



441 G St. N.W.  
Washington, DC 20548

December 15, 2022

Congressional Committees

**Telecommunications Workforce: Additional Workers Will Be Needed to Deploy Broadband, but Concerns Exist About Availability**

Federal and industry investments have made broadband available to the majority of Americans, but at least 25 percent of the population in certain areas reported not having internet service, according to the U.S. Census Bureau’s 2015-2019 American Community Survey data. According to a recent media report, people living in rural areas, low-income areas, and some predominantly Black and Hispanic and tribal communities are disproportionately affected by a lack of broadband availability.<sup>1</sup>

Broadband has become critical for daily life as everyday activities like work, school, and health care appointments increasingly occur online. Broadband also helps provide access to economic opportunity and civic engagement.

The COVID-19 pandemic underscored the importance of access to broadband. Recently enacted legislation includes large increases in federal funding for broadband deployment. For example, the Infrastructure Investment and Jobs Act authorized the Broadband Equity, Access, and Deployment (BEAD) program and appropriated \$42.45 billion in funding for this program that may be used for broadband deployment.<sup>2</sup>

The Infrastructure Investment and Jobs Act also includes a provision for GAO to review and estimate the number of skilled telecommunications workers who will be required to build and maintain broadband infrastructure in rural areas based on current and potential need, as well as the wireless infrastructure needed to support 5G wireless technology.<sup>3</sup> This report: (1) describes the current telecommunications workforce and estimates the number of additional skilled telecommunications workers needed to deploy broadband and 5G based on funding from selected recent federal programs and (2) examines what existing data reveal about a potential labor shortage for skilled telecommunications workers and stakeholder views on workforce concerns relevant to these skilled workers. The enclosed report addresses these two objectives in greater detail.

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<sup>1</sup>Sarah Atske and Andrew Perrin, *Home Broadband Adoption, Computer Ownership Vary by Race, Ethnicity in the U.S.*, Pew Research Center (Washington, D.C.: Jul. 16, 2021).

<sup>2</sup>Pub. L. No. 117-58, § 60102, 135 Stat. 429, 1182 (authorizing BEAD) (codified as amended at 47 U.S.C. § 1702), div. J, tit. II, 135 Stat. 429, 1353 (appropriating BEAD funding) (2021).

<sup>3</sup>IJA § 60604. The fifth generation of mobile communications, referred to as 5G, promises consumers faster data rates with lower latency in transmitting data. We refer to 5G as mobile broadband in this report.

To determine the size of the current telecommunications workforce, we analyzed Bureau of Labor Statistics' (BLS) data for the wired and mobile telecommunications industries. To estimate the number of additional workers needed to deploy broadband and 5G as a result of new or increased funding for broadband infrastructure deployment from eight federal programs we selected, we used data from the BLS 2020 nominal domestic employment requirements table.<sup>4</sup> These requirements allow us to make estimates of additional jobs supported directly and indirectly in the fixed and mobile telecommunications industries per \$1 million (in nominal dollars) of output. Although this is a common methodology, there are some limitations. For example, the analysis holds 2020 data static, cannot differentiate between fulltime and part-time occupations, and assumes that there will be no future changes in areas such as worker productivity or technology, among other things. We spoke with officials from the Department of Labor to confirm the appropriateness of the methodology we used.

To examine what current data reveal about a potential labor shortage, we selected 10 occupations we identified as relevant for broadband infrastructure deployment based on stakeholder input.<sup>5</sup> For the 10 selected occupations, we analyzed data that can indicate potential labor shortages. We used data from IPUMS Current Population Survey from the Census Bureau to analyze unemployment rates, employment levels, and wage growth rates.<sup>6</sup> A labor shortage is often defined as a sustained period during which demand for workers exceeds the supply of workers available and willing to work at a particular wage and specific working conditions at a particular place. We selected these indicators based on economic literature and our previous work.<sup>7</sup> While no single metric can be used to identify whether a labor shortage exists, labor market data can be used as indicators that may suggest the existence of a labor shortage. We used these indicators to compare our selected workforce occupations against the overall economy. We determined that BLS data are sufficiently reliable for our purposes of estimating additional workers supported by the selected federal broadband infrastructure programs and for analyzing unemployment rates, employment levels, and wage growth rates.

To obtain stakeholder perspectives on concerns related to the telecommunications workforce, we interviewed representatives from nine telecommunications industry associations, two telecommunications consulting firms, a telecommunications provider, and a construction company focused on fixed broadband deployment. We selected these industry stakeholders to obtain a range of views. The views of those we interviewed are not generalizable.

We conducted this performance audit from December 2021 to December 2022 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for

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<sup>4</sup>We selected these programs on the basis that they (1) either have broadband deployment as the only legally available purpose or have broadband deployment as one legally available purpose but the program is to primarily focus on funding broadband deployment; (2) provide over \$2 million per year in funding; and (3) received additional funding—or were established in—2020 or 2021.

<sup>5</sup>We selected 10 BLS-defined occupations—referred to as BLS Standard Occupation Classifications—based on stakeholder input regarding occupations necessary to deploy broadband.

<sup>6</sup>IPUMS is an organization that standardizes, documents, and preserves U.S. census data.

<sup>7</sup>Carolyn Veneri, "Can Occupational Labor Shortages be Identified Using Available Data," *Monthly Labor Review* (March 1999) 15-21. GAO, *Aviation Workforce: Current and Future Availability of Airline Pilots*, GAO-14-232 (Washington, D.C.: Feb. 28, 2014).

our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

## **Background**

Consumers can receive broadband service through fixed and mobile technologies. Fixed broadband is provided to single locations, such as customers' homes or businesses. Fixed broadband service is provided by cable, fiber, terrestrial fixed-wireless technologies, or satellite technologies. The types of workers involved in building and maintaining fixed broadband service include, but are not limited to:

- Central office technicians
- Construction equipment laborers, such as those operating digging equipment
- Fiber splicing technicians
- General laborers, such as for shoveling
- Home installation and repair technicians
- Line (e.g., fiber) technicians, both for aerial and underground installation
- Network engineers and architects
- Survey/rights-of-way technicians

Mobile technologies, on the other hand, provide internet access wherever a customer has access to a signal. Mobile broadband service connects consumers to wireless networks through a mobile device, such as a smartphone. The occupations necessary to deploy 5G networks include tower erectors and tower climbers, as well as those occupations mentioned above for fixed broadband. The installation of fiber lines remains a critical component of deploying 5G networks given that the towers themselves are often connected to fiber networks.

