

# Nationwide Public Safety Broadband Network Draft Programmatic Environmental Impact Statement for the Non-Contiguous United States



**FirstNet®**

## First Responder Network Authority

Volume 1 - Chapters 1, 2, & 3

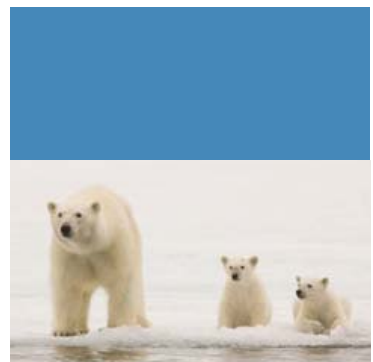
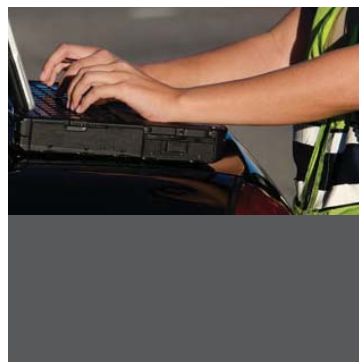
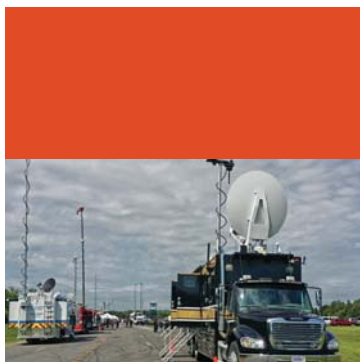


### Alaska

Hawaii  
American Samoa  
Guam  
Northern Mariana Islands  
Puerto Rico  
U.S. Virgin Islands



March 2016



-Page Intentionally Left Blank-

# First Responder Network Authority



## Nationwide Public Safety Broadband Network Draft Programmatic Environmental Impact Statement for the Non-Contiguous United States

### Volume 1

Amanda Goebel Pereira, AICP  
NEPA Coordinator  
First Responder Network Authority  
U.S. Department of Commerce  
12201 Sunrise Valley Dr. M/S 243  
Reston, VA 20192

#### **Cooperating Agencies**

Federal Communications Commission  
General Services Administration  
U.S. Department of Agriculture—Rural Utilities Service  
U.S. Department of Agriculture—U.S. Forest Service  
U.S. Department of Agriculture—Natural Resource Conservation Service  
U.S. Department of Defense—Department of the Air Force  
U.S. Department of Energy  
U.S. Department of Homeland Security

March 2016

Cover Art Sources:

- Map Service. 2015. *OpenStreetMap*. ArcGIS Map Image Layer by Esri. Sourced from: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community.
- NOAA (National Oceanic and Atmospheric Administration). 2016. *Polar bear (Ursus maritimus)*. Uncredited Marine Mammal Commission Photograph. Accessed: January 2016. Retrieved from: <http://search.noaa.gov/search/images?utf8=%E2%9C%93&sc=0&query=Polar+bear+%28Ursus+maritimus%29&m=&affiliate=noaa.gov&commit=Search>
- NPS (National Park Service). 2016. *Fruit Bat [White-necked Flying Fox (Pteropus tonganus)]*. Uncredited NPS Photograph. Accessed: January 2016. Retrieved from: <http://www.nps.gov/npsa/learn/education/fruit-bats-are-our-friends.htm>
- USFWS (U.S. Fish and Wildlife Service). 2013a. *Mariana Fruit Bat Pteropus mariannus / Fanihi*. Uncredited USFWS Photograph. Accessed: January 2016. Retrieved from: [http://www.fws.gov/refuge/guam/wildlife\\_and\\_habitat/mariana\\_fruit\\_bat.html](http://www.fws.gov/refuge/guam/wildlife_and_habitat/mariana_fruit_bat.html)
- \_\_\_\_\_. 2013b. *Nēnē Branta sandvicensis / Hawaiian Goose*. Photograph by Laura Beauregard, USFWS. Accessed: January 2016. Retrieved from: [http://www.fws.gov/refuge/Hakalau\\_Forest/wildlife\\_and\\_habitat/nene.html](http://www.fws.gov/refuge/Hakalau_Forest/wildlife_and_habitat/nene.html)
- \_\_\_\_\_. 2015. *Rota blue damselfly (Ischura luta)*. Photograph by A. Asquith, USFWS. Accessed: January 2016. Retrieved from: <https://www.fws.gov/news/ShowNews.cfm?ID=4DA36523-E516-A820-414BB2B0165E7461>
- \_\_\_\_\_. 2016. *West Indian Manatee*. Photograph by Keith Ramos, USFWS. Accessed: January 2016. Retrieved from: <http://www.fws.gov/southeast/wildlife/mammal/manatee/>
- USFWS Alaska (Alaska Region U.S. Fish and Wildlife Service). 2004. *Walrus Cows and Yearlings on Ice*. Photograph by Joel Garlich-Miller, USFWS. Accessed: January 2016. Retrieved from: [https://www.flickr.com/photos/usfws\\_alaska/5390772958/](https://www.flickr.com/photos/usfws_alaska/5390772958/)

## TABLE OF CONTENTS

<b>1. Introduction.....</b>	<b>1-1</b>
1.1. Overview and Background .....	1-1
1.2. Programmatic Approach and Tiering.....	1-3
1.3. Project Regions and Description of the Proposed Action Area .....	1-4
1.4. Purpose and Need for the Proposed Action .....	1-5
1.5. Federal Agency Participation.....	1-7
1.5.1. Lead Agency .....	1-7
1.5.2. Cooperating Agencies .....	1-7
1.5.3. Consulting Parties .....	1-8
1.6. Cultural Resources Consultation.....	1-8
1.7. The NEPA Process and Public Involvement .....	1-8
1.7.1. Public Involvement .....	1-9
1.7.2. Scoping .....	1-9
1.8. Overview of Relevant Federal Laws and Executive Orders .....	1-10
1.8.1. National Environmental Policy Act .....	1-10
1.8.2. National Historic Preservation Act .....	1-11
1.8.3. Endangered Species Act .....	1-11
1.8.4. Magnuson-Stevens Fishery Conservation and Management Act .....	1-12
1.8.5. Marine Mammal Protection Act .....	1-12
1.8.6. Migratory Bird Treaty Act .....	1-12
1.8.7. Clean Water Act.....	1-13
1.8.8. Coastal Zone Management Act.....	1-14
1.8.9. Occupational Safety and Health Act.....	1-14
1.8.10. Executive Order 11988 – Floodplain Management .....	1-14
1.8.11. Executive Order 11990 – Protection of Wetlands .....	1-15
1.8.12. Executive Order 12898 – Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations .....	1-15
1.8.13. Executive Order 13186 – Responsibilities of Federal Agencies to Protect Migratory Birds .....	1-15
1.8.14. Executive Order 13690 – Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input .....	1-16
1.9. PEIS Organization .....	1-16
1.10. References .....	1-17

<b>2.</b>	<b>Description of the Proposed Action and Alternatives .....</b>	<b>2-1</b>
2.1.	Proposed Action.....	2-1
2.1.1.	Characteristics of the NPSBN.....	2-2
2.1.2.	Proposed Action Infrastructure .....	2-2
2.1.2.1.	Wired Projects.....	2-2
2.1.2.2.	Wireless Projects.....	2-4
2.1.2.3.	Deployable Technologies.....	2-4
2.1.2.4.	Satellites and Other Technologies .....	2-5
2.2.	Description of Alternatives .....	2-5
2.2.1.	Preferred Alternative.....	2-6
2.2.2.	Deployable Technologies Alternative.....	2-6
2.2.3.	No Action Alternative.....	2-6
2.3.	Alternatives Considered but not Carried Forward .....	2-6
2.3.1.	New Construction Only Alternative .....	2-7
2.3.2.	New Satellite Alternative .....	2-7
2.3.3.	Collocation-Only Alternative.....	2-7
2.4.	Radio Frequency Emissions.....	2-7
2.4.1.	Introduction.....	2-7
2.4.2.	RF Emissions and Humans .....	2-10
2.4.2.1.	Regulatory Framework for RF Emissions .....	2-12
2.4.2.2.	Overview of Research for Potential Non-Thermal Effects to Humans .....	2-13
2.4.2.3.	Conclusions on RF Emissions and Humans .....	2-18
2.4.3.	RF Emissions and Non-Human Species .....	2-18
2.4.3.1.	Research on the Potential Effects to Animal and Plant Species .....	2-19
2.4.3.2.	Conclusions on RF Emissions and Species .....	2-21
2.4.4.	Summary .....	2-21
2.5.	References.....	2-22
<b>3.</b>	<b>Alaska.....</b>	<b>3-1</b>
3.1.	Affected Environment.....	3.1-1
3.1.1.	Infrastructure.....	3.1.1-1
3.1.2.	Soils.....	3.1.2-1
3.1.3.	Geology.....	3.1.3-1
3.1.4.	Water Resources .....	3.1.4-1
3.1.5.	Wetlands .....	3.1.5-1
3.1.6.	Biological Resources .....	3.1.6-1
3.1.6.1.	Introduction.....	3.1.6-1
3.1.6.2.	Specific Regulatory Considerations.....	3.1.6-1
3.1.6.3.	Terrestrial Vegetation .....	3.1.6-2
3.1.6.4.	Wildlife .....	3.1.6-11

	3.1.6.5. Fisheries and Aquatic Habitats .....	3.1.6-33
	3.1.6.6. Threatened and Endangered Species and Species of Conservation Concern.....	3.1.6-43
3.1.7.	Land Use, Airspace, and Recreation.....	3.1.7-1
3.1.8.	Visual Resources.....	3.1.8-1
3.1.9.	Socioeconomics .....	3.1.9-1
3.1.10.	Environmental Justice.....	3.1.10-1
3.1.11.	Cultural Resources .....	3.1.11-1
3.1.12.	Air Quality .....	3.1.12-1
3.1.13.	Noise .....	3.1.13-1
3.1.14.	Climate Change.....	3.1.14-1
3.1.15.	Human Health and Safety .....	3.1.15-1
3.2.	Environmental Consequences.....	3.2-1
3.2.1.	Infrastructure.....	3.2.1-1
3.2.2.	Soils.....	3.2.2-1
3.2.3.	Geology.....	3.2.3-1
3.2.4.	Water Resources .....	3.2.4-1
3.2.5.	Wetlands .....	3.2.5-1
3.2.6.	Biological Resources .....	3.2.6-1
	3.2.6.1. Introduction.....	3.2.6-1
	3.2.6.2. Impact Assessment Methodology and Significance Criteria .....	3.2.6-1
	3.2.6.3. Terrestrial Vegetation .....	3.2.6-8
	3.2.6.4. Wildlife .....	3.2.6-16
	3.2.6.5. Fisheries and Aquatic Habitats .....	3.2.6-38
	3.2.6.6. Threatened and Endangered Species and Species of Conservation Concern.....	3.2.6-52
3.2.7.	Land Use, Airspace, and Recreation.....	3.2.7-1
3.2.8.	Visual Resources.....	3.2.8-1
3.2.9.	Socioeconomics .....	3.2.9-1
3.2.10.	Environmental Justice.....	3.2.10-1
3.2.11.	Cultural Resources .....	3.2.11-1
3.2.12.	Air Quality .....	3.2.12-1
3.2.13.	Noise .....	3.2.13-1
3.2.14.	Climate Change.....	3.2.14-1
3.2.15.	Human Health and Safety .....	3.2.15-1
3.3.	References.....	3.3-1
	3.3.1. Introduction.....	3.3-1
	3.3.2. Affected Environment.....	3.3-2
	3.3.3. Environmental Consequences.....	3.3-33

<b>4. Hawaii .....</b>	<b>4-1</b>
4.1. Affected Environment.....	4.1-1
4.1.1. Infrastructure.....	4.1.1-1
4.1.2. Soils.....	4.1.2-1
4.1.3. Geology.....	4.1.3-1
4.1.4. Water Resources .....	4.1.4-1
4.1.5. Wetlands .....	4.1.5-1
4.1.6. Biological Resources .....	4.1.6-1
4.1.6.1. Introduction.....	4.1.6-1
4.1.6.2. Specific Regulatory Considerations.....	4.1.6-1
4.1.6.3. Terrestrial Vegetation .....	4.1.6-2
4.1.6.4. Wildlife .....	4.1.6-8
4.1.6.5. Fisheries and Aquatic Habitats .....	4.1.6-18
4.1.6.6. Threatened and Endangered Species and Species of Conservation Concern.....	4.1.6-26
4.1.7. Land Use, Airspace, and Recreation.....	4.1.7-1
4.1.8. Visual Resources.....	4.1.8-1
4.1.9. Socioeconomics .....	4.1.9-1
4.1.10. Environmental Justice.....	4.1.10-1
4.1.11. Cultural Resources .....	4.1.11-1
4.1.12. Air Quality .....	4.1.12-1
4.1.13. Noise .....	4.1.13-1
4.1.14. Climate Change.....	4.1.14-1
4.1.15. Human Health and Safety .....	4.1.15-1
4.2. Environmental Consequences.....	4.2-1
4.2.1. Infrastructure.....	4.2.1-1
4.2.2. Soils.....	4.2.2-1
4.2.3. Geology.....	4.2.3-1
4.2.4. Water Resources .....	4.2.4-1
4.2.5. Wetlands .....	4.2.5-1
4.2.6. Biological Resources .....	4.2.6-1
4.2.6.1. Introduction.....	4.2.6-1
4.2.6.2. Impact Assessment Methodology and Significance Criteria .....	4.2.6-1
4.2.6.3. Terrestrial Vegetation .....	4.2.6-8
4.2.6.4. Wildlife .....	4.2.6-16
4.2.6.5. Fisheries and Aquatic Habitats .....	4.2.6-36
4.2.6.6. Threatened and Endangered Species and Species of Conservation Concern.....	4.2.6-50
4.2.7. Land Use, Airspace, and Recreation.....	4.2.7-1
4.2.8. Visual Resources.....	4.2.8-1
4.2.9. Socioeconomics .....	4.2.9-1
4.2.10. Environmental Justice.....	4.2.10-1



4.2.11.	Cultural Resources .....	4.2.11-1
4.2.12.	Air Quality .....	4.2.12-1
4.2.13.	Noise .....	4.2.13-1
4.2.14.	Climate Change.....	4.2.14-1
4.2.15.	Human Health and Safety .....	4.2.15-1
4.3.	References .....	4.3-1
4.3.1.	Introduction.....	4.3-1
4.3.2.	Affected Environment.....	4.3-3
4.3.3.	Environmental Consequences .....	4.3-28
<b>5.</b>	<b>American Samoa .....</b>	<b>5-1</b>
5.1.	Affected Environment.....	5.1-1
5.1.1.	Infrastructure.....	5.1.1-1
5.1.2.	Soils.....	5.1.2-1
5.1.3.	Geology.....	5.1.3-1
5.1.4.	Water Resources .....	5.1.4-1
5.1.5.	Wetlands .....	5.1.5-1
5.1.6.	Biological Resources .....	5.1.6-1
5.1.6.1.	Introduction.....	5.1.6-1
5.1.6.2.	Specific Regulatory Considerations.....	5.1.6-1
5.1.6.3.	Terrestrial Vegetation .....	5.1.6-2
5.1.6.4.	Wildlife .....	5.1.6-10
5.1.6.5.	Fisheries and Aquatic Habitats .....	5.1.6-19
5.1.6.6.	Threatened and Endangered Species and Species of Conservation Concern.....	5.1.6-29
5.1.7.	Land Use, Airspace, and Recreation.....	5.1.7-1
5.1.8.	Visual Resources.....	5.1.8-1
5.1.9.	Socioeconomics .....	5.1.9-1
5.1.10.	Environmental Justice.....	5.1.10-1
5.1.11.	Cultural Resources .....	5.1.11-1
5.1.12.	Air Quality .....	5.1.12-1
5.1.13.	Noise .....	5.1.13-1
5.1.14.	Climate Change.....	5.1.14-1
5.1.15.	Human Health and Safety .....	5.1.15-1
5.2.	Environmental Consequences .....	5.2-1
5.2.1.	Infrastructure.....	5.2.1-1
5.2.2.	Soils.....	5.2.2-1
5.2.3.	Geology.....	5.2.3-1
5.2.4.	Water Resources .....	5.2.4-1
5.2.5.	Wetlands .....	5.2.5-1

5.2.6.	Biological Resources .....	5.2.6-1
5.2.6.1.	Introduction.....	5.2.6-1
5.2.6.2.	Impact Assessment Methodology and Significance Criteria .....	5.2.6-1
5.2.6.3.	Terrestrial Vegetation .....	5.2.6-8
5.2.6.4.	Wildlife .....	5.2.6-16
5.2.6.5.	Fisheries and Aquatic Habitats .....	5.2.6-36
5.2.6.6.	Threatened and Endangered Species and Species of Conservation Concern.....	5.2.6-50
5.2.7.	Land Use, Airspace, and Recreation.....	5.2.7-1
5.2.8.	Visual Resources.....	5.2.8-1
5.2.9.	Socioeconomics .....	5.2.9-1
5.2.10.	Environmental Justice.....	5.2.10-1
5.2.11.	Cultural Resources .....	5.2.11-1
5.2.12.	Air Quality .....	5.2.12-1
5.2.13.	Noise .....	5.2.13-1
5.2.14.	Climate Change.....	5.2.14-1
5.2.15.	Human Health and Safety .....	5.2.15-1
5.3.	References.....	5.3-1
5.3.1.	Introduction.....	5.3-1
5.3.2.	Affected Environment.....	5.3-2
5.3.3.	Environmental Consequences.....	5.3-27
<b>6.</b>	<b>Guam.....</b>	<b>6-1</b>
6.1.	Affected Environment.....	6.1-1
6.1.1.	Infrastructure.....	6.1.1-1
6.1.2.	Soils.....	6.1.2-1
6.1.3.	Geology.....	6.1.3-1
6.1.4.	Water Resources .....	6.1.4-1
6.1.5.	Wetlands .....	6.1.5-1
6.1.6.	Biological Resources .....	6.1.6-1
6.1.6.1.	Introduction.....	6.1.6-1
6.1.6.2.	Specific Regulatory Considerations.....	6.1.6-1
6.1.6.3.	Terrestrial Vegetation .....	6.1.6-2
6.1.6.4.	Wildlife .....	6.1.6-7
6.1.6.5.	Fisheries and Aquatic Habitats .....	6.1.6-18
6.1.6.6.	Threatened and Endangered Species and Species of Conservation Concern.....	6.1.6-26
6.1.7.	Land Use, Airspace, and Recreation.....	6.1.7-1
6.1.8.	Visual Resources.....	6.1.8-1
6.1.9.	Socioeconomics .....	6.1.9-1
6.1.10.	Environmental Justice.....	6.1.10-1
6.1.11.	Cultural Resources .....	6.1.11-1

6.1.12.	Air Quality .....	6.1.12-1
6.1.13.	Noise .....	6.1.13-1
6.1.14.	Climate Change.....	6.1.14-1
6.1.15.	Human Health and Safety .....	6.1.15-1
6.2.	Environmental Consequences .....	6.2-1
6.2.1.	Infrastructure.....	6.2.1-1
6.2.2.	Soils.....	6.2.2-1
6.2.3.	Geology.....	6.2.3-1
6.2.4.	Water Resources .....	6.2.4-1
6.2.5.	Wetlands .....	6.2.5-1
6.2.6.	Biological Resources .....	6.2.6-1
6.2.6.1.	Introduction.....	6.2.6-1
6.2.6.2.	Impact Assessment Methodology and Significance Criteria .....	6.2.6-1
6.2.6.3.	Terrestrial Vegetation .....	6.2.6-8
6.2.6.4.	Wildlife .....	6.2.6-16
6.2.6.5.	Fisheries and Aquatic Habitats .....	6.2.6-36
6.2.6.6.	Threatened and Endangered Species and Species of Conservation Concern.....	6.2.6-50
6.2.7.	Land Use, Airspace, and Recreation.....	6.2.7-1
6.2.8.	Visual Resources.....	6.2.8-1
6.2.9.	Socioeconomics .....	6.2.9-1
6.2.10.	Environmental Justice.....	6.2.10-1
6.2.11.	Cultural Resources .....	6.2.11-1
6.2.12.	Air Quality .....	6.2.12-1
6.2.13.	Noise .....	6.2.13-1
6.2.14.	Climate Change.....	6.2.14-1
6.2.15.	Human Health and Safety .....	6.2.15-1
6.3.	References.....	6.3-1
6.3.1.	Introduction.....	6.3-1
6.3.2.	Affected Environment.....	6.3-2
6.3.3.	Environmental Consequences.....	6.3-24
<b>7.</b>	<b>Northern Mariana Islands .....</b>	<b>7-1</b>
7.1.	Affected Environment.....	7.1-1
7.1.1.	Infrastructure.....	7.1.1-1
7.1.2.	Soils.....	7.1.2-1
7.1.3.	Geology.....	7.1.3-1
7.1.4.	Water Resources .....	7.1.4-1
7.1.5.	Wetlands .....	7.1.5-1
7.1.6.	Biological Resources .....	7.1.6-1
7.1.6.1.	Introduction.....	7.1.6-1
7.1.6.2.	Specific Regulatory Considerations.....	7.1.6-1

	7.1.6.3. Terrestrial Vegetation .....	7.1.6-2
	7.1.6.4. Wildlife .....	7.1.6-8
	7.1.6.5. Fisheries and Aquatic Habitats .....	7.1.6-17
	7.1.6.6. Threatened and Endangered Species and Species of Conservation Concern.....	7.1.6-25
7.1.7.	Land Use, Airspace, and Recreation.....	7.1.7-1
7.1.8.	Visual Resources.....	7.1.8-1
7.1.9.	Socioeconomics .....	7.1.9-1
7.1.10.	Environmental Justice.....	7.1.10-1
7.1.11.	Cultural Resources .....	7.1.11-1
7.1.12.	Air Quality .....	7.1.12-1
7.1.13.	Noise .....	7.1.13-1
7.1.14.	Climate Change.....	7.1.14-1
7.1.15.	Human Health and Safety .....	7.1.15-1
7.2.	Environmental Consequences .....	7.2-1
7.2.1.	Infrastructure.....	7.2.1-1
7.2.2.	Soils.....	7.2.2-1
7.2.3.	Geology.....	7.2.3-1
7.2.4.	Water Resources .....	7.2.4-1
7.2.5.	Wetlands .....	7.2.5-1
7.2.6.	Biological Resources .....	7.2.6-1
	7.2.6.1. Introduction.....	7.2.6-1
	7.2.6.2. Impact Assessment Methodology and Significance Criteria .....	7.2.6-1
	7.2.6.3. Terrestrial Vegetation .....	7.2.6-8
	7.2.6.4. Wildlife .....	7.2.6-16
	7.2.6.5. Fisheries and Aquatic Habitats .....	7.2.6-37
	7.2.6.6. Threatened and Endangered Species and Species of Conservation Concern.....	7.2.6-51
7.2.7.	Land Use, Airspace, and Recreation.....	7.2.7-1
7.2.8.	Visual Resources.....	7.2.8-1
7.2.9.	Socioeconomics .....	7.2.9-1
7.2.10.	Environmental Justice.....	7.2.10-1
7.2.11.	Cultural Resources .....	7.2.11-1
7.2.12.	Air Quality .....	7.2.12-1
7.2.13.	Noise .....	7.2.13-1
7.2.14.	Climate Change.....	7.2.14-1
7.2.15.	Human Health and Safety .....	7.2.15-1
7.3.	References.....	7.3-1
	7.3.1. Introduction.....	7.3-1
	7.3.2. Affected Environment.....	7.3-2
	7.3.3. Environmental Consequences.....	7.3-23

