

# The Economic Benefits and Impacts of Expanded Infrastructure Investment

The Council of Economic Advisers  
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# Executive Summary

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In this paper, CEA investigates the likely impacts from a comprehensive public infrastructure program. The program includes a 10-year, \$1.5 trillion program of infrastructure investment as well as new administrative and regulatory policies intended to increase efficiency and speed delivery of infrastructure projects. CEA assesses the likely impacts of the program across three key domains: GDP growth, time needed for project completion, and labor market opportunities for infrastructure workers.

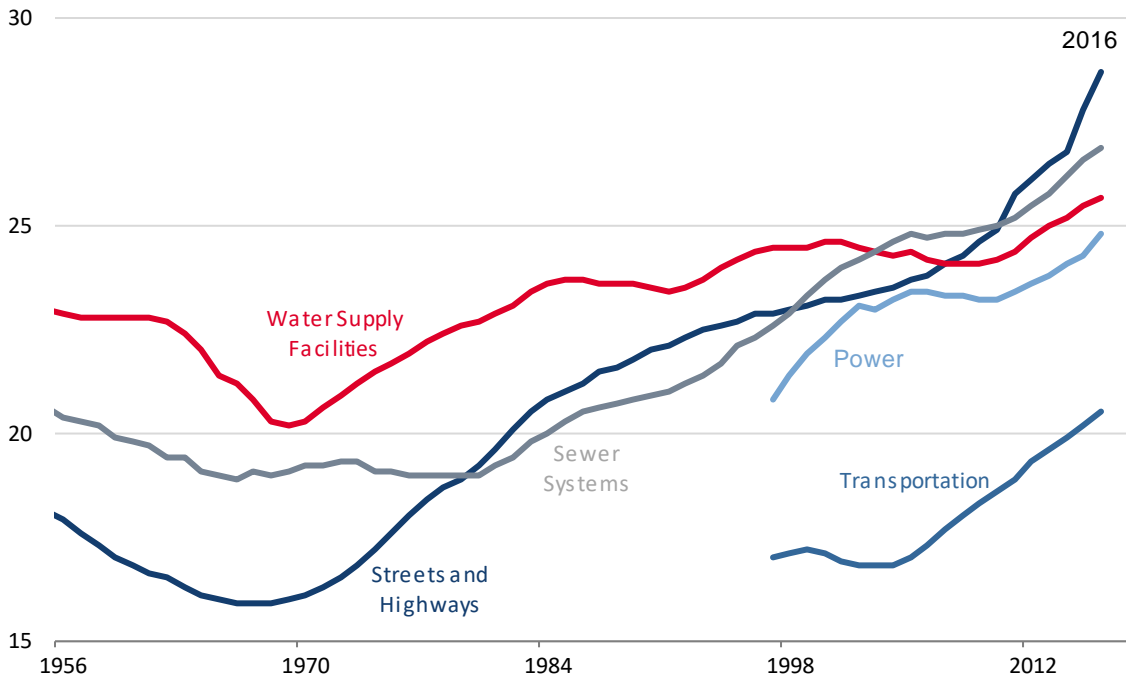
- CEA estimates that a 10-year, \$1.5 trillion program of infrastructure investment could add between 0.1 and 0.2 percentage point to average annual real growth in gross domestic product (GDP). We further argue that getting the greatest possible impact from the program will require using our existing assets more efficiently, for example by using congestion pricing to allocate scarce capacity to its best uses.
- CEA notes that the average time needed to complete final Environmental Impact Statements (EIS) reached 5.1 years for EIS completed in 2016, up from 4.7 years from two years earlier. CEA also finds that the average time needed to approve pipeline permit applications submitted to the Federal Energy Regulatory Commission (FERC) has risen over time and estimates that the median days needed for approval of pipeline project applications submitted in 2015 was 472 days. Speeding up the time needed to complete infrastructure projects is valuable because it accelerates the receipt of project benefits. CEA notes that the full Federal environmental and permitting process includes many components, of which compliance with the National Environmental Policy Act (NEPA) is only one element. Contingent on the projected impacts of a project, both the lead Federal agency and other agencies may have to issue permits to satisfy Federal laws, and each of those determinations would also be subject to a NEPA determination by that agency. Overall, the entire process can include many studies and procedures that occur prior to the initiation of one agency's NEPA process and continue after that agency's NEPA process has concluded.
- Expanded infrastructure investment would also have direct implications for American workers. The President's plan would likely result in the employment of 290,000 to 414,000 additional infrastructure workers, on average, over a 10-year window, although these employment gains may be offset by losses elsewhere in the economy. Infrastructure jobs are particularly lucrative for, and disproportionately employ, workers with a high school degree or less. Infrastructure workers with a high school degree or less earn 14 percent more in median hourly wages than non-infrastructure

occupations, while a subset of these workers, in skilled trades, obtain an even higher median hourly earnings premium of 32 percent.

# Introduction

America’s infrastructure needs an upgrade. In 2017, the American Society of Civil Engineers (ASCE) gave the nation a grade of D+ in its most recent infrastructure report card, little changed from previous years, and put a \$4.6 trillion price tag on the investments that would be required between 2016 and 2025 to bring the nation’s infrastructure assets to a state of good repair across many sectors, including surface transportation, aviation, water utilities and water resource management, and energy. Furthermore, the ASCE estimates that over the same 10 years, there will be an infrastructure funding gap of nearly \$2.1 trillion, which will be significantly reduced by the current infrastructure plan put forth by the Administration. Without continued investment and maintenance, America’s infrastructure will continue to age (Figure 1), deteriorate in quality and capacity, and gradually contribute less to American output.

**Figure 1. Average Age of Public Structures, 1956–2016**  
(Age, Years)



Source: Bureau of Economic Analysis.

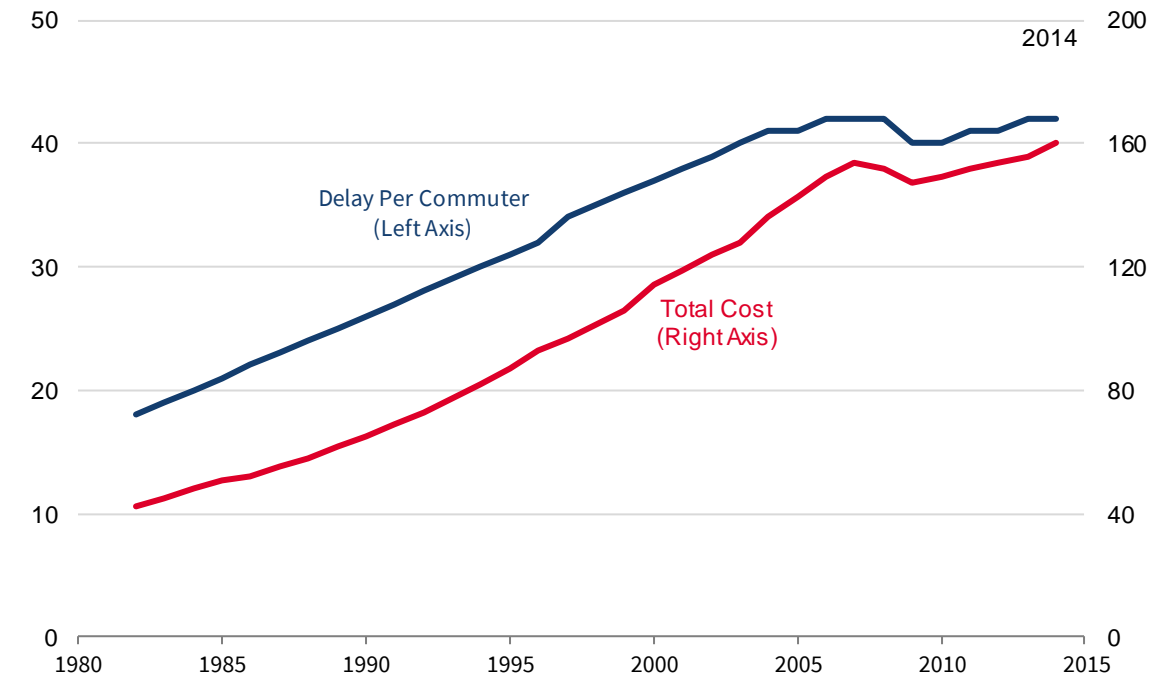
Note: Water supply facilities and sewer systems exclude Federal structures—which account for at most 6 percent of the value of their combined capital stock—because disaggregated Federal data are unavailable. Data for power and transportation fixed assets begin in 1997 because disaggregated data are unavailable for years prior to 1997. Transportation includes railroad transportation, local and interurban passenger transit, trucking and warehousing, water transportation, transportation by air, pipelines, excluding natural gas, and transportation services.

Our Nation's infrastructure—its roads, bridges, waterways, energy facilities, telecommunications networks, and other public assets—support our economic activity, trade, and commerce both domestically and abroad. However, recent decades have seen sustained growth in the demand for infrastructure services that has not been met with corresponding growth in and maintenance of their supply. Because infrastructure is not allocated through a price system but through public investments, increased demand does not raise prices or give signals about the value of increased supply. Because of this lack of supply response, we systematically experience excess demand, overuse, and congestion—as, for example, on many of our urban roads and highways. We allocate our existing infrastructure inefficiently, do not properly maintain existing assets or invest to add needed capacity, and instead often experience rising levels of congestion, delay, and quality degradation. In a nutshell, our infrastructure assets, owned and funded by a complex mixture of Federal, State, and local public entities as well as private sector stakeholders, are being used far beyond their intended capacities and useful lives.

Congestion, crowding, and delays are evident on our roads (Figure 2A) and waterways (Figure 2B). The average annual congestion delay per auto commuter in the nation's 471 urban areas reached 42 hours in 2014 (TTI 2015). After placing a monetary value on lost time and wasted fuel costs, the Texas A&M Transportation Institute estimates that urban congestion costs totaled \$160 billion in 2014, equivalent to almost a full point (0.9 percent) of gross domestic product (GDP) in that year and far higher than the value measured 15 years prior. Similarly, average delays at locks along the nation's inland waterways system (IWS) have crept up from under 1 hour per tow in 2009 to nearly 2.5 hours in 2016, despite a 9.2 percent decline in the number of vessels served during this period.

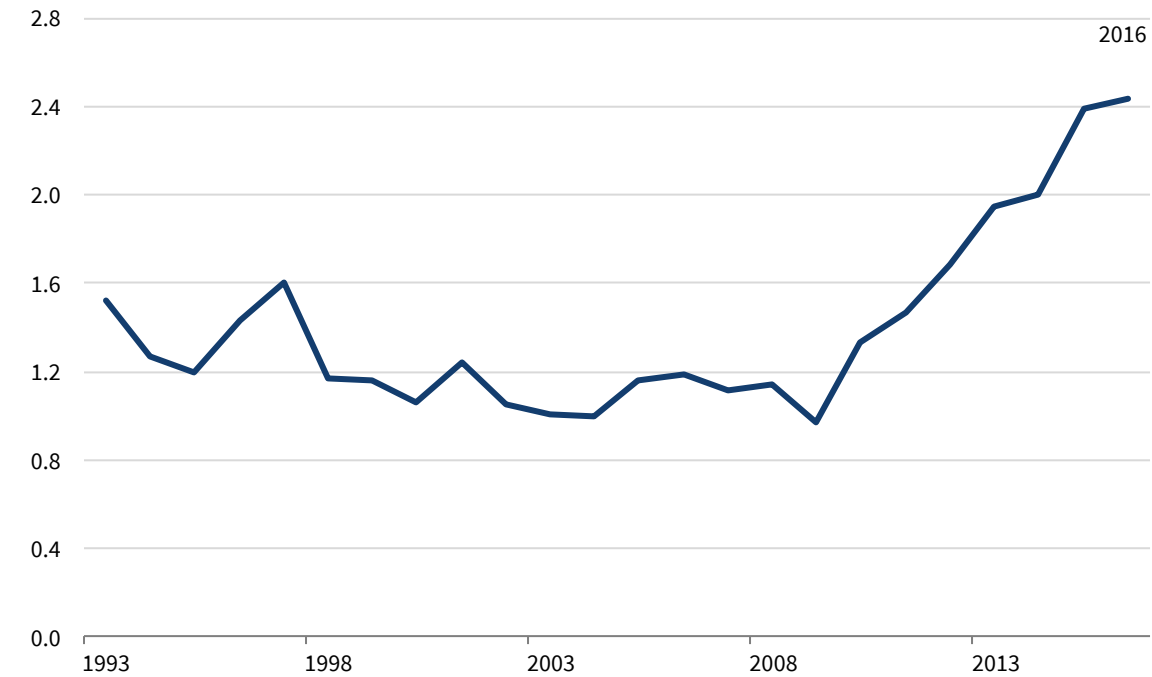
Excess demand and service quality problems are not confined to the transportation sector. In the water and wastewater sector, the U.S. Environmental Protection Agency (EPA) estimates that \$655 billion is needed over the course of 20 years to upgrade and replace infrastructure in the water and wastewater sectors (EPA 2016). The \$271 billion wastewater collection and treatment facilities investment (EPA 2012), alongside a \$384 billion drinking water investment (EPA 2013), would reduce the risk of water loss from water main breaks and raw sewage discharges into local water supplies, and improve overall water quality. Recent research (Allaire, Wu, and Lall 2018) indicates that 9 percent of community water systems serving nearly 21 million people violated health-based water quality standards in 2015, with violation incidence higher in rural areas than in urbanized areas.

