaa and Franklin Ford (2018), 28.
- ³⁴ Interview, Rhonda Mustafaa and Franklin Ford (2018), 18.
- ³⁵ Rogers, "BOM Squad." Although DLA fulfilled the vast majority of the early orders for the BOM, TF Power also had two other options for acquiring parts. First, TF Power could work with the Edison Electric Institute to check on the availability of components in power industry inventories. Second, TF Power could use its own Blanket Purchasing Agreement.
- ³⁶ Interview, Rhonda Mustafaa and Franklin Ford (2018), 29.
- ³⁷ Interview, Carlos Torres, Power Restoration Coordinator, Commonwealth of Puerto Rico, by Jonah Bea-Taylor, by phone, August 1, 2019, 25-26, CEHO.
- ³⁸ Jared T. Brown and Daniel H. Else, "The Defense Production Act of 1950: History, Authorities, and Reauthorization," Congressional Research Service, Report R43118, July 28, 2014, 3, <https://digital.library.unt.edu/ark:/67531/metadc462762/>.
- ³⁹ "Defense Production Act Authorities," Office of Program and Policy Analysis, FEMA, Last Updated August 13, 2018, <https://www.fema.gov/defense-production-act-overview>.
- ⁴⁰ "Procedures for Placing a Priority-Rated Contract or Order," Office of Program and Policy Analysis, FEMA, Last Updated August 13, 2018, <https://www.fema.gov/procedures-placing-priority-rated-contract-or-order>.
- ⁴¹ Interview, Rhonda Mustafaa and Franklin Ford (2018), 32.
- ⁴² Interview, Carlos Torres (2019), 17-19.
- ⁴³ Interview, Rhonda Mustafaa and Franklin Ford (2018), 57.
- ⁴⁴ Task Force Power, "Mission Operational Assessment Brief," BOM Programmatic Costs Over Time, March 13, 2018, 31, Emergency Operations Collection, CEHO. A little more than half (\$138 million) of the \$240 million in obligations by mid-March 2018 had been for about 44,000 poles of different types, and 93% of the value of the orders (\$223 million) had been executed by DLA.
- ⁴⁵ Interview, Rhonda Mustafaa and Franklin Ford (2018), 77.
- ⁴⁶ Interview, Rhonda Mustafaa and Franklin Ford (2018), 76.
- ⁴⁷ Interview, José Sánchez, Part 2 (2018), 13-14.
- ⁴⁸ Interview, Rhonda Mustafaa and Franklin Ford (2018), 14.
- ⁴⁹ Interview, Rhonda Mustafaa and Franklin Ford (2018), 58.
- ⁵⁰ Interview, Rhonda Mustafaa and Franklin Ford (2018), 65.
- ⁵¹ "USACE & PREPA launch mass distribution of materials to contractors," News Release 18-011, USACE South Atlantic Division, January 14, 2018, <http://www.sad.usace.army.mil/Media/News-Releases/Article/1415513/usace-prepa-launch-mass-distribution-of-materials-to-contractors/>.
- ⁵² Interview, Carlos Torres (2019), 23-25.
- ⁵³ TF Power Restoration, "Daily Log SITREP: Pacing Item Slant," January 12 and 27, 2018, 4, Emergency Operations Collection, CEHO.
- ⁵⁴ Kaneshiro, "Puerto Rico power grid re-energizes with DLA-provided materials."
- ⁵⁵ Interview, Michael Ornella, Sr., Deputy District Engineer, Task Force Power Restoration, by Jonah Bea-Taylor, by phone, June 27, 2018, 37, CEHO.
- ⁵⁶ Interview, Rhonda Mustafaa and Franklin Ford (2018), 84.

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Col. Jason Kirk visited contractors working on a distribution line near the Municipality of Ciales, Apr. 15, 2018. Because of the rugged terrain, helicopters were used to support the lineworkers. Helicopters transported equipment, material, and even the workers themselves in some cases. (USACE photo by Dave Palmer)

— CHAPTER 6 —

**THE COMMITTED RESPONSE
TO THE LONGEST BLACKOUT,
JANUARY–MAY 2018**

By early January 2018 Task Force Power was fully executing the power restoration program for the Unified Command Group and had entered a “glide path of restoration.”¹ The monitoring system of the Puerto Rico Electric Power Authority (PREPA) was still not quite repaired to the point where it could precisely assess how many customers remained without power, but electrical usage levels were routinely reaching greater than half of the pre-storm average.² As the Unified Command Group executed the power restoration master plan, circuit by circuit, they could make more accurate assessments of how many customers had their power restored by estimating how many were connected through each energized distribution circuit.³

Reliability remained an issue. Even with the three large generators in place at key power plants to help change supply to match changes in demand, surges and temporary outages continued. “That’s kind of what the progress was like,” remembered Task Force Power project manager Marc Glowczewski. “You’d see lights turn on and then lights would go off. At one point in time I think they restored power to the central grid, so the lights in parts of San Juan kind of were stabilized. But then there was a surge or something and then it was dark for a day and a half. Holy cow. It was kind of whiplash.”⁴

The urgency remained, but the lights were slowly coming back on all over the island. The restoration was only possible with the logistics organization in place, the components to repair the grid arriving by barge, and enough vehicles available to support the crews. “It’s really a matching of resources. That means people, equipment, and materials,” explained power program director José Sánchez. “So when all those three factors come together we



Neighbors celebrated outside the home of Mara Aleres Gomez in the Maleza Baja neighborhood of Aguadilla as a porch light illuminated, indicating power was restored to the residence, Nov. 14, 2017. Gomez's home was the last of approximately 320 residences in that area to receive power, as electrical repair crews stayed after hours to repair a breaker that had stymied the effort. Scenes like this were repeated across the island over the next several months. (USACE photo by Steven Shepard)

knew we were going to have an accelerated repair rate.... [There] was a lot of push for additional personnel on the ground, but in reality we needed to be cautious on that approach because we could have just people sitting and waiting for materials and it would not be a good use of the taxpayer dollars.”⁵

Still, as PREPA and the Incident Management Teams (IMTs) continued to assess the extent of damage to local distribution systems into January, region by region and municipality by municipality, there were gaps in the coordination of personnel, equipment, and supplies. “Even late into the mission we were getting requirements,” recalled Task Force Power Commander Col. John Lloyd. “One day they came and said ‘hey, we need about four thousand transformers.’ Well, there were no transformers of the size we needed on the island. We reached out to manufacturers. There were long lead times in some cases to get the transformers.”⁶ Frank Ford remembered that it never felt like the mission truly reached a steady state, in terms of having just the right amount of parts for the crews that were available to fix the wires. There were always metaphorical fires to put out in attempting to match up the workers with the materials they needed in the area where they were restoring power. “Every day you came into work and you put your fireman’s hat on and you just, you buckled up and you got ready. It just happened. That’s just the way it was,” said Ford.⁷



A large supply of transformers stored at the laydown yard in Ponce, Puerto Rico, May 22, 2018. The transformers, a critical component of the grid restoration mission, were in high demand early on in the mission to “turn the lights on” in Puerto Rico. USACE logisticians continued supporting Hurricane Maria recovery efforts by maintaining supply chains at the port. (USACE photo by Patrick N. Moes)

South Atlantic Division Commander Brig. Gen. Diana Holland returned to the division’s headquarters in Atlanta on January 3, 2018. Command of the forward element in Puerto Rico passed to her division forward deputy, Col. Donovan Ollar, deputy commander of the Southwestern Division, until February. By that time the Mobile, Wilmington, and Jacksonville Districts had taken over the coordinating functions that General Holland had been leading at a division level. Holland’s redeployment to Atlanta was a recognition that the immediate crisis had stabilized and the mission was entering a steady state of extended recovery, one that could be run consistently at the district level. For Holland the move represented a return to the normal process and a recognition that the power restoration mission, while still urgent, was now “a program that needed to be managed in the way that the Corps does that in other places, not a crisis action that has to be tracked and watched every hour.”⁸

Colonel Lloyd remained in charge of Task Force Power for another month. The commander of Jacksonville District, Col. Jason Kirk, had been leading the Corps’ response to Hurricane Irma in Florida, but as that situation stabilized, he was able to prepare for an expanded role for the Jacksonville District in recovery operations in Puerto Rico. Kirk had been district engineer in Jacksonville since July 2015 and had led the district’s response to Hurricane Matthew in 2016. Previously he had been district engineer in Charleston.



With an insulator standing in for the unit colors traditionally used for a military change-of-command, Col. John Lloyd (left) handed off the top leadership role with Task Force Power in Puerto Rico to Col. Jason Kirk (right), Feb. 1, 2018. (Task Force Power Restoration, Public Affairs)