<b>8. Puerto Rico .....</b>	<b>8-1</b>
8.1. Affected Environment.....	8.1-1
8.1.1. Infrastructure.....	8.1.1-1
8.1.2. Soils.....	8.1.2-1
8.1.3. Geology.....	8.1.3-1
8.1.4. Water Resources .....	8.1.4-1
8.1.5. Wetlands .....	8.1.5-1
8.1.6. Biological Resources .....	8.1.6-1
8.1.6.1. Introduction.....	8.1.6-1
8.1.6.2. Specific Regulatory Considerations.....	8.1.6-1
8.1.6.3. Terrestrial Vegetation .....	8.1.6-2
8.1.6.4. Wildlife .....	8.1.6-6
8.1.6.5. Fisheries and Aquatic Habitats .....	8.1.6-19
8.1.6.6. Threatened and Endangered Species and Species of Conservation Concern.....	8.1.6-26
8.1.7. Land Use, Airspace, and Recreation.....	8.1.7-1
8.1.8. Visual Resources.....	8.1.8-1
8.1.9. Socioeconomics .....	8.1.9-1
8.1.10. Environmental Justice.....	8.1.10-1
8.1.11. Cultural Resources.....	8.1.11-1
8.1.12. Air Quality .....	8.1.12-1
8.1.13. Noise .....	8.1.13-1
8.1.14. Climate Change.....	8.1.14-1
8.1.15. Human Health and Safety .....	8.1.15-1
8.2. Environmental Consequences.....	8.2-1
8.2.1. Infrastructure.....	8.2.1-1
8.2.2. Soils.....	8.2.2-1
8.2.3. Geology.....	8.2.3-1
8.2.4. Water Resources .....	8.2.4-1
8.2.5. Wetlands .....	8.2.5-1
8.2.6. Biological Resources .....	8.2.6-1
8.2.6.1. Introduction.....	8.2.6-1
8.2.6.2. Impact Assessment Methodology and Significance Criteria .....	8.2.6-1
8.2.6.3. Terrestrial Vegetation .....	8.2.6-8
8.2.6.4. Wildlife .....	8.2.6-16
8.2.6.5. Fisheries and Aquatic Habitats .....	8.2.6-36
8.2.6.6. Threatened and Endangered Species and Species of Conservation Concern.....	8.2.6-50
8.2.7. Land Use, Airspace, and Recreation.....	8.2.7-1
8.2.8. Visual Resources.....	8.2.8-1
8.2.9. Socioeconomics .....	8.2.9-1
8.2.10. Environmental Justice.....	8.2.10-1

8.2.11.	Cultural Resources .....	8.2.11-1
8.2.12.	Air Quality .....	8.2.12-1
8.2.13.	Noise .....	8.2.13-1
8.2.14.	Climate Change.....	8.2.14-1
8.2.15.	Human Health and Safety .....	8.2.15-1
8.3.	References .....	8.3-1
8.3.1.	Introduction.....	8.3-1
8.3.2.	Affected Environment.....	8.3-2
8.3.3.	Environmental Consequences .....	8.3-27
<b>9.</b>	<b>U.S. Virgin Islands .....</b>	<b>9-1</b>
9.1.	Affected Environment.....	9.1-1
9.1.1.	Infrastructure.....	9.1.1-1
9.1.2.	Soils.....	9.1.2-1
9.1.3.	Geology.....	9.1.3-1
9.1.4.	Water Resources .....	9.1.4-1
9.1.5.	Wetlands .....	9.1.5-1
9.1.6.	Biological Resources .....	9.1.6-1
9.1.6.1.	Introduction.....	9.1.6-1
9.1.6.2.	Specific Regulatory Considerations.....	9.1.6-1
9.1.6.3.	Terrestrial Vegetation .....	9.1.6-2
9.1.6.4.	Wildlife .....	9.1.6-7
9.1.6.5.	Fisheries and Aquatic Habitats .....	9.1.6-19
9.1.6.6.	Threatened and Endangered Species and Species of Conservation Concern.....	9.1.6-27
9.1.7.	Land Use, Airspace, and Recreation.....	9.1.7-1
9.1.8.	Visual Resources.....	9.1.8-1
9.1.9.	Socioeconomics .....	9.1.9-1
9.1.10.	Environmental Justice.....	9.1.10-1
9.1.11.	Cultural Resources .....	9.1.11-1
9.1.12.	Air Quality .....	9.1.12-1
9.1.13.	Noise .....	9.1.13-1
9.1.14.	Climate Change.....	9.1.14-1
9.1.15.	Human Health and Safety .....	9.1.15-1
9.2.	Environmental Consequences .....	9.2-1
9.2.1.	Infrastructure.....	9.2.1-1
9.2.2.	Soils.....	9.2.2-1
9.2.3.	Geology.....	9.2.3-1
9.2.4.	Water Resources .....	9.2.4-1
9.2.5.	Wetlands .....	9.2.5-1

9.2.6.	Biological Resources .....	9.2.6-1
9.2.6.1.	Introduction.....	9.2.6-1
9.2.6.2.	Impact Assessment Methodology and Significance Criteria .....	9.2.6-1
9.2.6.3.	Terrestrial Vegetation .....	9.2.6-8
9.2.6.4.	Wildlife .....	9.2.6-16
9.2.6.5.	Fisheries and Aquatic Habitats .....	9.2.6-36
9.2.6.6.	Threatened and Endangered Species and Species of Conservation Concern.....	9.2.6-50
9.2.7.	Land Use, Airspace, and Recreation.....	9.2.7-1
9.2.8.	Visual Resources.....	9.2.8-1
9.2.9.	Socioeconomics .....	9.2.9-1
9.2.10.	Environmental Justice.....	9.2.10-1
9.2.11.	Cultural Resources .....	9.2.11-1
9.2.12.	Air Quality .....	9.2.12-1
9.2.13.	Noise .....	9.2.13-1
9.2.14.	Climate Change.....	9.2.14-1
9.2.15.	Human Health and Safety .....	9.2.15-1
9.3.	References.....	9.3-1
9.3.1.	Introduction.....	9.3-1
9.3.2.	Affected Environment.....	9.3-2
9.3.3.	Environmental Consequences.....	9.3-27
<b>10.</b>	<b>Cumulative Effects.....</b>	<b>10-1</b>
<b>11.</b>	<b>BMPs and Mitigation Measures .....</b>	<b>11-1</b>
11.1.	Infrastructure.....	11-2
11.1.1.	BMPs and Mitigation Measures for All Project Types.....	11-2
11.1.2.	Project-Type Specific BMPs and Mitigation Measures.....	11-3
11.2.	Soils.....	11-3
11.2.1.	BMPs and Mitigation Measures for All Project Types.....	11-3
11.2.2.	Project-Type Specific BMPs and Mitigation Measures.....	11-4
11.3.	Geology.....	11-4
11.3.1.	BMPs and Mitigation Measures for All Project Types.....	11-4
11.3.2.	Project-Type Specific BMPs and Mitigation Measures.....	11-5
11.4.	Water Resources .....	11-6
11.4.1.	BMPs and Mitigation Measures for All Project Types.....	11-6
11.4.2.	Project-Type Specific BMPs and Mitigation Measures.....	11-8
11.5.	Wetlands .....	11-9
11.5.1.	BMPs and Mitigation Measures for All Project Types.....	11-9
11.5.2.	Project-Type Specific BMPs and Mitigation Measures.....	11-11

11.6.	Biological Resources .....	11-12
11.6.1.	Terrestrial Vegetation .....	11-12
11.6.2.	Wildlife .....	11-13
11.6.3.	Fisheries and Aquatic Habitats .....	11-19
11.6.4.	Threatened and Endangered Species and Species of Conservation Concern .....	11-21
11.7.	Land use, Airspace, and Recreation.....	11-24
11.7.1.	BMPs and Mitigation Measures for All Project Types.....	11-24
11.7.2.	Project-Type Specific BMPs and Mitigation Measures.....	11-24
11.8.	Visual Resources.....	11-25
11.8.1.	BMPs and Mitigation Measures for All Project Types.....	11-25
11.8.2.	Project-Type Specific BMPs and Mitigation Measures.....	11-26
11.9.	Socioeconomics .....	11-26
11.9.1.	BMPs and Mitigation Measures for All Project Types.....	11-26
11.9.2.	Project-Type Specific BMPs and Mitigation Measures.....	11-27
11.10.	Environmental Justice.....	11-27
11.10.1.	BMPs and Mitigation Measures for All Project Types.....	11-27
11.10.2.	Project-Type Specific BMPs and Mitigation Measures.....	11-28
11.11.	Cultural Resources .....	11-29
11.11.1.	BMPs and Mitigation Measures for All Project Types.....	11-29
11.11.2.	Project-Type Specific BMPs and Mitigation Measures.....	11-29
11.12.	Air Quality .....	11-30
11.12.1.	BMPs and Mitigation Measures for All Project Types.....	11-30
11.12.2.	Project-Type Specific BMPs and Mitigation Measures.....	11-31
11.13.	Noise .....	11-31
11.13.1.	BMPs and Mitigation Measures for All Project Types.....	11-31
11.13.2.	Project-Type Specific BMPs and Mitigation Measures.....	11-32
11.14.	Climate Change.....	11-32
11.14.1.	BMPs and Mitigation Measures for All Project Types.....	11-32
11.14.2.	Project-Type Specific BMPs and Mitigation Measures.....	11-33
11.15.	Human Health and Safety .....	11-33
11.15.1.	BMPs and Mitigation Measures for All Project Types.....	11-33
11.15.2.	Project-Type Specific BMPs and Mitigation Measures.....	11-36
11.16.	References.....	11-36
11.16.1.	Wildlife .....	11-36
11.16.2.	Fisheries and Aquatic Habitats .....	11-37
11.16.3.	Threatened and Endangered Species and Species of Conservation Concern .....	11-38
11.16.4.	Land Use, Airspace, and Recreation.....	11-38
11.16.5.	Socioeconomics .....	11-38
11.16.6.	Environmental Justice.....	11-38
11.16.7.	Human Health and Safety .....	11-38



<b>12. Comparison of Alternatives .....</b>	<b>12-1</b>
12.1. Introduction.....	12-1
12.2. Comparison of Alternatives .....	12-3
12.3. References.....	12-9
<b>13. Other Required Analyses .....</b>	<b>13-1</b>
13.1. Unavoidable Adverse Impacts .....	13-1
13.2. Irreversible or Irretrievable Commitment of Resources .....	13-1
13.3. Relationship Between Short-term and Long-term Productivity .....	13-3
<b>14. List of Preparers and Contributors.....</b>	<b>14-1</b>
<b>15. Distribution List.....</b>	<b>15-1</b>
<b>16. Index.....</b>	<b>16-1</b>
<b>17. Glossary .....</b>	<b>17-1</b>

## **APPENDICES**

- A Cooperating Agencies
- B First Responder Network Authority Nationwide Public Safety Broadband Network  
Programmatic Environmental Impact Statement Scoping Summary Report
- C Environmental Laws and Regulations
- D Threatened and Endangered Species
- E Environmental Justice Demographic Data
- F Climate Change Sources and Models
- G Hawaii Register of Historic Places

## LIST OF TABLES

Table 2.4.1-1:	FCC Regulatory Levels .....	2-10
Table 3.1.1-1:	Public Safety Communications System.....	3.1.1-7
Table 3.1.1-2:	Other Communication Systems .....	3.1.1-8
Table 3.1.2-1:	Major Land Resource Areas in Alaska .....	3.1.2-4
Table 3.1.2-2:	General Characteristics of Soil Suborders Found in Alaska.....	3.1.2-7
Table 3.1.4-1:	Total Surface Waters for Alaska.....	3.1.4-2
Table 3.1.4-2:	Water Quality Summary for Alaska Waterbodies .....	3.1.4-6
Table 3.1.4-3:	Alaska Groundwater Withdrawals in 2005.....	3.1.4-9
Table 3.1.5-1:	Acreages, Types, and Descriptions of Wetlands in Alaska .....	3.1.5-5
Table 3.1.6.3-1:	Vegetation Types/ Land Cover Classes in Alaska.....	3.1.6-4
Table 3.1.6.3-2:	Biophysical Settings and Plant Associations of Concern in Alaska .....	3.1.6-5
Table 3.1.6.6-1:	Federal- and State-listed Threatened and Endangered and Candidate Species Known to Occur in Alaska .....	3.1.6-46
Table 3.1.7-1:	Land Use/Land Cover in Alaska.....	3.1.7-4
Table 3.1.7-2:	Major Land Owners in Alaska.....	3.1.7-5
Table 3.1.7-3:	Acreage of Recreational Lands in Alaska, by Type .....	3.1.7-9
Table 3.1.9-1:	National, State, and Borough Population, Population Density, and Growth Rates .....	3.1.9-5
Table 3.1.9-2:	Population Projections .....	3.1.9-7
Table 3.1.9-3:	Select Economic Indicators .....	3.1.9-8
Table 3.1.9-4:	Housing Units, Occupancy, and Tenure .....	3.1.9-12
Table 3.1.9-5:	Housing Costs.....	3.1.9-13
Table 3.1.9-6:	Median Value of Owner Occupied Single Family Homes, 2009 to 2013 American Community Survey .....	3.1.9-14
Table 3.1.9-7:	Real Estate Taxes, Owner-Occupied Units with a Mortgage, 2013 .....	3.1.9-16
Table 3.1.10-1:	Race and Ethnicity, Alaska.....	3.1.10-3
Table 3.1.11-1:	Cultural Resources Listed on the NRHP .....	3.1.11-8
Table 3.1.12-1:	Ambient Air Quality Standards in Alaska.....	3.1.12-2
Table 3.1.12-2:	Nonattainment and Maintenance Areas in Alaska.....	3.1.12-4
Table 3.1.12-3:	PSD Allowable Increase Increments .....	3.1.12-6
Table 3.1.12-4:	Alaska Class I Areas.....	3.1.12-6
Table 3.1.12-5:	General Conformity Emissions Thresholds in Alaska.....	3.1.12-8
Table 3.1.13-1:	Allowable Noise Levels by Receiving Land Use in Anchorage, Alaska .....	3.1.13-1
Table 3.1.13-2:	Typical Noise Levels and Possible Human Effects .....	3.1.13-2
Table 3.1.13-3:	Typical Outdoor Sound Levels by Land Use Category .....	3.1.13-3
Table 3.1.14-1:	Climatic Regions of Alaska .....	3.1.14-7
Table 3.1.14-2:	Annual Average Temperature, Humidity, Precipitation, and Wind Speed Data for Anchorage, Barrow, Fairbanks, Juneau, and Kodiak, Alaska .....	3.1.14-8
Table 3.1.14-3:	Recorded Severe Weather Occurrences for Alaskan Boroughs/Census Zones (1996-2014) .....	3.1.14-8

Table 3.1.15-1:	Key Health Indicators for Alaska .....	3.1.15-2
Table 3.1.15-2:	Health Conditions Affected by Air Pollution .....	3.1.15-4
Table 3.1.15-3:	Alaska Active Superfund Sites .....	3.1.15-5
Table 3.2.1-1:	Impact Significance Rating Criteria for Infrastructure .....	3.2.1-2
Table 3.2.2-1:	Impact Significance Rating Criteria for Soils .....	3.2.2-2
Table 3.2.3-1:	Impact Significance Rating Criteria for Geology .....	3.2.3-2
Table 3.2.4-1:	Impact Significance Rating Criteria for Water Resources .....	3.2.4-2
Table 3.2.5-1:	Impact Significance Rating Criteria for Wetlands .....	3.2.5-2
Table 3.2.6.2-1:	Impact Significance Rating Criteria for Terrestrial Vegetation, Wildlife, and Fisheries and Aquatic Habitats .....	3.2.6-2
Table 3.2.6.6-1:	Impact Significance Rating Criteria for Listed Species and Critical Habitats .....	3.2.6-53
Table 3.2.6.6-2:	Summary of Information on Federally and State-Listed Species and Critical Habitats .....	3.2.6-56
Table 3.2.6.6-3:	Determination of Impact Significance for Listed Species as a Result of the Preferred Alternative .....	3.2.6-69
Table 3.2.6.6-4:	Determination of Impact Significance for Listed Species and Critical Habitats as a Result of the Deployable Technologies Alternative .....	3.2.6-71
Table 3.2.7-1:	Impact Significance Rating Criteria for Land Use, Airspace, and Recreation .....	3.2.7-2
Table 3.2.8-1:	Impact Significance Rating Criteria for Visual Resources .....	3.2.8-2
Table 3.2.9-1:	Impact Significance Rating Criteria for Socioeconomics .....	3.2.9-2
Table 3.2.10-1:	Impact Significance Rating Criteria for Environmental Justice .....	3.2.10-2
Table 3.2.11-1:	Impact Significance Rating Criteria for Cultural Resources .....	3.2.11-2
Table 3.2.12-1:	Impact Significance Rating Criteria for Air Quality .....	3.2.12-2
Table 3.2.12-2:	Combustion Emission Estimates (Monthly) from New Buried Wired Project Deployment .....	3.2.12-7
Table 3.2.12-3:	Combustion Emission Estimates (Monthly) from New Aerial Wired Project Deployment .....	3.2.12-8
Table 3.2.12-4:	Combustion Emission Estimates (Monthly) from Tower, Structure, and Transmission Equipment Delivery and Installation .....	3.2.12-8
Table 3.2.12-5:	Dust Emission Estimates (Monthly) from Excavation/Filling and Grading/ Earth Moving Activities .....	3.2.12-9
Table 3.2.12-6:	Combustion Emission Estimates from Heavy-Duty Vehicles .....	3.2.12-12
Table 3.2.12-7:	Combustion Emission Estimates from Light-Duty Trucks .....	3.2.12-12
Table 3.2.12-8:	Combustion Emission Estimates from Diesel Backup Power Generators at Wireless Communication Towers .....	3.2.12-16
Table 3.2.12-9:	Combustion Emission Estimates from Diesel Generators on On-Road Vehicles Stationed On-Site .....	3.2.12-17
Table 3.2.13-1:	Impact Significance Rating Criteria for Noise .....	3.2.13-2
Table 3.2.13-2:	Limiting Distances for Maximum Noise Levels Associated with New Buried Wired Activities such as Plowing, Wire Installation, and Construction of Points of Presence and Fiber Huts .....	3.2.13-6

Table 3.2.13-3:	Limiting Distances for Maximum Noise Levels Associated with New Aerial Wired Activities such as Excavation, Grading, and Pole Delivery and Installation .....	3.2.13-7
Table 3.2.13-4:	Limiting Distances for Maximum Noise Levels Associated with Tower, Structure, and Transmission Equipment Delivery and Installation .....	3.2.13-7
Table 3.2.13-5:	Limiting Distances for Maximum Noise Levels Associated with Collocation on Existing Wireless Tower, Structure, or Building.....	3.2.13-10
Table 3.2.13-6:	Limiting Distances for Maximum Noise Levels Associated with Deployable Technologies Implementation—Short-Term.....	3.2.13-11
Table 3.2.13-7:	Limiting Distances for Maximum Noise Levels Associated with Power Generators and Ventilation Fans at Fiber Huts or Central Offices.....	3.2.13-16
Table 3.2.13-8:	Limiting Distances for Maximum Noise Levels Associated with Deployable Technologies Implementation – Long-Term .....	3.2.13-18
Table 3.2.14-1:	Impact Significance Rating Criteria for Climate Change.....	3.2.14-2
Table 3.2.14-2:	Projected Temperature and Precipitation Changes.....	3.2.14-4
Table 3.2.14-3:	Projected Global Sea Level Rise Relative to 1992 .....	3.2.14-6
Table 3.2.14-4:	GHG Emission Estimates from Buried Wired Project Deployment.....	3.2.14-10
Table 3.2.14-5:	GHG Emission Estimates from New Aerial Wired Project Deployment.....	3.2.14-12
Table 3.2.14-6:	GHG Emissions Estimates from Tower, Structure, and Transmission Equipment Delivery and Installation .....	3.2.14-13
Table 3.2.14-7:	GHG Emissions Estimates from Heavy and Light Duty Vehicles .....	3.2.14-14
Table 3.2.14-8:	GHG Emissions from Back-up Diesel Power Generators for Wireless Projects .....	3.2.14-17
Table 3.2.14-9:	GHG Emissions from Power Generators for Deployable Technologies .....	3.2.14-17
Table 3.2.15-1:	Impact Significance Rating Criteria for Human Health and Safety .....	3.2.15-2
Table 4.1.1-1:	Airport Distribution by Island in the State of Hawaii.....	4.1.1-6
Table 4.1.1-2:	Hospitals by County in the State of Hawaii.....	4.1.1-10
Table 4.1.1-3:	Public Safety Communications System.....	4.1.1-13
Table 4.1.1-4:	Other Communication Systems .....	4.1.1-13
Table 4.1.2-1:	Major Land Resource Areas in Hawaii .....	4.1.2-4
Table 4.1.2-2:	General Characteristics of Soil Suborders Found in Hawaii .....	4.1.2-6
Table 4.1.3-1:	Volcanoes in Hawaii.....	4.1.3-7
Table 4.1.4-1:	Total Surface Waters for Hawaii .....	4.1.4-2
Table 4.1.4-2:	Summary of Impaired and Attaining Marine Waterbodies in Hawaii.....	4.1.4-10
Table 4.1.5-1:	Acreages, Types, and Descriptions of Wetlands in Hawaii.....	4.1.5-5
Table 4.1.6.3-1:	Vegetation Types/ Land Cover Classes in Hawaii .....	4.1.6-4
Table 4.1.6.6-1:	Federal- and State-listed Threatened and Endangered and Candidate Species Known to Occur in Hawaii .....	4.1.6-28
Table 4.1.7-1:	Land Use/Land Cover in Hawaii .....	4.1.7-7
Table 4.1.7-2:	State Land Use Districts .....	4.1.7-9
Table 4.1.7-3:	Major Land Owners in Hawaii .....	4.1.7-10
Table 4.1.7-4:	Acreage of Recreational Lands in Hawaii, by Type.....	4.1.7-15

Table 4.1.9-1:	National, State, and County Population, Population Density, and Growth Rates .....	4.1.9-3
Table 4.1.9-2:	Population Projections .....	4.1.9-3
Table 4.1.9-3:	Select Economic Indicators .....	4.1.9-4
Table 4.1.9-4:	Housing Units, Occupancy, and Tenure .....	4.1.9-6
Table 4.1.9-5:	Housing Costs .....	4.1.9-7
Table 4.1.9-6:	Median Value of Owner Occupied Single Family Homes, 2009 to 2013 American Community Survey .....	4.1.9-7
Table 4.1.9-7:	Real Estate Taxes, Owner-Occupied Units with a Mortgage .....	4.1.9-8
Table 4.1.10-1:	Race and Ethnicity .....	4.1.10-4
Table 4.1.11-1:	Cultural Resources Listed on the NRHP .....	4.1.11-6
Table 4.1.12-1:	Ambient Air Quality Standards in Hawaii .....	4.1.12-2
Table 4.1.12-2:	PSD Allowable Increase Increments .....	4.1.12-5
Table 4.1.12-3:	Hawaii Class I Areas .....	4.1.12-5
Table 4.1.13-1:	Maximum Permissible Sound Levels (dBA) in Hawaii .....	4.1.13-2
Table 4.1.13-2:	Maximum Permissible Sound Levels per Octave Band Center Frequency for Intensive Industrial and Waterfront Districts in Honolulu .....	4.1.13-2
Table 4.1.13-3:	Typical Noise Levels and Possible Human Effects .....	4.1.13-3
Table 4.1.13-4:	Typical Outdoor Sound Levels by Land Use Category .....	4.1.13-4
Table 4.1.14-1:	Annual Average Temperature, Humidity, Precipitation, and Wind Speed Data for Hawaii .....	4.1.14-6
Table 4.1.14-2:	Hawaii Severe Weather System Characteristics .....	4.1.14-6
Table 4.1.14-3:	Severe Weather Data for Hawaii (1996-2014) .....	4.1.14-7
Table 4.1.15-1:	Key Health Indicators for Hawaii .....	4.1.15-2
Table 4.1.15-2:	Health Conditions Affected by Air Pollution .....	4.1.15-4
Table 4.1.15-3:	Hawaii Active Superfund Sites .....	4.1.15-5
Table 4.2.1-1:	Impact Significance Rating Criteria for Infrastructure .....	4.2.1-2
Table 4.2.2-1:	Impact Significance Rating Criteria for Soils .....	4.2.2-2
Table 4.2.3-1:	Impact Significance Rating Criteria for Geology .....	4.2.3-2
Table 4.2.4-1:	Impact Significance Rating Criteria for Water Resources .....	4.2.4-2
Table 4.2.5-1:	Impact Significance Rating Criteria for Wetlands .....	4.2.5-2
Table 4.2.6.2-1:	Impact Significance Rating Criteria for Terrestrial Vegetation, Wildlife, and Fisheries and Aquatic Habitats .....	4.2.6-2
Table 4.2.6.6-1:	Impact Significance Rating Criteria for Listed Species and Critical Habitats .....	4.2.6-51
Table 4.2.6.6-2:	Summary of Information on Federally and State-Listed Species in Hawaii .....	4.2.6-54
Table 4.2.6.6-3:	Determination of Impact Significance for Listed Species as a Result of the Preferred Alternative .....	4.2.6-67
Table 4.2.6.6-4:	Determination of Impact Significance for Listed Species as a Result of the Deployable Technologies Alternative .....	4.2.6-69
Table 4.2.7-1:	Impact Significance Rating Criteria for Land Use, Airspace, and Recreation .....	4.2.7-2
Table 4.2.8-1:	Impact Significance Rating Criteria for Visual Resources .....	4.2.8-2
Table 4.2.9-1:	Impact Significance Rating Criteria for Socioeconomics .....	4.2.9-2
Table 4.2.10-1:	Impact Significance Rating Criteria for Environmental Justice .....	4.2.10-2