**Figure 2A. Congestion Delay per Urban Commuter and Costs, 1982–2014**  
 (Hours) (Billions of 2014 U.S. Dollars)



Source: Texas A&M Transportation Institute.

**Figure 2B. Average Delay at Locks along the Inland Waterway System, 1993–2016**  
 (Hours)



Source: United States Army Corps of Engineers, Public Lock Usage Report.

Upgrading our infrastructure and adding needed capacity can deliver meaningful improvements in overall welfare. Reducing traffic congestion may raise productivity and increase opportunities for leisure time, and improving water quality can deliver public health benefits. The benefits from having more and higher quality infrastructure include what is paid for that infrastructure as well as its value above and beyond those payments, or consumer surplus. Further, “spillover” benefits may accrue to nonusers, and those represent potential gains in social welfare as well. For example, a highway interchange project may lower travel times along an entire travel corridor, not just on individual segments.

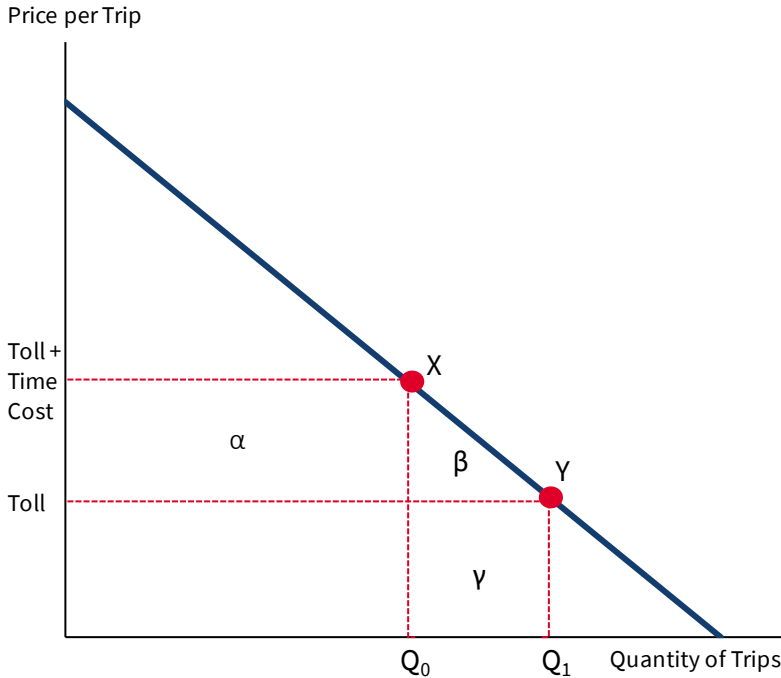
To illustrate some of these issues, consider Figure 3 below, which depicts the demand for motor vehicle trips along a certain toll road. Trip price includes the toll plus the value of time spent making the trip. Drivers choose to make  $Q_0$  trips, given initial values for the toll and the time needed to drive the segment; this corresponds to point X on the demand schedule. Now consider the value of some unspecified infrastructure improvement or expansion that decreases the time needed to make the trip, and hence decreases the time cost facing motorists. For simplicity, we assume that the time needed to travel drops to 0. Motorists will respond to the decrease in total price per trip by increasing the number of trips made on the toll road, from  $Q_0$  to  $Q_1$ , corresponding to point Y. Motorists experience gains in consumer surplus of  $\alpha + \beta$ , where the first term,  $\alpha$ , represents the increase in consumer surplus experienced by motorists who previously chose to drive on that road segment (because they now spend less time making their original number of trips), and the second term,  $\beta$ , represents the consumer surplus experienced by motorists who now take additional trips on the road. Toll revenues rise by  $\gamma$ , as more trips are now taken along the road. Thus, overall surplus, or social welfare, has risen by  $\alpha + \beta + \gamma$ , but any market-based measure, such as GDP, would include only  $\gamma$ , the value of additional toll revenues.

This example illustrates the limitations of using transactions-based measures to trace the effects of infrastructure investments. In the current example, area  $\gamma$  understates the true welfare improvements coming from the project because it excludes consumer surplus experienced by motorists.

Furthermore, while assessing benefits may be relatively straightforward for a specific asset or project such as a toll road, doing so for an overall infrastructure investment program as a whole is more difficult. Thus, economists often consider the relationship between infrastructure and productivity or output, commonly measured by GDP. GDP’s limitations as a measure of economic progress or well-being have been discussed at length elsewhere, and we simply note here that GDP captures market transactions only, excludes household-based activities, and fails to account for unpriced positive or negative externalities or for environmental degradation. Despite its limitations as a measure of overall economic welfare or progress, GDP offers a meaningful measure of an economy’s productive activities, and economists have long

studied the relationship between many varieties of policies—fiscal, monetary, regulatory, social—and GDP growth.

**Figure 3. Demand for Toll-Road Trips**



Source: Council of Economic Advisers.

In the rest of this paper, we analyze and, where possible, provide empirical estimates of the impacts of comprehensive infrastructure program which includes a 10-year, \$1.5 trillion infrastructure investment as well as policy initiatives intended to streamline and accelerate infrastructure project delivery. We consider the program’s impact in three domains: GDP growth, length of time needed to complete projects, and labor markets.

The rest of this paper is organized as follows. Section 1 reviews recent trends in infrastructure investment spending and capital accumulation, summarizes the evidence for the links between infrastructure, productivity, and growth, and provides estimated impacts on GDP growth. Section 2 reviews evidence on time needed to conduct environmental reviews and to issue needed permits by selected Federal agencies. Sections 3, 4, and 5 explore the program’s impacts on employment and wages while discussing potential impediments to infrastructure employment, such as occupational licensing requirements. Section 6 concludes.



# 1. Infrastructure, Productivity, and Growth

## *A. How Public Sector Capital Affects Productivity and GDP Growth*

An increased stock of public sector capital would mean increased flows of capital services available to the economy’s workers, fueling GDP growth through at least two channels.<sup>1</sup> First, by raising the productivity of other factors of production (labor, private capital, and land), increased public capital services encourage firms to increase their own investments and expand economic activity. This indirect, or “crowding in,” effect has been identified in numerous studies (e.g., Aschauer 1989; Abiad et al. 2016). A second, direct effect works through increases in public capital services per employee hour, or public capital deepening, which typically accounts for between 0.05 and 0.20 percentage point of growth in labor productivity—not nearly as large as the impact of private sector capital accumulation, but nonetheless important.<sup>2</sup> Since 2007, public capital deepening has accounted for 0.15 percentage point of the 1.2 percent growth in labor productivity (Figure 4). Although higher than the measured values between 1973 and 2007, the contribution of public capital after 2007 is lower than the measure from years prior to 1973.

Increasing infrastructure investment can generate additional economic output, but the quantitative relationship will depend on many factors, including the responsiveness of output to increases in public capital (the elasticity of output with respect to public sector capital), the economy’s initial level of capital intensity, depreciation rates, how quickly assets can be installed and brought into productive service, and even how the investments are financed. Estimates of the marginal product of public sector capital vary. CBO (2016) estimates the real marginal product at about 8 percent, while in 2016, CEA’s estimate was about 14 percent (CEA 2016a). Our updated preferred estimate is 12.9 percent, based on Bom and Ligthart’s (2014) output elasticity estimate of 0.083 and current levels of public sector capital intensity (the ratio

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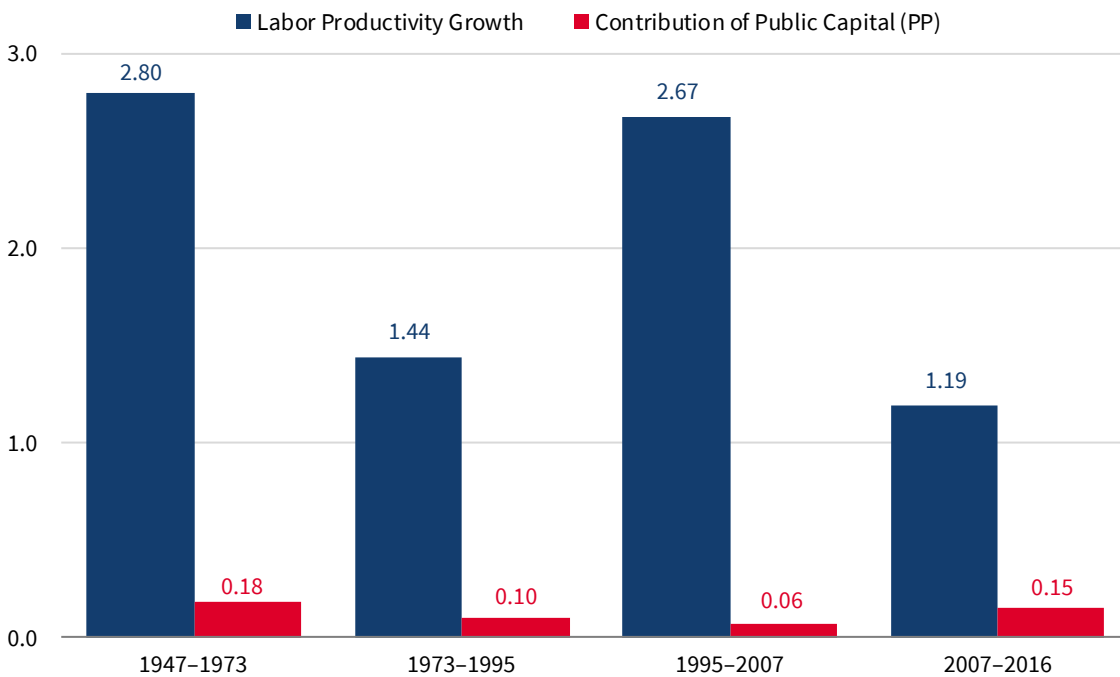
<sup>1</sup> In this analysis, we use the terms “infrastructure” and “public sector capital stock” interchangeably. In fact, a sizeable share of infrastructure in the energy and communications sectors is privately owned. The research findings referenced below focus on publicly owned capital stock, but, where appropriate, CEA applies those findings to privately owned infrastructure assets as well.

<sup>2</sup> Recall that labor productivity growth comes from growth in capital deepening, or the amount of private capital services per labor input; growth in the skills of workers—often called a labor composition effect—and increased overall efficiency, calculated as a residual and called total factor productivity. Historically, in the United States, capital deepening has driven a significant share of labor productivity growth, though with a marked slowdown in the post–Great Recession period. From 1953 to 2010, capital deepening accounted for more than 0.9 percentage point of that era’s 2.2 percent labor productivity growth, but actually detracted from productivity growth from 2010 to 2015.

of nondefense public fixed assets to annual nominal GDP was .645 in 2016; hence the estimated marginal product is  $100 \times (.083/.645)=12.9$  percent).<sup>3</sup>

### Figure 4. The Contribution of Public Capital to Productivity Growth, 1947–2016

(Percentage Points)



Sources: Bureau of Economic Analysis; Bureau of Labor Statistics; CEA calculations.

Applying CBO’s more conservative estimate of 8 percent, \$100 billion in new public capital stock would raise the level of annual GDP by \$8.0 billion, while under CEA’s 12.9 percent preferred estimate, the GDP increase would be \$12.9 billion, or about 0.07 percent of GDP. This additional capital stock would continue to generate additional GDP over time, though at a decreasing rate because of depreciation of the installed public capital assets.

These calculations convert the stock of public sector capital, not annual infrastructure spending, into estimated increases in output. The complete timeline and output implications of increased infrastructure spending will depend on the timing of conceiving and constructing infrastructure assets and bringing those assets into productive service, as well as the method of financing the program and the depreciation rate of installed assets. Furthermore, an increase in investment funds from the Federal government could lead to reductions in resources provided by states and local governments if Federal money serves to crowd out nonfederal support.

<sup>3</sup>Mathematically, the output elasticity equals the (marginal product of public capital) x (public sector capital intensity), or  $\epsilon = (dQ/dK)(K/Q)$ ; therefore, dividing both sides by the capital intensity yields  $(dQ/dK) = \epsilon / ((K/Q))$ .

