

Infrastructure Codes, Standards, and Regulations: Frequently Asked Questions

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Linda R. Rowan,
Coordinator

Analyst in Natural
Resources and Earth
Sciences

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Ensuring the safe operation of and uninterrupted services provided by infrastructure, as well as resiliency, efficiency, environmental protection, and other aspects of infrastructure performance, may raise issues of congressional interest. Given that codes, standards, and regulations and their implementation affect infrastructure performance, Congress may consider the role of the federal government and nonfederal stakeholders in developing, adopting, and enforcing infrastructure codes, standards, and regulations.

Infrastructure consists of physical networks (systems and facilities) that provide functions and services to the community. Federal agencies and some nonfederal organizations provide codes, standards, and/or regulations for various type of infrastructure, including those related to transportation, energy, communications, and water. Adoption and enforcement of infrastructure codes or standards varies across the United States.

Transportation infrastructure is divided into five groups: (1) roads, bridges, highways, and road tunnels; (2) rail; (3) air; (4) ports, harbors, and waterways; and (5) pipelines for the transport of fuel alone (e.g., a natural gas pipeline). The Federal Highway Administration (FHWA), the American Association of State Highway and Transportation Officials, and other organizations provide codes, standards, and/or regulations for some aspects of roads, bridges, highways, and road tunnels. The Federal Transit Administration, the Federal Railroad Administration, and other organizations provide codes, standards, and/or regulations for some aspects of rail transportation infrastructure. The Federal Aviation Administration (FAA) and other organizations provide codes, standards, and/or regulations for some aspects of air transportation infrastructure. Pipelines delivering natural gas, crude oil, refined products (e.g., gasoline, diesel), and natural gas liquids (e.g., ethane, propane) are part of the transportation infrastructure because they transport fuels. The U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) oversees the design, construction, operation, and maintenance of pipelines that carry natural gas or hazardous liquids.

Energy infrastructure includes electric power systems, natural gas, and liquid fuels systems as they relate to the generation, transmission, and distribution of electric power and emergency and standby power systems. For electric power systems, the Federal Energy Regulatory Commission (FERC) regulates the interstate transmission and wholesale sale of electricity. FERC is also responsible for regulating the reliability of the bulk power system.

Communications infrastructure includes wireline, wireless, cable and broadcast, and satellite networks. The Federal Communications Commission (FCC) regulates interstate and international communication services and has jurisdiction over communications by telephone, cable, radio, wireless, wireline, and internet. State agencies have authority over local wireline telephone services, and most often a public service commission (PSC) oversees communications infrastructure at the state level.

Water infrastructure includes drinking water, wastewater, dam, and levee infrastructure. The U.S. Environmental Protection Agency (EPA) establishes requirements for drinking water quality under the authority of the Safe Drinking Water Act (SDWA; codified generally as 42 U.S.C. §§300f-300j) and for wastewater effluent quality under the authority of the Federal Water Pollution Control Act or Clean Water Act (codified generally as 33 U.S.C. §§1251-1387). The Federal Emergency Management Agency (FEMA) administers a National Dam Safety Program (NDSP) to facilitate dam safety. Every state except Alabama has established a state regulatory program for dam safety. The U.S. Army Corps of Engineers and FEMA are developing levee safety guidelines to serve as voluntary best practices.

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Introduction

Members of Congress may be interested in ensuring the safe operation and uninterrupted services provided by infrastructure, as well as in improving infrastructure performance.¹ Performance objectives may include reliability, resiliency, efficiency, sustainability, and environmental protection. Given that codes, standards, and regulations may impact infrastructure performance, Congress may consider the role of the federal government and nonfederal stakeholders in developing, guiding, adopting, and enforcing infrastructure codes, standards, and regulations. This report addresses some frequently asked questions about federal and nonfederal activities to develop, guide, adopt, or enforce codes, standards, and/or regulations related to infrastructure.

In this report, infrastructure does not include buildings, although some building codes, standards, and regulations influence infrastructure performance. Additional information about building codes, standards, and regulations that may influence infrastructure are described in *CRS Report Buildings Codes, Standards, and Regulations: Frequently Asked Questions* (hereinafter Building Codes FAQ).

Infrastructure

What Is Infrastructure?

For purposes of this report, *infrastructure* is defined as physical networks (systems and facilities) that provide functions and services to the community.² Some definitions of infrastructure include buildings, but this report does not. For information about codes, standards, and guidelines for buildings and some that may also relate to infrastructure, see the Building Codes FAQ.

Infrastructure is a distributed service involving structures or systems that may cross over large regions of different jurisdictions and may be owned, operated, and regulated by different stakeholders.³ Likewise, different stakeholders may develop codes, standards, guidelines, or certifications for the planning, construction, repair, or renovation of infrastructure.⁴

What Is the Purpose of Codes, Standards, and Regulations for Infrastructure?

Codes, standards, and regulations for the planning, design, materials, construction, operation and maintenance, repair, and renovation of infrastructure promote a minimum level of safety, public

¹ For example, the Federal Power Act (16 U.S.C. §§791 et seq.) authorized the Federal Energy Regulatory Commission (FERC) to certify a national Electric Reliability Organization, which is the North American Electric Reliability Corporation (NERC). NERC is a nonprofit entity whose mission is to ensure the reliability of the power grid in North America. The Energy Policy Act of 2005 (P.L. 109-58) directed FERC to oversee mandatory and enforceable reliability standards for the nation's wholesale power grid.

² National Institute of Standards and Technology (NIST), *Community Resilience Planning Guide for Buildings and Infrastructure Systems*, NIST SP 1190GB-16, October 2020, p. 3, at <https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.1190GB-16.pdf>.

³ Stakeholders may include federal agencies; state, local, tribal, or territorial agencies; private companies; and other organizations.

⁴ Stakeholders may include federal agencies; state, local, tribal, or territorial agencies; private companies; standards developing organizations; engineering and other professional societies; architects; designers; engineers; and other professionals.

health, welfare, function, and operation. Codes, standards, and regulations seek to provide a consistent, transparent, and systematic approach to constructing and operating infrastructure that facilitates compatibility, interoperability, safety, quality, and reliability. In addition, the use of codes, standards, and guidelines may make it more efficient to implement infrastructure performance improvements, such as increasing resiliency and energy efficiency. Stakeholders can suggest modifications to existing codes, standards, or guidelines using an existing method based on transparency and consensus-building.⁵ (See the Building Codes FAQ for more general information on codes, standards, and guidelines.)

What Types of Infrastructure Are Discussed in This FAQ?

The National Institute of Standards and Technology (NIST) created the *Community Resilience Planning Guide for Buildings and Infrastructure System*, which divides infrastructure in the United States into the categories and subcategories shown in **Table 1**.⁶ The rest of this report is organized using these categories and subcategories. The infrastructure systems discussed, as well as the codes, standards, and regulations, are examples rather and do not constitute a comprehensive overview.