### **Thousands of Additional Skilled Telecommunications Workers Will Be Needed to Deploy Broadband and 5G Funded Through Selected Federal Programs**

According to our analysis, thousands of additional skilled workers will be needed to deploy broadband and 5G funded from the eight federal programs we selected. As of January 2022, there were an estimated 477,700 workers in the fixed broadband workforce and 88,600 in the mobile workforce, according to BLS's Current Employment Statistics.

Our analysis indicates that if funds are provided over 10 years, at its peak in 2023 the funding would support about 23,000 additional workers. The additional number of workers supported would decline due to the impact of inflation to about 9,000 workers by 2031. That is, over time, the same amount of money results in less infrastructure investment and in turn fewer required workers to install such infrastructure. Funding also declines over time because several programs' funds must be expended prior to 2032. If funding timeframes for broadband infrastructure deployment programs are shortened, more workers would be required per year on average since more projects would be funded per year.

## Indicators Are Mixed Regarding a Labor Shortage for Telecommunications Workers, and Stakeholders Cited Various Workforce Concerns

Our analysis of three key labor market indicators developed from BLS data provided mixed evidence regarding a possible labor shortage for telecommunications workers. If a labor shortage of these workers were to exist, one would expect (1) a low unemployment rate signaling limited availability of workers in a profession; (2) increases in the employment level due to increased demand for that occupation; and (3) increases in wages to draw more people into the occupation.

Our analysis of Current Population Survey data for 2010 to 2021 indicate that, for most of the selected broadband deployment occupations, unemployment rates were below the national average. Given the low unemployment rate, this indicator suggests the potential for a labor shortage in these occupations. On the other hand, we did not find observable increases in employment levels and wages for the selected occupations.

Stakeholders we spoke with expressed various concerns about the availability of the skilled telecommunications workers needed to deploy broadband infrastructure and 5G. These concerns included challenges rural areas may face in attracting these workers, the impact of other industries competing for the same labor force, and overall trends regarding new entrants into broadband-deployment-related occupations.

### Agency Comments

We provided a draft of this report to the Department of Labor for review and comment. The agency provided a technical correction that we incorporated into the report.

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We are sending copies of this report to the Secretary of Labor, relevant congressional committees, and other interested parties. In addition, the report is available at no charge on the GAO website at <http://www.gao.gov>.

If you or your staff have any questions about this report, please contact me at (202) 512-2834 or [vonaha@gao.gov](mailto:vonaha@gao.gov). Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are Sally Moino (Assistant Director); Sean Standley (Analyst-in-Charge); Blake Ainsworth; Michael Kniss; Neelaxi Lakhmani; Terence Lam; Abigail Loxton; Kailas Menon; Mary-Catherine P. Overcash; Tina Sherman; Andrew Stavisky; Michael Steinberg; Janet Temko-Blinder; and Alwynne Wilbur.



Andrew Von Ah  
Director, Physical Infrastructure

Enclosure

*List of Committees*

The Honorable Maria Cantwell  
Chair  
The Honorable Roger F. Wicker  
Ranking Member  
Committee on Commerce, Science, and Transportation  
United States Senate

The Honorable Patty Murray  
Chair  
The Honorable Richard Burr  
Ranking Member  
Committee on Health, Education, Labor, and Pensions  
United States Senate

The Honorable Frank Pallone, Jr.  
Chairman  
The Honorable Cathy McMorris Rodgers  
Republican Leader  
Committee on Energy and Commerce  
House of Representatives

The Honorable Robert C. Scott  
Chairman  
The Honorable Virginia Foxx  
Republican Leader  
Committee on Education and Labor  
House of Representatives



## Telecommunications Workforce

### Additional Workers Will Be Needed to Deploy Broadband, but Concerns Exist About Availability

#### Objectives

The Infrastructure Investment and Jobs Act included a provision for GAO to review and estimate the number of skilled telecommunications workers who will be required to build and maintain broadband infrastructure in rural areas based on current and potential need, as well as the wireless infrastructure needed to support 5G wireless technology.

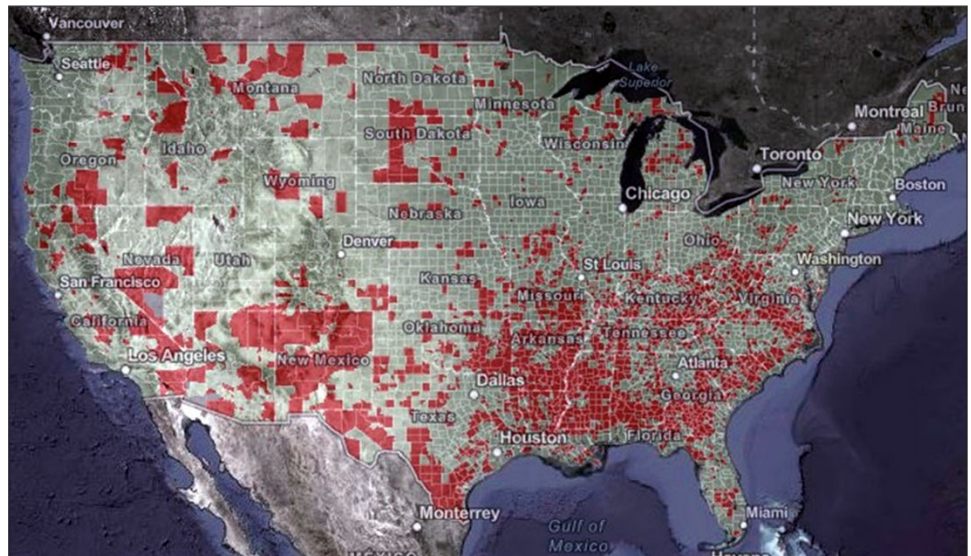
This report:

(1) describes the current telecommunications workforce and estimates the number of additional skilled telecommunications workers needed to deploy broadband and 5G infrastructure funded by certain recent federal programs; and (2) examines what existing data reveal about a potential labor shortage for skilled telecommunications workers, as well as stakeholder views on workforce concerns relevant to these skilled workers.

#### Introduction

Federal and industry investments have made broadband available to the majority of Americans, but at least 25 percent of the population in certain areas reported not having internet service, according to the U.S. Census Bureau's American Community Survey (see fig. 1). People living in rural areas, low-income areas, and some predominantly Black and Hispanic and tribal communities are, according to a recent media report, disproportionately affected by a lack of broadband availability.<sup>1</sup> Broadband has become critical for daily life as everyday activities like work, school, and health care appointments increasingly occur online. Broadband also helps provide access to economic opportunity and civic engagement. The COVID-19 pandemic underscored the importance of access to broadband.