## *B. Evaluating a Program of Sustained Additional Infrastructure Investment*

CEA has estimated the GDP impacts of a sustained \$1.5 trillion infrastructure program spread out over 10 years. Such a program would rely on Federal, State, and local government and private sector resources to support increased investment in infrastructure. CEA assumes that the full program would include \$200 billion in Federal resources, matched by \$1.3 trillion in nonfederal resources coming from States and localities and the private sector, bringing the 10-year total to \$1.5 trillion.<sup>4</sup> CEA uses a partial equilibrium model to estimate GDP impacts relative to baseline under a range of parameter assumptions and different timing paths for the infrastructure investments.<sup>5</sup> CEA's general approach was to use conservative parameter values to avoid overstating impacts throughout.

In the short run, additional infrastructure spending may affect GDP in the year in which the spending occurs, generating direct and possibly indirect (“multiplied”) effects on GDP. If the increased spending is offset by equivalent increases in taxes or declines in spending, then these short-run effects would likely be nil. However, to the extent that additional spending is financed via increased deficits and the economy is below full employment, the infrastructure spending here would represent net additions to government spending and could therefore generate direct short-term spending impacts, which could then be amplified or diminished by subsequent indirect impacts. In general, the sign and magnitude of these “fiscal multipliers” remains a topic of active research, and recent evidence suggests that spending multipliers exceed zero, meaning that the net impact of additional government spending is positive (Auerbach and Gorodnichenko 2012; Ramey and Zubairy 2017). Auerbach and Gorodnichenko find that these multipliers are larger during recessions, while Ramey and Zubairy find no evidence that multipliers are higher during periods of slack. Abiad et al. (2014, 2016) find that increased infrastructure spending, during recessions in particular, can raise GDP through demand-side multiplier relationships.

In the long run, public capital deepening raises labor productivity and real output, driven by the marginal product of public capital estimates discussed above. However, long-run impacts may be attenuated by several factors. If the additional infrastructure investment spending is financed purely by debt, then we may expect some “crowding out” to occur as interest rates

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<sup>4</sup>The assumed timing of the investments over the 10 year period is based on Table S-2 from President Trump's proposed FY 2019 budget (<https://www.whitehouse.gov/wp-content/uploads/2018/02/budget-fy2019.pdf>). Contributions from States and localities are assumed to be offset by tax or other revenue increases.

<sup>5</sup>In large part, CEA's analysis of the program is scalable, so that a larger or smaller program with a similar timing profile would be expected to generate proportionally larger or smaller impacts on GDP. However, a significant change in nonfederal resources may affect interest rates and crowding out, since States and localities typically rely more heavily on budget-neutral funding plans for infrastructure.

rise and some amount of private sector spending, particularly fixed investment spending, is curtailed.

Another potentially important factor affecting the output impacts of an infrastructure investment program is the response of States and local governments to an infusion of additional Federal funds for infrastructure investment. Such an increase could lead to reductions in resources provided by States and local governments if Federal money serves to crowd out nonfederal support. Note that even if the additional Federal funding takes the form of matching grants, this “crowding out” effect can still occur if grant recipients are already spending well in excess of their previously required matching funds. Under these circumstances, recipients treat the additional grant funding as a simple increase in income and may then choose to both increase overall spending on the target infrastructure assets and decrease their own resources directed to those investments. State and local governments’ responses to additional Federal spending matter, because they are critical partners with the Federal government, owning more than \$6 of public infrastructure for every \$1 of nondefense capital stock owned by the Federal government.

Empirical evidence for the sign and size of this state and local crowding out effect is mixed. The CBO estimates this crowding out effect at about one-third, implying that any sustained increase in Federal funding of infrastructure would be offset by sizable displacement of previous State and local government effort. In practice, the extent of displacement will be driven by the details of specific legislative and funding proposals and how States and local governments respond to the new programs and opportunities. However, the largest of the programs within the President’s Infrastructure Plan, the Incentives program, has potential to have minimal displacement effects. The program’s primary grant selection criterion is the amount of new non-Federal revenue raised by the applicant for infrastructure investment, providing a matching grant of up to 20 percent of such revenue.

Given these factors, we can estimate the long-run supply-side effects of a debt-financed, \$1.5 trillion investment program. The CEA’s analysis of several different models indicates that these supply-side effects would cumulatively add 0.2 to 0.4 percent to the level of real GDP over 10 years, depending on the marginal productivity of public capital. Further, depending on timing, the extent of possible crowding out or, conversely, multiplier effects, and the marginal product of public capital, CEA estimates the 10 year, \$1.5 trillion infrastructure investment program discussed above would add an average of 0.1 to 0.2 percentage point to annual growth in real GDP. If investment is front-loaded, there is no crowding out, the fiscal multiplier is consistent with Zandi (2012), and the marginal product of public capital is as reported in the 2016 Economic Report of the President (CEA 2016), we expect the average annual contribution to be at the upper end of that range. With crowding out, no multiplier, and assuming the CBO

estimate of the marginal product of public capital, we expect the contribution to growth instead to be closer to 0.1.

### *C. Using Existing Assets Efficiently*

CEA also notes that getting the greatest possible impact of an infrastructure investment program will depend on how we allocate our existing assets. When our existing roads, waterways, and airports are crowded, for example, using time-varying prices or tolls to govern access can increase efficiency and, in some cases, raise revenues needed to pay for operations and maintenance of these assets as well. Time-varying tolls would encourage only users with high valuations to use highly congested infrastructure assets during peak demand times, improving efficiency.

The recent introduction of dynamic tolling along Interstate 66 in Northern Virginia offers an example of how congestion pricing can improve travel times and raise revenues for transportation projects. Preliminary figures from the Virginia Department of Transportation indicate that morning rush-hour tolls averaged between \$8.20 and \$12.87 for the 10-mile segment but that peak tolls reached \$40.00 for a short time. Further, travel speeds in the tolled lanes were far higher than during a comparable period a year earlier, and travel speed in the non-tolled lanes as well as parallel roadways were similar or improved.

While efficiency (or surplus) is enhanced by such policies, it is possible that congestion pricing may make some drivers worse off, particularly low-income drivers who may be priced out of the tolled lanes (CBO 2009). Using toll revenues to improve other travel options, particularly transit, can counteract this distributional effect, but most discussions of congestion pricing acknowledge its potential to create both winners and losers from the policy. Even so, the lack of appropriate congestion pricing mechanisms creates winners and losers as well, and some evidence suggests that at least some low-income drivers in practice find tolled lanes worth paying for (Federal Highway Administration, n.d.).

More evidence on distributional effects comes from studies of California's State Route 91 tolled express lanes, which show that at any given time about 25 percent of the vehicles in toll lanes belong to high-income individuals, while the remaining 75 percent are low and middle-income commuters. Based on research conducted by the state of California, pricing schemes do not necessarily disadvantage low-income individuals. Assessments of State Route 91 has found that low-income drivers do use express lanes and are as likely to endorse the use of express lanes as drivers with higher incomes. As a matter of fact, over half of commuters with household incomes under \$25,000 a year approved of providing toll lanes (Department of Transportation, 2000).

Furthermore, Hall (2015) shows that congestion pricing can be Pareto-improving, not just potentially Pareto-improving, especially under conditions of bottleneck congestion, which

occurs when the number of vehicles that can use the road per unit of time (its “throughput”) decreases. Bottleneck congestion occurs when traffic backs up at an exit ramp, slowing down through traffic on the roadway. Tolling a portion of the highway’s lanes (value pricing) serves to internalize both motorist travel time externalities as well as these bottleneck effects, raising speeds on both the tolled and nontolled highway segments. When drivers differ in terms of income and valuations of their time, partial time-varying tolls will raise welfare for drivers along both the tolled and nontolled segments as long as high-income drivers use the highway during rush hour. Under the policy, drivers “sort” into the road segments and are better off, even before accounting for how toll revenues are spent.

A different variation on congestion pricing comes from San Francisco, which in 2011 established a pilot program, *SFpark*, in which 25 percent of city-controlled parking spaces had parking rates that varied as demand for parking changed over time. This demand-responsive pricing structure was intended to increase parking availability and decrease congestion due to drivers “circling the block” to find a parking space. An early project evaluation of the pilot (SFMTA 2014) found that the amount of time in which parking occupancy rates hit the target range of 60 to 80 percent rose 31 percent in pilot areas, compared with an increase of only 6 percent in control areas. Further, the amount of time in which blocks had 90 to 100 percent occupancy, so were “too full” to accommodate new arrivals, decreased 16 percent in pilot neighborhoods, while increasing 51 percent in control areas. The project evaluation also reported that greenhouse emissions decreased, traffic speed improved, and net parking revenues rose slightly. Even sales taxes grew more in pilot areas compared with controls, though the study could not rule out the difference was due to other factors distinguishing pilot from control areas. After continued experimentation with this approach, the city has now implemented dynamic pricing city wide, so that rates on all city-controlled parking spaces will vary based on demand.

Finally, CEA notes that congestion or “peak load” pricing has long been successfully used by public transit systems in many cities across the United States, and other infrastructure assets offer plentiful opportunities to implement similar pricing structures. For example, the FAA issued a proposed rule in 2015 which would have established a secondary market for airport landing slots at Kennedy, LaGuardia, and Newark airports, though withdrew the proposal in 2016. Under the proposed rule, carriers would have been allowed to buy, sell, lease, and trade slots.

On balance, these examples suggest that using time-varying prices to allocate access to scarce public assets—such as roads, on-street parking spaces, or landing slots at airports—can have positive impacts on welfare and economic activity and would make any given infrastructure investment program that much more productive.

## 2. Regulatory and Environmental Review Processes

Complaints and concerns about conflicting, unduly complex, and uncoordinated rules and regulations governing infrastructure investment have been expressed by many observers. Implementing a more efficient and streamlined regulatory and environmental review process can speed up the benefits of that improved infrastructure in terms of time savings, health benefits, and business activity. Howard (2015) estimates that the costs of six-year long delays in getting infrastructure projects completed costs the American economy \$3.7 trillion, and the ASCE (2016) estimated that failure to bring the nation's infrastructure to a state of good repair would impose GDP losses of almost \$4 trillion in GDP by 2025, as business costs rise, productivity falls, and employment and disposable incomes fall as well.

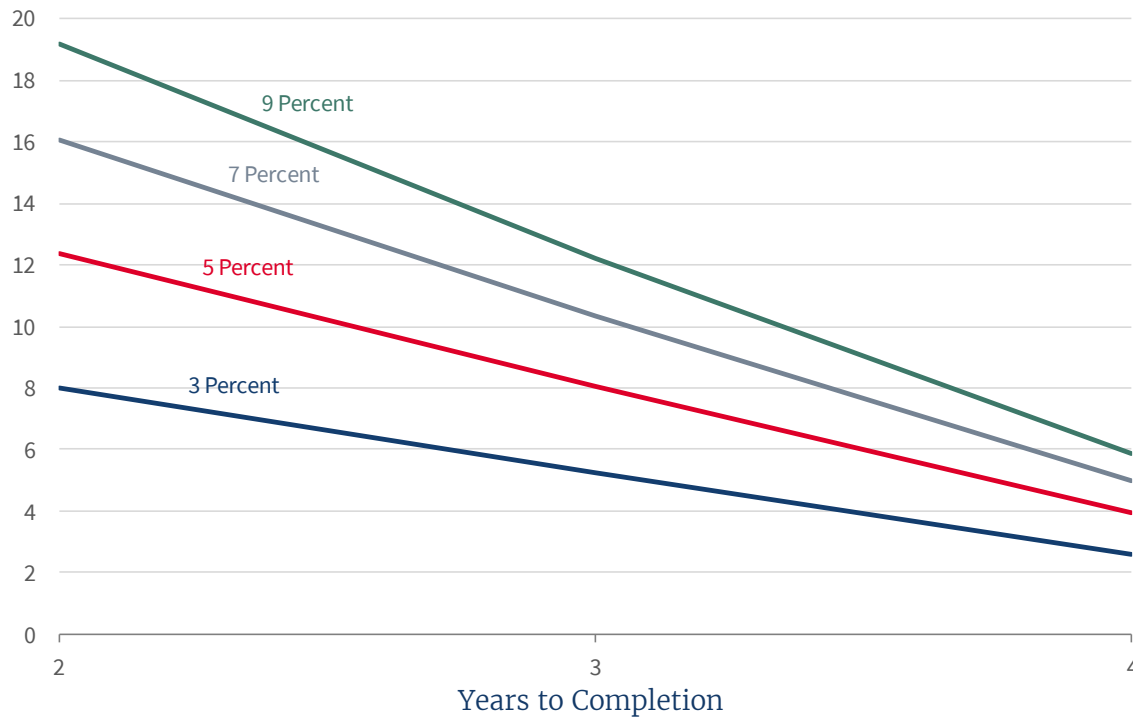
Lengthy project completion times, whether planned or not, can result in increased construction costs, additional financing costs, and other business costs. However, the key costs associated with lengthy project completion times come in the form of delayed enjoyment of the benefits or value that the infrastructure would have provided had it been brought into service sooner. These delayed benefits can include time savings, fuel cost savings, health benefits, shipping costs—any number of positive impacts whose receipt is delayed. Consider a project that delivers \$X in benefits in perpetuity starting in year 0; that project's present value is  $\$X(1 + 1/r)$ , where  $r$  is the discount rate. A delay of one year in the project means benefits are not realized until year 1, lowering the present value to  $\$X/r$ . The difference in those present values,  $\$X$ , represents the cost of the one year delay.