Table 1. Selected Types of Infrastructure Systems and Categories of Infrastructure

Infrastructure Systems	Categories Within Infrastructure Systems
Transportation	<p>Highways, including roads, bridges, and tunnels</p> <p>Rail, including public transportation, intercity passenger, and freight</p> <p>Air</p> <p>Ports, harbors, and waterways</p> <p>Pipelines used to move fuel alone (e.g., natural gas pipeline)</p>
Energy and Electric Power	<p>Electric power—generation, transmission, and distribution</p> <p>Fuel supply for electric power (except fuel pipelines covered in transportation)</p> <p>Emergency and standby power</p>

⁵ Stakeholders are listed in footnote 3. NIST, *Community Resilience Planning Guide for Buildings and Infrastructure Systems, Volume II*, NIST Special Publication 1190, 2016, doi: 10.6028/NIST.SP.1190v2 (hereinafter, NIST, *Resilience Guide II*). For example, various entities are working on ways to incorporate climate change-related hazard considerations into infrastructure design and management. In 2018, the American Society of Civil Engineers' (ASCE's) Committee on Adaptation to a Changing Climate released a manual of practice to provide guidance on methods for infrastructure analysis and design (Bilal M. Ayyub, ed., *Climate-Resilient Infrastructure: Adaptive Design and Risk Management*, Committee on Adaptation to a Changing Climate, ASCE (Reston, VA: American Society of Civil Engineers, 2018); for more information about the chapters of this book, see <https://ascelibrary.org/doi/book/10.1061/9780784415191>).

⁶ NIST, *Resilience Guide II*. The NIST guide uses the same categories of infrastructure as defined under the term *lifeline infrastructure* to include “public works and utilities, including transportation facilities and infrastructure, oil and gas pipelines, electrical power and communication facilities and infrastructure, and water supply and sewage treatment facilities” (42 U.S.C. § 7703(6)).

Infrastructure Systems	Categories Within Infrastructure Systems
Communication	Landline telephone Cellular and mobile Internet and voice over internet protocol Cable television and radio Broadcast television and radio
Water	Drinking water—supply, transmission, treatment, pumping, storage, and distribution Wastewater and stormwater—collection, conveyance, pumping, treatment, and discharge Dams Levees

Source: Congressional Research Service (CRS) using National Institute of Standards and Technology (NIST), *Guide for Buildings and Infrastructure Systems, Volume II*, NIST Special Publication 1190, 2016, doi: 10.6028/NIST.SP.1190v2 (hereinafter, NIST, *Resilience Guide II*). Dams and levees categories added by CRS.

Do Building Codes Apply to Infrastructure?

In general, state or local building codes and model building codes do not apply to infrastructure (see the Building Codes FAQ). Where infrastructure connects to or runs through a building, some building codes and standards may apply to some components of infrastructure. For example, electrical, plumbing, parking, and building access have building codes and standards, because these components are part of the building structure.

What Is Transportation Infrastructure?

The NIST *Community Resilience Planning Guide* divides transportation infrastructure into five categories: (1) roads, bridges, highways, and road tunnels; (2) rail; (3) air; (4) ports, harbors, and waterways; and (5) pipelines for the transport of fuel alone, such as a natural gas pipeline.⁷

The category of *roadways* includes roads, bridges, highways, and road tunnels. According to NIST, roads and highways serve as the primary transportation infrastructure used by the most people and businesses in the United States. The road network needs to consider vehicles, bicycles, and pedestrians as the most common methods of transportation and may consider restrictions, such as the size of vehicles on certain roads or alternative methods of transportation, such as scooters.⁸

The category of *air* includes airports and heliports. As defined in statute (49 U.S.C. §47102), an airport includes (1) an area of land or water used or intended to be used for the landing and taking off of aircraft, (2) an appurtenant area used or intended to be used for airport buildings or other airport facilities or rights of way, and (3) airport buildings and facilities located in any of those areas. Almost all commercial service airports in the United States are owned by local and state governments or by public entities, such as airport authorities or multipurpose port authorities.

The category of *rail*, as defined by NIST, includes public transportation (e.g., commuter rail, subways, light-rail), intercity passenger rail (e.g., rail operated by Amtrak), and freight rail.

⁷ NIST, *Resilience Guide II*, p. 81.

⁸ *Ibid.*, p. 88.

Passenger rail systems are predominantly owned and operated by the public sector, and freight rail systems are predominantly owned and operated by the private sector.

The category of *waterways* includes ports, harbors, and waterways. According to NIST, waterways are primarily used to import or export goods and materials. The U.S. Army Corps of Engineers (USACE) estimates that over 95% of U.S. trade, by volume, moves through ports.⁹

Pipelines delivering natural gas; crude oil; refined products, such as gasoline and diesel; and natural gas liquids, such as ethane and propane, are part of the transportation infrastructure, because they transport fuels. Pipeline infrastructure includes gathering (small-diameter, short-length pipelines that gather oil and gas in production areas), transmission (larger, longer pipelines that transport products from supply areas to market areas), and distribution (pipelines delivering product to residential, commercial, or industrial end users). The U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration oversees the design, construction, operation, and maintenance of pipelines carrying natural gas or hazardous liquids.

What Codes, Standards, and Regulations May Apply to Transportation Infrastructure?

According to NIST, several federal agencies, many organizations (e.g., American Society of Civil Engineers, American Concrete Institute), and others may provide codes, standards, or guidelines for the construction or repair of different types of transportation infrastructure.¹⁰ **Table 2** lists different categories of transportation infrastructure and some of the organizations that may provide codes, standards, or guidelines. In general, these organizations are not responsible for regulation or enforcement of these codes, standards, or guidelines. The adoption and enforcement of infrastructure codes or standards varies. In some cases, a federal agency may regulate and enforce some codes or standards for construction, repair, or operation and maintenance of some types of transportation infrastructure.

The application of standards to transportation is complex. For example, highway design and construction standards vary depending on the type of highway, its ownership, and its funding source.¹¹ Federal standards apply only to roads, bridges, and tunnels on the National Highway System (NHS). The NHS is a nationwide designated network of 220,000 miles of arterial highways and includes the Interstate System highways.¹² No matter the source of funding, federal standards apply to all work, other than routine maintenance, on NHS roads.¹³ Projects on other roads and bridges that are eligible for federal highway aid under 23 U.S.C. Chapter I are federally required to adhere to state standards—but only if the projects use federal highway funds. On any non-NHS road projects that do not use federal highway funds, the federal standards do not apply, and the projects adhere to state or local standards as set forth under state and local law.

⁹ Ibid., p. 94.

¹⁰ See the Building Codes FAQ for information about standards related to engineering design and materials, such as concrete and steel; these standards may apply to buildings and infrastructure.