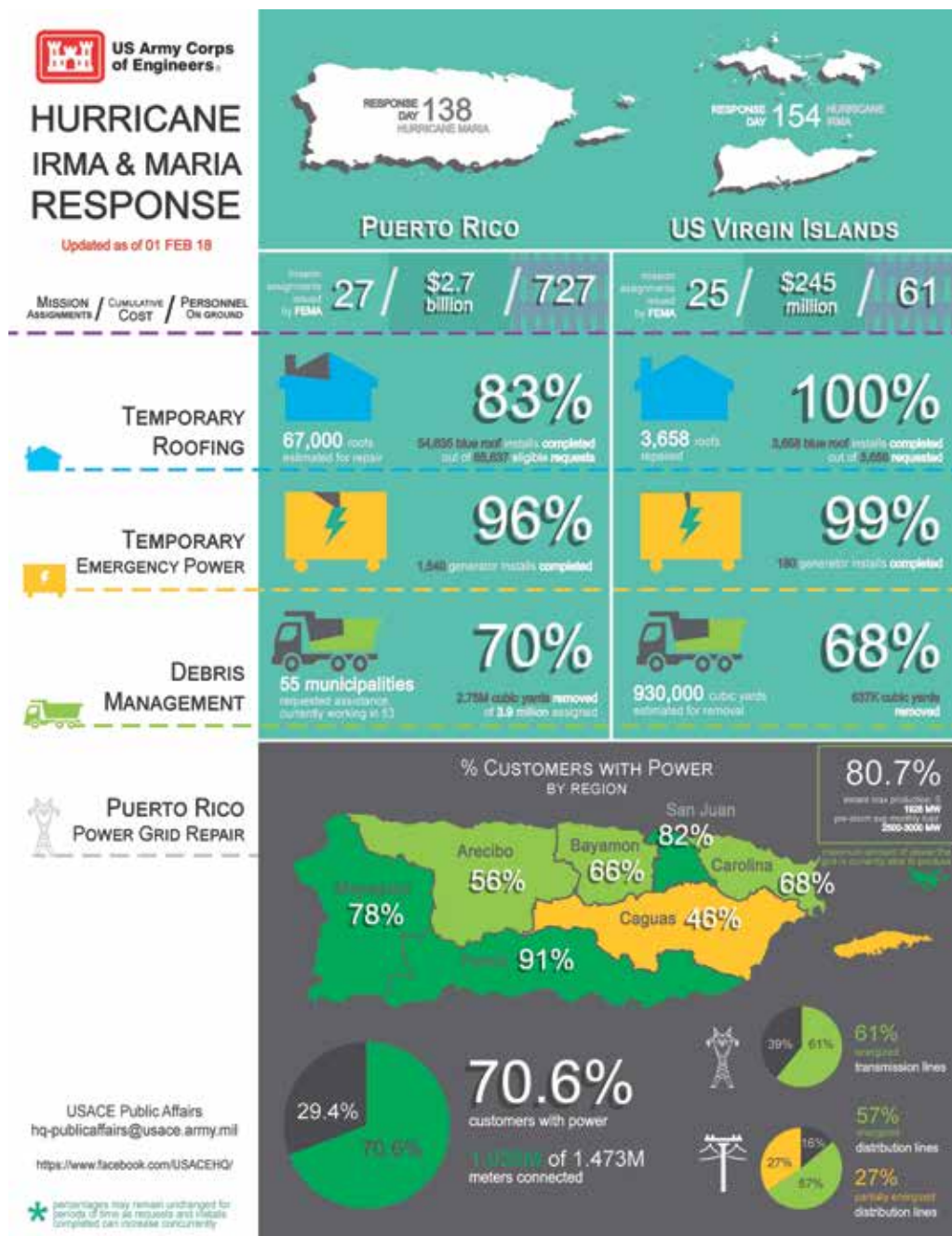
Both the Virgin Islands and Puerto Rico lie within the Jacksonville District's area of responsibility, and all the Corps' work on the islands would eventually transition back to Jacksonville's management. "We worked really hard to see, on the timeline, when can we transition this back to Colonel Kirk and Jacksonville so that they can rebuild their relationships on the island that they had had before the storm," remembered Holland. "We wanted them to be in the driver's seat of the Corps effort, closing this thing out so that they could go back to their normal relationship with Puerto Rico."⁹

On February 1, Colonel Lloyd passed command of Task Force Power to Colonel Kirk at a ceremony at the task force's district offices in San Juan.¹⁰ Instead of the usual passing of the command flag, the task force created a variation on military tradition by passing a six-foot-long insulator to represent the continuity of leadership in the daily effort to restore power, part by part, line by line, home by home. Kirk would see the Corps' work on the lines through to May 18, 2018, with nearly 99 percent of customers' power restored. At that time, the task force transitioned the remaining work to PREPA.¹¹

"Finish Strong" was the key message from the chief of engineers to Corps personnel who were volunteering to rotate into Puerto Rico to help with grid restoration. "As General Semonite has told us on a number of occasions," explained Michael Ornella, the deputy district engineer of Task Force Power, "the first person to get power is not

Fig. 6.1. USACE Hurricane Response Infographic

Status of the Corps' complex response to Hurricanes Irma and Maria in the Caribbean, Feb. 1, 2018, when Col. Jason Kirk took command of Task Force Power in Puerto Rico. (CEHO, Emergency Operations Collection)



any more important than the last person to get power, and so his statements of finishing strong, and making sure that we get to that last person who needed power, really resonated heavily within our force.”¹² Ornella deployed to Puerto Rico in mid-February 2018 when 72 percent of PREPA’s pre-storm customers had been reconnected. He would stay on past the end of the Corps’ grid restoration mission, into June, when PREPA was still trying to reconnect the last 1 percent.

Restoring Power to All Regions of the Island

Task Force Power’s original plan to restore electricity to the entire island over a five- to six-month period had been divided into three distinct phases. Much of the work on these phases, however, was carried out concurrently. For example, even as the phase one work continued around San Juan and Mayagüez, Task Force Power began expanding into five other power “regions” so as to restore power to other major population centers on the island. The goal for phase two was to have 95 percent of pre-storm customers back online in each of the seven regions. The regions had initially been designated by PREPA, and their prioritization reflected FEMA’s assessment of key population centers and industrial areas and the Unified Command Group’s assessment of how extensive damage was in each region.¹³ Phase two began in late October 2017 and continued until the Corps’ work on the power grid ended on May 18, 2018.¹⁴ “So these were benchmarks and milestones that I think help paint the picture of when things would be done,” explained Michael Ornella. “It was not particularly good news to the public to say that certain areas of Puerto Rico would not be fully energized for a couple of months, but it depicted the reality of what resources were available and with the pace that the work could be performed at.”¹⁵

Just getting half of the average pre-storm load back on Puerto Rico’s grid had been one of the criteria for completing phase one. Fifty percent was a handy, but superficial, indicator in the absence of more precise data, and PREPA first reported that amount of load to the Department of Energy around November 16.¹⁶ By that time, FEMA had increased funding for the grid repair mission to \$1 billion, and there were 176 Corps employees deployed to the island working directly in support of Task Force Power.¹⁷ The power authority did not have the system-monitoring data to confirm exactly how many customers were actually getting power until late December. On December 29, 2018, the power authority announced that about 55 percent of the homes on the island that were in condition to receive electricity actually had their lights back on.¹⁸

As the mission moved beyond the capital region, it became more important to update and coordinate with the mayors of the island’s seventy-eight municipalities, since they were in direct contact with people in their communities. Without power, many of the rural areas did not have good access to television broadcast or online media, and they relied on radio and word-of-mouth communication. “People are obviously passionate when you’ve been without



Sitting from left to right: FEMA Power Sector Chief Dr. Ahsha Tribble, Puerto Rico Power Restoration Coordinator Carlos Torres, and Task Force Power Commander Col. John Lloyd met with Cayey Mayor Rolando Ortiz, Dec. 19, 2017, to discuss concerns and ways to improve communications and processes to restore power for the people of Puerto Rico. Mayor Ortiz had received input from multiple mayors throughout the island and offers of expertise and personnel from local officials. (USACE photo by San Luciano Vera)

power for a long period of time,” said Colonel Lloyd, “but as far as the support the Corps received, it was always very positive. From the mayors, from local officials, in any meeting that I ever went to, what they really just wanted was, ‘Hey, tell us what the plan is. Tell us what you think the timeline’s going to be. What are you thinking? How can we help?’”¹⁹

As the months went on, and the country’s longest blackout continued in many parts of the island, mayors began organizing local citizens in volunteer brigades to repair distribution lines and get their communities reconnected to the grid. Sometimes they even worked with retired PREPA employees who lived in the municipality.²⁰ “The mayors started to be very forward-thinking, trying to protect their own power contractors to restore lines and poles in their own boundaries,” explained José Sánchez. “Well, that was a challenge because we needed everything to be coordinated, so we needed to put the brakes on that and utilize it, but after coordination.”²¹

In early March, Governor Ricardo Rosselló invited Colonel Kirk and interim PREPA director Justo González to address a meeting of the island’s mayors about the status of the grid restoration program. “So we had forty-plus of the seventy-eight mayors from across the island came to hear an update,” remembered Kirk. “And during that meeting we provided



Task Force Power Restoration major deployment nodes and personnel locations, Oct. 25, 2017. (CEHO, Emergency Operations Collection)

custom-made maps for every single one of the *municipios* [municipalities], the seventy-eight of them, to help them understand the current status and the schedule for restoration moving forward. That was appreciated, and over time we used that tool—and needed to use that tool—to update them so that they could then in turn update their citizens.”²²

By the end of March, five of the seven regions had more than 95 percent of pre-storm customers restored.²³ Arecibo, on the northwest coast of the island near where Hurricane Maria had exited, was close to making the goal with 94 percent restored. The mountainous Caguas region, which had been severely impacted by the full force of the storm, lagged behind significantly, with only 78.5 percent power restoration. There the Corps continued to focus its contractors’ efforts on repairing the 38-kV sub-transmission system. Nevertheless, all major population centers had been energized, and the Unified Command began relocating resources to the hardest hit locations within the interior of the island. In this effort, FEMA, the Corps, and PREPA focused their efforts on a daily basis to coordinate the available repair teams based on their capabilities, special tools, and their capacity to complete the work so as to provide power to the largest number of customers.²⁴

How the Work was Organized in the Field

Following much the same model as a Corps district building civil works projects over a wide area on the mainland, Task Force Power developed a robust organization to restore power in different regions of the island. In October 2017, in the early days of the mission, the task force opened three field offices: first in the capital, San Juan; then in what it called the Western Area in Aguadilla on the northwest corner of the island; and finally for the Eastern Area at Ceiba on the far eastern coast. Different divisions within the Corps took responsibility for staffing these area offices which usually had around twenty-five personnel.²⁵ With a full spectrum of engineering staff, quality assurance (QA) personnel, and administrative staff to provide support to contractors in the field, these offices were integral



Carlos Torres, Power Restoration Coordinator (left), and Col. Jason Kirk, Commander, Task Force Power Restoration (center), spoke with Mayor Ernesto Irizarry Salvá (right) of Utuado, Puerto Rico, Apr. 24, 2018. The mayor spoke of his community's needs and his concerns with the coming hurricane season. (USACE photo by Dave Palmer)

to achieving the phase one goals of initially restoring power to metro San Juan and the western area of the island, centered on the municipality of Mayagüez.²⁶

As the Corps' restoration efforts evolved in phase two, the task force opened several other area offices, including those at Ponce and Arecibo, to accelerate repair work in different regions of the island. Area offices were better able to focus on the local repair issues in each region, and they also helped coordinate with regional PREPA administrators and mayors of local municipalities. "They're the ones that really know where the damage is or where the lines that most are needed for restoration are," explained Marc Glowczewski. "You can talk with them or coordinate with them and make a lot of good progress really fast."²⁷ Local officials also helped the Corps identify and repair critical facilities that could support the surrounding communities.