Table 4.2.11-1:	Impact Significance Rating Criteria for Cultural Resources .....	4.2.11-2
Table 4.2.12-1:	Impact Significance Rating Criteria for Air Quality .....	4.2.12-2
Table 4.2.12-2:	Combustion Emission Estimates (Monthly) from New Buried Wired Project Deployment .....	4.2.12-7
Table 4.2.12-3:	Combustion Emission Estimates (Monthly) from New Aerial Wired Project Deployment .....	4.2.12-8
Table 4.2.12-4:	Combustion Emission Estimates (Monthly) from Tower, Structure, and Transmission Equipment Delivery and Installation.....	4.2.12-8
Table 4.2.12-5:	Dust Emission Estimates (Monthly) from Excavation/Filling and Grading/ Earth Moving Activities .....	4.2.12-9
Table 4.2.12-6:	Combustion Emission Estimates from Heavy-Duty Vehicles.....	4.2.12-11
Table 4.2.12-7:	Combustion Emission Estimates from Light-Duty Trucks.....	4.2.12-12
Table 4.2.12-8:	Combustion Emission Estimates from Diesel Backup Power Generators at Wireless Communication Towers.....	4.2.12-15
Table 4.2.12-9:	Combustion Emission Estimates from Diesel Generators on On-Road Vehicles Stationed On-site .....	4.2.12-16
Table 4.2.13-1:	Impact Significance Rating Criteria for Noise .....	4.2.13-2
Table 4.2.13-2:	Limiting Distances for Maximum Noise Levels Associated with New Buried Wired Activities such as Plowing, Wire Installation, and Construction of Points of Presence and Fiber Huts.....	4.2.13-6
Table 4.2.13-3:	Limiting Distances for Maximum Noise Levels Associated with New Aerial Wired Activities such as Excavation, Grading, and Pole Delivery and Installation .....	4.2.13-7
Table 4.2.13-4:	Limiting Distances for Maximum Noise Levels Associated with Tower, Structure, and Transmission Equipment Delivery and Installation .....	4.2.13-7
Table 4.2.13-5:	Limiting Distances for Maximum Noise Levels Associated with Collocation on Existing Wireless Tower, Structure, or Building.....	4.2.13-10
Table 4.2.13-6:	Limiting Distances for Maximum Noise Levels Associated with Deployable Technologies Implementation – Short-Term.....	4.2.13-11
Table 4.2.13-7:	Limiting Distances for Maximum Noise Levels Associated with Power Generators and Ventilation Fans at Fiber Huts or Central Offices.....	4.2.13-16
Table 4.2.13-8:	Limiting Distances for Maximum Noise Levels Associated with Deployable Technologies Implementation – Long-Term .....	4.2.13-18
Table 4.2.14-1:	Impact Significance Rating Criteria for Climate Change.....	4.2.14-2
Table 4.2.14-2:	Projected Temperature Changes .....	4.2.14-4
Table 4.2.14-3:	Projected Global Sea Level Rise Relative to 1992 .....	4.2.14-6
Table 4.2.14-4:	GHG Emission Estimates from Buried Wired Project Deployment.....	4.2.14-9
Table 4.2.14-5:	GHG Emission Estimates from New Aerial Wired Project Deployment.....	4.2.14-11
Table 4.2.14-6:	GHG Emissions Estimates from Tower, Structure, and Transmission Equipment Delivery and Installation .....	4.2.14-12
Table 4.2.14-7:	GHG Emissions Estimates from Heavy and Light Duty Vehicles .....	4.2.14-13
Table 4.2.14-8:	GHG Emissions from Back-up Diesel Power Generators for Wireless Projects .....	4.2.14-15

Table 4.2.14-9:	GHG Emissions from Power Generators for Deployable Technologies .....	4.2.14-16
Table 4.2.15-1:	Impact Significance Rating Criteria for Human Health and Safety .....	4.2.15-2
Table 5.1.2-1:	Major Characteristics of MUIDs and Soil Types Found in American Samoa .....	5.1.2-3
Table 5.1.4-1:	Total Surface Waters for American Samoa .....	5.1.4-2
Table 5.1.5-1:	Acreages, Types, and Descriptions of Wetlands in the islands of Tutuila and Aunu'u, American Samoa .....	5.1.5-5
Table 5.1.6.3-1:	Vegetation Types/ Land Cover Classes in American Samoa .....	5.1.6-4
Table 5.1.6.3-2:	Endemic Plant Species in American Samoa .....	5.1.6-7
Table 5.1.6.6-1:	Federal- and Territory-listed Threatened and Endangered and Candidate Species Known to Occur in American Samoa .....	5.1.6-31
Table 5.1.7-1:	Land Use/Land Cover in American Samoa .....	5.1.7-5
Table 5.1.7-2:	Major Land Owners in American Samoa .....	5.1.7-6
Table 5.1.7-3:	Acreage of Recreational Lands in American Samoa, by Type .....	5.1.7-8
Table 5.1.9-1:	National, Territory, and District Population, Population Density, and Growth Rates .....	5.1.9-2
Table 5.1.9-2:	Population Projections .....	5.1.9-3
Table 5.1.9-3:	Select Economic Indicators, 2010 .....	5.1.9-4
Table 5.1.9-4:	Housing Units, Occupancy, and Tenure, 2010 .....	5.1.9-4
Table 5.1.9-5:	Housing Costs .....	5.1.9-4
Table 5.1.9-6:	Median Value of Owner Occupied Single Family Homes .....	5.1.9-5
Table 5.1.10-1:	Race and Ethnicity, American Samoa, 2010 .....	5.1.10-3
Table 5.1.11-1:	Cultural Resources Listed on the NRHP .....	5.1.11-5
Table 5.1.12-1:	Ambient Air Quality Standards in American Samoa .....	5.1.12-2
Table 5.1.12-2:	PSD Allowable Increase Increments .....	5.1.12-4
Table 5.1.13-1:	Typical Noise Levels and Possible Human Effects .....	5.1.13-2
Table 5.1.13-2:	Typical Outdoor Sound Levels by Land Use Category .....	5.1.13-3
Table 5.1.14-1:	Annual Average Temperature, Humidity, Precipitation, and Wind Speed Data for American Samoa .....	5.1.14-6
Table 5.1.14-2:	Severe Weather Data for Inhabited Islands in American Samoa (1996-2014) .....	5.1.14-6
Table 5.1.15-1:	Key Health Indicators for American Samoa .....	5.1.15-2
Table 5.1.15-2:	Health Conditions Affected by Air Pollution .....	5.1.15-4
Table 5.2.1-1:	Impact Significance Rating Criteria for Infrastructure .....	5.2.1-2
Table 5.2.2-1:	Impact Significance Rating Criteria for Soils .....	5.2.2-2
Table 5.2.3-1:	Impact Significance Rating Criteria for Geology .....	5.2.3-2
Table 5.2.4-1:	Impact Significance Rating Criteria for Water Resources .....	5.2.4-2
Table 5.2.5-1:	Impact Significance Rating Criteria for Wetlands .....	5.2.5-2
Table 5.2.6.2-1:	Impact Significance Rating Criteria for Terrestrial Vegetation, Wildlife, and Fisheries and Aquatic Habitats .....	5.2.6-2
Table 5.2.6.6-1:	Impact Significance Rating Criteria for Listed Species and Critical Habitats .....	5.2.6-51
Table 5.2.6.6-2:	Summary of Information on Federally and Territory-Listed Species in American Samoa .....	5.2.6-54
Table 5.2.6.6-3:	Determination of Impact Significance for Listed Species as a Result of the Preferred Alternative .....	5.2.6-66



Table 5.2.6.6-4:	Determination of Impact Significance for Listed Species as a Result of the Deployable Technologies Alternative .....	5.2.6-68
Table 5.2.7-1:	Impact Significance Rating Criteria for Land Use, Airspace, and Recreation .....	5.2.7-2
Table 5.2.8-1:	Impact Significance Rating Criteria for Visual Resources.....	5.2.8-2
Table 5.2.9-1:	Impact Significance Rating Criteria for Socioeconomics.....	5.2.9-2
Table 5.2.10-1:	Impact Significance Rating Criteria for Environmental Justice .....	5.2.10-2
Table 5.2.11-1:	Impact Significance Rating Criteria for Cultural Resources .....	5.2.11-2
Table 5.2.12-1:	Impact Significance Rating Criteria for Air Quality .....	5.2.12-2
Table 5.2.12-2:	Combustion Emission Estimates (Monthly) from New Buried Wired Project Deployment .....	5.2.12-7
Table 5.2.12-3:	Combustion Emission Estimates (Monthly) from New Aerial Wired Project Deployment .....	5.2.12-8
Table 5.2.12-4:	Combustion Emission Estimates (Monthly) from Tower, Structure, and Transmission Equipment Delivery and Installation.....	5.2.12-8
Table 5.2.12-5:	Dust Emission Estimates (Monthly) from Excavation/Filling and Grading/Earth Moving Activities .....	5.2.12-9
Table 5.2.12-6:	Combustion Emission Estimates from Heavy-Duty Vehicles.....	5.2.12-11
Table 5.2.12-7:	Combustion Emission Estimates from Light-Duty Trucks.....	5.2.12-12
Table 5.2.12-8:	Combustion Emission Estimates from Diesel Backup Power Generators at Wireless Communication Towers.....	5.2.12-15
Table 5.2.12-9:	Combustion Emission Estimates from Diesel Power Generators on On-Road Vehicles Stationed On-Site.....	5.2.12-16
Table 5.2.13-1:	Impact Significance Rating Criteria for Noise .....	5.2.13-2
Table 5.2.13-2:	Limiting Distances for Maximum Noise Levels Associated with New Buried Wired Activities such as Plowing, Wire Installation, and Construction of Points of Presence and Fiber Huts.....	5.2.13-6
Table 5.2.13-3:	Limiting Distances for Maximum Noise Levels Associated with New Aerial Wired Activities such as Excavation, Grading, and Pole Delivery and Installation .....	5.2.13-7
Table 5.2.13-4:	Limiting Distances for Maximum Noise Levels Associated with Tower, Structure, and Transmission Equipment Delivery and Installation .....	5.2.13-7
Table 5.2.13-5:	Limiting Distances for Maximum Noise Levels Associated with Collocation on Existing Wireless Tower, Structure, or Building.....	5.2.13-10
Table 5.2.13-6:	Limiting Distances for Maximum Noise Levels Associated with Deployable Technologies Implementation – Short-term .....	5.2.13-11
Table 5.2.13-7:	Limiting Distances for Maximum Noise Levels Associated with Power Generators and Ventilation Fans at Fiber Huts or Central Offices.....	5.2.13-16
Table 5.2.13-8:	Limiting Distances for Maximum Noise Levels Associated with Deployable Technologies Implementation – Long-term .....	5.2.13-18
Table 5.2.14-1:	Impact Significance Rating Criteria for Climate Change.....	5.2.14-2
Table 5.2.14-2:	Projected Average Annual Temperature Changes.....	5.2.14-4
Table 5.2.14-3:	Projected Global Sea Level Rise Relative to 1992 .....	5.2.14-5
Table 5.2.14-4:	GHG Emission Estimates from Buried Wired Project Deployment.....	5.2.14-9

Table 5.2.14-5:	GHG Emission Estimates from New Aerial Wired Project Deployment.....	5.2.14-10
Table 5.2.14-6:	GHG Emissions Estimates from Tower, Structure, and Transmission Equipment Delivery and Installation .....	5.2.14-12
Table 5.2.14-7:	GHG Emissions Estimates from Heavy and Light Duty Vehicles .....	5.2.14-13
Table 5.2.14-8:	GHG Emissions from Back-up Diesel Power Generators for Wireless Projects .....	5.2.14-15
Table 5.2.14-9:	GHG Emissions from Power Generators for Deployable Technologies .....	5.2.14-16
Table 5.2.15-1:	Impact Significance Rating Criteria for Human Health and Safety .....	5.2.15-2
Table 6.1.2-1:	Major Characteristics of MUIDs and Soil Types Found in Guam .....	6.1.2-5
Table 6.1.3-1:	Geologic Rock Unit Ages in Guam .....	6.1.3-3
Table 6.1.4-1:	Total Surface Waters for Guam.....	6.1.4-2
Table 6.1.5-1:	Acreages, Types, and Descriptions of Wetlands in Guam.....	6.1.5-5
Table 6.1.6.3-1:	Vegetation Types/ Land Cover Classes in Guam .....	6.1.6-4
Table 6.1.6.6-1:	Federal- and Territory-listed Threatened and Endangered and Candidate Species Known to Occur in Guam.....	6.1.6-28
Table 6.1.7-1:	Land Use/Land Cover in Guam.....	6.1.7-6
Table 6.1.7-2:	Major Land Owners in Guam .....	6.1.7-6
Table 6.1.7-3:	Acreage of Recreational Lands in Guam, by Type.....	6.1.7-9
Table 6.1.9-1:	National and Territory Population, Population Density, and Growth Rates.....	6.1.9-3
Table 6.1.9-2:	Population Projections .....	6.1.9-3
Table 6.1.9-3:	Select Economic Indicators, 2010 .....	6.1.9-4
Table 6.1.9-4:	Housing Units, Occupancy, and Tenure, 2010 .....	6.1.9-4
Table 6.1.9-5:	Housing Costs.....	6.1.9-4
Table 6.1.9-6:	Median Value of Owner-Occupied Single Family Homes, 2010 .....	6.1.9-5
Table 6.1.10-1:	Race and Ethnicity, Guam, 2010 .....	6.1.10-3
Table 6.1.11-1:	Cultural Resources Listed on the GRHP and NRHP .....	6.1.11-7
Table 6.1.12-1:	Ambient Air Quality Standards in Guam .....	6.1.12-2
Table 6.1.12-2:	Nonattainment Areas in Guam .....	6.1.12-4
Table 6.1.12-3:	PSD Allowable Increase Increments .....	6.1.12-5
Table 6.1.12-4:	General Conformity Emissions Threshold in Guam.....	6.1.12-6
Table 6.1.13-1:	Typical Noise Levels and Possible Human Effects .....	6.1.13-2
Table 6.1.13-2:	Typical Outdoor Sound Levels by Land Use Category .....	6.1.13-3
Table 6.1.14-1:	Annual Average Temperature, Humidity, Precipitation, and Wind Speed Data for Guam .....	6.1.14-5
Table 6.1.14-2:	Severe Weather Data for Guam (1996-2014) .....	6.1.14-6
Table 6.1.15-1:	Key Health Indicators for Guam.....	6.1.15-2
Table 6.1.15-2:	Health Conditions Affected by Air Pollution .....	6.1.15-5
Table 6.2.1-1:	Impact Significance Rating Criteria for Infrastructure .....	6.2.1-2
Table 6.2.2-1:	Impact Significance Rating Criteria for Soils.....	6.2.2-2
Table 6.2.3-1:	Impact Significance Rating Criteria for Geology .....	6.2.3-2
Table 6.2.4-1:	Impact Significance Rating Criteria for Water Resources.....	6.2.4-2
Table 6.2.5-1:	Impact Significance Rating Criteria for Wetlands.....	6.2.5-2

Table 6.2.6.2-1:	Impact Significance Rating Criteria for Terrestrial Vegetation, Wildlife, and Fisheries and Aquatic Habitats .....	6.2.6-2
Table 6.2.6.6-1:	Impact Significance Rating Criteria for Listed Species and Critical Habitats.....	6.2.6-51
Table 6.2.6.6-2:	Summary of Information on Federally and Territory-Listed Species in Guam .....	6.2.6-54
Table 6.2.6.6-3:	Determination of Impact Significance for Listed Species as a Result of the Preferred Alternative .....	6.2.6-68
Table 6.2.6.6-4:	Determination of Impact Significance for Listed Species as a Result of the Deployable Technologies Alternative .....	6.2.6-71
Table 6.2.7-1:	Impact Significance Rating Criteria for Land Use, Airspace, and Recreation .....	6.2.7-2
Table 6.2.8-1:	Impact Significance Rating Criteria for Visual Resources .....	6.2.8-2
Table 6.2.9-1:	Impact Significance Rating Criteria for Socioeconomics.....	6.2.9-2
Table 6.2.10-1:	Impact Significance Rating Criteria for Environmental Justice .....	6.2.10-2
Table 6.2.11-1:	Impact Significance Rating Criteria for Cultural Resources .....	6.2.11-2
Table 6.2.12-1:	Impact Significance Rating Criteria for Air Quality .....	6.2.12-2
Table 6.2.12-2:	Combustion Emission Estimates (Monthly) from New Buried Wired Project Deployment .....	6.2.12-7
Table 6.2.12-3:	Combustion Emission Estimates (Monthly) from New Aerial Wired Project Deployment .....	6.2.12-8
Table 6.2.12-4:	Combustion Emission Estimates (Monthly) from Tower, Structure, and Transmission Equipment Delivery and Installation.....	6.2.12-8
Table 6.2.12-5:	Dust Emission Estimates (Monthly) from Excavation/Filling and Grading/Earth Moving Activities .....	6.2.12-9
Table 6.2.12-6:	Combustion Emission Estimates from Heavy-Duty Vehicles .....	6.2.12-12
Table 6.2.12-7:	Combustion Emission Estimates from Light-Duty Trucks.....	6.2.12-12
Table 6.2.12-8:	Combustion Emission Estimates from Diesel Backup Power Generators at Wireless Communication Towers.....	6.2.12-15
Table 6.2.12-9:	Combustion Emission Estimates from Diesel Generators on On-Road Vehicles Stationed On-Site.....	6.2.12-16
Table 6.2.13-1:	Impact Significance Rating Criteria for Noise .....	6.2.13-2
Table 6.2.13-2:	Limiting Distances for Maximum Noise Levels Associated with New Buried Wired Activities such as Plowing, Wire Installation, and Construction of Points of Presence and Fiber Huts .....	6.2.13-6
Table 6.2.13-3:	Limiting Distances for Maximum Noise Levels Associated with New Aerial Wired Activities such as Excavation, Grading, and Pole Delivery and Installation .....	6.2.13-7
Table 6.2.13-4:	Limiting Distances for Maximum Noise Levels Associated with Tower, Structure, and Transmission Equipment Delivery and Installation .....	6.2.13-7
Table 6.2.13-5:	Limiting Distances for Maximum Noise Levels Associated with Collocation on Existing Wireless Tower, Structure, or Building.....	6.2.13-10
Table 6.2.13-6:	Limiting Distances for Maximum Noise Levels Associated with Deployable Technologies Implementation – Short-term .....	6.2.13-11

Table 6.2.13-7:	Limiting Distances for Maximum Noise Levels Associated with Power Generators and Ventilation Fans at Fiber Huts or Central Offices.....	6.2.13-16
Table 6.2.13-8:	Limiting Distances for Maximum Noise Levels Associated with Deployable Technologies Implementation – Long-term .....	6.2.13-18
Table 6.2.14-1:	Impact Significance Rating Criteria for Climate Change.....	6.2.14-2
Table 6.2.14-2:	Projected Average Annual Temperature Changes.....	6.2.14-4
Table 6.2.14-3:	Projected Global Sea Level Rise Relative to 1992.....	6.2.14-5
Table 6.2.14-4:	GHG Emission Estimates from Buried Wired Project Deployment.....	6.2.14-9
Table 6.2.14-5:	GHG Emission Estimates from New Aerial Wired Project Deployment.....	6.2.14-10
Table 6.2.14-6:	GHG Emissions Estimates from Tower, Structure, and Transmission Equipment Delivery and Installation .....	6.2.14-12
Table 6.2.14-7:	GHG Emissions Estimates from Heavy and Light Duty Vehicles .....	6.2.14-13
Table 6.2.14-8:	GHG Emissions from Back-up Diesel Power Generators for Wireless Projects .....	6.2.14-15
Table 6.2.14-9:	GHG Emissions from Power Generators for Deployable Technologies .....	6.2.14-16
Table 6.2.15-1:	Impact Significance Rating Criteria for Human Health and Safety .....	6.2.15-2
Table 7.1.2-1:	Major Characteristics of MUIDs and Soil Types Found in the Northern Mariana Islands.....	7.1.2-5
Table 7.1.4-1:	Total Surface Waters for the Northern Mariana Islands.....	7.1.4-2
Table 7.1.5-1:	Acreages, Types, and Descriptions of Wetlands on the Northern Mariana Islands.....	7.1.5-5
Table 7.1.6.3-1:	Vegetation Types/ Land Cover Classes in the Northern Mariana Islands .....	7.1.6-4
Table 7.1.6.6-1:	Federal- and Territory-listed Threatened and Endangered and Candidate Species Known to Occur in the Northern Mariana Islands .....	7.1.6-27
Table 7.1.7-1:	Land Use/Land Cover in the Northern Mariana Islands.....	7.1.7-6
Table 7.1.7-2:	Major Land Owners in the Northern Mariana Islands.....	7.1.7-7
Table 7.1.7-3:	Acreage of Recreational Lands in the Northern Mariana Islands, by Type.....	7.1.7-9
Table 7.1.9-1:	National, Territory, and Municipality Population, Population Density, and Growth Rates .....	7.1.9-3
Table 7.1.9-2:	Population Projections.....	7.1.9-3
Table 7.1.9-3:	Select Economic Indicators, 2010 .....	7.1.9-4
Table 7.1.9-4:	Housing Units, Occupancy, and Tenure, 2010 .....	7.1.9-4
Table 7.1.9-5:	Housing Costs.....	7.1.9-5
Table 7.1.9-6:	Median Value of Owner Occupied Single Family Homes .....	7.1.9-5
Table 7.1.10-1:	Race and Ethnicity, North Mariana Islands, 2010.....	7.1.10-3
Table 7.1.11-1:	Cultural Resources Listed on the NRHP .....	7.1.11-7
Table 7.1.12-1:	Ambient Air Quality Standards in the Northern Mariana Islands .....	7.1.12-2
Table 7.1.12-2:	PSD Allowable Increase Increments .....	7.1.12-5
Table 7.1.13-1:	Typical Noise Levels and Possible Human Effects .....	7.1.13-2
Table 7.1.13-2:	Typical Outdoor Sound Levels by Land Use Category.....	7.1.13-3
Table 7.1.14-1:	Annual Average Temperature, Humidity, Precipitation, and Wind Speed Data for Guam (representative of the Northern Mariana Islands).....	7.1.14-5
Table 7.1.14-2:	Severe Weather Data for the Northern Mariana Islands (1996-2014).....	7.1.14-6