**Figure 1: 2015-2019 U.S. Census Bureau Data Showing Locations (in Red) With At Least 25 Percent of the Population Reporting No Internet Access**



Source: GAO analysis of U.S. Census Bureau Data. | GAO-23-105626

Recently enacted legislation includes large increases in federal funding for broadband deployment. For example, the Infrastructure Investment and Jobs Act (IIJA) authorized the Broadband Equity, Access, and Deployment (BEAD) program and appropriated \$42.45 billion in funding for this program that may be used for broadband deployment.<sup>2</sup> However, some industry stakeholders, such as some broadband providers, are expressing concern that the labor force may not be sufficient to deploy the broadband infrastructure associated with such additional funding.

<sup>1</sup>Sarah Atske and Andrew Perrin, *Home Broadband Adoption, Computer Ownership Vary by Race, Ethnicity in the U.S.*, Pew Research Center, (Washington, D.C.: Jul. 16, 2021).

<sup>2</sup>Pub. L. No. 117-58, § 60102, 135 Stat. 429, 1182 (authorizing BEAD) (codified as amended at 47 U.S.C. § 1702), div. J, tit. II, 135 Stat. 429, 1353 (appropriating BEAD funding) (2021).

## Selection Criteria for Federal Programs that Fund Broadband Deployment

For our analysis, we selected eight federal programs that:

- either have broadband deployment as the only legally available purpose, or have broadband deployment as one legally available purpose but the program is to primarily focus on funding broadband deployment;
- provide over \$2 million per year in funding; and
- received additional funding or were established in 2020 or 2021.<sup>3</sup>

Three of the programs we selected have matching requirements whereby the recipients of the federal funds are required to provide additional funds. For the programs requiring matching funds, we calculated the minimum amount of matching funds that each program requires and included those amounts in our analysis.

For more information contact Andrew Von Ah at (202) 512-2834 or [vonaha@gao.gov](mailto:vonaha@gao.gov)

## Scope and Methodology

We determined the size of the current telecommunications workforce for both fixed and mobile industries by reviewing Bureau of Labor Statistics (BLS) data. To estimate the number of additional workers needed to deploy broadband and 5G infrastructure funded from selected recent federal programs, we selected eight federal programs that fund broadband deployment based on our review of applicable statutes and prior work.<sup>4</sup> See table 1 for information on the programs we selected.

**Table 1: Selected Federal Programs that Fund Broadband Deployment**

Agency	Program name	Federal funding available <sup>a</sup>	Matching requirement to receive funding <sup>b</sup>
National Telecommunications and Information Administration	Broadband Equity and Access Deployment Program	\$41,601,000,000	25%
Federal Communications Commission	Rural Digital Opportunity Fund	\$20,400,000,000	No requirement
Department of the Treasury	Capital Projects Fund	\$10,000,000,000	No requirement
National Telecommunications and Information Administration	Tribal Broadband Connectivity Program	\$2,980,000,000	No requirement
Department of Agriculture	ReConnect Program	\$1,848,960,000	25% if receiving 100% grant
National Telecommunications and Information Administration	Enabling Middle Mile Grants Program	\$980,000,000	30%
National Telecommunications and Information Administration	Broadband Infrastructure Program	\$288,000,000 <sup>c</sup>	No requirement
Department of Agriculture	Rural Broadband Program <sup>d</sup>	\$71,040,000	No requirement

Source: GAO analysis of official agency documentation. | GAO-23-105626

<sup>a</sup>Funding available includes the amount of available funding described in a Notice of Funding Opportunity (NOFO) or, where a NOFO has not yet been issued for the full appropriation, the amount appropriated for the program less any allowable agency administrative expenses.

<sup>b</sup>Matching requirements may include some exceptions.

<sup>c</sup>Although this is the amount of available funding described in the NOFO, we used in our analysis the amount of funding awarded as of September 2022, which is \$277,203,665.

<sup>d</sup>Formerly known as the "USDA Rural Broadband Loans," "Loan/Grant Programs," and "Loan Guarantees" programs.

<sup>3</sup>We included programs established by the Consolidated Appropriations Act, 2021, the American Rescue Plan Act of 2021, and the Infrastructure Investment and Jobs Act; and included funding other than annual appropriations that was provided to existing programs by those acts.

<sup>4</sup>GAO, *Broadband: National Strategy Needed to Guide Federal Efforts to Reduce Digital Divide*, GAO-22-104611 (Washington, D.C.: May 31, 2022).

## Limitations of Estimation Methodology

Estimating future employment using the employment requirements table is a commonly used methodology. However, it has the following limitations:

- The data are based on a snapshot of the economy as of 2020 and do not consider future changes in productivity based on increases in production (for example, economies of scale or improvements in production technology).
- Estimates for the employment requirements table are based on the fixed and mobile telecommunications industries as wholes. Obtaining position-specific estimates is not possible.
- These estimates of federal broadband deployment spending's impact on fixed and mobile telecommunications employment include the effect of inputs into production, but not the additional impact of spending by these employees on consumer goods.
- Estimates on fixed and mobile telecommunications employment are of jobs, but not necessarily full-time ones.

We used the BLS 2020 nominal domestic employment requirements table to calculate an estimate of workers needed to support broadband infrastructure deployment from our selected programs.

The employment requirements tables are the result of scaling historical input-output relationships by industry productivity factors. These requirements allow us to make estimates of additional jobs supported directly and indirectly in the fixed and mobile telecommunications industries per \$1 million (in nominal dollars) of output. We validated our approach with officials from the Department of Labor.

Based on input from industry stakeholders, we assumed the distribution of deployment between fixed and mobile technologies would be 90 percent and 10 percent, respectively. We examined statutes and documentation to determine which of our selected programs have matching requirements.



## Limitations of Labor Shortage Analysis

- COVID-related data collection challenges affected response rates for March-June 2020; this outcome may limit comparability of 2020 data with other years.
- Survey results of unemployment rates are based on the person's last job, rather than what the person is looking for work in. For example, a recently trained line installer who is seeking employment as a line installer but was previously working in a different occupation would not be included in our estimates of unemployment for line installers.

A labor shortage is often defined as a sustained period during which demand for workers exceeds the supply of workers available and willing to work at a particular wage and specific working conditions at a particular place. While no single metric can be used to identify whether a labor shortage exists, labor market data can be used as “indicators” that may suggest the possible existence of a labor shortage.

For a selection of 10 BLS-defined occupations,<sup>5</sup> we examined the indicators of unemployment rates, employment levels, and wage growth rates, using data from IPUM'S Current Population Survey data files and the Census Bureau.<sup>6</sup> We selected these indicators based on economic literature<sup>7</sup> and our previous work.<sup>8</sup> We used these indicators to compare our selected workforce occupations against the overall economy. Since the Current Population Survey is a statistical sample, we used 600 “bootstrap replicates” to obtain variance estimates.<sup>9</sup> This labor shortage analysis is subject to certain limitations, including those identified in the sidebar.