"It also became a problem because we had to start moving resources around," remembered Ornella. "So with one of our contractors who established these fairly sizeable base camps, moving a base camp was a real challenge. Trailers for their workers to work in, tents to feed them, cook food and feed them, as well as all the rest of the logistical support that they needed. So that was probably the biggest thing for the Corps of Engineers is getting our people where we needed them to finish up their remaining work."²⁸



William Schadle, a quality assurance manager from North Atlantic Division assigned to Task Force Power, ensured proper installation of a transformer in one of the many neighborhoods in Carolina Municipality, Jan. 22, 2018. The transformer facilitated the provision of electricity to at least 11 homes in this small community. (USACE photo by Robert DeDeaux)

Working directly on their assigned transmission lines, or on a local distribution network, contractors had their own quality control staff, and Corps QA specialists worked with them to confirm that work was actually moving ahead in each contractor's geographic area.²⁹ Almost all of the QA specialists were volunteers, and few had practical experience in electrical infrastructure because grid repair was such an unusual kind of mission. "It wasn't an in-depth kind of quality assurance that we would say when we build a barracks or we build a civil works project, a pump station or a dam or something like that," explained Ornella. "It was mostly just making sure that people were working safely, that the numbers of people that were working were accounted for, the amount of material that was being used was accounted for, and things like that."³⁰

Because so many QA volunteers were coming in with no prior electrical experience, Task Force Power worked with Department of Energy subject matter experts to develop a training course.³¹ The course explained the basic process of how electric service is provided—from generation to delivery. The course gave volunteers a basic understanding of the configurations for transmission towers, sub-transmission lines, and distribution lines—even the wide variety of power poles used in different parts of the island. That formal course was followed by on-the-job training with more experienced QAs in the field.

The range of QA volunteers, from all thirty-eight of the Corps' civil works districts, reflected the agency's enterprise-wide commitment to seeing the power restoration work succeed. "We had people from most of our division offices; many from our labs and centers. It was pretty neat," remembered Ornella. "On some of the more unique ones, we had a dredge cook come to be a QA out of the Philadelphia District, I think she was, and she wanted to contribute and she came down and did this. We had program managers out of division offices that came down to be QAs. So a wide range of skill sets, a wide range of grade levels, that were part of this whole effort."³²

The quality assurance activities were part of keeping some accountability in place for the massive island-wide grid repair effort. Meanwhile, decisions about which sections of specific lines were actually repaired was managed on multiple levels on a day-to-day basis. Supervisors for the power contractors reported to the Contracting Officer's Representative (COR), who represented the Corps district that had developed the contract for power restoration that was being carried out in that area. The COR, in turn, reported to the resident engineer who was in charge of the area office. Glowczewski explained:

Coordinating with the contractor was very interesting for several reasons. One is that the contracts weren't let by Pittsburgh District and so...some of the districts that had awarded those contracts sent forward CORs to deal with those contracts. So really they were the only ones that were able to direct the contractor in some instances. So we had these area offices that were set up and they would have a lead engineer, and the lead engineer would try and have coordination meetings with the contractor with the COR present, and so that created some issues if the COR was across the island or ten miles away and you were having a meeting.³³

In addition, the resident engineer often had to act as a liaison to PREPA to coordinate with their personnel and contractors undertaking operations in the local area.

Throughout this entire operation, of course, the Corps worked in support of PREPA, its primary customer. Regional PREPA managers prioritized the areas chosen for repairs to the distribution system while PREPA's central office in San Juan decided how to prioritize work on the long-distance transmission system and coordinated with the task force's project management office senior engineers and program managers under the command of Colonel Lloyd and later Colonel Kirk. Coordination was crucial in a rehabilitation effort involving multiple actors. Across the entire transmission and distribution system, the Corps and its contractors would accomplish around 40 percent of the restoration work, and the Corps was often responsible for making repairs in some of the toughest terrain on the island.³⁴ PREPA and its contractor, Cobra, completed another 40 percent, and the mainland utility companies providing mutual aid finished about 20 percent.³⁵ Ultimately,

Microgrids

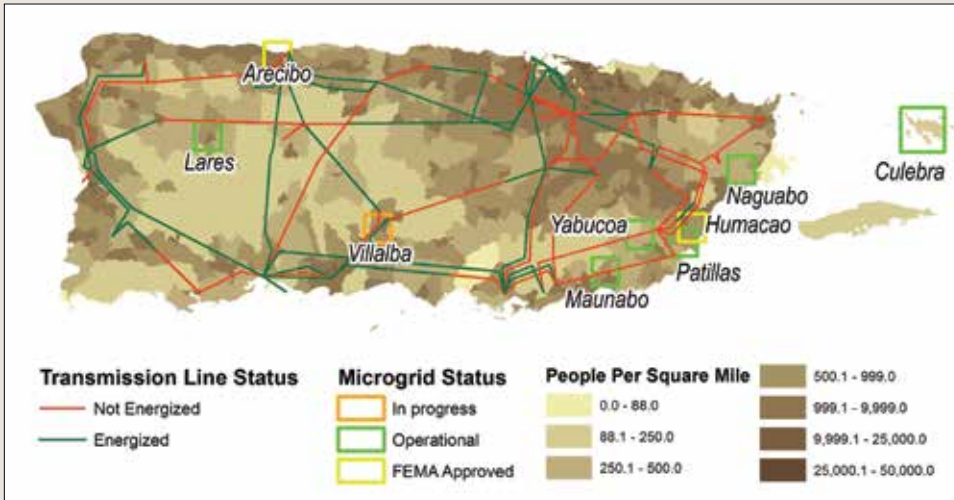
By December 2017, hundreds of generators were providing power to individual critical facilities across Puerto Rico, but many isolated communities had no generators to provide power to homes for months. In order to bring temporary power to some of these population centers, those that were likely to have to wait a long time to see their primary grid service restored, the Corps used an approach that a DoD-sponsored joint research team first developed in 2008 to help military facilities sustain operations during prolonged power outages: microgrids.^a Although originally envisioned as part of a system of smart, renewable, and efficient energy technologies at military bases, the microgrids installed in Puerto Rico were much simpler: they consisted of one to three tractor-trailer-sized diesel generators and a transformer connected to a local substation or equivalent infrastructure to energize the surrounding distribution system.

For the Corps, using microgrids during a disaster response was a historic first and a huge success. The commander of Task Force Power, Col. John Lloyd, praised the program. He remembered: “We got started in the microgrid game later than what I would have wanted to. If I was going to do it all over again, we would have done that analysis right away and installed those microgrids.... We were able to communicate with a lot of local leaders that, ‘we know it’s going to take a while to get the grid up, but we’ve got a solution here by putting in a microgrid, and how can you help us? We need a location to put this, and we need some help coordinating,’ and I think it was a huge success, that coordination.”^b

In total the Corps installed nine microgrids, each generating around 1.8 MW of electricity, and each powering between

four hundred and thirty-nine hundred Puerto Rico Electric Power Authority (PREPA) customers. Some microgrids operated for only about a month; others were slated to last for years. During their lifetime, the microgrids served between thirteen thousand and fifteen thousand PREPA customers directly; but in terms of bringing life back to towns by powering supermarkets, schools, community centers, and clinics, they benefited far more survivors indirectly.^c

Generally, a community was a good candidate for a microgrid if it was located in a region that was going to be one of the last to see restoration of grid power, contained a number of critical facilities already running on generators, had a high population density, and needed a minimal amount of repairs to its distribution system.^d The outlying island of Culebra was just such a community. Culebra, with about 1,868 residents, had been without reliable electrical service since early September, when Hurricane Irma severed the undersea cable connecting it with Puerto Rico via the nearby island of Vieques.^e Hurricane Maria did not improve the situation, and generators were the exclusive source of electricity on Culebra for the next three months. The only generator powering the public electrical system in Culebra was a single 1.8-MW generator located behind city hall, and it was reserved for nighttime operation only. The lines coming to life at six-thirty each evening provided a moment of minor celebration on the streets of this small island town. Outside that twelve-hour overnight block when the city hall generator was running, some critical infrastructure facilities, such as the island’s hospital, relied on additional devices that had been donated by foundations or private companies.^f



Status of USACE microgrids, Jan. 17, 2018. Task Force Power weighed factors such as population density, length of time until grid power was likely to be restored, and the number of critical facilities already running on generators when considering sites for microgrids. (CEHO, Emergency Operations Collection)

After the 249th Engineer Battalion completed an assessment on Culebra, Task Force Temporary Emergency Power and Louis Berger Group contractors installed the first microgrid there on December 2, 2017. Two 1.85-MW generators from the Federal Emergency Management Agency (FEMA) powered the microgrid, and therefore also the island’s hospital, municipal buildings, wastewater treatment plant, and downtown street lights. Each generator ran for twelve hours at a time.⁹

After Culebra, the Corps and its contractors installed the next four microgrids in the southeast portion of Puerto Rico, which sustained tremendous damage when Hurricane Maria made landfall. By early January, those four microgrids were operating in Patillas, Maunabo, Naguabo, and Yabucoa. Capt. Aaron Anderson, an operations officer with Task Force Power Restoration who helped lead the microgrid effort, described the installation process in January 2018: “Once we

complete our assessments to make sure that the grid is good enough to accept power, and what types of facilities are on that system, we then go out and install these semi-trailer-sized generators. This initiative helps us do multiple things: get power quickly and more efficiently to a lot of homes, businesses, and critical facilities, but it also allows us to look at those facilities that are down range that already have smaller generators on them. We can get those generators back and put them where needed. With two large generators on a microgrid configuration, I may be able to get back 8, 9, or 10 smaller ones for use elsewhere.”