Table 7.1.15-1:	Key Health Indicators for Northern Mariana Islands .....	7.1.15-2
Table 7.1.15-2:	Health Conditions Affected by Air Pollution .....	7.1.15-4
Table 7.2.1-1:	Impact Significance Rating Criteria for Infrastructure .....	7.2.1-2
Table 7.2.2-1:	Impact Significance Rating Criteria for Soils.....	7.2.2-2
Table 7.2.3-1:	Impact Significance Rating Criteria for Geology .....	7.2.3-2
Table 7.2.4-1:	Impact Significance Rating Criteria for Water Resources.....	7.2.4-2
Table 7.2.5-1:	Impact Significance Rating Criteria for Wetlands.....	7.2.5-2
Table 7.2.6.2-1:	Impact Significance Rating Criteria for Terrestrial Vegetation, Wildlife, and Fisheries and Aquatic Habitats .....	7.2.6-2
Table 7.2.6.6-1:	Impact Significance Rating Criteria for Listed Species and Critical Habitats....	7.2.6-52
Table 7.2.6.6-2:	Summary of Information on Federally and Territory-Listed Species in the Northern Mariana Islands .....	7.2.6-54
Table 7.2.6.6-3:	Determination of Impact Significance for Listed Species as a Result of the Preferred Alternative .....	7.2.6-68
Table 7.2.6.6-4:	Determination of Impact Significance for Listed Species as a Result of the Deployable Technologies Alternative .....	7.2.6-71
Table 7.2.7-1:	Impact Significance Rating Criteria for Land Use, Airspace, and Recreation .....	7.2.7-2
Table 7.2.8-1:	Impact Significance Rating Criteria for Visual Resources.....	7.2.8-2
Table 7.2.9-1:	Impact Significance Rating Criteria for Socioeconomics.....	7.2.9-2
Table 7.2.10-1:	Impact Significance Rating Criteria for Environmental Justice .....	7.2.10-2
Table 7.2.11-1:	Impact Significance Rating Criteria for Cultural Resources .....	7.2.11-2
Table 7.2.12-1:	Impact Significance Rating Criteria for Air Quality .....	7.2.12-2
Table 7.2.12-2:	Combustion Emission Estimates (Monthly) from New Buried Wired Project Deployment .....	7.2.12-7
Table 7.2.12-3:	Combustion Emission Estimates (Monthly) from New Aerial Wired Project Deployment .....	7.2.12-8
Table 7.2.12-4:	Combustion Emission Estimates (Monthly) from Tower, Structure, and Transmission Equipment Delivery and Installation.....	7.2.12-8
Table 7.2.12-5:	Dust Emission Estimates (Monthly) from Excavation/Filling and Grading/ Earth Moving Activities .....	7.2.12-9
Table 7.2.12-6:	Combustion Emission Estimates from Heavy-Duty Vehicles.....	7.2.12-11
Table 7.2.12-7:	Combustion Emission Estimates from Light-Duty Trucks.....	7.2.12-12
Table 7.2.12-8:	Combustion Emission Estimates from Diesel Backup Generators at Wireless Communication Towers .....	7.2.12-15
Table 7.2.12-9:	Combustion Emission Estimates from Diesel Generators on On-Road Vehicles Stationed On-Site.....	7.2.12-16
Table 7.2.13-1:	Impact Significance Rating Criteria for Noise .....	7.2.13-2
Table 7.2.13-2:	Limiting Distances for Maximum Noise Levels Associated with New Buried Wired Activities such as Plowing, Wire Installation, and Construction of Points of Presence and Fiber Huts.....	7.2.13-6
Table 7.2.13-3:	Limiting Distances for Maximum Noise Levels Associated with New Aerial Wired Activities such as Excavation, Grading, and Pole Delivery and Installation .....	7.2.13-7

Table 7.2.13-4:	Limiting Distances for Maximum Noise Levels Associated with Tower, Structure, and Transmission Equipment Delivery and Installation .....	7.2.13-7
Table 7.2.13-5:	Limiting Distances for Maximum Noise Levels Associated with Collocation on Existing Wireless Tower, Structure, or Building.....	7.2.13-10
Table 7.2.13-6:	Limiting Distances for Maximum Noise Levels Associated with Deployable Technologies Implementation – Short-term .....	7.2.13-11
Table 7.2.13-7:	Limiting Distances for Maximum Noise Levels Associated with Power Generators and Ventilation Fans at Fiber Huts or Central Offices.....	7.2.13-16
Table 7.2.13-8:	Limiting Distances for Maximum Noise Levels Associated with Deployable Technologies Implementation – Long-term .....	7.2.13-18
Table 7.2.14-1:	Impact Significance Rating Criteria for Climate Change.....	7.2.14-2
Table 7.2.14-2:	Projected Average Annual Temperature Changes.....	7.2.14-4
Table 7.2.14-3:	Projected Global Sea Level Rise Relative to 1992.....	7.2.14-5
Table 7.2.14-4:	GHG Emission Estimates from Buried Wired Project Deployment.....	7.2.14-9
Table 7.2.14-5:	GHG Emission Estimates from New Aerial Wired Project Deployment.....	7.2.14-10
Table 7.2.14-6:	GHG Emissions Estimates from Tower, Structure, and Transmission Equipment Delivery and Installation .....	7.2.14-12
Table 7.2.14-7:	GHG Emissions Estimates from Heavy and Light Duty Vehicles .....	7.2.14-13
Table 7.2.14-8:	GHG Emissions from Back-up Diesel Power Generators for Wireless Projects .....	7.2.14-15
Table 7.2.14-9:	GHG Emissions from Power Generators for Deployable Technologies .....	7.2.14-16
Table 7.2.15-1:	Impact Significance Rating Criteria for Human Health and Safety .....	7.2.15-2
Table 8.1.2-1:	General Characteristics of Soil Suborders Found in Puerto Rico.....	8.1.2-6
Table 8.1.3-1:	Large Earthquakes Recorded Near Puerto Rico and the U.S. Virgin Islands.....	8.1.3-5
Table 8.1.4-1:	Total Surface Waters for Puerto Rico.....	8.1.4-2
Table 8.1.5-1:	Acreages, Types, and Descriptions of Wetlands in Puerto Rico .....	8.1.5-5
Table 8.1.6.3-1:	Vegetation Types/ Land Cover Classes in Puerto Rico.....	8.1.6-4
Table 8.1.6.6-1:	Federal- and Territory-listed Threatened and Endangered and Candidate Species Known to Occur in Puerto Rico .....	8.1.6-28
Table 8.1.7-1:	Land Use/Land Cover in Puerto Rico.....	8.1.7-5
Table 8.1.7-2:	Major Land Owners in Puerto Rico.....	8.1.7-7
Table 8.1.7-3:	Acreage of Recreational Lands in Puerto Rico, by Type .....	8.1.7-12
Table 8.1.9-1:	National and Territory Population, Population Density, and Growth Rates.....	8.1.9-2
Table 8.1.9-2:	Population Projections.....	8.1.9-4
Table 8.1.9-3:	Select Economic Indicators, 2013 .....	8.1.9-4
Table 8.1.9-4:	Housing Units, Occupancy, and Tenure .....	8.1.9-8
Table 8.1.9-5:	Housing Costs.....	8.1.9-9
Table 8.1.9-6:	Median Value of Owner-Occupied Single Family Homes, 2013 .....	8.1.9-9
Table 8.1.9-7:	Real Estate Taxes, Owner-Occupied Units with a Mortgage, 2013 .....	8.1.9-9
Table 8.1.10-1:	Race and Ethnicity, Puerto Rico.....	8.1.10-3
Table 8.1.11-1:	Cultural Resources Listed on the NRHP .....	8.1.11-5
Table 8.1.12-1:	Ambient Air Quality Standards in Puerto Rico .....	8.1.12-2
Table 8.1.12-2:	Nonattainment and Maintenance Areas in Puerto Rico.....	8.1.12-4

Table 8.1.12-3:	PSD Allowable Increase Increments .....	8.1.12-5
Table 8.1.12-4:	General Conformity Emissions Thresholds in Puerto Rico .....	8.1.12-6
Table 8.1.13-1:	Noise Level Limits .....	8.1.13-2
Table 8.1.13-2:	Typical Noise Levels and Possible Human Effects .....	8.1.13-2
Table 8.1.13-3:	Typical Outdoor Sound Levels by Land Use Category .....	8.1.13-3
Table 8.1.14-1:	Annual Average Temperature, Humidity, Precipitation, and Wind Speed Data for Puerto Rico .....	8.1.14-5
Table 8.1.14-2:	Severe Weather Data for Puerto Rico (1996-2014) .....	8.1.14-5
Table 8.1.15-1:	Key Health Indicators for Puerto Rico .....	8.1.15-2
Table 8.1.15-2:	Health Conditions Affected by Air Pollution .....	8.1.15-4
Table 8.2.1-1:	Impact Significance Rating Criteria for Infrastructure .....	8.2.1-2
Table 8.2.2-1:	Impact Significance Rating Criteria for Soils .....	8.2.2-2
Table 8.2.3-1:	Impact Significance Rating Criteria for Geology .....	8.2.3-2
Table 8.2.4-1:	Impact Significance Rating Criteria for Water Resources .....	8.2.4-2
Table 8.2.5-1:	Impact Significance Rating Criteria for Wetlands .....	8.2.5-2
Table 8.2.6.2-1:	Impact Significance Rating Criteria for Terrestrial Vegetation, Wildlife, and Fisheries and Aquatic Habitats .....	8.2.6-2
Table 8.2.6.6-1:	Impact Significance Rating Criteria for Listed Species and Critical Habitats .....	8.2.6-51
Table 8.2.6.6-2:	Summary of Information on Federally and Territory-Listed Species in Puerto Rico .....	8.2.6-53
Table 8.2.6.6-3:	Determination of Impact Significance for Listed Species as a Result of the Preferred Alternative .....	8.2.6-68
Table 8.2.6.6-4:	Determination of Impact Significance for Listed Species as a Result of the Deployable Technologies Alternative .....	8.2.6-71
Table 8.2.7-1:	Impact Significance Rating Criteria for Land Use, Airspace, and Recreation .....	8.2.7-2
Table 8.2.8-1:	Impact Significance Rating Criteria for Visual Resources .....	8.2.8-2
Table 8.2.9-1:	Impact Significance Rating Criteria for Socioeconomics .....	8.2.9-2
Table 8.2.10-1:	Impact Significance Rating Criteria for Environmental Justice .....	8.2.10-2
Table 8.2.11-1:	Impact Significance Rating Criteria for Cultural Resources .....	8.2.11-2
Table 8.2.12-1:	Impact Significance Rating Criteria for Air Quality .....	8.2.12-2
Table 8.2.12-2:	Combustion Emission Estimates (Monthly) from New Buried Wired Project Deployment .....	8.2.12-7
Table 8.2.12-3:	Combustion Emission Estimates (Monthly) from New Aerial Wired Project Deployment .....	8.2.12-8
Table 8.2.12-4:	Combustion Emission Estimates (Monthly) from Tower, Structure, and Transmission Equipment Delivery and Installation .....	8.2.12-8
Table 8.2.12-5:	Dust Emission Estimates (Monthly) from Excavation/Filling and Grading/ Earth Moving Activities .....	8.2.12-9
Table 8.2.12-6:	Combustion Emission Estimates from Heavy-Duty Vehicles .....	8.2.12-11
Table 8.2.12-7:	Combustion Emission Estimates from Light-Duty Trucks .....	8.2.12-12
Table 8.2.12-8:	Combustion Emission Estimates from Diesel Backup Power Generators at Wireless Communication Towers .....	8.2.12-15

Table 8.2.12-9:	Combustion Emission Estimates from Diesel Generators on On-Road Vehicles .....	8.2.12-16
Table 8.2.13-1:	Impact Significance Rating Criteria for Noise .....	8.2.13-2
Table 8.2.13-2:	Limiting Distances for Maximum Noise Levels Associated with New Buried Wired Activities such as Plowing, Wire Installation, and Construction of Points of Presence and Fiber Huts .....	8.2.13-6
Table 8.2.13-3:	Limiting Distances for Maximum Noise Levels Associated with New Aerial Wired Activities such as Excavation, Grading, and Pole Delivery and Installation .....	8.2.13-7
Table 8.2.13-4:	Limiting Distances for Maximum Noise Levels Associated with Tower, Structure, and Transmission Equipment Delivery and Installation .....	8.2.13-7
Table 8.2.13-5:	Limiting Distances for Maximum Noise Levels Associated with Collocation on Existing Wireless Tower, Structure, or Building .....	8.2.13-10
Table 8.2.13-6:	Limiting Distances for Maximum Noise Levels Associated with Deployable Technologies Implementation – Short-term .....	8.2.13-11
Table 8.2.13-7:	Limiting Distances for Maximum Noise Levels Associated with Power Generators and Ventilation Fans at Fiber Huts or Central Offices .....	8.2.13-16
Table 8.2.13-8:	Limiting Distances for Maximum Noise Levels Associated with Deployable Technologies Implementation – Long-term .....	8.2.13-18
Table 8.2.14-1:	Impact Significance Rating Criteria for Climate Change .....	8.2.14-2
Table 8.2.14-2:	Projected Global Sea Level Rise Relative to 1992 .....	8.2.14-5
Table 8.2.14-3:	GHG Emission Estimates from Buried Wired Project Deployment .....	8.2.14-8
Table 8.2.14-4:	GHG Emission Estimates from New Aerial Wired Project Deployment .....	8.2.14-9
Table 8.2.14-5:	GHG Emissions Estimates from Tower, Structure, and Transmission Equipment Delivery and Installation .....	8.2.14-11
Table 8.2.14-6:	GHG Emissions Estimates from Heavy and Light Duty Vehicles .....	8.2.14-12
Table 8.2.14-7:	GHG Emissions from Back-up Diesel Power Generators for Wireless Projects .....	8.2.14-14
Table 8.2.14-8:	GHG Emissions from Power Generators for Deployable Technologies .....	8.2.14-15
Table 8.2.15-1:	Impact Significance Rating Criteria for Human Health and Safety .....	8.2.15-2
Table 9.1.2-1:	Major Characteristics of MUIDs and Soil Types Found in U.S. Virgin Islands ..	9.1.2-5
Table 9.1.3-1:	Large Earthquakes Recorded Near U.S. Virgin Islands and Puerto Rico .....	9.1.3-4
Table 9.1.5-1:	Acreages, Types, and Descriptions of Wetlands in the U.S. Virgin Islands .....	9.1.5-5
Table 9.1.6.3-1:	Vegetation Types/ Land Cover Classes in the U.S. Virgin Islands .....	9.1.6-4
Table 9.1.6.6-1:	Federal- and Territory-listed Threatened and Endangered and Candidate Species Known to Occur in the U.S. Virgin Islands .....	9.1.6-29
Table 9.1.7-1:	Land Use/Land Cover in U.S. Virgin Islands .....	9.1.7-4
Table 9.1.7-2:	Major Land Owners in U.S. Virgin Islands .....	9.1.7-7
Table 9.1.7-3:	Acreage of Recreational Lands in U.S. Virgin Islands, by Type .....	9.1.7-10
Table 9.1.9-1:	National and Territory Population, Population Density, and Growth Rates .....	9.1.9-2
Table 9.1.9-2:	Population Projections .....	9.1.9-3
Table 9.1.9-3:	Select Economic Indicators, 2010 .....	9.1.9-4
Table 9.1.9-4:	Housing Units, Occupancy, and Tenure, 2010 .....	9.1.9-5



Table 9.1.9-5:	Housing Costs, 2010.....	9.1.9-6
Table 9.1.9-6:	Value of Owner Occupied Single Family Homes, 2010 U.S. Census.....	9.1.9-6
Table 9.1.10-1:	Race and Ethnicity, U.S. Virgin Islands, 2010 .....	9.1.10-3
Table 9.1.11-1:	Cultural Resources Listed on the NRHP .....	9.1.11-5
Table 9.1.12-1:	Ambient Air Quality Standards in the U.S. Virgin Islands .....	9.1.12-2
Table 9.1.12-2:	PSD Allowable Increase Increments .....	9.1.12-5
Table 9.1.12-3:	U.S. Virgin Islands Class I Area.....	9.1.12-5
Table 9.1.13-1:	Typical Noise Levels and Possible Human Response .....	9.1.13-2
Table 9.1.13-2:	Typical Outdoor Sound Levels by Land Use Category .....	9.1.13-3
Table 9.1.14-1:	Annual Average Temperature, Humidity, Precipitation, and Wind Speed Data for the U.S. Virgin Islands .....	9.1.14-5
Table 9.1.14-2:	Severe Weather Data for the U.S. Virgin Islands (1996-2014) .....	9.1.14-6
Table 9.1.15-1:	Key Health Indicators for U.S. Virgin Islands.....	9.1.15-2
Table 9.1.15-2:	Health Conditions Affected by Air Pollution .....	9.1.15-4
Table 9.1.15-3:	U.S. Virgin Islands Active Superfund Sites .....	9.1.15-5
Table 9.2.1-1:	Impact Significance Rating Criteria for Infrastructure .....	9.2.1-2
Table 9.2.2-1:	Impact Significance Rating Criteria for Soils.....	9.2.2-2
Table 9.2.3-1:	Impact Significance Rating Criteria for Geology .....	9.2.3-2
Table 9.2.4-1:	Impact Significance Rating Criteria for Water Resources.....	9.2.4-2
Table 9.2.5-1:	Impact Significance Rating Criteria for Wetlands.....	9.2.5-2
Table 9.2.6.2-1:	Impact Significance Rating Criteria for Terrestrial Vegetation, Wildlife, and Fisheries and Aquatic Habitats .....	9.2.6-2
Table 9.2.6.6-1:	Impact Significance Rating Criteria for Listed Species and Critical Habitats....	9.2.6-51
Table 9.2.6.6-2:	Summary of Information on Federally and Territory-Listed Species in the U.S. Virgin Islands .....	9.2.6-53
Table 9.2.6.6-3:	Determination of Impact Significance for Listed Species as a Result of the Preferred Alternative .....	9.2.6-66
Table 9.2.6.6-4:	Determination of Impact Significance for Listed Species as a Result of the Deployable Technologies Alternative .....	9.2.6-69
Table 9.2.7-1:	Impact Significance Rating Criteria for Land Use, Airspace, and Recreation .....	9.2.7-2
Table 9.2.8-1:	Impact Significance Rating Criteria for Visual Resources.....	9.2.8-2
Table 9.2.9-1:	Impact Significance Rating Criteria for Socioeconomics.....	9.2.9-2
Table 9.2.10-1:	Impact Significance Rating Criteria for Environmental Justice .....	9.2.10-2
Table 9.2.11-1:	Impact Significance Rating Criteria for Cultural Resources .....	9.2.11-2
Table 9.2.12-1:	Impact Significance Rating Criteria for Air Quality .....	9.2.12-2
Table 9.2.12-2:	Combustion Emission Estimates (Monthly) from New Buried Wired Project Deployment .....	9.2.12-7
Table 9.2.12-3:	Combustion Emission Estimates (Monthly) from New Aerial Wired Project Deployment .....	9.2.12-8
Table 9.2.12-4:	Combustion Emission Estimates (Monthly) from Tower, Structure, and Transmission Equipment Delivery and Installation.....	9.2.12-8
Table 9.2.12-5:	Dust Emission Estimates (Monthly) from Excavation/Filling and Grading/ Earth Moving Activities .....	9.2.12-9

Table 9.2.12-6:	Combustion Emission Estimates from Heavy-Duty Vehicles.....	9.2.12-11
Table 9.2.12-7:	Combustion Emission Estimates from Light-Duty Trucks.....	9.2.12-12
Table 9.2.12-8:	Combustion Emission Estimates from Diesel Backup Power Generators at Wireless Communication Towers.....	9.2.12-15
Table 9.2.12-9:	Combustion Emission Estimates from Diesel Power Generators on On-Road Vehicles Stationed On-Site.....	9.2.12-16
Table 9.2.13-1:	Impact Significance Rating Criteria for Noise .....	9.2.13-2
Table 9.2.13-2:	Limiting Distances for Maximum Noise Levels Associated with New Buried Wired Activities such as Plowing, Wire Installation, and Construction of Points of Presence and Fiber Huts .....	9.2.13-6
Table 9.2.13-3:	Limiting Distances for Maximum Noise Levels Associated with New Aerial Wired Activities such as Excavation, Grading, and Pole Delivery and Installation .....	9.2.13-7
Table 9.2.13-4:	Limiting Distances for Maximum Noise Levels Associated with Tower, Structure, and Transmission Equipment Delivery and Installation .....	9.2.13-7
Table 9.2.13-5:	Limiting Distances for Maximum Noise Levels Associated with Collocation on Existing Wireless Tower, Structure, or Building.....	9.2.13-10
Table 9.2.13-6:	Limiting Distances for Maximum Noise Levels Associated with Deployable Technologies Implementation – Short-term .....	9.2.13-11
Table 9.2.13-7:	Limiting Distances for Maximum Noise Levels Associated with Power Generators and Ventilation Fans at Fiber Huts or Central Offices.....	9.2.13-16
Table 9.2.13-8:	Limiting Distances for Maximum Noise Levels Associated with Deployable Technologies Implementation – Long-term .....	9.2.13-17
Table 9.2.14-1:	Impact Significance Rating Criteria for Climate Change.....	9.2.14-2
Table 9.2.14-2:	Projected Global Sea Level Rise Relative to 1992 .....	9.2.14-5
Table 9.2.14-3:	GHG Emission Estimates from Buried Wired Project Deployment.....	9.2.14-8
Table 9.2.14-4:	GHG Emission Estimates from New Aerial Wired Project Deployment.....	9.2.14-9
Table 9.2.14-5:	GHG Emissions Estimates from Tower, Structure, and Transmission Equipment Delivery and Installation .....	9.2.14-11
Table 9.2.14-6:	GHG Emissions Estimates from Heavy and Light Duty Vehicles .....	9.2.14-12
Table 9.2.14-7:	GHG Emissions from Back-up Diesel Power Generators for Wireless Projects .....	9.2.14-14
Table 9.2.14-8:	GHG Emissions from Power Generators for Deployable Technologies .....	9.2.14-15
Table 9.2.15-1:	Impact Significance Rating Criteria for Human Health and Safety .....	9.2.15-2
Table 10-1:	Additional Broadband Infrastructure Projects .....	10-2
Table 12.2-1:	Comparison of Alternatives by Resource Area and Type of Effect .....	12-4
Table 13.2-1:	Summary of Irreversible and Irretrievable Commitment of Resources by Resource Area.....	13-2

## LIST OF FIGURES

Figure 1.3-1:	FirstNet Programmatic Environmental Impact Statement Regions of Analysis .....	1-5
Figure 2.4.1-1:	The Electromagnetic Spectrum.....	2-9
Figure 2.4.2-1:	Lattice Cell Tower with Multiple Panel Antennas .....	2-14
Figure 2.4.2-2:	Depiction of Primary Radiation Lobe of a Panel Antenna Attached to a 200-foot (61 meter) Cell Tower .....	2-14
Figure 2.4.2-3:	60 W Antenna (780 MHz) - Power Intensity vs Distance with Respect to FCC Guidelines for Limiting Thermal Radiation .....	2-15
Figure 3-1:	Alaska Geography .....	3-4
Figure 3.1.1-1:	Ports, Railroads, and Roads in Alaska by Location.....	3.1.1-3
Figure 3.1.1-2:	Alaska State Trooper Detachment Boundaries and Post Locations.....	3.1.1-5
Figure 3.1.1-3:	Rural Alaska Water and Sewer System Types .....	3.1.1-9
Figure 3.1.2-1:	Major Land Resources Areas of Alaska .....	3.1.2-3
Figure 3.1.2-2:	Soil Suborder Map of Alaska .....	3.1.2-15
Figure 3.1.3-1:	Primary Mineral Production Areas in Alaska.....	3.1.3-3
Figure 3.1.3-2:	General Seismic Hazard Map of Alaska.....	3.1.3-6
Figure 3.1.3-3:	Active and Dormant Volcanoes in Alaska.....	3.1.3-7
Figure 3.1.4-1:	Spatial Distribution of Alaska Surface Waters.....	3.1.4-3
Figure 3.1.4-2:	Major Watersheds in Alaska.....	3.1.4-5
Figure 3.1.4-3:	Example Floodplain Map for Alaska Floodplains.....	3.1.4-8
Figure 3.1.5-1:	Alaska Wetland Types.....	3.1.5-4
Figure 3.1.5-2:	Palustrine Vegetated Wetland in Alaska .....	3.1.5-7
Figure 3.1.5-3:	Estuarine Vegetated Wetland in Alaska .....	3.1.5-7
Figure 3.1.5-4:	Marine Intertidal Wetland in Alaska .....	3.1.5-8
Figure 3.1.6.3-1:	Vegetation Types and Land Cover Classes in Alaska .....	3.1.6-3
Figure 3.1.6.3-2:	Canada Thistle .....	3.1.6-6
Figure 3.1.6.3-3:	European Bird Cherry.....	3.1.6-7
Figure 3.1.6.3-4:	Giant Hogweed.....	3.1.6-7
Figure 3.1.6.3-5:	Leafy Spurge.....	3.1.6-8
Figure 3.1.6.3-6:	Purple Loosestrife.....	3.1.6-8
Figure 3.1.6.3-7:	Smooth Cordgrass.....	3.1.6-9
Figure 3.1.6.3-8:	Spotted Knapweed.....	3.1.6-9
Figure 3.1.6.4-1:	ADFG Game Management Regions .....	3.1.6-14
Figure 3.1.6.4-2:	Distribution of Alaska Caribou Herds .....	3.1.6-19
Figure 3.1.6.4-3:	Dall Sheep, Bison, and Muskox Distributions in Alaska .....	3.1.6-20
Figure 3.1.6.4-4:	Distribution of Pacific Walrus in Alaska.....	3.1.6-24
Figure 3.1.6.4-5:	Distribution of Beluga Whales in Alaska .....	3.1.6-25
Figure 3.1.6.4-6:	Bird Conservation Regions in Alaska.....	3.1.6-26
Figure 3.1.6.4-7:	Protected Areas in Alaska.....	3.1.6-30
Figure 3.1.6.4-8:	Important Bird Areas in Alaska.....	3.1.6-31
Figure 3.1.6.5-1:	Spatial Distribution of Alaska Fisheries Regions .....	3.1.6-34