In this example, the value of reducing the time needed for project completion depends on the underlying present value of benefits generated by the project; the reduction in completion time; and the discount rate. For example, as detailed further below, the average time needed to complete a final Environmental Impact Statement (EIS) has risen and now exceeds 5 years. Reducing the average time from 5 years to 2, 3, or even 4 years would add value, as benefits are received earlier than under the status quo. Continuing our simple example, Figure 5 shows that reducing the time needed for project completion from 5 years to 2 years generates an 8.0 percent increase in value at a 3 percent discount rate, but a 19.2 percent in value at a 9 percent discount rate. At higher discount rates, the delay in receiving benefits is very costly in present value terms.

In the rest of this section, we discuss Federal regulatory review requirements and processes and present recent estimates of the length of time needed for some of these processes. The limited evidence available suggests that permitting and review processes are taking increasingly long periods of time to complete, extending the length of time between the start of a project and its completion. CEA notes that several recent Federal actions have begun to move in this direction, including President Trump's August 15, 2017, Executive Order 13807 to reduce unnecessary delays and barriers to infrastructure investment.



**Figure 5. Value of Reducing Time to Completion from Current Levels**  
(Percent of Project's Present Value)



Source: CEA calculations.

### A. The Infrastructure Investment Process

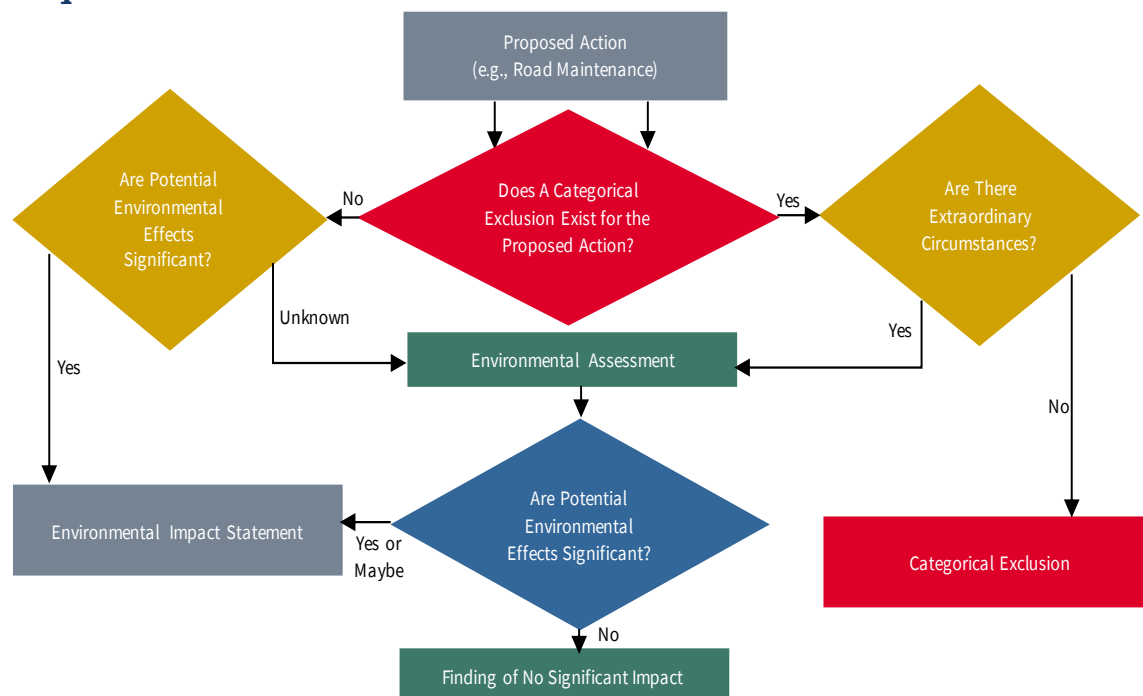
It is important to note that Federal regulatory requirements are complex and often include the need for project sponsors to apply for and receive one or more permits in order to move forward with a project. State and local governments also establish and enforce their own regulatory requirements, so there is no “one source” of regulatory authority and no “one type” of environmental review. That said, GAO (2014) describes the basic process by which Federal agencies meet their obligations under the National Environmental Protection Act (NEPA), depicted in Figure 6 below.

The Federal environmental process for infrastructure projects typically involve multiple Federal agencies. For instance, with respect to a highway project using Federal grant funds made available from the Federal Highway Administration (FHWA), the FHWA, as the primary funding agency, would have to comply with NEPA by analyzing the environmental impacts of the project and issuing the appropriate NEPA decision through a categorical exclusion determination, finding of no significant impact, or record of decision. However, depending on the impacts of the project, other agencies may have to issue permits in order for the project to be fully authorized under Federal law, and each of those determinations would also be subject to a NEPA review by that agency. Also, if the project involves funding from any other agencies, then those agencies must also comply with NEPA. As such, the full federal environmental and



permitting process for infrastructure projects involves many activities, studies and processes that occur prior to the initiation of one agency’s NEPA process and continue after that agency’s NEPA process has concluded—meaning that the overall time needed for project completion exceeds the time needed to complete the NEPA process. The NEPA process is overseen by the Council on Environmental Quality (CEQ), part of the Executive Office of the President.

**Figure 6. Process for Implementing National Environmental Policy Act Requirements**



Source: U.S. Government Accountability Office.

In brief, NEPA requires that Federal agencies evaluate the potentially significant environmental impacts of proposed projects, with requirements to consider ecological, aesthetic, historic, cultural, economic, social, and health effects (GAO 2014, p. 3). The initial step is typically to determine whether a Categorical Exclusion (CE) applies, in which case no further analysis is needed. If a CE does not apply, then the lead agency must complete either an Environmental Assessment (EA) or an Environmental Impact Statement (EIS). If an EA is conducted and an agency determines that the proposed project would have no significant impact (“Finding of No Significant Impact”, or “FONSI”), the review process is complete. If, however, the agency determines that there may be significant potential effects, then the agency must prepare the more thorough EIS, which typically include a draft EIS, which is published and is used to solicit comments and input from relevant stakeholders, followed by a final EIS. Agencies can skip the EA and move directly to EIS.

In practice, little systematic data are available on the number and varieties of analyses undertaken by Federal agencies under NEPA. According to the GAO (2014, p. 7):

“Government-wide data on the number and type of most NEPA analyses are not readily available, as data collection efforts vary by agency....Agencies do not routinely track the number of EAs or CEs, but CEQ estimates that EAs and CEs comprise most NEPA analyses. EPA publishes and maintains government-wide information on EISs.”

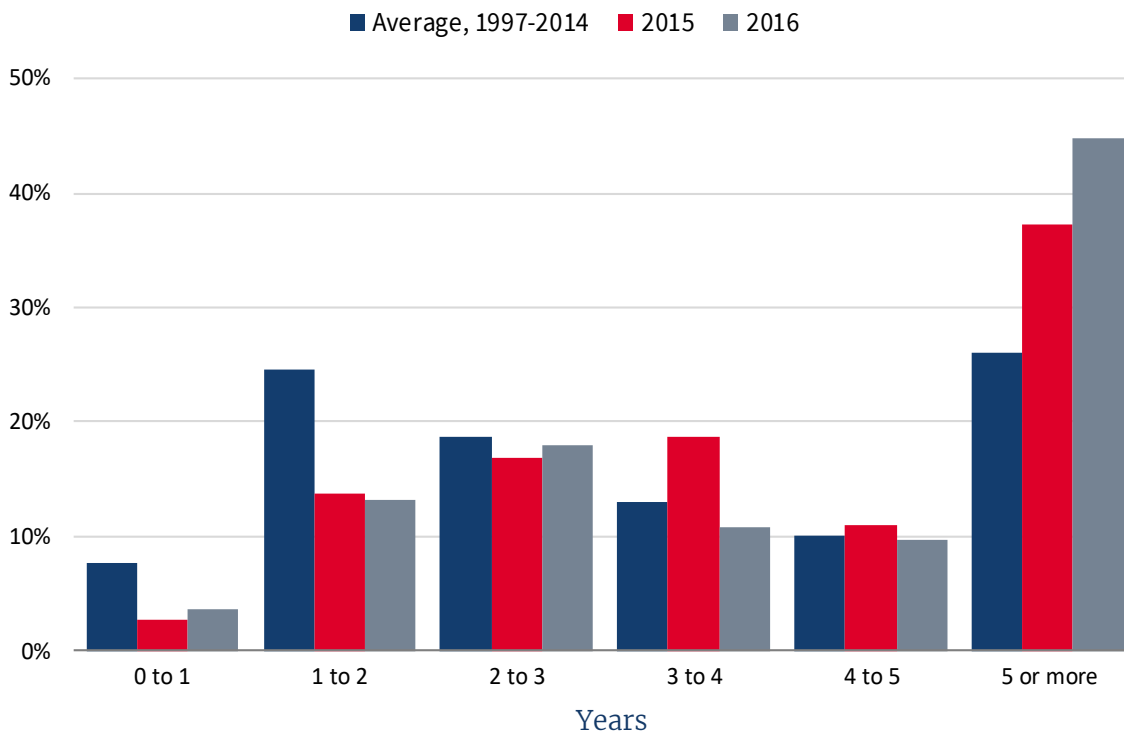
Specifically, CEQ estimates that about 95 percent of NEPA analyses are CEs, less than 5 percent are EAs, and less than 1 percent are EISs. In other words, by far the greatest share of proposed projects are *not* subject to extensive and exhaustive reviews likely to take significant resources and time to conduct. As a share of project dollars, however, EAs and EISs may be more important, as larger projects are, other things equal, more likely to generate significant impacts relevant under NEPA.

Conducting the required analyses and preparing these reviews can be costly and take many years (GAO 2014; NAEP 2016), but limited specific data are available. GAO (2014, p. 15) reports some agency-specific figures: for example, the average (median) time needed to complete EAs by the Department of Energy was 13 (11) months in the 12 months ending March 31, 2013, and the Forest Service took an average of about 18 months to complete its 501 EAs in fiscal year 2012. Completing CE determinations may take significantly less time than EAs, with reported figures ranging from 1 or 2 days (Department of the Interior’s Office of Surface Mining) to nearly 180 days (Forest Service).

While CEs and some EAs may be straightforward and take little time to conduct, the average number of years needed to complete a Final Environmental Impact Statement (EIS) has risen over time, reaching 5.1 years in 2016, up from 4.7 years in 2014 (NAEP 2016). In 2016, almost 45 percent of all final EIS issued that year had taken five or more years to complete (from the date of Notice of Intent to the date on which the final EIS was issued) (Figure 7).

Some additional data on length of time needed for environmental reviews comes from the Federal Highway Administration (FHWA) and the GAO (2014, p. 10), which reported that complex and expensive highway projects are likely to require EIS, with a median completion time of over 7 years. EAs take less time to complete, ranging from 14 to 41 months, and CEs can be done even more quickly, averaging 6 to 8 months. The FHWA estimated that in 2009, most (96 percent) federal-aid highway projects required only a CE, with EAs and EISs accounting for 3 percent and 1 percent of projects, respectively. However, as mentioned above, the share of projects by dollar value requiring an EIS would likely be significantly higher than 96 percent. FHWA (2012) reports that CEs comprised between 90 and 90 percent of NEPA decisions, based on a 2012 survey of 522 agencies regarding NEPA actions since 2005.

**Figure 7. Years from Notice of Intent to Final EIS, 1997–2016**  
(Percent)



Sources: National Association of Environmental Professionals, Annual NEPA Report, 2015, 2016; CEA calculations.

### *B. Permitting Requirements*

One specific and common project need is to obtain a permit from the U.S. Army Corps of Engineers under Section 404 of the Clean Water Act. Ulibarri’s (2016) preliminary study of a sample of permits for projects in California finds that the average number of days for a permit decision is 427, with a median value of 314. That study also found that projects requiring multiple permits did not experience increases in time needed for a decision, but projects requiring consultation under Section 7 of the Endangered Species Act did, in fact, see an increase in the number of days needed for the USACE’s permitting decision. Projects proposed by public agencies (state or federal government) were also more likely to receive permits quickly relative to a business or nonprofit organization.