¹¹ 23 U.S.C. §§103, 109, 315, 402. 23 C.F.R. §625. For general materials requirements, see 23 C.F.R. §635 subpart D. A *Federal-Aid Highway* is a public highway eligible for assistance under 23 U.S.C. Chapter I. Currently, about 1 million miles of the 4.2 million total miles of U.S. public access highways are Federal-Aid Highways. All bridges listed in the National Bridge Inventory are eligible for federal aid, as well.

¹² See 23 U.S.C. §109(b). See also 23 C.F.R. §625.4(a)(2). For documents incorporated by reference, see 23 C.F.R. §625.4(d).

¹³ 23 C.F.R. §§625.2-625.4. Design documents incorporated by reference are listed in 23 C.F.R. §625(b)-(d).

The Federal Aviation Administration (FAA) develops engineering, design, and construction standards for civil airports.¹⁴ For example, the FAA develops standards for airfield pavement; airport visual aids, such as lighting and signs; deicing and other facilities; and fencing.¹⁵ In addition, through FAA-sponsored airport security research programs, there are security guidelines for airport planning, design, and construction.¹⁶

Port infrastructure can generally be divided into two main divisions that dictate the federal involvement in terms of codes or standards for construction of such facilities: waterside and landside infrastructure. *Waterside infrastructure* includes the navigation channels and the breakwaters and jetties that form a harbor or waterway. These facilities are largely constructed by USACE, which sets the guidance for their construction in various engineering manuals.¹⁷ The U.S. Coast Guard sets standards and maintains the channel marker buoys and navigation aids (sounds and lights) on federal waterways to guide mariners.

Landside port infrastructure, such as wharfs and docks where ships tie up, is primarily a state or local government endeavor, and the standards are largely established by the American Society of Civil Engineers, specifically the Coasts, Oceans, Ports, and Rivers Institute.¹⁸ Port land itself is owned by state and local governments and is often administered by a public port authority, but some marine terminals are privately owned. The International Organization for Standardization is particularly relevant to international container shipping; this body sets standards for the construction of shipping containers and the gantry cranes that load and unload containers.¹⁹ The World Association for Waterborne Transport Infrastructure is an international body providing guidance and technical assistance in both landside and waterside port construction.²⁰

¹⁴ Federal Aviation Administration (FAA), “Airport Engineering, Design, & Construction,” at <https://www.faa.gov/airports/engineering>.

¹⁵ FAA, “Airport Design and Engineering Standards,” at https://www.faa.gov/airports/engineering/design_standards.

¹⁶ National Safe Skies Alliance, Inc., Program for Applied Research in Airport Security (PARAS), *Recommended Security Guidelines for Airport Planning, Design, and Construction*, February 2021.

¹⁷ Among the examples for ports and waterways, the manuals cover coastal engineering, deep draft navigation projects, and designs for seawalls. See U.S. Army Corps of Engineers, “Official Publications of the Headquarters,” at <https://www.publications.usace.army.mil/>.

¹⁸ ASCE, “Coasts, Oceans, Ports & Rivers Institute (COPRI),” at <https://www.asce.org/communities/institutes-and-technical-groups/coasts-oceans-ports-rivers-institute>.

¹⁹ International Organization for Standardization, at <https://www.iso.org/home.html>.

²⁰ World Association for Waterborne Transport Infrastructure, “The World Association for Waterborne Transport Infrastructure,” at <https://www.pianc.org/about>.

Table 2. Transportation Infrastructure: Examples of Responsible Organizations and Codes, Standards, or Guidelines

Category	Purpose	Examples
Road, bridges, highways, and road tunnels	New construction	Federal Highway Administration (FHWA): 23 C.F.R. part 265, “Design Standards for Highways”; for materials, 23 C.F.R. part 635 subpart D and 23 C.F.R. 625.4 (d) American Association of State Highway and Transportation Officials (AASHTO): <i>A Policy on Geometric Design of Highways and Streets</i> ; <i>Standard Specifications for Highway Bridges</i> ; <i>A Policy on Design Standards—Interstate System</i> ; and other documents by reference in 23 C.F.R. §625.4 American Welding Society (AWS), <i>Structural Welding Code-Reinforcing Steel</i>
	Coastal environment	FHWA
	Coastal storm and extreme weather	AASHTO and FHWA
	Coastal storm and extreme weather	AASHTO and FHWA
	Climate change and extreme weather	FHWA (Order 5520), U.S. Department of Transportation (DOT), and U.S. Global Change Research Program (USGCRP)
	Existing infrastructure seismic retrofit	AASHTO, FHWA, and state and local entities For existing infrastructure, see references under “New Construction” For seismic retrofit, see FHWA, <i>Seismic Retrofitting Manual for Highway Structures: Part I Bridges and Part II Retaining Structures, Slopes, Tunnels, Culverts, and Roadways</i>
	Security	Transportation Security Administration (TSA)
Rail	New construction	American Railway Engineering and Maintenance-of-Way Association (AREMA), American Public Transportation Association (APTA)
	Signals and communications	AREMA, APTA
	Operations and maintenance	Federal Transit Administration (FTA), Federal Railroad Administration, AREMA, APTA, Association of American Railroads
	Natural hazards	DOT, FTA, and USGCRP

Category	Purpose	Examples
Air	New construction	Federal Aviation Administration (FAA); FAA may comply with state or local codes, standards, or guidelines
	Security	TSA
	Hazards and emergency plans	FAA
	Maintenance of pavement and visual aid facilities	FAA
	Wildlife hazards	FAA
	Preconstruction environmental review	Environmental Protection Agency
Ports, harbors, and waterways	New construction and natural hazards, such as earthquakes or tsunamis	AASHTO, World Association for Waterborne Transport Infrastructure, American Society of Civil Engineers, American Concrete Institute, U.S. Department of Defense, U.S. Army Corps of Engineers, American Institute of Steel Construction, British Standards Institution, International Organization for Standardization, and Overseas Coastal Area Development Institute of Japan
Pipelines	New construction and natural hazards, such as earthquakes	Pipeline and Hazardous Materials Safety Administration, American Society of Mechanical Engineers, American Petroleum Institute, American Gas Association, National Fire Protection Association, and ASTM International

Source: NIST, *Resilience Guide II*, p. 81.

What Is Energy Infrastructure?

According to NIST, *energy infrastructure* includes electric power systems, natural gas and liquid fuels systems as they relate to electric power, and emergency and standby power systems. Pipelines that transport natural gas and liquid fuels are discussed as part of transportation infrastructure because the engineering standards for pipeline safety and design are administered by the Pipeline and Hazardous Materials Safety Administration.

What Codes, Standards, and Regulations May Apply to Energy Infrastructure?

According to NIST, a few organizations may provide codes, standards, or guidelines for the construction, repair, or operation of different types of energy infrastructure related to electric power systems (**Table 3**). The adoption and enforcement of most electric power infrastructure codes or standards varies and depends on state regulations. Except for the federal reliability standards, the organizations listed in **Table 3** are not responsible for regulation or enforcement of

the codes, standards, or guidelines. Instead, these industry-led organizations develop standards, and state or local utility regulators oversee adoption and enforcement of the standards.