Figure 3.1.6.5-2:	Fisheries Regions of Alaska .....	3.1.6-35
Figure 3.1.6.6-1:	Designated Critical Habitats in Alaska.....	3.1.6-59
Figure 3.1.7-1:	Land Use/Land Cover in Alaska.....	3.1.7-6
Figure 3.1.7-2:	Alaska Airspace.....	3.1.7-8
Figure 3.1.7-3:	Recreational Areas.....	3.1.7-10
Figure 3.1.8-1:	Areas in Alaska Managed for Visual Resources .....	3.1.8-2
Figure 3.1.9-1:	Nonsubsistence Use Areas in Alaska .....	3.1.9-3
Figure 3.1.9-2:	Population Distribution and Density .....	3.1.9-6
Figure 3.1.9-3:	Median Household Income.....	3.1.9-9
Figure 3.1.9-4:	Unemployment .....	3.1.9-10
Figure 3.1.9-5:	Property Values .....	3.1.9-15
Figure 3.1.9-6:	Alaska Subsistence Harvest.....	3.1.9-17
Figure 3.1.10-1:	Potential for Environmental Justice Populations.....	3.1.10-7
Figure 3.1.11-1:	Cultural Resources Listed on the NRHP .....	3.1.11-21
Figure 3.1.12-1:	Alaska Class I Areas.....	3.1.12-7
Figure 3.1.12-2:	Nonattainment and Maintenance Areas in Alaska.....	3.1.12-9
Figure 3.1.12-3:	Alaska Fuel Distribution and Rural/Urban Transportation Areas .....	3.1.12-11
Figure 3.1.14-1:	The Greenhouse Gas Effect.....	3.1.14-2
Figure 3.1.14-2:	Map of Climatic Regions in Alaska.....	3.1.14-6
Figure 3.2.14-1:	Projected Temperature and Precipitation Changes for Alaska .....	3.2.14-5
Figure 3.2.14-2:	Projected Annual Mean Ground Temperatures at 1-Meter Depth for High (A2) and Low (B1) Scenarios.....	3.2.14-7
Figure 4-1:	Hawaii Geography.....	4-4
Figure 4.1.1-1:	Hawaii Road Transportation Systems .....	4.1.1-3
Figure 4.1.1-2:	Honolulu Rail Transit Route Map .....	4.1.1-4
Figure 4.1.1-3:	Hawaii Port and Airport Transportation Systems.....	4.1.1-5
Figure 4.1.1-4:	Hawaii Hospitals.....	4.1.1-11
Figure 4.1.2-1:	Major Land Resource Areas of Hawaii .....	4.1.2-3
Figure 4.1.2-2:	Soil Suborder Map Hawaii .....	4.1.2-12
Figure 4.1.3-1:	Simplified Geologic Map of Hawaii.....	4.1.3-3
Figure 4.1.3-2:	Primary Mineral Production Areas in Hawaii .....	4.1.3-4
Figure 4.1.3-3:	General Seismic Hazard Map of Hawaii .....	4.1.3-6
Figure 4.1.3-4:	Active and Dormant Volcanoes in Hawaii .....	4.1.3-8
Figure 4.1.4-1:	Spatial Distribution of Hawaii Watersheds .....	4.1.4-3
Figure 4.1.4-2:	Perennial Streams in Hawaii by Island.....	4.1.4-4
Figure 4.1.4-3:	Spatial Distribution of Hawaii Surface Waters.....	4.1.4-5
Figure 4.1.4-4:	Number of Impaired Inland Waterbodies in Hawaii .....	4.1.4-7
Figure 4.1.4-5:	Example Floodplain Map for Hawaii .....	4.1.4-9
Figure 4.1.4-6:	Spatial Distribution of Hawaii Basal and High-Level Aquifers.....	4.1.4-12
Figure 4.1.5-1:	Hawaii Wetland Types .....	4.1.5-4
Figure 4.1.5-2:	Marine Intertidal Wetland on Hawaii .....	4.1.5-4
Figure 4.1.5-3:	Anchialine Pool on Hawaii.....	4.1.5-7
Figure 4.1.5-4:	Estuarine Wetland Along Stream, With Invasive Mangroves on Hawaii .....	4.1.5-7

Figure 4.1.5-5:	Spatial Distribution of Hawaii Wetland Types.....	4.1.5-8
Figure 4.1.6.3-1:	Vegetation Types and Land Cover Classes in Hawaii.....	4.1.6-3
Figure 4.1.6.3-2:	Miconia Invasive Plant.....	4.1.6-5
Figure 4.1.6.3-3:	Cattail.....	4.1.6-6
Figure 4.1.6.3-4:	Ivy Gourd.....	4.1.6-7
Figure 4.1.6.4-1:	Protected Areas of the Hawaiian Islands.....	4.1.6-16
Figure 4.1.6.5-1:	Protected Marine Areas on Hawaii.....	4.1.6-19
Figure 4.1.6.5-2:	Expanded View of Protected Marine Areas on Hawaii.....	4.1.6-20
Figure 4.1.7-1:	Land Use/Land Cover in Hawaii.....	4.1.7-6
Figure 4.1.7-2:	State Land Use Districts.....	4.1.7-8
Figure 4.1.7-3:	Hawaii Airspace.....	4.1.7-12
Figure 4.1.7-4:	Recreational Areas.....	4.1.7-14
Figure 4.1.8-1:	Areas in Hawaii Managed for Visual Resources.....	4.1.8-2
Figure 4.1.10-1:	Potential for Environmental Justice Populations.....	4.1.10-8
Figure 4.1.11-1:	Cultural Resources Listed on the NRHP.....	4.1.11-16
Figure 4.1.12-1:	Hawaii Class I Areas.....	4.1.12-6
Figure 4.1.14-1:	The Greenhouse Gas Effect.....	4.1.14-2
Figure 4.2.14-1:	Projected Temperature and Precipitation Changes for Hawaii.....	4.2.14-5
Figure 5-1:	American Samoa Geography.....	5-4
Figure 5.1.1-1:	American Samoa Transportation and Hospital Locations.....	5.1.1-3
Figure 5.1.2-1:	Soil Associations Map of American Samoa.....	5.1.2-5
Figure 5.1.3-1:	Topographic Characteristics of Tutuila Island, American Samoa.....	5.1.3-2
Figure 5.1.3-2:	General Seismic Hazard Map of American Samoa.....	5.1.3-4
Figure 5.1.3-3:	Volcanoes in American Samoa.....	5.1.3-5
Figure 5.1.4-1:	Spatial Distribution of American Samoa Watersheds.....	5.1.4-3
Figure 5.1.4-2:	Spatial Distribution of American Samoa Surface Waters.....	5.1.4-4
Figure 5.1.4-3:	Example Floodplain Map for American Samoa Floodplains.....	5.1.4-6
Figure 5.1.5-1:	American Samoa Wetland Types.....	5.1.5-6
Figure 5.1.5-2:	Marine Intertidal Wetland on American Samoa.....	5.1.5-6
Figure 5.1.6.3-1:	Vegetation Types and Land Cover Classes in American Samoa.....	5.1.6-3
Figure 5.1.6.3-2:	Rhus Secondary Forest Vegetation on American Samoa.....	5.1.6-5
Figure 5.1.6.3-3:	Rain Forest Vegetation on American Samoa.....	5.1.6-6
Figure 5.1.6.3-4:	Secondary Scrub Vegetation on American Samoa.....	5.1.6-6
Figure 5.1.6.4-1:	Protected Areas on American Samoa.....	5.1.6-17
Figure 5.1.6.5-1:	Coral Reefs and National Park Areas in American Samoa.....	5.1.6-23
Figure 5.1.6.5-2:	American Samoa Marine Protected Areas.....	5.1.6-24
Figure 5.1.7-1:	Land Use/Land Cover in American Samoa.....	5.1.7-4
Figure 5.1.7-2:	Recreational Areas.....	5.1.7-7
Figure 5.1.11-1:	Cultural Resources Listed on the NRHP.....	5.1.11-6
Figure 5.1.14-1:	The Greenhouse Gas Effect.....	5.1.14-2
Figure 6-1:	Guam Geography.....	6-4
Figure 6.1.1-1:	Guam Ports and Major Roads.....	6.1.1-3
Figure 6.1.1-2:	Guam Airports.....	6.1.1-4

Figure 6.1.2-1:	Major Land Resource Areas of Guam .....	6.1.2-3
Figure 6.1.2-2:	Soil Associations Map of Guam .....	6.1.2-7
Figure 6.1.3-1:	Geologic Rock Unit Ages in Guam .....	6.1.3-2
Figure 6.1.4-1:	Spatial Distribution of Guam Watersheds .....	6.1.4-4
Figure 6.1.4-2:	Spatial Distribution of Guam Surface Waters .....	6.1.4-5
Figure 6.1.4-3:	Example Floodplain Map for Guam Floodplains .....	6.1.4-7
Figure 6.1.4-4:	Spatial Distribution of Guam Aquifers.....	6.1.4-10
Figure 6.1.5-1:	Guam Wetland Types .....	6.1.5-7
Figure 6.1.5-2:	Marine Intertidal Wetland on Guam.....	6.1.5-7
Figure 6.1.5-3:	Spatial Distribution of Guam Wetland Types .....	6.1.5-8
Figure 6.1.6.3-1:	Vegetation Types and Land Cover Classes in Guam .....	6.1.6-3
Figure 6.1.6.4-1:	Location of Conservation Lands and Marine Preserves on Gaum .....	6.1.6-16
Figure 6.1.6.5-1:	Marine Protected Areas and Coral around Guam.....	6.1.6-19
Figure 6.1.7-1:	Land Use/Land Cover in Guam.....	6.1.7-5
Figure 6.1.7-2:	Recreational Areas.....	6.1.7-8
Figure 6.1.10-1:	Potential for Environmental Justice Populations.....	6.1.10-7
Figure 6.1.11-1:	Cultural Resources Listed on the GRHP and NRHP .....	6.1.11-12
Figure 6.1.14-1:	The Greenhouse Gas Effect.....	6.1.14-2
Figure 6.1.15-1:	Location of TRI Facilities in Guam.....	6.1.15-6
Figure 6.2.6.6-1:	Location of Designated Critical Habitat for Mariana Fruit Bat.....	6.2.6-57
Figure 7-1:	Northern Mariana Islands Geography .....	7-4
Figure 7.1.1-1:	Northern Mariana Islands Transportation and Hospital Locations.....	7.1.1-3
Figure 7.1.2-1:	Major Land Resource Areas of the Northern Mariana Islands .....	7.1.2-3
Figure 7.1.2-2:	Soil Associations Map of the Northern Mariana Islands .....	7.1.2-7
Figure 7.1.3-1:	General Seismic Hazard Map of the Northern Mariana Islands .....	7.1.3-4
Figure 7.1.3-2:	Volcanoes in the Northern Mariana Islands .....	7.1.3-5
Figure 7.1.4-1:	Spatial Distribution of the Northern Mariana Islands Surface Waters .....	7.1.4-4
Figure 7.1.4-2:	Spatial Distribution of the Northern Mariana Islands Watersheds .....	7.1.4-5
Figure 7.1.4-3:	Example Floodplain Map for the Northern Mariana Islands Floodplains .....	7.1.4-7
Figure 7.1.5-1:	Northern Mariana Islands Wetland Types .....	7.1.5-4
Figure 7.1.5-2:	Marine Intertidal Wetland (Submerged) on the Northern Mariana Islands.....	7.1.5-7
Figure 7.1.5-3:	Estuarine Mangrove Wetland on the Northern Mariana Islands .....	7.1.5-7
Figure 7.1.5-4:	Wetland Types of the Southern, Inhabited Northern Mariana Islands where NWI Mapping was Available .....	7.1.5-8
Figure 7.1.6.3-1:	Vegetation Types and Land Cover Classes in the Northern Mariana Islands .....	7.1.6-3
Figure 7.1.6.3-2:	Smothering Invasive Vines in the Northern Mariana Islands.....	7.1.6-7
Figure 7.1.6.4-1:	Protected Areas in the Northern Mariana Islands.....	7.1.6-15
Figure 7.1.6.5-1:	Northern Mariana Islands Coral and Marine Protected Areas.....	7.1.6-20
Figure 7.1.6.6-1:	Designated Critical Habitat in Northern Mariana Islands .....	7.1.6-39
Figure 7.1.7-1:	Land Use/Land Cover in the Northern Mariana Islands.....	7.1.7-5
Figure 7.1.7-2:	Recreational Areas.....	7.1.7-8
Figure 7.1.11-1:	Cultural Resources Listed on the NRHP .....	7.1.11-8
Figure 7.1.14-1:	The Greenhouse Gas Effect.....	7.1.14-2

Figure 8-1:	Puerto Rico Geography .....	8-4
Figure 8.1.1-1:	Major Roads, Ports, and Railroad Transportation in Puerto Rico .....	8.1.1-3
Figure 8.1.1-2:	Airports in Puerto Rico.....	8.1.1-5
Figure 8.1.2-1:	Major Land Resource Areas of Puerto Rico.....	8.1.2-3
Figure 8.1.2-2:	Soil Suborder Map of Puerto Rico.....	8.1.2-11
Figure 8.1.3-1:	Geologic Periods and General Rock Types of Puerto Rico.....	8.1.3-2
Figure 8.1.3-2:	Primary Mineral Production Areas in Puerto Rico.....	8.1.3-4
Figure 8.1.3-3:	General Seismic Hazard Map of Puerto Rico.....	8.1.3-6
Figure 8.1.4-1:	Spatial Distribution of Puerto Rico Watersheds.....	8.1.4-4
Figure 8.1.4-2:	Spatial Distribution of Puerto Rico Surface Waters .....	8.1.4-5
Figure 8.1.4-3:	Example Floodplain Map for Puerto Rico Floodplains .....	8.1.4-8
Figure 8.1.4-4:	Spatial Distribution of Principal Aquifers in Puerto Rico .....	8.1.4-10
Figure 8.1.5-1:	Puerto Rico Wetland Types.....	8.1.5-4
Figure 8.1.5-2:	Marine Intertidal Wetland on Puerto Rico.....	8.1.5-7
Figure 8.1.5-3:	Estuarine Intertidal Wetland on Puerto Rico .....	8.1.5-7
Figure 8.1.5-4:	Palustrine Wetland on Puerto Rico.....	8.1.5-8
Figure 8.1.5-5:	Spatial Distribution of Puerto Rico Wetland Types .....	8.1.5-9
Figure 8.1.6.3-1:	Vegetation Types and Land Cover Classes in Puerto Rico .....	8.1.6-3
Figure 8.1.6.4-1:	General Habitat Types in Puerto Rico .....	8.1.6-9
Figure 8.1.6.4-2:	Protected Areas in Puerto Rico.....	8.1.6-17
Figure 8.1.6.5-1:	Puerto Rico Marine Protected Areas and Habitats of Particular Concern.....	8.1.6-23
Figure 8.1.6.6-1:	Critical Habitat Designations in Puerto Rico.....	8.1.6-49
Figure 8.1.7-1:	Land Use/Land Cover in Puerto Rico.....	8.1.7-6
Figure 8.1.7-2:	Puerto Rico Airspace .....	8.1.7-9
Figure 8.1.7-3:	Recreational Areas.....	8.1.7-11
Figure 8.1.8-1:	Areas in Puerto Rico Managed for Visual Resources.....	8.1.8-2
Figure 8.1.9-1:	Population Distribution and Density .....	8.1.9-3
Figure 8.1.9-2:	Median Household Income.....	8.1.9-5
Figure 8.1.9-3:	Unemployment .....	8.1.9-6
Figure 8.1.9-4:	Property Values .....	8.1.9-10
Figure 8.1.10-1:	Potential for Environmental Justice Populations.....	8.1.10-7
Figure 8.1.11-1:	Cultural Resources Listed on the NRHP .....	8.1.11-15
Figure 8.1.12-1:	Nonattainment and Maintenance Areas in Puerto Rico.....	8.1.12-7
Figure 8.1.14-1:	The Greenhouse Gas Effect.....	8.1.14-2
Figure 8.1.15-1:	Location of TRI Facilities in Puerto Rico.....	8.1.15-5
Figure 9-1:	U.S. Virgin Islands Geography.....	9-4
Figure 9.1.1-1:	Major Roads and Ports in the U.S. Virgin Islands.....	9.1.1-3
Figure 9.1.1-2:	Airports in the U.S. Virgin Islands .....	9.1.1-5
Figure 9.1.2-1:	Major Land Resources Areas of the U.S. Virgin Islands.....	9.1.2-3
Figure 9.1.2-2:	Soil Associations Map of the U.S. Virgin Islands .....	9.1.2-7
Figure 9.1.3-1:	Geologic Periods and General Rock Types of the U.S. Virgin Islands .....	9.1.3-2
Figure 9.1.3-2:	General Seismic Hazard Map of the U.S. Virgin Islands .....	9.1.3-5
Figure 9.1.4-1:	Spatial Distribution of the U.S. Virgin Islands Watersheds .....	9.1.4-3

Figure 9.1.4-2:	U.S. Virgin Islands Surface Waters .....	9.1.4-4
Figure 9.1.4-3:	Example Floodplain Map for U.S. Virgin Islands Floodplains .....	9.1.4-6
Figure 9.1.4-4:	Spatial Distribution of Principal Aquifers in the U.S. Virgin Islands .....	9.1.4-9
Figure 9.1.5-1:	U.S. Virgin Islands Wetland Types .....	9.1.5-7
Figure 9.1.5-2:	Marine Wetland (Coast) and Estuarine Wetland (Lagoon) U.S. Virgin Islands...	9.1.5-7
Figure 9.1.5-3:	Estuarine Wetland (Red Mangroves) in the U.S. Virgin Islands.....	9.1.5-8
Figure 9.1.5-4:	Overview of Spatial Distribution of U.S. Virgin Islands Wetland Types .....	9.1.5-9
Figure 9.1.5-5:	Spatial Distribution of Wetland Types on St. Thomas and St. John.....	9.1.5-10
Figure 9.1.5-6:	Spatial Distribution of Wetland Types on St. Croix.....	9.1.5-11
Figure 9.1.6.3-1:	Vegetation Types and Land Cover Classes in the U.S. Virgin Islands.....	9.1.6-3
Figure 9.1.6.4-1:	General Habitat Types on the U.S. Virgin Islands .....	9.1.6-10
Figure 9.1.6.4-2:	Protected Areas on the U.S. Virgin Islands .....	9.1.6-18
Figure 9.1.6.5-1:	U.S. Virgin Islands Coastal Protected Areas .....	9.1.6-24
Figure 9.1.6.6-1:	Designated Critical Habitat in the U.S. Virgin Islands.....	9.1.6-52
Figure 9.1.7-1:	Land Use/Land Cover in U.S. Virgin Islands.....	9.1.7-5
Figure 9.1.7-2:	Recreational Areas.....	9.1.7-9
Figure 9.1.10-1:	Potential for Environmental Justice Populations.....	9.1.10-7
Figure 9.1.11-1:	Cultural Resources Listed on the NRHP .....	9.1.11-8
Figure 9.1.12-1:	U.S. Virgin Islands Class I Area.....	9.1.12-6
Figure 9.1.14-1:	The Greenhouse Gas Effect.....	9.1.14-2



## ACRONYMS AND ABBREVIATIONS

°F	degree Fahrenheit	ATWC	Alaska Tsunami Warning Center
°N	degrees north	AURORA	Alaska Uniform Response Online Reporting Access
µg/m <sup>3</sup>	microgram(s) per cubic meter	BACT	best available control technology
µPa	micro Pascal	BCE	before Common Era
%	percent	BCR	Bird Conservation Regions
A	attained	BGEPA	Bald and Golden Eagle Protection Act
AAC	Alaska Administrative Code	BLM	Bureau of Land Management
AAFIS	Alaska Public Safety Identification System	BLS	U.S. Bureau of Labor Statistics
AAQS	Ambient Air Quality Standards	BMP	best management practice
ACHP	Advisory Council on Historic Preservation	BRFSS	Behavioral Risk Factor Surveillance System
ACS	American Community Survey (U.S. Census Bureau)	BSAI	Bering Sea/Aleutian Island
ADEC	Alaska Department of Environmental Conservation	BWG	BioInitiative Working Group
ADFG	Alaska Department of Fish and Game	CAA	Clean Air Act
AGL	above ground level	CAB	Clean Air Branch
AIRFA	American Indian Religious Freedom Act	CARB	California Air Resources Board
AJRCCM	American Journal of Respiratory and Critical Care Medicine	CBIA	Coastal Barrier Improvement Act of 1990
AKNHP	Alaska National Heritage Program	CBRA	Coastal Barrier Resources Act of 1982
AKOSH	Alaska Occupational Safety and Health	CCP	Comprehensive Conservation Plan
AKWAS	Alaska Warning System	CDC	Center for Disease Control
ALMR	Alaska Land Mobile Radio	CDLNR	Commonwealth Department of Lands and Natural Resources
ANFIRS	Alaska Fire Incident Reporting System	CE	Common Era
ANSCA	Alaska Native Claims Settlement Act	CELCP	Coastal and Estuarine Land Conservation Program
ANSI	American National Standards Institute	CEPD	Caribbean Environmental Protection Division
APE	Area of Potential Effect	CEQ	Council on Environmental Quality
APLIC	Avian Power Line Interaction Committee	CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
APSIN	Alaska Public Safety Information Network	CFMC	Caribbean Fisheries Management Council
AQCR	air quality control region	CFR	Code of Federal Regulations
ARFF	Aircraft Rescue and Firefighting	cfs	cubic feet per second
ARMS	Alaska Records Management System	CH <sub>4</sub>	methane
ARPA	Archaeological Resources Protection Act of 1979	CHC	Commonwealth Health Center
AS	Alaska Statute	CIA	Central Intelligence Agency
A.S.A.C.	American Samoa Administrative Code	CMIP3	Coupled Model Intercomparison Project phase 3
ASCA	American Samoa Code Annotated	CNMI	Commonwealth of Northern Mariana Islands
ASCMP	American Samoa Coastal Management Program	CNMIAC	Commonwealth of Northern Mariana Islands Administrative Code
ASDMWR	American Samoa Department of Marine and Wildlife Resources	CO	carbon monoxide
ASEPA	American Samoa Environmental Protection Agency	CO <sub>2</sub>	carbon dioxide
ASHPO	American Samoa Historic Preservation Office	CO <sub>2e</sub>	carbon dioxide equivalents
ASPA	American Samoa Power Authority	COMAR	Committee on Man and Radiation
ATO	Air Traffic Organization	CPA	Commonwealth Ports Authority