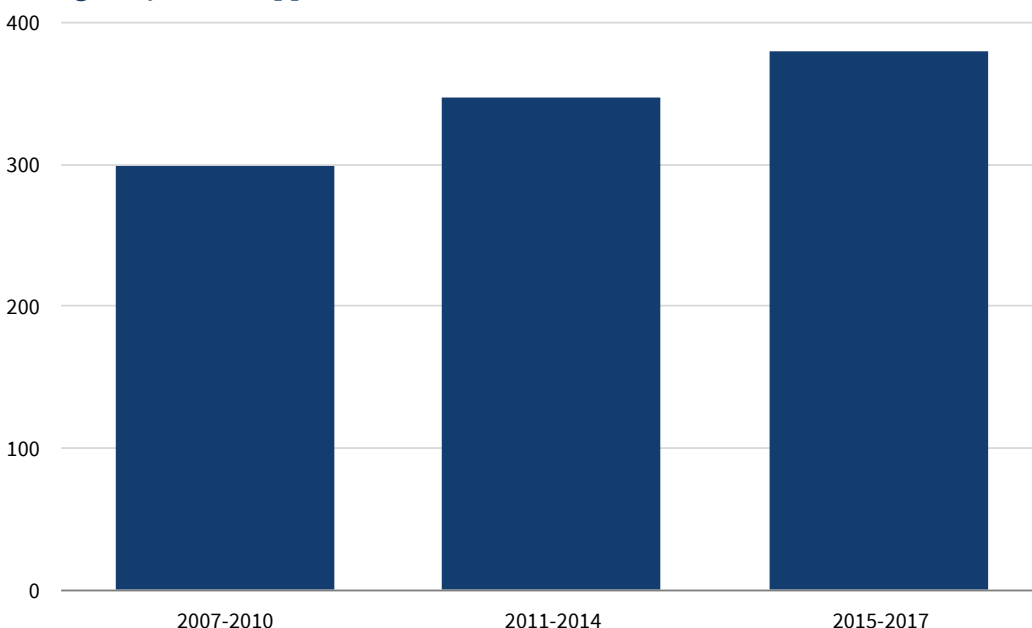
Environmental reviews and studies take time to conduct, and project sponsors know this, hence plan accordingly when assembling a project timeline. However, delays can and do happen, though such delays are not always due to permitting problems. For example, one recent industry study of highway projects in Texas between January 2012 and March 2014 (Beaty et al. 2016) found that environmental clearance problems accounted for 14.2 percent of projects in the pre-construction phase; this compares with 10.7 percent of projects delayed for funding problems. The authors reviewed 282 delayed projects and reported that projects with

environmental clearance delays at the district level had average delays of 243 days, or 8.1 months, but a median of only 4.5 months.

The energy sector also offers multiple examples of projects for which permitting and environmental review concerns and potential delays are salient. Firms wishing to build pipelines for natural gas must submit applications to the Federal Energy Regulatory Commission (FERC). Data on such applications suggests that the time needed to approve such applications has increased over time: applications approved in 2007-2010 took at an average of 299 days to approve; by 2011-2014, that average had risen to 348 days; and over the 2015-2017 period, rose even further to 380 (Figure 8).

### **Figure 8. Time for Pipeline Permit Approval, by Period of Initial Filing, 2007–2017**

(Average Days from Application Date to Permit Issue)



Source: Federal Energy Regulatory Commission, Pipeline Approvals, CEA calculations.

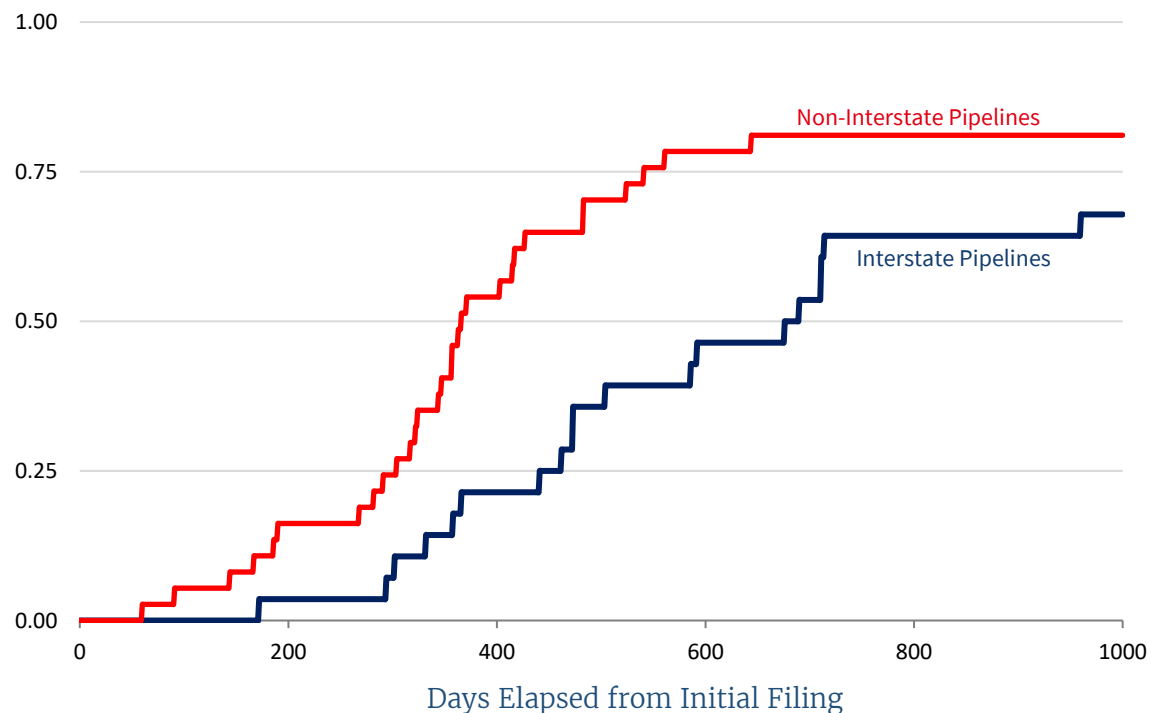
These figures do not reflect applications that have been filed but are still open, or pending. FERC’s data indicate that 65 permit applications were filed in calendar year 2015; of those 65, 49 had been approved by October 31, 2017, while the remaining 16 remained under review. Using the Kaplan-Meier nonparametric estimate of survival time in the presence of censoring, we estimate the median number of days until approval to be 472 days, meaning that half of all applications have been approved by then.

While many factors likely affect the time needed to consider and ultimately approve a given pipeline permit, one factor may be the number of different jurisdictions affected by the proposed project. The FERC data indicate whether a proposed project crosses state

boundaries, and in fact, we find that interstate projects do have significantly longer approval times. Figure 9 below shows the estimated cumulative probability of approval over time functions for interstate projects (N = 28) and within-state projects (N = 37), and a log-rank test of the hypothesis that the two groups have the same survival function (cumulative probability of approval) suggests the difference is statistically significant at the .05 significance level.

### Figure 9. Kaplan-Meier Estimated Probability of Approval for Applications Filed in 2015

(Cumulative Probability of Approval)



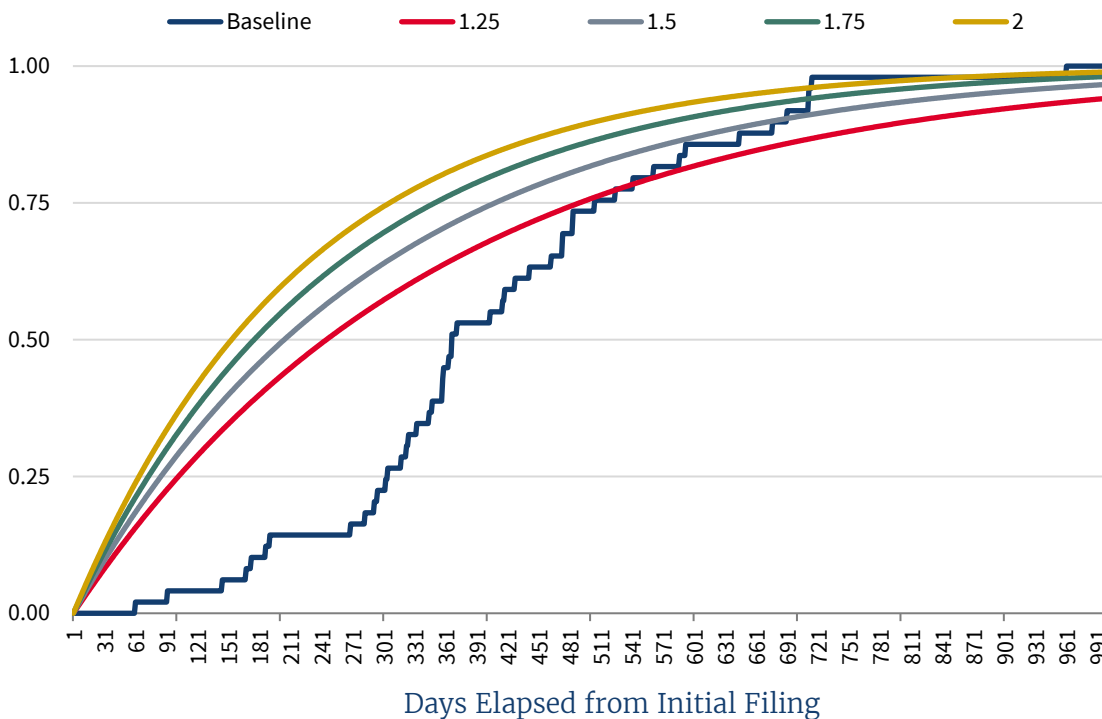
Source: Federal Energy Regulatory Commission and CEA calculations.

We can also use these data to investigate the impact of speeding up permit approval times. Figure 10 plots the baseline cumulative probability of approval along with alternative paths based on an exponential decay hazard model fit with constants calibrated to the underlying FERC data. Speeding up the approval process would lead to more pipeline projects being brought into service sooner.

We cannot assess the value of speeding up permit approvals in this setting, as we lack information on size, capacity, revenue or profit generation, or other measures that reflect the value of bringing these assets into productive service sooner rather than later. Furthermore, CEA notes that the optimal time needed will reflect a balance between the benefits of speedier project approval and its potential costs (perhaps arising from a less-thorough or comprehensive analysis) at the margin. A 30-day increase in time needed for a large, valuable project may be more costly than a 60-day increase for a smaller, less valuable project. However,

Figure 11 below shows the impact of speedier approval times on the number of pipeline-days in service, which is essentially a quantity measure representing the additional infrastructure availability gained over a given permitting period due to the improved processing speeds. Over a 1,000 day horizon, CEA estimates that doubling the speed of the permitting process would increase total potential capacity of the project available over the period of development period by 32 percent.

**Figure 10. Improvement in Permitting Speed vs. Expected Time to Permit Approval in 2015, by Improvement over Baseline**  
(Cumulative Probability of Approval)



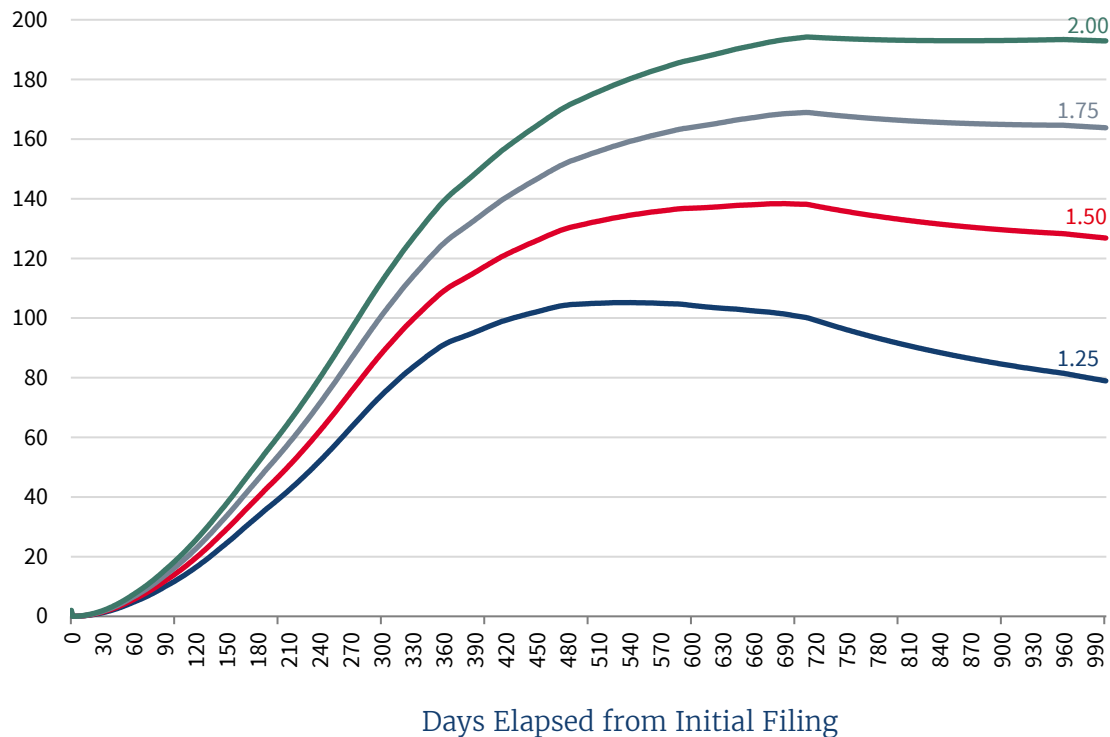
Source: Federal Energy Regulatory Commission.