Anderson said the team is very selective because they must make sure they have the right systems in place to meet the needs. They draw upon the local knowledge of FEMA’s liaison officers, local folks on the ground, and they talk to mayors to find the best places to put these systems. FEMA is the approval authority. “So when



Three large generators powered a microgrid in the municipality of Maunabo, Puerto Rico, Jan. 3, 2018. (USACE photo by Jerry Rogers)

we meet with the local government, when we meet with that local mayor,” explained Anderson, “we get our rights of entry and other required legal documents, and FEMA is a major partner in that process. They also help us prioritize each system and where it should go next.”

The microgrid mission restored electrical service to tens of thousands of Puerto Rican citizens. It also demonstrated the value of partnerships—between Task Forces Power Restoration and Temporary Emergency Power and among the Corps, PREPA, and FEMA. “Throughout this mission, PREPA has been a great partner. They’re 110 percent behind this initiative,” said Anderson. “It’s their system, so we

have the ability to put the microgrid in place and install the transformers, and when we go from our system into theirs, PREPA performs those connections. So they are fully on board.”^h

Notes

- a. U.S. Department of Energy, “Office of the Secretary of Defense Recognizes SPIDERS Project with 2015 JCTD ‘TEAM OF THE YEAR’ Award,” Office of Energy Efficiency and Renewable Energy, 2018, <https://www.energy.gov/eere/femp/spiders-jctd-smart-cyber-secure-microgrids>; USACE Engineer Research and Development Center, “CERL supports successful microgrid demonstrations,” News Stories, February 8, 2013, <https://www.erdc.usace.army.mil/Media/News-Stories/Article/476482/cerl-supports-successful-microgrid-demonstrations/>.
- b. Interview, Col. John P. Lloyd, Commander, Task Force Power Restoration, by Jonah Bea-Taylor and James Garber, by phone, June 8, 2018, 42-44, Oral History Collection, Office of History, HQUSACE, Alexandria, Virginia [Hereafter cited as CEHO].
- c. “TF Power-Microgrids,” Microgrid SITREP, March 16, 2018, 2, Emergency Operations Collection, CEHO.
- d. “Micro-Grid Concept of Operations,” LTG Semonite Microgrid CONOP 17DEC17, December 17, 2017, Emergency Operations Collection, CEHO.
- e. “Information Paper: Culebra,” Whitepaper Draft, February 19, 2018, 1, Emergency Operations Collection, CEHO.
- f. Maj. Brett Walker, “Generating Business,” *DVIDS News*, November 29, 2017, <https://www.dvidshub.net/news/256790/generating-business>.
- g. “Information Paper: Culebra,” 1.
- h. Jerry Rogers, “Microgrid technology brings vital electricity to Puerto Rico’s hardest hit towns,” HQUSACE News Archive, January 5, 2018, <https://www.usace.army.mil/Media/News-Archive/Story-Article-View/Article/1409887/microgrid-technology-brings-vital-electricity-to-puerto-ricos-hardest-hit-towns/>.

however, it was the Unified Command Group that made decisions about the prioritization of power restoration efforts in different areas of the island. “That division of labor is an important fact,” explained Kirk. “Some folks may think that the Army Corps had the entire mission. That was never the case. From FEMA’s scheme of maneuver it was always set up as a ‘coalition effort.’ To maximize technical expertise, the Corps in the early days focused mostly on transmission. The mutual assistance utilities focused mostly on distribution. The PREPA forces could do a little bit of both.”³⁶

An additional challenge was communicating this prioritization process to the local level to the people who were waiting week after week for their lights to come back on.

Power authority representatives did not seem particularly excited about reaching out to community leaders either in municipalities where grid repair work was under way or to officials in places where people were patiently waiting for any work begin. “As much as we really tried to convince PREPA, this is what you need to be doing, I never got a sense that they wanted to do that,” said Lloyd. “So we kind of said, ‘hey, we’re going to do it regardless. We’re going to go out and engage these community leaders. We’re going to engage the populace.’ And I’ll tell you, they were hugely receptive to it.”³⁷

An Enterprise-Wide Effort

In a season of unfolding natural disasters, the resultant emergency response operations began to stretch the Corps of Engineers thin as response efforts extended into early 2018. Much of the support for the power repair and restoration missions in the Caribbean had come from the Great Lakes and Ohio River Division, but its seven districts could not send enough volunteers to staff the program office at PREPA, to operate the field offices, and to provide quality assurance supervision over the contractors’ work.³⁸ Much in the same way the Corps’ other disaster-response missions in Puerto Rico (such as temporary roofing and debris management) had required support from throughout the nationwide organization of the U.S. Army Corps of Engineers—“the enterprise”—Task Force Power also developed into an enterprise-wide effort. “I think probably when we initially went down there we were thinking, oh, we’ll be able to do this through the Pittsburgh District,” explained Marc Glowczewski. “Then we got down there and we were like there’s no way in the world we’re going to be able to just do this through the Pittsburgh District. We’re going to need the help of the entire enterprise.”³⁹ By February 2018, when Colonel Lloyd stepped down as head of the task force, 220 Corps employees from more than 30 different districts had deployed to Task Force Power.⁴⁰

Some districts took an especially significant role in providing leadership for the power missions. Pittsburgh District, of course, provided the first military and civilian leadership for Task Force Power. But the next civilian deputy district engineer for the task force was Patty Coffey from Nashville District. “I give Nashville District a shout out,” emphasized Michael Ornella. “[Lieutenant] Colonel [Cullen A.] Jones [commander of Nashville District] said that they would bleed until they were white, meaning they would give every resource that was necessary to meet this important mission for the Corps. And not only did he come, he sent his deputy district engineer for program and project management, he sent his chief of regulatory down there, and dozens of other employees from the Nashville District.” Other Corps commanders deployed from Portland, Philadelphia, and Detroit Districts to take a turn as deputies managing the task force’s work as grid restoration and recovery continued into the spring and summer of 2018.



Task Force Power volunteers in the field with Col. Jason Kirk (center), Feb. 25, 2018. (Photo courtesy of Jason Kirk)

On one hand the large number of volunteers from throughout the agency was a sign of the enterprise's commitment to Puerto Rico's recovery, but on the other, the frequent turnover of personnel affected several of the Corps' missions. Thirty-day rotations were often just enough time to build up enough knowledge of the situation on the island and gain the trust of local partners, and then personnel were returning back to their home districts on the mainland.⁴¹ Some Corps personnel were able to extend their deployments, but there were multiple rotations at all levels during the long recovery period. "So that was kind of a unique challenge itself," explained Lloyd. "You've got to completely change the team out every thirty days, and how do you do that while at the same time continuing the mission.... But it was hugely amaz-

ing. People would come and show up in Puerto Rico and once they got their bearings after finding their way from the airport, they would jump right in and figure things out...and we just kind of kept the flow of the mission going on that entire time without any setbacks."⁴²

Deputy Commanding General for Civil and Emergency Operations, Maj. Gen. Donald E. Jackson, further emphasized the point about the Corps' tradition of volunteerism: "We need to continue to sustain this culture of wanting to help others that we have in USACE. It produces employees that rise under the direst circumstances, setting aside their personal lives to go and spend their Christmas in Puerto Rico, helping people they don't know and be excited about it. How awesome is that?"⁴³

"That number of people deploying, it was phenomenally tough to do," recalled Ornella. "And as we got towards the end, finding people that could come back was, when I left in mid-June, it was getting tougher and tougher to get people to volunteer. Most everybody volunteers for this, so it was a volunteer force of people who had been there twice and three times, and entering the summer months where people didn't have near the flexibility with their children and families...truly a challenge."⁴⁴

The Final Five Percent

On March 29, 2018, the Corps, PREPA, their respective contractors, and utility partners from across the U.S. mainland had officially restored power to 95 percent of the pre-storm customers. This accomplishment meant that 1.4 million homes and businesses, out of 1.47 million pre-storm customers, had their lights back on. It was a major achievement, one that had been celebrated incrementally in grateful communities across the island on many occasions since the start of the year.⁴⁵ It was also about a month behind the dates that Task Force Power had anticipated back in October 2017. Early plans had estimated that the overall mission goal of 95 percent of power restored to Puerto Rico would be met in mid-to-late-February 2018.⁴⁶ While some projections from those plans turned out to be pretty accurate—getting 70 percent of pre-storm customers reconnected by late January 2018, for example—other milestones were harder to reach than anticipated. Some areas, such as San Juan and Ponce, reached the 95 percent restoration level significantly earlier than expected, while other areas, such as Bayamon and Caguas, ran behind schedule.⁴⁷

In early October task force planners had made an earnest attempt at reasonable calculations for how quickly repairs could proceed based on incomplete data, and despite delays in some areas, the Corps largely followed the phases included in their early plans until PREPA took over the remaining line repair work in May 2018.⁴⁸ “As far as the timeline, it was pretty much exactly how we had laid it out to the governor early on,” explained Colonel Lloyd. “We always knew as part of the mission that some of our greatest challenges were going to be these very remote areas of Puerto Rico where you have just a few people living in houses on a mountaintop and trying to restring distribution to them was going to be a challenge. I thought we laid that out pretty clearly.”⁴⁹

The second phase of the mission—restoring 95 percent of power to PREPA’s seven regions of the island—had proven incredibly challenging, and predictions about the completion date had turned out to be overly aggressive. The forested, mountainous terrain was daunting, and the numbers of residents getting their power back each day had diminished as the Corps shifted focus to lightly-populated, more remote areas. “I think that looking at those projections, we were really looking at straight crew production rates,” said Task Force Power planner Capt. Brian Molloy. “And we took into account and flowed all the crews down, understanding that a lot of the right of ways hadn’t been cleared and that we were going to have to do a lot of stuff by helicopter and that sort of stuff. But that last piece, the really, really difficult stuff, takes so much longer than it does on flat land in Florida, and those pieces I don’t think we took into account nearly as much as we probably could have.”⁵⁰

Colonel Lloyd explained:

Most of it had to be done by helicopter. Restringing lines, bringing in towers [to replace the ones] that were destroyed. All of that had to be flown in by helicopter. And what I always tell people is when you’re in the United States and you’re