CRMP	Coastal Resources Management Program	FMP	Fishery Management Plan
CSP	Central South Pacific	FPPA	Farmland Protection Policy Act of 1981
CUC	Commonwealth Utilities Corporation	FR	Federal Register
CWA	Clean Water Act	ft	feet
CZMA	Coastal Zone Management Act	g/hp-hr	grams per horsepower-hour
CZMP	Coastal Zone Management Program	g/mi	grams per mile
DACA	Deployable Airborne Communications Architecture	GAP	Gap Analysis Program
DAR	Division of Aquatic Resources (Hawaii)	GCA	Guam Code Annotated
DAWR	Division of Aquatic and Wildlife Resources (Guam)	GDA	Guam Department of Agriculture
dB	decibel(s)	GEPA	Guam Environmental Protection Agency
dba	A-weighted decibel(s)	GHG	greenhouse gas
DBCP	1,2-dibromo-3-chloropropane	GIS	geographic information system
dBZ	Z-weighted decibel(s)	GMP	General Management Plan
DCP	1,2-dichloropropane	GOA	Gulf of Alaska
DEC	Department of Environmental Conservation	GRHP	Guam Register of Historic Places
DHHL	Department of Hawaiian Homelands	GWP	global warming potential
DLNR	Department of Land and Natural Resources (Hawaii)	H <sub>2</sub> S	hydrogen sulfide
DMA	Disaster Mitigation Act of 2000	HDOH	Hawaii Department of Health
DNER	Department of Natural and Environmental Resources of Puerto Rico	HEI	Health Effects Institute
DOA	Department of Agriculture	HHCA	Hawaiian Homes Commission Act of 1920
DOD	Department of Defense	HIANG	Hawaii Air National Guard
DOE	U.S. Department of Energy	HIARNG	Hawaii Army National Guard
DOH	Department of Health	HIHWNMS	Hawaiian Islands Humpback Whale National Marine Sanctuary
DOH-CAB	Hawaii Department of Health, Clean Air Branch	HIOSH	Hawaii Occupational Safety and Health Division
DOT	U.S. Department of Transportation	hp	horsepower
DPNR	Department of Planning and Natural Resources (U.S. Virgin Islands)	HRD	(Guam) Historic Resources Division
DPS	Department of Public Safety	HRHP	Hawaii Register of Historic Places
EA	Environmental Assessment	HRS	Hawaii Administrative Rules, Revised Statute
EAS	Emergency Alert System	HTA	Hawai'i Tourism Authority
EBS	Emergency Broadcast System	HUC	hydrologic unit code
EDB	ethylene dibromide	I/M	Inspection/Maintenance
EFH	essential fish habitat	IARC	International Agency for Research on Cancer
EMS	emergency medical services	IBA	Important Bird Area
ENSO	El Niño/Southern Oscillation	IEEE	Institute of Electrical and Electronics Engineers
EO	Executive Order	IFC	International Finance Corporation
EPCRA	Emergency Planning and Community Right-to-Know Act	in	inches
ERP	effective radiated power	IPCC	Intergovernmental Panel on Climate Change
ESA	Endangered Species Act	IR	ionizing radiation
ESI	Environmental Sensitivity Index	ITCZ	Intertropical Convergence Zone
FAA	Federal Aviation Administration	IUCN	International Union for Conservation of Nature
FAD	Fish Aggregating Device	kg/gal	kilograms per gallon
FCC	Federal Communications Commission	KIRC	Kaho'olawe Island Reserve Commission
FEMA	Federal Emergency Management Agency	LAER	lowest achievable emission rate
FirstNet	First Responder Network Authority	lb/day	pounds per day
		lb/hp-hr	pounds per horsepower-hour

LBJ	Lyndon B. Johnson	NP	National Park
Ldn	day-night average sound level	NPDES	National Pollutant Discharge Elimination System
Leq	equivalent noise levels	NPL	National Priorities List
LNG	liquefied natural gas	NPS	National Park Service
LTE	Long Term Evolution	NPSBN	nationwide public safety broadband network
µg/m <sup>3</sup>	microgram(s) per cubic meter	NRCS	Natural Resources Conservation Service
µPa	micro Pascal	NRHP	National Register of Historic Places
m/s	meter per second	NSPS	New Source Performance Standards
MBTA	Migratory Bird Treaty Act	NTIA	National Telecommunications and Information Administration
mg/m <sup>3</sup>	Milligram(s) per cubic meter	NVSR	National Vital Statistics Report
mgd	million gallons per day	NWI	National Wetland Inventory
MHz	megahertz	NWR	National Wildlife Refuge
MLRA	Major Land Resource Area	NWWS	National Weather Wire Satellite System
mm/s	millimeters per second	OHA	Office of History and Archaeology
MMPA	Marine Mammal Protection Act	OIA	Office of Insular Affairs (USDI)
MOA	Memorandum of Agreement	OSHA	Occupational Safety and Health Administration
MPA	Marine Protected Area	PA	Programmatic Agreement
mph	miles per hour	PAG	Port Authority of Guam
MSA	Magnuson-Stevens Fishery Conservation and Management Act	PAHO	Pan American Health Organization
MTR	Military Training Route	PCB	polychlorinated biphenyl
MUID	Map Unit Identification Data	PCP	pentachlorophenol
MW	megawatt	PDO	Pacific Decadal Oscillation
mW/cm <sup>2</sup>	milliwatts per centimeter squared	PEIS	Programmatic Environmental Impact Statement
N	north; not attained	PL	Public Law
N <sub>2</sub> O	nitrous oxide	PM	particulate matter
NA	not applicable; not assessed	PM <sub>10</sub>	particulate matter up to 10 micrometers in diameter
NAAQS	National Ambient Air Quality Standards	PM <sub>2.5</sub>	particulate matter up to 2.5 micrometers in diameter
NAGPRA	Native American Graves Protection and Repatriation Act	POPs	points of presence
NANSR	Nonattainment New Source Review	ppm	parts per million
NAWAS	National Warning System	PRDNER	Puerto Rico Department of Natural and Environmental Resources
NCA	National Climate Assessment	PREQB	Puerto Rico Environmental Quality Board
NCD	non-communicable disease	PR OSHA	The Puerto Rico Occupational Safety and Health Administration
NCDC	National Climatic Data Center	PRASA	Puerto Rico Aqueduct and Sewer Authority
NCN	no common name	PREPA	Puerto Rico Electric Power Authority
NCRP	National Council on Radiation Protection and Measurements	PRSHPO	Puerto Rico State Historic Preservation Office
ND	no data	PSD	Prevention of Significant Deterioration
NE	northeast	PUAG	Public Utility Agency of Guam
NEPA	National Environmental Policy Act	PV	photovoltaic
NESHAP	National Emission Standards for Hazardous Air Pollutants	RAN	radio access network
NFIP	National Flood Insurance Program	RCP	Representative Concentration Pathway
NFIRS	National Fire Incident Reporting System	RCRA	Resource Conservation and Recovery Act
NHPA	National Historic Preservation Act		
NIR	non-ionizing radiation		
NMFS	National Marine Fisheries Service		
NMHC	non-methane hydrocarbon compounds		
NMOG	non-methane organic compounds		
NNE	north-northeast		
NOAA	National Oceanic and Atmospheric Administration		
NOx	nitrogen oxides		

RF	radio frequency	vog	volcanic smog
RIN	Regulation Identification Number	VRM	Visual Resource Management
rms	root mean square	W	watt(s)
ROW	right-of-way	W/m <sup>2</sup>	watts per meters squared
SAAQS	State Air Quality Standards	WAPA	Water and Power Authority
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users	WHO	World Health Organization
SARA	Superfund Amendments and Reauthorization Act of 1986	WIMARCS	West Indies Marine Animal Research and Conservation Science
SCD	State Civil Defense	WNP	Western North Pacific
SE	Standard of Error	WNW	west-northwest
SHPO	State Historic Preservation Office	WPC	watts per channel
SIP	State Implementation Plan	WPRFMC	Western Pacific Regional Fishery Management Council
SLR	sea level rise		
SMA	Special Management Area		
SMS	Scenery Management System		
SO <sub>2</sub>	sulfur dioxide		
SO <sub>x</sub>	sulfur oxides		
SPCZ	South Pacific Convergence Zone		
SPOC	Single Point of Contact		
SRES	Special Report on Emission Scenarios		
SSA	sole source aquifer		
STATSGO2	State Soil Geographic [Database]		
SW	southwest		
TAAQS	Territory Ambient Air Quality Standards		
TCP	traditional cultural property		
TEMCO	Territorial Emergency Management Coordinating Office		
TMDL	Total Maximum Daily Load		
TOC	total organic compound		
tpy	tons per year		
TRI	Toxic Release Inventory		
TSCA	Toxic Substances Control Act		
U.S.	United States		
UAMES	University of Alaska Museum Earth Sciences		
USACE	U.S. Army Corps of Engineers		
USC	United States Code		
USDA	U.S. Department of Agriculture		
USDI	U.S. Department of the Interior		
USEPA	U.S. Environmental Protection Agency		
USFWS	U.S. Fish and Wildlife Service		
USGCRP	U.S. Global Climate Change Research Program		
USGS	U.S. Geological Survey		
USVIDOH	U.S. Virgin Islands Department of Health		
USVIPD	U.S. Virgin Islands Police Department		
UVA	University of Virginia		
VIC	Virgin Islands Code		
VIPA	Virgin Islands Port Authority		
VISHPO	Virgin Islands State Historic Preservation Office		
VOC	volatile organic compound		

## **2. DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES**

In accordance with the National Environmental Policy Act (NEPA), FirstNet must examine a range of reasonable alternatives to design, construct, and operate the Nationwide Public Safety Broadband Network (NPSBN). These alternatives must be reasonable ways in which FirstNet could meet the purpose and need for the Proposed Action. In addition to the range of reasonable alternatives, this document also describes those alternatives considered but not carried forward for analysis. Alternatives not carried forward were initially considered but found to not reasonably meet the purpose and need. FirstNet is also required to “include the alternative of no action” as part of the alternatives analysis in the Programmatic Environmental Impact Statement. The “No Action Alternative” describes what would happen if FirstNet did not construct the NPSBN, and is used as a baseline against which the potential impacts of the action alternatives can be compared.

### **2.1. PROPOSED ACTION**

The Proposed Action would encompass the design, deployment/construction, and operation of the NPSBN by FirstNet or a partner organization(s) through a comprehensive network procurement process, currently underway. FirstNet anticipates a competitive process to procure a comprehensive technical and business solution to meet its stated mission and objectives. By statute, the network must have several characteristics, including security, resiliency, backwards compatibility with existing commercial networks, integration with public safety answering points<sup>1</sup> or their equivalents, substantial rural coverage; it must be built to open, non-proprietary, commercially available standards; and it must use existing infrastructure to the maximum extent economically desirable. The FirstNet network would have two components, the core network, and the radio access network (RAN). The core network is a key component for ensuring that users have a single interoperable platform nationwide, and would consist of a wide range of telecommunications infrastructure including fiber optic cable, towers, data centers, microwave technology, and others. The core has six primary functions: it switches data, processes and reformats information, stores and maintains data, and keeps it secure. The core network would interface with local, tribal, state, and federal networks, including 911 and the internet, thereby serving as the backbone connecting the 50 states, 5 territories, and the District of Columbia. The core network would be constructed and maintained to the most up-to-date technological standards, comprised of all standard Evolved Packet Core (EPC) elements under the 3rd Generation Partnership Project (3GPP). The EPC is the collection of systems that manages the connection of all voice calls, data sessions, messaging, and video services in a wireless network. Since the EPC is responsible for the management of all services, it is the central “brain” of the network. The RAN would consist of all radio base station infrastructure that would connect user devices. This infrastructure would include communication towers, cell site equipment, antennas, deployable mobile hotspots, and backhaul equipment required to enable wireless communications with devices using the public safety broadband spectrum. Finally, the Act

---

<sup>1</sup> Public safety answering points are call centers responsible for answering calls to an emergency telephone number for police, fire, and emergency medical services.

states that FirstNet must continue to maintain and improve the NPSBN to account for new and evolving technologies.

FirstNet may enter into Spectrum Manager Lease Agreements (SMLAs) with states that opt-out of the FirstNet network. The range of methods that would be employed by states to connect their RAN to the FirstNet core network are expected to include methods described and analyzed in the various alternatives listed below.

### **2.1.1. Characteristics of the NPSBN**

The Act specifies that the FirstNet network would be based on the minimum technical requirements on the commercial standards for Long Term Evolution (LTE) service. LTE is a proven upgradeable technology, now in its fourth generation (4G). Improvements in speed and function are achieved with each subsequent generation, and 4G LTE standards are continuing to evolve. FirstNet is involved in the research and development of new standards and is working closely with the public safety community as part of this process, with the goal of ensuring that the unique needs of public safety can be met.

The core network would have six primary functions: it would switch data, process and reformat information, store and maintain data, and keep that data secure. Other functions, such as applications, services, and operational and business support systems would also be part of the core network. The backhaul, or intermediate links that carry user traffic, including voice, data, and video, and signaling from radio base stations to the core network, would likely be accomplished through fiber optic and microwave technology, with an emphasis on redundancy to allow the network to continue to function in events of extreme demand.

The RAN would place an emphasis on reliability, prioritizing physical hardening and security. Redundant power backup, redundant backhaul capabilities, structural hardening, and security measures would be implemented as appropriate to provide a resilient and reliable radio base station infrastructure.

### **2.1.2. Proposed Action Infrastructure**

There is currently a wide range of technologies that FirstNet may use to implement and deploy the NPSBN, ranging from fixed assets to mobile, deployable infrastructure. The following are general descriptions of the types of wired, wireless, and deployable projects that FirstNet may consider.

#### **2.1.2.1. *Wired Projects***

##### **New Build – Buried Fiber Optic Plant**

The installation of fiber optic cable would generally consist of plowing or trenching cable alongside the road usually in utility corridor or within public road right-of-way (ROW), where possible. ROWs could also include utility corridors or other easements and may be public or private. This could involve either burying both conduit and cable inside the conduit or only direct buried cable. Installation may involve plowing, trenching (including vibratory plowing),

or directional boring, and may involve the construction of points of presence (POPs),<sup>2</sup> huts, or other facilities to house outside plant equipment or hand-holes to access the fiber.

### **Use of Existing Conduit – New Buried Fiber Optic Plant**

The installation of new fiber optic cable in existing conduit typically requires blowing or pulling new fiber optic cable into existing, buried conduit. In this project scenario, any ground disturbance would usually be limited to the entry and exit points of the existing conduit.

### **New Build – Aerial Fiber Optic Plant**

Construction of new aerial fiber optic cable would generally consist of installing new poles and hanging cables in previously disturbed or new (undisturbed) ROWs or easements, or installing replacement poles in previously disturbed ROWs or easements. Installation of new poles and fiber may involve construction of access roads, depending on the availability of ROWs. This type of activity may also involve the constructions of POPs, huts, or other facilities to house outside plant equipment.

### **Collocation on Existing Aerial Fiber Optic Plant**

Installation of new fiber on existing poles may require structural hardening or reinforcement to improve disaster resistance and resiliency. It may also require pole replacement to accommodate an increased load from new users. All replacement poles must be placed in the exact same hole in order for the action to qualify as “collocation”.

### **Use of Existing Buried or Aerial Fiber Optic Plant or Existing Submarine Cable**

This project type would involve lighting up dark fiber owned by and leased from various providers. Dark fiber is fiber that has been installed without a transmitter and receiver, typically to provide capacity for future growth.

### **New Build – Submarine Fiber Optic Plant**

Deployment of new submarine cable, if implemented, would involve the installation of specially sealed cables in limited near-shore or inland bodies of water, and construction of landings / facilities on the shore to accept a cable, which is typically buried close to shore. Transoceanic submarine cables are not anticipated to be used as part of the Proposed Action; therefore, submarine repeaters and large marine vessels for installation or repairs would not be used. However, small marine vessels could be required for installation and repairs of smaller, non-transoceanic cables in limited near-shore or inland bodies of water.

### **Installation of Optical Transmission or Centralized Transmission Equipment**

All fiber installation activities may require additional installation of equipment to enhance the digital signals travelling through the fiber, depending on the network configuration. FirstNet may also install transmission equipment as part of the core network construction.

---

<sup>2</sup> POPs are connections or access points between two different networks, or different components of one network.

This equipment is usually installed in small boxes or huts in the ROW of the utility corridor, and may involve construction of access road, depending on the availability of public ROW.

#### **2.1.2.2. *Wireless Projects***

##### **New Wireless Communication Towers**

FirstNet may undertake the construction of new towers of various heights and configurations (e.g., monopoles, lattice, and guy-wired) to support wireless infrastructure, such as antennas and microwave dishes. Tower construction may also include associated structures including generators, equipment sheds, fencing, security lighting, aviation lighting, electrical feeds, and concrete foundations and pads. This type of project may require the construction of access road, depending on the availability of public ROW.

##### **Collocation on Existing Wireless Tower, Structure, or Building**

Collocation projects would involve mounting or installation of equipment such as antennas or microwave dishes on an existing tower to transmit and/or receive signals, or provide backhaul. Installation of power units, such as an uninterruptible power supply could be added. Existing towers, structures, or buildings may require structural hardening or increased physical security measures.

#### **2.1.2.3. *Deployable Technologies***

As part of the Proposed Action, there may be areas where permanent, fixed infrastructure cannot be erected due to a variety of factors. Deployable technologies may provide an option to either provide coverage in such areas, or they may be used to supplement existing coverage during a large-scale planned or emergency event. In addition, deployable technologies could also be used in areas where potential permanent impacts to significant sensitive resources/receptors cannot be avoided or mitigated. In general, some limited construction could be associated with the implementation of deployable technologies such as land clearing or paving for parking or staging areas.

##### **Cell on Wheels**

The Cell on Wheels deployable technology consists of a cellular base station on a trailer with an expandable antenna mast, typically between 15 feet to 40 feet, and usually a microwave or satellite link back to the main controller. Cell on Wheels typically contain a small generator and may also connect to utility power cables. This type of technology is designed to be part of a cellular network and augment existing capacity.

##### **Cell on Light Truck**

The Cell on Light Truck deployable technology consists of a cellular base station on a light truck platform with an expandable antenna mast, typically between 15 feet and 40 feet, and usually a microwave or satellite link back to the main controller. Cell on Light Truck typically contains a



small generator and may also connect to utility power cables. This type of technology is designed to be part of a cellular network and augment existing capacity.

### **System on Wheels**

The System on Wheels deployable technology consists of a full base station and controller on a large towable trailer or truck. A System on Wheels is a fully self-contained cellular system that can provide an island system with no need for satellite/microwave link back. System on Wheels typically contains a power generator and a larger antenna mast (ranging from approximately 50 feet to 120 feet), suitable to address larger localized coverage or capacity shortages in the event of planned or unplanned incidents.

### **Deployable Aerial Communications Architecture**

Deployable Aerial Communications Architecture consists of aerial vehicles, including, but not limited to, drones, piloted aircraft, balloons, and blimps, which would be deployed at a variety of altitudes and are capable of providing wide-area coverage, although with relatively low capacity/throughput. Deployable Aerial Communications Architectures would be used for addressing wide scale loss of coverage after a major catastrophic event, which would have the network down for a significant period.

#### ***2.1.2.4. Satellites and Other Technologies***

### **Satellite-Enabled Devices and Equipment**

FirstNet may install permanent equipment on existing structures or support the use of portable devices that use satellite technology, such as satellite phones or video cameras.

### **Deployment of Satellites**

FirstNet does not anticipate launching satellites as part of the deployment of the NPSBN; however, it could include equipment on satellites that are already being launched for other purposes and may work with other federal agencies or commercial entities that engage in satellite launches to use Global Positioning System satellites to support devices requiring location information.

## **2.2. DESCRIPTION OF ALTERNATIVES**

In accordance with NEPA, FirstNet has considered a variety of alternatives to ensure the building, deployment, and operation of the NPSBN. The Council on Environmental Quality has defined reasonable alternatives as those that are economically and technically feasible ways to meet the purpose and need. NEPA also requires the analysis of the No Action Alternative, which provides a baseline against which the potential impacts of the Action Alternatives may be compared. FirstNet is carrying two alternatives plus the No Action Alternative, forward for analysis. Furthermore, FirstNet has considered three additional alternatives and dismissed them from further consideration.

### **2.2.1. Preferred Alternative**

Under the Preferred Alternative, FirstNet and/or its partners would construct a nationwide broadband LTE network using a combination of the wired, wireless, deployable, and satellite technologies. This may include, but is not limited to, the following methods: collocation of the network equipment on existing towers, poles and structures; construction of new communication towers, poles and associated structures to include generators, equipment sheds, fencing, and concrete pads; use of existing fiber facilities, including lighting up dark fiber and installation of new fiber on existing poles and in existing conduit; installation of new conduit and fiber using trenching (including vibratory plowing) or directional boring (including horizontal directional drilling); deployment of satellite phones and other portable satellite technology; installation of microwave facilities for cell-site backhaul communication; and the utilization of deployable technologies.

### **2.2.2. Deployable Technologies Alternative**

Under the Deployable Technologies Alternative, FirstNet would procure, deploy, and maintain a nationwide fleet of mobile communications systems, including ground-based and aerial deployable technologies, to provide temporary coverage in areas not covered by existing, usable infrastructure, as there would be no collocation of equipment or new construction associated with wired or wireless projects discussed above under the Preferred Alternative. Generally, these units would be deployed at times of an incident to the affected area for either planned or unplanned incidents or events. Equipment would be stationed in every state and territory, often at multiple locations in each state or territory, to facilitate suitable response. These mobile communication units would be temporarily installed and may use existing satellite, microwave, or radio systems for backhaul. In general, some limited construction could be associated with the implementation of deployable technologies such as land clearing or paving for parking or staging areas. However, these construction activities would be minimal in comparison to the combination of project types associated with the Preferred Alternative as described above.

### **2.2.3. No Action Alternative**

Under the No Action Alternative, the NPSBN would not be constructed; there would be no nationwide, coordinated system dedicated to public safety interoperable communications. The existing multiplicity of communications networks would remain in place, as would the current, known limitations and problems of existing communication networks during times of emergency or disaster. This alternative would require an act of Congress to revise the Act, which currently requires the NPSBN.

## **2.3. ALTERNATIVES CONSIDERED BUT NOT CARRIED FORWARD**

During the course of the development of the Proposed Action, several additional alternatives to implement the Proposed Action were considered. Each of these alternatives was found deficient in some way, and did not meet the purpose and need for the Proposed Action as discussed below.

### **2.3.1. New Construction Only Alternative**

Under the New Construction Only Alternative, FirstNet would construct a nationwide network using all new construction and installation of fiber optic cable, conduit, utility poles, communication towers, and installed equipment. This alternative has been dismissed from further consideration because it is counter to FirstNet's legislative mandate to leverage existing infrastructure. Furthermore, new construction of the entire network would be cost-prohibitive and the construction timeline would cause unnecessary delays in network implementation as a result of the need for building an entirely new NPSBN from the ground up, which would not meet the agency's legislative purpose and the needs of the Proposed Action.

### **2.3.2. New Satellite Alternative**

Under the New Satellite Alternative, FirstNet would construct a nationwide network using new and existing satellite technology only. Generally, satellite technology is not cost effective due to limited spectrum, and technical issues such as limited in-building coverage and performance. This alternative has been dismissed from further consideration because it is counter to FirstNet's mandate to use standards-based LTE technology to provide coverage, and its performance capabilities would not meet the purpose and need of the Proposed Action.

### **2.3.3. Collocation-Only Alternative**

Under the Collocation-Only Alternative, FirstNet would construct the NPSBN using existing infrastructure only, by collocating equipment exclusively on existing towers, buildings, or other structures. This alternative has been dismissed from further consideration because suitable infrastructure does not exist to provide nationwide broadband coverage using only existing infrastructure. Many areas of the country, particularly rural areas, would have little to no service options from FirstNet if existing infrastructure alone were required to build the network. Therefore, this alternative would not meet the purpose and need of the Proposed Action.

## **2.4. RADIO FREQUENCY EMISSIONS**

### **2.4.1. Introduction**

General interest in the topic of the safety of radio frequency (RF) electromagnetic field emissions (RF emissions),<sup>3</sup> a form of radiation, from communication towers and their relationship to human health and the environment has increased with the number of devices being used and the degree of connectivity needed for people to go about their daily lives. This interest has been demonstrated in the comments received by FirstNet for its Programmatic Environmental Impact Statement (PEIS) for the nationwide public safety broadband network (NPSBN), other telecommunications projects, as well as active discussions within the human health and

---

<sup>3</sup> RF emissions refer to RF radiation emitted by devices. OSHA defines RF radiation as "electromagnetic radiation in the frequency ranges 3 kilohertz (kHz) - 300 Megahertz (MHz), and 300 MHz - 300 gigahertz (GHz), respectively" (*OSHA Undated*).

environmental science communities and among the general public. Accordingly, FirstNet has determined it is important to analyze the potential human and environmental effects for the PEIS.