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<sup>5</sup>We selected a subset of 10 BLS-defined occupations—referred to as BLS Standard Occupation Classifications—based on stakeholder input regarding occupations necessary to deploy broadband. For two occupations where the average relative margin of error for a 95 percent confidence interval of the annual estimates exceeded 25 percent, we combined these occupations with similar occupations.

<sup>6</sup>IPUMS is an organization that standardizes U.S. census data.

<sup>7</sup>Carolyn Veneri, “Can Occupational Labor Shortages be Identified Using Available Data,” *Monthly Labor Review* (March 1999) 15-21.

<sup>8</sup>GAO, *Aviation Workforce: Current and Future Availability of Airline Pilots*, GAO-14-232 (Washington, D.C.: Feb. 28, 2014).

<sup>9</sup>All Current Population Survey estimates have variances. The bootstrapping method is recommended by the Census Bureau in cases like ours, when published results and variance models are not available. Bootstrapping allows us to estimate variances by repeated resampling of the data and characterizing the distribution of the results.

## List of Agencies and Stakeholders Interviewed

### *Federal Agencies*

- Department of Commerce, National Telecommunications and Information Administration
- Department of Labor, Bureau of Labor Statistics
- Federal Communications Commission

### *Associations*

- Communications Workers of America
- Fiber Broadband Association
- NATE
- NTCA
- Power and Communication Contractors Association
- Rural Wireless Association
- Wireless Infrastructure Association
- Wireless Internet Service Providers Association
- USTelecom

### *Industry*

- Dycom
- EchoStar Corporation
- Jackson Thornton
- MoffettNathanson LLC

To obtain a range of stakeholder views on workforce concerns, we interviewed relevant federal agency officials and industry stakeholders. We spoke with officials from the Departments of Labor and Commerce, and the Federal Communications Commission. We selected a non-generalizable sample of association and private sector stakeholders. This sample included representatives from nine telecommunications-related associations, two telecommunications consulting firms, a telecommunications provider, and a construction company focused on fixed broadband deployment (see the sidebar for the list of stakeholders). We selected these stakeholders on the basis of our prior work, published work, and other stakeholders' recommendations.

## Types of Telecommunications Workers Involved in Broadband Infrastructure Deployment

The types of skilled workers involved in building and maintaining fixed broadband service include, but are not limited to:

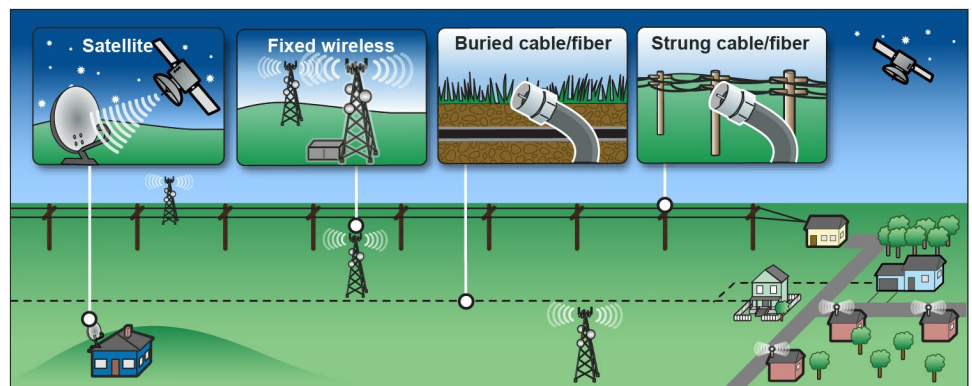
- Central office technicians
- Construction equipment laborers, such as those operating digging equipment
- Fiber splicing technicians
- General laborers, such as for shoveling
- Home installation and repair technicians
- Line (e.g., fiber) technicians, both for aerial and underground installation
- Network engineers and architects
- Survey/rights of way technicians

## Background

### Fixed Broadband Service

One way consumers can receive broadband service is through “fixed” technologies, which provide broadband to single static locations such as customers’ homes or businesses. Fixed broadband service is provided by cable, fiber, terrestrial fixed-wireless technologies, or satellite technologies (see fig. 2).

Figure 2: Types of Fixed Broadband



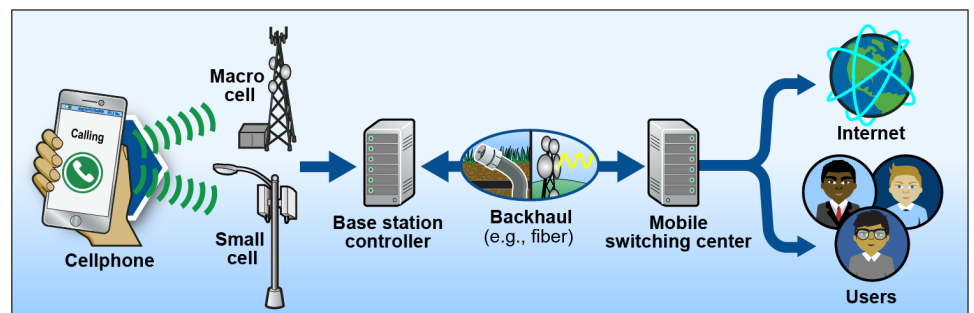
Source: GAO. | GAO-23-105626

Note: “Fixed wireless” refers to a technology that provides broadband via wireless signals that are directed to a single, static location, such as a home, and does not provide connectivity to other locations.

### Mobile Broadband Service

A second way consumers can receive broadband is through mobile technologies, which provide internet access wherever a customer has access to a signal. Mobile broadband service connects consumers to wireless networks through a mobile device, such as a smartphone. These networks include several components, which may include tower-mounted “macro cells” or smaller wireless infrastructure, known as “small cells,” which can be installed on existing structures like light poles (see fig. 3).

Figure 3: General Overview of Mobile Network Components



Source: GAO. | GAO-23-105626

For more information contact Andrew Von Ah at (202) 512-2834 or [vonaha@gao.gov](mailto:vonaha@gao.gov)

## Required Members of the Telecommunications Interagency Working Group

### Federal Agencies

- Department of Education
- National Telecommunications and Information Administration
- Federal Communications Commission
- Occupational Safety and Health Administration

### Nonfederal Entities

- a registered apprenticeship program in construction or maintenance
- a telecommunications industry association
- an Indian Tribe or Tribal organization
- a rural telecommunications carrier
- a telecommunications contractor firm
- an institution of higher education described in 20 U.S.C. § 1067q(a) (historically Black colleges and universities and other minority-serving institutions)
- a public interest advocate for tower climber safety
- a labor organization representing the telecommunications workforce

For more information contact Andrew Von Ah at (202) 512-2834 or [vonaha@gao.gov](mailto:vonaha@gao.gov)

The occupations necessary to deploy mobile networks include tower erectors and tower climbers, as well as those occupations mentioned in the sidebar above for fixed broadband. The installation of fiber remains a critical component of deploying mobile networks given that the towers themselves are often connected to fiber networks.