The Federal Energy Regulatory Commission (FERC) regulates the interstate trading and transmission of electric energy and services.²¹ FERC is also responsible for regulating the reliability of the bulk power system.²² States have jurisdiction over the retail sale of electricity and the reliability of the distribution systems of investor-owned utilities by setting standards for and controlling the investments in distribution networks.²³

Table 3. Electric Power Infrastructure: Examples of Responsible Organizations and Codes, Standards, or Guidelines

Purpose	Examples
New Construction	National Electric Safety Code and Rural Utilities Service office of the U.S. Department of Agriculture
Hazards	American Society of Civil Engineers and American National Standards Institute (ANSI)
Materials	ANSI 05 (2008) for wood poles and ANSI C29 (2013) for insulators
Planning and Operations	Federal Energy Regulatory Commission and North American Electric Reliability Corporation

Source: NIST, *Resilience Guide II*, pp. 149-157.

Notes: Electric power infrastructure includes electric power systems, natural gas and liquid fuels systems as they relate to electric power, and emergency and standby power systems.

What Is Communications Infrastructure?

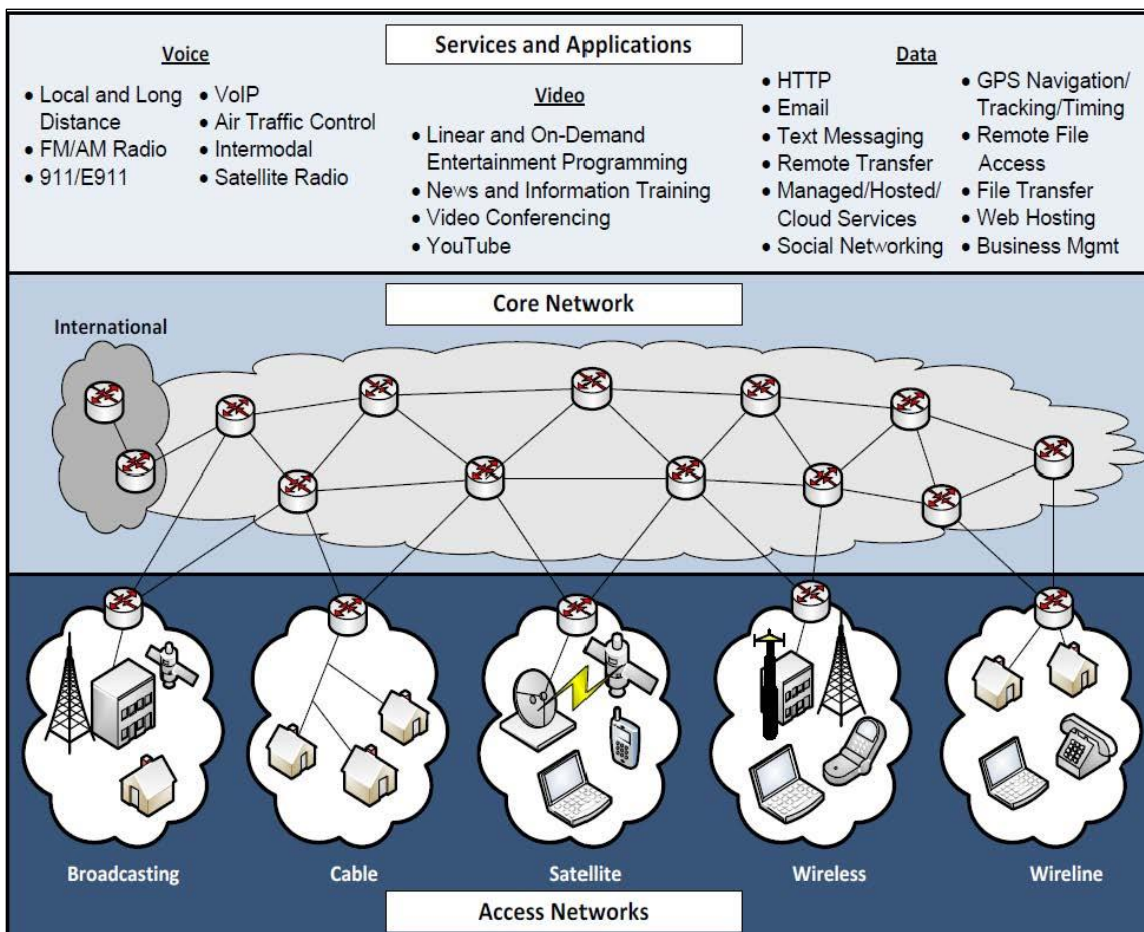
According to NIST, communications infrastructure includes wireline, wireless, cable and broadcast, and satellite networks (**Figure 1**). Wireline and cable communications include wireline and cable for voice, video, and/or data transfers. Distribution centers and network hubs, typically with their own power supplies, provide services through wires (e.g., copper, coaxial cable, fiber-optic cable) that are deployed underground or overhead. Wireless communications for voice, video, and/or data rely on a cellular tower and radio tower network, typically with their own facilities and power supplies, to communicate information via radio waves. Broadcast communications rely on a radio tower network to communicate information via radio waves. Emergency communications include the Federal Emergency Management Agency's (FEMA's) 911 services through wireline infrastructure and Integrated Public Alert and Warning System through wireline, wireless, cable, broadcast, and satellite communications infrastructure.²⁴

²¹ FERC does not regulate electric power infrastructure in Alaska or Hawaii because there is no interstate trading or transmission.

²² For an overview of the reliability standards overseen by FERC, see CRS Report R45764, *Maintaining Electric Reliability with Wind and Solar Sources: Background and Issues for Congress*, by Ashley J. Lawson.

²³ For more information about the regulation of rates, services, and reliability of electrical systems, see National Academies of Sciences, Engineering and Medicine, *The Future of Electric Power in the United States*, 2021, Chapter 3 and Table 3.1.

²⁴ FirstNet Authority, "9-1-1/Emergency Communications," at <https://www.firstnet.gov/public-safety/firstnet-for/9-1-1-emergency-communications>; Federal Emergency Management Agency (FEMA), "Integrated Public Alert & Warning System," at <https://www.fema.gov/emergency-managers/practitioners/integrated-public-alert-warning-system>; and CRS Report R47521, *Electricity: Overview and Issues for Congress*, by Ashley J. Lawson.

Figure 1. Examples of Communications Infrastructure

Source: NIST, *Resilience Guide II*, Figure 15-2. Modified by CRS.

Notes: The Services and Applications in the top panel list some of the services and applications available via voice, video, or data. The Core Network in the middle panel refers to the high-capacity communications facilities that connect primary nodes. Core or backbone networks provide paths to exchange information between sub-networks. The Access Networks in the bottom panel connect the end customers to the core network. Access networks use different technologies. For broadcasting, the network uses radio towers, satellites, and buildings for equipment and power supplies. For cable, the network uses wirelines. For satellite, the network uses satellite dishes and satellites. For wireless, the network uses cell towers, radio towers, and buildings for equipment and power supplies. For wireline, the network uses wirelines. This graphic approximates communications infrastructure and does not show all components. VoIP stands for voice over Internet Protocol.