USACE and its contractors restored power to the S.U. Martha Lafontaine School, near Utuado, Puerto Rico, May 17, 2018. Restoring power in mountainous areas often required helicopter support to connect electrical cable to remote distribution sites. (USACE photo by Patrick N. Moes)

driving down the highway and you see a transmission line system, if you look at it, it's probably been cleared out, grubbed, there's probably a nice thoroughfare for people to do the maintenance on those transmission lines. You just don't have that in Puerto Rico, that level of maintenance. A lot of that is because it is in jungle type terrain where it's overgrown and you've got trees and vines growing on the lines and things like that causing part of the problem.⁵¹

Colonel Kirk pointed out that there was no other access to many of the remote locations where the task force was working in March and April:

You needed helicopters to move equipment. And we used helicopters to sling men—the utility workers—into the sites because the transmission lines that go across the island go right through the jungle and go on top of the *mogotes*—the limestone outcroppings that look like moguls on a ski slope, except they're bigger than a high-rise building. So the terrain variability, the reliance on helicopters, the need to cut roads through the jungle in some cases to get to the tower foundation points. Those are some of the varied complexities that we dealt with, with the environment.⁵²



The rural Lafontaine School had been without grid power for nearly 8 months. (USACE photo by Patrick N. Moes)

As Task Force Power worked its way into some of the more remote areas, where it could take a line crew a full day just to reconnect a few houses located up on a hillside, it became even more important to remain motivated to complete the mission for every client who had lost power in the storm. “One phrase that we used all the time is ‘if you’ve only got one client energized, that was one more client that got to have dinner with their lights on with their families that night,’” remembered Michael Ornella. “That was great.”⁵³

Colonel Kirk recalled one way Task Force Power celebrated the daily accomplishment of restoring power to Puerto Ricans who had been living in the dark for months:

Our mantra each and every day was “Get the lights on!” At the end of the day we would, with a little bit of musical accompaniment—because there’s no shortage of songs that mention lights or power—we would fire up the music and then announce the numbers for the day. There were days where we got 12,000 people’s lights on. There were days when we got 700 people’s lights on. In the final piece there were days when we got 98 individuals’ lights on—pre-storm customers. The passion was there each and every day to keep our contractors moving, to keep the supplies moving, and get that outcome. The essential outcome of getting the lights on.⁵⁴



Capt. George Wiley read out the daily numbers, percent and number of customers energized, at the Task Force Power Restoration headquarters in the PREPA offices in San Juan, Mar. 3, 2018. (USACE photo by Sarah Bennett)

When the Corps' direct role in grid repair ended on May 18, 2018—240 days after Hurricane Maria's landfall—just over 1 percent of customers were still waiting to get their power back.⁵⁵ At that time, the Corps had 163 personnel and 1,022 contractors in Puerto Rico working on power restoration. Additionally, there were 172 Corps personnel and 1,011 contractors on the island supporting the broader Emergency Support Function 3 missions for FEMA; 758 of those contractors were working directly on temporary power generation.

The Corps continued supporting FEMA's disaster response in Puerto Rico long after the grid repair mission ended. Throughout the summer and fall of 2018, the Corps' Task Force Puerto Rico Recovery (TFPRR) managed the Bill of Materials, making sure PREPA had the replacement parts it needed to complete the restoration of power to every eligible customer. TFPRR also maintained the utility-scale generators at Palo Seco and Yabucoa power plants and many other large generators on the island at critical facilities where power remained unreliable. Repairs to critical facilities continued, as did the collection and disposal of storm debris from municipalities across the island.

The Temporary Emergency Power task force continued to focus on providing generators to facilities that still needed supplemental power and on servicing the many sites where generators had been running for months.⁵⁶ In May and June 2018, the rate at which the task force was uninstalling generators finally equaled the unprecedented rate of installations



Despite the rugged terrain, power workers with USACE contractor PowerSecure reconnected power lines near the town of Lares, Puerto Rico, Jan. 24, 2018. (USACE photo by Preston L. Chasteen)

that had occurred in November 2017.⁵⁷ The choice of which sites had reliable power and could really be self-sufficient without a generator required close coordination among Task Force Temporary Emergency Power, Task Force Power, and PREPA. Ultimately the teams needed to get FEMA's permission to remove generators, but no one forcibly uninstalled any. If there were concerns about letting go of a generator that had become a lifeline over the months of unreliable grid service, FEMA and the Puerto Rican government stepped in and assuaged facility managers. By mid-August 2018, about 130 generators remained installed, still undergoing regular inspections and service, and three micro-grids remained in operation in Arecibo and on the outlying islands of Culebra and Vieques.⁵⁸

In May, PREPA and its contractors had taken charge of reconnecting the last sixteen thousand customers. On August 14, 2018, the last of the eligible pre-storm customers were reconnected to grid power, 328 days after Hurricane Maria's landfall in Puerto Rico.⁵⁹ Although the Corps' direct repair mission was complete and PREPA's primary goal was achieved, Puerto Rico's grid was still not fully repaired. In fact, the Corps continued managing the shipment and accounting of parts and equipment to Puerto Rico throughout 2018

Preparing for the Next Storm

The Corps of Engineers' typical support to the Federal Emergency Management Agency (FEMA) following disasters involves making emergency repairs to public works, not rebuilding them. This limit on what the Corps is authorized to do under the 1988 Stafford Act means that it would have taken congressional action to allow the Corps to consider rebuilding Puerto Rico's electrical grid to a more resilient design following Hurricanes Irma and Maria.^a In December 2017, Deputy Commanding General for Civil Works Maj. Gen. Donald E. Jackson explained that Congress was considering how to invest in a more resilient grid in Puerto Rico, given the extent to which the Puerto Rico Electric Power Authority (PREPA) had allowed the pre-storm system to degrade. "That debate continues," said Jackson, "but I think most members of Congress understand. Although in public they may say rebuilding the current system is a waste of money, privately, they know, and have expressed to me their number one priority is power restoration. The Congress and administration must eventually decide how much the American taxpayer should pay to rebuild Puerto Rico's power grid and under what conditions they would be willing to do that."^b

In early February 2018, Congress passed the Bipartisan Budget Act which essentially waived parts of the Stafford Act for the Virgin Islands and Puerto Rico. Specifically, it allowed FEMA to use disaster relief funding to help PREPA restore the Puerto Rican electrical system to industry standards, regardless of its condition before the storm.^c In June 2018, the Department of Energy (DOE) recommended that "USDA Rural Utilities Service standards should be adopted where feasible and appropriate to standardize equipment and design." By

simply repairing the system to current rural electric standards, it would likely be more resilient than was the aging and poorly maintained system that Hurricane Maria almost destroyed.^d

At the Senate Energy and Natural Resources Committee hearing in May 2018, Department of Energy (DOE) Assistant Secretary Bruce Walker said, "no single investment in energy infrastructure at one point in time will achieve resilience. The energy infrastructure of Puerto Rico must be designed, built, managed, and maintained in such a way to withstand likely stresses, ameliorate disruptions when they inevitably occur, recover quickly, and incorporate lessons learned into post-event planning and operations. This is a continual process of improvement, one involving a reassessment and adaptation of solutions and technologies to address changing needs."^e

While the Corps did not undertake construction projects related to making the Puerto Rican grid more resilient, it did attempt to improve the posture of both the Virgin Islands and Puerto Rico to respond more quickly to a disaster. Making sure there were components on hand was one way to better enable these territories to repair sections of the power grid speedily and to avoid the long delays inherent in manufacturing parts and transporting materials from the mainland.^f "Logistics is the number one thing, and I think, looking forward, if we want to be even more responsive than we already are here, we need to think about hurricane response on islands," said Brig. Gen. Diana M. Holland, who commanded the South Atlantic Division. "It's different than it is in Florida, and maybe that means more presence early on, because the ports and

the airports were closed for days, and if we want to be in a better position, even better than we were, then we need to put more people in here.”^g

Providing temporary power—the fastest way to ensure the continued operation of life-saving facilities—was also addressed. In advance of the 2018 hurricane season, FEMA stored 750 generators in Puerto Rico to avoid the long delay in staging and shipping them from the mainland. Those generators will require ongoing maintenance and servicing even when not in use, but, at the very least, they will allow crews to supply temporary power to a larger number of critical facilities a lot faster if a major storm knocks out the electric grid again.^h

During the 2018 hurricane season, the Corps began incorporating some of the lessons it learned from the experience in Puerto Rico into their disaster response plans and operations. Responders deploying to Hawaii in preparation for Hurricane Lane in late August brought satellite phones because communication challenges had been so daunting in the first couple of weeks of the response to Maria. In addition, temporary power planning and response teams (PRTs), USACE Logistics Activity teams, contractors, and Charlie Company of the 249th Engineer Battalion all pre-deployed to Oahu and Kauai to initiate the Corps’ response to the storm.ⁱ Lane ultimately veered away from making a direct landfall on Hawaii, but the Corps had been well-prepared to face the logistical difficulties of responding to widespread damage overseas.

After Hurricane Florence brought huge amounts of rain and strong storm surge to the Carolinas in September, the Corps leveraged army engineer resources to help Savannah District repair the Military Ocean Terminal at Sunny Point, North

Carolina.^j Three days after landfall, ninety-three soldiers from the 27th Airborne Combat Engineer Battalion at Fort Bragg began clearing fallen trees. This marked the first time U.S. Army Forces Command task organized a combat engineer battalion under the command of a USACE district. The benefits from this kind of wider engagement between the Corps and active duty soldiers and National Guard was one of the key lessons of Maria.

Perhaps the greatest demonstration of what the Corps had learned from its response to Maria occurred during the late-October response to Super Typhoon Yutu in Saipan and Tinian, two tiny islands in the U.S. Commonwealth of the Northern Marianas, thirty-eight hundred miles west of Hawaii. In preparation for the Category 5 storm, a Honolulu-based temporary emergency power PRT, contractors, and Alpha Company of the 249th Engineer Battalion deployed to Saipan. The Corps staged communications, debris, and logistics subject matter experts in nearby Guam, where FEMA had stockpiled seventy-seven generators.^k Much in the same way Maria did in Puerto Rico, Yutu knocked out 100 percent of the grid power in Saipan and Tinian. Commonwealth Utilities Corporation of the Northern Mariana Islands would work with its power industry partners on the months-long effort to repair the electrical grids on Saipan and Tinian through its mutual assistance agreements. In the meantime however, the Corps was already engaged and ready immediately to inspect facilities and install generators at hospitals, water supply plants, and cell towers.^l

Notes

a. Disaster Relief and Emergency Assistance Amendments, Pub. L. No. 100-707, 42 U.S.C. 5170b § 403 (1988), <https://www.gpo.gov/fdsys/pkg/STATUTE-102/pdf/STATUTE-102-Pg4689.pdf>.