## Examples of Federal Efforts Related to the Telecommunications Workforce

The Department of Labor, through its Employment and Training Administration, helps to support occupational training programs throughout the United States, including for broadband infrastructure deployment. Examples of these programs include:

- The Office of Job Corps provides career technical training, career counseling, and job placement services at 121 centers located across the United States to about 30,000 members of the emerging workforce. For example, five of these Jobs Corps Centers offer training in network cable installation and repair, which are skills necessary for deploying and maintaining broadband infrastructure.
- The Office of Apprenticeship is involved in the Department of Labor's oversight of the Telecommunications Industry Registered Apprenticeship Program (TIRAP). TIRAP provides partnered telecommunications companies with the resources to provide employees with on-the-job training, classroom training, mentoring, and—upon completion—a nationally recognized credential.

As required by the IIJA, FCC, in partnership with the Department of Labor, established the Telecommunications Interagency Working Group.<sup>10</sup> The working group is charged with developing recommendations to address the workforce needs of the telecommunications industry, including the safety of that workforce. The working group is required to submit a report containing its recommendations to FCC, the Department of Labor, and certain congressional committees no later than January 2023. As required by statute, this working group is to include representatives of federal agencies and nonfederal entities, as articulated in the sidebar.

<sup>10</sup>IIJA § 60602. Federal Communications Commission, *FCC Announces Establishment and Membership of the Telecommunications Interagency Working Group*, (Washington, D.C.: Jan. 14, 2022).

## Travel Trends in Broadband Infrastructure Deployment Workforce

Stakeholders had mixed opinions about the extent to which the existing broadband infrastructure deployment workforce tends to travel for work. For example:

- One stakeholder told us that no more than about 10 percent of the broadband infrastructure deployment workforce ever travels more than 100 miles away from their home for work.
- Alternatively, a union told us that the broadband infrastructure deployment workforce travels often, especially due to the industry's shift toward travel-prone contract workers. To the extent the workforce is more inclined to travel, fewer workers may be needed to complete deploying broadband infrastructure to all Americans if these deployments are scheduled non-concurrently.

For more information contact Andrew Von Ah at (202) 512-2834 or [vonaha@gao.gov](mailto:vonaha@gao.gov)

## Thousands of Additional Skilled Telecommunications Workers Will Be Needed to Deploy Broadband and 5G Infrastructure Funded Through Selected Federal Programs

### Current Telecommunications Workforce

According to BLS's Current Employment Statistics data as of January 2022, there were an estimated 477,700 workers in the fixed broadband workforce, and 88,600 in the mobile broadband workforce. Where these workers are located in the U.S. is largely unknown, and a portion of this workforce travels to broadband deployment project sites.<sup>11</sup>

Our analysis of BLS data indicated that two of our selected occupations—(1) radio and telecommunications equipment installers and repairers and (2) telecommunications line installers and repairers—had the most telecommunications workers in 2021 out of our selected occupations.<sup>12</sup>

### Additional Skilled Telecommunications Workers Needed

We estimate that in addition to the workforce described above, thousands of skilled workers will be needed to deploy broadband and 5G infrastructure funded by the eight federal programs we selected. The number of additional workers needed varies based on when federal funds from our selected programs are provided to and used by recipients. The number also varies based on assumptions we made.<sup>13</sup>

Our analysis indicates that if funds from programs without funding timetables are provided over 10 years, at its peak in 2023 the funding would support about 23,000 additional workers. The additional number of workers supported would decline due to the impact of inflation to about 9,000 workers by 2031 (see fig. 4). Funding also declines over time because several programs' funds have expenditure deadlines before 2032.

<sup>11</sup>BLS data used in this analysis does not provide information to generate reliable estimates for smaller geographic areas.

<sup>12</sup>BLS data is not reliable for the purpose of analyzing the number of workers in the remaining eight selected occupations. BLS data also does not provide information on a per-industry basis regarding numbers of contracted workers.

<sup>13</sup>For example, we assumed that 90 percent fixed and 10 percent wireless broadband infrastructure will be deployed. Due to the higher labor productivity in the wireless sector, a higher percentage of funding used for wireless technologies would result in a lower estimate of total required workers.

## Eight Selected Programs That Fund Broadband Infrastructure Deployment

### Federal Communications Commission

- Rural Digital Opportunity Fund

### National Telecommunications and Information Administration

- Broadband Equity, Access and Deployment Program
- Broadband Infrastructure Program
- Enabling Middle Mile Grants Program
- Tribal Broadband Connectivity Program

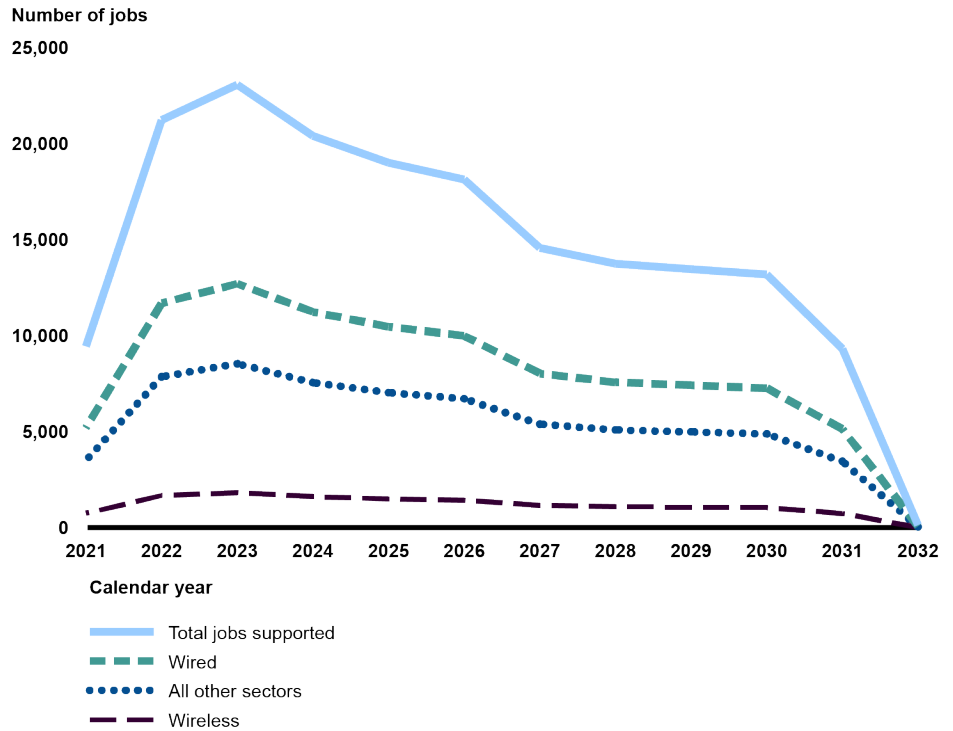
### Department of the Treasury

- Capital Projects Fund

### Department of Agriculture

- Rural Broadband Program
- ReConnect Program

**Figure 4: Estimated Number of Additional Telecommunications Workers Supported by Selected Federal Broadband Infrastructure Deployment Programs per Year Assuming 10-Year Funding Timetables**