What Codes, Standards, and Regulations May Apply to Communications Infrastructure?

Codes and standards for communications infrastructure may establish minimum acceptable criteria for design and construction (**Table 4**). In particular, the American National Standards Institute/Telecommunications Industry Association, the Network Equipment Building Standards, and the Institute of Electrical and Electronics Engineers' National Electrical Safety Code provide codes and standards for communications infrastructure.²⁵ The American Society of Civil

²⁵ Telecommunications Industry Association (TIA), "Standards," at <https://tiaonline.org/what-we-do/standards/>; and (continued...)

Engineers in their all hazards resistant standard, ASCE 7, sets minimum design loads and associated criteria for buildings and other structures used by communications infrastructure (see the Building Codes FAQ).²⁶

Multiple regulatory entities (federal, state, and local) have authority over communications infrastructure, and evolving technologies have led to changes in regulatory jurisdiction.²⁷ The Federal Communications Commission (FCC) regulates interstate and international communication services and has jurisdiction over communications by telephone, cable, radio, wireless, wireline, and internet.²⁸ The FCC advisory group on Communications Security, Reliability, and Interoperability Council promotes best practices for reliability and resilience, but the FCC does not enforce any codes or standards for communications infrastructure.²⁹

State agencies have authority over local wireline telephone services, and most often a public service commission oversees communications infrastructure at the state level. In addition, state departments of transportation may have jurisdiction over communications infrastructure constructed within rights-of-way adjacent to roads. Local agencies may have jurisdiction for enforcing local building codes and may regulate placement or construction of radio towers, cell towers, electrical equipment, standby power, and fuel storage at communications facilities. Large cities may regulate the construction and location of communications infrastructure through city transportation departments or other city agencies.

Table 4. Communications Infrastructure: Examples of Responsible Organizations and Codes, Standards, or Guidelines

Purpose	Examples
Specifies loading and strength requirements for antennae and their supporting structures (e.g., cell and broadcast towers)	TIA-222-G Structural Standards for Antennae Supporting Structures and Antennae
Provides minimum loading criteria for buildings housing critical communications equipment (i.e., communications buildings) and loading criteria for towers	ASCE 7 Minimum Design Loads for Buildings and Other Structures
Standard providing requirements for safe installation, operation, and maintenance of electrical power, standby power, and communication systems (overhead and underground wiring)	IEEE National Electrical Safety Code

Source: NIST, *Resilience Guide II*, Table 15-2.

Notes: TIA = Telecommunications Industry Association; ASCE = American Society of Civil Engineers; IEEE = Institute of Electrical and Electronics Engineers.

Institute of Electrical and Electronics Engineers, *The National Electrical Safety Code (NESC)*, 092-1-22, 2022, at https://standards.ieee.org/wp-content/uploads/import/documents/other/NESC_overview.pdf.

²⁶ ASCE, “ASCE 7,” at <https://www.asce.org/publications-and-news/asce-7>.

²⁷ NIST, *Resilience Guide II*.

²⁸ Federal Communications Commission, “Federal Communications Commission Homepage,” at <https://www.fcc.gov/>.

²⁹ See Table 15-3 in NIST, *Resilience Guide II*, for examples of best practices for communications infrastructure.

What Is Drinking Water and Wastewater Infrastructure?

Water for drinking, cooking, hygiene, flushing toilets, laundry, and other purposes is supplied through water infrastructure from surface or ground waters.³⁰ Wastewater or used water from residential, commercial, government, or other sources is removed through wastewater infrastructure—typically pipes, pumps, and treatment facilities—before discharge into the environment.³¹ In general, water infrastructure consists of supply, transmission, treatment, pumping, storage, and distribution, and wastewater infrastructure consists of collection, conveyance, pumping, treatment, and discharge.³² In addition, wastewater infrastructure can include infrastructure for stormwater.

What Codes, Standards, and Regulations May Apply to Drinking Water and Wastewater Infrastructure?

Codes, standards, and guidelines for drinking water and wastewater infrastructure may be provided by state and local building codes, the American Society of Civil Engineers (ASCE), American Concrete Institute, American Water Works Association, American Lifeline Alliance, Water Environment Federation, Water Research Foundation, and Multidisciplinary Center for Earthquake Engineering Research, among others (see the Building Codes FAQ).³³ **Table 5** lists examples of some such organizations and the standards or guidelines they provide for different parts of the water or wastewater infrastructure.

Table 5. Drinking Water and Wastewater Infrastructure: Examples of Responsible Organizations and Codes, Standards, or Guidelines

Purpose	Examples
Design loads for buildings and related structures and guidelines for earthquake design for pipelines	American Society of Civil Engineers (ASCE 7)
Standards for storage and treatment facilities constructed with concrete	American Concrete Institute
Standards for storage, facilities operation and management, and emergency preparedness practices; guidelines for buried steel pipes, emergency power, drought and earthquake preparedness and response, and business continuity plans for water utilities	American Water Works Association
Guidelines for facility performance, design of buried steel pipes, earthquake design of pumping and treatment systems	American Lifeline Alliance
Guidelines for emergency planning, response, and recovery; municipal wet weather strategies; municipal wastewater treatment systems; upgrades for treatment systems; and prevention and control of sewer system overflows	Water Environment Federation

³⁰ NIST, *Resilience Guide II*, p. 198. For a definition of *groundwater*, see U.S. Geological Survey, “Groundwater: What Is Groundwater?,” at <https://www.usgs.gov/special-topics/water-science-school/science/groundwater-what-groundwater>.

³¹ NIST, *Resilience Guide II*, p. 198. Some wastewater may be recycled for reuse. See Environmental Protection Agency (EPA), “Basic Information About Water Reuse,” at <https://www.epa.gov/waterreuse/basic-information-about-water-reuse>.

³² NIST, *Resilience Guide II*, pp. 202 and 209.

³³ ASCE, “American Society of Civil Engineers,” at <https://www.asce.org/>; American Concrete Institute, at <https://www.concrete.org/>; Water Research Foundation, at <https://www.waterrf.org/>; American Water Works Association, at <https://www.awwa.org/>; and Multidisciplinary Center for Earthquake Engineering Research (MCEER), “Engineering solutions for earthquake loss reduction,” at <https://www.nsf.gov/pubs/2000/nsf00137/nsf00137m.htm>.

Purpose	Examples
Guidelines for fragility analysis of water supply systems and for earthquake design of pipelines	Multidisciplinary Center for Earthquake Engineering Research
Guidelines for emergency drinking water supply and business continuity planning for water utilities	Environmental Protection Agency

Source: NIST, *Resilience Guide II*, Table 16-4.