- b. Interview, Maj. Gen. Donald E. Jackson, Jr., Deputy Commanding General for Civil and Emergency Operations, HQUSACE, by Jonah Bea-Taylor and James Garber, HQUSACE, Washington, D.C., December 20, 2017, 55, Oral History Collection, Office of History, HQUSACE, Alexandria, Virginia [Hereafter cited as CEHO].
- c. Federal Emergency Management Agency, "Implementing Section 20601 of the 2018 Bipartisan Budget Act through the Public Assistance Program," FEMA Recovery Policy FP-104-009-5, September 14, 2018, 1, https://www.fema.gov/media-library-data/1569249349814-4e3a5164b53d77fc76f4320c10c2d52b/BBA-Policy_V2_9-11-2019_508.pdf.
- d. U.S. Department of Energy, "Energy Resilience Solutions for the Puerto Rico Grid," Final Report, June 2018, 18, <https://www.energy.gov/oe/articles/office-electricity-releases-energy-resilience-solutions-puerto-rico-grid-report>; Interview, José Sánchez, South Atlantic Division (SAD) Power Program Director, by James Garber and Jonah Bea-Taylor, HQUSACE, Part 1, April 9, 2018, CEHO.
- e. "Written Testimony of Assistant Secretary Bruce J. Walker, Office of Electricity Delivery and Energy Reliability, U.S. Department of Energy, Before the United States Senate Committee on Energy and Natural Resources," May 8, 2018, 2-3, https://www.energy.senate.gov/public/index.cfm/files/serve?File_id=0B4C1042-B0A9-4BFB-BC0A-5454141E2E10.
- f. Interview, Col. John P. Lloyd, Commander, Task Force Power Restoration, by Jonah Bea-Taylor and James Garber, by phone, June 8, 2018, 26, CEHO.
- g. Interview, Brig. Gen. Diana Holland, Commander, USACE South Atlantic Division (SAD), by Matt Percy and James Garber, San Juan, Puerto Rico, October 19, 2017, 22, CEHO.
- h. Jerry Rogers, "Microgrid technology brings vital electricity to Puerto Rico's hardest hit towns," HQUSACE News Archive, January 5, 2018, <https://www.usace.army.mil/Media/News-Archive/Story-Article-View/Article/1409887/microgrid-technology-brings-vital-electricity-to-puerto-ricos-hardest-hit-towns/>; Interview, Albert Coglio, Emergency Management Specialist, USACE Pittsburgh District, by Jonah Bea-Taylor, by phone, June 22, 2018, 25-26, CEHO.
- i. USACE Operations Center (UOC) Staff, "U.S. Army Corps of Engineers Operational Update," HQUSACE, August 22, 2018, 18, Emergency Operations Collection, CEHO.
- j. Russell Wicke, "Engineer Task Force revolutionizes disaster response with MOTSU recovery," U.S. Army, News, September 26, 2018, https://www.army.mil/article/211674/engineer_task_force_revolutionizes_disaster_response_with_motsu_recovery.
- k. UOC Staff, "U.S. Army Corps of Engineers Operational Update," HQUSACE, October 24, 2018, 19, Emergency Operations Collection, CEHO. Additional dates: October 26 and 31.
- l. Paul Ciampoli, "Power restoration efforts underway on Northern Mariana Islands," *American Public Power Association*, November 2, 2018, <https://www.publicpower.org/periodical/article/power-restoration-efforts-underway-northern-mariana-islands>.

so PREPA could finish repairs to transmission lines and substations.⁶⁰ Perhaps the final homes eventually to have power restored will be those that were so damaged by the storm that they could not be safely reconnected through the existing equipment where distribution lines enter the houses.⁶¹ These damaged residences had been beyond the scope of the Corps' grid restoration mission.⁶² Federal programs for housing assistance are in place to help those survivors rebuild, and once those homes are sufficiently repaired with operable equipment, they can be reconnected to the power grid. But it is also possible that a significant number of Puerto Rican residents will choose to relocate on the island or move permanently to the mainland, and some damaged homes may never be reconnected to grid power.

Reflecting on their time helping Puerto Rico recover from Hurricane Maria, many Corps personnel felt it was some of the most meaningful work of their careers. "I've said this experience is probably the most rewarding experience I've had in my twenty-three years with the Corps of Engineers," said José Sánchez. "Not only because it was the place where I grew up in, and I had obviously a personal connection with it, but because it was so impactful, directly impactful to the lives of the people that are, at the end of the day, U.S. citizens, taxpayers, that we serve and protect. That was for me a key thing from here."⁶³

Colonel Lloyd shared similar thoughts on his time commanding Task Force Power Restoration and on the people who volunteered to support the sometimes daunting mission:

I tell people, twenty-nine years in the Army, I've deployed a few times outside of just combat operations. I would say that the challenge of Puerto Rico and the grid mission was the greatest I've had in my military career. But also at the same time the most rewarding. A lot of that was the people of the U.S. Army Corps of Engineers, the employees. These are all volunteers that raised their hand and said "I'll go to Puerto Rico because I want to do that mission, I want to help fellow Americans out." I think they saw it as a historic moment in USACE history, where this was just a unique mission for USACE to take on, where we were the only ones that stepped up for this challenge. And while there may be criticism along the way, I think if you really look at the amount of work that USACE did to coordinate the restoration—by bringing in the amount of material that we did, bringing in the amount of contractors and utility workers and the coordination we did—I think the mission was hugely successful.⁶⁴

Many others in the Corps would undoubtedly agree.

Notes

¹ Interview, José Sánchez, South Atlantic Division (SAD) Power Program Director, by James Garber and Jonah Bea-Taylor, Headquarters, U.S. Army Corps of Engineers (HQUSACE), Washington, DC, Part 1, April 9, 2018, 20, Oral History Collection, Office of History, HQUSACE, Alexandria, Virginia [Hereafter cited as CEHO].

² USACE Public Affairs, "Hurricane Irma & Maria Response," Infographic, January 2, 2018, Emergency Operations Collection, CEHO.

³ Interview, Carlos Torres, Power Restoration Coordinator, Commonwealth of Puerto Rico, by Jonah Bea-Taylor, by phone, August 1, 2019, 19-20, CEHO.

⁴ Interview, Marc Glowczewski, Senior Project Manager, Task Force Power Restoration, by Jonah Bea-Taylor, by phone, May 17, 2018, 25, CEHO.

⁵ Interview, José Sánchez, South Atlantic Division (SAD) Power Program Director, by James Garber and Jonah Bea-Taylor, HQUSACE, Washington, DC, Part 2, April 16, 2018, 12, CEHO.

⁶ Interview, Col. John P. Lloyd, Commander, Task Force Power Restoration, by Jonah Bea-Taylor and James Garber, by phone, June 8, 2018, 13, CEHO.

⁷ Interview, Rhonda Mustafaa, Chief of Plans and Operations, Directorate of Logistics, HQUSACE, and Franklin Ford, Officer in Charge, Task Force Power, Materials Section, by Jonah Bea-Taylor and Lt. Col. David McGuire, HQUSACE, Washington, DC, July 12, 2018, 82, CEHO.

⁸ Interview, Brig. Gen. Diana Holland, Commander, South Atlantic Division (SAD), by Jonah Bea-Taylor,

SAD Headquarters, Atlanta, GA, December 14, 2018, 13, CEHO.

⁹ Interview, Brig. Gen. Diana Holland (2018), 10.

¹⁰ Preston Chasteen, "USACE Task Force Power Restoration Change of Command," News, U.S. Army, February 1, 2018, https://www.army.mil/article/199967/usace_task_force_power_restoration_change_of_command.

¹¹ HQUSACE Public Affairs, "Talking Points for USACE Puerto Rico Power Grid Repair Mission," May 18, 2018, Emergency Operations Collection, CEHO.

¹² Interview, Michael Ornella, Sr., Deputy District Engineer, Task Force Power Restoration, by Jonah Bea-Taylor, by phone, June 27, 2018, 13, CEHO.

¹³ Capt. Brian Molloy to author, "RE: Follow up question on Puerto Rico regions," Email, July 5, 2018, Historian's Files, CEHO.

¹⁴ Task Force Power, "TF Power Restoration Update," Daily Update, May 18, 2018, Emergency Operations Collection, CEHO.

¹⁵ Interview, Michael Ornella, Sr. (2018), 17.

¹⁶ "Hurricanes Maria and Irma: November 16 Event Summary," Report No. 77, Infrastructure Security and Energy Restoration, U.S. Department of Energy (DOE), 1, <https://www.energy.gov/sites/prod/files/2017/11/f46/Hurricanes%20Maria%20and%20Irma%20Event%20Summary%20November%2016%2C%202017.pdf>. DOE noted that "the percent of normal peak load restored is not a direct proxy for the number of customers restored. DOE

will begin reporting customer level data as soon as the information is available.”

¹⁷ USACE Operations Center (UOC) Staff, “USACE Operational Update Brief,” HQUSACE, November 17, 2017, Emergency Operations Collection, CEHO.

¹⁸ Frances Robles and Jess Bidgood, “Three Months After Maria, Roughly Half of Puerto Ricans Still Without Power,” *New York Times*, December 29, 2017, <https://www.nytimes.com/2017/12/29/us/puerto-rico-power-outage.html>; “Hurricanes Maria and Irma: January 3 Event Summary,” Report No. 85, Infrastructure Security and Energy Restoration, DOE, 2, <https://www.energy.gov/sites/prod/files/2018/01/f46/Hurricanes%20Maria%20and%20Irma%20Event%20Summary%20January%203%2C%202018.pdf>. Even in early 2018, the customer-level data was still less than ideal. DOE reported: “On January 2, PREPA reported that 57% of its customers have power. Based off of this metric, approximately 675,000 customers remain without power on Puerto Rico. Note: This number is a preliminary estimate by PREPA obtained manually.”