Note: Data are all pipeline filings submitted to FERC in calendar year 2015 receiving approval by FERC's latest 2017 review.

On balance, then, CEA's review of available evidence suggests that the value of reducing project completion times can be considerable. Streamlining and simplifying the many environmental and regulatory review processes that affect the ability of investors to start and complete projects in a timely fashion will mean earlier enjoyment of the benefits those projects can deliver.

## Figure 11. Incremental Number of Pipeline-Days Gained Through Faster Permitting Process, by Improvement over Baseline

(Net Days of Functionality Gained over Baseline Permitting Speed)



Source: Federal Energy Regulatory Commission.

Note: Data are all pipeline filings submitted to FERC in calendar year 2015.

### 3. Infrastructure Investment, Employment, and the Labor Market

In addition to raising U.S. productivity and competitiveness, a boost to infrastructure spending would increase labor demand for workers with infrastructure-related skills, and we discuss the characteristics of these workers more fully in this section.

#### A. Impact on Demand for Labor

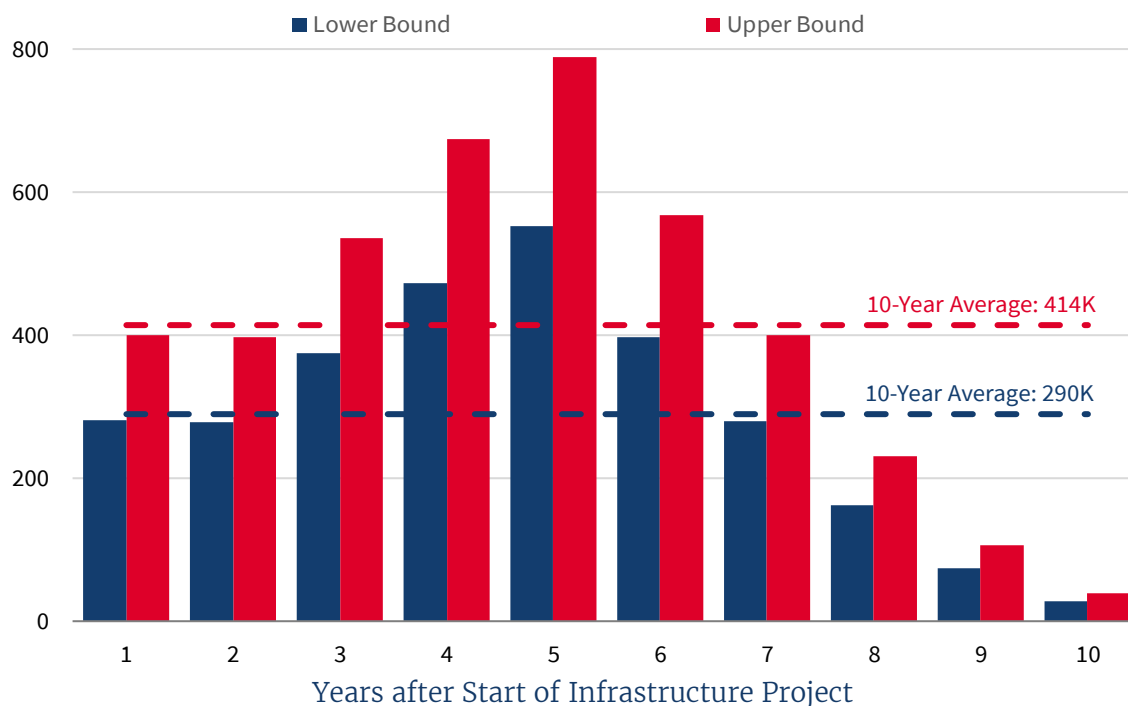
Increased investment in the country's infrastructure will result in an increase in the employment of infrastructure workers. Using the GDP estimates from Section 1B above, we estimate the change in infrastructure employment resulting from an additional \$1.5 trillion spent on infrastructure over a period of 10 years. Our estimates are based on the increase in GDP that results from the spending itself, ignoring any employment responses to higher levels of installed public capital and any employment multipliers to other sectors. The lower bound of the estimated employment range reflects GDP impacts under the assumption of crowd-out and the upper bound assumes no crowd-out. In addition to the crowd-out parameters, the net employment effect of the spending package will also depend on any multipliers, on the

available labor supply when the spending is enacted, and on the reduction in economic activity that accompanies either deficit spending or the revenue generation needed to fund the investment. Thus, the increase in infrastructure employment estimated below may be partially, or even fully, offset by job losses elsewhere in the economy, depending on these effects.

The estimated increase in infrastructure employment is shown in Figure 12 below. Over the 10 year period, we estimate an average infrastructure employment effect of 290,000 to 414,000 jobs, depending on the parameters above. These estimates are an increase relative to the baseline level of infrastructure employment that would otherwise have occurred, and the employment effects end when the spending ends after year 10.

**Figure 12. Additional Infrastructure Employment in Each Year, Relative to Baseline**

(Number of Jobs)



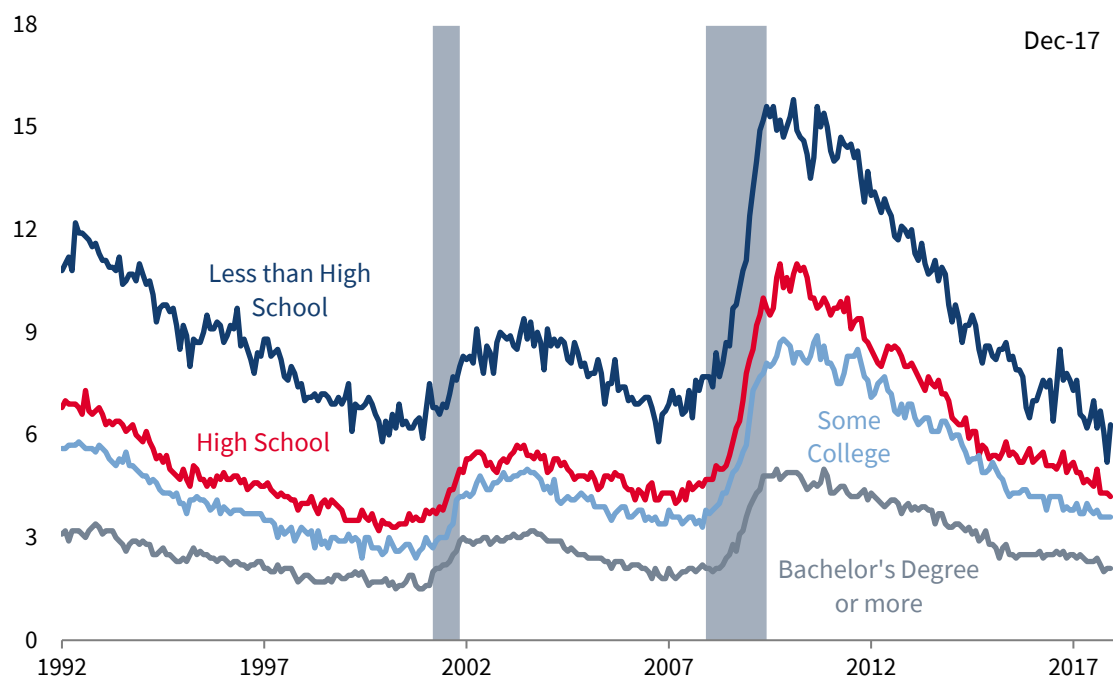
Source: CEA calculations.

Expanded infrastructure spending, and the jobs it entails, is likely to disproportionately favor particular segments of the population. In February 2018, only 4.1 percent of U.S. labor force participants reported being without a job. But the rate is substantially higher for workers with less education, a trend that is apparent as far back as the collected series extends (1992). Although the group with the fewest years of education reached a series low unemployment rate in 2017, as of December, workers without a high school degree still had unemployment



rates 4.2 percentage points higher than workers with a bachelor’s degree, 6.3 and 2.1 percent, respectively. Labor force participants with a high school degree but no college work had unemployment rates of 4.2 percent in that month. Figure 13 shows the unemployment rate by education level in the United States since 1992, when the series began.

**Figure 13. U.S. Unemployment Rate by Education Level, 1992–2017**  
(Percent)



Source: Bureau of Labor Statistics.  
Note: Series begins in January 1992.

### B. Characteristics of Infrastructure Workers

To investigate the differential impact of enhanced infrastructure spending on different educational attainment groups, we define a list of “infrastructure occupations” and provide worker characteristics for all U.S. labor force participants in these occupations. A version of this exercise, published in 2015 by Kane and Puentes, identifies a list of Census-defined 4-digit North American Industry Classification System (NAICS) industry codes that are infrastructure-related based on their definition of national infrastructure (Kane and Puentes 2015). Their list includes industries that might benefit indirectly from improved infrastructure (for example, freight transportation arrangements or rail transportation) but would not experience a direct increase in economic activity from increased infrastructure spending. We identify a much narrower list of 4-digit NAICS industry codes that would be the direct beneficiaries of additional infrastructure spending likely to receive Congressional approval, dubbing these “infrastructure industries.” The industry codes covered include 4-digit NAICS sectors related to heavy and civil engineering construction (all sectors falling under NAICS 3-digit code 237000), including utility

system construction along with highway, street, and bridge construction, other specialty trade contractors (NAICS code 238900), and remediation and other waste management services (NAICS code 562900), including former industrial site cleanup. We then use National Employment Matrix data for 2016 from the Bureau of Labor Statistics (BLS) on the occupation distribution within these industries to define a set of occupations which comprise more than 1 percent of employment in at least one of these industries. The resulting set of 47 occupations is refined further to exclude management occupations; job tasks for management occupations are at least somewhat scalable, and employment in these occupations is more likely to be fixed even under expanded economic activity in infrastructure construction.

The final defined set of “infrastructure occupations,” 31 in total (see Table 1), includes workers who design and carry out infrastructure projects, including engineers, pipefitters, construction laborers, etc. But it also includes transportation and warehousing occupations, along with workers in installation, maintenance, and repair occupations. The list includes occupations for which infrastructure industries comprise the majority of employment, along with occupations for which infrastructure industries represent a small proportion of the overall industry structure of employment.<sup>6</sup> For example, both paving, surfacing, and tamping equipment operators and pipelayers are overwhelmingly employed in the NAICS 3-digit heavy and civil engineering construction sector, while electricians and plumbers are largely employed elsewhere (in residential and building construction, for example) but nevertheless are critical for the successful completion of infrastructure projects. Similarly, our occupation list includes civil engineers although only a small share of civil engineers are directly employed in the infrastructure sectors defined above.<sup>7</sup> Of course, the set of occupations ultimately affected by expanded infrastructure investment would depend on the particular set of investments undertaken in any infrastructure legislative package, and the analysis in this report reflects current infrastructure employment, not necessarily the footprint of future employment.

In 2016, the infrastructure occupations defined by this algorithm represented 1.2 million workers in the defined set of infrastructure industries out of a total of 1.7 million workers in these industries. Economy-wide, 13.8 million workers reported these as primary occupations. Table 1 contains a list of defined infrastructure occupations and their broad occupation categories, and Figure 14 shows the distribution of these workers across broad categories.

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<sup>6</sup> An alternative exercise would define “infrastructure occupations” as those where a majority of employment is in an infrastructure industry. The conclusions in this report are remarkably similar under this alternative definition. See also Kane and Puentes (2015), but note that the wage premia calculations in that report do not control for gender and are, therefore, higher than those presented here.