Notes: For more about ASCE 7 see ASCE, “ASCE 7,” at <https://www.asce.org/publications-and-news/asce-7>.

The U.S. Environmental Protection Agency (EPA) establishes requirements for drinking water quality under the authority of the Safe Drinking Water Act (SDWA; codified generally as 42 U.S.C. et seq. §§300f-300j) and for wastewater effluent quality under the authority of the Federal Water Pollution Control Act or Clean Water Act (CWA; codified generally as 33 U.S.C. §§1251-1387).³⁴ A state agency that meets certain criteria may be granted primary enforcement responsibility for these requirements. In addition to meeting SDWA and CWA requirements, water or wastewater systems may have to comply with state or local requirements such as regulations, codes, standards, or guidelines, or such systems may voluntarily adopt codes from other organizations.

What Are Dams and Levees?

The nation’s dams were constructed for various and sometimes multiple purposes. The most common type of dam is an earthen dam, which is made from natural soil or rock or from mining waste materials. Other dams include concrete dams, tailings dams (i.e., dams that store mining byproducts), overflow dams (i.e., dams regulating downstream flow), and dikes (i.e., dams constructed at a low point of a reservoir of water).³⁵ The National Inventory of Dams (NID), a database of dams in the United States that is maintained by USACE, lists over 91,000 dams.³⁶ For the purposes of inclusion in the NID, a *dam* is defined as any artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material, for the purpose of storage or control of water that (1) is at least 25 feet in height with a storage capacity of more than 15 acre-feet; (2) is greater than 6 feet in height with a storage capacity of at least 50 acre-feet; or (3) poses a significant threat to human life or property, should it fail (i.e., high or significant hazard dams).³⁷ Thousands of dams do not meet these criteria; therefore, they are not included in the NID. Most dams in the United States are owned by private entities, state or local governments, or public utilities. Federal agencies reported owning 3% of dams listed in the NID, including some of the largest dams in the United States.

The United States has approximately 100,000 miles of built urban, rural, and agricultural engineered earthen embankments, often referred to as levees, floodwalls (which are constructed of metal or reinforced concrete), and engineered coastal dunes and berms. These structures collectively are often referred to as *levees* when discussing types of infrastructure, because they share the purpose of excluding water from a landscape to protect property and infrastructure from

³⁴ EPA, “Safe Drinking Water Act (SDWA),” at <https://www.epa.gov/sdwa>; and EPA, “Summary of the Clean Water Act,” at <https://www.epa.gov/laws-regulations/summary-clean-water-act>.

³⁵ United States Society on Dams, “Types of Dams,” at <https://www.ussdams.org/dam-levee-education/overview/types-of-dams/>.

³⁶ U.S. Army Corps of Engineers (USACE), “National Inventory of Dams (NID),” at <https://nid.usace.army.mil/#/>. NID data in this report were accessed on November 14, 2022, with NID showing data as of November 3, 2022.

³⁷ 33 U.S.C. §467.

flooding. Some of these levees are being repaired after damage or rehabilitated to sustain their performance. Federal, state, local, and private entities also continue to plan and construct new levees.

Historically, engineering practices for levee design and construction have varied across the United States, with original construction of many levees predating modern engineering practices. Municipalities and agricultural districts are responsible for the operation and maintenance of many of these structures; other levees may be privately owned. USACE maintains 4,200 miles of levees, and a few other federal agencies (e.g., Bureau of Reclamation, National Park Service) maintain an unknown number of levees.

What Codes, Standards, and Regulations May Apply to Dams?

Dams were built to engineering and construction standards and regulations corresponding to the time of their construction. Although construction of some dams may predate modern engineering practices (approximately 2,300 National Inventory of Dams [NID] dams were built before 1900), over 43,000 dams—nearly half of the dams in the NID—were built between 1950 and 1980.³⁸ After this period, construction of new dams slowed (e.g., the NID lists approximately 4,700 dams built since 2000). Some dams, including older dams, may not meet current dam safety standards, which have evolved as scientific data and engineering have improved over time.³⁹ Dam owners generally are responsible for operation and maintenance of these structures and for investing in dam rehabilitation (i.e., bringing a dam up to current safety standards) and repair. FEMA, federal agencies with large portfolios of sizable dams (e.g., USACE, Bureau of Reclamation), and the Association of State Dam Safety Officials also publish various federal guidelines, technical manuals, and factsheets that other dam owners may use for operation and maintenance and rehabilitation and repair projects.⁴⁰

No single agency regulates all dams. The National Dam Safety Program Act, as amended (Section 215 of the Water Resources Development Act of 1996; P.L. 104-303; 33 U.S.C. §§467f et seq.), established the National Dam Safety Program (NDSP) as a federal program, administered by FEMA, to facilitate dam safety activities and collaboration among the various federal agencies, states, and owners with responsibility for dam safety.⁴¹ Each federal dam is regulated according to the policies and guidance of the individual federal agency that owns the dam, and FEMA's *Federal Guidelines for Dam Safety* provide basic guidance for federal agencies' dam safety programs.⁴² Every state (except Alabama) in the United States has established a regulatory program for dam safety, as has Puerto Rico.⁴³ Collectively, these programs have regulatory

³⁸ NID as of a November 3, 2022, update.

³⁹ National Research Council (NRC), *Dam and Levee Safety and Community Resilience: A Vision for Future Practice*, 2012, at <https://doi.org/10.17226/13393>.

⁴⁰ For example, see FEMA, "National Dam Safety Program Publications," at <https://www.fema.gov/emergency-managers/risk-management/dam-safety/publications>; Key Documents at USACE, "Dam Safety Program," at <https://www.usace.army.mil/Missions/Civil-Works/Dam-Safety-Program/>; Association of State Dam Safety Officials (ASDSO), "Dam Safety Resource Database," at <https://www.damsafety.org/resource-center>.

⁴¹ For more information on dam safety, see CRS Report R45981, *Dam Safety Overview and the Federal Role*, by Anna E. Normand. For information on the National Dam Safety Program, see FEMA, "National Dam Safety Program," at <https://www.fema.gov/national-dam-safety-program>.

⁴² FEMA, *Federal Guidelines for Dam Safety Risk Management*, FEMA P-1025, 2015, at https://www.fema.gov/sites/default/files/2020-08/fema_dam-safety_risk-management_P-1025.pdf.