¹⁹ Interview, Col. John P. Lloyd (2018), 38.

²⁰ Daniel Alarcon, “What Happened in the Dark: Puerto Rico’s Year of Fighting for Power,” *Wired*, August 23, 2018, <https://www.wired.com/story/puerto-rico-hurricane-maria-recovery/>.

²¹ Interview, José Sánchez, Part 2 (2018), 20.

²² Interview, Col. Jason Kirk, Commander, Task Force Power, by Jonah Bea-Taylor and James Garber, by phone, May 24, 2018, 20, CEHO.

²³ Task Force Power, “TF Power Restoration Update,” Daily Update, March 30, 2018, 1, Emergency Operations Collection, CEHO.

²⁴ Lt. Gen. Todd T. Semonite to Sen. Kirsten Gillibrand, Email, March 23, 2018, Emergency Operations Collection, CEHO.

²⁵ Interview, Marc Glowczewski (2018), 11.

²⁶ Interview, Col. John Lloyd (2018), 29.

²⁷ Interview, Marc Glowczewski (2018), 26.

²⁸ Interview, Michael Ornella, Sr. (2018), 23.

²⁹ Interview, Michael Ornella, Sr. (2018), 23.

³⁰ Interview, Michael Ornella, Sr. (2018), 30.

³¹ Interview, Michael Ornella, Sr. (2018), 30.

³² Interview, Michael Ornella, Sr. (2018), 31.

³³ Interview, Marc Glowczewski (2018), 13.

³⁴ Interview, Michael Ornella, Sr. (2018), 21. According to Task Force Power Deputy District Engineer Michael Ornella, the Corps repaired only about 35% of the lines that were actually energized. However, Ornella points to Task Force Power’s “Earned Value Analysis”—an industry standard technique for comparing actual costs for a project under construction to the budgeted costs—which produced the 40% figure for the USACE contribution to the overall

grid restoration work. He recalled: “The Corps actually had the privilege to work in some of the toughest areas. And so when you look at what was hardest hit, and how much work there was to do on each of these lines, the Corps actually performed well over 40 percent of the work that was accomplished in restoring the grid.”

³⁵ Interview, Col. Jason Kirk (2018), 11.

³⁶ Interview, Col. Jason Kirk (2018), 11.

³⁷ Interview, Col. John Lloyd (2018), 38.

³⁸ Interview, Marc Glowczewski (2018).

³⁹ Interview, Marc Glowczewski (2018), 9-10.

⁴⁰ Interview, Col. John Lloyd (2018), 45-46.

⁴¹ Interview, José Sánchez, Part 1 (2018), 27.

⁴² Interview, Col. John Lloyd (2018), 47.

⁴³ Interview, Maj. Gen. Donald E. Jackson, Jr., Deputy Commanding General for Civil and Emergency Operations, HQUSACE, by Jonah Bea-Taylor and James Garber, HQUSACE, Washington, DC, December 20, 2017, 82-83, CEHO.

⁴⁴ Interview, Michael Ornella, Sr. (2018), 12.

⁴⁵ USACE Public Affairs, “Hurricane Irma & Maria Response,” Infographic, March 29, 2018, Emergency Operations Collection, CEHO; Preston Chasteen, USACE Tulsa District, “Power Restoration in Rio Piedras Heights, San Juan,” Video, DVIDS, January 19, 2018, <https://www.dvidshub.net/video/580552/power-restoration-rio-piedras-heights-san-juan>.

⁴⁶ “Task Force Power Restoration Operational Concept,” (draft) October 15, 2017, 15, Emergency Operations Collection, CEHO.

⁴⁷ USACE Public Affairs, “Hurricane Irma & Maria Response,” Infographic, January 31, 2018, Emergency Operations Collection, CEHO; Task Force Power Restoration, “Mission Operational Assessment Brief,” Programmatic Schedule Analysis, March 13, 2018, 19, Emergency Operations Collection, CEHO. Carolina, Mayaguez, and Ponce had all reached 95% restoration in early March, a month to six weeks ahead of schedule. San Juan had reached that goal in early February, about three weeks earlier than expected. Meanwhile, in mid-March 2018, Bayamon was running three weeks behind, and parts of Caguas would probably not reach 95% until July, which would be at least a month delayed.

⁴⁸ Interview, Capt. Brian Molloy, Operations Officer, Task Force Power Restoration, by Jonah Bea-Taylor, by phone, May 14, 2018, 20, CEHO.

⁴⁹ Interview, Col. John Lloyd (2018), 33.

⁵⁰ Interview, Capt. Brian Molloy (2018), 35.

⁵¹ Interview, Col. John Lloyd (2018), 28.

⁵² Interview, Col. Jason Kirk (2018), 21.

⁵³ Interview, Michael Ornella, Sr. (2018), 14-15.

⁵⁴ Interview, Col. Jason Kirk (2018), 24.

⁵⁵ HQUSACE Public Affairs, "Talking Points for...Grid Repair Mission," 2. At the time, the Corps and PREPA acknowledged that there were still 15,936 clients without power.

⁵⁶ Interview, Col. John Lloyd (2018).

⁵⁷ Interview, Albert Coglio, Emergency Management Specialist, USACE Pittsburgh District, by Jonah Beatty, by phone, June 22, 2018, CEHO.

⁵⁸ Andrew Kornacki, USACE Buffalo District, "A Day in the Life: Temporary Emergency Power QA in Puerto Rico," News, DVIDS, August 17, 2018, <https://www.dvidshub.net/news/289234/day-life-temporary-emergency-power-qa-puerto-rico>.

⁵⁹ Joshua Hoyos, "Nearly 1 year after Hurricane Maria, 100 percent of customers have power in Puerto Rico: Officials," US, ABC News, August 14, 2018, <https://abcnews.go.com/US/year-hurricane-maria-100-percent-customers-power-puerto/story?id=57175710>; Frances Robles, "Puerto Rico Spent 11 Months Turning the Power Back On. They Finally Got to Her," *New York Times*, August 14, 2018, <https://www.nytimes.com/2018/08/14/us/puerto-rico-electricity-power.html>. Note that grid repair continued even after all customers had their power restored. The *New York Times* article quoted Gil Quinones, the CEO of NYPA: "PREPA still needs to complete repairs to five critical transmission lines, 12 damaged substations and three transmission centers that are needed for grid stability and redundancy... The No. 1 goal was to get electricity back as quickly as possible. On the one hand, there's lots of new stuff. On the other hand, the crews and other contractors really rushed the work to put it back together."

⁶⁰ UOC Staff, "U.S. Army Corps of Engineers Operational Update," HQUSACE, December 7, 2018, 27, and January 4, 2019; both Emergency Operations Collection, CEHO.

⁶¹ Puerto Rico Electric Power Authority, "Grid Status Update," August 8, 2018, Historians Files, 3, CEHO. The same week PREPA claimed they had restored 100% of clients, they reported that electricity sales had mostly rebounded from before the storm, but there had been some losses. "Current load is approximately 93% of comparable 2017 levels," PREPA reported.

⁶² Interview, José Sánchez, Part 2 (2018), 9.

⁶³ Interview, José Sánchez, Part 2 (2018), 35.

⁶⁴ Interview, Col. John Lloyd (2018), 53-54.



Across the island of Puerto Rico, the Corps of Engineers oversaw environmental stabilization efforts at sites that were impacted by power restoration activities. Near Las Piedras, Dean Austin, of USACE Nashville District, and Scott Guinn, of USACE Savannah District, conducted quality assessments to ensure proper remediation of the site. (USACE photo by Andrew Kornacki)

CONCLUSION

In a season of unprecedented disasters— including never-before-seen amounts rainfall along the Texas coast from Hurricane Harvey and the most destructive wildfire season in California history—Hurricane Maria’s impact on Puerto Rico stood out because of the legacy of fragile infrastructure and economic hardship. A year after the storm made land-fall, the Federal Emergency Management Agency (FEMA) reflected on the extraordinary nature of the mission the agency had undertaken in Puerto Rico: “Never before has FEMA coordinated federal resources to rebuild an entire commonwealth with a population of 3.3 million people, 78 municipalities, electrical, water and telecommunications systems, sea-ports, airports, schools, healthcare system, roads and bridges. More than 166,000 homes need repair or reconstruction.”¹

On September 20, 2017, Hurricane Maria produced a complex catastrophe in the Caribbean and therefore a thorny and trying situation for those responding to the calamity. For the U.S. Army Corps of Engineers, the difficulty of deploying resources into Puerto Rico complicated almost every mission it undertook in response to the disaster. For example, its personnel had to depend on a limited number of commercial flights that were often completely booked for the first ten days after the storm. Even once personnel arrived on the island, they had to adapt to an environment where transportation was difficult, mobile communications were unreliable, and internet access was limited. Outside of San Juan, language barriers made it clear that the Corps needed more Spanish-speaking volunteers to help explain the federal role to officials and survivors both. Clearly, the “overseas” aspect of the location meant that the logistics of bringing in everything from pumps to bucket trucks to generators to blue roof material by air and ship would be different from operations on the mainland. Finally, the Commonwealth of Puerto Rico was facing preexisting structural challenges in addition to damage from the storm, including bad roads, destroyed cell towers, and a debilitating financial crisis. Thus, the ability of local agencies and personnel

to guide and facilitate the Corps' relief programs was lacking. All these factors rendered obsolete approaches to recovery that had been designed with conditions on the mainland in mind, and they consequently slowed the Corps' initial response to the hurricane.²