<sup>7</sup> A much larger number are employed in services industries, which would also experience increased demand with expanded infrastructure. The 4-digit NAICS code encompassing engineering services is architectural, engineering, and related services. Given this broad set of activities, this 4-digit category was not included in our list of direct beneficiaries of an infrastructure package; civil engineering establishments are not separately identifiable. Civil engineers, however, are an infrastructure occupation as defined above.

Nearly a million infrastructure workers were employed in construction and extraction occupations in our defined set of infrastructure industries in 2016 while 156,700 hold transportation and material moving jobs. The remainder are employed in installation, maintenance and repair, business and financial occupations (in particular, cost estimators), production, and architecture and engineering jobs.

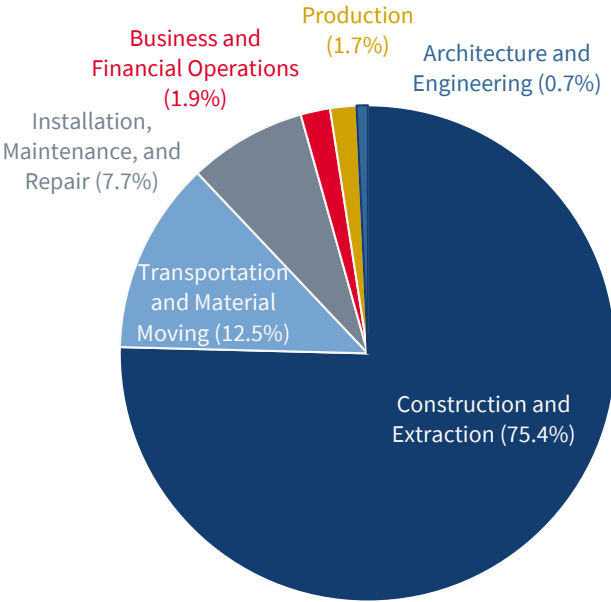
**Table 1. Infrastructure Occupations by Broad Category**

Installation, Maintenance and Repair	Construction and Extraction	Transport and Material Moving	Business and Financial Operations
First-line supervisors of mechanics, installers, and repairers	First-line supervisors of construction trades and extraction workers	Heavy and tractor-trailer truck drivers Light truck or delivery services drivers	Cost estimators
Mobile heavy equipment mechanics, except engines	Carpenters	Crane and tower operators	Architecture and Engineering
Electrical power-line installers and repairers	Cement masons and concrete finishers	Excavating and loading machine and dragline operators	
Telecommunications line installers and repairers	Construction laborers	Laborers and freight, stock, and material movers, hand	Civil engineers
Maintenance and repair workers, general	Paving, surfacing, and tamping equipment operators	Refuse and recyclable material collectors	Production
	Pile-driver operators		Welders, cutters, solderers, and brazers
	Operating engineers and other construction equipment operators		
	Electricians		
	Pipelayers		
	Plumbers, pipefitters, and steamfitters		
	Fence erectors		
	Hazardous materials removal workers		
	Highway maintenance workers		
	Rail-track laying and maintenance equipment operators		
	Septic tank servicers and sewer pipe cleaners		
	Earth drillers, except oil and gas		
	Roustabouts, oil and gas		

Source: BLS Occupation-Industry Matrix; CEA calculations.

Worker characteristics are obtained from the Current Population Survey (CPS), which provides demographic information on the American population along with the stated occupation of both employed and unemployed workers. Using the monthly CPS public use files for 2017 from Integrated Public Use Microdata Series (IPUMS)-CPS, we compare the demographic characteristics of labor force participants with infrastructure occupations to those reporting other occupations in the survey.

**Figure 14. Distribution of 1.2 Million Infrastructure Workers in Infrastructure Industries, 2016**



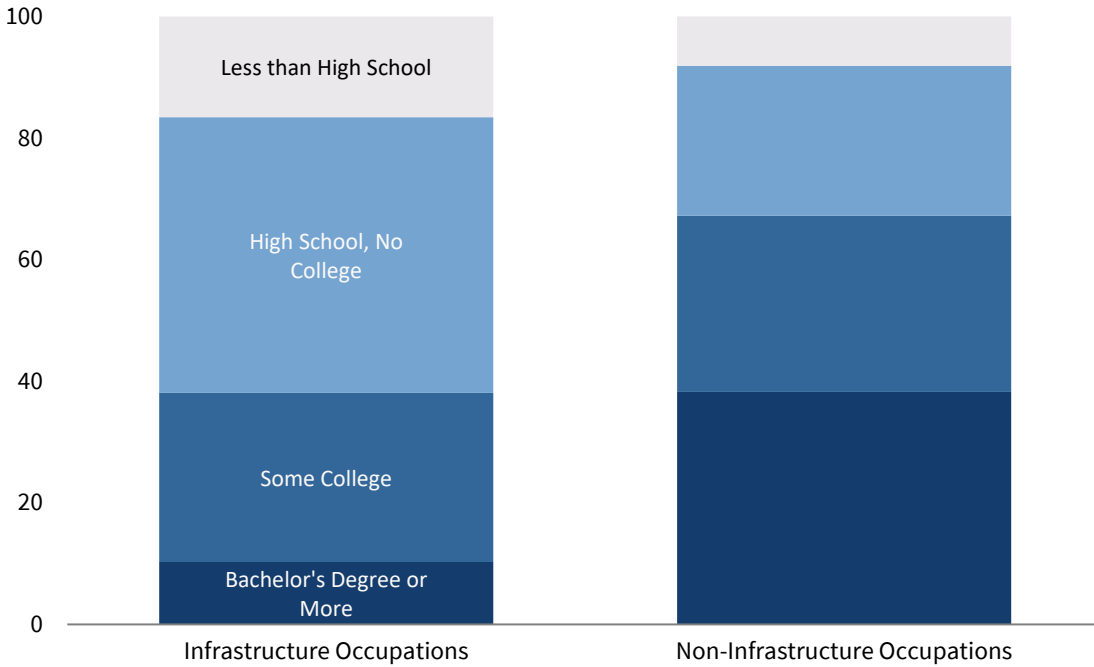
Sources: BLS Occupation-Industry Matrix; CEA calculations.

Note: Job titles reflect 2010 Standard Occupational Classification (SOC) codes. For CPS analysis purposes, these occupation codes are converted to CPS/Census coding using a crosswalk provided by BLS Office of Occupational Statistics and Employment Projections.

The education composition of the infrastructure labor force differs notably from the labor force at large; workers with less education are disproportionately employed in infrastructure occupations (Figure 15). 62.0 percent of infrastructure workers in 2016 had a high school degree or less, compared with 32.4 percent of the non-infrastructure labor force. Infrastructure occupations and non-infrastructure occupations had a similar share of workers with some college coursework but without a 4-year bachelor’s degree. Correspondingly, the share of infrastructure occupation workers with a bachelor’s degree in 2017, 10.6 percent, was less than one-third the rate for non-infrastructure occupation workers, 39.1 percent.

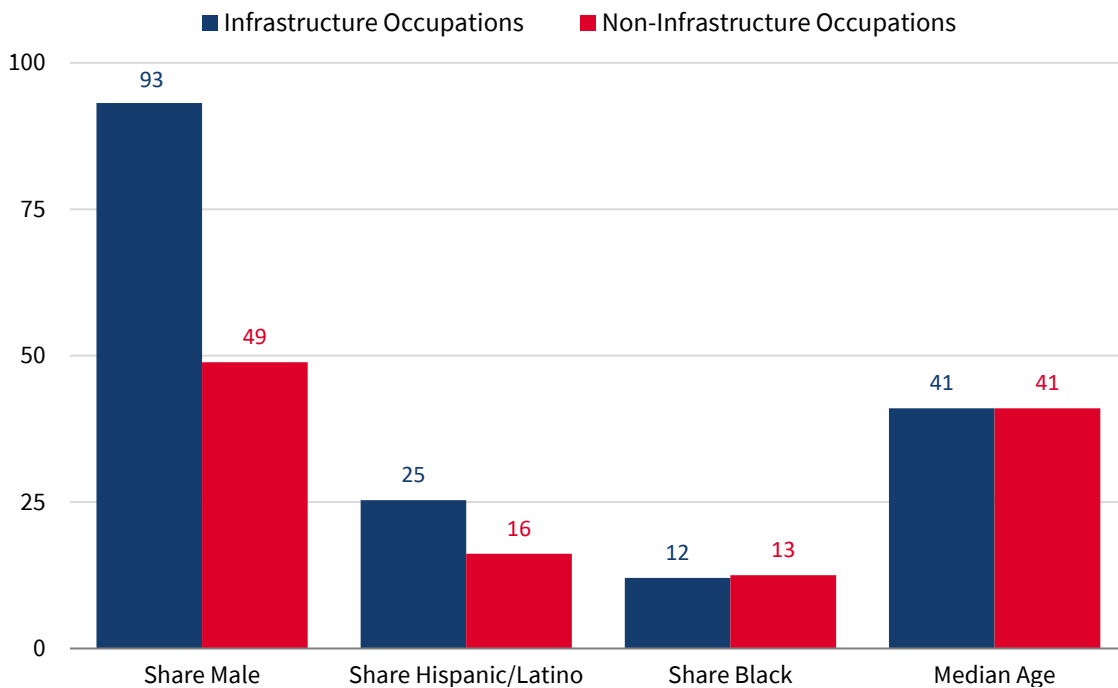
Additional characteristics of infrastructure occupation workers indicate a labor force comprised mainly of men and with an age distribution similar to the labor force at large (Figure 16). While 49 percent of the U.S. labor force outside of infrastructure occupations is male, 93 percent of infrastructure occupation workers are male. Hispanics are over-represented in the infrastructure labor force by approximately nine percentage points, while blacks are slightly under-represented. Both differences are statistically significant. The age distribution is similar between the infrastructure and non-infrastructure labor forces; the median age for both groups is 41.

**Figure 15. Educational Attainment, 2017**  
(Percentage of Labor Force Participants)



Sources: Current Population Survey; CEA calculations.

**Figure 16. Gender, Race, Ethnicity, and Age, 2017**  
(Percentage of Labor Force Participants)



Sources: Current Population Survey; CEA calculations.

### *C. Pool of Available Infrastructure Workers*

To estimate potential worker availability for future infrastructure projects, we begin by tabulating employment status in the Current Population Survey (CPS) for 2017. The unemployment rate for experienced workers who reported having an infrastructure occupation was 6.1 percent compared with 3.8 percent for non-infrastructure experienced workers last year.<sup>8</sup> CPS tabulations indicate that the unemployment rate for infrastructure workers has been consistently higher than for all labor force participants since at least 2003, and the gap between the two has averaged 3.4 percent between 2003 and 2017. Still, the unemployment rate gap in 2017 between infrastructure and non-infrastructure workers was somewhat larger than the gap in each year between 2005 and 2007 when the aggregate unemployment rate had reached the lowest levels of the post-2001 business cycle. The difference in unemployment rates between infrastructure and non-infrastructure labor force participants in 2017, 2.3 percentage points, implies an excess supply of nearly 350,000 infrastructure workers who are not employed but are currently looking for a job. In other words, if infrastructure labor force participants had the unemployment rate of their non-infrastructure counterparts, nearly 350,000 additional infrastructure workers would be employed.

However, these 350,000 infrastructure workers may not be sufficient to meet the increased labor demand arising from an ambitious infrastructure investment program. Some of these workers are temporarily unemployed while on layoff from a quasi-steady job. Further, the geography and skill mix of these workers may not match the needs of expanded infrastructure activity. Thus, there may be a need to retrain unemployed workers previously employed in other sectors, new labor market entrants, and current labor force non-participants for careers in infrastructure occupations. The latter group, consisting of individuals who have dropped out of the labor force altogether, may be of special interest. Although labor market non-participation is multi-causal, declining demand for lower-skilled workers is frequently assigned some of the blame (CEA 2016b). Heightened demand for workers with less education, and the associated increase in wages, may draw additional workers into the labor force, particularly prime-aged men, whose recent labor force participation weakness has been dubbed the problem of the “missing” men.

In order to bridge the gap between the set of potential workers, including those currently in and out of the labor force, and the skill needs of infrastructure projects, the Federal government could reconsider the current restrictions on Pell Grant eligibility. These grants,

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<sup>8</sup> The crosswalk from SOC codes in the National Employment Matrix to occupation codes in the CPS files is not perfect, and the translation results in an over-definition of infrastructure occupations in the CPS due to aggregation of occupations in the CPS occupation codes. As a result, for 2016, we identify 14.9 million infrastructure workers in the CPS files compared to 13.8 million in the National Employment Matrix. The demographic characteristics and earnings premia presented in this report reflect the characteristics of this broader group.

which are generally only available to students without a bachelor’s degree and who are enrolled in programs with more than 600 clock hours of instruction over 15 weeks, do not provide support to workers who require shorter-term investments, as some infrastructure jobs would require. (See Section 5 for further discussion of licensing and credentialing in infrastructure occupations.) Workforce Innovation and Opportunity Act funds can be used for these short-term programs, but funds from this program are not dedicated to this purpose and are therefore subject to competing priorities. Although it would require Congressional approval, expanding Pell Grant eligibility to include investments in short-term training (or retraining) programs would help ensure workers are not kept from infrastructure work due to financial constraints.