⁴³ FEMA, *The National Dam Safety Program: Biennial Report to the United States Congress, Fiscal Years 2018-2019*, November 2022, at https://www.fema.gov/sites/default/files/documents/fema_ndsp-report-congress-fy18-fy19.pdf.

authority over 71% of NID dams.⁴⁴ The NDSP does not mandate uniform standards across dam safety programs but has developed the Model State Dam Safety Program, a guideline for developing state dam safety programs.⁴⁵ Congress also has enacted legislation for certain federal agencies to regulate activities that may use dams, such as hydropower projects, certain mining activities, and nuclear facilities.⁴⁶

Federal agencies traditionally approached dam safety through a deterministic, standards-based approach by mainly considering structural integrity to withstand maximum probable floods and maximum credible earthquakes. Many agencies with large dam portfolios (e.g., Bureau of Reclamation, USACE, FERC) have since moved from this solely standards-based approach for their dam safety programs to a portfolio risk management approach. According to FEMA, “a risk-management approach seeks to improve the resilience of dam infrastructure and mitigate failure of dams and related structures through inspection programs, risk reduction measures, and rehabilitation and repair.”⁴⁷ This approach prioritizes rehabilitation and repair efforts for structures where failure would pose the greatest threat to life and property. Some state dam safety agencies also are working to incorporate a risk management approach (e.g., Colorado).⁴⁸

What Codes, Standards, and Regulations May Apply to Levees?

There is no broadly applicable national standard or requirement for levee construction or maintenance. Pursuant to direction in P.L. 113-121 in 2014, USACE and FEMA are working on developing national levee safety guidelines to serve as voluntary best practices.⁴⁹ Ultimately, levee owners are responsible for maintaining their levees.

USACE has developed regulations and guidance documents for levee design, construction, evaluation, operation, and maintenance. USACE provides for some regional differences tailored to different water-loading conditions (e.g., riverine versus coastal levees), geologic variability, climate, and hydrology (e.g., arid versus temperate environments), as well as environmental factors (e.g., vegetation management).⁵⁰ USACE and some other federal agencies use these documents to guide their work on levees. Other federal agencies also have developed guidance

⁴⁴ NID as of a November 3, 2022, update. States define their own regulatory jurisdiction (the height, volume, and type of dams to be regulated): state laws may exclude the regulation of certain dams in the NID. Personal correspondence between CRS and ASDSO on August 30, 2019. ASDSO, *Summary of State Laws and Regulations on Dam Safety*, May 2022, at https://damsafety-prod.s3.amazonaws.com/s3fs-public/files/FINAL%20-%202020%20Update%20State%20Laws%20and%20Regulations%20Summary_0.pdf.

⁴⁵ ASDSO notes that a task force has updated the Model Dam Safety Program and has provided FEMA the draft update for final review. Personal correspondence between CRS and ASDSO on October 17, 2022. FEMA, *Model State Dam Safety Program*, 2007, at https://damsafety-prod.s3.amazonaws.com/s3fs-public/files/FEMA%20316_%20Model%20State%20Dam%20Safety%20Program_2007.pdf.

⁴⁶ For example, under the Federal Power Act (16 U.S.C. §§791a-828c), FERC has the authority to issue licenses for the construction and operation of hydroelectric projects, among other things. Many of these projects involve dams, some of which may be owned by a state or local government.

⁴⁷ FEMA, *The National Dam Safety Program: Biennial Report to the United States Congress, Fiscal Years 2018-2019*, November 2022, at https://www.fema.gov/sites/default/files/documents/fema_ndsp-report-congress-fy18-fy19.pdf.

⁴⁸ State of Colorado, Department of Natural Resources, *Guidelines for Comprehensive Dam Safety Evaluation (CDSE) Risk Assessments & Risk Informed Decision Making (RIDM)*, March 8, 2021, at <https://dnrwebblink.state.co.us/dwr/ElectronicFile.aspx?docid=3566811&dbid=0>.

⁴⁹ For more information on development of the levee safety guidelines, see USACE and FEMA, “National Levee Safety Program,” at <https://www.leveesafety.org/pages/nlsg>.

⁵⁰ European Club of International Commission on Large Dams, Working Group on Levees and Flood Defences, *European and U.S. Levees and Flood Defences: Characteristics, Risks and Governance*, July 1, 2018, Chapter 12, at https://www.barrages-cfbr.eu/IMG/pdf/lfd_inventory_of_characteristics_risks_and_governance_full_report_final_20190308.pdf.

for their own levee-related programs, such as the Dike and Levee practice standard for the U.S. Department of Agriculture’s Natural Resources Conservation Service. Some states use the USACE documents to guide levee construction in their states, whereas other states maintain their own documents and criteria or adopt other guidance. A few states, such as California, have established design and safety criteria or standards for levees.⁵¹

In P.L. 113-121, Congress authorized FEMA to support the establishment or improvement of state and tribal levee safety programs. Although this initiative has remained largely unfunded, federal agencies have advanced related efforts to improve levee safety, such as the release of a National Levee Database and the 2019 publication for emergency managers of a *Guide to Public Alerts and Warning for Dam and Levee Emergencies*. USACE and representatives from five other countries launched in 2013 an *International Levee Handbook* identifying good practice on levees based on current knowledge and experience from six countries.

Federal flood insurance regulations may shape how some levees are designed, operated, and maintained, because levees can reduce flood insurance requirements (see the Building Codes FAQ).⁵² For a levee, floodwall, or coastal dune or berm to appear on a National Flood Insurance Program (NFIP) Flood Insurance Rate Map, the levee owner is required to obtain a certification consisting of documentation, signed and sealed by a registered professional engineer, that the levee meets the NFIP requirements at 44 C.F.R. §65.10, “Mapping of Areas Protected by Levee Systems.”⁵³

What Is the Federal Flood Risk Management Standard?

The Federal Flood Risk Management Standard (FFRMS) is a flood resilience standard that is required for *federally funded projects*, which are defined as actions where federal funds are used for new construction, for substantial improvement, or to address substantial damage to structures and facilities, including infrastructure.⁵⁴ The floodplain management policy for the FFRMS was first set forth in 2015 by President Obama’s Executive Order (E.O.) 13690, revoked in 2017 by President Trump’s E.O. 13807, and reinstated in 2021 by President Biden’s E.O. 13990. For

⁵¹ For example, in the early 2010s, California developed Urban Levee Design Criteria and Urban Level of Protection Criteria. The state also encourages levee designers and owners to review and consider the USACE documents. California relies on the due diligence of local governments; that is, the state does not enforce the Urban Level of Protection Criteria.

⁵² Another federal program that may shape how participating nonfederal levees are operated and maintained is referred to as the P.L. 84-99 Rehabilitation Program, operated by USACE. The program provides federal funding for repairs of participating levees. The participating levees must pass an inspection of various components of the levee system to be eligible for assistance. The program’s regulations are published at 33 C.F.R. §§203.41-203.52. For more information on this program and other federal levee safety activities, see CRS In Focus IF12404, *Nonfederal Levee Safety: Primer, Status, and Considerations*, by Nicole T. Carter and Diane P. Horn.

⁵³ These requirements include levee design and operation and maintenance criteria related to reducing the risk of flooding from a 1%-annual-chance flood, such as foundation stability criteria and operational plan criteria for closures in a levee system. FEMA uses the certification to accredit a levee for purposes of appearing on a Flood Insurance Rate Map as providing a specified level of protection and for the area behind the levee to not be mapped into the special flood hazard area. Properties in a special flood hazard area are required to purchase flood insurance as a condition of receiving a federally backed mortgage.