Source: GAO analysis of Bureau of Labor Statistics data. | GAO-23-105626

Note: At the time of our review, not all programs had set timetables for providing funds, and in these cases we assumed that the program's total funding would be disbursed in equal increments over a 10-year timeframe.

## Workers Needed to Maintain Broadband Infrastructure

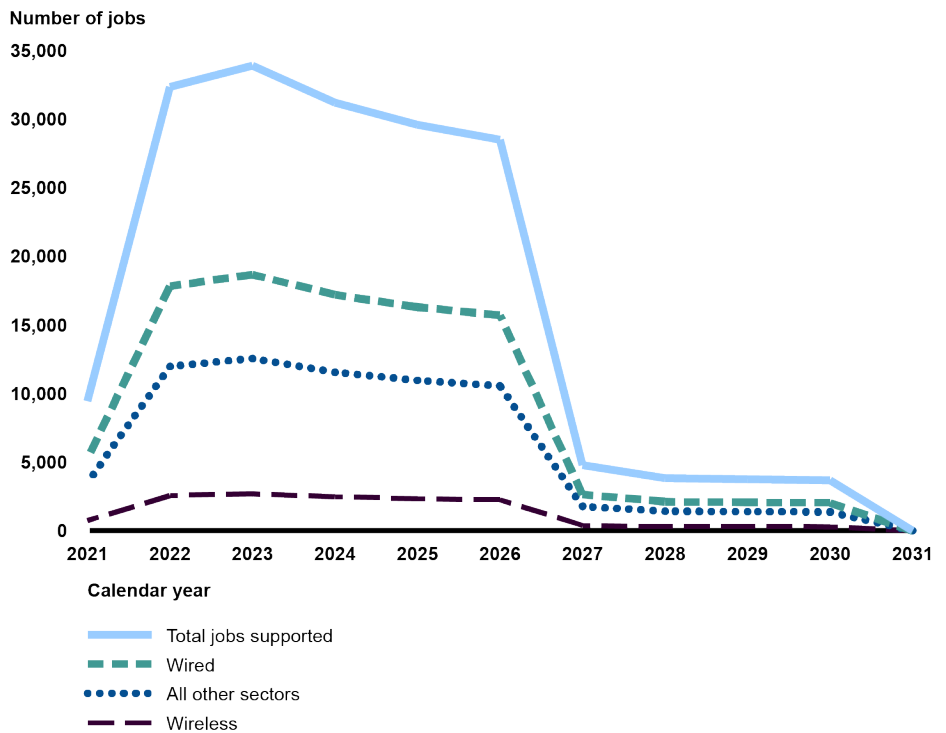
We could not make estimates of the workforce needed to maintain fixed broadband and 5G networks once deployed. However, the stakeholders we interviewed agreed that it will be considerably fewer than needed for initial deployment.

One stakeholder specified that the number of workers needed for maintenance would vary based on the amount of fiber in the network. In particular, this stakeholder told us that a network with more fiber needs more workers for installation, and fewer workers for maintenance.

If funds for programs without funding timetables were provided to recipients over shorter timeframes, more workers would be needed per year since more construction efforts would be funded in those shorter time spans. For example:

- With a 5-year funding time period for those programs with uncertain funding timetables, we found that about 34,000 additional workers would be needed in the peak year, which is estimated to be 2023 (see fig. 5).

**Figure 5: Estimated Number of Additional Telecommunications Workers Supported by Selected Federal Broadband Infrastructure Deployment Programs per Year Assuming 5-Year Funding Timetables**



Source: GAO analysis of Bureau of Labor Statistics data. | GAO-23-105626

Note: At the time of our review, not all programs had set timetables for providing funds, and in these cases we assumed that the program's total funding would be disbursed in equal increments over a 5-year timeframe.

## Description of Key Labor Market Indicators and How They Signal Potential Labor Shortages

**Unemployment rate:** the number of unemployed people as a percentage of the labor force. Unemployment rates indicate the availability of potential workers. If a labor shortage were to exist, one would expect a low unemployment rate signaling limited availability of workers in a profession.

**Employment level:** the number of people holding jobs in an occupation. If a labor shortage were to exist, one would expect increases in the employment level due to increased demand for that occupation.

**Wage growth rate:** the rise of median weekly wages (or earnings) for full time workers in a particular occupation adjusted for inflation. If a labor shortage were to exist, one would expect increases in wages as companies try to draw more people into the occupation.

## Indicators Are Mixed Regarding a Labor Shortage for Telecommunications Workers, but Stakeholders Cited Various Workforce Concerns