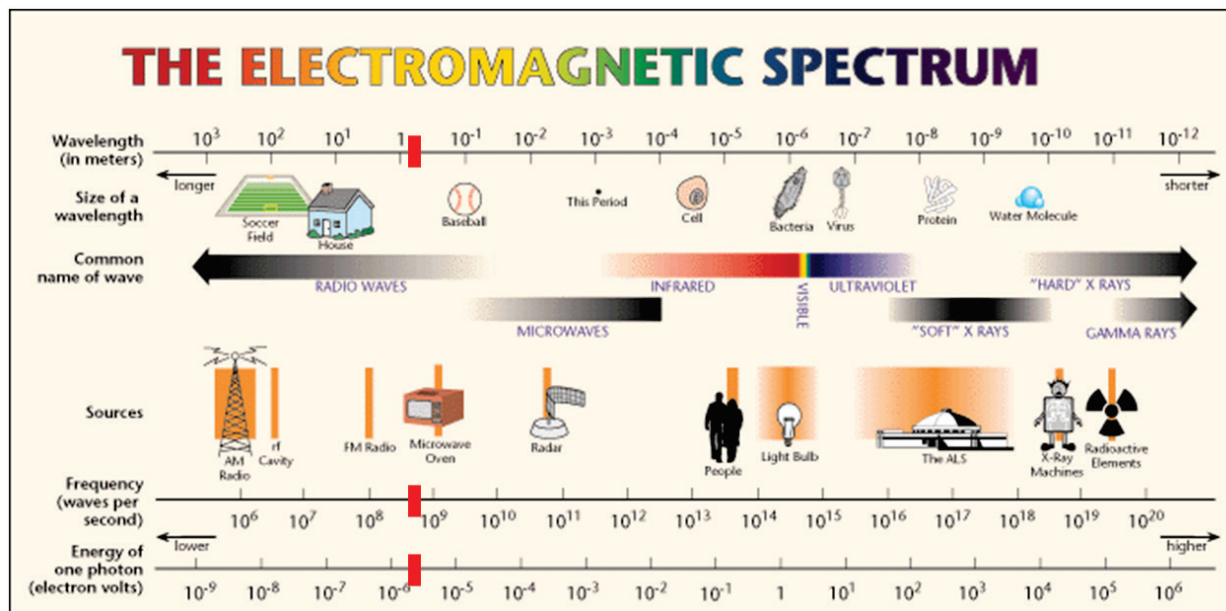
This document provides a general overview regarding RF emissions, the existing regulatory framework for limiting RF exposures, the general discussions on the current state of research for potential effects on humans, as well as information on animal and plant species, and some of the general conclusions on data gaps and the paths forward. While this document is not intended to be a complete analysis of all aspects of RF emissions and their potential effects, it does provide a general discussion of some of the credible scientific literature and information that relates to RF emissions and potential effects to human health and other species.

In general, radiation is the product of a wide range of energies that form the electromagnetic spectrum. A number of radiation sources exist in nature—such as the radon emitted from the breakdown of certain minerals in the ground or the radiation from energy in space and others are artificial (such as RF emissions created by broadcasting, radio, and cellular equipment).

The electromagnetic spectrum is divided into two main classes:

- **Non-ionizing radiation (NIR).** NIR is at the low end of the electromagnetic spectrum. Visible Light, AM/FM radio, cellular, and microwaves are all classified as NIR. FirstNet system would operate in the 700 megahertz (MHz) frequency band, which means that it would emit NIR (*Zamanian 2005*).
- **Ionizing radiation (IR).** IR can produce charged particles (ions) in matter and is produced by unstable atoms that have an excess of energy or mass or both. Gamma radiation and x-rays are examples of IR. FirstNet equipment would not produce any IR (*Zamanian 2005*).

This review focuses on NIR related to cellular systems (e.g., tower and building-mounted equipment) and, specifically, the 700 MHz Long Term Evolution spectrum band licensed for use by FirstNet. Figure 4.2.1-1 details the full electromagnetic spectrum (*U.S. Department of Energy 2009*). The red band on each line of Figure 2.4.1-1 indicates the 700 MHz frequency band.



Source: U.S. Department of Energy 2009

**Figure 2.4.1-1: The Electromagnetic Spectrum**

Radiation is frequently presented in the terms of *power intensity* or *irradiance*. The power intensity is the radiant flux<sup>4</sup> received by a specific surface area. The units for irradiance are watts (W) per meters squared ( $\text{W}/\text{m}^2$ ). Frequently, RF emissions and exposure standards are defined in terms of power density. Some standards are explicitly defined while others are a function of the frequency of the radiation. Table 2.4.1-1 below summarizes the current Federal Communications Commission (FCC) standards for RF emissions for occupational/controlled exposure, as well as uncontrolled exposure.

Since FirstNet is licensed to operate in the 700 MHz range,<sup>5</sup> the FCC regulations establishing exposure limits would govern FirstNet operations and (power density) would be between 2.33 milliwatts per centimeter squared ( $\text{mW}/\text{cm}^2$ ) and 2.66  $\text{mW}/\text{cm}^2$  for occupational or controlled exposure for frequencies of 700 and 799 MHz, respectively.<sup>6</sup> For these same frequencies and general population/uncontrolled exposure, the FCC standard exposure limits are 0.47  $\text{mW}/\text{cm}^2$  to 0.53  $\text{mW}/\text{cm}^2$ . This analysis is intended to outline some preliminary information on the topic in order to describe the state of current research, science, and the unsettled issues surrounding RF emissions that better aid FirstNet in making its decisions and further analysis this topic as part of the PEIS.

<sup>4</sup> The radiant flux is the amount of energy per unit time radiated from a source.

<sup>5</sup> FirstNet holds a single 700 MHz Public Safety Broadband Nationwide License, under Call Sign WQQE234.

<sup>6</sup> See 47 U.S.C. § 1421(a).

**Table 2.4.1-1: FCC Regulatory Levels**

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm <sup>2</sup> )	Averaging Time (E) <sup>2</sup> , (H) <sup>2</sup> , or S (minutes)
<b>Limits for Occupational/Controlled Exposure</b>				
0.3-3.0	614	1.63	(100) <sup>a</sup>	6
3.0-30	1842/f	4.89/f	(900/f <sup>2</sup> ) <sup>a</sup>	6
30-300	61.4	0.163	1.0	6
300-1500	--	--	f/300	6
1500-100,000	--	--	5	6
<b>Limits for Occupational/Controlled Exposure</b>				
0.3-1.34	614	1.63	(100) <sup>a</sup>	30
1.34-30	842/f	2.19/f	(180/f <sup>2</sup> ) <sup>a</sup>	30
30-300	27.5	0.073	0.2	30
300-1500	--	--	f/1500	30
1500-100,000	--	--	1.0	30

Source: FCC 1997

A/m = amperes per meter; f = frequency in MHz; MHz = megahertz; mW/cm<sup>2</sup> = milliwatts per centimeter squared; V/m = volts per meter

<sup>a</sup> Plane-wave equivalent power density

## 2.4.2. RF Emissions and Humans

For 20 years, the regulatory levels for human exposure to RF emissions have been established by the FCC as a means of protecting both workers and the general public from any potential effects.<sup>7</sup> Concerns about RF emissions have been raised for a number of years by various nongovernmental stakeholder groups about whether the FCC's exposure levels—and similar standards established by other developed nations—are protective enough based upon the current science on the potential health effects.

The FCC's standards were first established in 1996 based upon the guidelines formulated by the National Council on Radiation Protection and Measurements (NCRP), a Congressionally-chartered nonprofit corporation that prepares recommendations on matters of radiation protection, as well as those promoted by two independent nonprofit organizations, the Institute of Electrical and Electronics Engineers (IEEE) and the American National Standards Institute (ANSI), both of whom have helped set industry standards for decades (*FCC 2013, 2014*).

These standards set effective radiated power (ERP) of no more than 500 watts per channel (WPC), depending on tower height and the total number of radio channels (transmitters) authorized at a specific site, so that the RF power transmitting at any particular location will vary, with most urban and suburban sites operating at an ERP of less than 100 WPC (*FCC 2014*).

According to the FCC and depending upon the type of antenna being used, the typical cell site emits an ERP of 100 WPC, which corresponds to an actual radiated power of 5 to 10 watts

<sup>7</sup> See 47 C.F.R. 1.1307(b), 1.1310, 2.1091, 2.1093.

(FCC 2014). Measurements taken of typical ground-level exposures are usually well below the FCC exposure standards because the power of RF emissions rapidly decrease as the distance from the transmitter increases (FCC 2014).

Demonstrating cause and effect in humans from low-level<sup>8</sup> environmental exposures is considered to generally require multiple studies over many years before consensus is reached and a clear cause and effect can be established (Webb and Bain 2011). In order to respond to a request by Congress to study the potential health effects of electric and magnetic fields on humans and other living organisms, the Department of Energy entered into an agreement with the National Research Council for the National Academy of Science to prepare a study.

That report, in looking at routine exposures to electric and magnetic fields found in homes and communities as the cause of disease and abnormalities, stated the following:

“There is no widely accepted understanding of how extremely low-frequency electric and magnetic fields, such as those associated with the distribution and use of electric power, could cause a disease or whether it causes a disease. Considerable research has been conducted in this area, and numerous research data can be found on the subject, but given the lack of a specific disease end point to track or a well-accepted theory of how the fields might affect biologic systems, the data are discordant; they have been gathered using different exposure conditions and have resulted in conflicting observations of different effects or no effects.” (National Research Council 1997)

Hence, the investigations into RF have not yet achieved scientific consensus on cause and effect.

Some of the major problems with demonstrating cause and effect for RF are listed below:

- No consistent measures of exposure. Exposure is changing with the proliferation of cell phone use, and there is no real unexposed or “control” population (Ahlbom et al. 2004; Khurana et al. 2010).
- No scientifically agreed upon biological mechanism for harm. The lack of a clear biological mechanism increases uncertainty into whether the health end point that the study examined is the correct endpoint to try and measure (Hauri et al. 2014; Ahlbom et al. 2004).
- Some potential effects of major concern are rare, such as brain cancer and acoustic neuroma, both of which have been potentially linked to RF exposure. If the health outcome is rare, it is even harder to demonstrate cause and effect (Ahlbom et al. 2004).

However, there is an active scientific research effort worldwide concerning the potential health effects of RF emissions, with new studies being published frequently. This research environment reflects the public interest in the topic, the increased level of interest within the scientific community and the desire by governments and health organizations to determine conclusively whether there are any potential effects from RF emissions to either people or the environment.

---

<sup>8</sup> For the purposes of this review, “low-level” is a qualitative description of the small amount of energy contained in these emissions.

#### **2.4.2.1. Regulatory Framework for RF Emissions**

As indicated above, RF emissions have been identified by the FCC as a potential environmental factor to be weighed in evaluating a transmitter's effect on the human environment. Currently, the FCC implements and enforces both occupational and public exposure limits to RF electromagnetic fields through its authorization and licensing process. In order for a facility operation or transmitter to be authorized or licensed, FCC requires licensees to be in compliance with its regulations relating to RF emissions.

In 1996, as a consequence of the authority granted by Congress to the FCC in the Telecommunications Act of 1996 to "prescribe and make effective rules regarding the environmental effects of radio frequency emissions" (Telecommunications Act of 1996, 104 P.L. 104), the agency adopted new guidelines and procedures reflected in its revised Office of Engineering and Technology Bulletin 65, *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields*, originally issued in 1985 (FCC 1997). The revised guidelines include limits for Maximum Permissible Exposure for transmitters operating between 300,000 hertz and 100 GHz which are averaged over a specified time-interval. The limits are different based on whether an occupational setting or a general population exposure setting is being evaluated. These standards have been challenged in federal courts and have been upheld (See, for example, *Cellular Phone Taskforce v. FCC*, 205 F.3d 82 [2d Cir. 2000]).

The FCC has updated its standards for evaluating mobile or personal communication devices "localized absorption" as well. The FCC's Maximum Permissible Exposure "localized absorption" limits are based on recommendations from the NCRP and the IEEE<sup>9</sup> and were adopted by the ANSI to replace the earlier ANSI guidelines of 1982. These limits are based on thermal effects (i.e., the amount of RF energy required to heat tissue). According to the FCC, the established limits are well below levels that are considered to have adverse health effects. These levels are shown in Table 2.4.1-1. Additionally, the IEEE's Committee on Man and Radiation (COMAR) states that the amount of RF emissions in buildings "will be lower than outside, since a substantial fraction of the signal is absorbed when it passes through most building materials" (IEEE COMAR 2000).

COMAR cites a study (Petersen et al. 1997) that measured the power density of radiation on the top floors of buildings with roof-mounted antennas (IEEE COMAR 2000). The study found that radiation emissions on these floors "were less than 0.0004 mW/cm<sup>2</sup> per 100 W Effective Radiated Power (ERP) per channel." For purposes of reference, this indicates that it is 1,000 times less than the FCC standard for general population exposure and 5,000 times less than the FCC standard for occupational workers.

COMAR also found that "roof-mounted base station antennas are normally designed to radiate energy in the horizontal direction away from the building, and they radiate very little energy into

---

<sup>9</sup> Outside of the United States, many countries (including most of Europe) use exposure guidelines developed by the International Commission on Non-Ionizing Radiation Protection). The International Commission on Non-Ionizing Radiation Protection safety limits are similar to those of the NCRP and IEEE (Classic 2015).



the building itself. Therefore, exposure to residents inside a building with roof-mounted base station antennas is invariably very low" (*IEEE COMAR 2000*).

In March 2013, the FCC voted to review current RF rules and regulations and put forth a *Notice of Inquiry*. The *Inquiry* was intended to open discussion around whether the existing RF exposure limits and policies need to be reassessed. Through this process, the FCC has gathered input from industry, scientific experts, and members of the public to help the agency to determine whether current policies and rules need to be changed (*FCC 2013*).

#### **2.4.2.2. Overview of Research for Potential Non-Thermal Effects to Humans**

A few organizations have provided research that is useful as a framework for the state of the research on RF and the basis of some of the concerns. For example, several studies of the potential non-thermal health effects cited below have focused on cancer outcomes (primarily childhood leukemia and brain cancers); however, reproductive/neonatal problems, neurological and neurobehavioral issues, and genotoxicity have also been studied. In addition to these studies, one group has raised concerns about potential non-thermal effects resulting from RF emissions coming from telecommunications equipment: the International Association of Fire Fighters (*IAFF 2015*).

As with any source, RF emissions from the FirstNet system would be dependent on the location, type, and power of antennas used. There are three basic forms of antennas: omnidirectional, narrow horizontal gain (focused beam), and panel.

The most common type of antenna is a panel antenna, as these are easily mounted on towers or rooftops and provide approximately 60 degrees of horizontal and vertical coverage. Omnidirectional antennas are frequently used for things such as Wi-Fi where a widespread area needs to be covered by a signal. Directional beam antennas are used to propagate a strong, focused beam to a specific location which is ideal for sending a stronger signal for greater distances without affecting areas outside the target. Thus, the omnidirectional and beam antennas are generally not suitable for deploying a cellular network.

Panel antennas do not produce a significant amount of radiation outside of the primary lobe, making them an ideal candidate for providing widespread coverage while maintaining control of the radiation beam. Figure 2.4.2-1 shows a typical lattice cell tower with multiple panel antennas arranged radially.



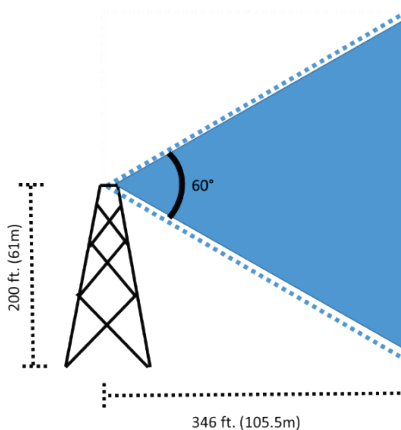
Source: *The Fiber Optic Association, Inc. 2014*

**Figure 2.4.2-1: Lattice Cell Tower with Multiple Panel Antennas**

Using the power intensity formula described above and assuming an antenna fixed to a base station transmits 60 W of power:

- The power density 0.30 meters (1 foot) from the base station would be  $4.77 \text{ W/m}^2$ ;
- The power density 0.61 meters (2 feet) from the base station drops to  $1.2 \text{ W/m}^2$ ; and
- At 100 meters (328 feet), the power intensity drops to  $0.000477 \text{ W/m}^2$ , a 99.99 percent reduction.

Figure 2.4.2-2 below depicts the radiation beam from a panel antenna on a 200 feet (61 meters) tower. Assuming a 60-degree vertical spread and no vertical tilt, the primary lobe of the radiation beam (shaded blue) would not reach the ground until 346 feet (approximately 106 meters) from the tower. At the point where the beam reaches the ground (approximately 346 feet [106 meters] from the base), there is a 99.99 percent reduction in power density compared to the power intensity 0.30 foot (1 meter) from the panel.

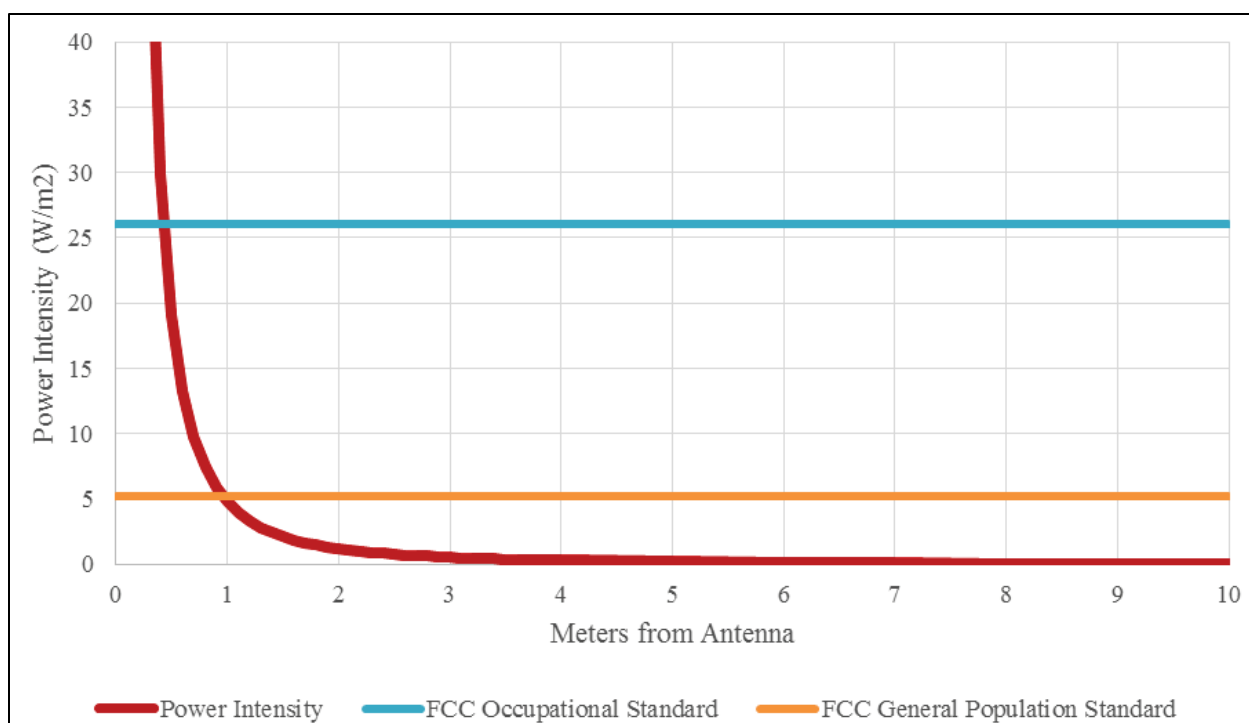


Source: *FCC 1997*

**Figure 2.4.2-2: Depiction of Primary Radiation Lobe of a Panel Antenna Attached to a 200-foot (61 meter) Cell Tower**

Correspondingly in Figure 2.4.2-2, the zone outside of the blue-shaded area is not within the primary radiation lobe of the antenna, and thus, would receive very little radiation (less than 0.01 percent of the density 0.30 meter [1 foot] in front of the antenna). This means that buildings and people under the tower would receive little RF emissions from those antennas, assuming none of the antennas are tilted downward.

Figure 2.4.2-3 depicts the decrease of power intensity from a 60 W antenna as a function of distance from the antenna and displays the FCC standards for 780 MHz frequency. The 780 MHz frequency is used for these calculations since it splits the two operating frequency bands the FirstNet system would operate at (i.e., 758 to 769 MHz and 788 to 799 MHz). While the FirstNet system would not operate specifically at 780 MHz, this frequency best represents all of the possible frequencies at which the system would operate.



Source: FCC 1997

Note: This figure is a simple representation of the power intensity versus distance from a 60 W antenna. There are many other factors that may affect the power intensity at a specific location, which are not accounted for in this graph. Some factors include positive or negative interference with other electromagnetic waves, absorption by building materials or other items, and varying power outputs dependent on signal demand.

**Figure 2.4.2-3: 60 W Antenna (780 MHz) - Power Intensity vs Distance with Respect to FCC Guidelines for Limiting Thermal Radiation**

Figure 2.4.2-3 further demonstrates that the FCC occupational standard is met at 0.42 meters (1.4 feet) while the standard for the general public is met at 0.96 meters (3.1 feet). While these distances may seem small and insignificant, this chart only represents one 60 W antenna. Generally speaking, there may be three or more antennas serving one area (1 transmitter, 2 receivers). Assuming there are three antennas operating at a power of 60 W at 780 MHz each, the standards are then met at 0.72 meters (2.4 feet) and 1.66 meters (5.5 feet), respectively using the formulas in Table 2.4.1-1.

As previously described, radiation can elicit both thermal and non-thermal effects in humans and other biological organisms. Given that thermal effects are only elicited when exposed to intense amounts of radiation, this section summarizes the available credible scientific information about potential non-thermal effects of RF emissions, particularly at low power intensities.

Among the research organizations studying RF emissions, the World Health Organization (WHO)—as an agency of the United Nations—is the most prominent. According to the WHO, there have been tens of thousands of papers published on RF, extremely low frequency and potentially related health effects over the last 30 years. A recent (May 2015) statement on the WHO website states:

“The heating effect of radio waves forms the underlying basis for current guidelines. Scientists are also investigating the possibility that effects below the threshold level for body heating occur as a result of long-term exposure. To date, no adverse health effects from low level, long-term exposure to radiofrequency or power frequency fields have been confirmed, but scientists are actively continuing to research this area.”  
(WHO 2015)

In 2011, based upon the inconclusive data and in an abundance of caution, WHO classified RF exposures due to cell phone use as a 2B carcinogen—indicating that it was possibly carcinogenic to humans—based upon some studies that found a potential increased risk of glioma (a type of brain cancer) associated with cell phone use (IARC 2011). However, WHO’s International Agency for Research on Cancer (IARC) noted that the evidence for carcinogenicity for occupational and environmental exposures (exposures to emissions from cell towers would fall into the “environmental” category) was inadequate to draw conclusions regarding carcinogenic potential.

The conclusions made by the IARC specifically identify RF emissions from wireless phones as the source for positive associations with negative health effects. Many of the studies examined by the IARC for fixed transmitter emissions suggested that living close to fixed transmitters increased the risk of developing brain cancer, leukemia, or lymphoma; nonetheless, the IARC identified several shortcomings of these studies, including (IARC 2013):

- Not accounting for mobile phone use or exposure to RF emissions from other sources (ambient RF emissions levels or confounding factors);
- Not accounting for buildings or other geographic features which impact the strength of the radiation;

- Small population size;
- Lack of controls;
- Poor exposure assessment (no individual data);
- Non-differential disease misclassification; and
- Lack of cumulative measure of exposure to RF emissions (take into account individual's place of residence between birth and diagnosis of cancer/disease).

While some of the studies indicated a positive correlation between distance from transmitters and risk of cancer, the caveats identified by the IARC indicate general lack of scientific rigor of previous research projects. Furthermore, most of the studies reviewed by the IARC focus on cellular telephone use rather than low-level, background radiation emitted from fixed transmitter sites. Overall, these studies do not indicate a clear trend, reproducible with regard to the effects of fixed transmitter radiation.

WHO is currently undertaking a health risk assessment of radiofrequency electromagnetic fields, to be published as a monograph in the Environmental Health Criteria Series. WHO scientists themselves began conducting research on RF emissions, and electromagnetic fields more broadly, when it established the International EMF Project in 1996 (*Repacholi 2001*). However, recent studies on behalf of WHO have concluded that “there is insufficient data to draw firm conclusions about health effects from long-term low-level exposure [to RF electromagnetic fields] typically occurring in the everyday environment” (*Roosli et al. 2010*).