⁵⁴ See CRS Insight IN12193, *The Federal Flood Risk Management Standard (FFRMS)*, by Diane P. Horn and Nicole T. Carter, for a summary of the FFRMS. FEMA, *Guidelines for Implementing Executive Order 11988, Floodplain Management, and Executive Order 13690, Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input*, October 8, 2018, p. 16, at https://www.fema.gov/sites/default/files/documents/fema_implementing-guidelines-EO11988-13690_10082015.pdf (hereinafter, *Guidelines for Establishing an FFRMS*). Note that the FEMA guidelines do not require the use of the National Flood Insurance Program’s definitions of substantial damage and substantial improvement (footnotes 98 and 99).

FFRMS compliance, the floodplain for federally funded projects is determined using one of three currently available approaches: (1) the freeboard value approach;⁵⁵ (2) the 500-year floodplain;⁵⁶ or (3) the climate-informed science approach (CISA).⁵⁷ Individual federal agencies may develop or update procedures and regulations tailored to their programs to account for the reinstated FFRMS. For example, the EPA determined the FFRMS would go into effect starting in FY2022, applying to certain projects funded by State Revolving Fund capitalization grants (including funding from the Infrastructure Investment and Jobs Act [P.L. 117-58]).⁵⁸ For its implementation of the FFRMS, USACE is using CISA methods set out in agency guidance to evaluate climate change impacts on coastal and inland flood hazard. USACE indicates that it infers the FFRMS to apply to vertical infrastructure, such as buildings, rather than horizontal infrastructure, such as levees or walls.⁵⁹ As of July 2023, the various other agencies providing federal funding to infrastructure projects discussed herein had not made publicly available information on the progress they have made implementing or otherwise complying with the FFRMS.

⁵⁵ The floodplain obtained through the freeboard value approach in the FFRMS is defined as the elevation and flood hazard area that result from adding an additional 2 feet to base flood elevation (BFE) for noncritical actions and adding an additional 3 feet to BFE for *critical actions*, which are defined as any activity for which even a slight chance of flooding would be too great. FEMA, *Guidelines for Establishing an FFRMS*, provides additional guidance to assist agencies in determining whether an action is critical.

⁵⁶ The *500-year floodplain* is defined as the area subject to flooding by the 0.2%-annual-chance flood.

⁵⁷ Defined as the elevation and flood hazard area that result from using a climate-informed science approach that uses the best-available, actionable hydrologic and hydraulic data and methods that integrate current and future changes in flooding based on climate science.

⁵⁸ Memorandum from Anita Maria Thompkins, Director, Drinking Water Protection Division, Office of Ground and Drinking Water, and Raffael Stein, Director, Water Infrastructure Division, Office of Wastewater Management, to Water Division Directors, Regions I-X, “Re-instatement of Federal Flood Risk Management Standard for State Revolving Fund Programs,” EPA, September 15, 2022, at <https://www.epa.gov/system/files/documents/2022-09/Federal%20Flood%20Risk%20Managment%20Standard%20.pdf>.

⁵⁹ USACE, “Federal Flood Risk Management Standard,” at <https://www.iwr.usace.army.mil/Missions/Flood-Risk-Management/Flood-Risk-Management-Program/About-the-Program/Policy-and-Guidance/Federal-Flood-Risk-Management-Standard/>.

Appendix. Abbreviation Table

Table A-1 contains a list of abbreviations used in this report.

Table A-1. Abbreviations Used in This Product

Abbreviation	Full Name
AASHTO	American Association of State Highway and Transportation Officials
ANSI	American National Standards Institute
AREMA	American Railway Engineering and Maintenance-of-Way Association
ASCE	American Society of Civil Engineers
BFE	Base Flood Elevation
DOT	Department of Transportation
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FAQ	Frequently asked question
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FFRMS	Federal Flood Risk Management Standard
FHWA	Federal Highway Administration
IEEE	Institute of Electrical and Electronics Engineers
NDSP	National Dam Safety Program
NFIP	National Flood Insurance Program
NID	National Inventory of Dams
NIST	National Institute of Standards and Technology
SDWA	Safe Drinking Water Act (P.L. 93-523)
USACE	U.S. Army Corps of Engineers
USGCRP	U.S. Global Change Research Program
TIA	Telecommunications Industry Association
TSA	Transportation Security Administration

Source: Congressional Research Service.

Author Information

Linda R. Rowan, Coordinator
Analyst in Natural Resources and Earth Sciences

Robert S. Kirk
Specialist in Transportation Policy

Nicole T. Carter
Specialist in Natural Resources Policy

Ashley J. Lawson
Specialist Energy Policy

Corrie E. Clark
Specialist in Energy Policy

William J. Mallett
Specialist in Transportation Policy

John Frittelli
Specialist in Transportation Policy

Anna E. Normand
Analyst in Natural Resources Policy

Jill C. Gallagher
Analyst in Telecommunications Policy

Paul W. Parfomak
Specialist in Energy Policy

Diane P. Horn
Specialist in Flood Insurance and Emergency
Management

Jonathan L. Ramseur
Specialist in Environmental Policy

Elena H. Humphreys
Analyst in Environmental Policy

Rachel Y. Tang
Analyst in Transportation and Industry

Key Policy Staff

Area of Expertise	Name	Phone	Email
Air—Transportation Infrastructure	Rachel Y. Tang	202-707-7875	rtang@crs.loc.gov
Codes—General, Science and Technology, Resilience	Linda R. Rowan	202-707-0602	lrowan@crs.loc.gov
Communications Infrastructure	Jill C. Gallagher	202-707-1024	jpgallagher@crs.loc.gov
Dams—Water Infrastructure	Anna E. Normand	202-707-9846	anormand@crs.loc.gov
Drinking Water—Water Infrastructure	Elena H. Humphreys	202-707-2054	ehumphreys@crs.loc.gov
Electric Power—Energy Infrastructure	Ashley J. Lawson	202-707-2596	alawson@crs.loc.gov
Energy Infrastructure	Corrie E. Clark	202-707-7213	cclark@crs.loc.gov
Flood Insurance	Diane P. Horn	202-707-3472	dhorn@crs.loc.gov
Levees—Water Infrastructure	Nicole T. Carter	202-707-0854	ncarter@crs.loc.gov
Pipelines—Transportation Infrastructure	Paul W. Parfomak	202-707-0030	pparfomak@crs.loc.gov
Ports, Harbors, and Waterways—Transportation Infrastructure	John Frittelli	202-707-7033	jfrittelli@crs.loc.gov

Roads and Rails—Transportation Infrastructure	Robert S. Kirk William J. Mallett	202-707-7769 202-707-2216	rkirk@crs.loc.gov wmallett@crs.loc.gov
Wastewater—Water Infrastructure	Jonathan L. Ramseur	202-707-7919	rramseur@crs.loc.gov

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