Ten days after landfall, with about 95 percent of the island lacking electrical power and with local efforts to restore service under-resourced and in disarray, the Corps took on the formidable mission to lead the repair of Puerto Rico's electrical grid for FEMA. The Corps accepted this mission wholeheartedly without knowing exactly how much of the system was damaged, who could provide replacement parts in the necessary quantities, and which contractors were capable of mobilizing to restore power quickly and efficiently. Answers to some of these unknowns came quickly; others took longer. There was a risk for the Corps in moving ahead without knowing all the answers, but from the start, the Corps showed a willingness to "try" in the spirit of the agency's motto—*Essayons*—and its long history of taking on difficult challenges. "We have done this in the past, but I guess, if there was a lesson learned, it was: be willing to take the hard missions on, because you're a good enough organization," said Lt. Gen. Todd T. Semonite, Chief of Engineers. "You'll figure it out on the fly, and don't feel like you've got to have a 100 percent solution before you even cross the start line."³

Indeed, the situation two weeks after the storm was distressing. Although 164 Corps personnel had deployed to Puerto Rico, and many roads had been cleared and spillway erosion at Guajataca dam had been greatly reduced, there were no blue roofs on storm-damaged homes, no municipal debris removed, and only twenty-seven generators installed at critical facilities. The power grid repair mission was only in the initial planning stages, and no orders for replacement parts had yet been made.⁴ A month after that, at the start of November 2017, relief programs were well underway, and the situation had improved dramatically. The Corps had deployed 536 personnel to the island, installed 4,739 blue roofs, removed 81,000 cubic yards of debris, and positioned 397 generators at critical facilities. Utility-scale generators at the Palo Seco Power Plant were up and running, producing responsive power for the San Juan area. Task Force Power and the Puerto Rico Electric Power Authority (PREPA) had restored almost half of the commonwealth's central high-voltage transmission loop and 40 percent of the distribution lines in key population centers. The first order of critical parts and equipment to repair the grid was about to arrive in Ponce.⁵ The Corps' persistence was starting to make a real difference.

As the months passed, the Corps really showed its commitment to the people of Puerto Rico and to the missions it had been assigned. In 2018, "*Estamos aquí*"—*We are here*—became a frequent refrain in the Corps' communications to reassure survivors who were still waiting for their lights to come back on, and it was also an earnest statement of the agency's determination to see the job done in Puerto Rico. At the end of March 2018, more than four hundred Corps personnel remained on site, and 95 percent of PREPA's

customers' had their power restored. Some areas, such as San Juan and Ponce, had gotten 95 percent of their power back earlier than expected. The month of March also saw the blue roof mission completed, 96 percent of temporary power generation tasks completed, and 98 percent of debris removed.⁶ Thousands of contractors had rotated through to support Corps missions on the island. A year after the storm, a hundred Corps employees were still in Puerto Rico seeing the final elements of these missions to closure.

Brig. Gen. Diana M. Holland argued that in addition to the Corps' engineering expertise, the three most important strengths the agency brought to help Puerto Rico recover from Hurricane Maria were "strong relationships across all levels of government; extensive experience in media and congressional engagement; and a diverse workforce."⁷ The Corps had a unique ability to build trust at the local level, in large part because of its employees who had been raised and educated in Puerto Rico. The Corps was also a federal agency trusted by Congress to be accountable for disaster relief funding and to successfully carry out its assigned tasks. The Corps was able to partner with utility experts across government and the power industry. Where the Corps' capacity was lacking to obtain parts on the scale needed in Puerto Rico, the Corps demonstrated its strength to learn and partner with defense agencies that did have that logistical capability. Most important, the Corps could explain its plans, and its progress towards completing those plans, both locally to survivors and to concerned senior leaders in government.

Thus, in Puerto Rico the Corps became an essential bridge between the federal and the local. In a crisis that desperately called for reassurance from trusted institutions and proactive planning on the part of those agencies, the Corps stepped forward to build confidence in its ability to use federal resources wisely and efficiently to restore power effectively and transparently. The Corps arrived with a determination to untangle logistical and organizational challenges, to break down the enormous grid restoration effort into manageable pieces, and to get the materials necessary to complete each of those pieces, all while accounting for the resources put into that effort. And the Corps stayed to see the mission completed. A year after the devastation of Hurricane Maria, Puerto Rico's recovery was far from finished, but the lights were back on.

Notes

¹ "Puerto Rico Hurricane Maria (DR-4339)," Disaster Declarations, Federal Emergency Management Agency, Internet Archive, Retrieved September 20, 2018, <https://web.archive.org/web/20180920200223/https://www.fema.gov/disaster/4339>.

² "2017 Year in Review," National Cadre Perspective (TL, ATL, N-LGL), July 23, 2018, Emergency Operations Collection Office of History, HQUSACE, Alexandria, Virginia [Hereafter cited as CEHO].

³ Interview, Lt. Gen. Todd T. Semonite, Chief of Engineers, by John Lonnquest, HQUSACE, Washington, DC, December 14, 2017, 5-6, Oral History Collection, CEHO.

⁴ "Hurricanes Irma and Maria," Common Operating Picture, October 5, 2017, 2, Emergency Operations Collection, CEHO; "Task Force Power Restoration Operational Concept," Way Forward Timeline, October 19, 2017, 19, Emergency Operations Collection, CEHO.

⁵ "Hurricanes Irma & Maria," Common Operating Picture, November 2, 2017, 2; "TF Power Restoration

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⁶ USACE Public Affairs, "Hurricane Irma & Maria Response," Infographic, March 29, 2018, Emergency Operations Collection, CEHO; Task Force Power, "TF Power Restoration Update," Daily Update, March 29, 2018, 1, Emergency Operations Collection, CEHO.

⁷ Brig. Gen. Diana M. Holland, "Responding to the Perfect Storm: The U.S. Army Corps of Engineers and Disaster Response in Puerto Rico, 2017," *Military Review* (May-June 2019): 11-25, <https://www.armyupress.army.mil/journals/military-review/english-edition-archives/may-june-2019/holland-perfect-storm/>.

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Damaged power lines along a road in Humacao, one of the hardest hit municipalities, October 28, 2017. (USACE photo by Michael Izard-Carroll)

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The predominant primary sources for this account are oral histories recorded, transcribed, and edited by the Office of History, Headquarters, U.S. Army Corps of Engineers (CEHO). Historians Matthew Percy and James Garber collected the first group of oral histories while deployed to San Juan, Puerto Rico, from October 16 to 23, 2017. They conducted most of their interviews with Corps personnel at the Recovery Field Office and at the headquarters of South Atlantic Division Forward. James Garber and Jonah Bea-Taylor conducted follow-up interviews by phone and at Headquarters, U.S. Army Corps of Engineers (HQUSACE), in Washington, D.C.

CEHO maintains a Digital Research Collection with a sub-collection on Emergency Operations that contains approximately sixty-five-hundred documents related to Hurricane Maria and Hurricane Irma. Most of the files collected came from digital documents managed by Task Force Power in a Bentley Systems *ProjectWise* database. Key knowledge and records managers that helped with this digital research effort are Bob Tyszkiewicz (Pittsburgh District), Ryan Meersman (Corps of Engineers Information Technology, Rock Island, Ill.), and Katherine Chambers (Coastal and Hydraulics Laboratory, HQUSACE).

Following Hurricane Maria, communications failures in Puerto Rico made it difficult to upload documents to web-based systems. Mobile District initially used a Microsoft *SharePoint* site for the ESF-3 missions, but only the infrastructure assessment team maintained records there. The temporary roofing team used paper records for rights of entry work orders, and boxes of those paper records are now at St. Louis District. USACE historians did not get a chance to review those documents.

Key secondary sources on the history of Puerto Rico's relationship with the United States include César J. Ayala and Rafael Bernabe's *Puerto Rico in the American Century: A History since 1898* from University of North Carolina Press (2007) and the much earlier,

but useful, *Economic History of Puerto Rico: Institutional Change and Capitalist Development* by James L. Dietz (Princeton University Press, 1986). Susan M. Collins, Barry P. Bosworth, and Miguel A. Soto-Class edited a series of valuable contributions to our understanding the origins of the commonwealth's economic crisis in *The Economy of Puerto Rico: Restoring Growth* from Brookings Institution Press (2006). For a range of well-researched articles on the history, culture, economy, and geography of contemporary Puerto Rico, the on-line *Enciclopedia de Puerto Rico* from Puerto Rico Endowment for the Humanities and the National Endowment for the Humanities is an exceptional (and hopefully growing) resource.

This book has benefited greatly from the work of public affairs service members from all branches who covered Corps missions in Puerto Rico as part of their duties. The Office of History also wishes to acknowledge the excellent work of many Corps of Engineers public affairs officers, including Andrew Kornacki, Patrick Moes, Preston Chasteen, and Sarah Bennett, as well as Eduardo Martinez for FEMA, which has helped to document visually the agency's role in Puerto Rico's recovery. Many of these photojournalists publicly distributed their images and videos on the Defense Visual Information Distribution Service (DVIDS).

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ABBREVIATIONS AND ACRONYMS

249EB – 249th Engineer Battalion

ACI – Advanced Contracting Initiative

BOA – Basic ordering agreement

BOM – Bill of materials

DLA – Defense Logistics Agency, U.S. Department of Defense

DoD – U.S. Department of Defense

DOE – U.S. Department of Energy

DVIDS – Defense Visual Information Distribution Service

EEI – Edison Electric Institute

ESF-3 – Emergency support function 3

FEMA – Federal Emergency Management Agency

IMT – Incident management team

JFO – Joint field office

LBG – Louis Berger Group

NOAA – National Oceanic and Atmospheric Administration

NYPA – New York Power Authority

OPORD – Operations order

PREMA – Puerto Rico Emergency Management Agency

PREPA – Puerto Rico Electric Power Authority

PRT – Planning and response team

QA – Quality assurance

RFO – Recovery field office

ROE – Right of entry

SAD – South Atlantic Division, USACE

SAM – Mobile District (U.S. Army Corps of Engineers)
SAJ – Jacksonville District (U.S. Army Corps of Engineers)
SAW – Wilmington District (U.S. Army Corps of Engineers)
SES – Senior executive service
SWD – Southwestern Division
TF TEP – Task Force Temporary Emergency Power
TFPRR – Task Force Puerto Rico Recovery
USACE – U.S. Army Corps of Engineers
USTRANSCOM – U.S. Transportation Command
UOC – USACE Operations Center
VIPR – Virgin Islands and Puerto Rico (area of responsibility)
WAPA – U.S. Virgin Islands Water and Power Authority

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