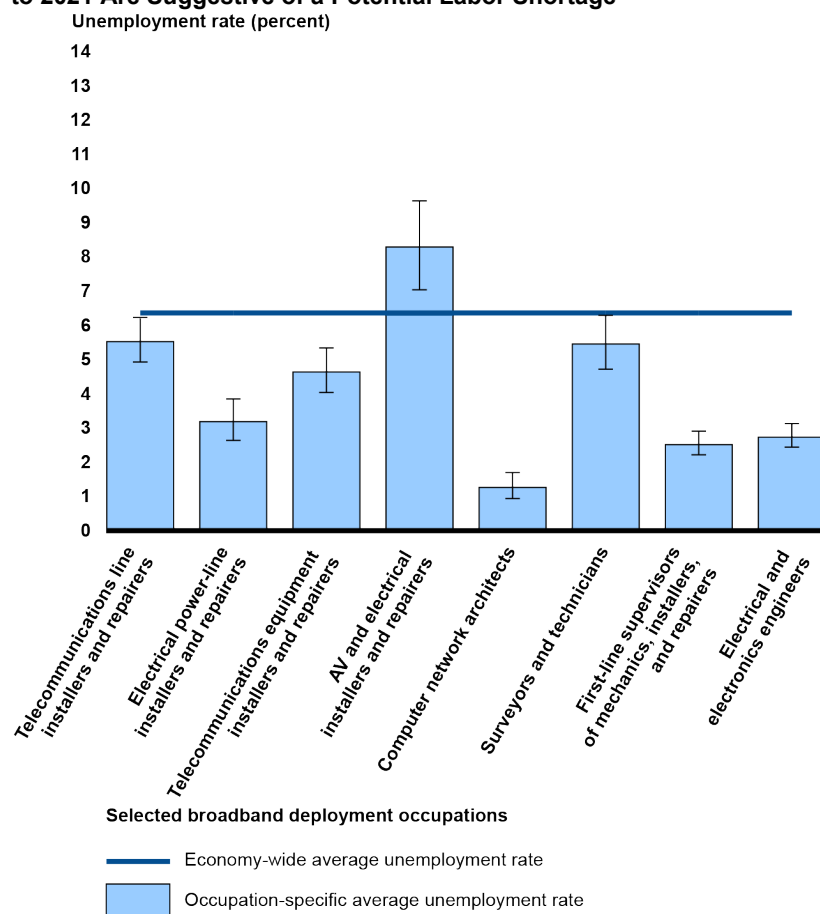
### Data Do Not Consistently Indicate the Presence of a Labor Shortage for Selected Broadband Deployment Occupations

Our analysis of three key labor market indicators developed from BLS Current Population Survey data for 2010 to 2021 provided mixed evidence regarding a possible labor shortage for telecommunications workers.

#### Unemployment Rate

Our analysis indicates that, for seven of the eight key broadband deployment occupations we selected, unemployment rates were below the national average, as shown in figure 6). Unemployment rates below the national average are suggestive of a labor shortage.

**Figure 6: Unemployment Rates for Broadband Deployment Occupations over 2010 to 2021 Are Suggestive of a Potential Labor Shortage**



Source: GAO analysis of IPUMS Current Population Survey data files. | GAO-23-105626

For more information contact Andrew Von Ah at (202) 512-2834 or [vonaha@gao.gov](mailto:vonaha@gao.gov)

Note: This figure combines “Audiovisual Equipment Installers and Repairers” and “Electrical and Electronics Repairers, Industrial and Utility” into “AV and Electrical Installers and Repairers,” and also combines “Surveyors, Cartographers, and Photogrammetrists” and “Surveying and Mapping Technicians” into “Surveyors and Technicians” because we determined available occupation-specific data for these occupations alone to be unreliable unless combined with other similar occupations. The estimated margins of error at the 95 percent confidence level are illustrated by error bars.



## Limitations of Indicator Analysis

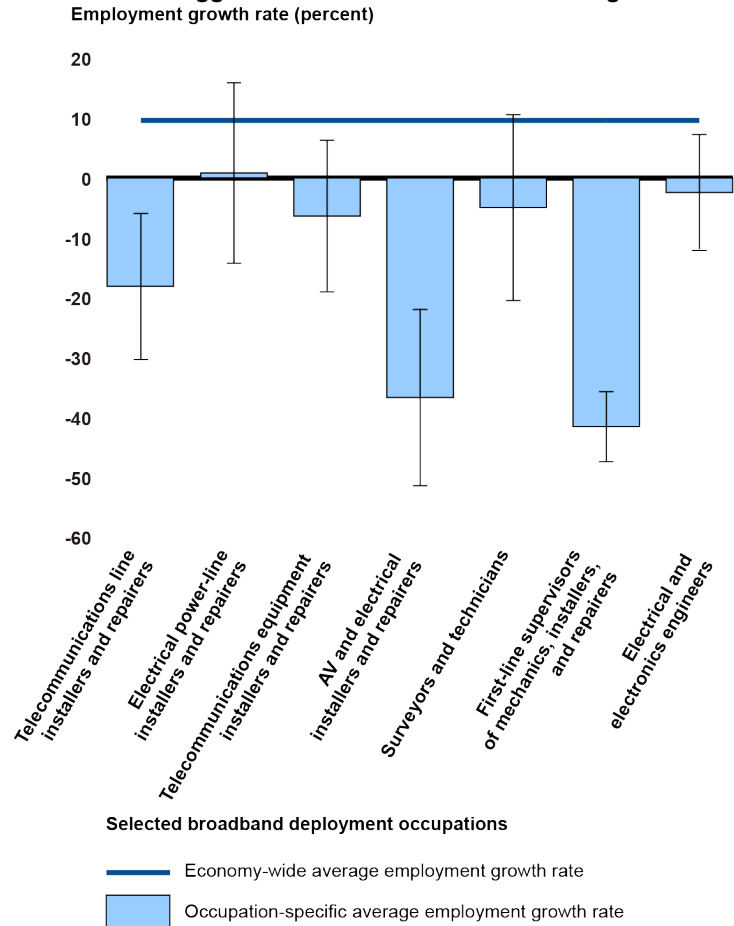
Our analysis of BLS’s labor market data has limitations given the nature of BLS data and the scope of our analysis. These limitations include:

- The data are collected at a national level; our analysis could not identify any regional labor market indicators.
- Some occupations may have an insufficient sample size to generate reliable estimates. and could not be reported separately but were combined with similar occupations
- BLS data are subject to sampling and response errors. Typically, one individual will identify occupation, employment, and wage data for all household members; individuals may report incorrect or inconsistent information.

## Employment Level

Generally, increasing employment levels may be suggestive of a labor shortage. However, according to our analysis of BLS data, for the seven key broadband deployment occupations we were able to examine, there were no observable increases in the employment levels relative to the national average from 2010 to 2021 (see fig. 7).

**Figure 7: Employment Levels for Broadband Deployment Occupations over 2010 to 2021 Are Not Suggestive of a Potential Labor Shortage**



Source: GAO analysis of IPUMS Current Population Survey data files. | GAO-23-105626

Note: This figure combines “Audiovisual Equipment Installers and Repairers” and “Electrical and Electronics Repairers, Industrial and Utility” into “AV and Electrical Installers and Repairers,” and also combines “Surveyors, Cartographers, and Photogrammetrists” and “Surveying and Mapping Technicians” into “Surveyors and Technicians” because we determined available occupation-specific data for these occupations alone to be unreliable unless combined with other similar occupations. This figure omits “Computer Network Architects” because we determined available occupation-specific data for this occupation to be unreliable for this calculation. The estimated margins of error at the 95 percent confidence level are illustrated by error bars.