In contrast to the WHO's statement on health effects, a public advocacy group of scientists, known as the BioInitiative Working Group (BWG), published the BioInitiative Report, first in 2007 and followed by a revised version in 2012 (*Sage and Carpenter 2012*), that found substantial evidence of adverse health effects associated with RF and extremely low frequency exposures. However, the BWG itself has been criticized by other scientific, professional and governmental bodies for ignoring conflicting, inconsistent or other credible evidence that clashed with its report (e.g., *Dolan and Rowley 2009*).

The BWG report concluded that there was evidence to support adverse health effects resulting from sustained low-intensity electromagnetic radiation on decreased male fertility, fetal and neonatal effects, brain tumors, childhood leukemia, genotoxicity, in addition to several other effects. The BioInitiative Report noted further that health effects due to emissions from cell towers were cited in a number of studies that possibly linked headaches/sleep disturbance/concentration issues in children, adolescents, and adults at levels in the range of 0.003 to 0.05  $\mu\text{W}/\text{cm}^2$ , much lower than current regulatory standards shown in Table 2.4.1-1. BWG recommends lower standards be established and that cell phone towers not be built within certain distances of sensitive receptors, such as schools, daycare centers and hospitals (*Sage and Carpenter 2012*).

These two positions illustrate the scientific and philosophical divide. First, there is some evidence of adverse health effects at levels below the current standards in a number of studies, but as is the case with other epidemiological studies attempting to prove causality, these studies

are subject to a variety of uncertainties inherent in the epidemiological process.<sup>10</sup> Consequently, it appears that the preponderance of the evidence to date does not definitively demonstrate that there are adverse health effects caused by RF emissions and there is still no single, plausible biological mechanism to indicate adverse effects. Second, although there is some scientific data in certain studies to warrant further investigation, some researchers urge that the precautionary principle should apply to reduce exposures as much as possible (*Sage and Carpenter 2012*).

#### **2.4.2.3. Conclusions on RF Emissions and Humans**

Based on the analysis above, there is insufficient and inconclusive data to make a definitive determination of effect of RF emissions on humans. Although there is some evidence of adverse health effects at levels below the current standards in a number of studies, these studies are subject to a variety of uncertainties inherent in the epidemiological process. Conversely, the preponderance of the evidence to date does not definitively demonstrate that there are adverse health effects caused by RF emissions and there is still no single, plausible biological mechanism to indicate adverse effects.

#### **2.4.3. RF Emissions and Non-Human Species**

Unlike those established for human exposure, no federal regulatory levels have been set for non-human species exposure to RF emissions. This is partly due to the nature of how environmental assessment is conducted under NEPA and how the mechanisms for potential environmental effects are enforced under that statute, as well as with other federal environmental laws and regulations.

Under NEPA, an environmental analysis is required to be conducted by the lead federal agency prior to undertaking any major federal action. This analysis requires the federal agency to consider any and all types of environmental impacts associated with the project and make qualitative decisions concerning the likelihood and severity of the potential effects and give potential environmental effects parity with engineering and economic decisions.

As is the case with considering the potential effects of RF emissions on humans, demonstrating cause and effect in animal and plant species from low-level environmental exposures is equally—if not more—challenging and it too requires multiple studies over many years and across many species. Although there is some research that shows that there could be potential effects on some animal species associated with RF emissions, here too there is no clear or definitive scientific research and literature, especially for animals or plants in North America, to achieve scientific consensus on whether there exists demonstrable cause and effect.

Undoubtedly, there is considerable public interest into the potential effects of RF emissions on both humans and other species. Research is continuing with a number of scientific and academic centers, although there is still no consensus within the larger scientific community. Consequently, there is still the need for more targeted information, research, and studies on RF

---

<sup>10</sup> It is difficult to attribute causation when other effects cannot be ruled out. The complexity of health conditions also makes it difficult to imply causation. Epidemiological studies can never provide proof or 100 percent certainty of an effect (*Webb and Bain 2011*).

emissions and human, plant and animal life. This means that we should expect that additional research will likely both continue and increase over the coming years.

#### **2.4.3.1. Research on the Potential Effects to Animal and Plant Species**

Since about the year 2000, a number of research studies have been conducted that focus on RF emissions and the potential effects to animal and plant species. However, general discussions of RF exposure to ground migrating and flying animal species, specifically bird species, are largely grouped as a component of broader discussions of direct and indirect effects of transmission and communication towers; many of these studies are from outside the United States (*Bhattacharya and Roy 2013, 2014*). Much of these studies focus on the effects to population abundance and habitat use resulting from anthropogenic features, such as tower siting and construction, as well as bird collision hazards caused by equipment siting and lighting. As a result, RF emission concerns and potential effects are used as a collective piece of information in some of these studies to discuss broader species impacts related to transmission and communication towers rather than being the focus of the study.

Mirroring the sentiments expressed by the larger environmental community, the United States Fish and Wildlife Service has indicated that RF emissions could be potentially harmful to migratory birds, even at levels too low to cause thermal effects (*Manville 2007, 2009, 2014*).<sup>11</sup> Although there has been more recent discussion on the RF emission potential of communication towers in the U.S., these discussions still focus on the European research that has been carried out on RF emission effects to birds. The emphasis of the research is on two areas: impacts on avian reproduction and interruption to avian navigation.

Research conducted by Balmori (2005, 2009), Balmori and Hallberg (2007), and DiCarlo *et al.* (2002) suggests that the presence of electromagnetic fields in the microwave range may be a consideration in the decline of some urban bird populations. Research in Balmori (2005) focused on several species of wild birds in relation to cellular tower sites in Spain and indicated negative correlations between levels of RF emissions and bird breeding, nesting, and roosting. Also, nest and site abandonment, plumage deterioration, locomotion issues, and even death was noted for some house sparrows, white storks, rock doves, magpies, collared doves, and other species that had historically been documented to roost and nest in close proximity to cellular antennas. The research suggested that these symptoms were not observed prior to construction of the cellular towers.

Balmori and Hallberg (2007) reported that declines of urban house sparrows in Spain increased as electromagnetic field strength increased. Everaert and Bauwens (2007) also found negative correlations between the amount of RF emissions present and the presence of male house sparrows and concluded that long-term exposure to higher emission levels may be affecting bird abundance or bird behavior in this species.

---

<sup>11</sup> It should be noted that although discussions of RF emissions generally involve “biological effects,” meaning terrestrial and avian species, the research and environmental community have focused largely on bird species, especially migratory.

Similarly, Bhattacharya and Roy (2014) looked at bird and nest occurrence in relation to tower proximity and electromagnetic fields in India. The study examined bird species within proximity to towers and used the point count method to identify the presence of birds and nests at various distances in all four cardinal directions from towers. This study found that bird occurrence was lowest within 20 meters of towers, which is the zone where power density was at peak values. Also, it was found that within this zone food sources were readily available and avoided. Additionally, no nests were identified within this zone and the closest nest was well outside this zone (approximately 80 meters or 263 feet).

Laboratory studies conducted with domestic chicken embryos have shown that emissions at the same frequency and intensity as that used in cellular telephones have appeared to result in death (DiCarlo *et al.* 2002; Manville 2007). These studies have been used to suggest that RF emissions at low levels (far below the existing exposure guidelines for humans) may be harmful to wild birds; however, given the controlled nature of the studies and potential exposure differences in the wild, this causation is left to interpretation and extrapolation. A number of other studies generally touch upon the nature of RF exposure and the disruption of biological processes that are fundamental to plant and animal growth and health, including but not limited to behavior, deoxyribonucleic acid (DNA) damage, immune deficiencies, reproductive system effects, hormone dysregulation, degraded cognition and sleep, and desynchronization of neural activity (Sage and Carpenter 2007 and 2012; Balmori 2015).

Further, it has been suggested that RF emissions may act as an attractant to certain other species of birds. Magnetite is a mineral found in high concentrations in bird eye, beak, and brain tissues and is used by birds for navigation. Since magnetite is highly sensitive to the electromagnetic frequencies, it has been suggested that RF emissions could lead to increased bird strikes and/or direct exposure to high levels of RF emissions due to the attractant quality of materials used in some equipment (Ritz *et al.* 2004; Balmori 2015). Along these same lines, Balmori (2015) has noted that other flying species that use magnetic fields for navigation purposes have been found to be affected by RF emissions, primarily honeybees and butterflies.

There are no available studies indicating that low-level RF emissions affect honeybees. After several studies were published regarding the effects of cell phones on bees, the author of one of the studies, Stefan Kimmel, “emailed *The Associated Press* to say that there is ‘no link between our tiny little study and the Colony Collapse Disorder (CCD)-phenomenon...anything else said or written is a lie’” (U.S. Department of Agriculture 2015).

Other, less defensible studies have purported to find that RF emissions from cell towers affect bees’ behavior and could be responsible for colony collapse disorder. In general, these studies are not published in peer-reviewed and in credible journals, such as some well-known honeybee studies either published in predatory journals or that are informal in nature.



#### **2.4.3.2. Conclusions on RF Emissions and Species**

The amount of research related to determining whether there are identifiable effects from RF emissions to species is fairly extensive and growing, although inconclusive. Those referenced above are merely a few of the more recent studies that are directly applicable to RF emissions and communication towers and potentially pertinent to the evaluation of the proposed Project. The conclusions to be drawn by these studies vary, as the research is still too fragmented and inconclusive to demonstrate the needed cause and effect to various species caused by RF emissions. However, even in those studies that conducted quantitative analysis and research, the widespread conclusion is that more research is essential to better understand the patterns of cause and effect, variations among species, and the potential sensitivities and severity to such species.

The common practice for NEPA documents related to cellular towers is to cite FCC standards and point to the fact that they would be built and operated according to allowable FCC RF emission limits. Some NEPA documents that have more directly addressed the RF emissions potential largely point to the existing literature and suggest that although there is evidence that RF emissions could potentially affect some species, the evidence is insufficient to support a finding of adverse impacts on these species due to RF emissions (*BMDO 2000; FCC 2012*).

#### **2.4.4. Summary**

FirstNet is a licensee of the FCC and FirstNet's operations in the 700 MHz range are governed by FCC regulations establishing exposure limits for RF emissions. Federal law authorizes the FCC to establish regulatory levels for human exposure to RF emissions. Over the years, the FCC has revised its standards and guidelines for protecting both workers and the general public—including limits for Maximum Permissible Exposure for transmitters covering the 700 MHz range and localized absorption limits for mobile devices—and these have been upheld by the federal courts.

Scientific investigations into RF emissions and the possible effects of exposure on humans, animals and plants are inconclusive. These studies do not indicate any clearly reproducible trend and, consequently, there is insufficient and inconclusive data to make a definitive determination of effect of RF emissions on humans.

As discussed in detail above, while the science is currently inconclusive regarding the effects of RF emissions on humans and animals, FirstNet will continue to monitor any new studies or information that may come to light before the PEISs are finalized. Any new information or studies will be considered as part of the final analysis and incorporated, as appropriate, into the final documents.

## 2.5. REFERENCES

- Ahlbom A., A. Green, L. Kheifets, D. Savitz, and A. Swerdlow. 2004. *Epidemiology of Health Effects of Radiofrequency Exposure*. Environmental Health Perspectives, 112(17).
- BMDO (Ballistic Missile Defense Organization). 2000. *Environmental Assessment of the Ballistic Missile Defense Organization Cooperative-Engagement-Capability/PATRIOT (CEC/PATRIOT) Interoperability Test*. McLean, VA: The Mangi Environmental Group, Inc.
- Balmori, A. 2005. *Possible Effects of Electromagnetic Fields from Phone Masts on a Population of White Stork (Ciconia ciconia)*. Electromagnetic Biology and Medicine, 24:109-119.
- \_\_\_\_\_. 2009. *Electromagnetic Pollution from Phone Masts*. Pathophysiology, 16:191-199.
- \_\_\_\_\_. 2015. *Anthropogenic Radiofrequency Electromagnetic Fields as an Emerging Threat to Wildlife Orientation*. Science of the Total Environment, 518-519:58-60.
- Balmori, A. and O. Hallberg. 2007. *The Urban Decline of the House Sparrow (Passer domesticus): A Possible Link with Electromagnetic Radiation*. Electromagnetic Biology and Medicine, 26:141-151.
- Bhattacharya, R. and R. Roy. 2013. *Impacts of Communication Towers on Avians: A Review*. International Journal of Innovative Research in Science, Engineering and Technology, 4(1): 137-139.
- \_\_\_\_\_. 2014. *Impact of Electromagnetic Pollution from Mobile Phone Towers on Local Birds*. International Journal of Innovative Research in Science, Engineering and Technology, 3(2): 32-36.
- Classic, K. 2015. *Radiofrequency (RF) Radiation*. Health Physics Society. Retrieved from: <http://hps.org/hpspublications/articles/rfradiation.html>
- Cooper D, Hemming K, Saunders P (2001). Re: Cancer incidence near radio and television transmitters in Great Britain. I. Sutton Coldfield transmitter; II. All high power transmitters. Am J Epidemiol, 153:202–204. doi:10.1093/aje/153.2.202 PMID:11159167
- DiCarlo, A., N. White, F. Guo, P. Garrett, and T. Litovitz. 2002. *Chronic Electromagnetic Field Exposure Decreases HSP70 Levels and Lowers Cytoprotection*. Journal of Cellular Biochemistry, 84:447-454.
- Dolan, Mike and Jack Rowley. 2009. *The Precautionary Principle in the Context of Mobile Phone and base Station Radiofrequency Exposures*. Environmental Health Perspectives 117 (9): 1329-1332.
- Dolk, H., G. Shaddick, P. Walls et al. 1997. "Cancer incidence near radio and television transmitters in Great Britain. I. Sutton Coldfield transmitter." Am J Epidemiol, 145: 1–9. PMID:8982016 Eastern Health Board. 1998.

- Elliott, P., M.B. Toledano, J. Bennett et al. 2010. Mobile phone base stations and early childhood cancers: case control study. *BMJ*, 340: jun22 1c3077 doi:10.1136/bmj.c3077. PMID:20570865
- Everaert, J. and D. Bauwens. 2007. *A Possible Effect of Electromagnetic Radiation from Mobile Phone Base Stations on the Number of Breeding House Sparrows (Passer domesticus)*. *Electromagnetic Biology and Medicine*, 26:63-72.
- FCC (Federal Communications Commission). 1996. *Guidelines for Evaluating the Environmental Effects of Radiofrequency Radiation*. Retrieved from: [https://transition.fcc.gov/Bureaus/Engineering\\_Technology/Orders/1996/fcc96326.pdf](https://transition.fcc.gov/Bureaus/Engineering_Technology/Orders/1996/fcc96326.pdf)
- \_\_\_\_\_. 1997. *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields: Additional Information for Amateur Radio Stations*. OET Bulletin 65: Supplement B, Edition 97-01. Prepared by Jerry L. Ulcek and Robert F. Cleveland, Jr. Accessed: January 2016. Retrieved from: [https://transition.fcc.gov/Bureaus/Engineering\\_Technology/Documents/bulletins/oet65/oet65.pdf](https://transition.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet65/oet65.pdf)
- \_\_\_\_\_. 2012. *Final Programmatic Environmental Assessment for the Antenna Structure Registration Program*. Germantown, MD: URS Group, Inc.
- \_\_\_\_\_. 2013. *In the Matter of Reassessment of Federal Communications Commission Radiofrequency Exposure Limits and Policies. Proposed Changes in the Commission's Rules Regarding Human Exposure to radiofrequency Electromagnetic Fields*. First Report and Order, Further Notice of Proposed Rule Making and Notice of Inquiry. ET Docket No.13-39, ET Docket No. 03-137. Adopted March 27, 2013. Released March 29, 2013. Washington: Federal Communications Commission.
- \_\_\_\_\_. 2014. *Human Exposure to Radio Frequency Fields: Guidelines for Cellular and PCS Sites*. FCC Consumer Guide. Washington: Federal Communications Commission, Consumer and Governmental Affairs Bureau.
- Fiber Optic Association, Inc., The. 2014. *Guide to Fiber Optics & Premises Cabling*. Accessed: January 2016. Retrieved from: <http://www.thefoa.org/tech/ref/appln/FTTA.html>
- Frei, P. 2009. "Temporal and spatial variability of personal exposure to radio frequency electromagnetic fields." *Environ. Res.* 109(6):779-85. doi: 10.1016/j.envres.2009.04.015.
- Ha, Mina, Hyounjune Im, Byung-Chan Kim, Yoon-Myoung Gimm, and Jeong-Ki Pack. 2008. *Five authors reply [Letter]*. *Am J Epidemiol*, 167: 884–885. doi:10.1093/aje/kwn013
- Ha, M., H. Im, M. Lee, H.J. Kim, B.C. Kim, Y.M. Gimm, J.K. Pack. 2007. *Radio-frequency radiation exposure from AM radio transmitters and childhood leukemia and brain cancer*. *Am J Epidemiol*, 166: 270–279. doi:10.1093/aje/kwm083 PMID:17556764
- Hauri D., B. Spycher, A. Huss, F. Zimmerman, N. Grotzer, N. von der Weid, A. Spoerri, C. Kuehni, and M. Roosli. 2014. *Exposure to Radio-Frequency Electromagnetic Fields*

- from Broadcast Transmitters and Risk of Childhood Cancer: A Census-Based Cohort Study*. Am J Epidemiol, 179(7):843-851.
- HPS (Health Physics Society). 2015. *Radiofrequency (RF) Radiation*. Retrieved from: <https://hps.org/hpspublications/articles/rfradiation.html>
- Hocking, B., I.R. Gordon, H.L. Grain and G.E. Hatfield. 1996. "Cancer incidence and mortality and proximity to TV towers." Med J Aust, 165: 601–605. PMID:8985435
- IEEE COMAR. 2000. "Safety Issues Associated with Base Stations Used for Personal Wireless Communications." Retrieved from: <http://ewh.ieee.org/soc/embs/comar/base.htm>
- IARC (International Agency for Research on Cancer). 2011. *IARC Classifies Radiofrequency Electromagnetic Fields as Possibly Carcinogenic to Humans*. Retrieved from: [http://www.iarc.fr/en/media-centre/pr/2011/pdfs/pr208\\_E.pdf](http://www.iarc.fr/en/media-centre/pr/2011/pdfs/pr208_E.pdf)
- \_\_\_\_\_. 2013. "Non-Ionizing Radiation, Part 2. Radiofrequency Electromagnetic Fields: Volume 102." Retrieved from: <http://monographs.iarc.fr/ENG/Monographs/vol102/mono102.pdf>
- IAFF (International Association of Fire Fighters). 2015. *Position on the Health Effects from Radio Frequency/Microwave (RF/MW) Radiation in Fire Department Facilities from Base Stations for Antennas and Towers for the Conduction of Cell Phone Transmitters*. IAFF Division of Occupational Health, Safety and Medicine. Retrieved from: <http://www.iaff.org/hs/facts/CellTowerFinal.asp>
- Khurana V., L. Hardell, J. Everaert, A. Bortkiewicz, M. Carlberg and M. Ahoden. 2010. *Epidemiological Evidence for a Health Risk from Mobile Phone Base Stations*. International Journal of Occupational Health, 16, 263-267.
- L-com: Global Connectivity. 2013. Antenna Gain Patterns and Wireless Network Design. Retrieved from: <http://www.l-com.com/content/Article.aspx?Type=N&ID=10264>
- Manville II, A. 2007. *U.S. Fish & Wildlife Service Concerns Over Potential Radiation Impacts of Cellular Communication Towers on Migratory Birds and Other Wildlife – Research Opportunities*. Congressional Staff Briefing on the Environmental and Human Health Effects of Radiofrequency (RF) Radiation, Washington D.C.
- \_\_\_\_\_. 2009. *Towers, Turbines, Power Lines, and Buildings—Steps Being Taken By the U.S. Fish and Wildlife Service to Avoid or Minimize Take of Migratory Birds at These Structures*. In Proceedings of the Fourth International Partners in Flight Conference: Tundra to Tropics - Partners in Flight, 262–272.
- \_\_\_\_\_. 2014. *Talking Points and Literature Citations, Available to the Public*. Status of U.S. Fish and Wildlife Service Developments with Communication Towers with a Focus on Migratory Birds: Updates to Services Staff Involved with Tower Issues – A Webinar, Washington D.C.
- Merzenich, H., S. Schmiedel, S. Bennack et al. 2008. Childhood leukemia in relation to radio frequency electromagnetic fields in the vicinity of TV and radio broadcast transmitters. Am J Epidemiol, 168: 1169– 1178. doi:10.1093/aje/kwn230 PMID:18835863

- Micheloizzi, P., A. Capon, U. Kirchmayer et al. 2002. Adult and childhood leukemia near a high-power radio station in Rome, Italy. *Am J Epidemiol*, 155: 1096–1103. doi:10.1093/aje/155.12.1096 PMID:12048223
- National Research Council. 1997. *Possible Health Effects of Exposure to Residential Electric and Magnetic Fields*. Committee of the Possible Effects of Electromagnetic Fields on Biologic Systems, Board of Radiation Effects Research, Commission on Life Sciences. Washington: National Academy Press.
- OSHA (Occupational Health and Safety Administration). Undated. *Radiofrequency and Microwave Radiation*. Retrieved from: <https://www.osha.gov/SLTC/radiofrequencyradiation/>
- Petersen, R.C., A.K. Fahy-Elwood, P.A. Testagrossa, and G.H. Zeman. 1997. "Wireless telecommunications part A: Technology and safety issues, in: *Nonionizing Radiation An Overview of the Physics and Biology*", edited by Meltz, M.L., Glickman, R.D., and Hardy, K., (Madison, WI: Medical Physics Publishing), pp. 197-226.
- Repacholi, Michael H. 2001. *Health risks from the use of mobile phones*. *Toxicology Letters* 120: 323-331.
- Roosli, Martin, Patrizia Frei, Evelyn Mohler and Kerstin Hug. 2010. *Systematic review on the health effects of exposure to radiofrequency electromagnetic fields from mobile phone base stations*. *Bulletin of the World Health Organization* 88: 887-896G.
- Ritz, T., P. Thalau, J.B. Phillips, R. Wiltchko, and W. Wiltchko. 2004. *Resonance Effects Indicate a Radical-Pair Mechanism for Avian Magnetic Compass*. *Nature*, 429:177-180.
- Sage, C. and D. Carpenter, eds. 2007. *BioInitiative Report: A Rationale for a Biologically-Based Public Exposure Standard for Electromagnetic Fields (ELF and RF)*. BioInitiative Working Group.
- \_\_\_\_\_. 2012. *BioInitiative Report: A Rationale for a Biologically-Based Public Exposure Standard for Electromagnetic Radiation*. BioInitiative Working Group.
- Schüz, J., R. Jacobsen, J.H. Olsen et al. 2006. *Cellular telephone use and cancer risk: update of a nationwide Danish cohort*. *J Natl Cancer Inst*, 98:1707–1713. doi:10.1093/jnci/djj464 PMID:17148772
- Selvin, S., J. Schulman, and D.W. Merrill. 1992. *Distance and risk measures for the analysis of spatial data: a study of childhood cancers*. *Soc Sci Med*, 34: 769–777. doi:10.1016/0277-9536(92)90364-V PMID:1604371
- Szumilas, M. 2010. Explaining Odds Ratios. *J Can Acad Child Adolesc Psychiatry*, 19:3. Retrieved from: [http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2938757/pdf/ccap19\\_3p227.pdf](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2938757/pdf/ccap19_3p227.pdf)
- U.S. Department of Agriculture. 2015. *Honey Bee Health and Colony Collapse Disorder*. Retrieved from: <http://www.ars.usda.gov/News/docs.htm?docid=15572#phones>

- U.S. Department of Energy. 2009. *Electromagnetic Radiation*. Retrieved from:  
<http://www2.lbl.gov/MicroWorlds/ALSTool/EMSpec/EMSpec2.html>
- Webb, P. and C. Bain. 2011. *Essential Epidemiology: An Introduction for Students and Health Professionals*. 2<sup>nd</sup> ed. New York: Cambridge University Press.
- WHO (World Health Organization). 2015. *Radio Frequency Fields: Environmental Health Criteria Monograph*. Retrieved from: [http://www.who.int/peh-emf/research/rf\\_ehc\\_page/en/](http://www.who.int/peh-emf/research/rf_ehc_page/en/)
- Zamanian, A. 2005. *Electromagnetic Radiation and Human Health: A Review of Sources and Effects*. Retrieved from:  
[http://www.highfrequencyelectronics.com/Jul05/HFE0705\\_Zamanian.pdf](http://www.highfrequencyelectronics.com/Jul05/HFE0705_Zamanian.pdf)