#### **4. The Wage Premium for Infrastructure Workers**

Labor markets tend to reward educational attainment; bachelor’s degree holders have higher wages than workers with some college who, in turn, out-earn high school degree holders, on average. But there are other paths to higher wages other than formal education. For workers with fewer years of schooling, the skilled trades occupations needed in infrastructure work are one of those paths. To see this, we estimate an “earnings premium,” the additional income earned in infrastructure relative to non-infrastructure occupations, given a worker’s sex, race, and age. These premia are measured separately for workers with a high school degree or less (“No College”), for workers with some college degree but no bachelor’s degree (“Some College”) and for those with a bachelor’s degree, and we measure the premium at the 25<sup>th</sup>, 50<sup>th</sup>, and 75<sup>th</sup> percentile of the education-specific income distribution.

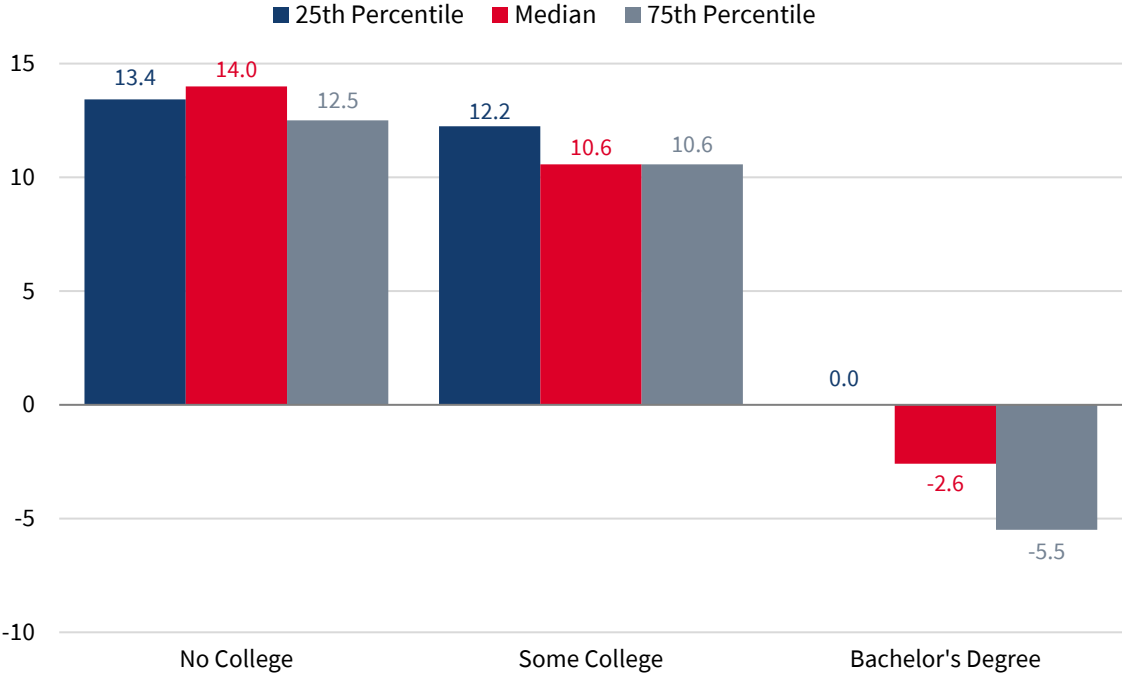
We begin by measuring hourly wage premia, the additional per-hour monetary compensation received by infrastructure workers after accounting for sex, race, age, and education level. These premia do not reflect any differences in non-monetary compensation, such as differences in benefits, and do not reflect differences in working conditions. Infrastructure occupations likely carry a higher risk of physical injury, and those risks are not accounted for in this exercise.

The results, contained in Figure 17, indicate a wage premium of 12 to 14 percent for infrastructure workers with a high school degree or less in 2016 and 2017. The premium is roughly the same across the wage distribution of these workers; at the median, infrastructure jobs provide a 14.0 percent hourly wage boost to workers in this lowest educational attainment

category.<sup>9</sup> The premium to infrastructure work is somewhat weaker for workers with some college, and workers with a bachelor’s degree tend to find higher-paying jobs in other sectors.

**Figure 17. Infrastructure Occupation Wage Premium by Income Quintile, 2016–2017**

(Wage Premium, Percent)



Sources: Current Population Survey; CEA calculations.

Note: Sample includes U.S. adults between the ages of 25 and 65. The earnings premium is estimated with a quantile regression, with the natural logarithm of annual earnings regressed on a binary variable indicating infrastructure occupations, sex, race, and age fixed effects. The coefficient on the infrastructure occupation indicator variable, converted to a percentage difference, is the median/25th/75th percentile wage premium.

The wage premium for infrastructure work is far more substantial in the set of occupations that encompass the skilled trades: engineers, equipment operators, vocational workers, and on-site managers.<sup>10</sup> To highlight the heterogeneous returns, we simultaneously estimate the median hourly wage premium for the set of skilled trade occupations and for all other infrastructure occupations, both measured relative to non-infrastructure occupations. The estimated hourly wage premium in the skilled trades is 31.7 percent (Figure 18). All other

<sup>9</sup> These premia for workers with a high school degree or less are smaller than those reported in Kane and Puentes (2014). Accounting for the gender of workers, as we do in these calculations, reduces the premia by up to 50 percent.

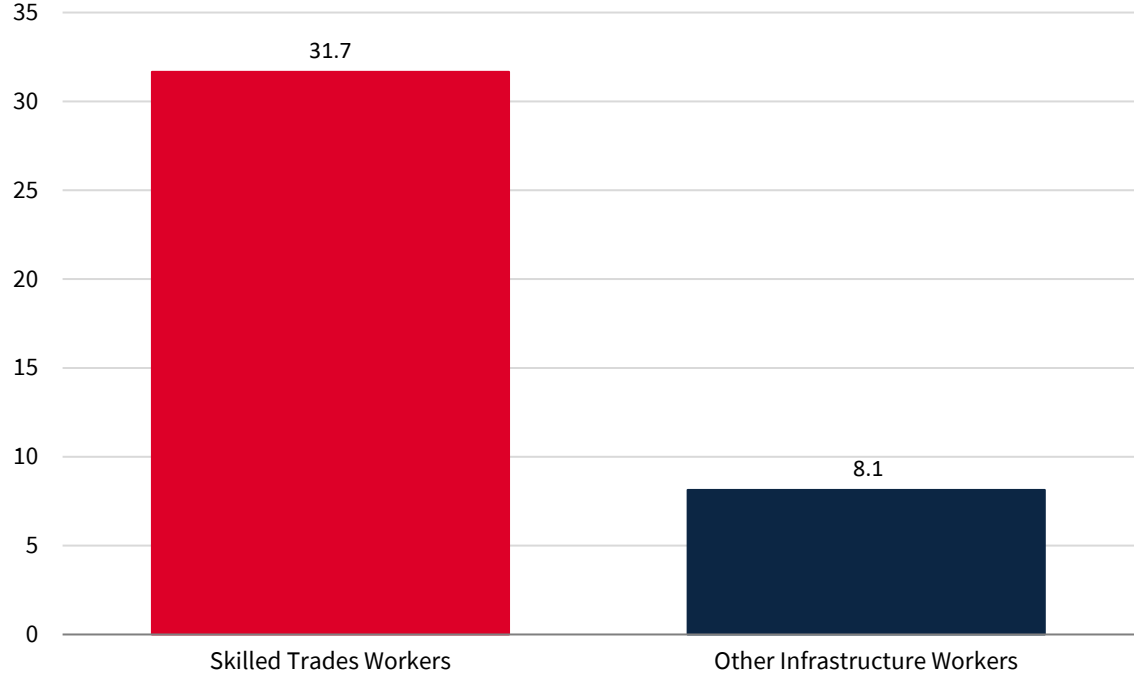
<sup>10</sup> Using the Standard Occupational Classification system, the occupation titles for what we deem skilled trades workers are cost estimators, civil engineers, first-line supervisors of construction trades and extraction workers, carpenters, electricians, plumbers, pipelayers and pipefitters, mechanics and heavy vehicle operators, first-line supervisors of mechanics, installers and repairers, welding and soldering workers, and crane and tower operators.



infrastructure workers earn a median hourly wage premium of 8.1 percent. Still the premia for both occupation categories are statistically significant at conventional levels (<1 percent). Again, each of these estimated median hourly wage premia account for gender, age, and race, and are only for workers who did not attend college.

**Figure 18. Median Earnings Premium for Workers with a High School Degree or Less by Occupation Category, 2016–2017**

(Wage Premium, Percent)



Sources: Current Population Survey; CEA calculations.

Note: Sample includes U.S. adults between the ages of 25 and 65. The earnings premium is estimated with a quantile regression, with the natural logarithm of annual earnings regressed on a binary variable indicating infrastructure occupations, sex, race, and age fixed effects. The coefficient on the occupation indicator variable, converted to a percentage difference, is the median wage premium.

In 2016, although infrastructure workers put in roughly the same number of hours each week as the economy-wide average, they worked, on average, one fewer week than other workers, potentially due to seasonality in work schedules or to weak labor demand. Survey responses in the CPS regarding the reason for work absences indicate that infrastructure workers were more than six times as likely to miss a week of work for slack work reasons than for weather. Further, in 2016, infrastructure workers were more than twice as likely to miss work due to a layoff, presumably reflecting weak demand, as were non-infrastructure workers.

As a result, infrastructure workers enjoy a smaller annual earnings premium than their hourly wage premium would indicate. Our estimate of the 2016 median *annual earnings* premium for infrastructure workers with a high school degree or less (8.5 percent) is still greater than half

the median hourly wage premium in 2016 and 2017 for these workers (14.0 percent, as in figure 17). Given the influence of weak demand on the number of weeks infrastructure workers worked in 2016, enhanced demand from increased infrastructure spending may serve to even out the work year for these workers, bringing annual earnings premia more in line with the premia in hourly wages.<sup>11</sup>

## 5. Occupational Licensing

Labor markets for public infrastructure projects are affected by a number of specific rules. First, workers in infrastructure occupations, much like the U.S. population at large, are frequently subject to occupational licensing which inhibits the flow of workers across states. Second, labor agreements and rules for publicly-funded projects, including the Federal Davis-Bacon Act and its local variants, affect the wages of infrastructure workers and may result in hiring processes that are skewed towards older, more experienced workers, making projects more costly. Finally, less-prevalent project labor agreements set the terms of employment between publicly-funded employers and workers in some states, including workers on Federal, State, and local projects. In addition to wages and benefits, these agreements may sometimes include mandates for union participation as a condition of employment on a public infrastructure project.

One impediment to filling newly created infrastructure jobs is the country's patchwork set of occupational licensing requirements. In 2017, 23.8 percent of all U.S. labor force participants reported having an active professional license or certification, while 21.2 percent of infrastructure labor force participants reported the same. Civil engineers, electricians, and pipelayers and plumbers had the highest licensing rate in 2017, with nearly 50 percent of workers in those occupations holding an active professional license or certification. Because these licenses are largely granted by states (rather than being nationally recognized), licensing inhibits the free flow of licensed workers across state boundaries to better match labor supply to labor demand (Johnson and Kleiner 2017). Unless the geographic footprint and skill needs of expanded infrastructure investments match the geographic distribution of currently unemployed infrastructure workers, some reshuffling of workers across state lines may be needed. The Federal government could encourage States to recognize out-of-state occupational licenses in order to facilitate the movement of labor across state boundaries, even if the recognition is only temporary. There is precedent for such an initiative; at the behest

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<sup>11</sup> These results are from the annual CPS-ASEC survey released in March. Data for 2017 are not currently available. Annual and hourly earnings premia may also differ due to sampling variation between CPS ASEC and monthly surveys.

of the Department of Defense, States have recognized occupational licenses issued in other states for military spouses, who frequently must move across state lines.<sup>12</sup>

## 6. Conclusion

This report has described the nation's infrastructure needs and the value of meeting them. An ambitious infrastructure investment program is estimated to raise welfare, increase GDP, and improve labor market opportunities and outcomes particularly for less educated workers. While the particular structure and details of the infrastructure program ultimately adopted will affect its subsequent future impacts, CEA believes the program's overall value will be considerable.

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<sup>12</sup> These waivers have been most frequent for teacher licenses, but licensure in healthcare occupations has also been included in some states.

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