## Wage Growth Rate

Earnings that increase faster in an occupation as compared to other occupations suggest employers are trying to draw more people into the profession. Our analysis of BLS data from 2010 to 2021 showed that for the five key broadband deployment occupations we were able to examine, median wage growth—as measured by the change in inflation-adjusted median weekly earnings for full-time workers—was not significantly above the wage growth in the overall economy (see fig. 8).

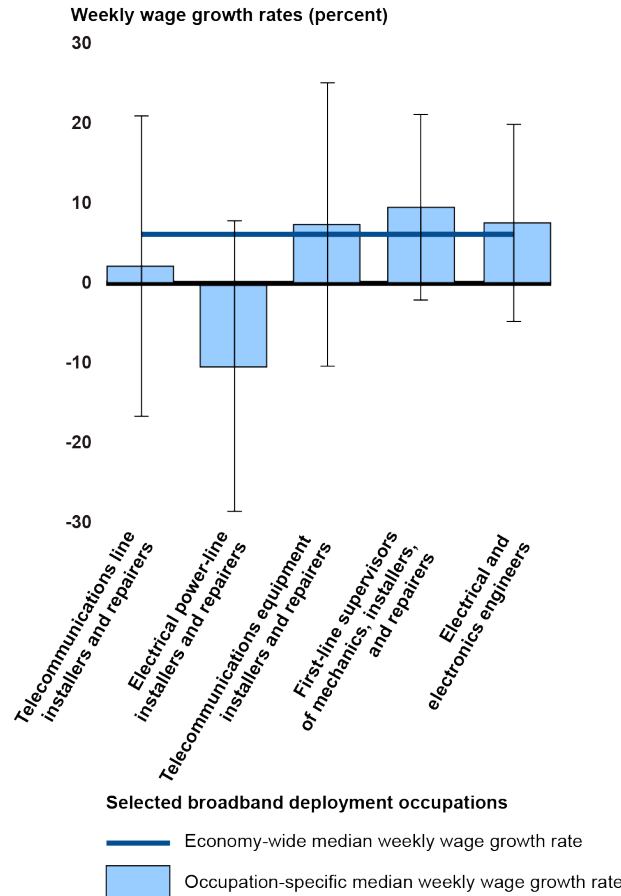
For more information contact Andrew Von Ah at (202) 512-2834 or [vonaha@gao.gov](mailto:vonaha@gao.gov)

## Selected Broadband Deployment-Related Occupations

The following are the BLS-derived occupations used in our analysis of labor market indicators:

- AV and Electrical Installers and Repairers (this occupation combines the following occupations: “Audiovisual Equipment Installers and Repairers” and “Electrical and Electronics Repairers, Industrial and Utility”)
- Computer Network Architects
- Electrical Power-Line Installers and Repairers
- Electronical and Electronics Engineers
- First-Line Supervisors of Mechanics, Installers, and Repairers
- Surveyors and Technicians (this occupation combines the following occupations: “Surveyors, Cartographers, and Photogrammetrists” and “Surveying and Mapping Technicians”)
- Telecommunications Equipment Installers and Repairers
- Telecommunications Line Installers and Repairers

**Figure 8: Wage Growth Rates for Broadband Deployment Occupations over 2010 to 2021 Are Not Suggestive of a Potential Labor Shortage**



Source: GAO analysis of IPUMS Current Population Survey data files. | GAO-23-105626

Note: This figure omits “Audiovisual Equipment Installers and Repairers,” “Computer Network Architects,” “Electrical and Electronics Repairers, Industrial and Utility,” “Surveying and Mapping Technicians,” and “Surveyors, Cartographers, and Photogrammetrists” because we determined available occupation-specific data for these occupations to be unreliable for this calculation. The estimated margins of error at the 95 percent confidence level are illustrated by error bars.

## Other Rural Concerns

Two stakeholders we interviewed mentioned factors that negatively affected broadband infrastructure deployment in rural areas. These factors are (1) low population density, which limits potential profits for the private-sector companies providing service and (2) geographical barriers (such as challenging terrain), which make it costly to deploy fiber or other fixed technologies.

## Supply Chain Issues

Several industry stakeholders told us supply chain issues exist, and may affect broadband deployment workforce needs. For instance, one stakeholder told us supply chain-driven delays exist for everything from raw materials to the actual fiber needed for deployment. Such delays affect the speed with which service can be deployed, a factor that introduces uncertainty about the number and timing of workers needed.

## Stakeholders Cited Various Uncertainties about the Future Sufficiency of the Telecommunications Workforce

Stakeholders we spoke with expressed various concerns about the ability of the broadband infrastructure deployment industry to attract sufficient numbers of workers that our analysis indicates will likely be needed. These concerns included uncertainties regarding (1) workforce needs in rural areas, (2) competition from other industries, and the (3) supply of new employees into broadband deployment-related occupations.

### Workforce Needs in Rural Areas

A stakeholder said it may be difficult acquiring skilled broadband deployment workers in rural areas given their lower population density and remoteness. Bringing workers into these rural areas may be difficult because one association estimated that 10 to 15 percent of telecommunications workers ever travel beyond 200 miles from their homes for work.

Rural areas that can receive broadband through fixed wireless services will require fewer workers for deployment given wireless workers' higher labor productivity. However, some stakeholders said that wireless options may run into difficulties in some rural areas given that they rely on line-of-sight between the providers' towers and the consumers' receivers. In some rural areas, trees and mountains can interfere with the signal's quality and often make this technology, according to these stakeholders, not reliable.

### Competition from Other Industries

Stakeholders expressed concern that the considerable amount of federal funding available for infrastructure projects other than broadband provided over the next several years will cause competition for workers who could work on any type of infrastructure project. For example, legislation that provides funding for other infrastructure-related projects, such as highway construction, may cause competition for limited construction crews.<sup>14</sup>

### Supply of New Employees to Broadband Occupations

An industry association we spoke with told us that the current telecommunications workforce is aging, and that retirements are currently straining the workforce. Adding to this strain, a stakeholder said that fully training telecommunications workers can take up to a year; a retired worker therefore cannot necessarily be quickly replaced. Other stakeholders told us that there are relatively few new employees entering into broadband deployment-related occupations. Stakeholders pointed to a few potential causes. One stakeholder said that there is insufficient advertising of the benefits of a career in broadband infrastructure deployment. Another stakeholder said that there is a trend away from jobs that require travel or construction-related work, especially among younger workers.

<sup>14</sup>See, e.g., IJA § 11101(a)(1).

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## Strategic Planning and External Liaison

Stephen J. Sanford, Managing Director, [spel@gao.gov](mailto:spel@gao.gov), (202) 512-4707  
U.S. Government Accountability Office, 441 G Street NW, Room 7814,  
Washington, DC 20548

